

In [116]:

```
%reload_ext autoreload
%autoreload 2
from openscad2 import *
set_printoptions(suppress=True)
# from IPython.display import display, HTML
# display(HTML("<style>.container { width:100% !important; }</style>"))
```

Table of Contents (alphabetic ordered)

- **3d-knots** : various interesting 3d knots
- **align_sol(sol,ang=10)** : same as align_sec but for solid with multiple slices
- **align_sol_1(sol)**: same a align_sec_1 but for a solid with multiple slices
- **ang(x,y)**: calculates the angle with base(x) and perpendicular(y) distances. if x<0 and y>0 the angle will be 90<x<180)
- **ang_2lineccw(p0,p1,p2)** : ccw angle of the line p0p2 from base line p0p1
- **ang_2linecw(p0,p1,p2)** : cw angle of the line p0p2 from base line p0p1
- **arc(radius=0,start_angle=0,end_angle=0,cp=[0,0],s=20)**: function for calculating 2d arc. 'cp': center point of the arc. 's': number of segments in the arc
- **arc_2p(p1,p2,r,cw=1,s=20)**: calculates arc with 2 given points.cw or ccw will change the arc, also this generates the shortest distance arc
- **arc_2p_3d(n1,p0,p1,r,cw=1,s=20)** : draws an arc with 2 points and normal in 3d space
- **arc_2p_cp(n1,p0,p1,r,cw=1)** : finds center point of the arc with 2 points and a normal
- **arc_2p_cp(p1,p2,r,cw=-1)** : calculates the center point of an arc based on 2 given points, cw or ccw dirctions are important to calculate the correct center point
- **arc_3d(v=[0,0,1],r=1,theta1=0,theta2=360,cw=-1,s=50)** : calculates the arc in 3d space w.r.t. plane defined by normal vector 'v1', radius 'r1', start and end angles, cw or ccw and number of segments 's'
- **arc_3p(p1,p2,p3,s=30)**: function to draw arc with 3 known points 'p1','p2','p3'. 's' is the number of segments of the arc
- **arc_3p_3d(points,s=20)** : draws an arc through the 3 points list. 's' is the number of segments of the circle
- **arc_long_2p(p1,p2,r,cw=1,s=20)**: long arc with 2 points 'p1,p2' with radius 'r' and with orientation clockwise (1) or counterclock wise(-1)
- **arc_long_2p_3d(n1,p0,p1,r,cw=1,s=20)** : draws a long arc with 2 points and normal
- **artifact** :
- **axis_rot(axis,solid,angle)**: rotate a solid around an axis
- **axis_rot_1(sol,ax1,loc1,theta)**: rotate a solid on any pivot point 'loc1' with axis of rotation 'ax1' by an angle 'theta'
- **axis_rot_o(axis,solid,angle)**: rotate a solid around an axis considering the solid is centered at origin
- **back-camera-clamp** :
- **ball-bearing** :
- **bb(prism)**: function to find the bounding box dimensions of a prism
- **bezier (p , s = 10)**: function to draw bezier curve with 'p' control points and 's' number of points on the resultant bezier curve)
- **bottle-with-cut-design** :
- **bspline_open(pl,deg,s=100)** : draws a bspline curve for the given control points 'pl' , 'deg' is the degree of curve that is quadratic, cubic or higher order 's' defines the number of points in a bspline curve
- **bspline_close(pl,deg,s=100)** : draws a bspline curve for the given control points 'pl' , 'deg' is the degree of curve that is quadratic, cubic or higher order 's' defines the number of points in a bspline curve
- **business-card-holder** :
- **c_hull(pnt)**: function to calculate convex hull for a list of points 'pnt'
- **c2ro(sol,s)** : change the orientation of points of a cylinder from circular to rectangular orientation. 'sol': is a cylindrical type 3d shape. 's': number of segments required between each straight line segments
- **c2t3(p)** : function to convert 2d to 3d, it just adds the z-coordinate to the points list
- **c3t2(a)**: function to convert 3d to 2d, it just removes the z-coordinate from the points list
- **cam-profile** :
- **Car Seat** :
- **chimney-panel-support** :
- **cir_2p(p1,p2,r,cw=1,s=20)** : circle with 2 points 'p1,p2' with radius 'r' and with orientation clockwise (1) or counterclock wise(-1)
- **cir_3p(p1,p2,p3,s=30)**: function to draw circle with 3 known points 'p1','p2','p3'. 's' is the number of segments of the circle
- **cir_3p_3d(points,s=20)**: draws a circle through the 3 points list. 's' is the number of segments of the circle
- **cir_p_t(cir,p)**: circle to point tangent line (point should be outside the circle)
- **circle(r,cp=[0,0],s=50)** : function for creating points in circle with radius "r", center point "cp" and number of segments "s"
- **coil-example** :
- **concave_hull(p_l,k=3)**:calculate the concave hull of a random list of points. larger number for 'k' will give smoother shape
- **convert_3lines2fillet(pnt1,pnt2,pnt3,f=1.9,s=10)** : Develops a fillet with 3 list of points (pnt1,pnt2,pnt3) in 3d space, f: is a factor which can be reduced to 1.5 in case of self intersection observed, s: number of segments in the fillet, increase the segments in case finer model is required
- **convert_3lines2fillet_closed(pnt1,pnt2,pnt3,f=1.9,s=10)** : Develops a fillet with 3 list of points (pnt1,pnt2,pnt3) in 3d space, f: is a factor which can be reduced to 1.5 in case of self intersection observed, s: number of segments in the fillet, increase the segments in case finer model is required
- **convert_secv(sec)** : function removes all the radiiuses from the section 'sec' where points are ccw
- **convert_secv1(sec)** : function removes all the radiiuses from the section 'sec'
- **convert_secv2(sec,d)** : function removes all the radiiuses from the section 'sec' where points are cw. 'd' should be > the maximum radius at cw corner to give the right results
- **convex(sec)** : function to check whether a section is convex or not
- **convex_hull(pnts)**: calculates convex hull for a list of points 'pnts'
- **corner_radius(sec,s)** : function to create section with corner radiiuses)
- **cosinewave(l,n,a,p)** : creates a cosinewave with length 'l', number of cycles 'n' amplitude 'a' and number of points 'p'
- **cp_3p(p1,p2,p3)** : function to calculate center point of a circle created from 3 known points 'p1','p2','p3'
- **cp_arc(arc1)** : function returns the center point of a given circle or arc
- **cp_cir_3d(cir)** : center point of circle with atleast 3 known list of 'points' in 3d space
- **cpo(prism)** : function to change the orientation of the points of the prism
- **cs1(sec,d)**: creates a cleaning section for removing excess points for offseting a section 'sec' with offset distance 'd'
- **cube(s,center=False)** : function to draw cube with size 's'

- **`cut_plane(nv=[0,0,1],size=[5,5],thickness=10,trns1=0,trns2=0,trns3=0)`** : function for defining a solid (cutting plane) oriented as per the defined normal vector, nv: normal vector for defining plane orientation of the section, thickness: thickness or height of the cutting plane, trns1: translate the solid in the direction of normal vector 'nv', trns2: translate the solid in the direction 'right' to the normal vector 'nv', trns3: translate the solid in the direction 'up' to the normal vector 'nv', '-ve' values given to the trns1,trns2,trns3 will translate the solid in the reverse direction
- **`cw(sec)`** : function to identify if an enclosed section is clockwise(cw) or counterclockwise(ccw). this returns 1 if section is clockwise and -1 if it is counterclockwise
- **`cwv(sec)`** : function to identify whether each point in a section is clockwise or counter clockwise.
- **`cylinder(r1=1,r2=1,h=1,cp=[0,0],s=50,r=0,d=0,d1=0,d2=0,center=False)`** : function for creating cylinder, cone
- **`cylinder-with-rectangular-pocket`** :
- **`cylinder-with-star-pocket`** :
- **`cytz(path)`**: converts 'y' points to 'z' points in a 2d list of points
- **`drill-bit`** :
- **`e_wave(l,a,w,t)`** : create a graph of exponential function $a \cdot e^{-(wt)}$ where, w: omega, t: time steps, a: amplitude, l: length of time
- **`end_cap(sol,r=1,s=10)`** : function to draw radius at the ends of 'path_extrude_open' models. sol: path extruded solid, r: radius at the ends, s: segments of the radius
- **`equidistant_path(path,s=10)`** : divides a path in to equally spaced points
- **`equidistant_pathc(path,s=10)`** : divides a closed path in to equally spaced points
- **`equivalent_rot_axis(r1=[])`** : function returns an equivalent axis for rotation and angle of rotation for a sequence of rotations given by list 'r1'
- **`example-of-rounding`** :
- **`exclude_points(list1,list_to_exclude)`** : function to remove points from a list
- **`f_prism(sec,path)`** : creates a solid or prism with a 2d section and a 2d path. This is a much faster version of function prism, but may not work with few shapes correctly)
- **`faces(l,m)`** : calculate the faces for the vertices with shape $l \times m$ with first and the last end closed
- **`faces_1(l,m)`** : calculate the faces for the vertices with shape $l \times m$ with first and the last end open
- **`fillet_2cir(r1,r2,c1,c2,r,s=50)`** : fillet between 2 circles with radius 'r1' and 'r2' and center points 'c1' and 'c2' and 'r' is the radius of the fillet
- **`fillet_3p_3d(p0,p1,p2,r,s)`** : fillet with 3 known points 'p0,p1,p2' in 3d space
- **`fillet_3p_3d_cp(p0,p1,p2,r)`** : center point 'cp' of the fillet with 3 known points 'p0,p1,p2' in 3d space. 'r' is the radius of fillet
- **`fillet_line_circle(l1,c1,r2,cw=-1,option=0,s=50)`** : function to draw a fillet between a line and a circle, option can be '0' or '1' to flip the fillet from one side to another, 's' is the number of segments in the arc
- **`fillet_2cir(r1,r2,c1,c2,r,s=50)`** : fillet between 2 circles with radius 'r1' and 'r2' and center points 'c1' and 'c2' and 'r' is the radius of the fillet. This is an open fillet where first or the second fillet can be called based on requirement
- **`flip(sec)`** : flips the sequence of a list or list of points
- **`gcd(a,b)`** : calculates greatest common divisor for 2 numbers
- **`glass-model`** :
- **`handling-trolley`** :
- **`helix(radius=10,pitch=10, number_of_coils=1, step_angle=1)`** : creates helix
- **`honeycomb(r,n1,n2)`** : function to draw a honeycomb structure with radius 'r', n1: number of hexagons in 1 layer, n2: number of layers
- **`i_line_fillet(sol1,sol2,ip,r1,r2,s=20,o=0)`** : calculates a fillet at the intersection of 2 solids when the intersection points 'ip' are separately defined. r1 and r2 would be same in most of the cases, but the signs can be different depending on which side the fillet is required. r1 is the distance by which intersection line offsets on sol2 and similarly r2 is on sol1
- **`i_line_planes(p1,p2)`**: intersection line between 2 planes 'p1' and 'p2'
- **`i_p_n(sol,i_p)`** : calculates normal at the intersection points, sol: solid on which the normal is required, i_p: list of intersection points between 2 solids
- **`i_p_p(sol,i_p,r)`** : function to project the intersection point on the cutting lines based on the distance 'r'
- **`i_p_t(path)`** : function to calculate tangent vectors to a given path
- **`intersections(segments)`** : calculates the intersections of adjacent line segments only
- **`ip(prism,prism1,side=-1)`**: function to calculate intersection point between two 3d prisms. "prism" is the 3d object which is intersected with "prism1". side: when a ray intersects a solid it can intersect at 2 locations, if the ray is travelling from outside, in that case if '0' is given meaning only the first intersection point is considered, and in case '-1' is given meaning the last intersection point will be considered.)
- **`ip_fillet(sol1,sol2,r1,r2,s=20,o=0)`** : calculates a fillet at the intersection of 2 solids. r1 and r2 would be same in most of the cases, but the signs can be different depending on which side the fillet is required. r1 is the distance by which intersection line offsets on sol2 and similarly r2 is on sol1
- **`ip_sol2line(sol,line)`** : function to calculate intersection point between a 3d solid and a line. "sol" is the 3d object which is intersected with a "line". in case there are more than 1 intersections of the line with the solid/ prism ip(sol,line)[0] will give the first intersection point and ip(sol,line)[-1] will give the last intersection point
- **`ip_sol2sol(sol,sol1,n=0)`** : function to find the intersection point between 2 solids. this function is to be used where the cutting lines of sol1 are intersecting sol at more than 1 times.sol: solid which is intersected. sol1: this intersects the solid 'sol'. n: if the first intersection points of all the cutting lines are to be considered, value of n should be '0'. if the last intersection points of all the cutting lines are to be considered, value of 'n' should be set to '-1'
- **`ip_triangle(sol1,p0)`** : finds the triangle where the intersection point "p0" lies in a solid "sol1"
- **`iterative-approach-towards-creating-fillets`** :
- **`l_cir_ip(line,cir)`** : line circle intersection point
- **`l_len(l)`** : calculates length of a line 'l'
- **`l_lenv(l)`** : calculates sum of lengths of all the segments in a line 'l' considering the section is closed
- **`l_lenv_o(l)`** : calculates sum of lengths of all the segments in a line 'l' considering the section is open
- **`l_sec_ip(line,sec)`** : line and section intersection point
- **`l_sec_ip_3d(sec,line)`** : finds the intersection points between a section in 3d space and a line in 3d space
- **`I2l_intersection(l1,l2)`** : function to find the intersection point between 2 lines in 3d space
- **`lamp`** :
- **`lcm`** : calculates least common multiple for 2 numbers
- **`lexicographic_sort_xy(p)`** : function sorts the points list 'p' first with x and then with y smallest to largest
- **`lexicographic_sort_yx(p)`** : function sorts the points list 'p' first with y and then with x smallest to largest
- **`linear_extrude(sec,h=1,a=0,steps=1)`** : function to linear extrude a section where, se/users/sanjeevprabhakar section to extrude, h: height of the extrusion, a: angle of twist while extruding, steps: number of steps in each angular extrusion
- **`list_r(sec)`** : function list the corner radiiuses of a given section (only where the radius is specified)
- **`ls(line,n)`**: plots 'n' points in a straight line)
- **`m10`** :
- **`m35`** :
- **`m39`** :
- **`max_r(sec)`** : finds the maximum radius of a given closed section)
- **`mobile-phone-stand`** :

- **`multiple_sec_extrude(path_points=[],radiuses_list=[],sections_list[],option=0,s=10)`**: path_points: are the points at which sections needs to be placed,radiuses: radius required at each path_point. this can be '0' in case no radius required in the path, sections_list= list of sections required at each path_points. same section can be provided for various path_points as well, option: can be '0' in case the number of points in each section do not match or '1' in case number of points for each section are same, s: in case value of radiuses is provided 's' is the number of segments in that path curve
- **`normals_along_path`**:
- **`nv(p)`** : finds the normal vector for a given points in a 3d plane
- **`o_3d(i_p,sol,r,o=0)`** : function to offset the intersection points 'i_p' on a solid 'sol' by distance 'r'. option 'o' can have values '0' or '1' and changes the direction of offset
- **`o_p_p(sol,i_p,d)`**: calculates projected points on the surface of a solid , sol: solid on which the points to be projected, i_p: list of points in 3d space near the solid, d: approximate distance of the points from the surface, specifying too big distance , may create multiple projection of the same point on the solid
- **`o_solid(nv=[0,0,1],sec=[],thickness=10,trns1=0,trns2=0,trns3=0,theta=[0,0,0])`** : function for defining a solid with any defined section. solid gets oriented as per the defined normal vector, nv: normal vector for defining plane orientation of the section, se/users/sanjeevprabhakar cross section of the solid, thickness: thickness or height of the solid, trns1: translate the solid in the direction of normal vector 'nv', trns2: translate the solid in the direction 'right' to the normal vector 'nv', trns3: translate the solid in the direction 'up' to the normal vector 'nv', '-ve' values given to the trns1,trns2,trns3 will translate the solid in the reverse direction , theta: rotate the section around axis fox example if nv is [1,0,0] or x-axis, the sequence of rotation will be x, y ,z axis
- **`offset(sec,r)`** : calculates offset for a section 'sec' by amount 'r'
- **`offset_3d(sec,d)`** : offsets an enclosed section in 3d space, in case the section is in 1 plane, se/users/sanjeevprabhakar section in 3d space, d: offset distance -ve sign means inner offset and +ve sign is outer offset
- **`offset_points(sec,r)`** : function to calculate offset of a list of 2d points. in defining sections, providing corner radius is a must
- **`offset_points_ccw(sec,r)`**: function to offset only those points which are counter clockwise
- **`offset_points_cw(sec,r)`** : function to offset only those points which are clockwise
- **`offset_seg_cw(sec,r)`** : function offsets the segment only when the point is clockwise
- **`offset_segv(sec,d)`** : function makes the segments of the original section and offset each segment by a distance 'd'
- **`orthos_along_path(path,scale=1)`**:
- **`oset(sec,r)`** : function to draw offset of a section 'sec' with distance 'r'
- **`p_cir_t(p,cir)`** : point to circle tangent line (point should be outside the circle)
- **`p2p_interseccion_line(pa,pb)`** : function to calculate intersection line between 2 planes in 3d space
- **`path_extrude_closed(sec,path,twist=0)`** : function to extrude a closed section to a closed path. closed path means the path provided has it's first and the last point same example a circle
- **`path_extrude_open(sec,path,twist=0)`**: function to extrude a closed section to an open path. twist can be set either to '0' or '1' depending on the shape produced
- **`path_offset(path,d)`** : function to offset a 'path' by 'd' distance
- **`pies1(sec,pnts)`** : function to find points 'pnts' which are inside an enclosed section 'sec'
- **`plane(nv,size=[100,100])`** : plane defined by normal 'nv' and 'size'
- **`plos (surf,line,vector,unidirection)`** : function to project line on a surface, vector is the vector in which direction the projection is required, unidirection is set to '1' by default meaning the projection will happen only in the direction of vector, if this parameter is set to '0' then the projection will happen in both direction, that of vector and opposite to vector
- **`pntsnfaces(bead2)`** : function returns points and faces of a prism
- **`points_inside_offset_surround(sec,sec2,r)`** : function returns points in a list 'sec2' which are inside the offset surround of a section 'sec' with offset radius of 'r'
- **`ppesec(p0,sec)`**: point's projection on an enclosed 3d section
- **`ppplane(p0,v1,loc)`** : function to find projected points of a given list of points 'p0' on a plane defined by normal'v1' and location 'loc'
- **`prism(sec,path)`** : function to make a prism with combination of 2d section and 2d path
- **`prism2cpo(s1)`** : function to change the orientation of the surface
- **`psos(s2,s3,v1)`** : function to project a surface on to another
- **`pts(p)`** : calculates the cumulative sum of 2d list of points 'p'
- **`pts1(p)`**: 'p' is a list of points. function calculates the cumulative sum of x,y values in the list while z value remains the same. this is mainly used in function corner_radius(pl,s).
- **`q(vector=[1,0,0],point=[0,5,0],theta=0)`** : function to rotate a point around a vector(axis) with angle theta)
- **`rot(a,sol)`** : function to rotate a group of points around a series of axis with defined angles
- **`rot2d(theta,sec)`** : function to rotate a 2d point or 2d points list by an angle theta around z-axis
- **`r_sec(r1,r2,cp1,cp2)`** : creates a rounded section around a line defined by points 'cp1' and 'cp2'. radius around 'cp1' is 'r1' and radius around 'cp2' is 'r2'
- **`reorient_sec(sec)`** :re-orient section to create a better surface through 'prism' function
- **`rounding-various-rounded-cubes`**:
- **`rsz2d(sec,rsz)`** : function to resize a 2d section to dimensions 'rsz'. resized section will be placed on bottom center of the original section
- **`rsz2dc(sec,rsz)`** : function to resize a 2d section to dimensions 'rsz'. resized section will be placed in center of the original section
- **`rsz3d(prism,rsz)`** : function to resize a 'prism' to dimensions 'rsz'. bottom left corner of both the prisms would be same
- **`rsz3dc(prism,rsz)`** : function to resize a 'prism' to dimensions 'rsz'. resized prism will be placed in the center of the original prism or center point of both the prisms will be same
- **`s_int(s)`** : calulates the self intersection points of a list of line segments 's'. it also picks the points in case the 2 lines are just connected at 1 point and are not crossing
- **`s_int1(s)`**: calcutes the self intersecting segments such that there is a complete intersection and not only end points touching
- **`samsung-tab-s6-holder`**:
- **`scl2d(sec,sl)`**: scale a 2d section to a scaling factor 'sl')
- **`scl2d_c(sec,sl)`** : scale a 2d section such that the center of original and scaled section is same)
- **`scl3d(p,s)`** : scale any 3d prism to a scaling factor 's')
- **`sec2vector(v1=[1,0,0],sec=[])`** : function to align a section 'sec' with a vector 'v1'
- **`sinewave(l,n,a,p)`** : creates a sinewave with length 'l', number of cycles 'n' amplitude 'a' and number of points 'p'
- **`sinwave-box`**:
- **`sl_int(sec,line)`** : function to find intersection between an enclosed section in 3d space and a line
- **`slice_sol(sol,n=10)`**: function to slice a solid with 'n' intermediate steps
- **`sol2path(sol,path)`**: function to extrude a solid along a path
- **`sol2vector(v1=[],sol=[],loc=[0,0,0])`**: orients a solid as per a given vector
- **`sort_points(sec,list1)`** : function picks the nearest point of a section from a reference section and matches the length of points for the 2 compared sections
- **`sphere(r=0,cp=[0,0,0],s=50)`** : function to draw sphere with radius 'r' , center point 'cp' and number of segments 's'
- **`sunflower`**:
- **`surf_base(surf,h=0)`** : creates a solid from any surface, 'h' is the height of the base of the surface
- **`surf_extrude(sec,path)`** : extrudes an open section 'sec' to a 3d 'path' to create surface

- **surf_extrude(surf,t=-.05)** : surface with a polyline 2d sketch and a 3d path. thickness of the surface can be set with parameter "t". positive and negative value creates thickness towards +z and -z directions respectively
- **surf_offset(sec,d)** : function to offset the surface 'sec' by a distance 'd'
- **surface_for_fillet(sol1=[],sol2=[],factor1=50,factor2=10,factor3=1,factor4=100,dia=40)**: sol1: Solid on which the surface needs to be created. sol2: Intersecting solid. factor1: number of segments in the circle. factor2: number of layers or slices of surface. factor3: decides the size of the surface lower value means bigger size. value can be set between 1 to any number. factor4: any high number should be ok like maybe 100 or greater, basically greater than the bounding box dimension of the "sol1". dia: diameter around the solid 2 where surfave needs to be created
- **surface_offset(surf,d)** : offsets the surface by an amount 'd'
- **surface_thicken(surf,d)** : Thickens the surface by an amount 'd'
- **SurfaceFrom3LinesInDifferentPlanes(l1,l2,l3,s1=15,s2=15)** : create surface with 3 lines in different planes
- **swp_prism_h(prism_big,prism_small)** : creates a hollow prism with 2 similar prisms (1 big and 1 smaller)
- **t_cir_tarc(r1,r2,cp1,cp2,r,side=0,s=50)** : function draws a arc which is tangent to 2 circles defined by radii 'r1' and 'r2' and center points 'cp1' and 'cp2'. 's' is the number of segments of the tangent arc. 'r' is the radius of the tangent arc (it should be $\geq (r1+r2+\text{center distance of 2 circles})/2$). 'side' there are 2 sides of the circles where the arc could be created defined by '0' and '1'
- **tangents_along_path(path,scale=1)** :
- **tcct(r1,r2,cp1,cp2,cw=-1)** : two circle cross tangent
- **tctp(r1,r2,cp1,cp2)** : 2 circle tangent points (one side) r1 and r2 are the radius of 2 circles and cp1 and cp2 are the center points
- **tctpf(r1,r2,cp1,cp2)** : 2 circle tangent point full (both the sides)
- **translate(p,sec)** : translates a prism or section by [x,y,z] distance
- **translate_2d(p,sec)** : function to translate a group of points "sec" by "p" distance defined in [x,y]
- **v_sec_extrude(sec,path,o)** : extrude a section 'sec' through a path 'path' . section will vary from start to end such that at the end the section will be offset by 'o' distance
- **wrap_around** : complex function see the example to understand

surf_extrude

```
In [2]: # example of surf_extrude
t0=time.time()

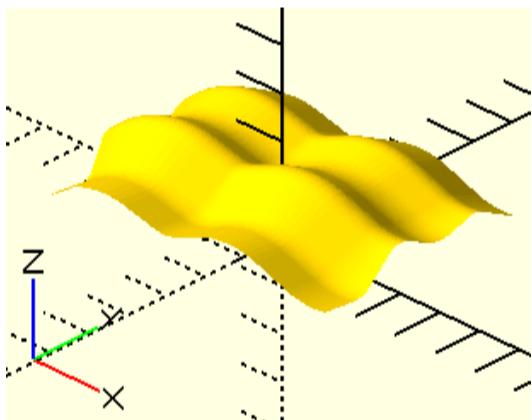
sec2=corner_radius(pts1([[-25,0],[10,5,5],[10,-3,10],[10,5,5],[10,-8,7],[10,1]]),10)
path2=cytz(corner_radius(pts1([[-35,5,0],[10,8,20],[20,-5,10],[20,8,20],[10,-9,20],[10,1,0]]),10))

surf2=surf_extrude(sec2,path2)
surf3=surface_offset(surf2,-1)
fileopen(f''''

{swp_surf(surf2)}
//color("grey"){swp_surf(surf3)}

'''')
t1=time.time()
total=t1-t0
total
```

Out[2]: 0.1444530487060547



surf_extrudef

surface_thicken

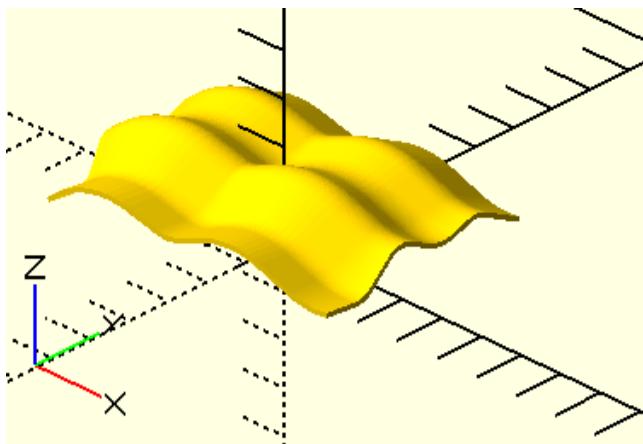
```
In [3]: # example of surf_extrudef
t0=time.time()

sec2=corner_radius(pts1([[-25,0],[10,5,5],[10,-3,10],[10,5,5],[10,-8,7],[10,1]]),10)
path2=cytz(corner_radius(pts1([[-35,5,0],[10,8,20],[20,-5,10],[20,8,20],[10,-9,20],[10,1,0]]),10))
surf2=surf_extrude(sec2,path2)
surf3=surf_extrudef(surf2,t=-1)
surf3=surface_thicken(surf3,-1)
fileopen(f''''

{swp(surf3)}
//color("blue")for(p={surf3})p_line3dc(p,.1,rec=1);

'''')
t1=time.time()
total=t1-t0
total
```

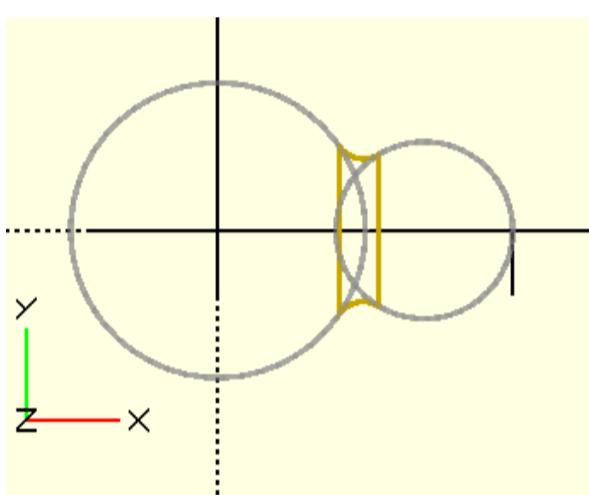
Out[3]: 0.11304879188537598



fillet_2cir

```
In [4]: # example of function fillet_2cir
t0=time.time()
fillet=fillet_2cir(r1=5,r2=3,c1=[0,0],c2=[7,0],r=1)
fileopen(f'''%p_line({circle(5)},.2);
    %p_line({circle(3,[7,0])},.2);
    p_line({fillet},.2);
    ''')
t1=time.time()
t1-t0
```

Out[4]: 0.0023119449615478516



fillet0_2cir

```
In [5]: # example of function fillet0_2cir and arc_long_2p
t0=time.time()

fillet=fillet0_2cir(r1=10,r2=10,c1=[0,0],c2=[20,0],r=10)
p0,p1,p2,p3=fillet[1][len(fillet[1])-1], fillet[0][0],fillet[0][len(fillet[0])-1],fillet[1][0]
cir1=arc_long_2p(p0,p1,10,-1,40)
cir2=arc_long_2p(p2,p3,10,-1,40)
fileopen(f'''//%p_line({circle(10)},.2);
    //%p_line({circle(10,[20,0])},.2);
    color("blue")p_lineo({fillet[0]},.2);
    color("yellow")p_lineo({fillet[1]},.2);
    color("magenta")p_lineo({cir1},.2);
    color("cyan")p_lineo({cir2},.2);

    ''')
t1=time.time()
t1-t0
```

Out[5]: 0.0032503604888916016

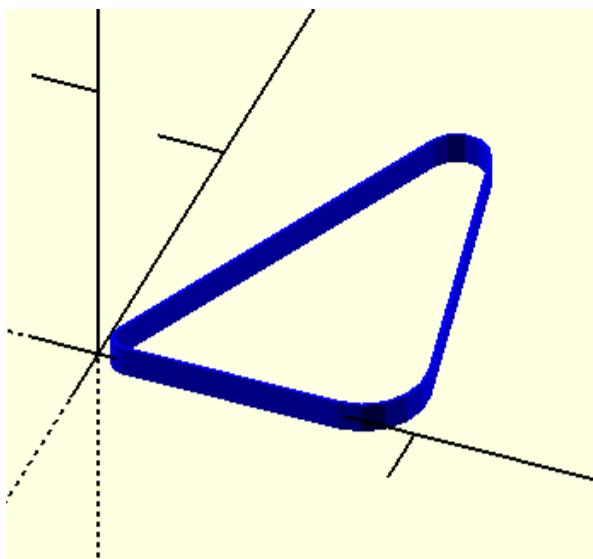


corner_radius(sec,s)

```
In [6]: # example of function corner_radius(pl,s)
t0=time.time()
sec=corner_radius(sec=[[0,0,.5],[10,0,2],[7,15,1]],s=5)
fileopen(f'''color("blue")p_line({sec},.1);
```

```
...)  
t1=time.time()  
t1-t0
```

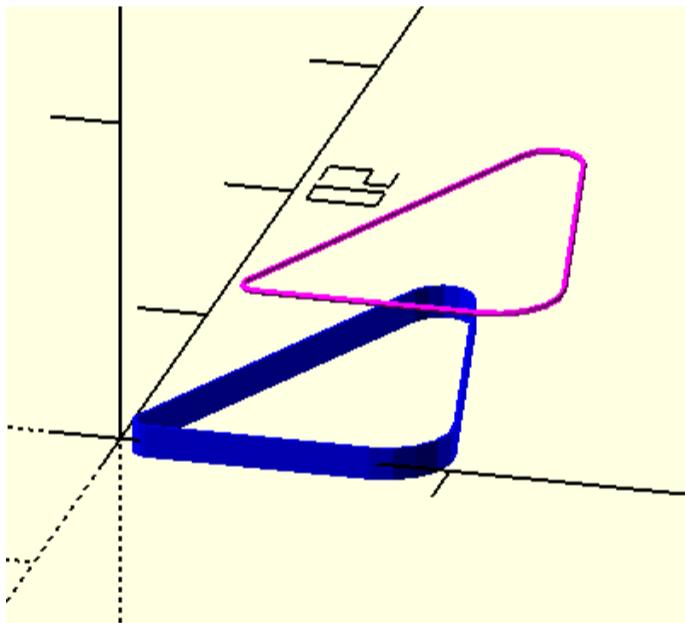
Out[6]: 0.004746913909912109



translate

```
In [7]: # example of function translate(p,sec)  
t0=time.time()  
sec=corner_radius([[0,0,.5],[10,0,2],[7,15,1]],5)  
sec1=translate(p=[10,5,3],sec=sec)  
  
fileopen(f'''  
  
color("blue")p_line({sec},.1);  
color("magenta")p_line3dc({sec1},.1);  
  
'''')  
t1=time.time()  
t1-t0
```

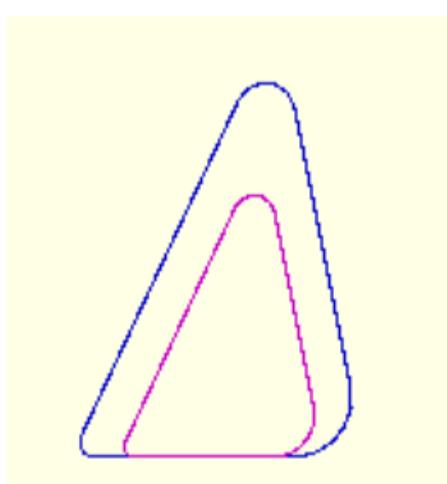
Out[7]: 0.0034830570220947266



scl2d(sec,sl)

```
In [8]: # example of function scl2d(sec,sl)  
t0=time.time()  
sec=corner_radius([[0,0,.5],[10,0,2],[7,15,1]],5)  
sec1=scl2d(sec,.7)  
fileopen(f'''  
  
color("blue")p_line({sec},.1);  
color("magenta")p_line({sec1},.1);  
  
'''')  
t1=time.time()  
t1-t0
```

Out[8]: 0.0047609806060791016



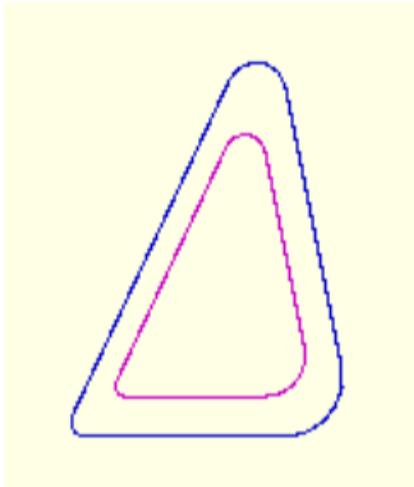
scl2d_c(sec,sl)

```
In [9]: # example of function scl2d_c(sec,sl)
t0=time.time()
sec=corner_radius([[0,0,.5],[10,0,2],[7,15,1]],5)
sec1=scl2d_c(sec,.7)

fileopen(f'''
color("blue")p_line({sec},.1);
color("magenta")p_line({sec1},.1);

''')
t1=time.time()
t1-t0
```

Out[9]: 0.003268718719482422



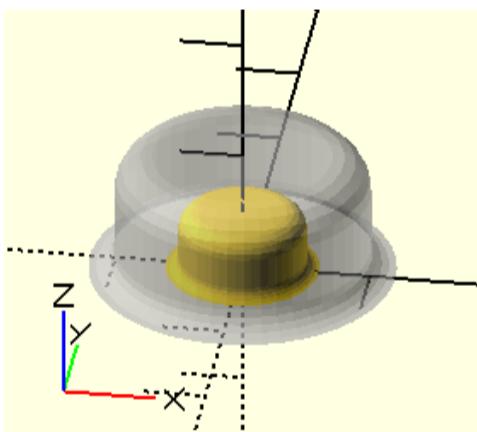
scl3d(p,s)

```
In [10]: # example of function scl3d(p,s)
t0=time.time()
sec=circle(10);
path=corner_radius(pts1([[2,0],[-2,0,2],[0,10,3],[-3,0]]),5)
sol=prism(sec,path)
sol1=scl3d(sol,.5)

fileopen(f'''
%{swp(sol)}
{swp(sol1)}

''')
t1=time.time()
t1-t0
```

Out[10]: 0.062113046646118164



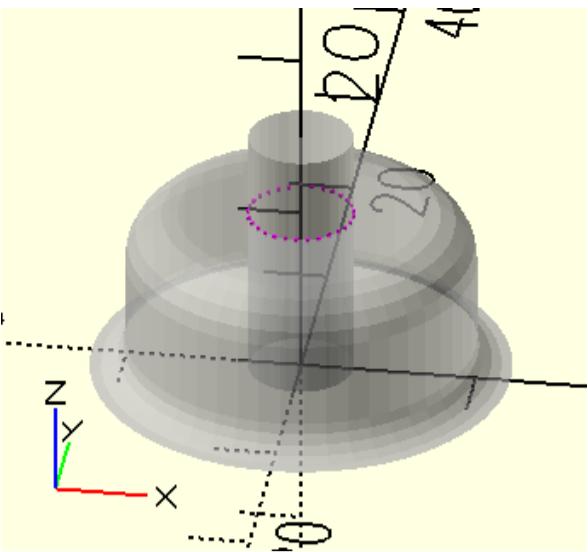
ip(prism,prism1)

```
In [11]: # example of function ip(prism,prism1)
t0=time.time()

sec=circle(10)
path=corner_radius(pts1([[2,0],[-2,0,2],[0,10,3],[-9.9,0]]),5)
p_0=prism(sec,path)
p_1=cylinder(r=3,h=15,s=30)
ip_1=ip(p_0,p_1)

fileopen(f'''
%{swp(p_0)}
%{swp(p_1)}
color("magenta")points({ip_1},.2);
//color("blue")for(p={cpo(p_0)})p_line3d(p,.05);
//color("blue")for(p={cpo(p_1)})p_line3d(p,.05);
''')
t1=time.time()
t1-t0
```

Out[11]: 0.07497382164001465



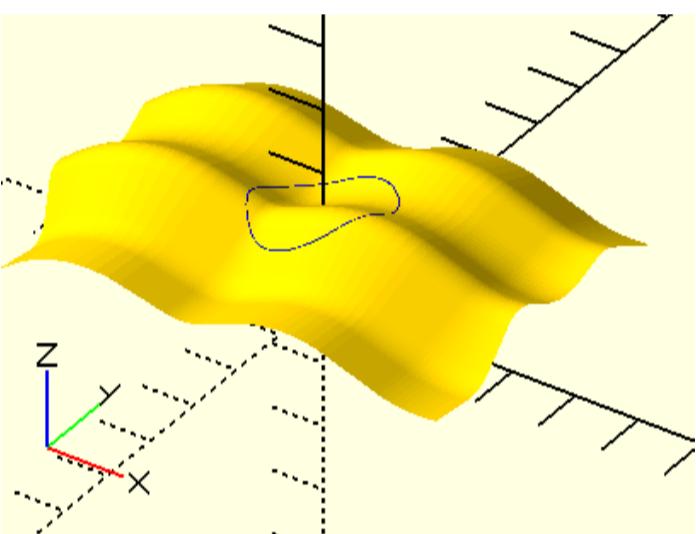
```
In [12]: t0=time.time()

sec2=corner_radius(pts1([[-25,0],[10,5,5],[10,-3,10],[10,5,5],[10,-8,7],[10,1]]),10)
path2=cytz(corner_radius(pts1([[-35,5,0],[10,8,20],[20,-5,10],[20,8,20],[10,-9,20],[10,1,0]]),10))
surf2=surf_extrude(sec2,path2)
sol1=linear_extrude(circle(10),30)
# sol1=slice_sol(sol1,10)
i_p1=ip_surf(surf2,sol1)

fileopen(f'''

color("blue")p_line3dc({i_p1},.2);
%{swp_surf(surf2)}
''')
t1=time.time()
total=t1-t0
total
```

Out[12]: 0.09333300590515137



tctp(r1,r2,cp1,cp2)

```
In [13]: # example of function tctp(r1,r2,cp1,cp2)
t0=time.time()
cir1=circle(10)
cir2=circle(5,[15,6])
sec=tctp(r1=10,r2=5,cp1=[0,0],cp2=[15,6]);

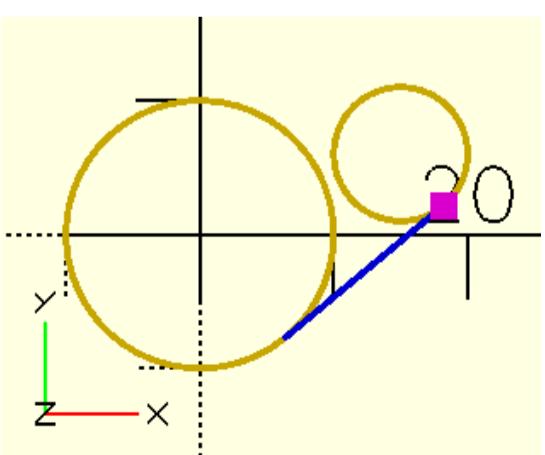
fileopen(f'''

p_line({cir1},.5);
p_line({cir2},.5);

color("blue")p_line({sec},.5);
color("magenta")points({[sec[1]}},2);
''')

t1=time.time()
t1-t0
```

Out[13]: 0.0020673274993896484



tctpf(r1,r2,cp1,cp2)

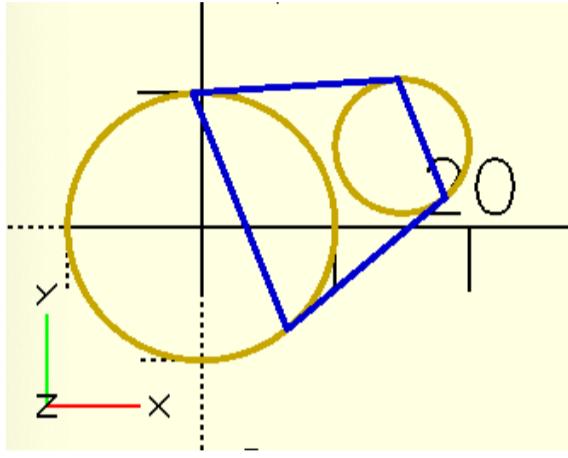
```
In [14]: # example of function tctpf(r1,r2,cp1,cp2)
t0=time.time()

cir1=circle(10)
cir2=circle(5,[15,6])
sec=tctpf(r1=5,r2=10,cp1=[15,6],cp2=[0,0])

fileopen(f'''
p_line({{cir1}},.5);
p_line({{cir2}},.5);
color("blue")p_line({{sec}},.5);

''')
t1=time.time()
t1-t0
```

Out[14]: 0.0025322437286376953



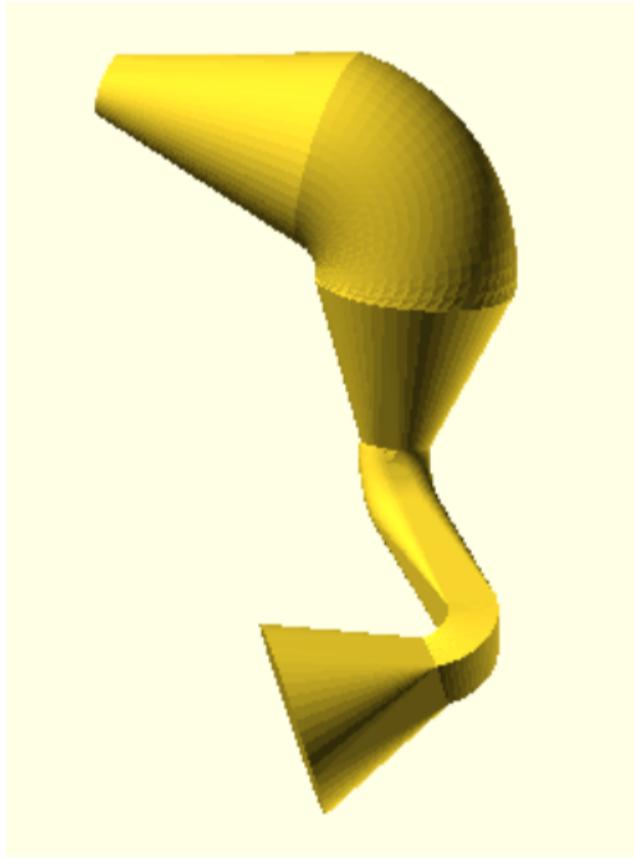
multiple_sec_extrude

```
In [15]: # example of function multiple_sec_extrude(path_points=[],radiuses_list[],sections_list[],option=0,s=10)
t0=time.time()

sec1=circle(10)
sec2=square(5,True)
sec3=corner_radius(pts1([[-3.5,-2.5,2.49],[7,0,2.49],[0,5,2.49],[-7,0,2.49]]))
sections=[sec1,sec2,sec3,sec1,sec3]
path=array([[0,0,0],[20,2,5],[-7,25,3],[5,10,30],[-30,15,3]]).cumsum(0)
r=[0,5,7,12,0]
sol=multiple_sec_extrude(path,r,sections,0,20)
sol=cpo([ bezier(p,200) for p in cpo(sol)])
fileopen(f'''

//color("blue")for(p={multiple_sec_extrude(path,r,sections,0,20)})p_line3dc(p,.1);
{swp(sol)}
''')
t1=time.time()
t1-t0
```

Out[15]: 1.9992609024047852



path_extrude_open(sec,path)

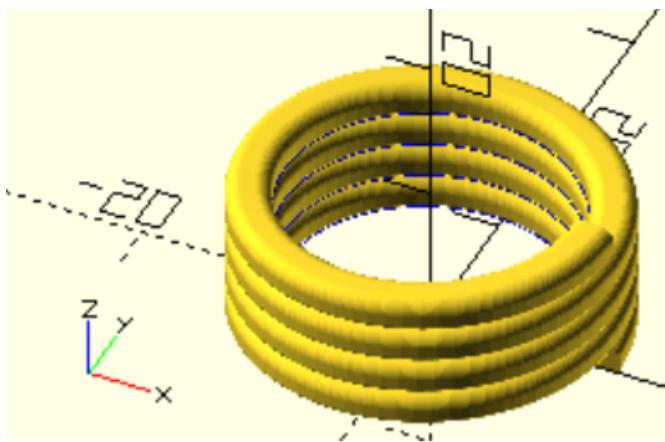
```
In [16]: # example of function path_extrude_open(sec,path)
t0=time.time()

sec=corner_radius(pts1([[0,0,.2],[3,0,.2],[0,2,1],[-3,0,1]]),10)
path=helix(10,2.5,4,5.01)
sol=path_extrude_open(sec,path)
fileopen(f'''

{swp(sol)}
color("blue")p_line3d({path},.1);
'''')
```

```
t1=time.time()
t1-t0
```

Out[16]: 0.11728692054748535

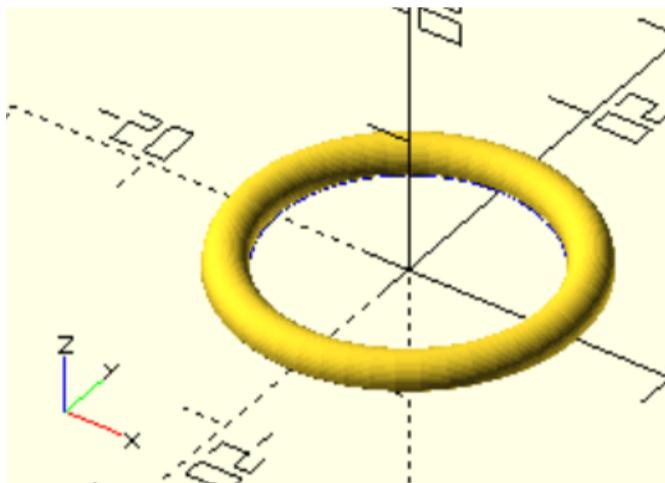


path_extrude_closed(sec,path)

```
In [17]: # example of function path_extrude_closed(sec,path)
t0=time.time()
sec=corner_radius(pts1([[0,0,.2],[3,0,.2],[0,2,1.49],[-3,0,1.49]]),10)
path=c2t3(circle(10))
sol=path_extrude_closed(sec,path)
fileopen(f'''
{swp_c(sol)}
color("blue")p_line3d({path},.1);
''')

t1=time.time()
t1-t0
```

Out[17]: 0.021183013916015625



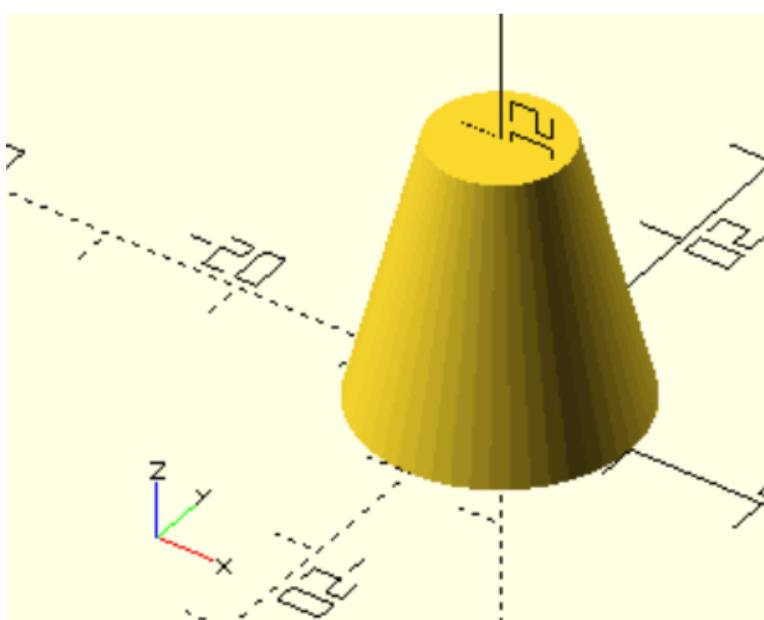
cylinder

```
In [18]: # example of function cylinder(r1=1, r2=1, h=1, s=50, r=0, d=0, dl=0, d2=0, center=False) and function swp
t0=time.time()
sol=cylinder(r1=10,r2=5,h=20)
fileopen(f'''

{swp(sol)}
''')

t1=time.time()
t1-t0
```

Out[18]: 0.002407073974609375



bezier(p,s=10)

```
In [19]: # example of function bezier(p,s=10)
t0=time.time()
control_points=array([[0,0,0],[10,5,5],[-10,10,20],[-10,5,15],[10,0,10]]).cumsum(0).tolist()
curve=beziers(control_points,50)

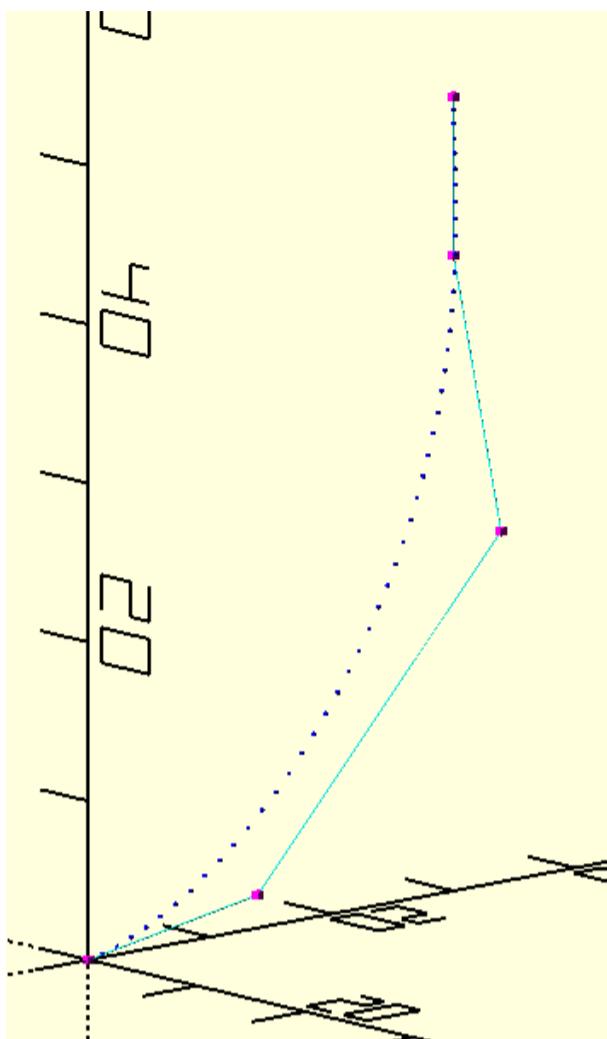
fileopen(f'''
```

```

color("blue")p_line3d({curve},.1);
// control points
color("magenta")points({control_points},.5);
color("cyan")p_line3d({control_points},.05);
  '')
t1=time.time()
t1-t0

```

Out[19]: 0.002679109573364258



arc_3d

```

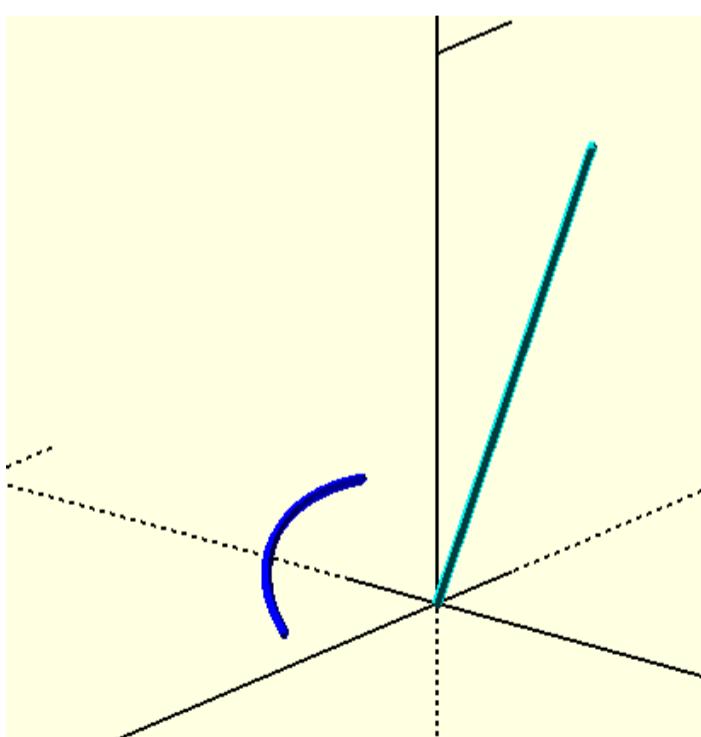
In [20]: # example of function arc_3d(v=[0,0,1],r=1,theta1=0,theta2=360,cw=-1,s=50)
t0=time.time()
vector=[[0,0,0],[1,0,1]]
arc1=arc_3d(v=[1,0,1],r=3,theta1=0,theta2=270,cw=-1,s=50)

fileopen(f'''
//arc
color("blue")p_line3d({arc1},.1);
// vector
color("cyan")p_line3d({vector},.1);

  ''')
t1=time.time()
t1-t0

```

Out[20]: 0.002767801284790039



plane

```

In [21]: # example of function plane(nv,radius)
t0=time.time()
vector=[[0,0,0],[-3,0,2]]
plane1=plane(nv=[-3,0,2],size=[10,10])

fileopen(f'''

//plane

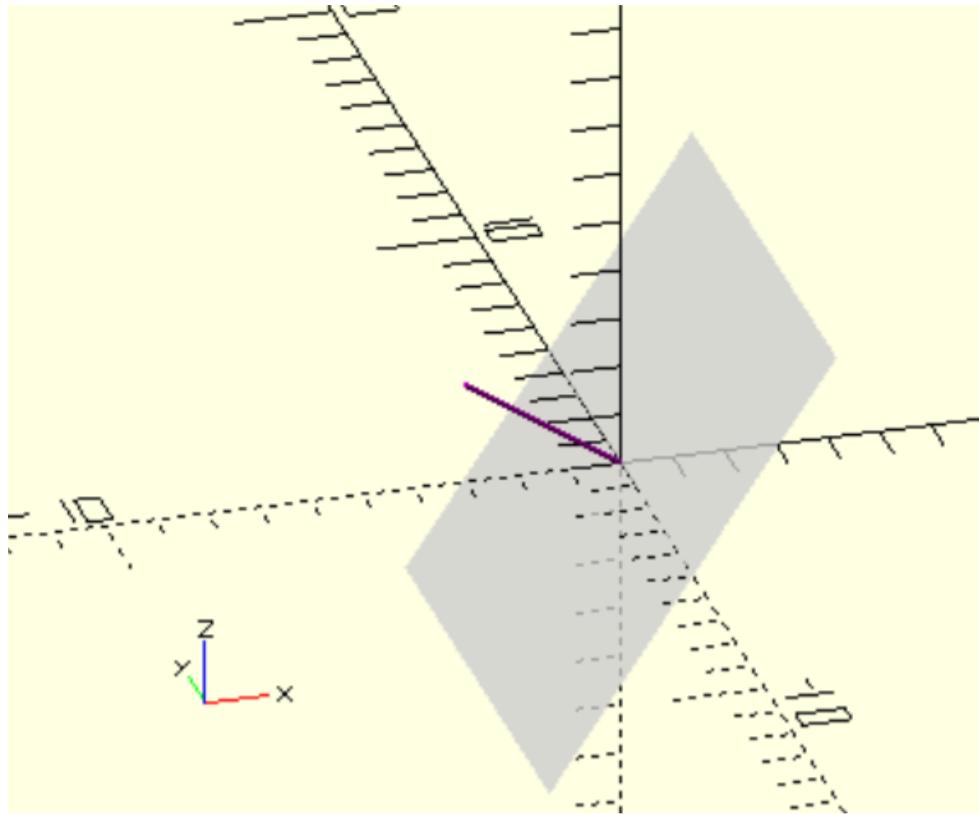
```

```
%{swp(plane1)}

// vector
color("magenta")p_line3d({vector},.1);

'''')
t1=time.time()
t1-t0
```

Out[21]: 0.0010869503021240234



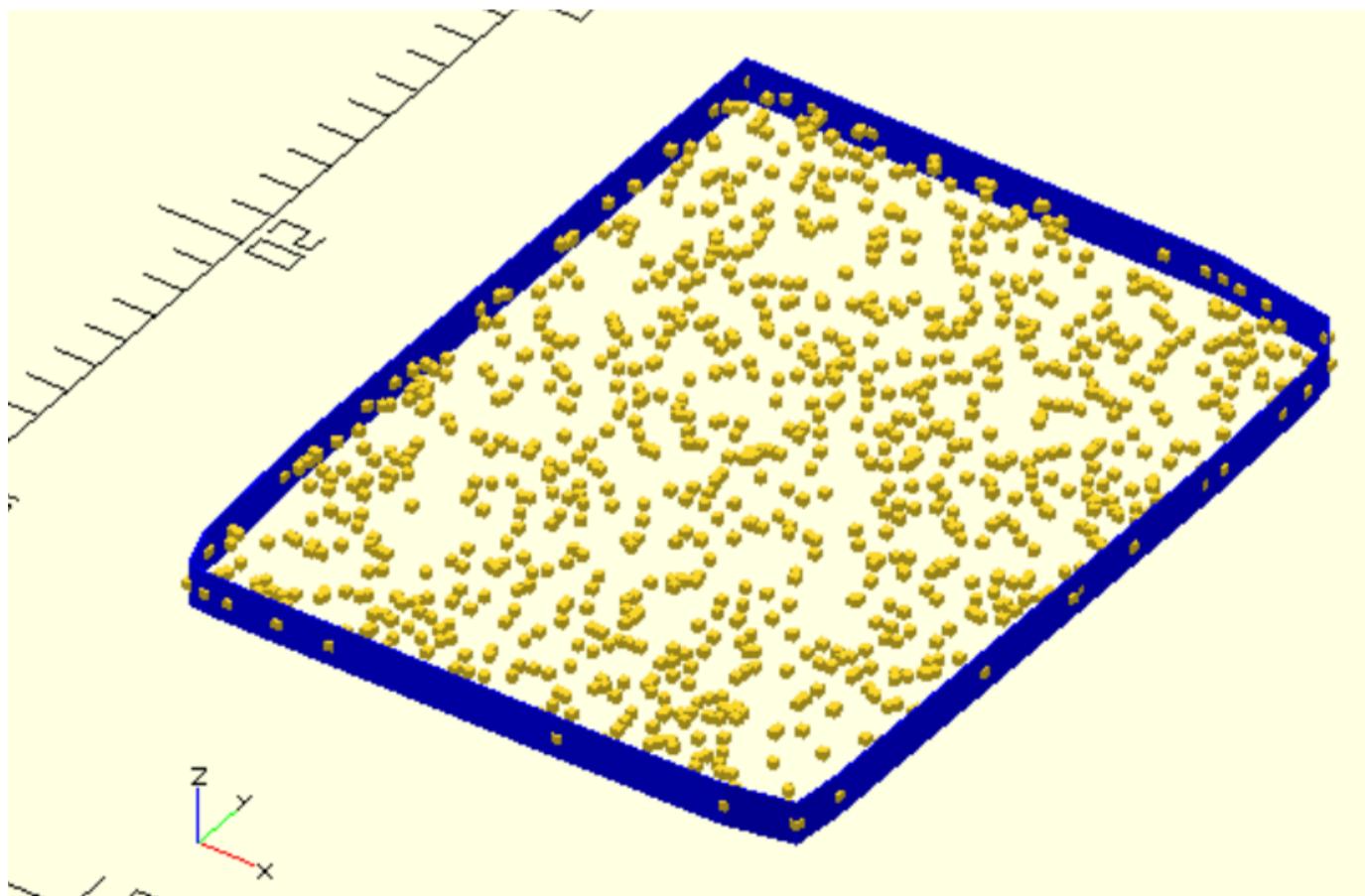
c_hull

```
# example of function c_hull(pnt)
t0=time.time()
a=random.random(1000)*(20-5)+5
b=random.random(1000)*(30-10)+10
points=array([a,b]).transpose(1,0).tolist()
sec=c_hull(points)
fileopen(f'''

points({points},.2);
color("blue")p_line({sec},.05);

'''')
t1=time.time()
t1-t0
```

Out[22]: 0.059960126876831055



convex

```
# example of function convex(sec)
t0=time.time()
sec1=corner_radius(pts1([[0,0,.2],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),20)
sec2=corner_radius(pts1([[0,0,1],[7,5,2],[5,7,3],[-5,7,2],[-7,5,3]]),20)

fileopen(f'''

// not a convex section
```

```

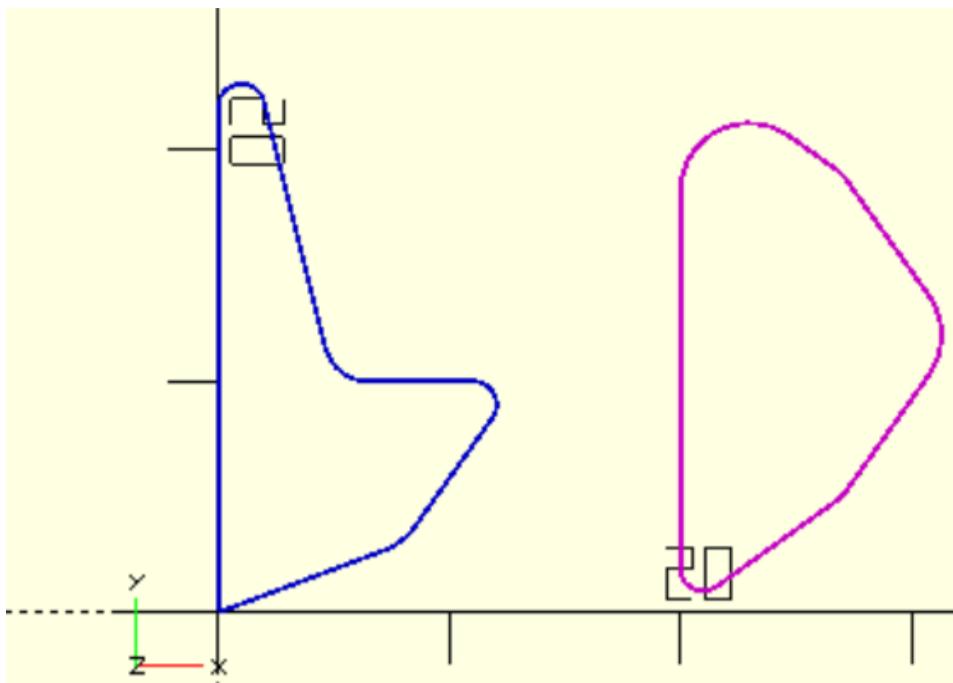
color("blue")p_line({sec1},.2);

//convex section
color("magenta")translate([20,0,0])p_line({sec2},.2);

''')
t1=time.time()
convex(sec1),convex(sec2),t1-t0

```

Out[23]: (np.False_, np.True_, 0.013673067092895508)



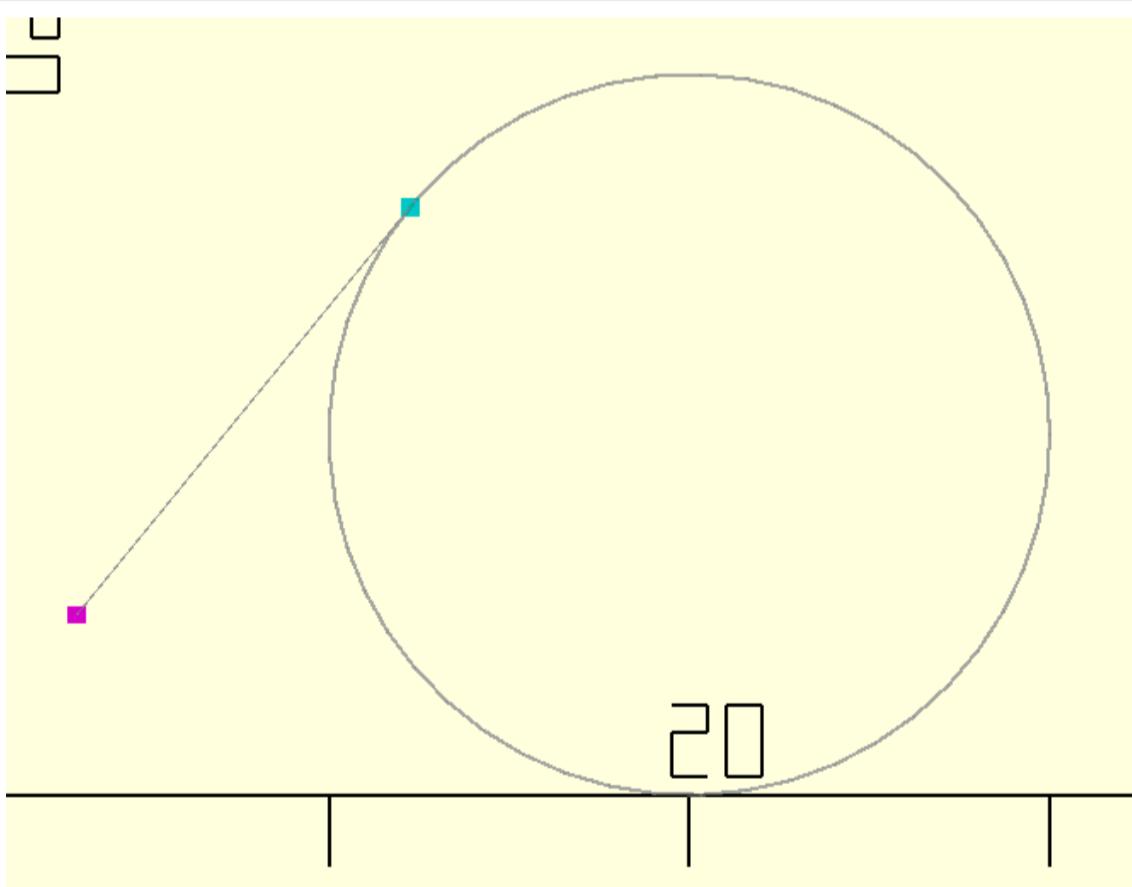
cir_p_t

```

In [24]: # example of function cir_p_t(cir,pnt)
cir=c3t2(translate([20,10,0],circle(10)))
point=[1,30]
tangent_point=cir_p_t(cir,point)
fileopen(f'''

// "cyan" is the tangent point from circle to some external point ("magenta color")
%p_line({cir},.1);
color("magenta")points({[point]},.5);
color("cyan")points({[tangent_point]},.5);
//color("blue")
%p_line({[point,tangent_point]},.05);
'''')

```



concave_hull

```

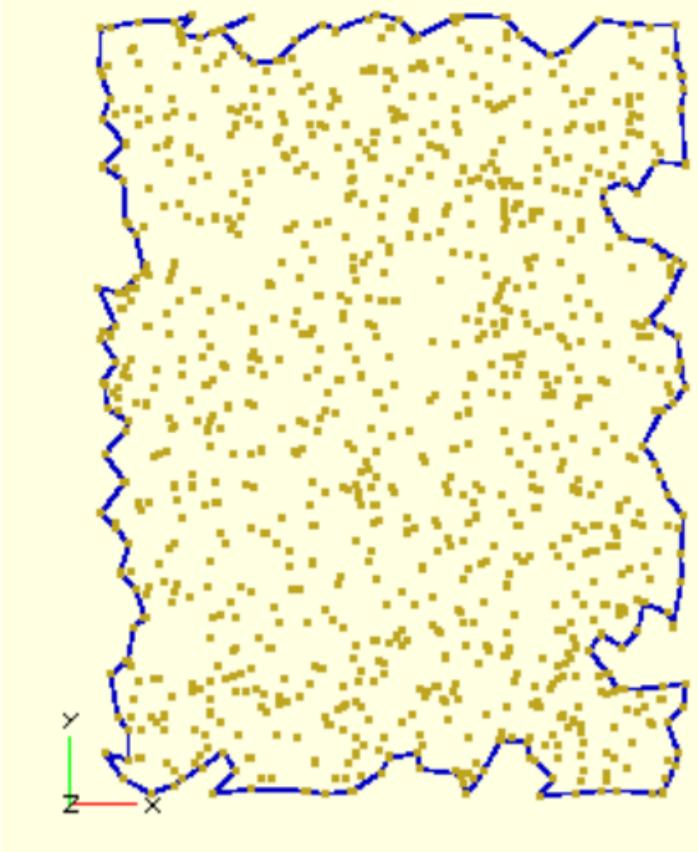
In [25]: # example of function concave_hull(pnts,x=1,loops=10)
t0=time.time()
a=random.random(1000)*(20-5)+5
b=random.random(1000)*(30-10)+10
points=remove_extra_points(array([a,b]).transpose(1,0))
conc_hull=concave_hull(points,3)
fileopen(f'''

points({points},.2);
color("blue")p_line3d({conc_hull},.1,1);

''')
t1=time.time()
t1-t0

```

Out[25]: 0.9855878353118896



```
In [26]: # example of pies1(sec,pnts) and concave_hull
t0=time.time()

a=random.random(10000)*(10-0)+0
b=random.random(10000)*(20-0)+0
c=array([a,b]).transpose(1,0).tolist()

sec=corner_radius(pts1([[1.5,8,.9],[2,0,.9],[0,-3,1.4],[3,0,1.4],[0,4,1.9],[-5,0,2.5],[0,6,2.5],
[7,0,2.5],[0,-4,.9],[-2,0,.9],[0,3,1.4],[-3,0,1.4],[0,-4,1.9],
[5,0,2.5],[0,-6,2.5],[-7,0,2.5]]),20)

pnts=pies1(sec,c)

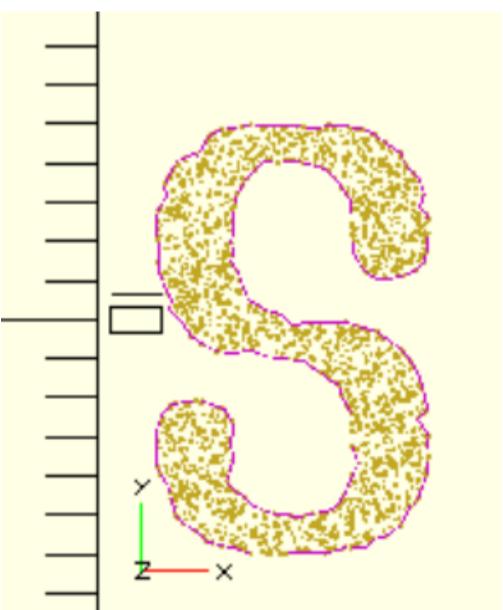
s1=concave_hull(pnts,50)

fileopen(f'''

points({pnts},.1);
color("magenta")p_line({s1},.05);

''')
t1=time.time()
t1-t0
```

Out[26]: 3.158837080001831



path_offset

```
In [27]: # example of function path_offset_n(path,d)
path=corner_radius(pts1([[-5,0],[5,0,2],[-1,10,2],[-5,0]]))
path1=path_offset_n(path,-1)
fileopen(f'''

// orginal path
color("blue")p_line3d({path},.1,1);
//offset path
color("magenta")p_line3d({path1},.1,1);

'''')
```

```
In [28]: # example of function path_offset(path,d)
r=-1
path=corner_radius(pts1([[-5,0],[5,0,2],[-1,10,2],[5,0]]),20)
# path=circle(10)
# path=corner_radius(pts1([[0,0],[10,0,.1],[-10,5,.1],[-10,-5]]),20)
```

```

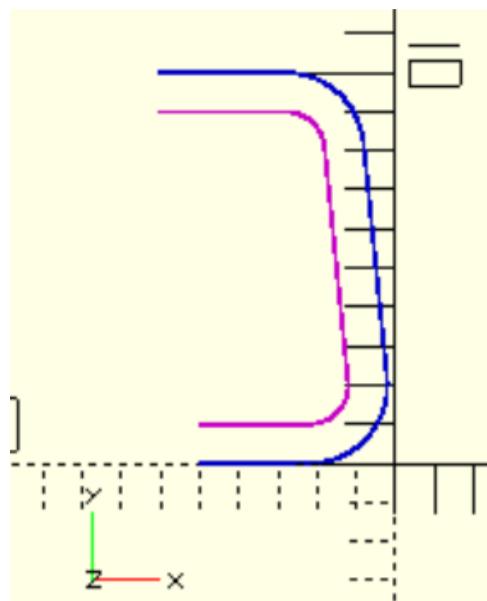
path1=path_offset(path,r)

fileopen(f'''

// orginal path
color("blue")p_lineo({path},.1);
//offset path
color("magenta")p_lineo({path1},.1);

''')

```



pntsfaces

In [29]:

```

# example of function pntsfaces(bead2)

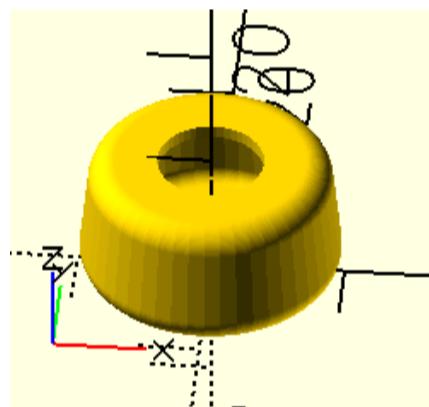
path=corner_radius(pts1([[-5,0],[5,0,2],[-1,10,2],[-5,0]]))
path1=path_offset(path,-1)
final_path=path+flip(path1)
sec=circle(10)
sol=prism(sec,final_path)

pnts, fcs=pntsfaces(sol)[0],pntsfaces(sol)[1]

fileopen(f'''

polyhedron({pnts},{fcs},convexity=10);
''')

```



offset_points

In [30]:

```

# example of function offset_points(sec,r)
t0=time.time()
sec=corner_radius(pts1([[0,0,.1],[7,5,2],[5,7,3],[-5,7,2],[-7,5,3]]),20)
sec1=offset_points(sec,2)

fileopen(f'''

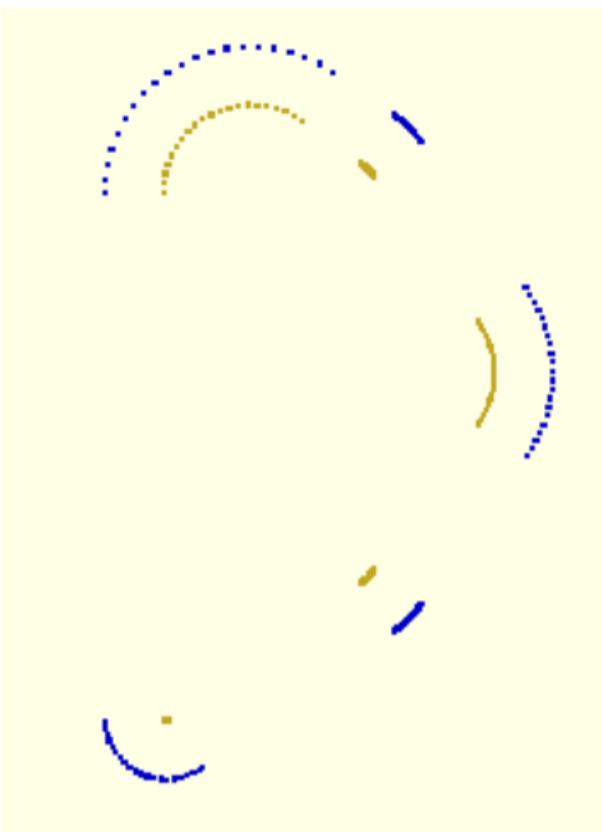
//original points
points({sec},.2);

// offset points
color("blue") points({sec1},.2);

''')
t1=time.time()
t1-t0

```

Out[30]: 0.009135246276855469



```
In [ ]: set_printoptions(suppress=True)
```

s_int

```
In [31]: # example of function s_int(s)
t0=time.time()
sec=corner_radius(pts1([[0,0,.1],[7,5,2],[-7,10,2]]),3)
sec1=offset_segv(sec,-1)
self_intersections=s_int1(sec1)

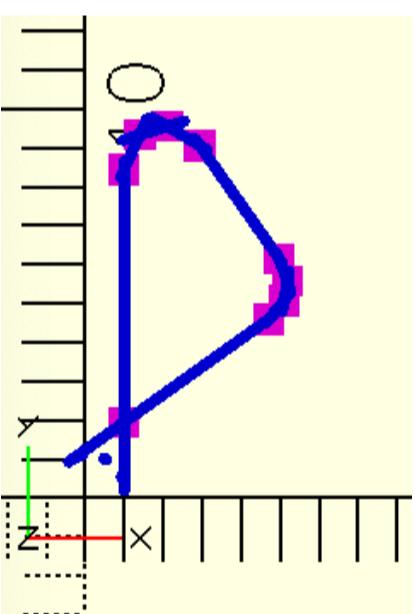
fileopen(f'''

// line segments
color("blue") for (p={sec1}) p_line(p,.3);

// intersection points
color("magenta")points({self_intersections},.8);

''')
t1=time.time()
t1-t0
```

```
Out[31]: 0.004378080368041992
```



```
In [32]: # example of function s_int(s)
t0=time.time()
sec=corner_radius(pts1([[0,0,2],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),5)
sec=seg(sec)
s=s_int(sec)

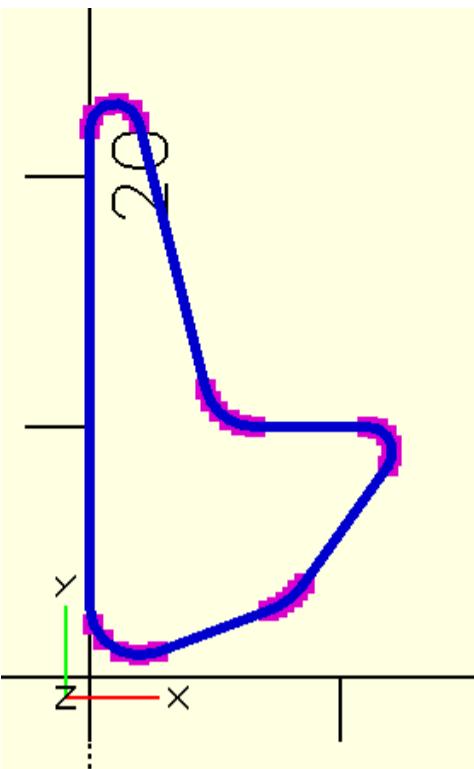
fileopen(f'''

// line segments
color("blue") for (p={sec}) p_line(p,.4);

// intersection points
color("magenta")points({s},.8);

''')
t1=time.time()
t1-t0
```

```
Out[32]: 0.006043195724487305
```



s_int1

```
In [33]: # example of function s_int1(s)
t0=time.time()
sec=offset_segv([[0,0],[10,0],[15,7]],-1)
self_intersections=s_int1(sec)

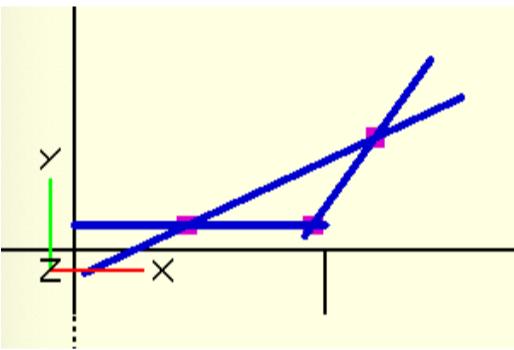
fileopen(f'''

// line segments
color("blue") for (p={sec}) p_line(p,.3);

// intersection points
color("magenta")points({self_intersections},.8);

''')
t1=time.time()
t1-t0
```

Out[33]: 0.0016281604766845703



offset_seg_cw

```
In [34]: # example of function offset_seg_cw(sec,r)
t0=time.time()
sec=sec=corner_radius(pts1([[0,0,2],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),5)
sec1=offset_seg_cw(sec,-2)

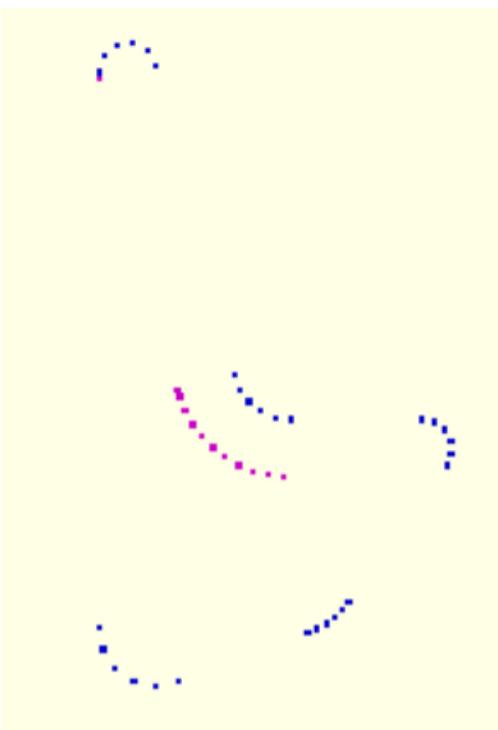
fileopen(f'''

// original section
color("blue") points({sec},.2);

// offset segments
color("magenta")points({sec1},.2);

''')
t1=time.time()
t1-t0
```

Out[34]: 0.012010574340820312



offset_segv

```
In [35]: # example of function offset_segv(sec,r)
t0=time.time()
sec=sec=corner_radius(pts1([[0,0,2],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),5)
sec1=offset_segv(sec,-1)

fileopen(f'''

// original section
color("blue") points({sec},.2);

// offset segments
color("magenta")for(p={sec1})points(p,.2);

'''')
t1=time.time()
t1-t0
```

Out[35]: 0.006024837493896484

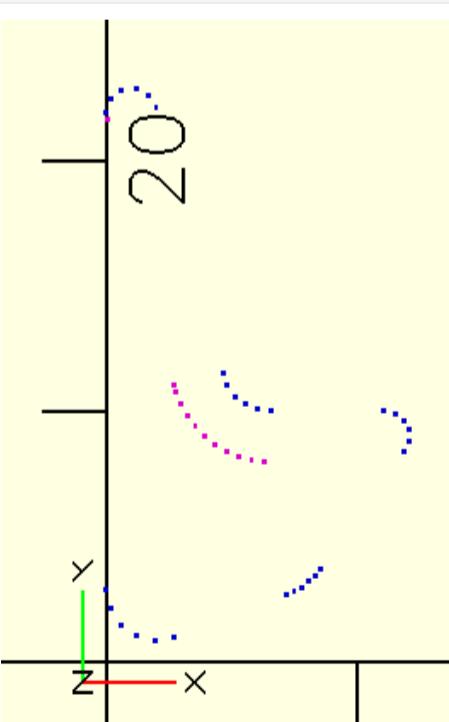
```
In [ ]: # example of another method to offset segment where points are clockwise and example function cwv(sec)
t0=time.time()
sec=corner_radius(pts1([[0,0,2],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),5)
sec0=seg(sec)
decision=cwv(sec)
sec1=[path_offset(sec0[i],-2) for i in range(len(sec0)) if decision[i]==1]

fileopen(f'''

// original section
color("blue") points({sec},.2);

// offset segments
color("magenta")for(p={sec1})points(p,.2);

'''')
t1=time.time()
t1-t0
```



sort_points

```
In [36]: # example of function sort_points(sec,sec1)
t0=time.time()
sec=circle(10)
sec1=corner_radius(pts1([[-2.5,-2.5,1],[5,0,1],[0,5,1],[-5,0,1]]))
sec2=sort_points(sec,sec1)
sec3=cpo([sec2,sec])
fileopen(f'''
```

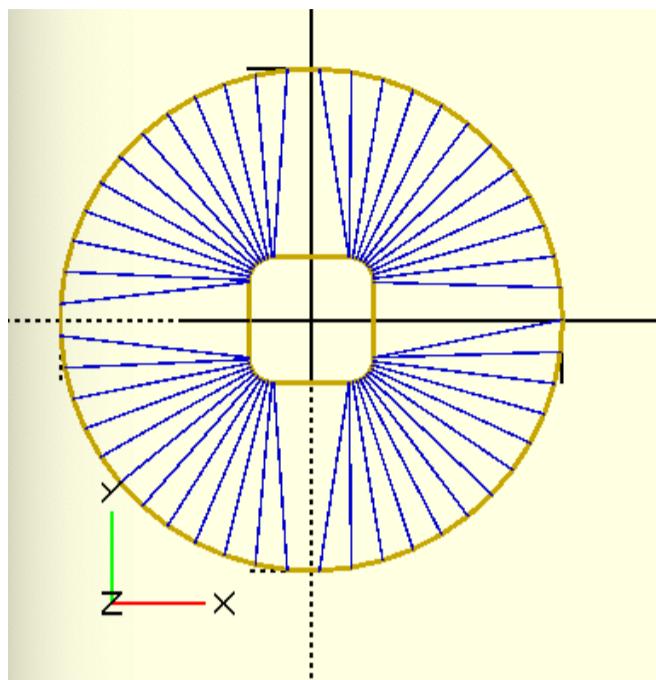
```

p_line({sec},.2);
p_line({sec2},.2);
color("blue") for(p={sec3})p_line(p,.1);

...
t1=time.time()
t1-t0

```

Out[36]: 0.008333206176757812



surf_offset

surface_offset :

Although surface_offset is more accurate function, it takes much longer to calculate the offset as compared to surf_offset

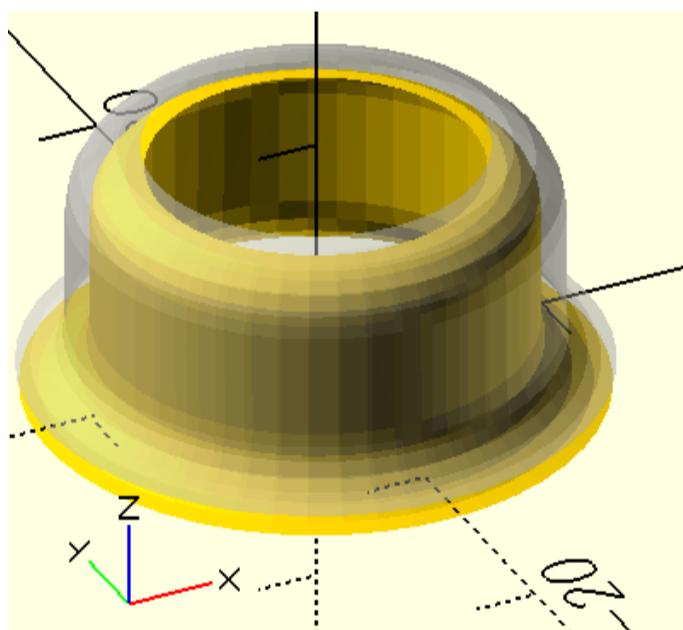
In [37]: # example of function surf_offset(surf,o)

```

sec=circle(10);
path=corner_radius(pts1([[2,0],[-2,0,2],[0,10,3],[-3,0]]),5)
sol=f_prism(sec,path)
sol1=surf_offset(sol,-1)
sol1=surface_offset(sol,1)
fileopen(f'')
%{swp_c(sol)}
{swp_c(sol1)}

...

```



pts1

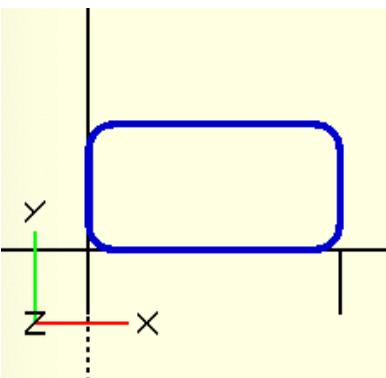
In [38]: # example of function pts1(p)

```

sec=corner_radius(pts1([[0,0,1], [10,0,1], [0,5,1], [-10,0,1]]),5)
fileopen(f'')
color("blue")p_line({sec},.3);

...

```



arc_2p

```
In [39]: # example of function arc_2p(p1,p2,r,cw=1,s=20)
```

```
p1=[2,0]
p2=[0,2]
arc1=arc_2p(p1,p2,2,1,20)

arc2=arc_2p(p1,p2,2,-1,20)

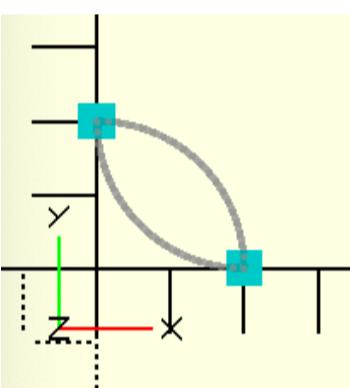
fileopen(f'''

// arc clockwise
//color("blue")
%p_lineo({arc1},.1);

// arc counter clockwise
//color("magenta")
%p_lineo({arc2},.1);

color("cyan")points({[p1,p2]},.5);

''' )
```



arc_long_2p

```
In [40]: # example of function arc_long_2p(p1,p2,r,cw=1,s=20)
```

```
p1=[2,0]
p2=[0,2]
arc1=arc_long_2p(p1,p2,2,1,20)

arc2=arc_long_2p(p1,p2,2,-1,20)

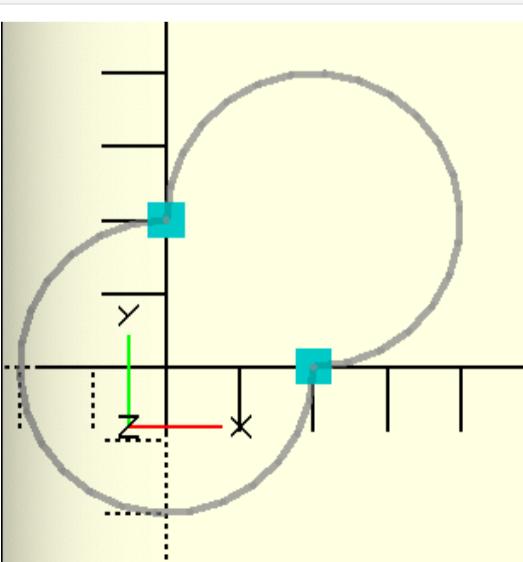
fileopen(f'''

// arc clockwise
//color("blue")
%p_lineo({arc1},.1);

// arc counter clockwise
//color("magenta")
%p_lineo({arc2},.1);

color("cyan")points({[p1,p2]},.5);

''' )
```



arc_2p_cp

In [41]: # example of function arc_2p_cp(p1,p2,r,cw=-1)

```
p1=[2,0]
p2=[0,2]
arc1=arc_2p(p1,p2,2,1,5)
cp1=arc_2p_cp(p1,p2,2,1)

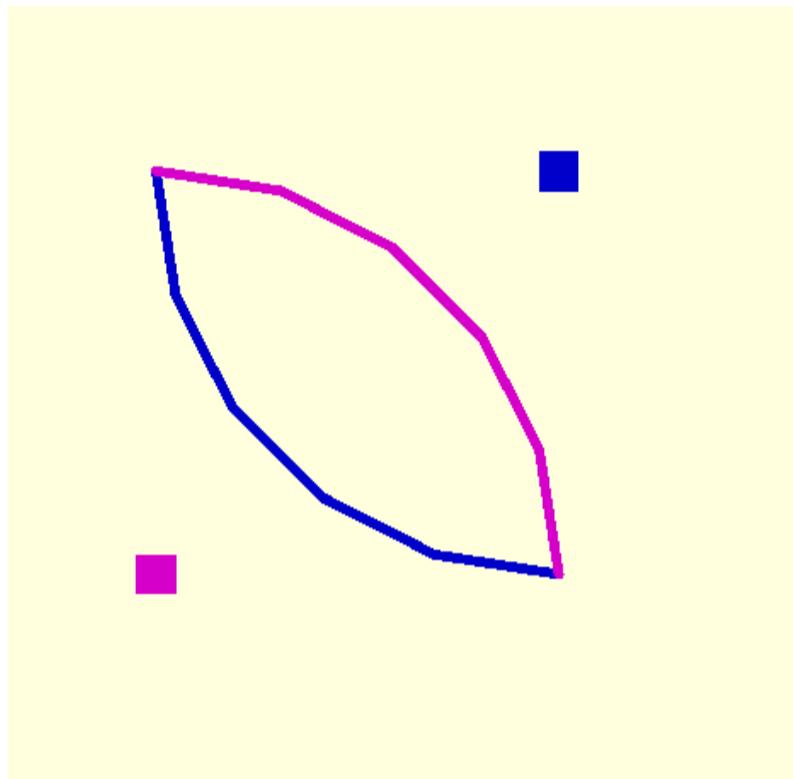
arc2=arc_2p(p1,p2,2,-1,5)
cp2=arc_2p_cp(p1,p2,2,-1)

fileopen(f'''

// arc clockwise with center point of the arc
color("blue")
{{p_lineo({arc1},.05);
points({[cp1]},.2);}}
```

```
// arc counter clockwise with center point of the arc
//color("magenta")
//{{p_lineo({arc2},.05);
//points({[cp2]},.2);}}
```

```
'')}
```



offset

In [42]: # example of function offset(sec,r)

```
t0=time.time()

# sec=corner_radius(pts1([[0,0,.2],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),20)

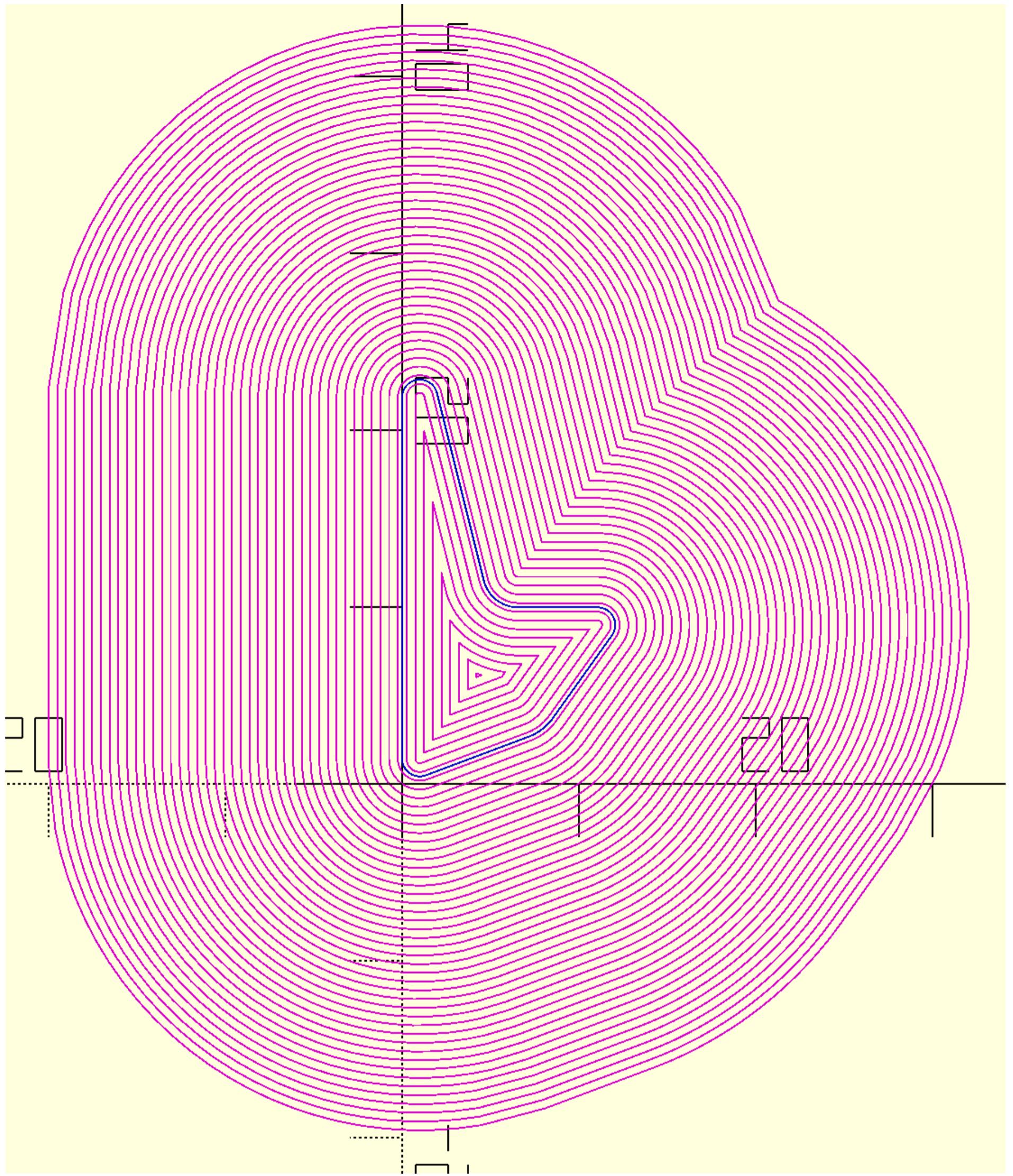
# sec=corner_radius(pts1([[0,0,1],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),10)
# sec=corner_radius(pts1([[0,0,1],[7,5,2],[5,7,3],[-5,7,2],[-7,5,3]]),10)
sec=corner_radius(pts1([[ -15,0,2.4],[0,15,3],[30,0,3],[0,-15,2.4],[5,0,2.4],[0,20,7],[-40,0,7],[0,-20,2.4]]),15)
# sec=corner_radius(pts1([[0,0,1],[10,0,1],[0,5,1],[-10,0,1]]),10)
# sec=circle(10)
# sec=pts([[0,0],[10,0],[0,5],[-10,0]])

# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,4.2],[-4.2,0]]),40)
# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,5.3],[-5.3,0]]),40)
# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,2],[-2,0]]),20)
os=linspace(-2.5,50,50)
sec1=[offset(sec,i) for i in os] #
fileopen(f'''

color("magenta")for(p={sec1})p_line(p,.1);
color("blue")p_line({sec},.1);

'''')
t1=time.time()
t1-t0
```

Out[42]: 11.975712060928345

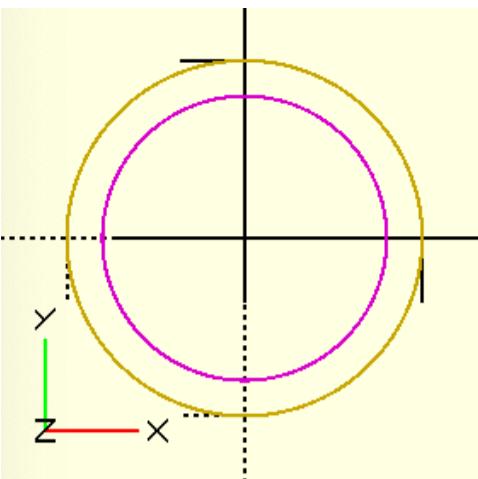


```
In [43]: t0=time.time()
r=2
# sec=corner_radius(pts1([[0,0,1],[7,5,2],[5,7,3],[-5,7,5],[-7,5,5]]),10)
sec=circle(10,s=200)
sec1=offset(sec,r)

fileopen(f'''
p_line({sec},.2);
color("magenta")p_line({sec1},.2;
''')

t1=time.time()
t1-t0
```

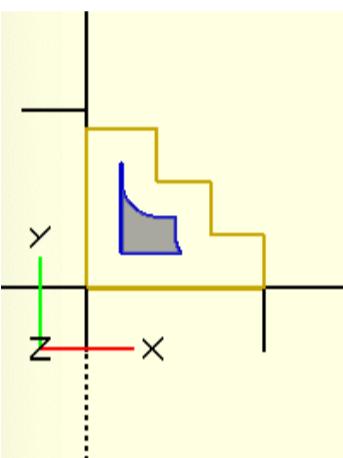
```
Out[43]: 0.05476093292236328
```



```
In [44]: sec=corner_radius(pts1([[0,0,.1],[10,0,.1],[0,3,.1],[-3,0,.1],[0,3,.1],[-3,0,.1],[0,3,.1],[-4,0,.1]]),20)

# sec=corner_radius(pts1([[0,0,1],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),40)
# sec=sec=corner_radius(pts1([[0,0,1],[7,5,2],[5,7,3],[-5,7,2],[-7,5,3]]),20)
# sec=corner_radius(pts1([[-15,0,2.49],[0,15,3],[30,0,3],[0,-15,2.49],[5,0,2.49],[0,20,7],[-40,0,7],[0,-20,2.49]]),20)
# sec=circle(10)
d=2

fileopen(f''''
p_line({sec},.2);
color("blue")p_line({offset(sec,d)},.2);
%offset({d})polygon({sec});
'''')
```



prism

```
In [45]: # example of function prism(sec,path) and function swp_prism_h(prism_big, prism_small)
t0=time.time()

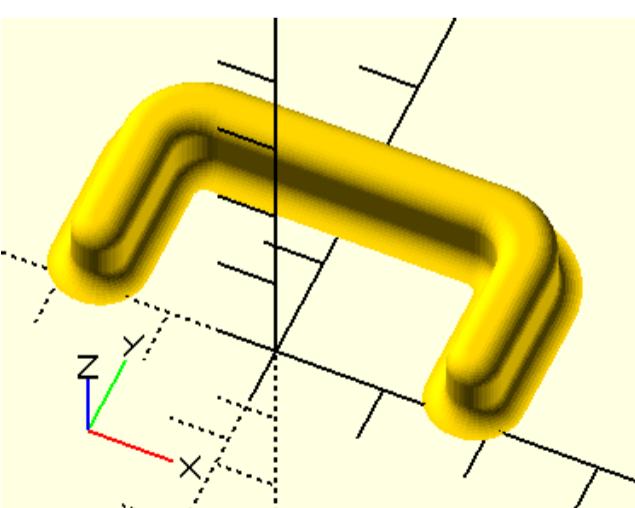
# sec=corner_radius(pts1([[0,0,.2],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),20)
# sec=corner_radius(pts1([[0,0,1],[7,5,2],[5,7,3],[-5,7,2],[-7,5,3]]),20)
sec=corner_radius(pts1([[-15,0,2.4],[0,15,3],[30,0,3],[0,-15,2.4],[5,0,2.4],[0,20,7],[-40,0,7],[0,-20,2.4]]),10)
# sec=pts([[0,0],[10,0],[0,5],[-10,0]])
# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,4.2],[-4.2,0]]),20)
# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,5.2],[-5.2,0]]),20)
path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,2],[-2,0]]),10)

sol=prism(sec,path)

fileopen(f''''
{swp(sol)}
''')

t1=time.time()
t1-t0
```

Out[45]: 0.22540521621704102



f_prism(sec,path)

```
In [46]: # example of function prism(sec,path) and function swp_prism_h(prism_big, prism_small)
t0=time.time()

# sec=corner_radius(pts1([[0,0,.2],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),20)
sec=corner_radius(pts1([[0,0,1],[7,5,2],[5,7,3],[-5,7,2],[-7,5,3]]),20)
# sec=corner_radius(pts1([[-15,0,2.4],[0,15,3],[30,0,3],[0,-15,2.4],[5,0,2.4],[0,20,7],[-40,0,7],[0,-20,2.4]]),20)
# sec=pts([[0,0],[10,0],[0,5],[-10,0]])
```

```

# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,4.2],[-4.2,0]]),20)
path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,5.2],[-5.2,0]]),20)
# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,2],[-2,0]]),20)

sol=f_prism(sec,path)
# sol1=f_prism(sec,path_offset(path,-.5))
# sol2=f_swp_prism_h(sol,sol1)

fileopen(f'''
{swp(sol)}
''')

t1=time.time()
t1-t0

```

Out[46]: 0.6484940052032471

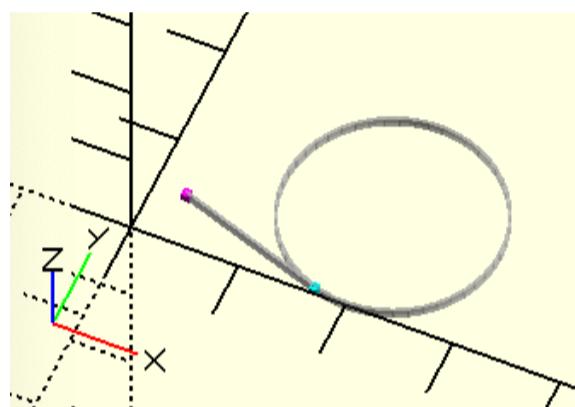
p_cir_t

```

In [47]: # example of function p_cir_t(pnt,cir)
cir=c3t2(translate([20,10,0],circle(10)))
point=[3,5]
tangent_point=p_cir_t(point,cir)
# tangent_point=point_to_circle_tangent(point,cir)
fileopen(f'''

%p_line({cir},.3);
color("magenta")points({[point]},.8);
color("cyan")points({[tangent_point]},.8);
%p_line({[point,tangent_point]},.3);
''')

```



v_sec_extrude

```

In [48]: # example of function v_sec_extrude(sec,path,o)

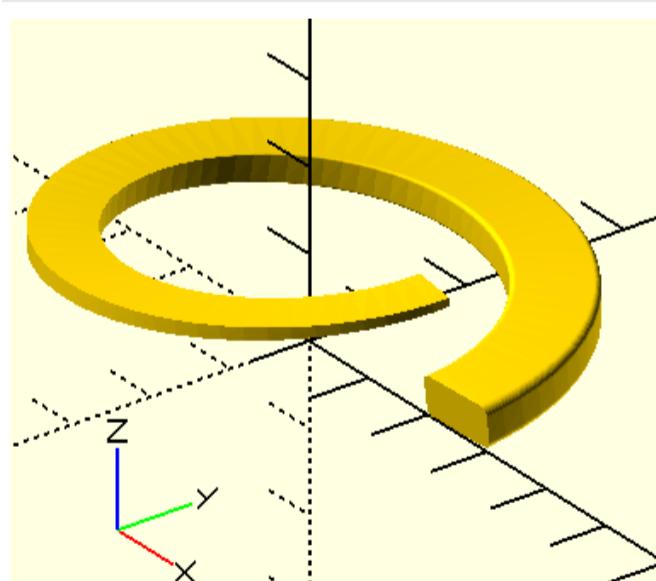
sec=corner_radius(pts1([[0,0,1],[10,0,1],[0,5,1],[-10,0,1]]),10)
path=helix(20,15,1,5)

sol=v_sec_extrude(sec,path,-2)

fileopen(f'''

{swp(sol)}
'''')

```



t_cir_tarc

```

In [49]: # example of function t_cir_tarc(r1,r2,cp1,cp2,r,side=0,s=50)

r=17
arc1=t_cir_tarc(10,5,[0,0],[-15,10],r,0,20)

c1=circle(10)
c2=circle(5,[-15,10])
arc1=two_circles_tangent_arc(c1,c2,r,0,20)
fileopen(f'''

%p_line({c1},.05);
%p_line({c2},.05);

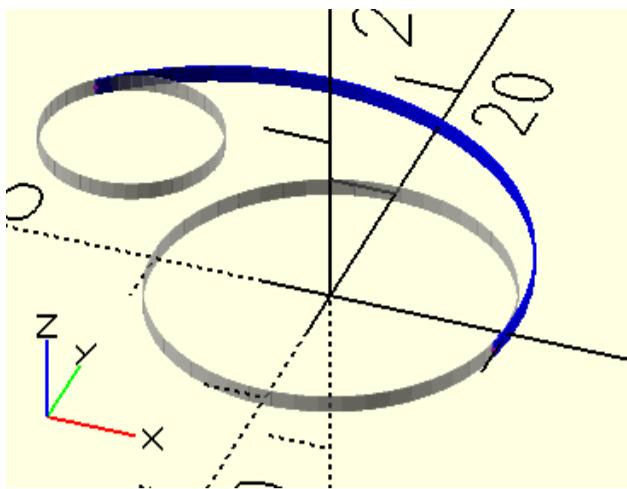
```

```

arc1={arc1};
color("blue") p_lineo(arc1,.1);
color("magenta") points({[arc1[0],arc1[-1]}},.2);

""")

```



In [50]: # example of function two_circles_tangent_arc

```

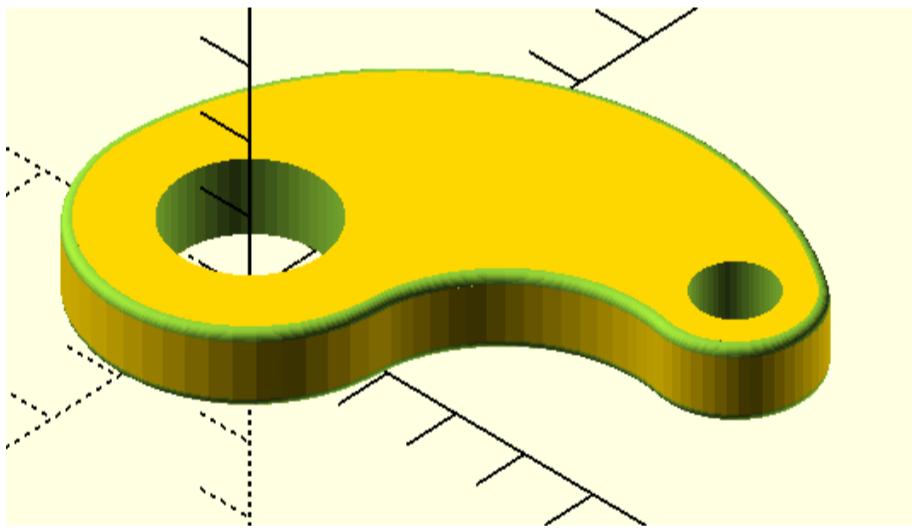
t0=time.time()
c1=circle(20)
c2=circle(10,rot2d(30,[52.5,0]))
a1=two_cir_tarc(c2,c1,45)
a2=two_cir_tarc(c1,c2,20)
sec1=concave_hull(c1+c2+a1+a2,5)
c3=circle(10)
c4=circle(5,rot2d(30,[52.5,0]))
s1=linear_extrude(sec1,10)
s2,s3=[translate([0,0,0],linear_extrude(p,10)) for p in [c3,c4]]
e1=end_cap(s1,2)
e2=end_cap_1(s2,2)
e3=end_cap_1(s3,2)
fileopen(f"""

difference(){
{swp(s1)}
for(p=[s2,s3])swp(p);
for(p={e1})swp_c(p);
for(p={e2})swp(p);
for(p={e3})swp(p);
}
""")
t1=time.time()
t1-t0

```

/Users/sanjeevprabhakar/python_openscad/openscad2.py:7983: RuntimeWarning: invalid value encountered in divide
u4=(v4/norm(v4, axis=1).reshape(-1,1)).round(4)

Out[50]: 1.905083179473877



tcct

In [51]: # example of function tcct(r1,r2,cp1,cp2,cw=-1)

```

c1=circle(10)
c2=circle(5,[15,-8])

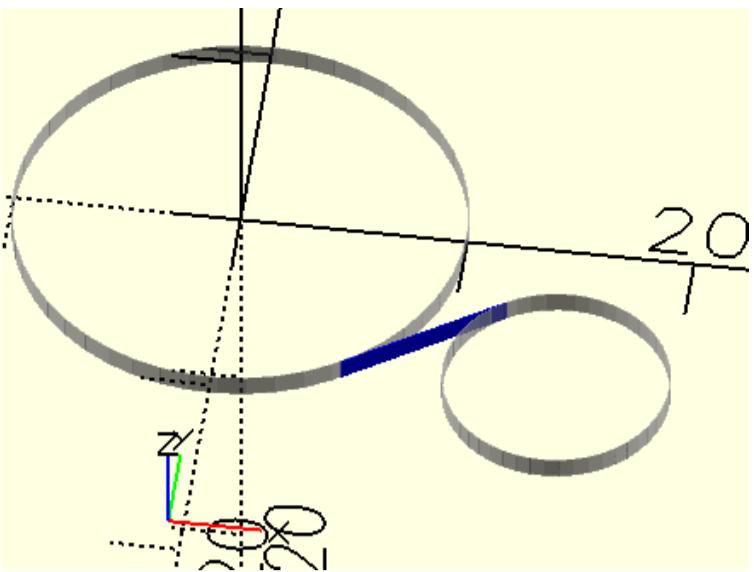
line= tcct(10,5,[0,0],[15,-8],cw=-1)

fileopen(f"""

%p_line({c1},.05);
%p_line({c2},.05);
color("blue") p_lineo({line},.05);

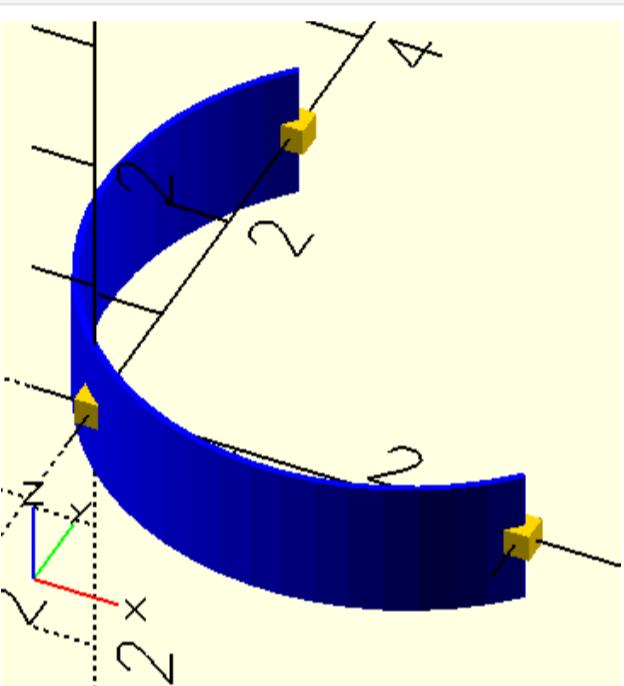
""")

```



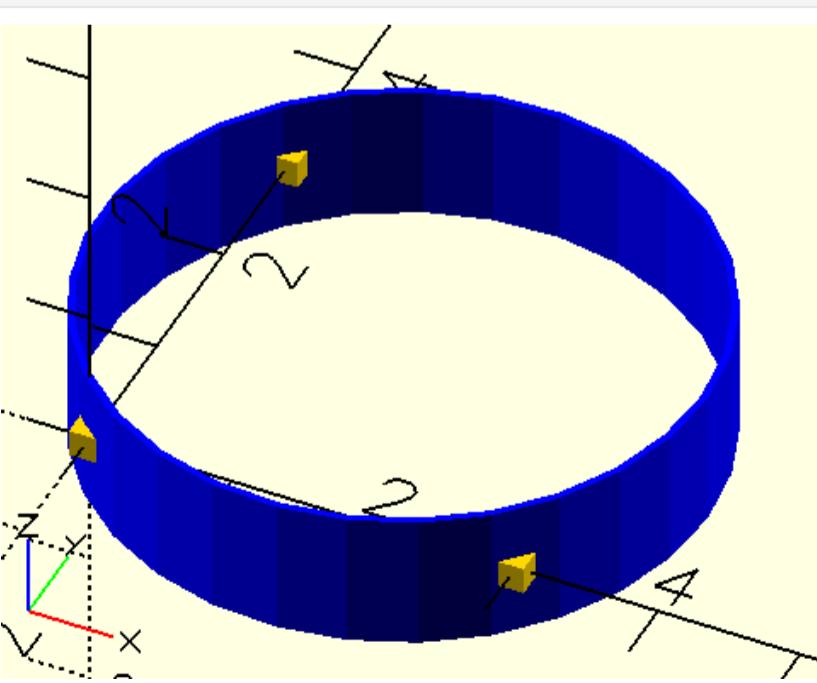
arc_3p

```
In [52]: # example of function arc_3p(p1,p2,p3,s=30)
p1,p2,p3=[3,0],[0,0],[0,3]
arc1=arc_3p(p1,p2,p3)
fileopen(f''''
color("blue") p_lineo({arc1},.05);
points({[p1,p2,p3]},.2);
'''')
```



cir_3p

```
In [53]: # example of function cir_3p(p1,p2,p3,s=30)
p1,p2,p3=[3,0],[0,0],[0,3]
cir=cir_3p(p1,p2,p3,30)
fileopen(f''''
color("blue") p_lineo({cir},.05);
points({[p1,p2,p3]},.2);
'''')
```



cp_3p

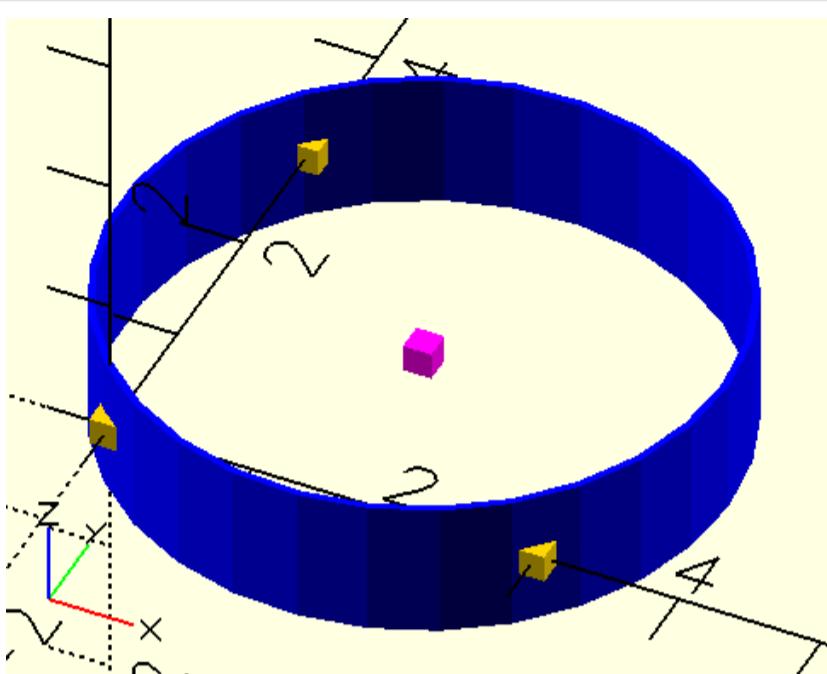
```
In [54]: # example of function cp_3p(p1,p2,p3)
p1,p2,p3=[3,0],[0,0],[0,3]
```

```

cir=cir_3p(p1,p2,p3,30)
center= cp_3p(p1,p2,p3)
fileopen(f''''

color("blue") p_line({cir},.05);
points({[p1,p2,p3]},.2);
color("magenta")points({[center]},.2);
''')

```



pies1

```

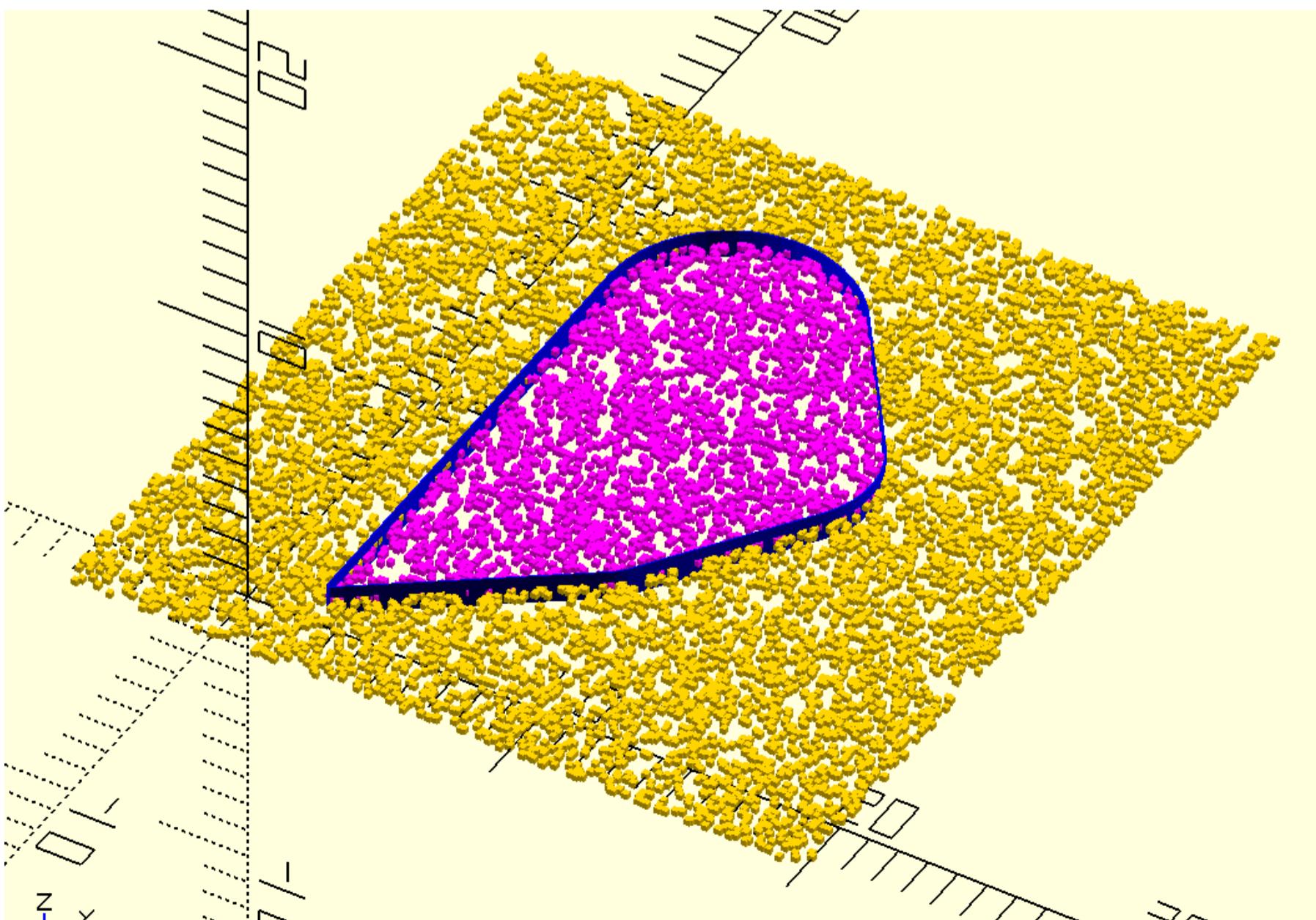
In [55]: # example of function pies1(sec,pnts)
# function points inside enclosed section
t0=time.time()
a=random.random(10000)*(20-(-5))+(-5)
b=random.random(10000)*(25-(-2))+(-2)
points=array([a,b]).transpose(1,0).tolist()
# sec=corner_radius(pts1([[2,1,.1],[7,5,2],[5,7,3],[-5,7,2],[-7,5,3]]),20)
sec=corner_radius(pts1([[8,0],[11,10,10],[0,10,5],[-10,0,5],[-1,-6,0.3],[-1,6,5],[-10,0,5],[0,-10,10]]))

fileopen(f'''

color("blue") p_line({sec},.05);
points({points},.2);
color("magenta")points({pies1(sec,points)},.2);
''')
t1=time.time()
t1-t0

```

Out[55]: 1.1195569038391113



```

In [56]: # example of pies1(sec,pnts)
t0=time.time()

```

```

a=random.random(10000)*(10-0)+0
b=random.random(10000)*(20-0)+0
c=array([a,b]).transpose(1,0).tolist()

sec=corner_radius(pts1([[1.5,8,.9],[2,0,.9],[0,-3,1.4],[3,0,1.4],[0,4,1.9],[-5,0,2.5],[0,6,2.5],
[7,0,2.5],[0,-4,.9],[-2,0,.9],[0,3,1.4],[-3,0,1.4],[0,-4,1.9],
[5,0,2.5],[0,-6,2.5],[-7,0,2.5]]),20)

pnts=pies1(sec,c)
pnts1=pies1(offset(sec,-.45),pnts)

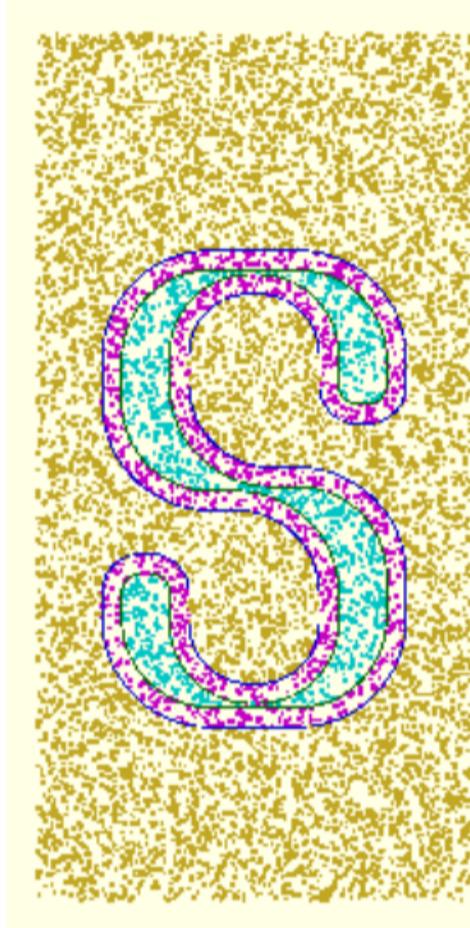
fileopen(f''''
points({c},.1);
color("magenta")points({pnts},.1);
color("cyan")points({pnts1},.1);
color("blue")p_line({sec},.05);
color("green")p_line({offset(sec,-.45)},.05);

'''')

t1=time.time()
t1-t0

```

Out[56]: 3.4311299324035645



swp_prism_h

surface_thicken_1

```

In [57]: # example of function swp_prism_h(prism_big,prism_small)

sec1=circle(10)
path=corner_radius(pts1([[2,0],[-2,0,2],[0,10,3],[-3,0]]),5)
sol=prism(sec1,path)
sol1=surf_offset(sol,-1)
sol2=swp_prism_h(sol,sol1)

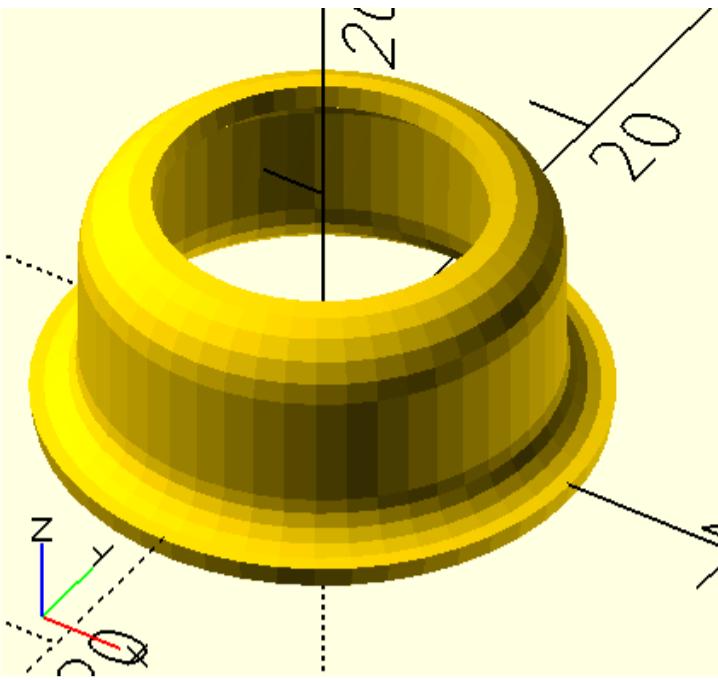
fileopen(f'''
{swp_c(sol2)}
'''')

```

```

In [ ]: # alternatively use function surface_thicken_1
sec1=circle(10)
path=corner_radius(pts1([[2,0],[-2,0,2],[0,10,3],[-3,0]]),5)
sol=prism(sec1,path)
sol2=surface_thicken_1(sol,1)
fileopen(f'''
{swp_c(sol2)}
'''')

```



```
In [58]: # example of function prism(sec,path) and function swp_prism_h(prism_big, prism_small)
t0=time.time()
# sec=corner_radius(pts1([[0,0,.2],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),20)
# sec=corner_radius(pts1([[0,0,1],[7,5,2],[5,7,3],[-5,7,5],[-7,5,5]]),20)
sec=corner_radius(pts1([[-15,0,2.4],[0,15,3],[30,0,3],[0,-15,2.4],[5,0,2.4],[0,20,7],[-40,0,7],[0,-20,2.4]]),20)
# sec=pts([[0,0],[10,0],[0,5],[-10,0]])
# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,4.2],[-4.2,0]]),20)
# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,5.2],[-5.2,0]]),20)
# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,2],[-2,0]]),20)

# sec=equidistant_pathc(sec,300)
sec1=offset(sec,.5)

sol=linear_extrude(sec,50)
sol1=linear_extrude(sec1,50)
sol2=swp_prism_h(sol1,sol)

fileopen(f'''
{swp_c(sol2)}
''')

t1=time.time()
t1-t0
```

Out[58]: 0.05268073081970215

```
In [59]: sec=corner_radius(pts1([[0,0,1],[25,0,1],[0,15,1],[-25,0,1]]),10)
sec1=offset(sec,2)
sol=linear_extrude(sec,10)
sol1=linear_extrude(sec1,10)
sol2=swp_prism_h(sol1,sol)

fileopen(f'''
{swp_c(sol2)}
''')
```

```
In [60]: sec=corner_radius(pts1([[0,0,1],[15,0,1],[0,10,1],[-15,0,1]]),10)
sec1=offset(sec,2)
sol=linear_extrude(sec,10)
sol1=linear_extrude(sec1,10)
sol2=swp_prism_h(sol1,sol)

fileopen(f'''
{swp_c(sol2)}
''')
```

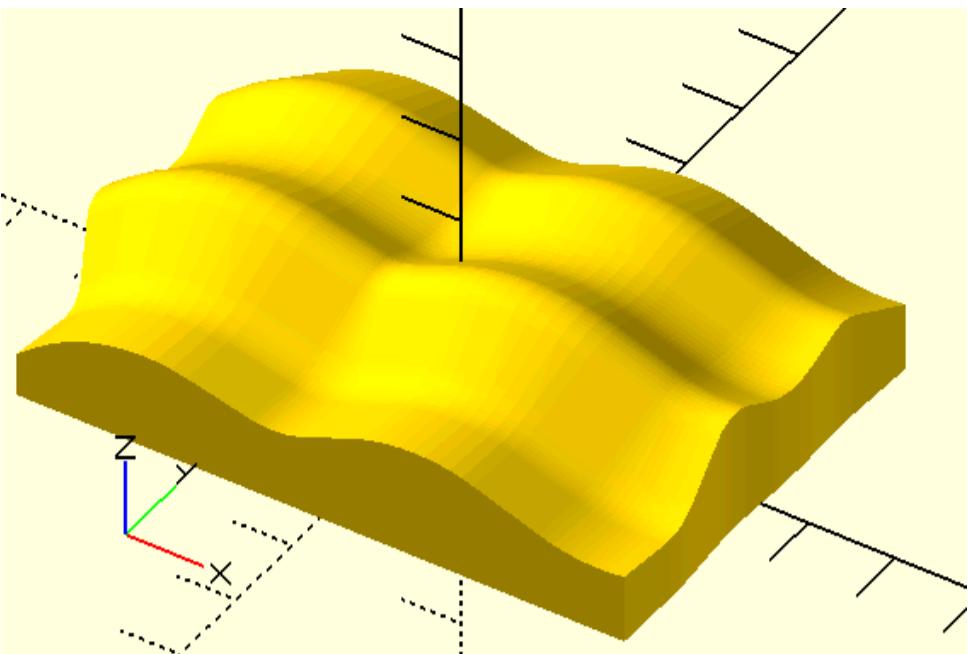
surf_base

```
In [61]: # example of function surf_base(surf,h)
t0=time.time()

sec2=corner_radius(pts1([-25,0],[10,5,5],[10,-3,10],[10,5,5],[10,-8,7],[10,1,1]),10)
path2=cytz(corner_radius(pts1([-35,5,0],[10,8,20],[20,-5,10],[20,8,20],[10,-9,20],[10,1,0])),10))
surf2=surf_extrude(sec2,path2)
sol=surf_base(surf2,0)
fileopen(f'''

difference() {{
{swp(sol)}
//{swp(cut_plane([0,0,1],[15,10],20,10))}}
''')
t1=time.time()
total=t1-t0
total
```

Out[61]: 0.06041431427001953

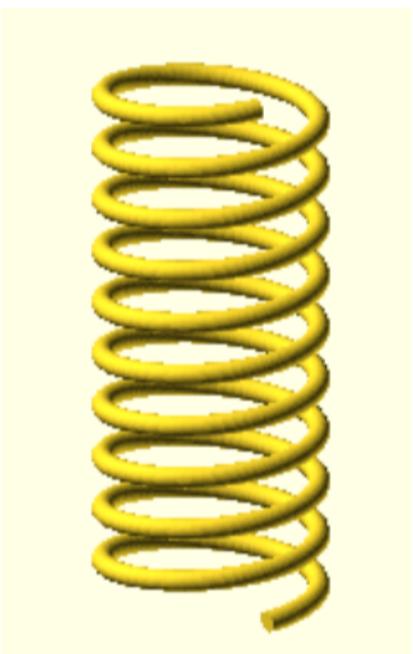


helix

```
In [62]: # example of function helix(radius=10,pitch=10, number_of_coils=1, step_angle=1)

path=helix(10,5,10,5)
sec=circle(1)
sol=path_extrude_open(sec,path)
fileopen(f'''

//p_line3d({path},1,$fn=20);
{swp(sol)}
''' )
```



offset_points_cw

```
In [63]: # example of function offset_points_cw(sec,r)

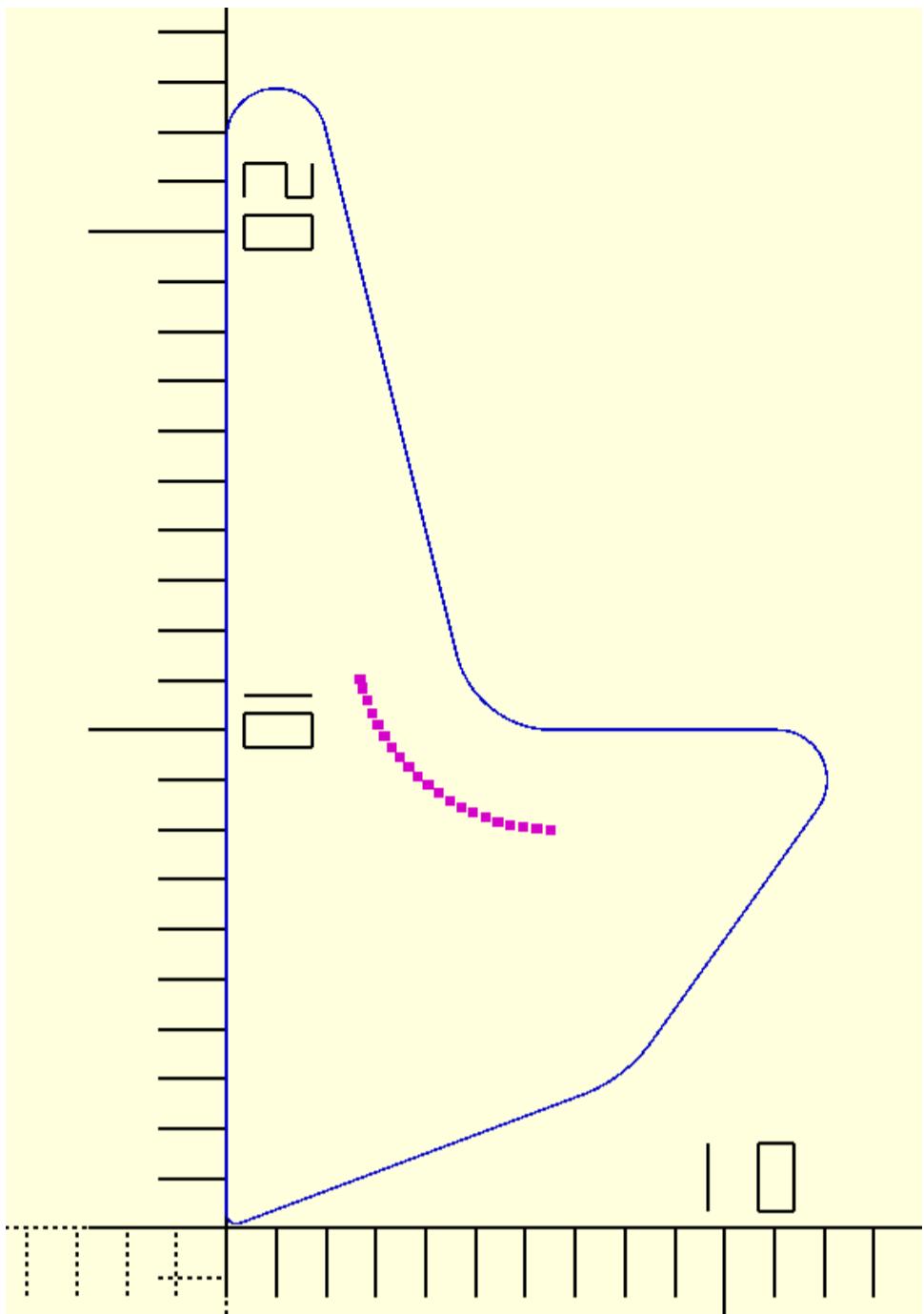
sec=corner_radius(pts1([[0,0,.2],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),20)
# sec=corner_radius(pts1([[0,0,.1],[7,5,2],[5,7,3],[-5,7,2],[-7,5,3]]),20)
# sec=corner_radius(pts1([[-15,0,2.4],[0,15,3],[30,0,3],[0,-15,2.4],[5,0,2.4],[0,20,7],[-40,0,7],[0,-20,2.4]]),20)

# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,4.2],[-4.2,0]]),40)
# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,5.3],[-5.3,0]]),40)
# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,2],[-2,0]]),20)

offsetPoints=offset_points_cw(sec,-2)
fileopen(f'''

color("blue")p_line({sec},.05);
color("magenta")points({offsetPoints},.2);

''' )
```



offset_points_ccw

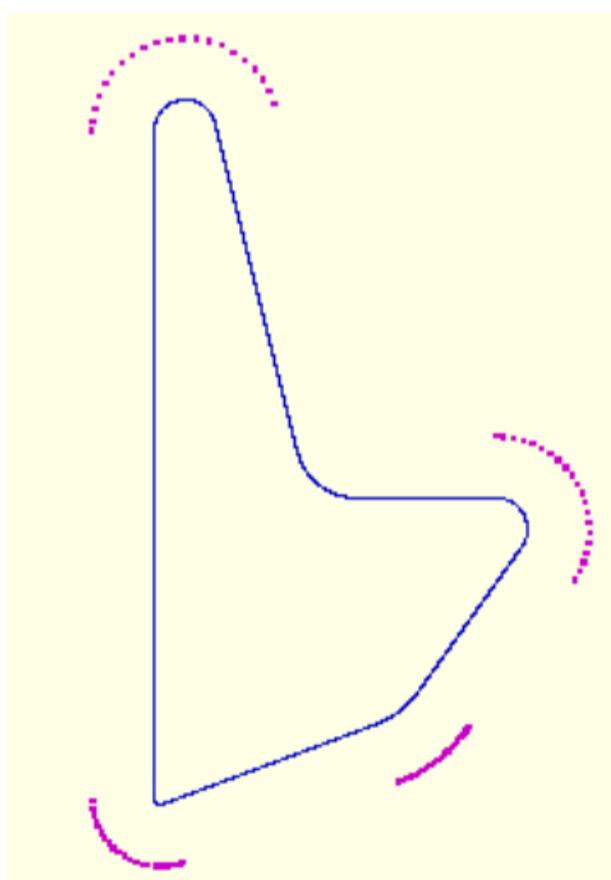
```
In [64]: # example of function offset_points_ccw(sec,r)

sec=corner_radius(pts1([[0,0,.2],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),20)
# sec=corner_radius(pts1([[0,0,.1],[7,5,2],[5,7,3],[-5,7,5],[-7,5,5]]),20)
# sec=corner_radius(pts1([[-15,0,2.4],[0,15,3],[30,0,3],[0,-15,2.4],[5,0,2.4],[0,20,7],[-40,0,7],[0,-20,2.4]]),20)

# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,4.2],[-4.2,0]]),40)
# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,5.3],[-5.3,0]]),40)
# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,2],[-2,0]]),20)

offsetPoints=offset_points_ccw(sec,2)

fileopen(f''''
color("blue")p_line({sec},.1);
color("magenta")points({offsetPoints},.2);
'''')
```



```
In [65]: # example of function cpo(prism)

sec=corner_radius(pts1([[0,0,.2],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),10)
# sec=corner_radius(pts1([[0,0,.1],[7,5,2],[5,7,3],[-5,7,5],[-7,5,5]]),20)
# sec=corner_radius(pts1([[-15,0,2.4],[0,15,3],[30,0,3],[0,-15,2.4],[5,0,2.4],[0,20,7],[-40,0,7],[0,-20,2.4]]),20)

path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,4.2],[-4.2,0]]),10)
# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,5.3],[-5.3,0]]),40)
# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,2],[-2,0]]),20)

sp1=translate([0,50,0],sphere(10,s=20))
sp2=translate([30,0,0],cpo(sp1))

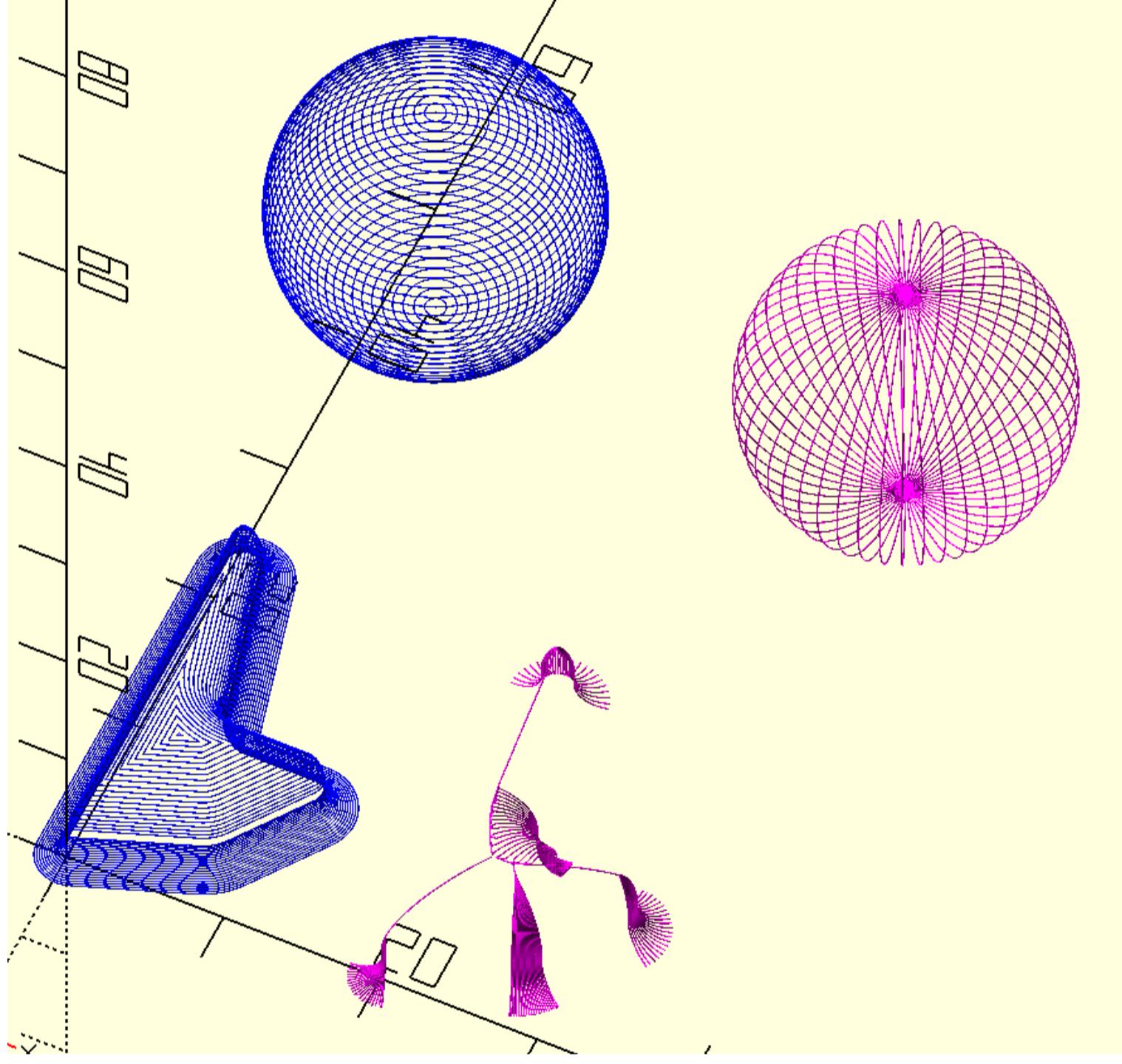
sol=prism(sec,path)
sol1=translate([20,0,0],cpo(sol))

fileopen(f'''
```

```
color("blue")for(p={sol})p_line3dc(p,.1,1);
color("magenta")for(p={sol1})p_line3d(p,.1,1);
```

```
color("blue")for(p={sp1})p_line3dc(p,.1,1);
color("magenta")for(p={sp2})p_line3d(p,.1,1);
```

```
'''')
```



fillet_3p_3d

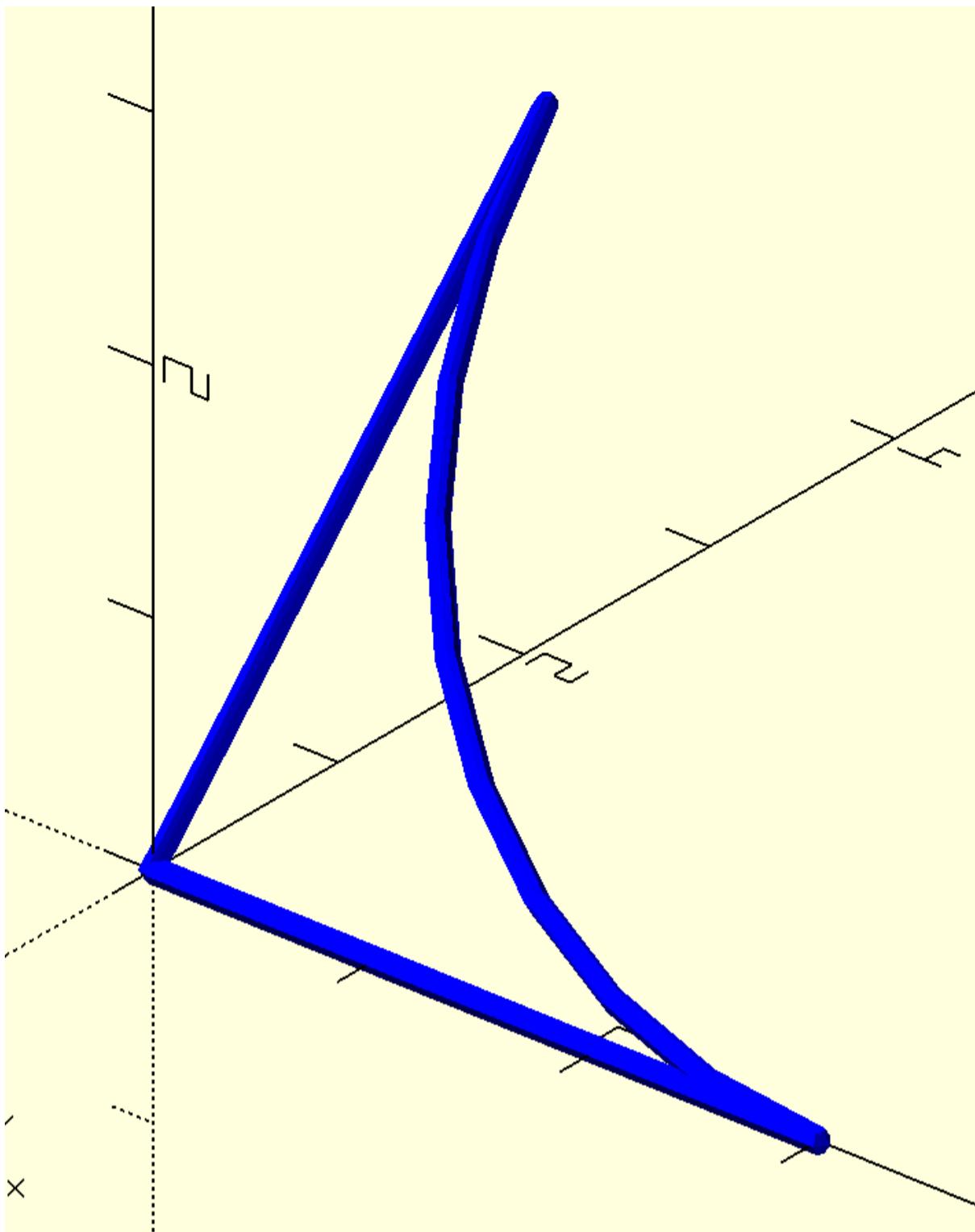
```
In [66]: # example of function fillet_3p_3d(p0,p1,p2,r,s)

p1,p2,p3=[[3,0,0],[0,0,0],[0,3,3]]
fillet=fillet_3p_3d(p1,p2,p3,3,10)

fileopen(f'''
```

```
color("blue")p_line3dc({fillet},.05);
color("cyan")points({[p1,p2,p3]},.2);
```

```
'''')
```



fillet_3p_3d_cp

```
In [67]: # example of function fillet_3p_3d_cp(p0,p1,p2,r)

p1,p2,p3=[[3,0,0],[0,0,0],[0,3,3]]
fillet=fillet_3p_3d(p1,p2,p3,3,10)[1:]
centerPoint=fillet_3p_3d_cp(p1,p2,p3,3)
cp1=cp_cir_3d(fillet)

fileopen(f'''

color("blue")p_line3d({fillet},.05);
%color("magenta",.2)points({[centerPoint]},.2);
color("cyan")points({[cp1]},.15);

''' )
```

arc_3p_3d

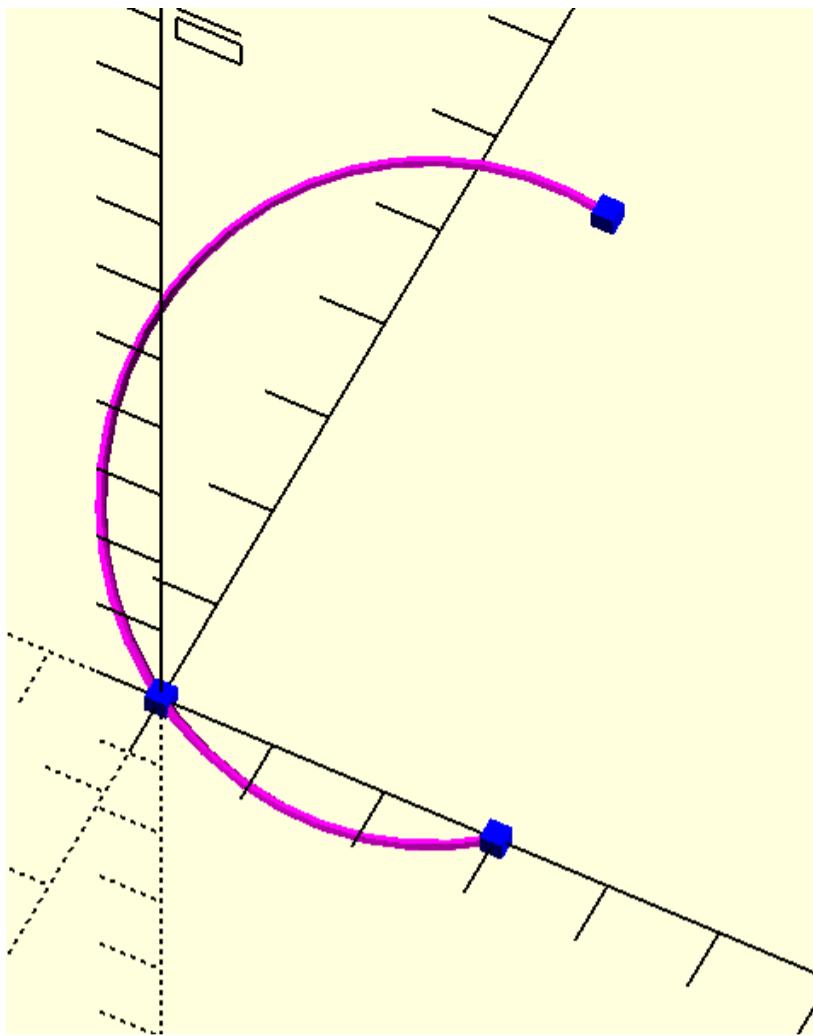
```
In [68]: # example of function arc_3p_3d(points,s)

p1,p2,p3=[[3,0,0],[0,1,0],[5,3,2]]
arc1=arc_3p_3d([p1,p2,p3],30)

fileopen(f'''

color("magenta")p_line3d({arc1},.05);
color("blue")points({[p1,p2,p3]},.2);

''' )
```



cir_3p_3d

cp_cir_3d

```
In [69]: # example of function cir_3p_3d(points,s)

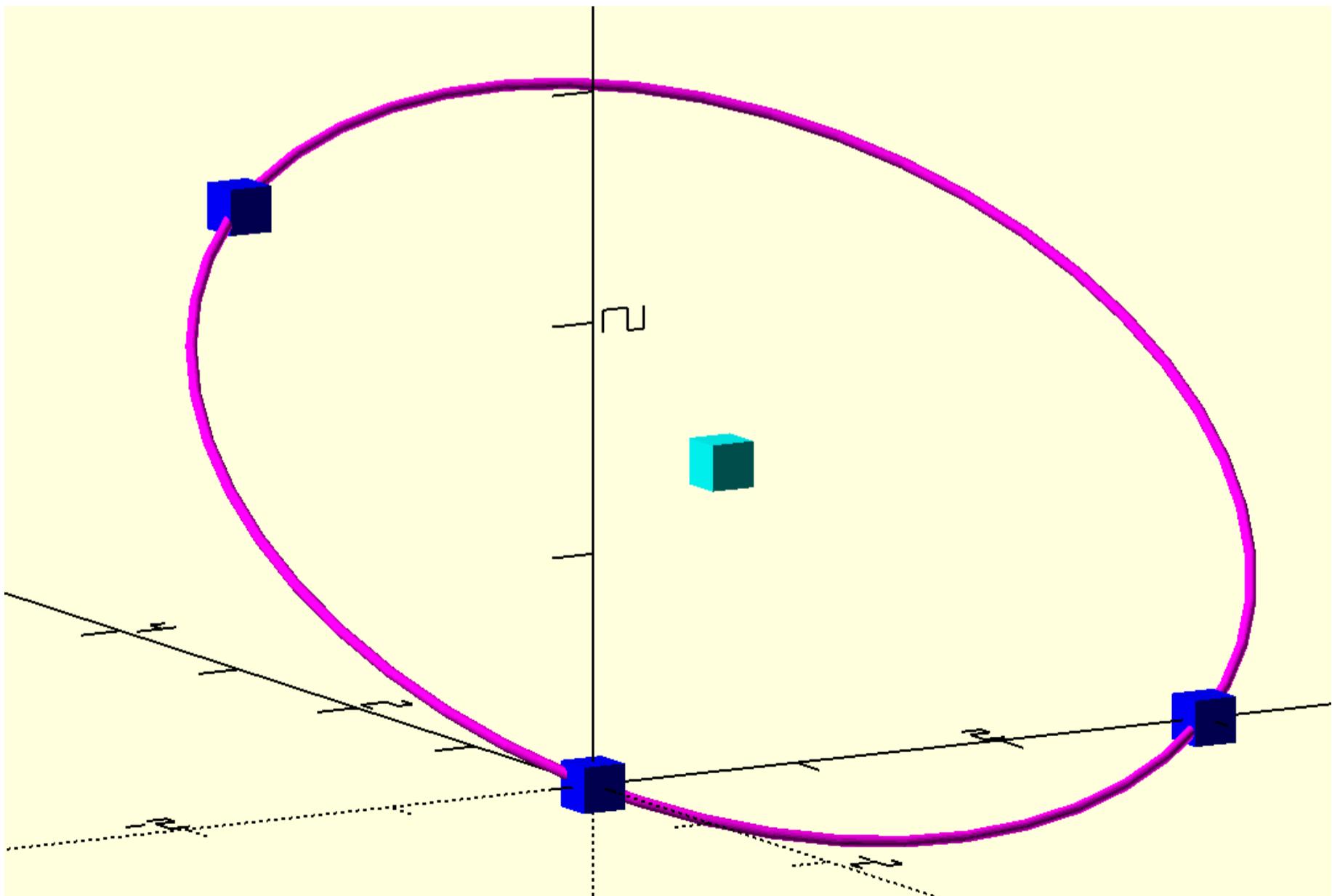
p1,p2,p3=[[3,0,0],[0,0,0],[0,3,2]]
cir=cir_3p_3d([p1,p2,p3],50)

cp1=cp_cir_3d(cir)

fileopen(f'''
```

```
color("magenta")p_line3dc({cir},.05);
color("blue")points({[p1,p2,p3]},.2);
color("cyan")points({[cp1]},.2);

...)
```

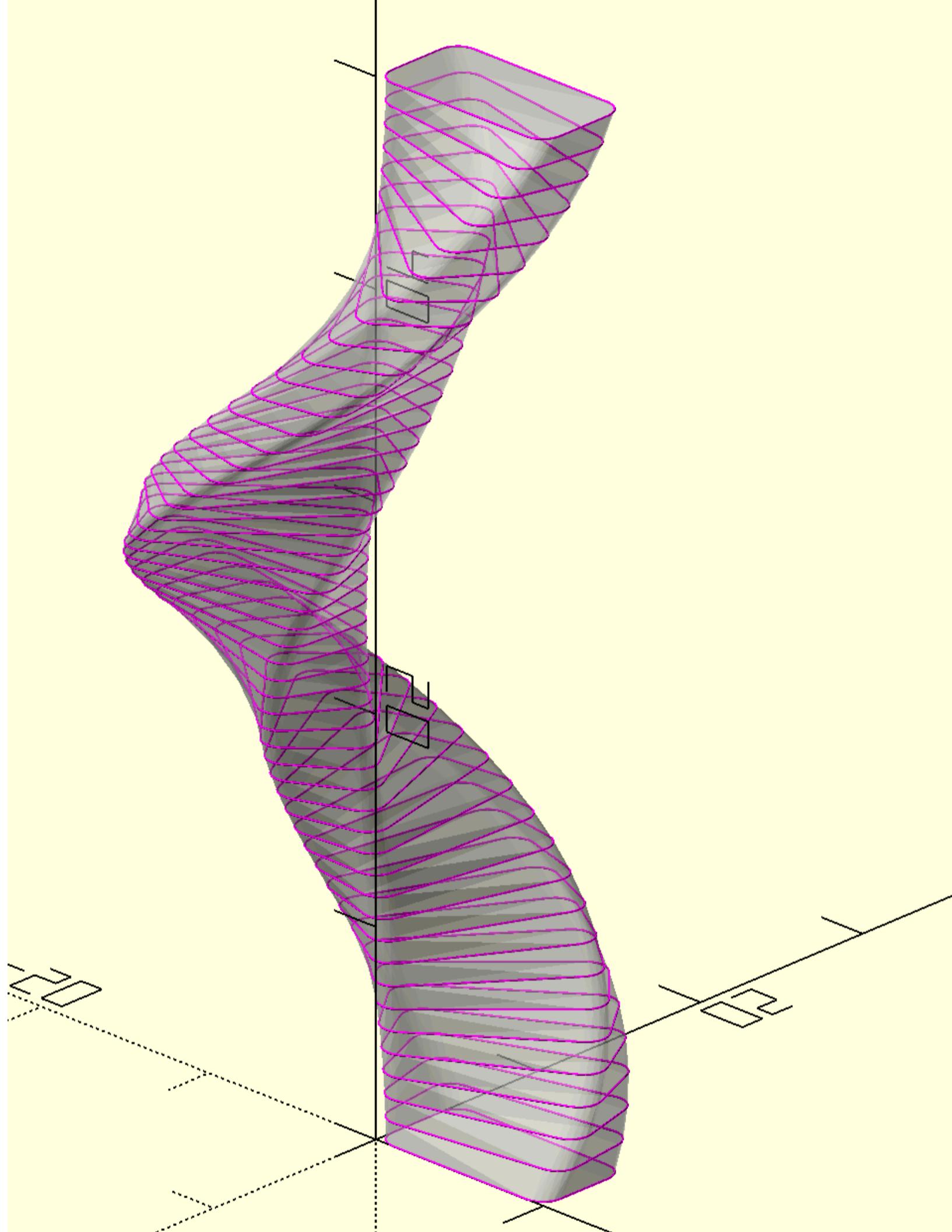


linear_extrude

```
In [70]: # example of function linear_extrude(sec,h=1,a=0,steps=1)

sec=corner_radius(pts1([[0,0,1],[10,0,1],[0,5,1],[-10,0,1]]),20)
sol=linear_extrude(sec,50,360,200)

fileopen(f'''
```



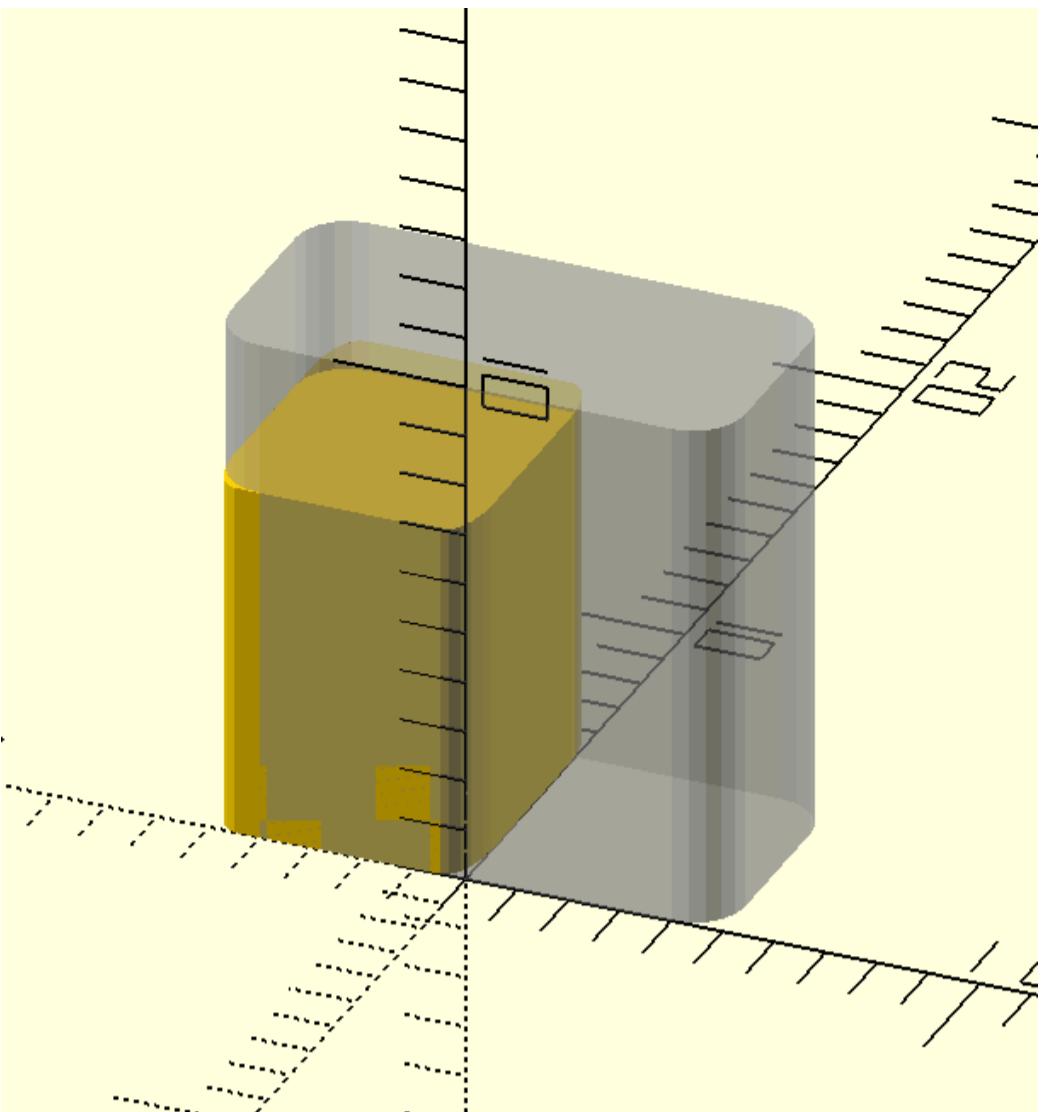
rsz3d

```
In [71]: # example of function rsz3d(prism,rsz)

sec=corner_radius(pts1([[0,0,1],[10,0,1],[0,5,1],[-10,0,1]]),5)
sol=translate([-5,0,0],linear_extrude(sec,10))
sol1=rsz3d(sol,[5,6,7])

fileopen(f'''
```

```
%{swp(sol)}
{swp(sol1)}
''' )
```



rsz3dc

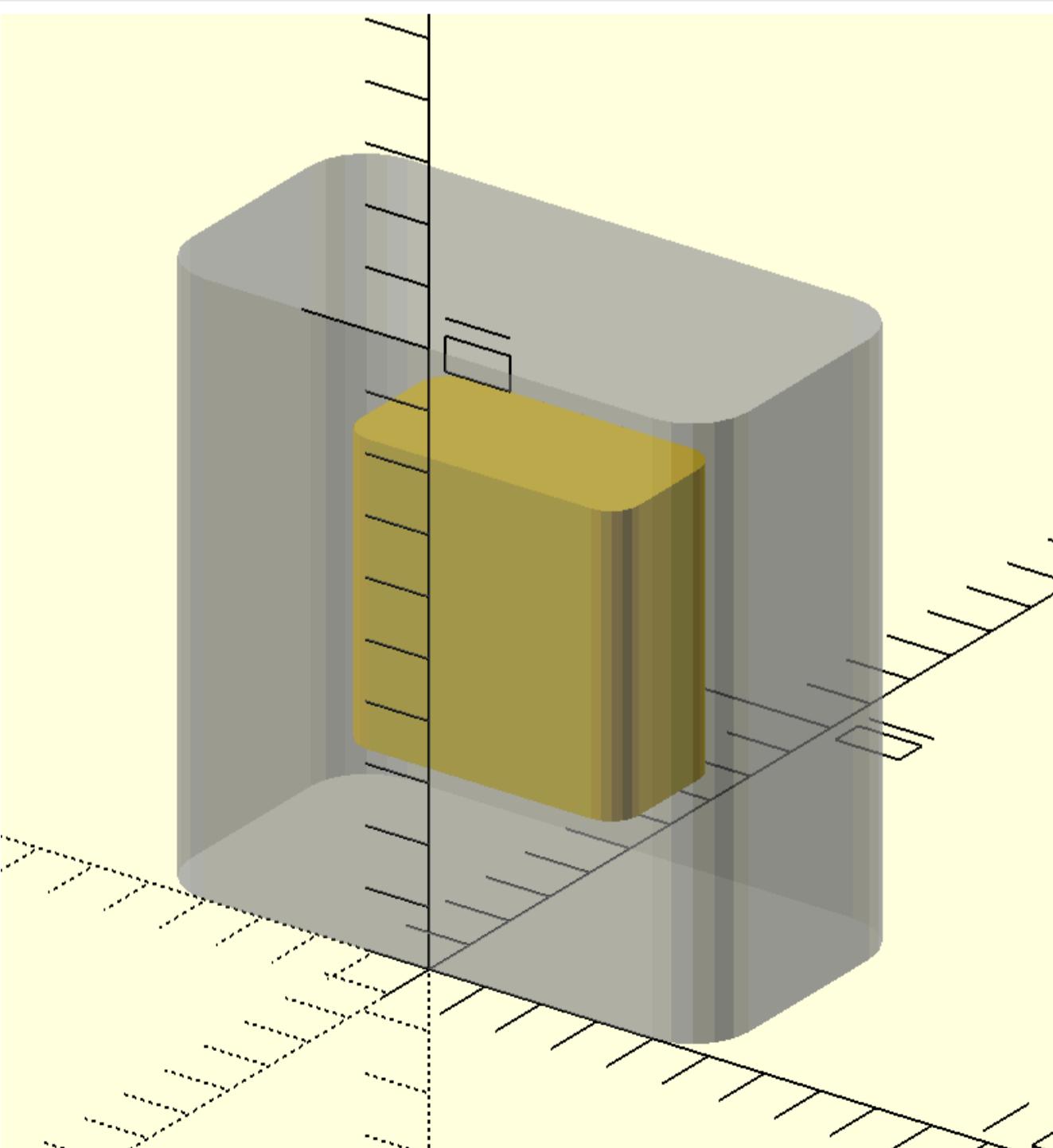
In [72]:

```
# example of function rsz3dc(prism,rsz)

sec=corner_radius(pts1([[0,0,1],[10,0,1],[0,5,1],[-10,0,1]]),5)
sol=translate([-5,0,0],linear_extrude(sec,10))
sol1=rsz3dc(sol,[5,2.5,5])

fileopen(f'''
```

```
%{swp(sol)}
{swp(sol1)}
''' )
```



bb

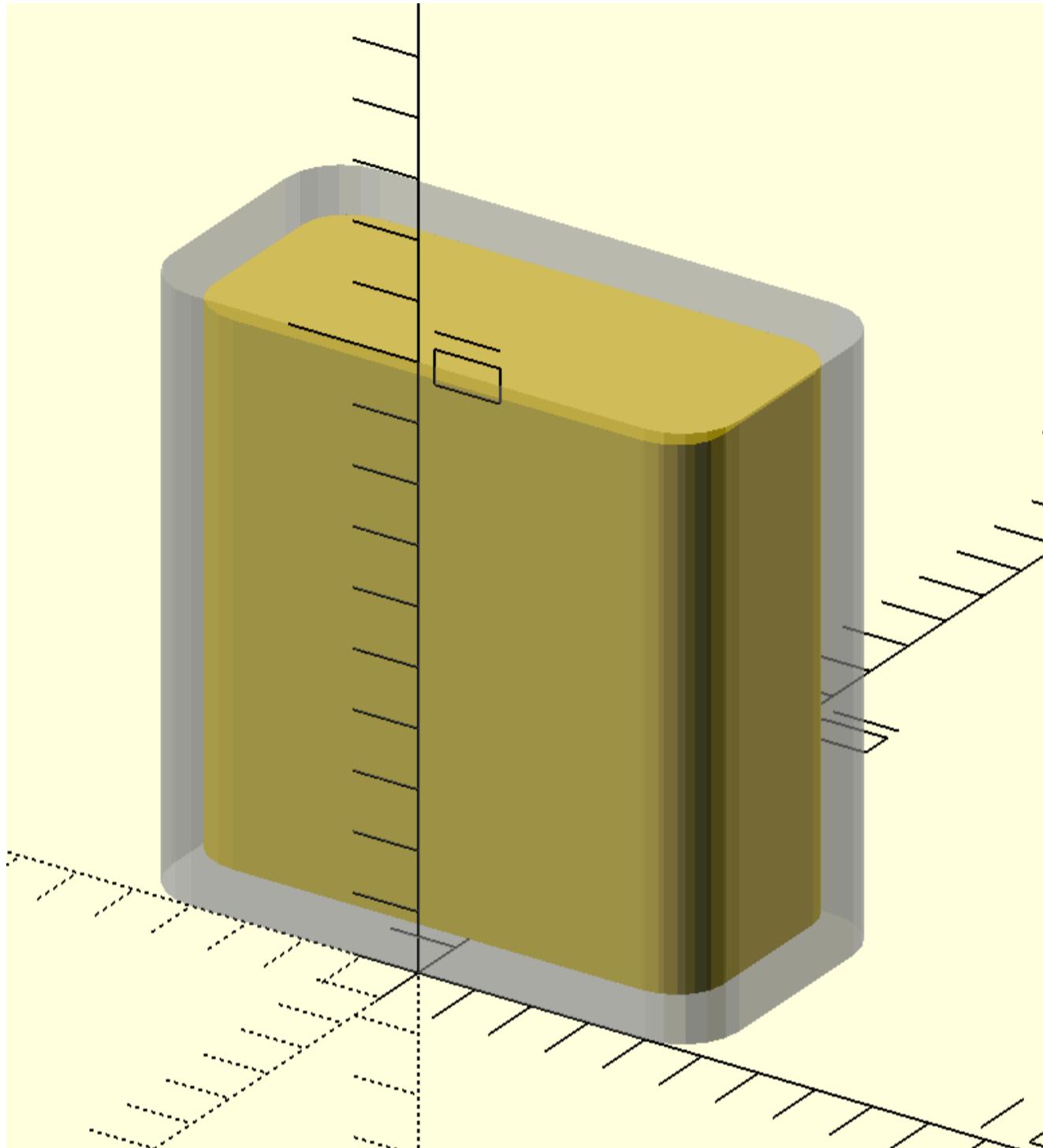
In [73]:

```
# example of function bb(prism)

sec=corner_radius(pts1([[0,0,1],[10,0,1],[0,5,1],[-10,0,1]]),5)
sol=translate([-5,0,0],linear_extrude(sec,10))
dim=bb(sol)
sol1=rsz3dc(sol,array(dim)-[2,2,2])

fileopen(f'''
```

```
%{swp(sol)}
{swp(sol1)}
'''')
```



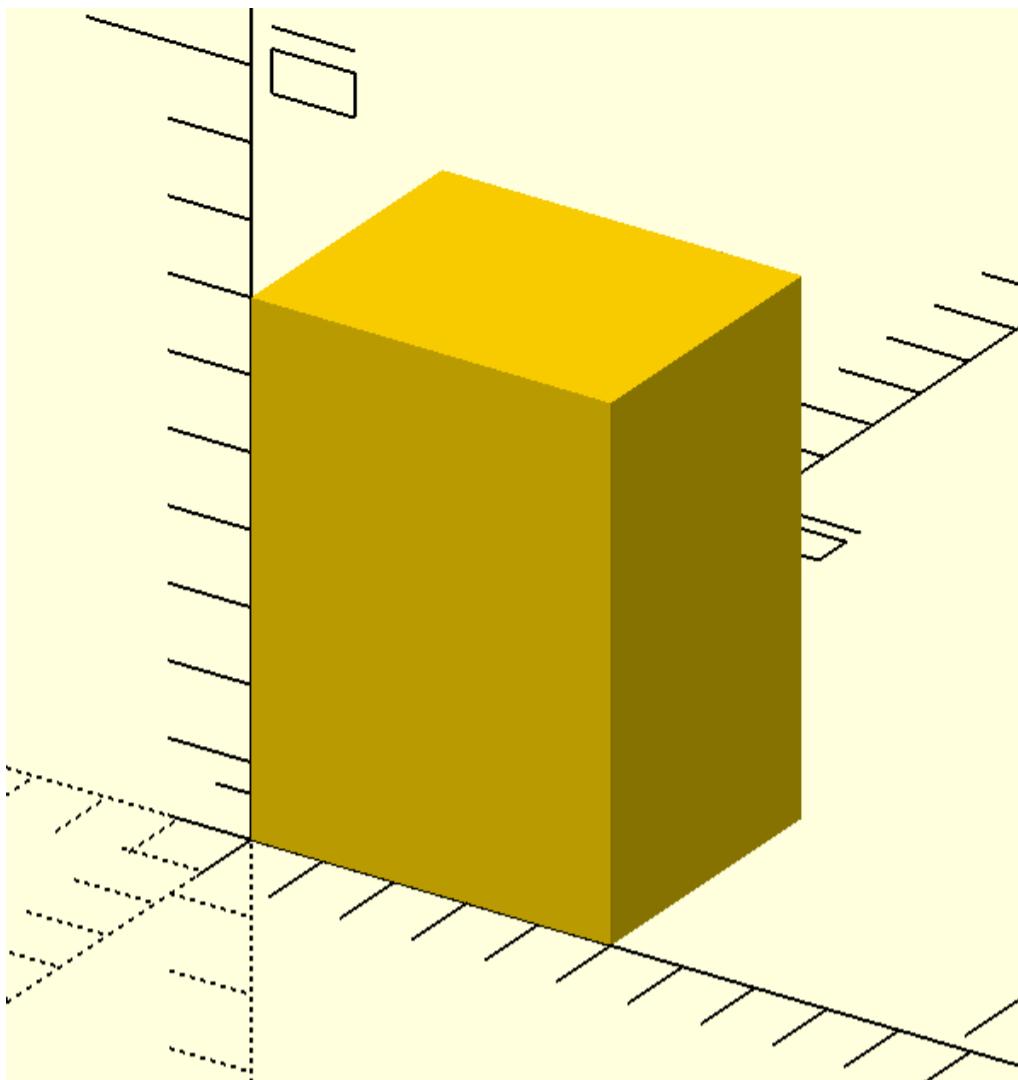
cube

In [74]:

```
# example of function cube(s,center=False)

sol=cube([5,4,7],False)
fileopen(f'''
```

```
%{swp(sol)}
'''')
```

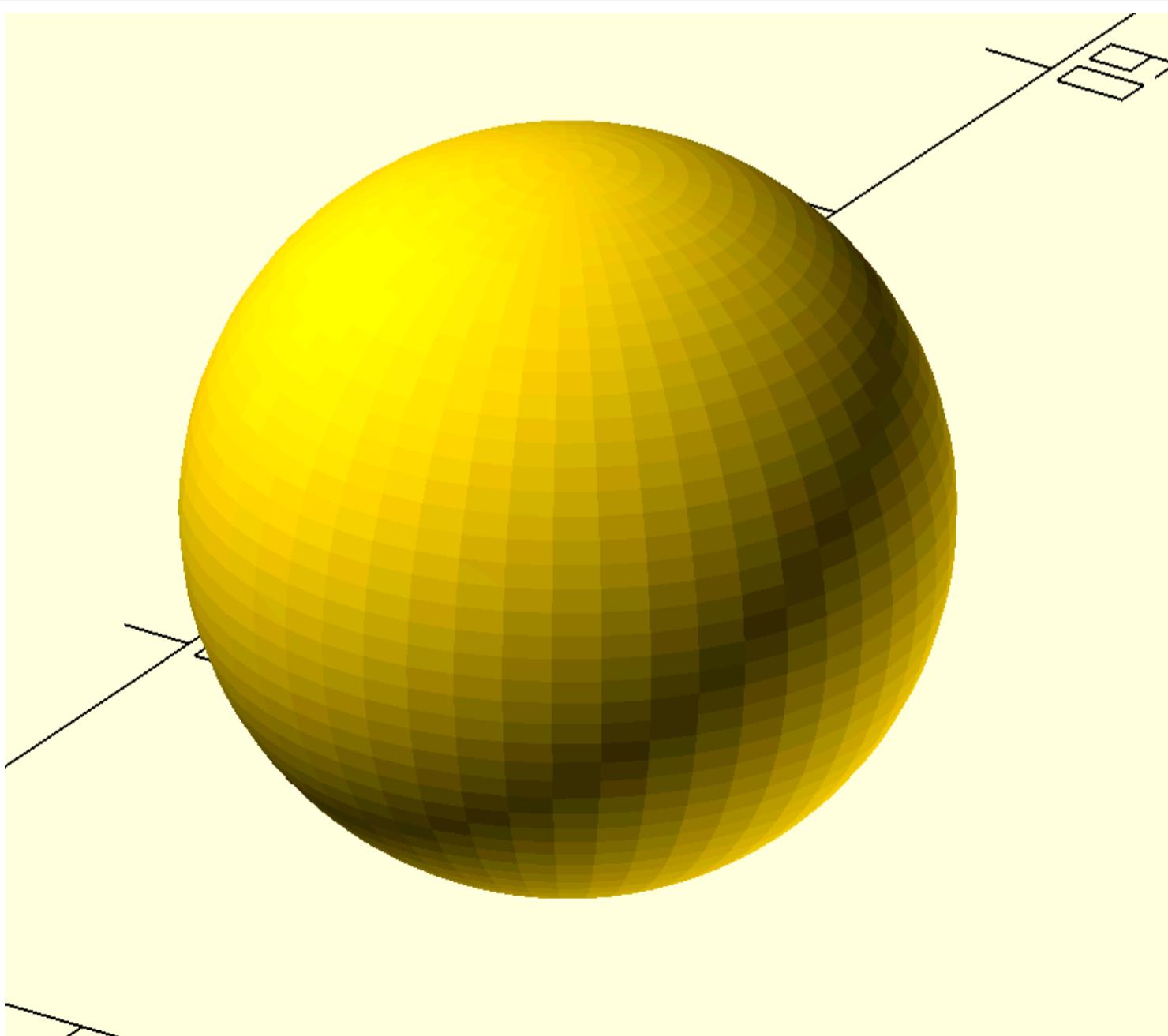


sphere

```
In [75]: # example of function sphere(r=0,c=[0,0,0],s=50)

sol=sphere(10,[15,15,10],30)

fileopen(f''''
difference(){
{swp(sol)}
//cube(10);
}
'''')
```



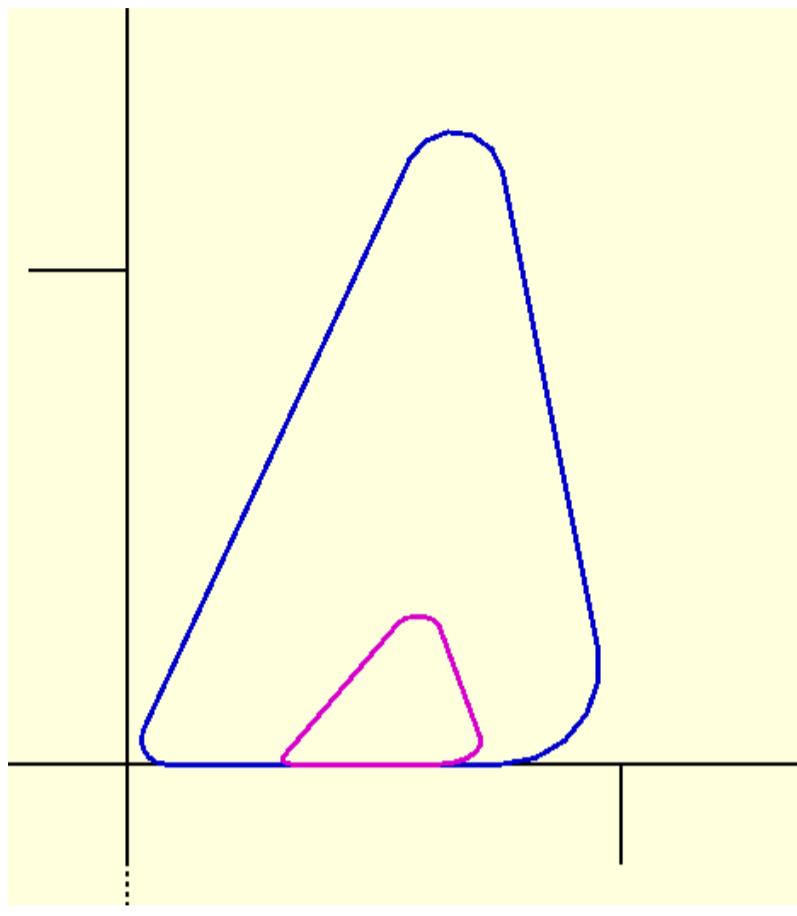
rsz2d

```
In [76]: # example of function rsz2d(sec,rsz)

sec=corner_radius([[0,0,.5],[10,0,2],[7,15,1]],5)
sec1=rsz2d(sec,[4,3])
fileopen(f''

color("blue")p_line({sec},.1);
color("magenta")p_line({sec1},.1);

'''')
```



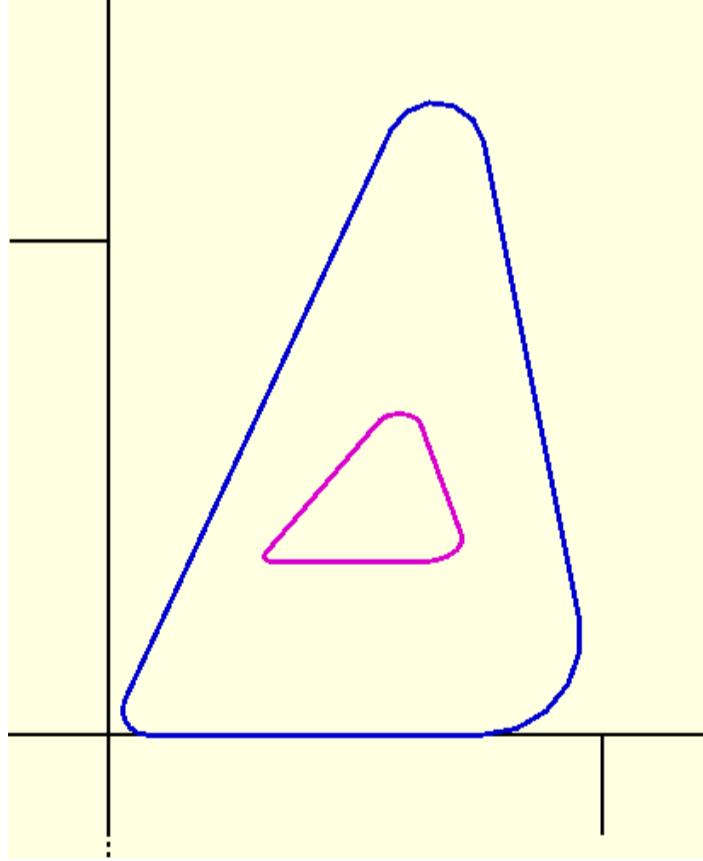
rsz2dc

```
In [77]: # example of function rsz2dc(sec,rsz)

sec=corner_radius([[0,0,.5],[10,0,2],[7,15,1]],5)
sec1=rsz2dc(sec,[4,3])
fileopen(f''

color("blue")p_line({sec},.1);
color("magenta")p_line({sec1},.1);

'''')
```



cs1

```
In [78]: # example of function cs1(sec,d) cs1 meaning cleaning section. This function is used in offset function for clearing extra points

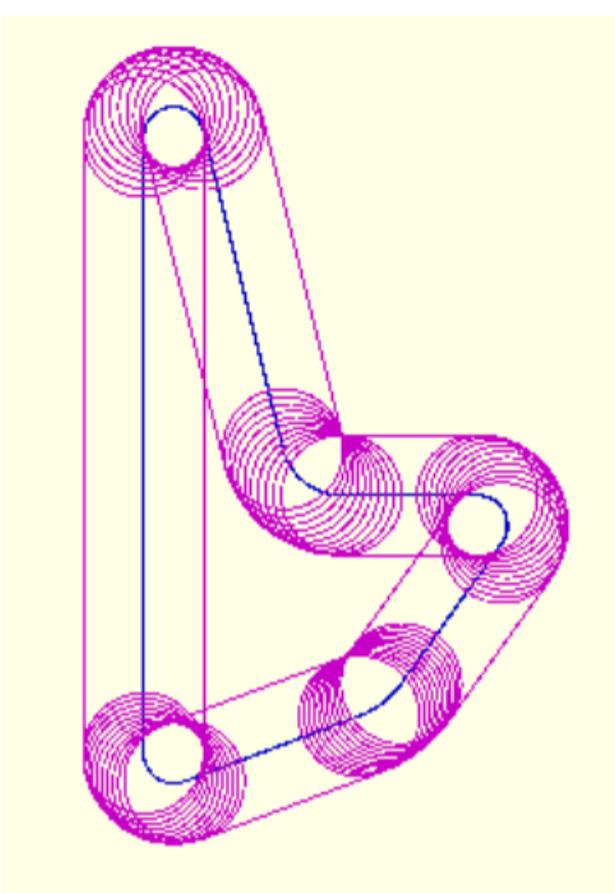
sec=corner_radius(pts1([[0,0,1],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),10)
# sec=corner_radius(pts1([[0,0,.1],[7,5,2],[5,7,3],[-5,7,5],[-7,5,5]]),20)
# sec=corner_radius(pts1([[-15,0,2.49],[0,15,3],[30,0,3],[0,-15,2.49],[5,0,2.49],[0,20,7],[-40,0,7],[0,-20,2.49]]),20)

fileopen(f''

color("blue")p_line({sec},.1);
color("magenta")for(p={cs1(sec,-2)})p_line(p,.08);

'''')
```

...)



convert_secv1

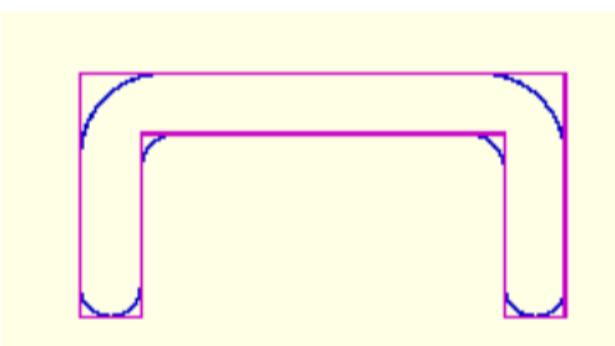
In [79]:

```
# example of function convert_secv1(sec,d)

sec=corner_radius(pts1([[0,0,1],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),20)
sec=sec=corner_radius(pts1([[0,0,.1],[7,5,2],[5,7,3],[-5,7,2],[-7,5,3]]),20)
sec=corner_radius(pts1([[-15,0,2.49],[0,15,3],[30,0,3],[0,-15,2.49],[5,0,2.49],[0,20,7],[-40,0,7],[0,-20,2.49]]),20)
# sec=circle(10)
# sec=pts([[0,0],[10,0],[0,10],[-10,0]])

sec1=convert_secv1(sec)

fileopen(f'''
color("blue")p_line({sec},.3);
color("magenta")p_line({sec1},.3);
...)
```



convert_secv

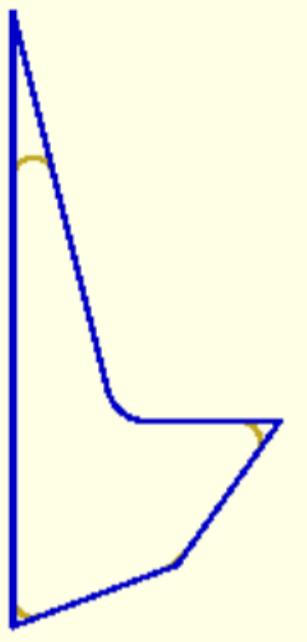
In [80]:

```
# example of function convert_secv(sec)

sec=corner_radius(pts1([[0,0,1],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),40)
# sec=sec=corner_radius(pts1([[0,0,.1],[7,5,2],[5,7,3],[-5,7,2],[-7,5,3]]),20)
# sec=corner_radius(pts1([[-15,0,2.49],[0,15,3],[30,0,3],[0,-15,2.49],[5,0,2.49],[0,20,7],[-40,0,7],[0,-20,2.49]]),20)
# sec=circle(10)
# sec=pts([[0,0],[10,0],[0,10],[-10,0]])
# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,4.2],[-4,2,0]]),40)
# path=corner_radius(pts1([[2,0],[-2,0,2.2],[0,7,5.3],[-5,3,0]]),40)
# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,2],[-2,0]]),20)

fileopen(f'''

p_line({sec},.3);
color("blue")p_line({convert_secv(sec)},.3);
...)
```



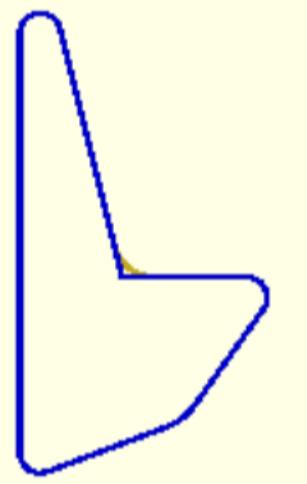
convert_secv2

```
In [81]: # example of function convert_secv2(sec,d)

sec=corner_radius(pts1([[0,0,1],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),40)
# sec=sec=corner_radius(pts1([[0,0,.1],[7,5,2],[5,7,3],[-5,7,2],[-7,5,3]]),20)
# sec=corner_radius(pts1([[-15,0,2.49],[0,15,3],[30,0,3],[0,-15,2.49],[5,0,2.49],[0,20,7],[-40,0,7],[0,-20,2.49]]),20)
# sec=circle(10)
# sec=pts([[0,0],[10,0],[0,10],[-10,0]])
# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,4.2],[-4.2,0]]),40)
# path=corner_radius(pts1([[2,0],[-2,0,2.2],[0,7,5.3],[-5.3,0]]),40)
# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,2],[-2,0]]),20)

fileopen(f'''

p_line({sec},.3);
color("blue")p_line({convert_secv2(sec,5)},.3);
''' )
```



c2ro

```
In [82]: # example of function c2ro(sol,s), 'c2ro' stands for circular to rectangular orientation

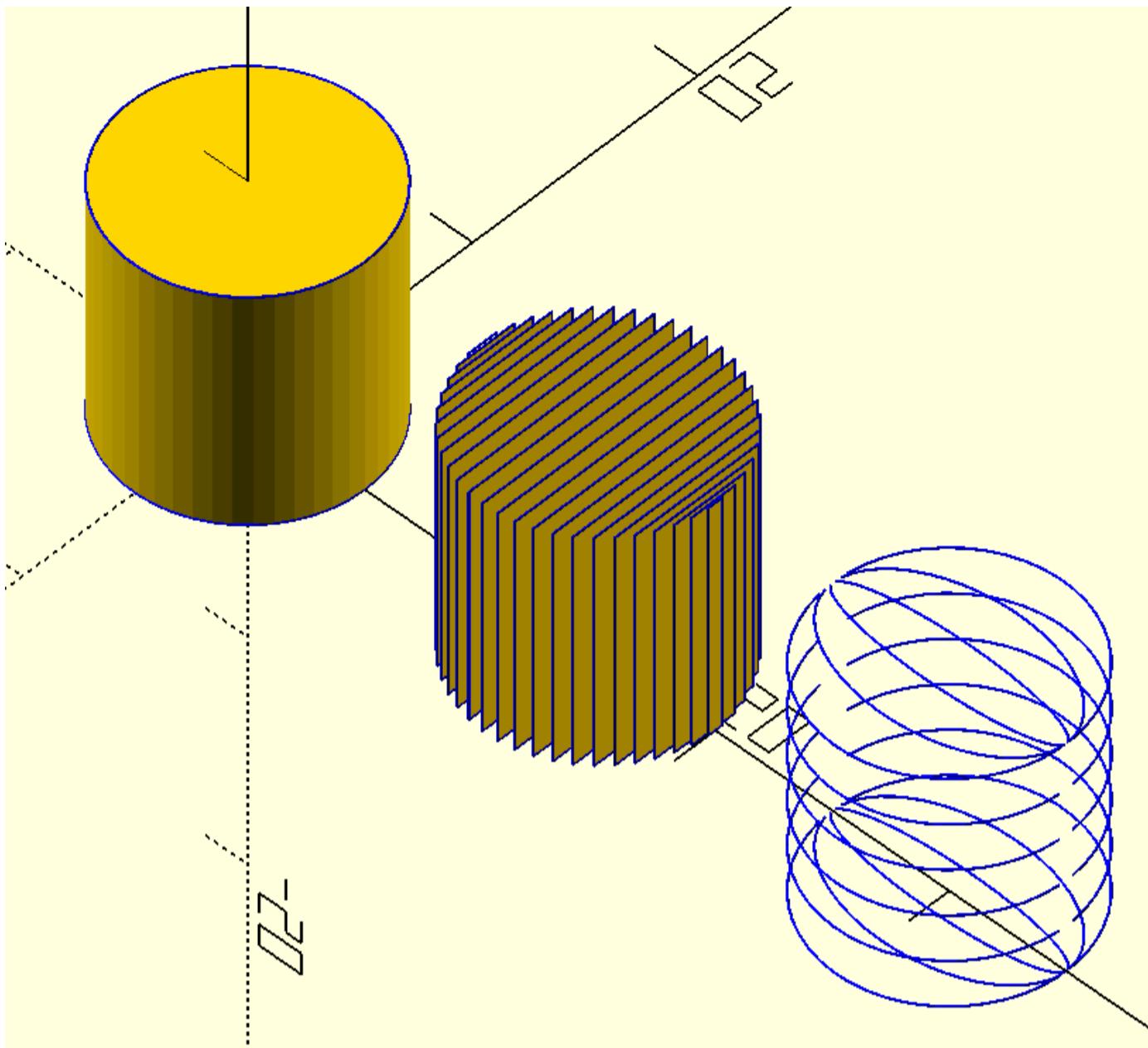
cyl=linear_extrude(circle(5,s=31),10)
cyl1=translate([15,0,0],c2ro(cyl,1))
cyl2=translate([30,0,0],cpo(c2ro(cyl,5)))

fileopen(f'''

color("blue")for(p={cyl})p_line3dc(p,.05);
color("blue")for(p={cyl1})p_line3dc(p,.05);
color("blue")for(p={cyl2})p_line3d(p,.05);
swp({cyl});
for(p={cyl1})polyhedron(p,[[0,1,2,3]]);

''')
# for i in range(14):
#     with open('trial.scad','a')as f:
#         f.write(f'''
# {swp(cyl1[i:i+1])}

# {swp(cyl)}
# ''')
```



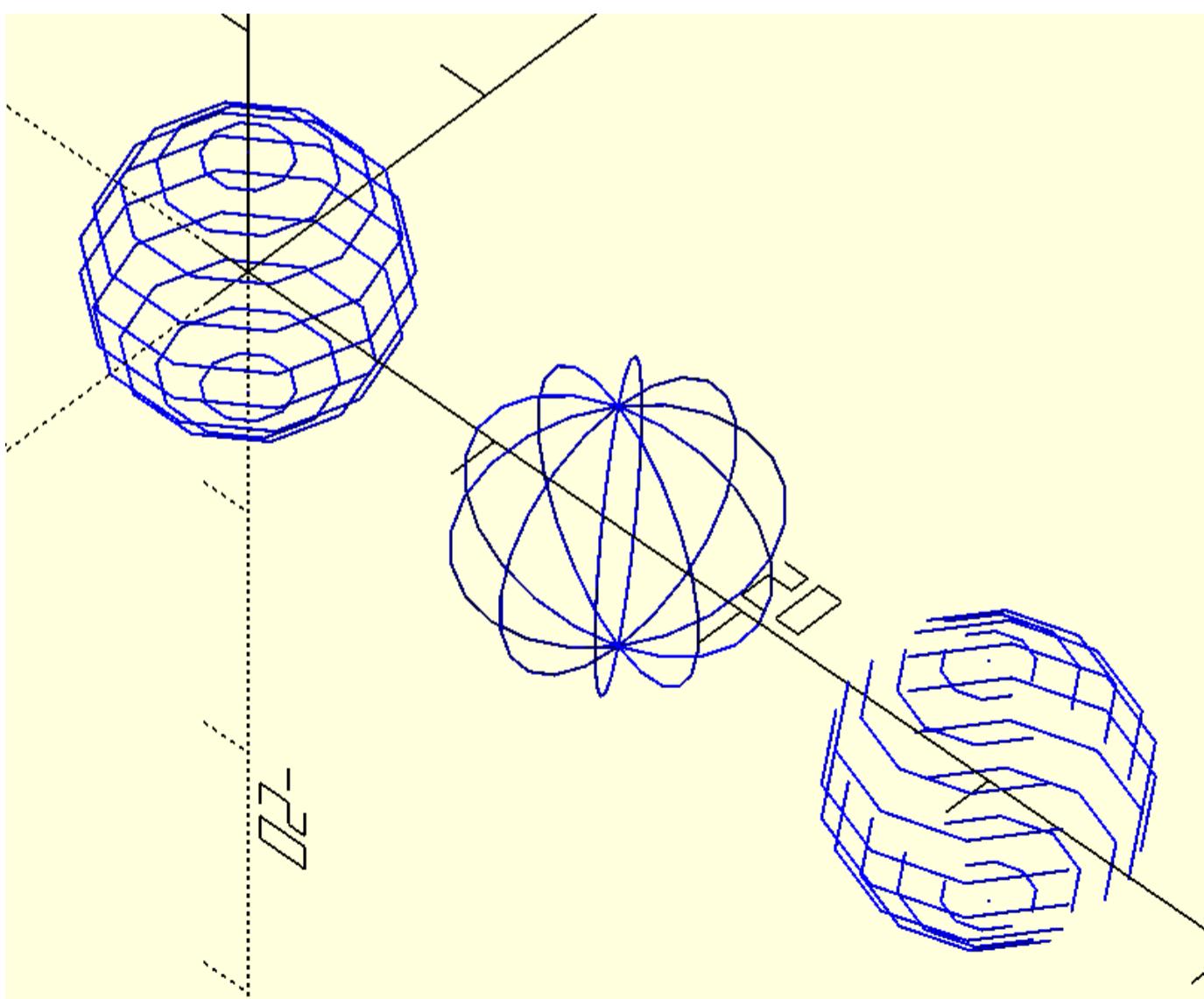
In [83]: # example of function c2ro(sol,s)

```
sp=sphere(5,s=21)
sp1=translate([15,0,0],c2ro(sp,3))
sp2=translate([30,0,0],cpo(c2ro(sp,3)))
fileopen(f'''
```



```
color("blue")for(p={sp})p_line3dc(p,.1);
color("blue")for(p={sp1})p_line3dc(p,.1);
color("blue")for(p={sp2})p_line3d(p,.1);

'''')
```



In [84]: sec=circle(5,s=50)

```
path=corner_radius(pts1([[-1,3],[1,0,1],[0,10,1],[-1,0]]),10)
```

```
s2=linear_extrude(circle(10,s=100),16)
```

```

s3=translate([10,0,0],prism(sec,path))

p1=corner_radius_with_turtle([[1,0],[-1,0,1],[0,1]],20)

s4=[ linear_extrude(circle(10+x,s=100),16) for (x,y) in p1]
s5=[translate([10,0,0],prism(sec,path_offset(path,y))) for (x,y) in p1]
e1=end_cap(s2,1.5)

fileopen(f'''

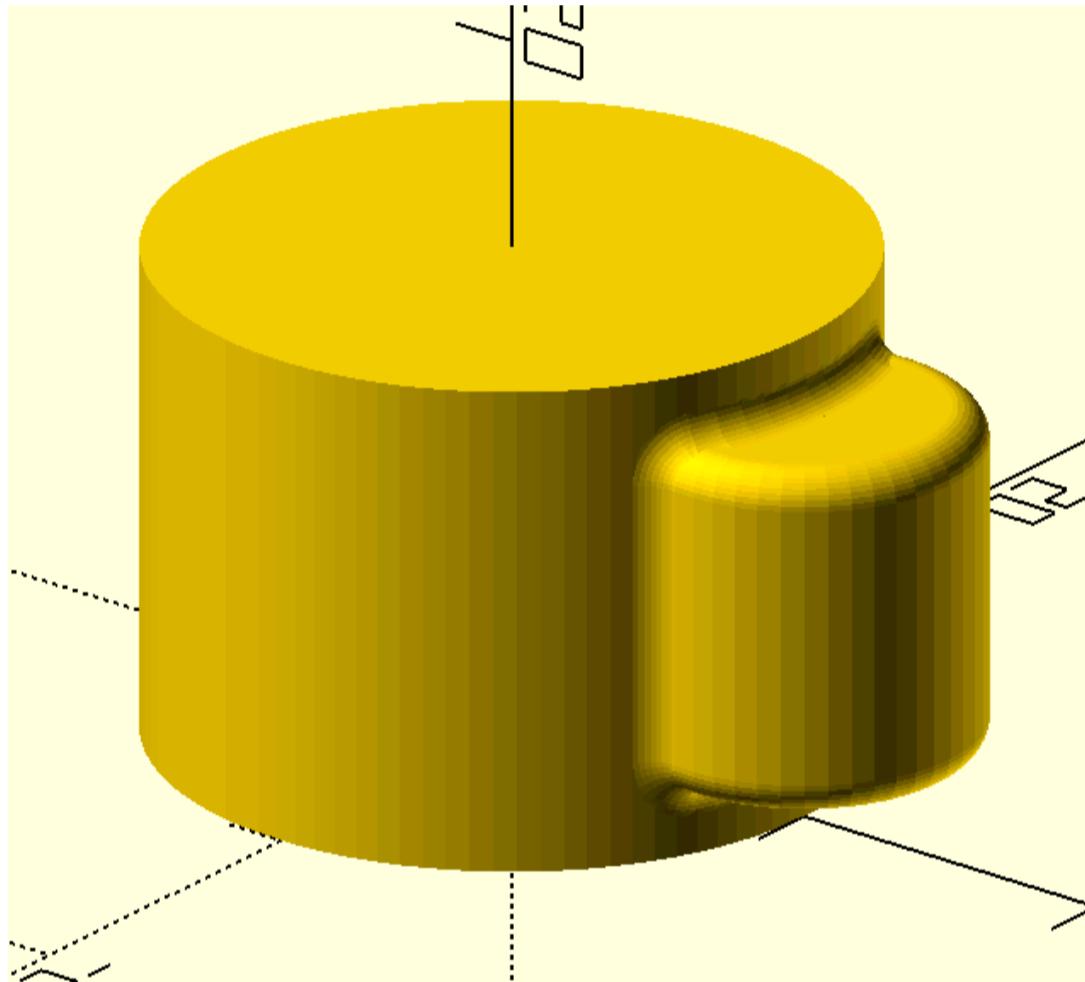
difference(){
{swp(s2)}
for(p={e1})swp_c(p);
}
{swp(s3)}

for(i=[0:19])
hull(){{}
intersection(){{
swp({s4}[i]);
swp({s5}[i]);
}}
}

intersection(){{
swp({s4}[i+1]);
swp({s5}[i+1]);
}}
}

''')

```



sl_int

```

In [85]: # example of function sl_int(sec,line)

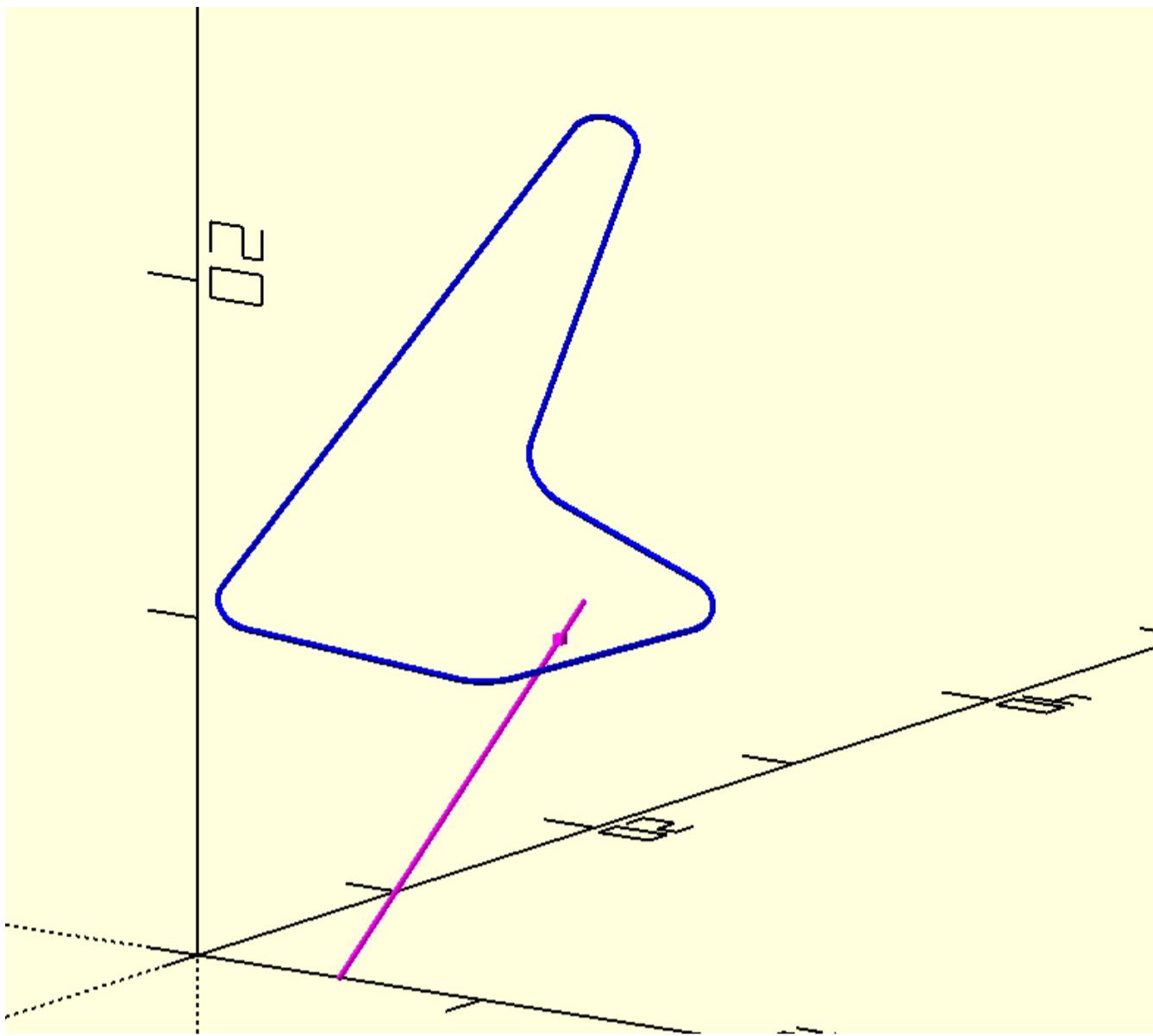
sec=corner_radius(pts1([[0,0,1],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),20)
sec=translate([0,0,10],rot('y30x30',sec))
line=[[5,0,0],[8,8,10]]
ip_1=sl_int(sec,line)

fileopen(f'''

color("blue")p_line3dc({sec},.1);
color("magenta")p_line3d({line},.1);
color("magenta")points({ip_1},.3);

''')

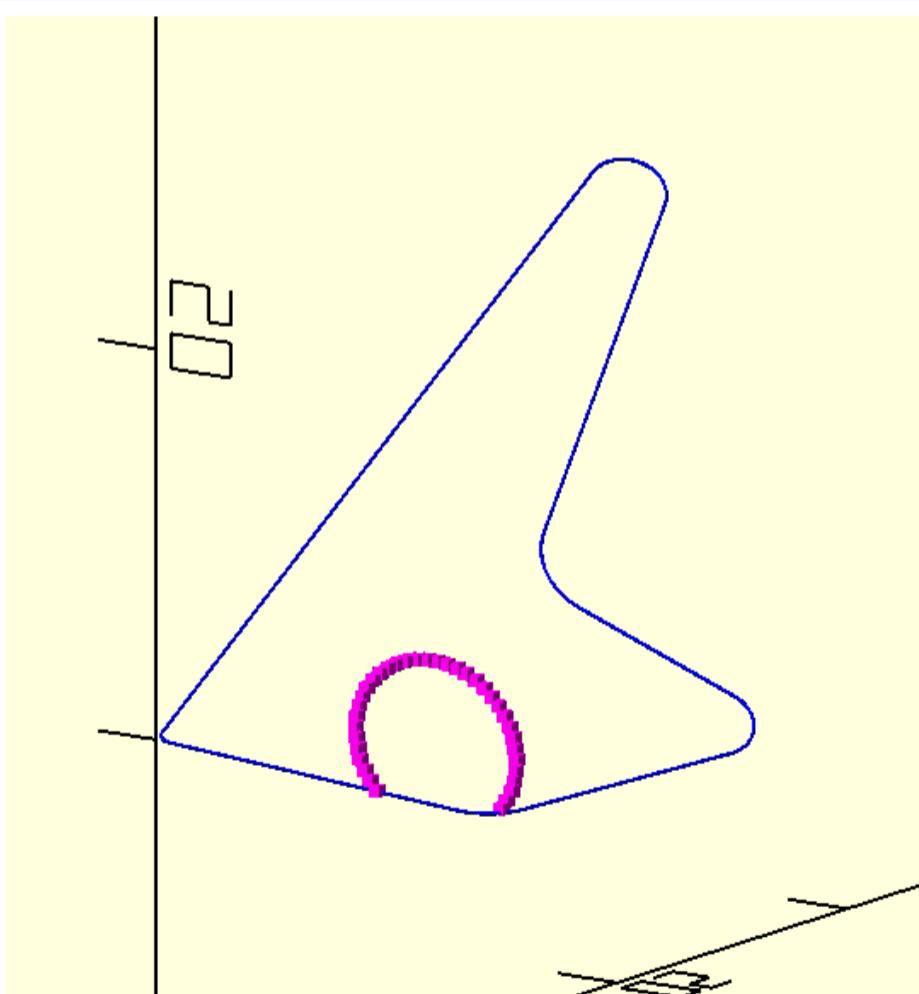
```



```
In [86]: sec=corner_radius(pts1([[0,0,1],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),20)
sec=translate([0,0,10],rot('y30x30',sec))
sol=cpo(linear_extrude(circle(2,[5,9],s=50),20))
# lines=array(sol).reshape(-1,2,3)
ip_1=[sl_int(sec,line) for line in sol if sl_int(sec,line)!=[]]
ip_1=concatenate(ip_1).tolist()
fileopen(f'''

polyhedron({sec},{{arange(len(sec)).tolist()}});
color("blue")p_line3dc({sec},.05);
color("magenta")points({ip_1},.1);
%{swp(cpo(sol))}

''' )
```

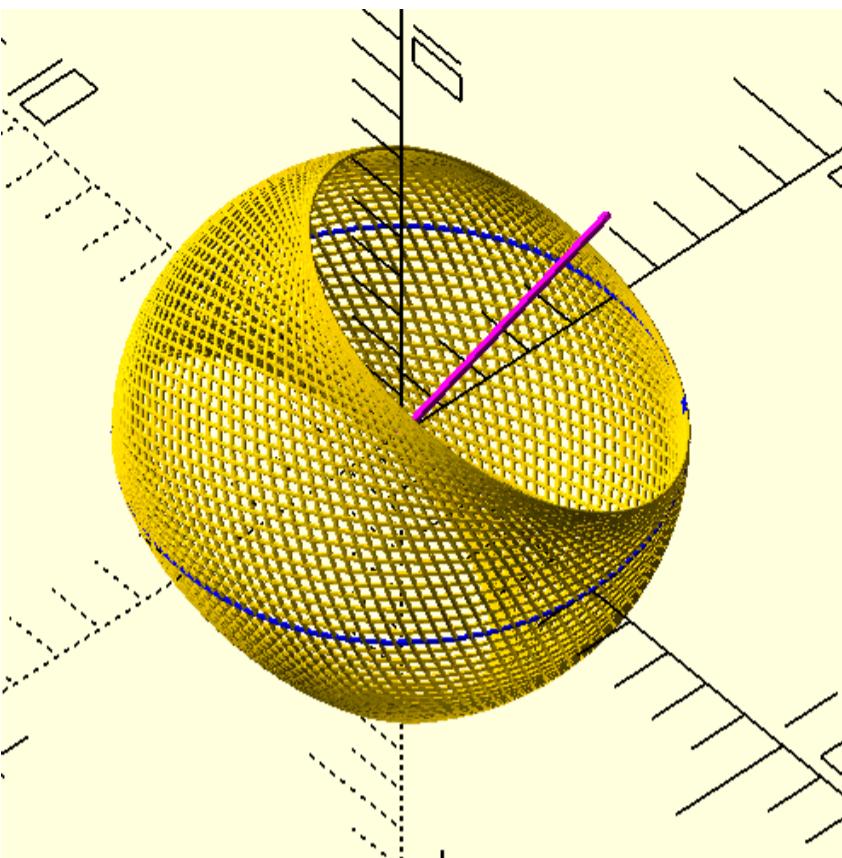


axis_rot

```
In [87]: # example of function axis_rot(axis,solid,angle)
vector=[2,0,2]
# sec=translate([-5,5,0],circle(5))
sec=path_extrude_closed(circle(.05),c2t3(circle(5)))
sec1=[path_extrude_closed(circle(.05),axis_rot(vector,circle(5),i)) for i in arange(0,360,5)]
fileopen(f'''

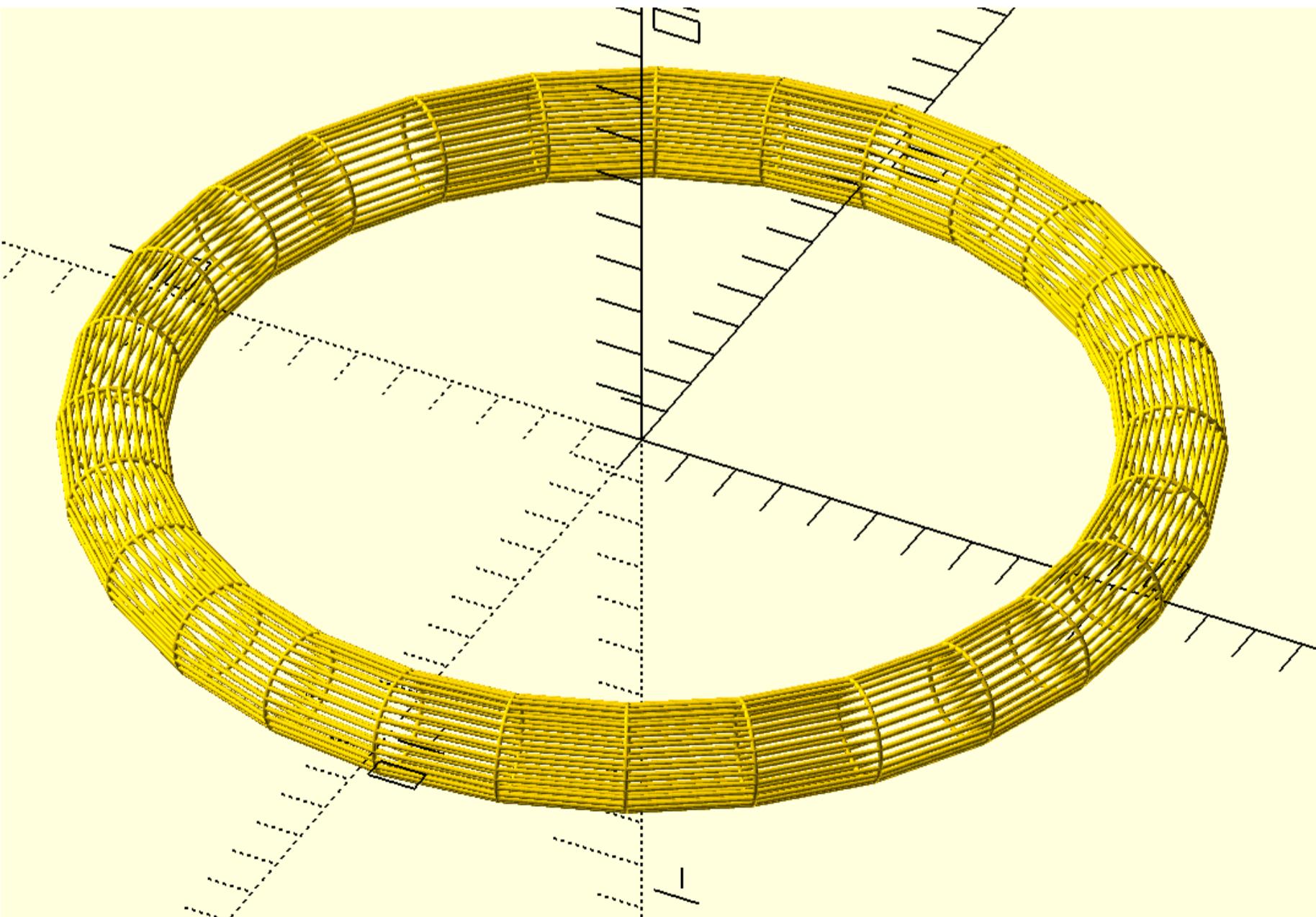
for(p={sec1})swp(p);
//original section
```

```
color("blue"){swp(sec)}  
// axis of rotation  
color("magenta")p_line3d({[[0,0,0],vector]},.1);  
'''
```



path_extrude_closed

```
In [88]: sec=circle(1,s=20)  
path=c2t3(circle(10,s=20))  
sol1=path_extrude_closed(sec,path)  
  
fileopen(f'''  
  
$fn=20;  
for(p={sol1})p_line3dc(p,.05);  
for(p={cpo(sol1)})p_line3dc(p,.05);  
'''
```



cam-profile

```
In [89]: # example of cam profile  
  
l_1=corner_radius(pts1([[0,50],[90,0,100],[180,-20,100],[360,0]]),30)  
l_1=rot('x90',equidistant_path(l_1,360))  
p1=c2t3(arc(30,0,362,s=360))  
l_2=extrude_wave2path(l_1,p1)  
l_3=[[-5,0],[5,0]]
```

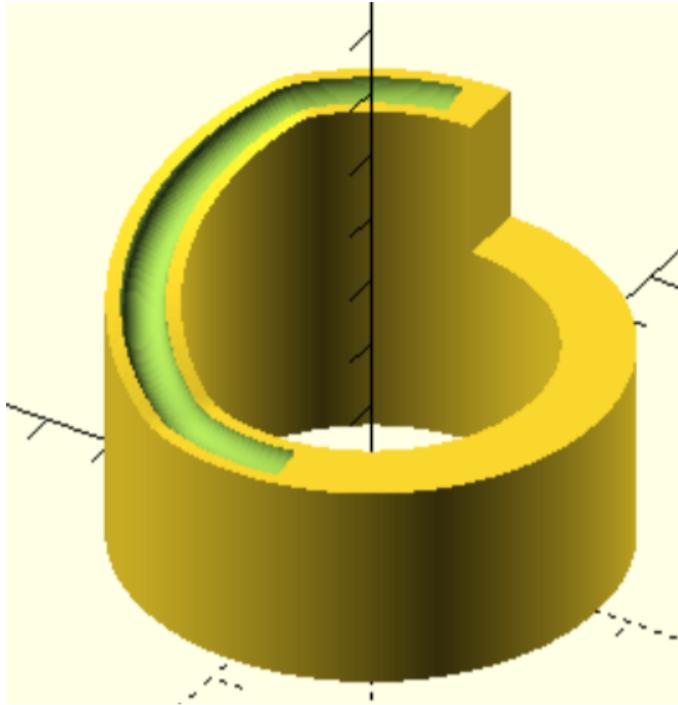
```

surf_1=path_extrude_open(l_3,l_2)
surf_2=c2t3(c3t2(surf_1))
sol_1=[surf_2[i]+flip(surf_1[i]) for i in range(len(surf_1))]
c1=circle(3)
sol_2=path_extrude_open(c1,l_2[10:190])

fileopen(f''''

difference(){{
{swp(sol_1)}
{swp(sol_2)}
}}
'''')

```



drill-bit

```

In [90]: # drill bit

sec=circle(7.5,s=100)

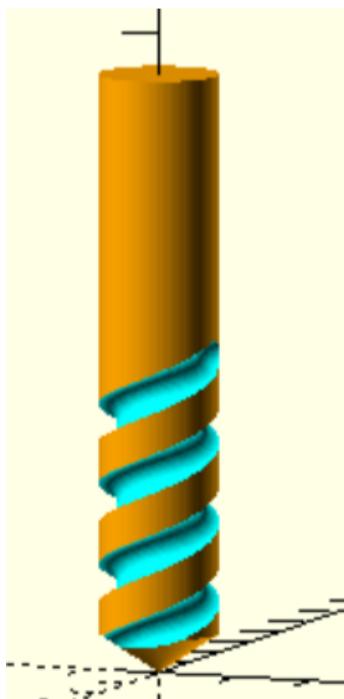
path=pts([[-7.49*cos(360/200*pi/180),0],[7.5,5],[0,70]])
sol=prism(sec,path)
hx1=helix(7.5,20,2,5)
hx2=rot('z180',hx1)
fileopen(f''''

//      render(){{

difference(){{
color("orange"){swp(sol)}
color("cyan")p_line3d({hx1},4.5,$fn=70);
color("cyan")p_line3d({hx2},4.5,$fn=70);

}}
//  }}
'''')

```



bottle-with-cut-design

```

In [91]: # bottle with cut design
i_t=time.time()
sec=circle(10,s=50)
path=corner_radius(pts1([[-3,0,0],[3,0,3],[3,5,7],[-5,20,100],[8,30,20],[-11,10,5],[0,10,0]]),50)
path=equidistant_path(path,100)
sol=prism(sec,path)

sec1=corner_radius(pts1([[-7.5,10,3],[15,0,3],[0,20,30],[-3,20,30],[0,10,4.4],[-9,0,4.4],[0,-10,30],[-3,-20,30]]),20)
sec1=equidistant_path(sec1,200)
path1=corner_radius(pts1([[1,0],[-1,0,1],[-1,1,2],[-2,0]]),10)
path1=equidistant_path(path1,10)
surf_1=f_prism(sec1,path1)

l1=equidistant_path([[0,15],[0,55]],10)

```

```

l1=equidistant_pathc(translate([0,0,1],surround(l1,.2,10)),200)
l1=align_sec_1(surf_1[-1],l1)[1]
# l1=sort_points(surf_1[-1],l1)
surf_1=surf_1[:-1]+slice_sol([surf_1[-1],l1],5)[1:]
# sol3=translate([0,0,-1.5],surf_1)
# sol2=flip(sol3)+surf_1#[+flip(sol3)[0]]
sol2=surf_1
path=equidistant_path(rot('y90',path),100)
sol2=[wrap_around(p,path) for p in sol2]
sol2=translate([0,8.61,0],rot('z90',sol2))
path2=rot('y90',circle(10,s=200))
sol2=[wrap_around(p,path2) for p in sol2]
sol2=rot('y90',sol2)
sol3=translate(surface_normal(sol2[:2],2),sol2)
sol4=flip(sol3)+sol2

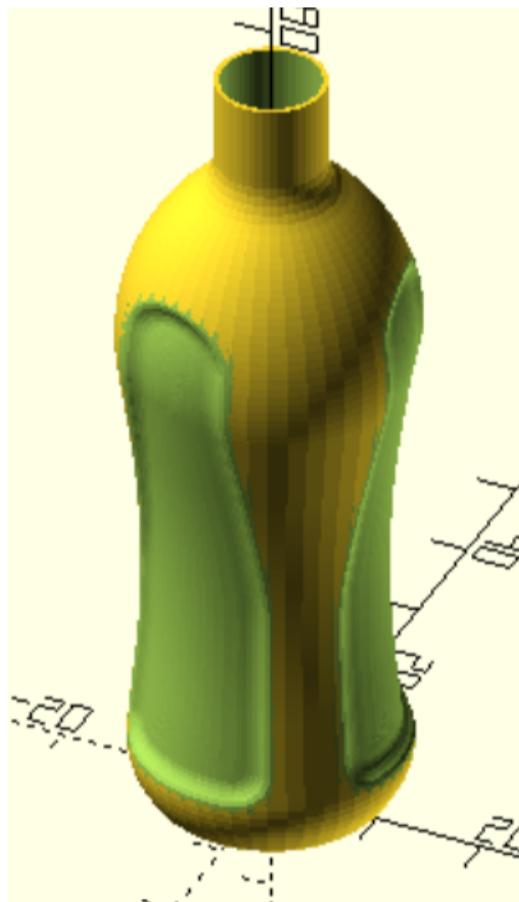
surf_2=surf_offset(sol2,.5)
surf_3=sol3=translate(surface_normal(sol2[:2],2),surf_2)
path=corner_radius(pts1([[-3,0,0],[3,0,3],[3,5,7],[-5,20,100],[8,30,20],[-11,10,5],[0,10,0]]),50)
path=equidistant_path(path,100)
sol_5=prism(sec,path_offset(path,-.5))
sol_6=flip(surf_3)+surf_2

fileopen(f''''
difference() {{
    union() {{
        difference() {{
            difference() {{
                {swp(sol)}
                for(i=[0,120,240])rotate([0,0,i])
{swp(sol4)}
            }}
            translate([0,0,.01])
            difference() {{
                {swp(sol_5)}
                for(i=[0,120,240])rotate([0,0,i])
                {swp(sol_6)}
            }}
        }}
    }}
}}
//{swp(cut_plane([0,-1,0],[300,300],100,theta=[0,0,20]))}
})
    ''')

f_t=time.time()
f_t-i_t

```

Out[91]: 2.3045549392700195



psos

reorient_sec

prism2cpo

```

In [92]: # example use of function psos (project a surface on to another without loosing the original points)
it=time.time()
# designing bottle with cut design
sec=circle(10,s=100)
path=corner_radius(pts1([[-3,0],[3,0,3],[3,5,7],[-5,20,100],
                      [8,30,20],[-11,10,5],[0,10,0]]),30)
path=equidistant_path(path,100)
sol=prism(sec,path)

sec1=corner_radius(pts1([-7.5,10,3],[15,0,3],[0,20,30],
                      [-3,20,30],[0,10,4.4],[-9,0,4.4],
                      [0,-10,30],[-3,-20,30])),10)

sec1=equidistant_pathc(sec1,100)

```

```

sec=reorient_sec(sec1)
path1=corner_radius(pts1([[1,0],[-1,0,1],[-1,2,2],[-2,0]]),10)
path1=equidistant_path(path1,10)
surf1=prism2cpo(prism(sec1,path1))
s1=[equidistant_path(p,100) for p in surf1]
p1=rot('y90',path)
s1=[wrap_around(p,p1) for p in s1]
s1=translate([0,10,0],rot('z-90',s1))
p2=rot('y90',circle(10,s=200))
s1=[wrap_around(p,p2) for p in s1]
s1=rot('y-90z30',s1)
sol=psos(s1,sol,[0,-1,0])
s1=rot('z120',s1)
v1=rot('z120',[0,-1,0])
sol=psos(s1,sol,v1)
s1=rot('z120',s1)
v1=rot('z240',[0,-1,0])
sol=psos(s1,sol,v1)
sol1=[offset_3d(p,-.5) for p in sol]
bottle=sol+flip(sol1)[:-16]
bottle=smoothening_by_subdivision_surf(bottle,2,[1,0])
fileopen(f'''')
{swp(bottle)}

''')

ft=time.time()
ft-it

```

Out[92]: 40.94603395462036



example-of-rounding

```

In [93]: # m37 rounded
i_t=time.time()
sec=[[i,3*sin(i*18*pi/180)] for i in arange(-20,20,.5)]

path=[[i,0,20+3*sin(i*12*pi/180)] for i in arange(-30,30,.5)]

surf=surf_extrude(sec,path)
surf1=surf_base(surf,-1)
sec1=corner_radius(pts1([[0,0,2],[20,0,2],[0,20,2]]),40)
sec1=equidistant_pathc(sec1,200)
l1=plos(surf,c23(sec1,[0,0,1]))
l2=plos(surf,c23(offset(sec1,-1)),[0,0,1])
l3=translate([0,0,-1],l1)
f1=cpo(convert_3lines2fillet(l3,l2,l1,s=20))[:-1]
l4=offset(sec1,-1)
sol=linear_extrude(l4,25)
sol1=c23([l4,sec1])+f1+[c23(l4)]
fileopen(f'''')

intersection(){{}
{swp(surf1)}
{swp(sol)}}

```

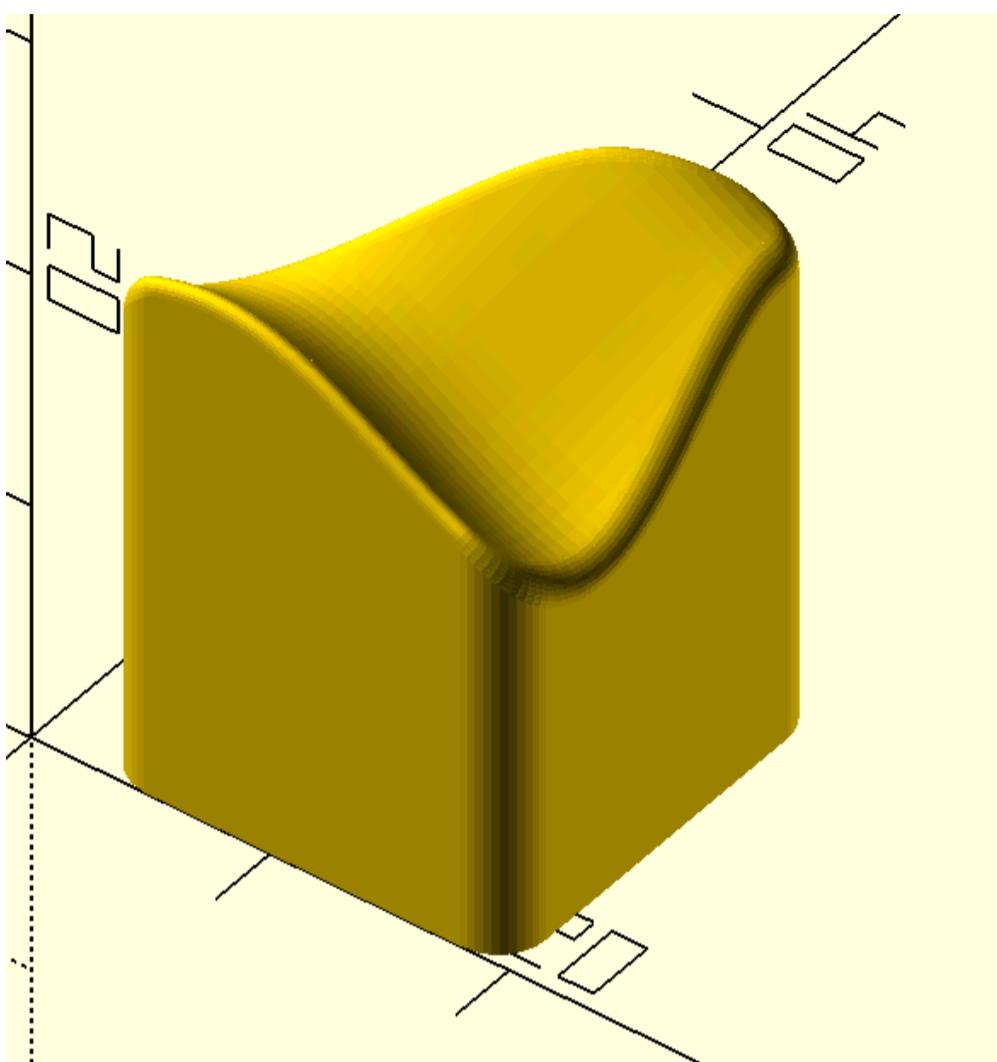
```

    })
{swp_c(sol1)}

    '')
f_t=time.time()
f_t-i_t

```

Out[93]: 0.9929361343383789



m39

```

In [94]: # m39
i_t=time.time()
p0=i_p2d(pts([[-45,0],[0,1]]),cir_theta_line(10,[-35,0],16.5,1))
p1=i_p2d(cir_theta_line(10,[-35,0],16.5,1),cir_theta_line(10,[35,0],-16.5,1))
p2=i_p2d(pts([[45,0],[0,1]]),cir_theta_line(10,[35,0],-16.5,1))
p3=[45,35]
p4=i_p2d([p3,p_cir_t(p3,circle(10,[0,44.06]))],[cir_p_t(circle(10,[0,44.06]),[-45,35]),[-45,35]])
p5=[-45,35]
p_l=array(c2t3([p0,p1,p2,p3,p4,p5]))
p_l=p_l+array([[0,0,i] for i in [10,32.5,10,10,10,10]])

sec1=corner_radius(p_l,20)

p0,p1,p2,p3,p4,p5=offset([p0,p1,p2,p3,p4,p5],-2.5)

c1,c2,c3=[circle(7.5,i) for i in [[-35,0],[35,0],[0,44.06]]]
a1=fillet_line_circle([p0,p1],c1,2.5,1)
a2=fillet_intersection_lines([p0,p1],[p2,p1],35,20)
a3=flip(fillet_line_circle([p1,p2],c2,2.5,3))
a4=fillet_line_circle([p2,p3],c2,2.5,1)
a3_1=arc_2p(a3[-1],a4[0],7.5,1,20)
a5=fillet_intersection_lines([p2,p3],[p4,p3],7.5,10)
a6=flip(fillet_line_circle([p3,p4],c3,2.5,3))
a7=fillet_line_circle([p4,p5],c3,2.5,1)
a6_1=arc_long_2p(a6[-1],a7[0],7.5,1,40)
a8=fillet_intersection_lines([p4,p5],[p0,p5],7.5,10)
a9=flip(fillet_line_circle([p5,p0],c1,2.5,3))
a10=arc_2p(a9[-1],a1[0],7.5,1,20)
sec2=a1+a2+a3+a3_1+a4+a5+a6+a6_1+a7+a8+a9+a10
sec2=remove_extra_points(array(sec2).round(4))

c4,c5,c6=[circle(5,i) for i in [[-35,0],[35,0],[0,44.06]]]

path1=corner_radius(pts1([[-1.25,0],[1.25,0,1.25],[0,10,1.25],[-1.25,0]]),10)
sol1=prism(sec1,path1)

path2=corner_radius(pts1([[-1.25,1.25],[1.25,0,1.25],[0,10-1.25,1.25],[1.25,0],[0,.2]]),10)
sol2=prism(sec2,path2)

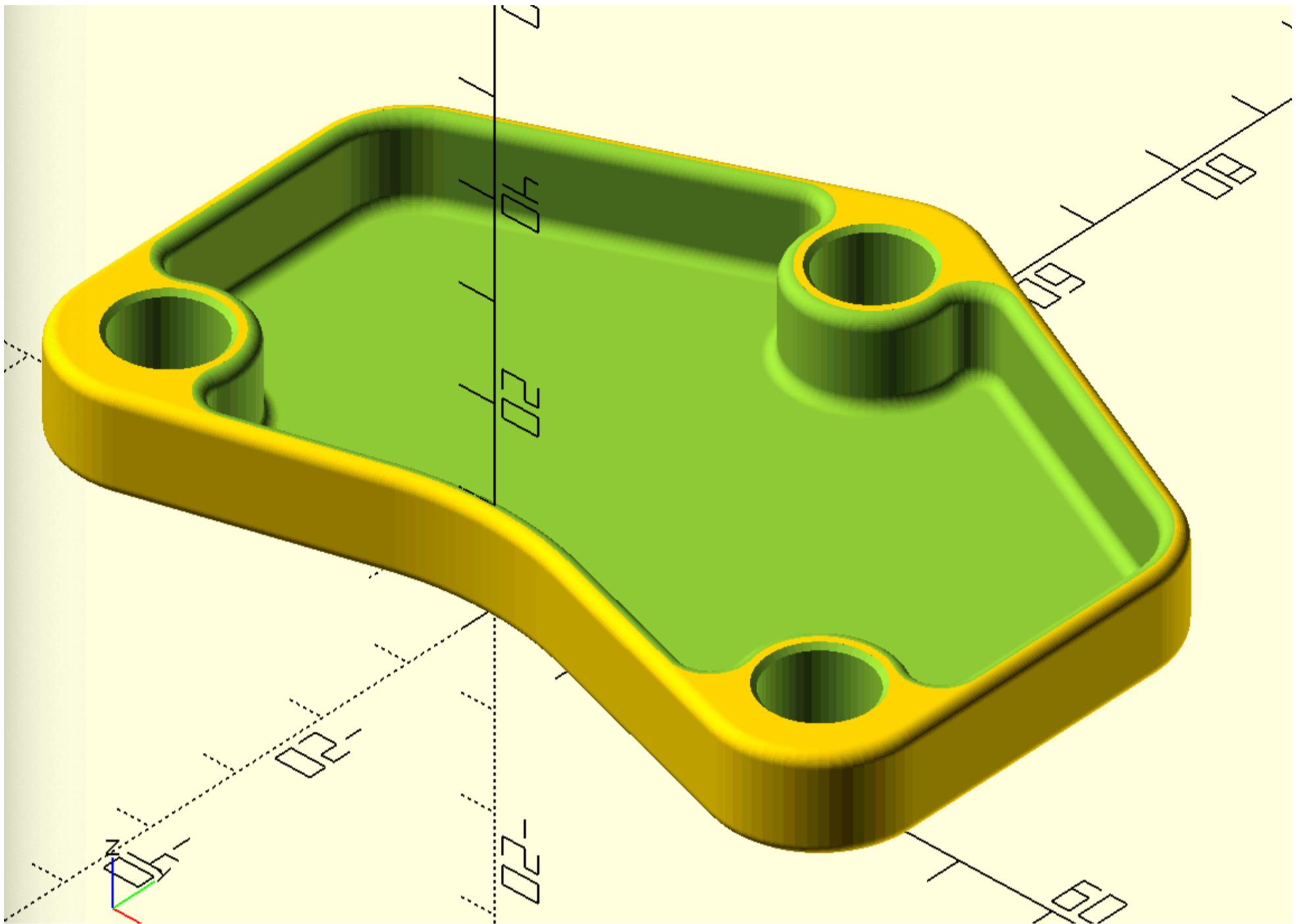
path3=corner_radius(pts1([[0.5,-.2],[0,0.2],[-.5,.5],[0,0],[.5,.5],[0,.2]]),5)
sol3=[prism(s,path3) for s in [c4,c5,c6]]

fileopen(f'''

difference(){
{swp(sol1)}
{swp(sol2)}
for(p={sol3}) swp(p);
}
    ''')
f_t=time.time()
f_t-i_t

```

Out[94]: 1.4395592212677002



cylinder-with-rectangular-pocket

```
In [95]: # cylinder with rectangular pocket
t=2 #thickness
n=100 # number of segments in the circle
s=[15,25] #size of the pocket
cir=circle(20,s=n)
path=corner_radius(pts1([[t/2,0,t/2],[0,80,t/2-.001],[-t,0,t/2-.001],[0,-80,t/2]]),20)
sol1=prism(cir,path)
sol1=sol1+[sol1[0]]

sec1=corner_radius(pts1([[-s[1]/2,-s[0]/2,t],[s[1],0,t],[0,s[0],t],[-s[1],0,t]]),10)
sol2=translate([0,0,40],rot("y90",linear_extrude(m_points(sec1,.51),40)))

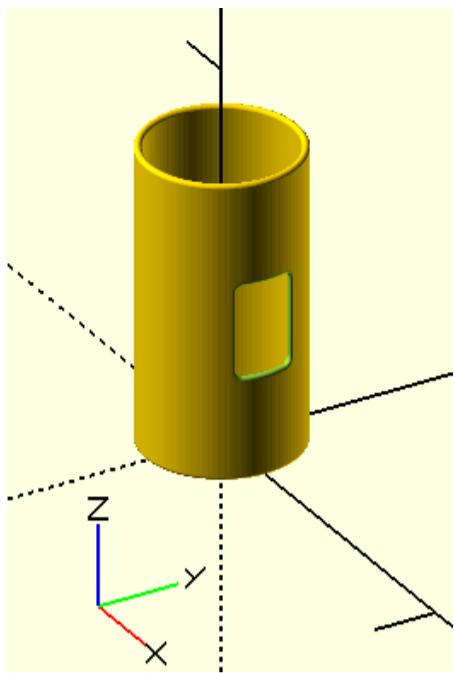
fillet1=cpo(ip_fillet(sol1,flip(sol2),-t/2,t/2))[:-1]
fillet2=cpo(ip_fillet(flip(sol1),sol2,-t/2,t/2))[:-1]
sol3=flip([translate([5,0,0],fillet1[0])]+fillet1+flip(fillet2)+[translate([-5,0,0],fillet1[0])])

fileopen(f''''

difference(){{
{swp_c(sol1)}
{swp(sol3)}
}'''

})

/Users/sanjeevprabhakar/python_openscad/openscad2.py:4497: RuntimeWarning: divide by zero encountered in divide
    t=einsum('kl,ijkl->ijk',cross(p01,p02),la[:, :,None]-p0)/(einsum('ijl,kl->ijk',(-lab),cross(p01,p02))+.00000)
/Users/sanjeevprabhakar/python_openscad/openscad2.py:4497: RuntimeWarning: invalid value encountered in divide
    t=einsum('kl,ijkl->ijk',cross(p01,p02),la[:, :,None]-p0)/(einsum('ijl,kl->ijk',(-lab),cross(p01,p02))+.00000)
/Users/sanjeevprabhakar/python_openscad/openscad2.py:4498: RuntimeWarning: divide by zero encountered in divide
    u=einsum('ijkl,ijkl->ijk',cross(p02[None,None,:,:],(-lab)[:, :,None,:]),(la[:, :,None,:,:]-p0[None,None,:,:]))/(einsum('ijl,kl->ijk',(-lab),cross(p01,p02))+.00000)
/Users/sanjeevprabhakar/python_openscad/openscad2.py:4498: RuntimeWarning: invalid value encountered in divide
    u=einsum('ijkl,ijkl->ijk',cross(p02[None,None,:,:],(-lab)[:, :,None,:]),(la[:, :,None,:,:]-p0[None,None,:,:]))/(einsum('ijl,kl->ijk',(-lab),cross(p01,p02))+.00000)
/Users/sanjeevprabhakar/python_openscad/openscad2.py:4499: RuntimeWarning: divide by zero encountered in divide
    v=einsum('ijkl,ijkl->ijk',cross((-lab)[:, :,None,:],p01[None,None,:,:]),(la[:, :,None,:,:]-p0[None,None,:,:]))/(einsum('ijl,kl->ijk',(-lab),cross(p01,p02))+.00000)
/Users/sanjeevprabhakar/python_openscad/openscad2.py:4499: RuntimeWarning: invalid value encountered in divide
    v=einsum('ijkl,ijkl->ijk',cross((-lab)[:, :,None,:],p01[None,None,:,:]),(la[:, :,None,:,:]-p0[None,None,:,:]))/(einsum('ijl,kl->ijk',(-lab),cross(p01,p02))+.00000)
/Users/sanjeevprabhakar/python_openscad/openscad2.py:4500: RuntimeWarning: invalid value encountered in add
    condition=(t>=0)&(t<=1)&(u>=0)&(u<=1)&(v>=0)&(v<=1)&(u+v<1)
/Users/sanjeevprabhakar/python_openscad/openscad2.py:4502: RuntimeWarning: invalid value encountered in multiply
    a=(la[:,None,:,:]+lab[:,None,:,:]*t[:,None,:,:,:None])
```



cylinder-with-star-pocket

In [96]:

```
# cylinder with star pocket

t=2 # thickness
n=100 # number of segments of circle
s=5 # number of sides of the star
d=20 # outer diameter of the star
h=50 # height of the star prism
cir1=circle(d,s=(s+1))
cir2=c3t2(rot(f"z{360/(s+1)/2}",circle(d/4,s=(s+1))))
sec1=array(c2t3([cir1,cir2]))
sec1=sec1.transpose(1,0,2).reshape(-1,3)
sec1=sec1
sec1=[(sec1[i]+[0,0,t/1.5]).tolist() if i%2==0 else (sec1[i]+[0,0,t]).tolist() for i in range(len(sec1)) ]
sec1=corner_radius(sec1,20)
sol1=translate([0,0,40],rot("y90",linear_extrude(m_points(sec1,1.1),h)))

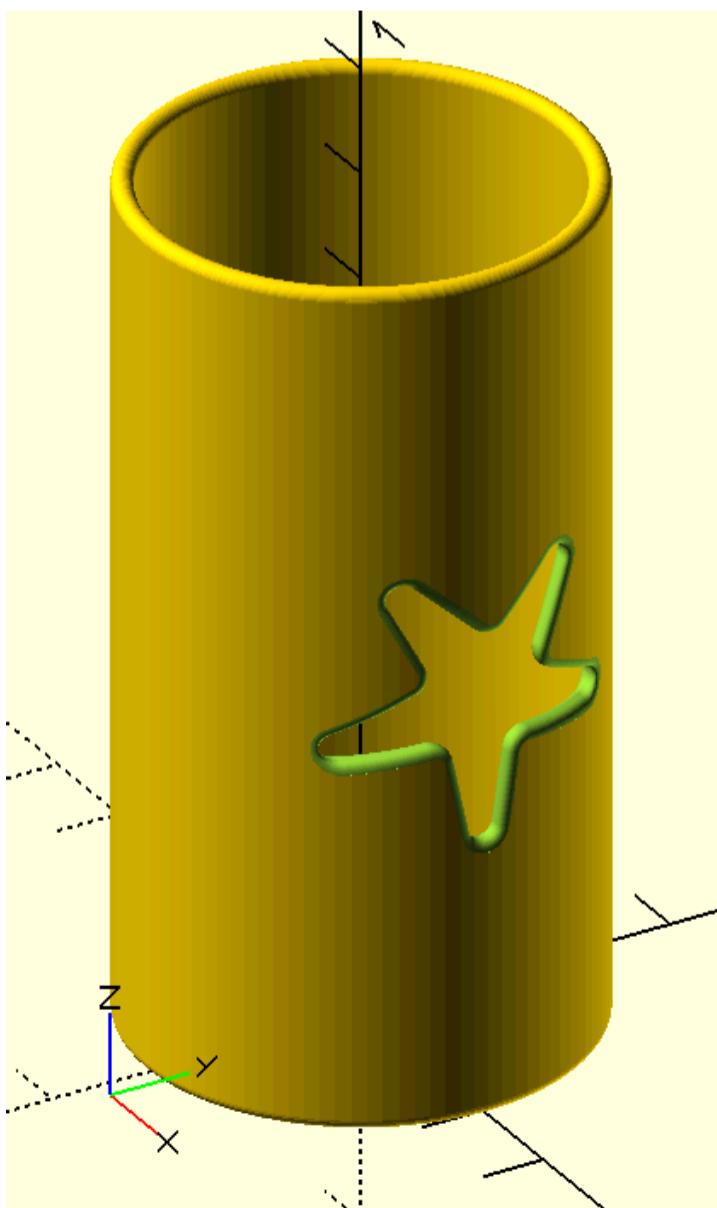
cir=circle(20,s=n)
path=corner_radius(pts1([[t/2,0,t/2],[0,80,t/2-.001],[-t,0,t/2-.001],[0,-80,t/2]]),10)
sol2=prism(cir,path)
sol2=sol2+[sol2[0]]

fillet1=cpo(ip_fillet(sol2,flip(sol1),-t/2,t/2))[:-1]
fillet2=cpo(ip_fillet(flip(sol2),sol1,-t/2,t/2))[:-1]
sol3=flip([translate([5,0,0],fillet1[0])]+fillet1+flip(fillet2)+[translate([-5,0,0],fillet1[0])])

fileopen(f''''

difference(){
{swp_c(sol2)}
{swp(sol3)}
}

...)
```



lamp

In [97]:

```
# lamp

n=20 #number of strands in the lamp
t=5 # thickness of each strand
path=[[42,0],[62,50],[25,100],[25,180]]

path1=cytz(bezier(path,100))

path2=[axis_rot([0,0,1],path1[i],i/(len(path1)-1)*(180+1.8)) for i in range(len(path1)-1)]

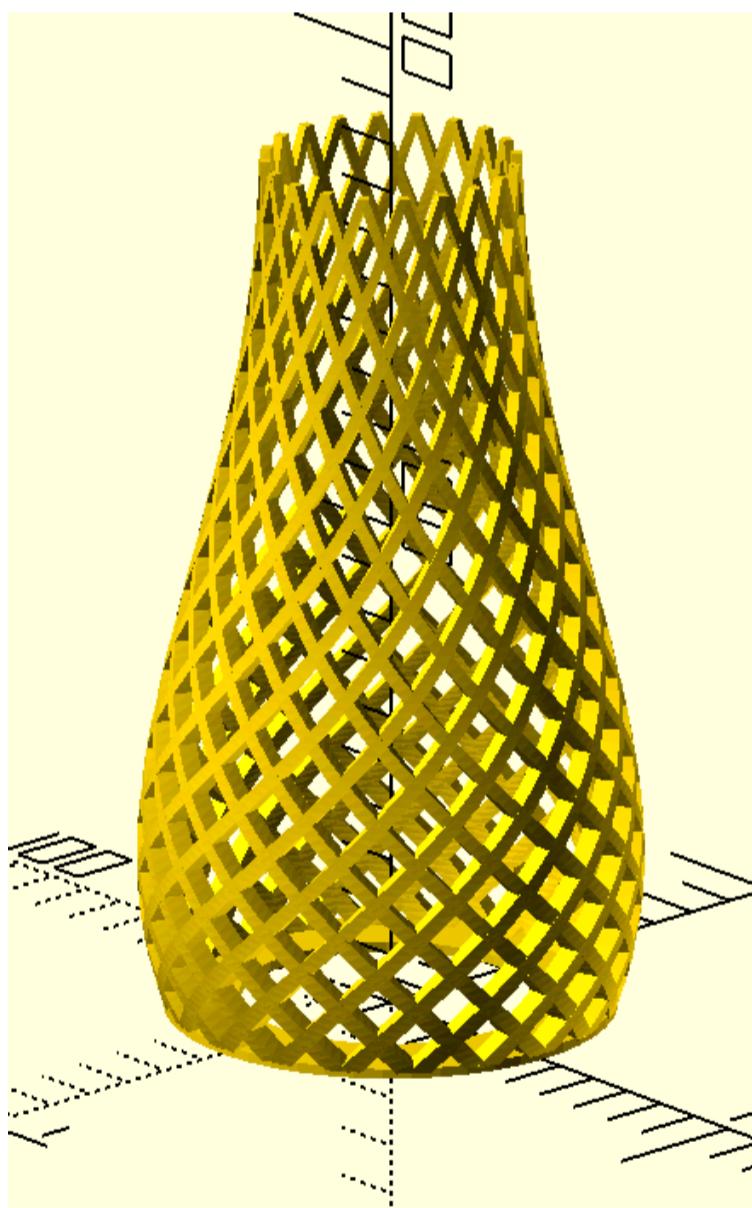
sol=[]
for i in range(len(path2)):
    theta=ang(path2[i][0],path2[i][1])
    sol.append(translate(path2[i],rot(f'z{theta}'), \
        offset(square(t,center=True),i/len(path2)*-1.5)))
sol=rot('z0',sol)

c1=circle(45)
c2=circle(30)

fileopen(f'''

for(i=[0:360/{n}:359])
rotate([0,0,i])
{{
{sweep(sol)}
//p_line3d({path2},.5);
mirror([0,1,0])
{sweep(sol)}
//p_line3d({path2},.5);

}}
linear_extrude(2)
difference()
{{
polygon({c1});
polygon({c2});
}}
''' )
```



samsung-tab-s6-holder

In [98]:

```
# samsung tab s6 holder to hang in car back seat

sec=corner_radius(pts1([[0,0,.1],[124,0,3], [27*cos(45*pi/180),27*sin(45*pi/180),1],
[15*cos(135*pi/180),15*sin(135*pi/180),1],
[5*cos((180+45)*pi/180),5*sin((180+45)*pi/180),1],
[10*cos(-45*pi/180),10*sin(-45*pi/180),1],
[17*cos((180+45)*pi/180),17*sin((180+45)*pi/180),1],
[10*cos(135*pi/180),10*sin(135*pi/180),1],
[8*cos(225*pi/180),8*sin(225*pi/180),1],[20*cos(135*pi/180),20*sin(135*pi/180),1],
[8*cos(45*pi/180),8*sin(45*pi/180),1],
[105*cos(135*pi/180),105*sin(135*pi/180),1],
[8*cos(225*pi/180),8*sin(225*pi/180),1],
[20*cos(135*pi/180),20*sin(135*pi/180),1],
[8*cos(45*pi/180),8*sin(45*pi/180),1],[10*cos(135*pi/180),10*sin(135*pi/180),1],
[17*cos(45*pi/180),17*sin(45*pi/180),1],[10*cos(-45*pi/180),10*sin(-45*pi/180),1],
[5*cos(45*pi/180),5*sin(45*pi/180),1],[15*cos(135*pi/180),15*sin(135*pi/180),1],
```

```

[21*cos(225*pi/180),21*sin(225*pi/180),1],[0,30,2],[-4,0,1]),10)

sec1=corner_radius(pts1([[0,0,2],[17,0,2],[0,85,2],[-17,17,2]]),5)
path1=[[0,0],[0,6]]
sol=translate([123.5,7.7,30],rot("x90z45",f_prism(sec1,path1)))

sol1=translate([5,129,130],rot("x90z45",f_prism(sec1,path1)))

sec2=corner_radius(pts1([[0,0,4],[10,0,4],[0,40,4],[-10,0,4]]),5)
path2=[[0,0],[0,8]]
sol2=translate([-0.25,140,40],rot("x90z90",f_prism(sec2,path2)))

sol3=translate([-0.25,140,170],rot("x90z90",f_prism(sec2,path2)))

sec4=corner_radius(pts1([[0,0,0],[15,0,5],[0,90,5],[-15,0,0]]),5)
path4=[[0,0],[0,3]]
sol4=translate([90,35,0],rot("z45",f_prism(sec4,path4)))

sec5=corner_radius(pts1([[0,0],[120,0,0],[32*cos(135*pi/180),32*sin(135*pi/180),1],
[8*cos(45*pi/180),8*sin(45*pi/180),1],
[105*cos(135*pi/180),105*sin(135*pi/180),1],[8*cos(225*pi/180),8*sin(225*pi/180),1],
[33*cos(135*pi/180),33*sin(135*pi/180),0]]),5)

sec6=corner_radius(pts1([[0,0,5],[90,0,5],[0,110,5],[-90,90,5]]),5)
path6=[[0,0],[0,7]]

sol6=translate([15,6,25],rot("x90",f_prism(sec6,path6)));
sol7=translate([-1,15,25],rot("x90z90",f_prism(sec6,path6)));
sol8=translate([94,30,25],rot("x90z135",f_prism(sec6,path6)));

fileopen(f'''

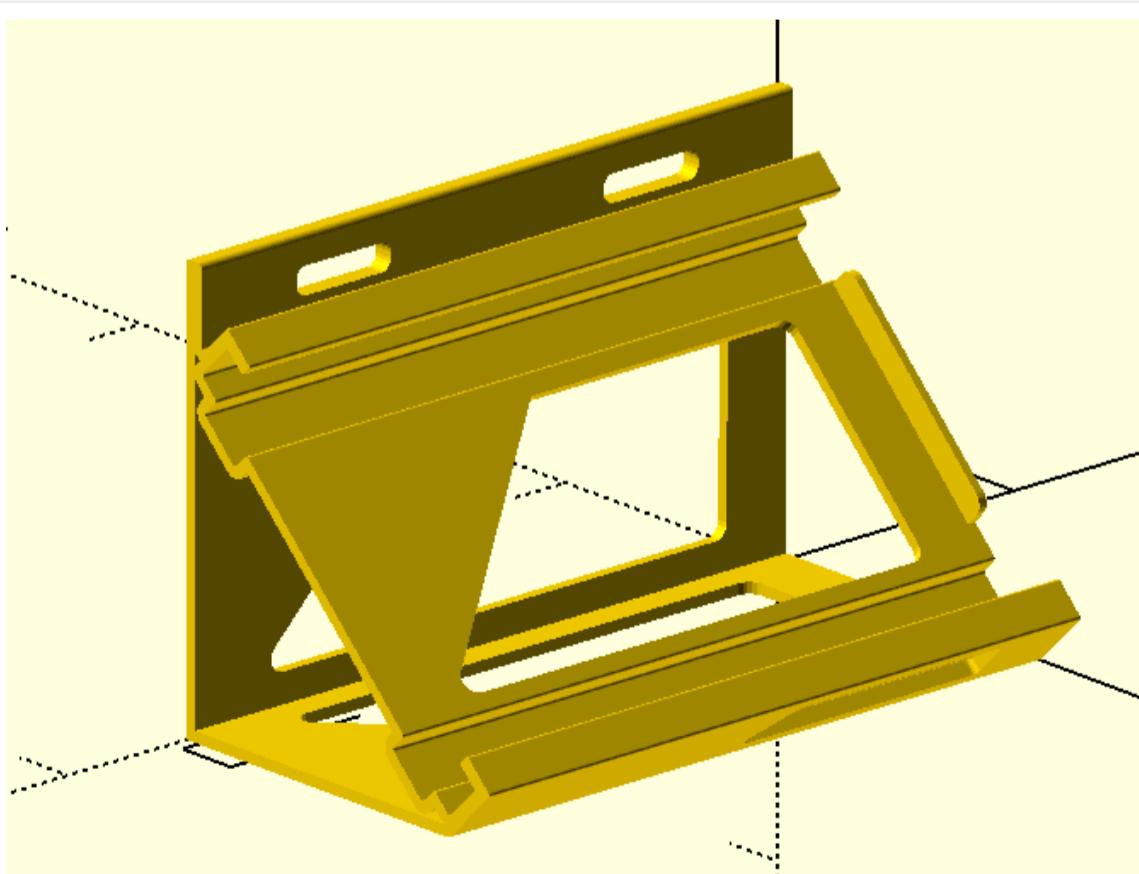
rotate([90,0,0])
{{{
difference(){{{
difference(){{{
linear_extrude(250)
polygon({sec});

translate([0,0,-.05])
linear_extrude(250.1)
polygon({offset(sec,-4.5,2)});}

//color("blue")
{swp(sol)}
//color("blue")
{swp(sol1)}
//color("blue")
{swp(sol2)}
//color("blue")
{swp(sol3)}
//color("blue")
{swp(sol6)}
//color("blue")
{swp(sol7)}
//color("blue")
{swp(sol8)}
}}}

//color("magenta")
{swp(sol4)}
}}}
''' )

```



business-card-holder

In [99]:

```
# business card holder

sec=corner_radius(pts1([[0,0,1],[95,0,1],[0,10,1],[-95,0,1]]),10)

sol2=linear_extrude(offset(sec,1),1);

sec1=corner_radius(pts1([[10,0,5],[50,0,5],[10,30],[-70,0]]),10);
```

```

sol3=translate([12.5,2,21],rot("x90",linear_extrude(sec1,5)));

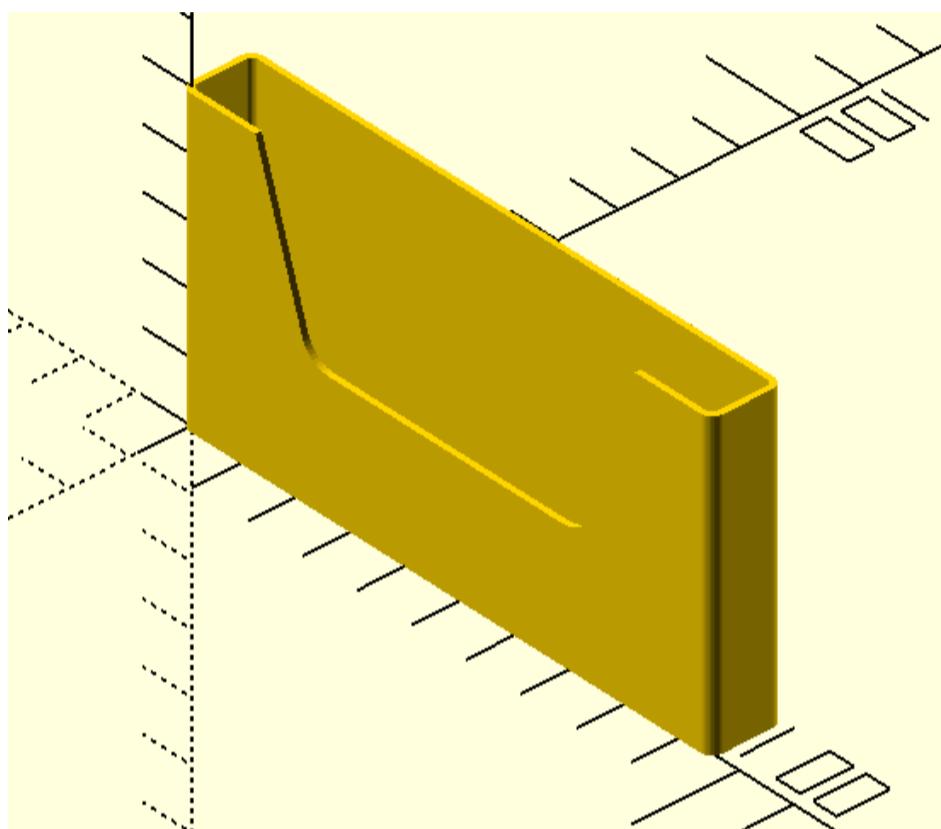
# difference(){}
# union(){}
# sol4=swp_prism_h(prism1,prism)
# swp(prism2);}
# swp(prism3);}

fileopen(f''

render(){{
difference(){}
linear_extrude(50)
difference(){}
polygon({offset(sec,1)}); 
polygon({sec}); 
}};

{swp(sol3)}
}}
{swp(sol2)}
}}
''' )

```



m10

```

In [100...]: t0=time.time()
c1=circle(17.5)
c2=circle(7.5,[14.5,0])
c3=circle(7.5,[-14.5,0])
sec1=c_hull(c1+c2+c3)
c4=circle(3,[14.5,0])
c5=circle(3,[-14.5,0])
c6=circle(10)
c7=circle(6.5)
c8=circle(19.5)
path=corner_radius3d_with_turtle([[0,0,-0.01],[0,0,29,17.5],[-44,0,0]],30)
c9,c10,c11,c12=[rot2d(i,circle(2.5,[15,0])) for i in [0,90,180,270]]
s1=linear_extrude(sec1,5.5)
s2,s3=[translate([0,0,0],linear_extrude(p,5.5)) for p in [c4,c5]]
s4=align_sol_1(path_extrude_open(c6,path))
s5=linear_extrude(c8,4)
s6,s7,s8,s9=[translate([0,0,0], linear_extrude(p,4)) for p in [c9,c10,c11,c12]]
s5,s6,s7,s8,s9=[translate(a_(path[-1])+[4.01,0,0], sol2vector([-1,0,0],flip(p))) for p in [s5,s6,s7,s8,s9]]
s10=align_sol_1(path_extrude_open(circle(6.5),path))
s11=swp_prism_h(s4,s10)
l1=i_p_p(s4,s4[0],5.5)
l2=offset_3d(l1,1.25)
l3=i_p_p(s4,s4[0],5.5+1.25)
f1=convert_3lines2fillet_closed(l2,l3,l1)

l4=i_p_p(s4,s4[-1],-4)
l5=offset_3d(l4,1.25)
l6=i_p_p(s4,s4[-1],-4-1.25)
f2=convert_3lines2fillet_closed(l6,l5,l4)
e1=end_cap(s1,1.25)
e2=end_cap(s5,1.25)
e3=end_cap_1(s2,.5)
e4=end_cap_1(s3,.5)
e5,e6,e7,e8=[ end_cap_1(p,.5) for p in [s6,s7,s8,s9]]
e9=end_cap_1(s10,1.25)
ey=l_(concatenate([e3,e4,e5,e6,e7,e8,e9]))
fileopen(f''

//color("blue")for(p={l4,l5,l6})p_line3dc(p,.2);
difference(){}
for(p={s1,s5})swp(p);
for(p={s2,s3})swp(p);
{swp(s4)}
for(p={s6,s7,s8,s9})swp(p);
for(p={e1})swp_c(p);
for(p={e2})swp_c(p);
for(p={ey})swp(p);

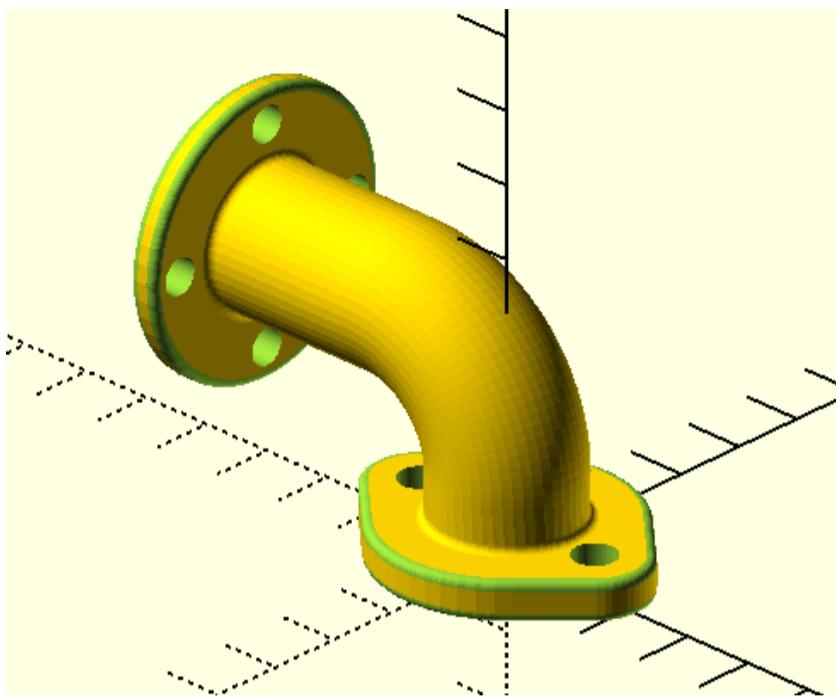
}}
```

```

difference(){
{sdp_c(s11)}
for(p={e9})sdp(p);
}
{sdp_c(f1)}
{sdp_c(f2)}
'')
t1=time.time()
t1-t0

```

Out[100... 3.2398972511291504



m35

```

In [101... # m35
t0=time.time()

p0=[15,0]
p1=[15,45]
cir1=circle(7.5,[0,75-7.5])
p2=p_cir_t(p1,cir1)
p4=[-15,45]
p3=cir_p_t(cir1,p4)
arc1=arc_2p(p2,p3,7.5,-1,45)
p5=[-15,0]
p0,p1,arc1,p4,p5=[[15,0,0]],[[15,45,20]],c2t3(arc1),[[-15,45,20]],[[-15,0,0]]
sec=corner_radius(p0+p1+arc1+p4+p5,10)
sec=translate([0,.1,0],sec)

path=corner_radius(pts1([[0,0],[45,0,7],[45*cos(d2r(30)),45*sin(d2r(30))]]),50)
path=rot('x90z90',path)

surf0=wrap_around(sec,path)
surf1=sec2surface_1(surf0)
surf2=surface_offset(surf1,4)
sol=solid_from_2surfaces(surf1,surf2)
sol=translate([0,0,9],rot('z-90',sol))

sec2=translate([0,0,-2],linear_extrude(circle(3.75,[0,75-7.5]),6.1))
surf3=[ wrap_around(p,path) for p in sec2]

sol1=flip(translate([0,0,9],rot('z-90',surf3)))

path1=cytz(pts([[0,9],[25.5+19.5,0],[(30-7.5)*cos(45*pi/180),(30-7.5)*sin(45*pi/180)]]))
# sec1=c2t3(m_points_o(pts([-15,0],[30,0],[0,5],[-30,0])),1)

sec3=[[-30,-15]]+arc_2p([0,-15],[0,15],15,-1,20)+[[-30,15]]
p6=l_cir_ip([[-30,-15+10.5],[0,-15+10.5]],circle(7.5))
p7=l_cir_ip([[-30,15-10.5],[0,15-10.5]],circle(7.5))
sec4=[[-30,-15+10.5]]+arc_long_2p(p6[0],p7[0],7.5,-1,30)+[[-30,15-10.5]]

sec5=circle(6)
path2=corner_radius(pts1([[0,-15.1],[0,4.6],[-3,0],[0,21],[3,0],[0,4.6]]),5)
sol2=translate([-30+12,0,11.25],rot('x-90',f_prism(sec5,path2)))

sec6=[[25.5+9,-15.1]]+arc_2p([25.5+9,0],[25.5,0],4.5,-1)+[[25.5,-15.1]]
txt1=dim_linear(translate([0,0,9],[sec6[-1],sec6[0]]),3)
txt2=dim_linear(point_vector(translate([0,0,9],sec6[-1]),[0,0,4]),-2)
txt3=dim_radial(translate([0,0,22.5],sec4[10:-1]))
txt4=dim_linear(translate([0,0,22.5],[sec4[-1],sec4[0]]),2)
txt5=dim_radial(sol1[0][10:])
txt6=dim_radial(sol2[0])
txt7=dim_radial(sol2[2])
txt8=dim_radial(translate([0,0,22.5],sec3[12:-1]),outside=1)
txt9=dim_linear(translate([0,0,22.5],[sec3[-1],sec3[0]]),10)
l1=translate([0,-20,9],rot('z-90',path))[2:]
l2=translate([0,-20,9],rot('z-90',path))[-2:]

txt10=dim_angular(l1,l2)
txt11=dim_radial(translate([0,0,13],sec6[1:-1]))
txt12=dim_linear(translate([0,0,13],mid_line(flip(sec6[:2]),sec6[-2:])))
txt13=dim_linear(point_vector(c23(sec3[0]),[0,0,22.5]),6)
txt14=dim_radial(translate([0,0,9],rot('z-90',surf0[20:30])),outside=1)
txt15=dim_radial(translate([0,0,9],rot('z-90',surf0[1:10])),outside=1)
l1=translate([0,0,22.5],[sec4[-1],sec4[0]])
p0=center_arc3d(translate([0,0,22.5],sec4[1:-1]))
p1=vcost1(l1,p0)
txt16=dim_linear([p0,p1],0)
p0=center_arc3d(sol2[0])
l1=c23(sec3[2])
p1=vcost1(l1,p0)

```

```

txt17=dim_linear(translate([0,-2,0],[p1,p0]),0)
l1=point_vector(c23(sec3[-1]),[0,0,22.5])
p0=center_arc3d(sol2[-1])
p1=vcost1(l1,p0)
txt18=dim_linear([p0,p1],2)

l1=cpo(sol2)[0][-2:]
txt19=dim_linear(l1,-5)
fileopen(f'''

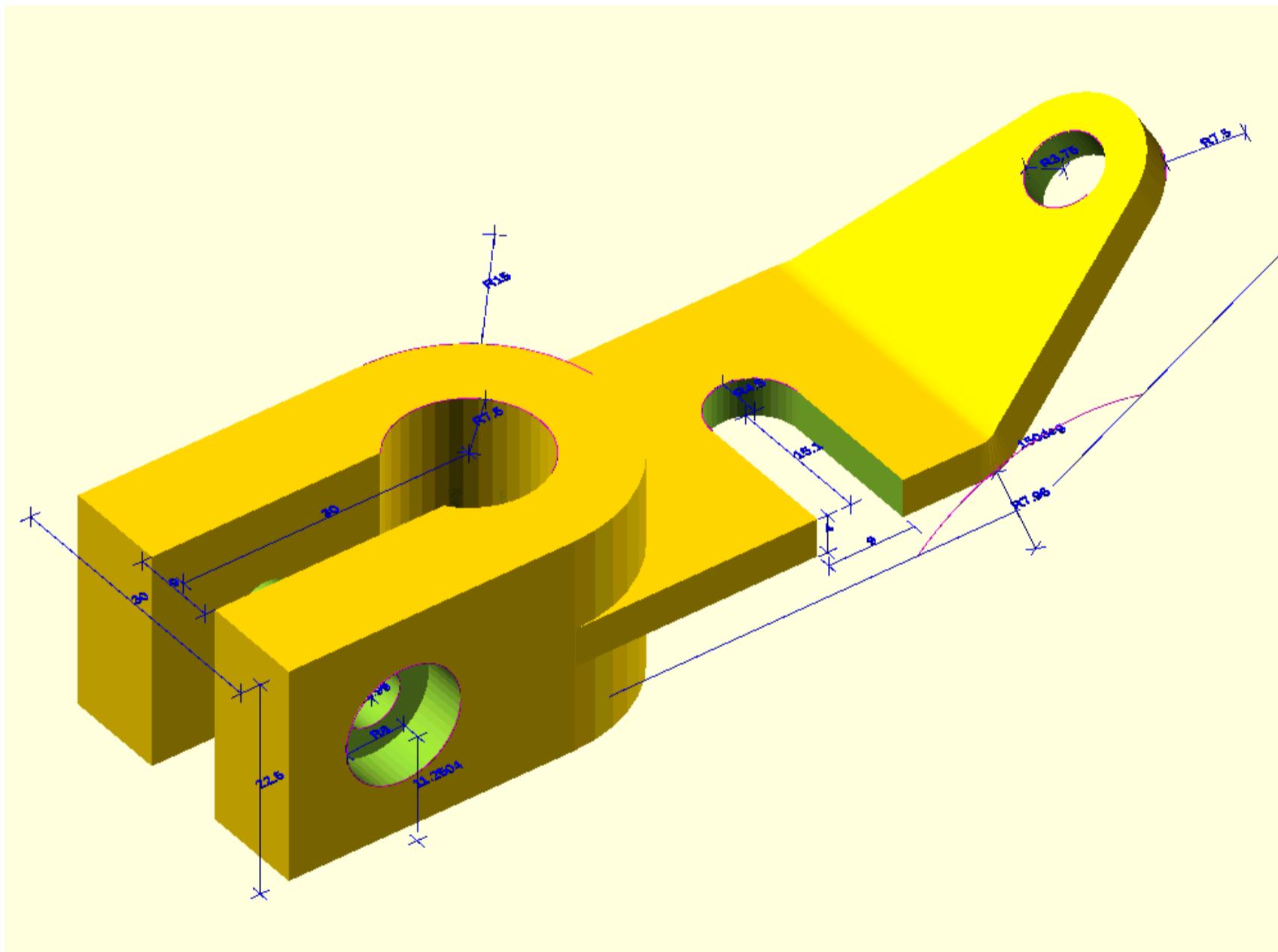
//color("cyan")for(p={[l1]})p_line3d(p,.3);
//color("cyan")points({[p0,p1]},.5);
{txt1}{txt2}{txt3}{txt4}{txt5}{txt6}{txt7}{txt8}{txt9}{txt10}{txt11}{txt12}
{txt13}{txt14}{txt15}{txt16}{txt17}{txt18}{txt19}
%
difference(){
{swp(sol)}
linear_extrude(22.5)polygon({sec4});
{swp(flip(sol1))}

linear_extrude(22.5)polygon({sec6});
}
%
difference(){
linear_extrude(22.5)
difference(){
polygon({sec3});
polygon({sec4});
}
{swp(sol2)}
}

''' )
t1=time.time()
t1-t0

```

Out[101... 0.13098597526550293



l_cir_ip

```

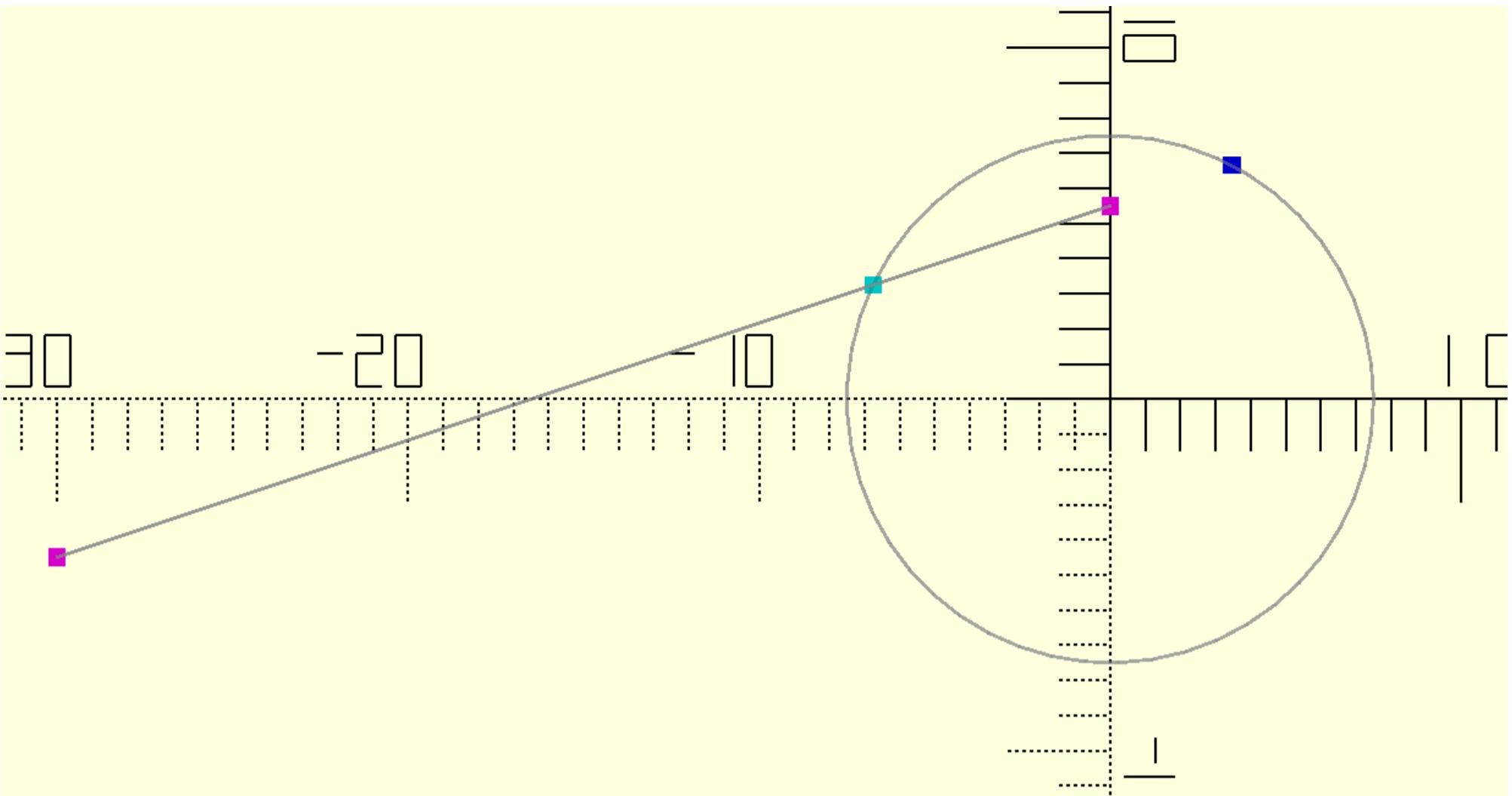
In [102... # example of function l_cir_ip(line, cir)
p0=[-30,-15+10.5]
p1=[0,-15+10.5+10]
line=[p0,p1]
cir=circle(7.5)
p2=l_cir_ip(line,cir)

fileopen(f'''

%p_line({cir},.1);
%p_line({[p0,p1]},.1);
color("magenta")points({[p0,p1]},.5);
color("cyan")points({[p2[0]]},.5);
color("blue")points({[p2[1]]},.5);

''' )

```



fillet_line_circle

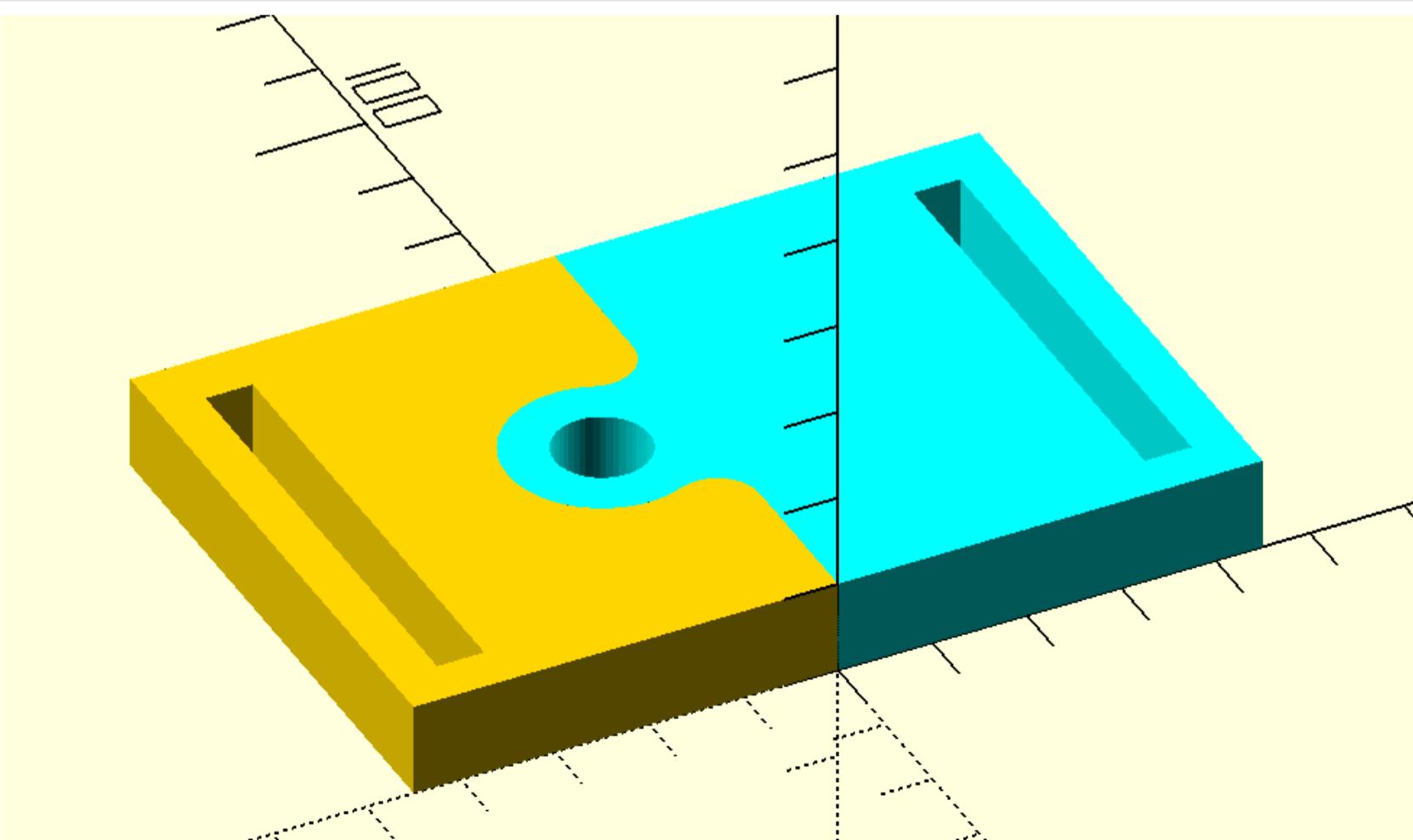
In [103]: # example of fillet_line_circle(l1, c1, r, o=1, s=10)

```

line=[[0,0],[0,60]]
cir1=circle(10,[-10,30])
cir2=circle(5,[-10,30])
fillet1=flip(fillet_line_circle(line,cir1,4.5,3,10))
fillet2=fillet_line_circle(line,cir1,4.5,1,10)
a,b=[fillet1[-1],fillet2[0]]
a1=lineFromPointToPointOnLine(flip(cir1),a,b,1)
sec1=remove_extra_points([[-45,0],[0,0]]+fillet1+a1+fillet2+[0,60],[-45,60]])
sec2=remove_extra_points([[45,60],[0,60]]+flip(fillet2)+flip(a1)+flip(fillet1)+[[0,0],[45,0]])
sol1=linear_extrude(sec1,10)
sol2=translate([0,0,.001],linear_extrude(sec2,10))
sol3=translate([0,0,-1],linear_extrude(cir2,12))

fileopen(f''''
{swp(sol1)}
color("cyan")
difference(){{
{swp(sol2)}
{swp(sol3)}
}}
'''')

```



In []: # example of fillet_line_circle(l1, c1, r, o=1, s=10)
h=15

```

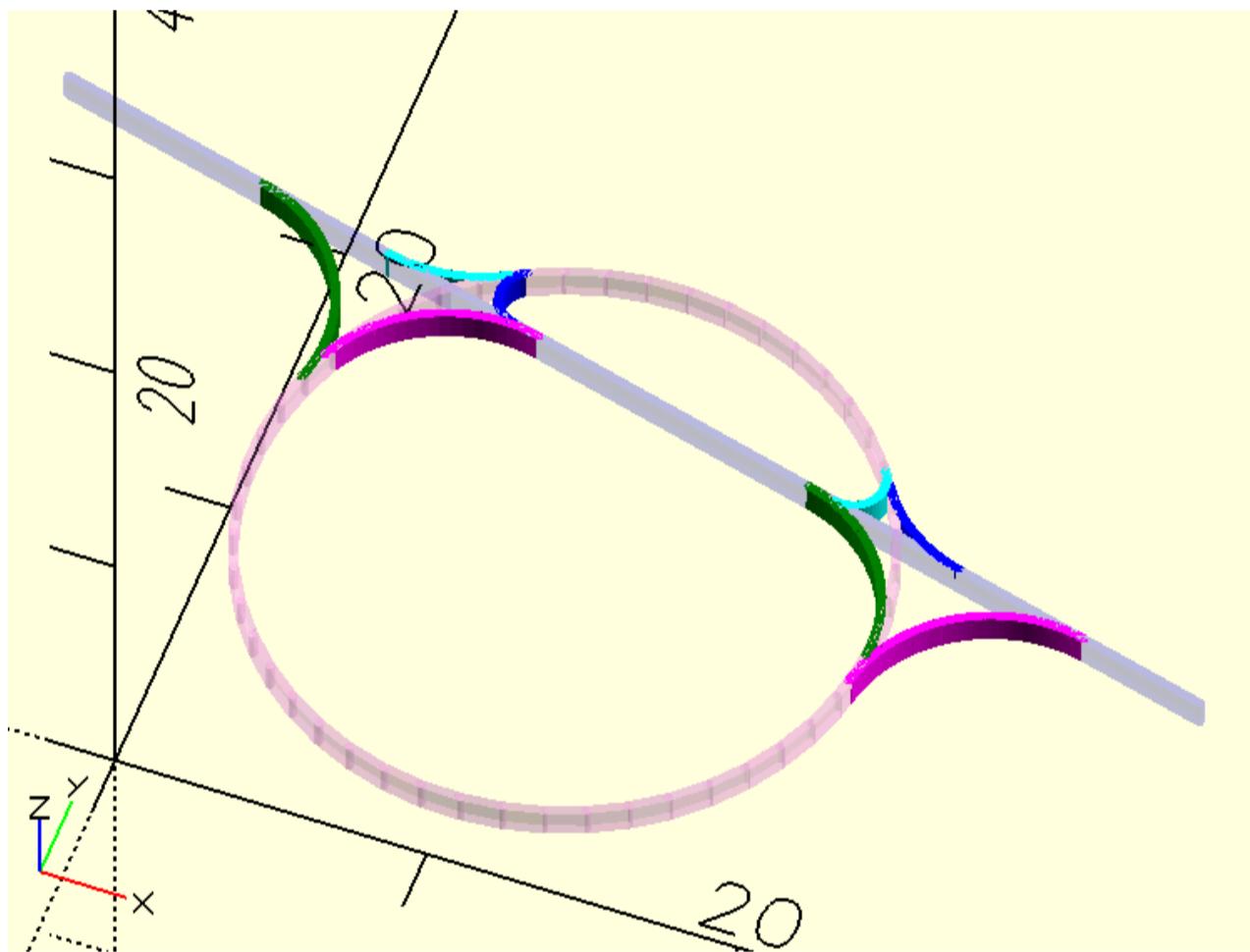
line=[[-10,h],[30,h]]
cir1=circle(10,[10,10])
r2=5
s=20
fillet1=fillet_line_circle(line,cir1,r2,1)
fillet2=fillet_line_circle(line,cir1,r2,2)
fillet3=fillet_line_circle(line,cir1,r2,3)
fillet4=fillet_line_circle(line,cir1,r2,4)
fillet5=fillet_line_circle_internal(line,cir1,1,1)
fillet6=fillet_line_circle_internal(line,cir1,r2,2)
fillet7=fillet_line_circle_internal(line,cir1,1,3)
fillet8=fillet_line_circle_internal(line,cir1,r2,4)

fileopen(f'''

color("blue",.1)p_line({line},.3);
color("violet",.2)p_line({cir1},.3);
color("cyan")p_lineo({fillet1},.3);
color("blue")p_lineo({fillet2},.3);
color("magenta")p_lineo({fillet3},.3);
color("green")p_lineo({fillet4},.3);
color("blue")p_lineo({fillet5},.3);
color("magenta")p_lineo({fillet6},.3);
color("cyan")p_lineo({fillet7},.3);
color("green")p_lineo({fillet8},.3);

''')
l_(a_[radius_arc2d(fillet1),
radius_arc2d(fillet2),
radius_arc2d(fillet3),
radius_arc2d(fillet4),
radius_arc2d(fillet5),
radius_arc2d(fillet6),
radius_arc2d(fillet7),
radius_arc2d(fillet8)]).round(3)

```



equidistant_pathc

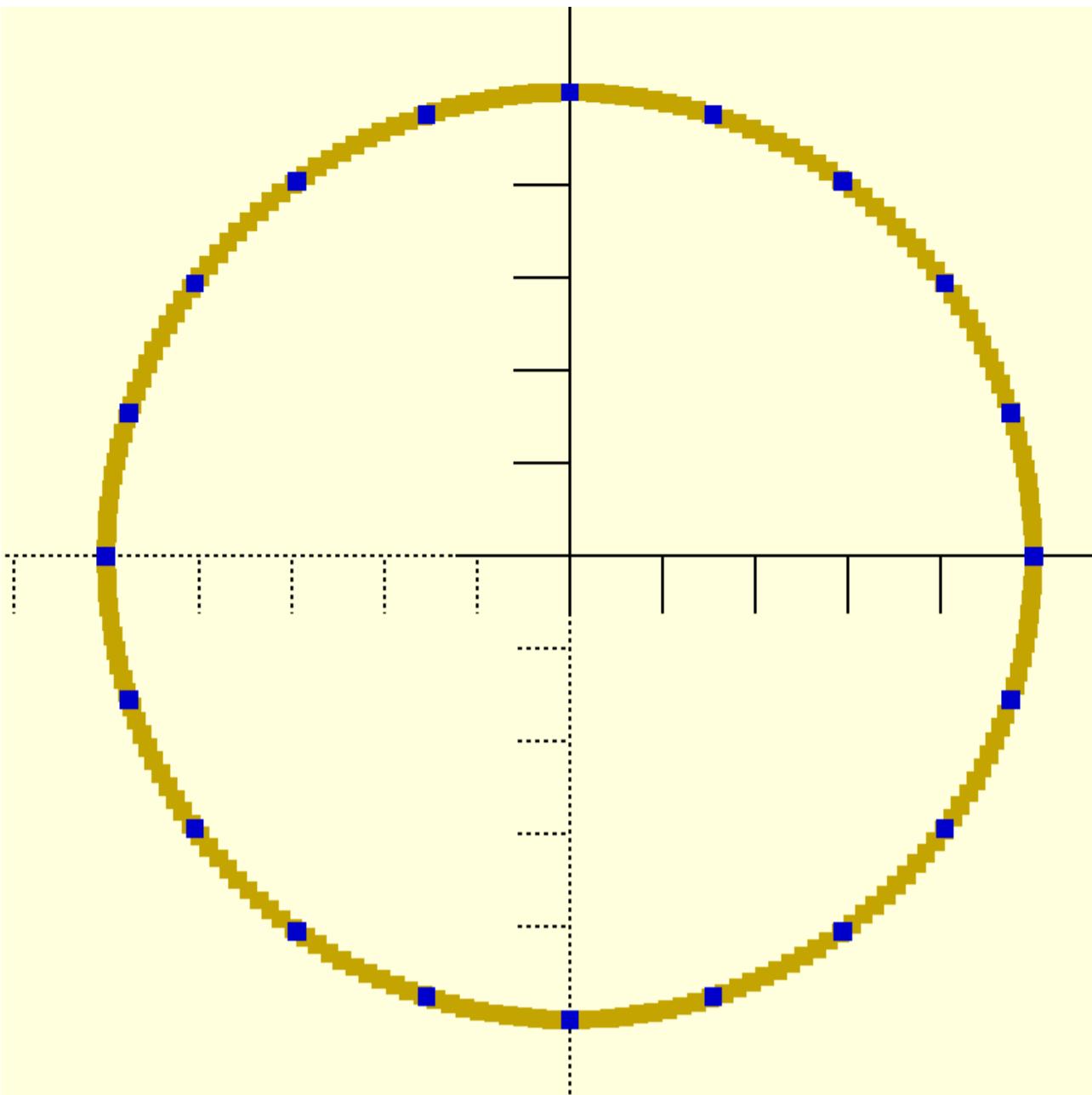
```

In [104... a=circle(5,s=200)
fileopen(f'''

points({a},.2);
color("blue")points({equidistant_pathc(a,20)},.2);

''')

```



artifact

oset

```
In [ ]: # it takes around 200 sec for calculations

t0=time.time()
stages =200
stage_height = 1.25
rad = 50
f1 = 25
f2 = 25
phase1 = 0
phase2 = 180
height_depth=5
depth1 = 20
depth2 = 20
thickness = 1
bottom_thickness = 3
myslices = 5
angle_step=.5
var=1

def pauw(x,p):
    return sign(x)*abs(x)**p

def f(i,stages):
    return sin(d2r(i/stages * 120))**2 * 7 + 1

def a(i,stages,var,height_depth):
    return (sin(d2r((i/stages*360*f(i,stages))%360)) * 0.5 + 0.5) * (var * height_depth)

# generate outer points

# points_base = [for (i = [0:1:stages])
#                 let(f = sin(i/stages * 120)^2 * 7 + 1, var = 1 , a=((sin((i/stages*360*f)%360) * 0.5 + 0.5) * (var * height_depth)))
#                 [for(j = [0:angle_step:360-angle_step])
#                  [sin(j) * (rad+a+(pauw(sin(j *f1+phase1),0.5)*0.5+0.5)*depth1*i/stages+(pauw(sin(j *f2+phase2),0.5)*0.5+0.5)*depth2*(1-i/stages)),
#                   cos(j) *(rad+a+(pauw(sin(j *f1+phase1),0.5)*0.5+0.5)*depth1*i/stages+(pauw(sin(j *f2+phase2),0.5)*0.5+0.5)*depth2*(1-i/stages)),
#                   i*stage_height]]]
#             points_base=[[]
```

```

        sin(d2r(j)) * (rad+a(i,stages,var,height_depth)+(pauw(sin(d2r(j *f1+phase1)),0.5)*0.5+0.5)*depth1*i/stages+(pauw(sin(d2r(j *f2+phase2)),0.5)*0.5+
        cos(d2r(j)) * (rad+a(i,stages,var,height_depth)+(pauw(sin(d2r(j *f1+phase1)),0.5)*0.5+0.5)*depth1*i/stages+(pauw(sin(d2r(j *f2+phase2)),0.5)*0.5-
        i*stage_height
    ]
    for j in arange(0,360,angle_step)] for i in range(stages+1)]
```

p1,p2=[],[]
for i in range(stages):
 points_base1= flip(c3t2(points_base[i]))#flip(c3t2(points_base[i])) if cw(c3t2(points_base[i]))==1 else c3t2(points_base[i])
 points_base2=oset(points_base1,-thickness)
 p1.append(translate([0,0,i*stage_height],points_base1))
 p2.append(translate([0,0,i*stage_height],points_base2))

p2=flip(p2)
l1,l2=p2[-5],p2[-3]
l3=translate([0,0,2.5],offset(c3t2(p1[2]),-7))
f1=cpo(convert_3lines2fillet(l1,l3,l2))[:-1]
sol=p1+p2[:-6]+f1
fileopen(f'''
{swp(sol)}
''')
t1=time.time()
t1-t0

```
In [ ]: p2=flip(p2)  

l1,l2=p2[-5],p2[-3]  

l3=translate([0,0,2.5],offset(c3t2(p1[2]),-7))  

f1=cpo(convert_3lines2fillet(l1,l3,l2))[:-1]  

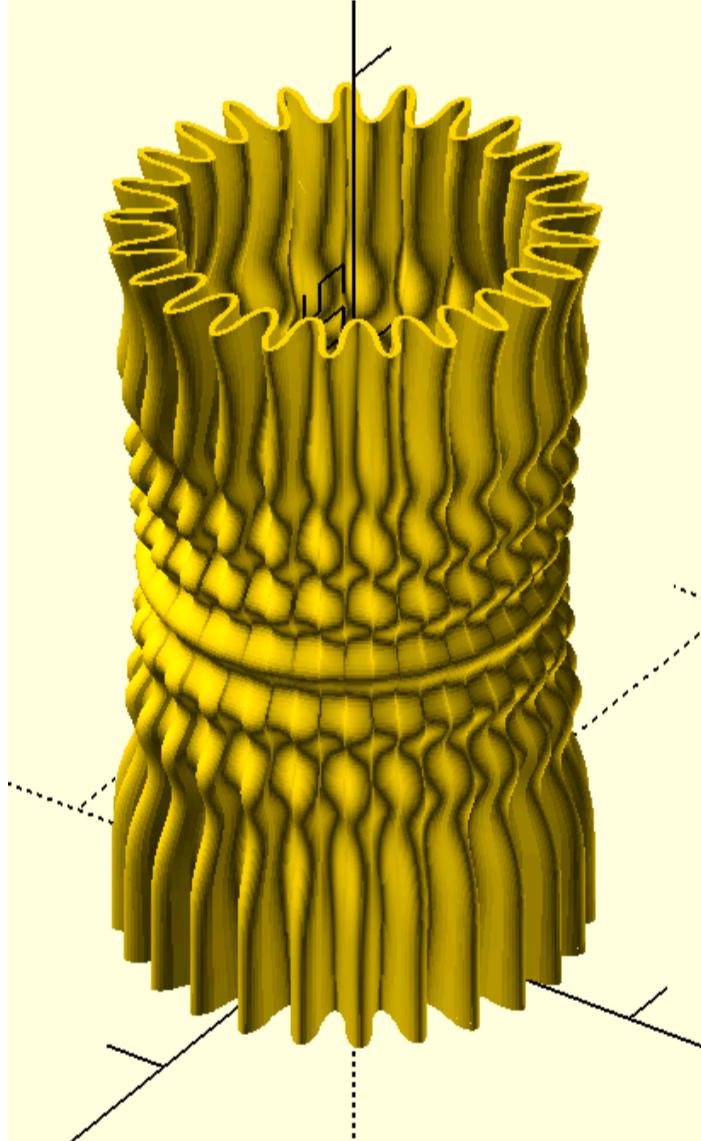
fileopen(f'''  

color("blue")p_line3d({l2},.2,1);  

color("magenta")p_line3d({l3},.2,1);  

{swp_c(f1)}  

''')
```



wrap_around

```
# example of function wrap_around(sec,path)
t0=time.time()

sec=corner_radius(pts1([[-10,0,2],[20,0,2],[0,15,5],[-10,10,1],[-10,-10,5]]),30)
sec_h_l=h_lines_sec(sec,500,.01)
path=cr3dt([[0,0,0,0],[0,15,0,1],[0,-4,5,1],[0,10,0,0]],50)

sec1=[wrap_around(p,path) for p in sec_h_l]
sec2=surface_offset(sec1,-.5)
sol1=flip(solid_from_2surfaces(sec1,sec2))

sol2=o_solid([0,1,0],circle(1),40,0,0,3.5)
fileopen(f'''  

difference(){  

{swp(sol1)}  

//{swp(sol2)}  

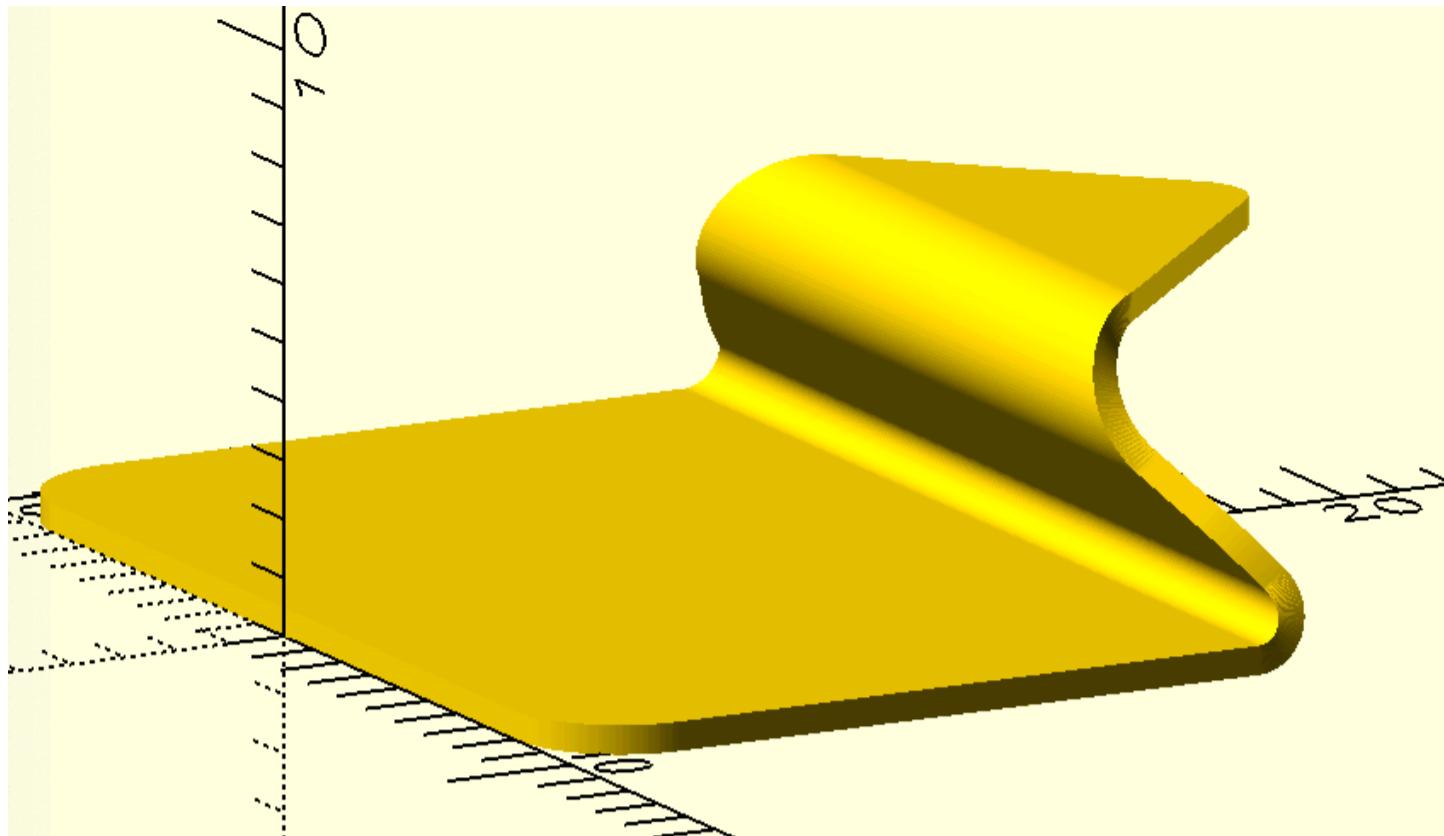
}  

''')  

t1=time.time()  

t1-t0
```

Out[106... 1.0425207614898682



In [107... # example of function wrap_around(sec,path) work flow

```
sec=equidistant_pathc(corner_radius(pts1([[-10,0,1,1],[20,0,1],[0,15,1],[-10,10,2],[-10,-10,1]]),20),200)

path1=corner_radius(pts1([[0,0],[15,0,1],[-16,15]]),50)
path2=circle(5,s=200)
path3=corner_radius(pts1([[0,0],[5,0,1],[0,5,1],[3,0,1],[0,-5,1],[10,0]]),10)
path1=rot('x90z90',path1)
path2=rot('x90z90',path2)
path3=rot('x90z90',path3)

sec1=wrap_around(sec,path1)
sec2=wrap_around(sec,path2)
sec3=wrap_around(sec,path3)

path4=corner_radius(pts1([[6,2],[-6,0,1],[0,-2.001,1],[25,0]]),10)
path4=rot('x90z90',path4)

sec4=translate([0,9,0],rot('z-45',sec1))
sec4=wrap_around(sec4,path4)

sec5=translate([0,9,0],rot('z90',translate([0,-9,0],sec4)))
sec5=wrap_around(sec5,path4)

sec6=rot('z-45',translate([0,-9,0],sec5))

fileopen(f''''

translate([30,40,0]){
p_line3d({path2},.1);
color("magenta")p_line3dc({sec2},.1);}

translate([30,60,0]){
p_line3d({path3},.1);
color("magenta")p_line3dc({sec3},.1);}

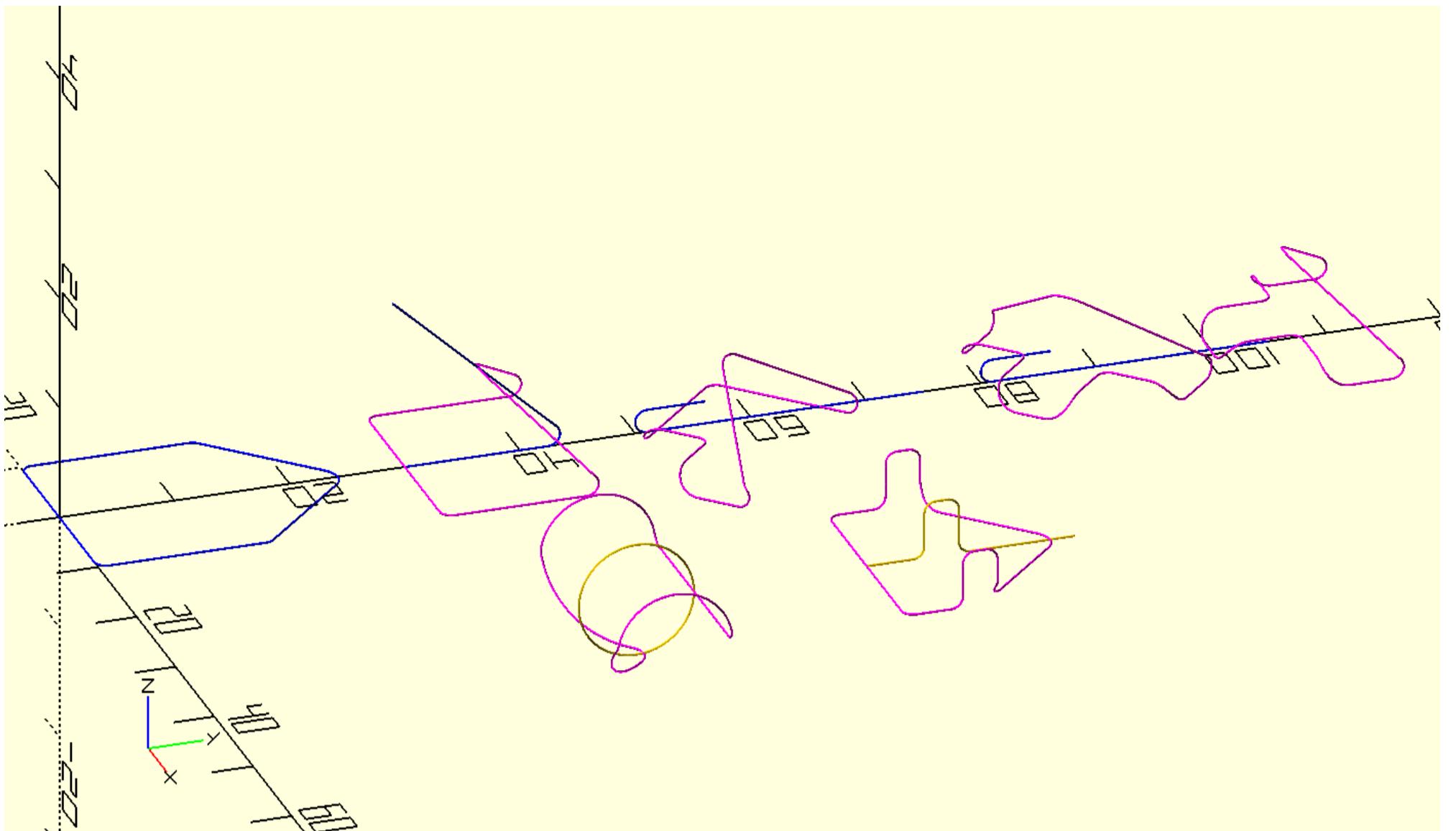
color("blue")p_line3dc({sec1},.1);
translate([0,30,0]){
color("blue")p_line3d({path1},.1);
color("magenta")p_line3dc({sec1},.1);}

translate([0,50,0]){
color("blue")p_line3d({path4},.1);
color("magenta")p_line3dc({sec4},.1);}

translate([0,80,0]){
color("blue")p_line3d({path4},.1);
color("magenta")p_line3dc({sec5},.1);}

translate([0,110,0]){
//p_line3d({path4},.1);
color("magenta")p_line3dc({sec6},.1);}

'''')
```



```
In [108... # wrap_around example 4
t0=time.time()

sec=corner_radius(pts1([[-10,0,2],[20,0,2],[0,15,5],[-10,10,1],[-10,-10,5]]),30)
sec1=h_lines_sec(sec,.01)
sec1=[equidistant_path(p,50) for p in sec1]

path1=corner_radius(pts1([[0,0],[15,0,1],[-16,15]]),50)
path1=rot('x90z90',path1)

sec1=[wrap_around(p,path1) for p in sec1]

path4=corner_radius(pts1([[7,5],[-7,-5,1],[45,0]]),10)
path4=rot('x90z90',path4)

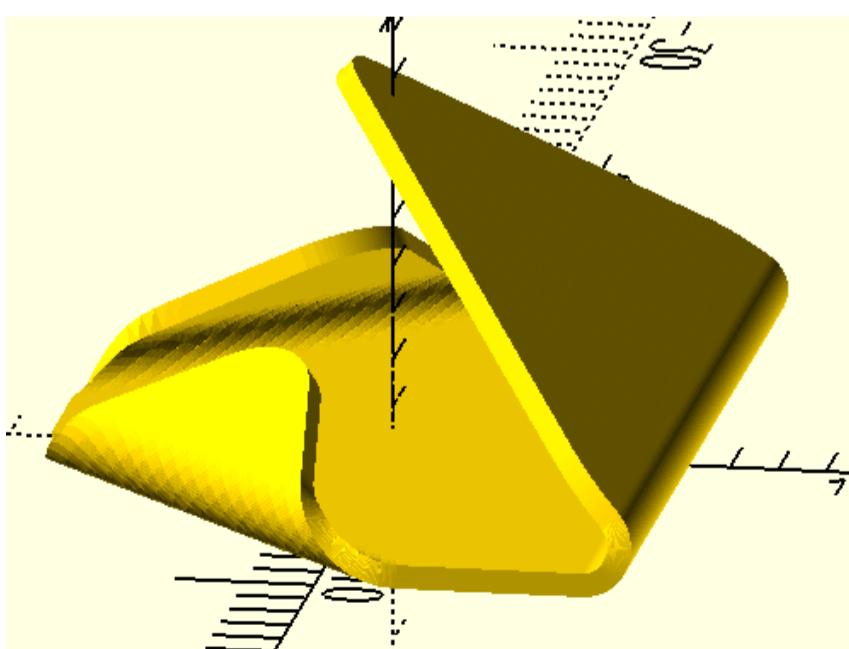
sec2=translate([0,9,0],rot('z-45',sec1))
sec2=[wrap_around(p,path4) for p in sec2]

sec3=translate([0,9,0],rot('z90',translate([0,-9,0],sec2)))
sec3=[wrap_around(p,path4) for p in sec3]

sec3=rot('z-45',translate([0,-9,0],sec3))
sec4=surface_offset(sec3,-.5)
sol=solid_from_2surfaces(sec3,sec4)

fileopen(f'''
{swp(sol)}
''')
t1=time.time()
t1-t0
```

Out[108... 7.177796840667725



ball-bearing

```
In [109... # ball bearing

sec=corner_radius(pts1([[31,.5,0],[.5,-.5,0],[9.5,0,1],[0,15,1],[-9.5,0,0],[-.5,-.5,0]]),10)
sec1=corner_radius(pts1([[16,.5,0],[.5,-.5],[9,0,0],[0.5,.5,0],[0,14,0],[-.5,.5,0],[-9,0,0],[-.5,-.5,0]]),10)
```

```

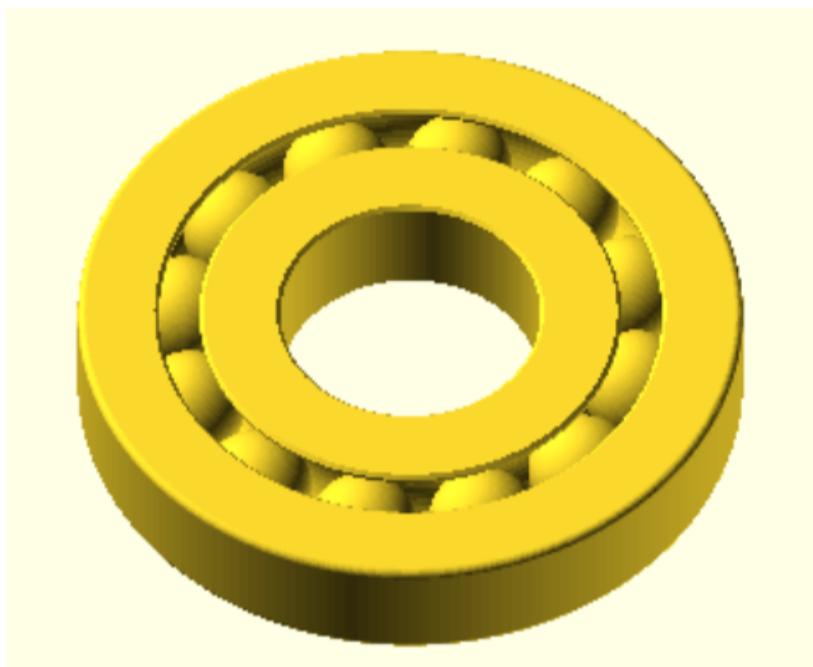
sec2=circle(7,[28.5,7.5])
fileopen(f'''

rotate_extrude($fn=200)
difference(){
union(){
polygon({sec});
polygon({sec1});
}
polygon({sec2});
}

for(i=[0:360/12:359])
rotate([0,0,i])
translate([28.5,0,7.5])
sphere(6.8,$fn=100);

''' )

```



mobile-phone-stand

```

In [110... t0=time.time()
sec=pts([[0,0],[120,0],[0,4.1]],rot2d(120,[7,0]),rot2d(210,[4.1,0]),
       rot2d(300,[4.7,0]),[-21.8,0],rot2d(120,[50,0]),
       rot2d(210,[4.1,0]),rot2d(300,[47.7,0]),[-88.7,0]))
r_l=[2,3,4,2,2,1,6,2,2,3,1.9]
sec1=corner_n_radius_list(sec,r_l,10)

p1=arc_2p([0,0],[150,0],350,s=20)
p2=rot('x60z90',p1)
p3=rot('z90',p1)
s1=sec1[33:55]
t=array(s1[0])
s1=translate(cytz([t])[0],path_extrude_open(translate_2d(-t,s1),p2))
s2=sec1[77:99]
t=array(s2[0])
s2=translate(cytz([t])[0],path_extrude_open(translate_2d(-t,s2),p2))

s3=sec1[110:]+sec1[:11]
s3=path_extrude_open(s3,p3)
s4=rot('x90',sec1[11:33])
s4=slice_sol(surface_line_vector(s4,[0,150,0]),20)

s5=rot('x90',sec1[55:77])
s5=slice_sol(surface_line_vector(s5,[0,150,0]),20)

s6=rot('x90',sec1[99:110])
s6=slice_sol(surface_line_vector(s6,[0,150,0]),20)

# now join all the surfaces together
# orientation of the surfaces needs to be changed
surf1=cpo(flip(cpo(s3))+cpo(s4)+flip(cpo(s1))+cpo(s5)+flip(cpo(s2))+cpo(s6))
l1=ppplane(surf1[0],[0,1,0],[0,0,0])
l2=offset_3d(l1,-1.8,1)
l3=i_p_p(surf1,surf1[0],2)
f1=cpo(convert_3lines2fillet(l2,l3,l1))[:-1]
f2=flip(mirror_surface(f1,[0,1,0],[0,75,0]))
# now create the solid with final shape
sol1=flip(f1+surf1[1:-1]+f2)
# radiiuses can be now increased as desired
# That's it
fileopen(f'''

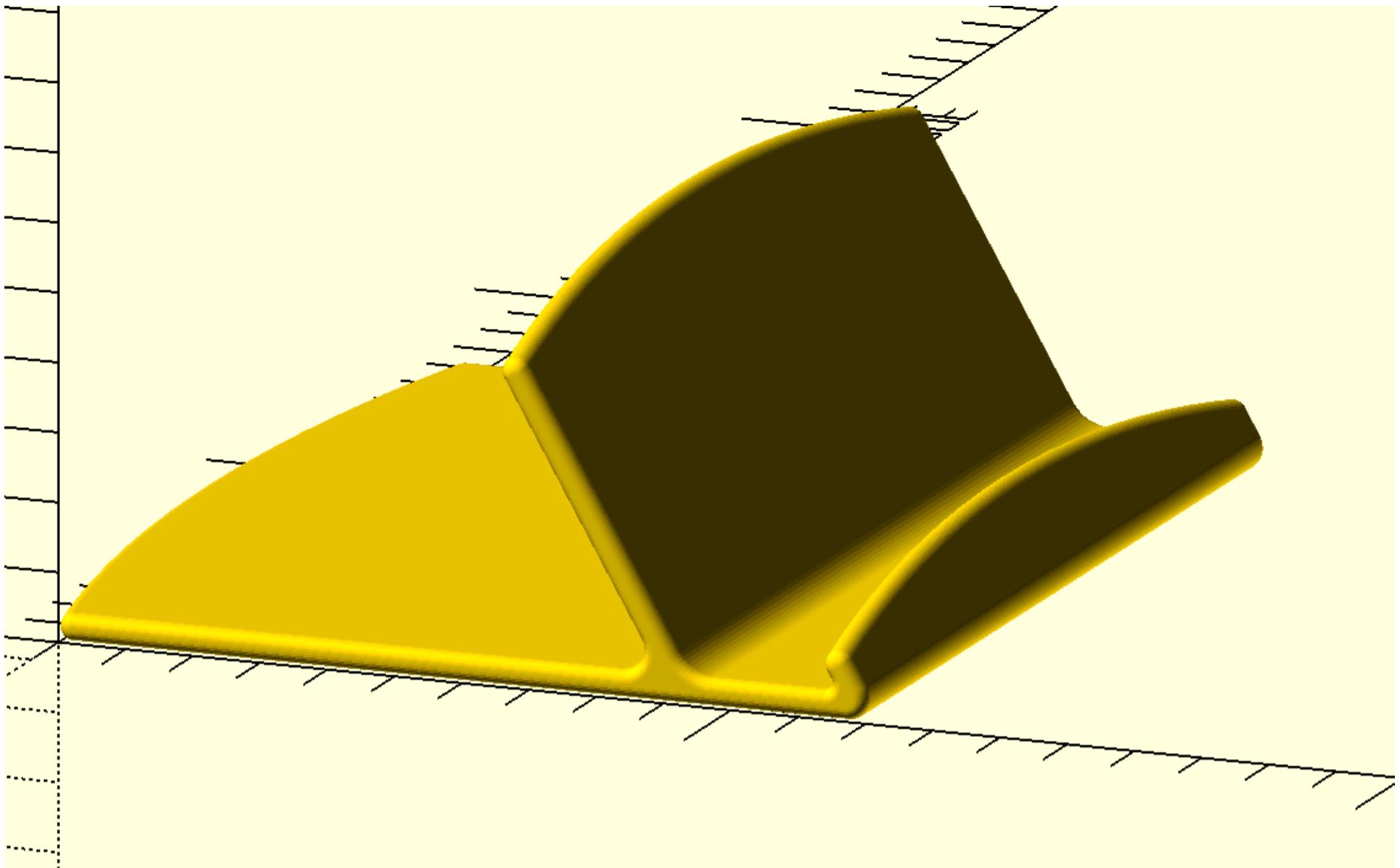
{swp(sol1)}

''' )

t1=time.time()
t1-t0

```

Out[110... 1.1850600242614746



In [111]: # mobile phone stand with application of functions wrap_around and surf_offset

```
t0=time.time()
sec1=corner_radius(pts1([[-75,20,2],[75,-20,280],[75,20,2],[0,70,2],[-75,7,280],[-75,-7,2]]),30)
cp1=array(offset(sec1,-35)).mean(0)
sec1=m_points(sec1,.5)
sec2=cpo([sort_points(sec1,[cp1]),sec1])
sec2=cpo([ls(p,60)for p in sec2])+[sec1]
path1=corner_radius(pts1([[0,60*sin(d2r(60)),0],[60*cos(d2r(-60)),60*sin(d2r(-60)),5+1],[15+10,0,4+1],[50*cos(d2r(120)),50*sin(d2r(120))]]),50)
path1=path1
path1=rot('x90z90',path1)

surf1=[wrap_around(p,path1) for p in sec2]
surf2=surf_offset(flip(surf1),3)
sol=surf1+surf2

sec1=corner_radius(pts1([-70,20,2],[70,-20,200],[70,20,2],[0,80,2],[-140,0,2]]),30)
cp1=array(offset(sec1,-25)).mean(0)
sec1=m_points(sec1,.5)
sec2=cpo([sort_points(sec1,[cp1]),sec1])
sec2=cpo([ls(p,60)for p in sec2])+[sec1]

path2=corner_radius(pts1([[0,0],[95,0,4+1],[100*cos(d2r(120)),100*sin(d2r(120))]]),50)
path2=rot('x90z90',path2)
surf1=[wrap_around(p,path2) for p in sec2]
surf2=surf_offset(flip(surf1),3)
sol1=surf1+surf2

sol2=[sol[57]]+slice_sol(sol[60:62],3)+[sol[63]]

p0,p1,p2,p3,p4,p5=sol2
fillet1=cpo(convert_3lines2fillet(p2,p0,p1))[:-1]
fillet2=cpo(convert_3lines2fillet(p5,p3,p4))[:-1]

sol3=flip(fillet1)+flip(fillet2)
sol4=sol[:57]+sol3+sol[64:]

sol2=[sol1[57]]+slice_sol(sol1[60:62],3)+[sol1[63]]

p0,p1,p2,p3,p4,p5=sol2
fillet1=cpo(convert_3lines2fillet(p2,p0,p1))[:-1]
fillet2=cpo(convert_3lines2fillet(p5,p3,p4))[:-1]

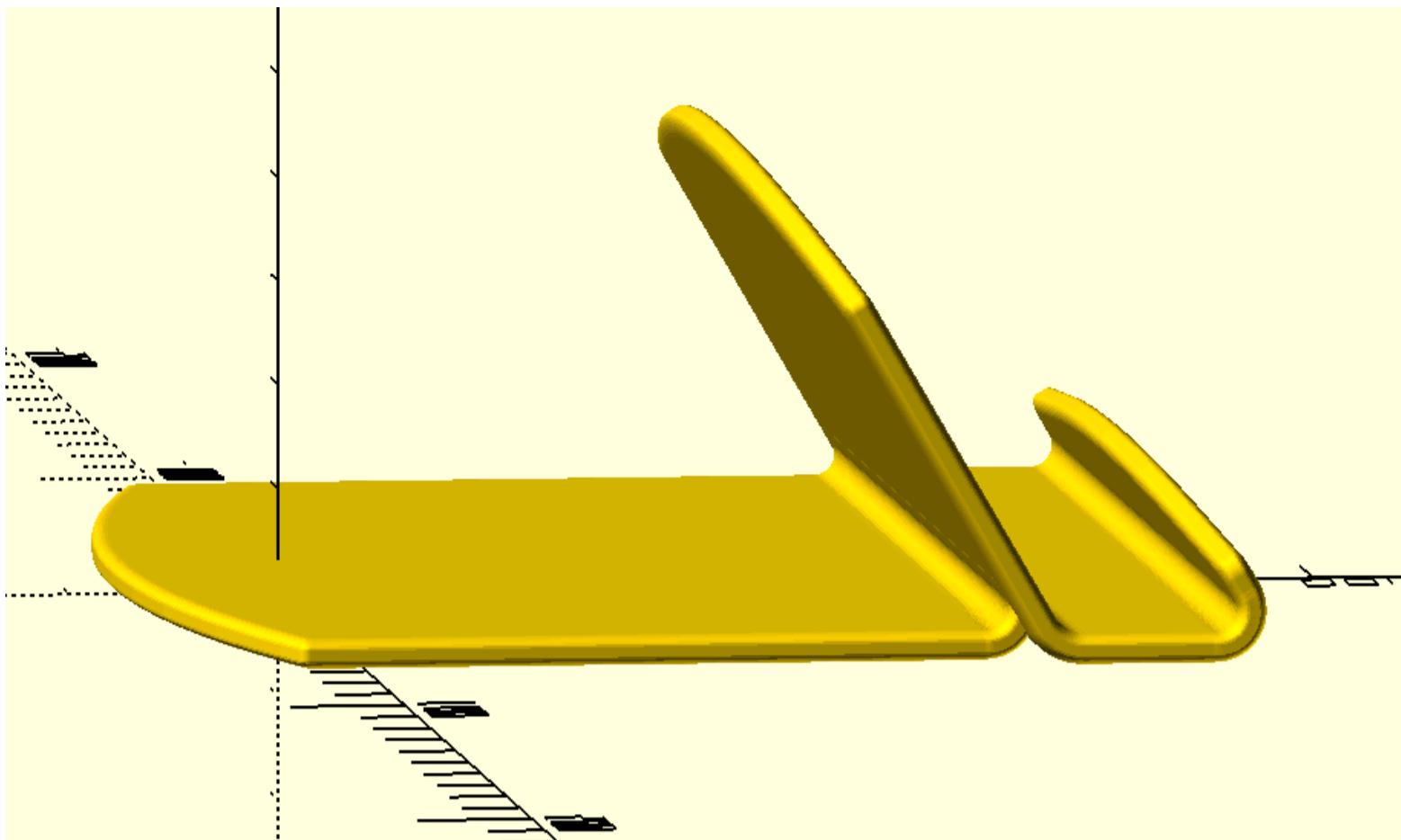
sol3=flip(fillet1)+flip(fillet2)
sol5=sol1[:57]+sol3+sol1[64:]

fileopen(f'''

translate([0,40-4.625,0])
{swp(sol4)}
translate([0,-26.2,0])
{swp(sol5)}

''')
t1=time.time()
t1-t0
```

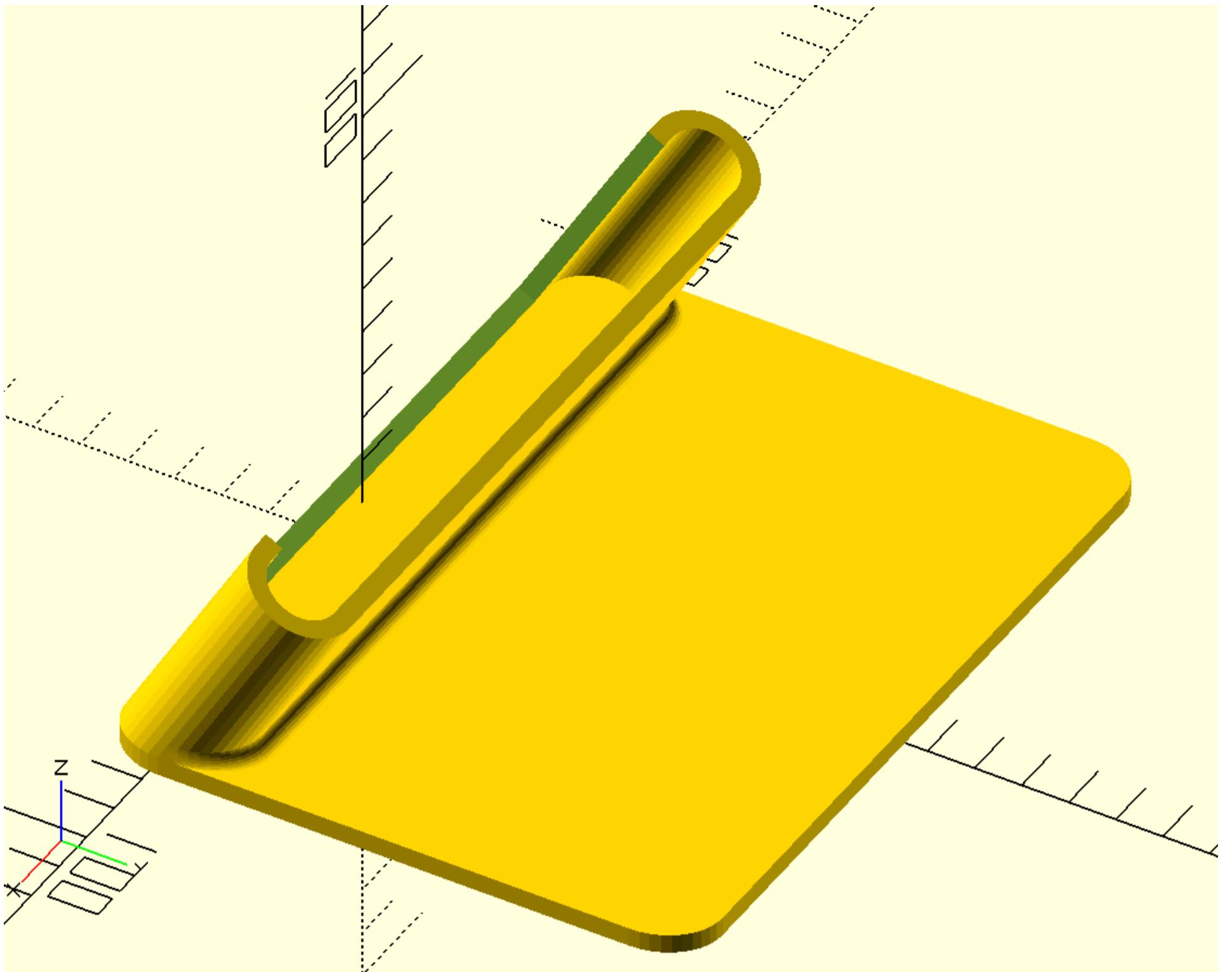
Out[111]: 9.977349042892456



```
In [121...]: # car mobile stand
sec=corner_radius(pts1([[-160/2-4,-15/2-4,23/2-.1],[160+2*4,0,23/2-.1],[0,15+2*4,23/2-.1],[-160-2*4,0,23/2-.1]]),10)
sol=o_solid([0,1,sqrt(3)],sec,60)
sol1=surf_offset(sol,-4)
sol2=swp_prism_h(sol,sol1)
surf1=translate([0,0,10],plane([0,0,1],200))
ip1=ip_solid(surf1,sol,0)
surf2=ip1[:22]+translate([0,100,0],ip1[22:44])
surf3=translate([0,0,-4],surf2)
sol3=[surf3]+[surf2]
sol4=o_solid([0,0,1],square(200,center=True),20,-10)

sec1=corner_radius(pts1([[-130/2,0],[130,0],[5,60],[-130-2*5,0]]),10)
sol5=o_solid([0,-sqrt(3),1],sec1,10,5,0,10)

sol6=[ip1[22:]]+[translate([0,2,0],ip1[22:])] + [translate([0,1,sqrt(3)],ip1[22:])]
fillet1=convert_3lines2fillet(translate([0,5,0],ip1[22:]),translate([0,2.4,4.34],ip1[22:]),ip1[22:])
fileopen(f'''
difference(){
{swp_c(sol2)}
{swp(sol4)}
{swp(sol5)}
}
//%{swp(surf1)}
//color("magenta")points({ip1[:22]},.5);
{swp(sol3)}
{swp(fillet1)}
''' )
```



back-camera-clamp

```
In [122]: # back camera clamp

sec=corner_radius(pts1([[-37/2,0.1,3],[37,0,3],[0,15,2],[-5,24,13.5],[-27,0,13.5],[-5,-24,2]]),20)
l1=h_lines_sec(sec,120)

path=corner_radius(pts1([[0,0],[15,0,3.5],[15,41.21]]),10)
path=rot('x90z90',path)

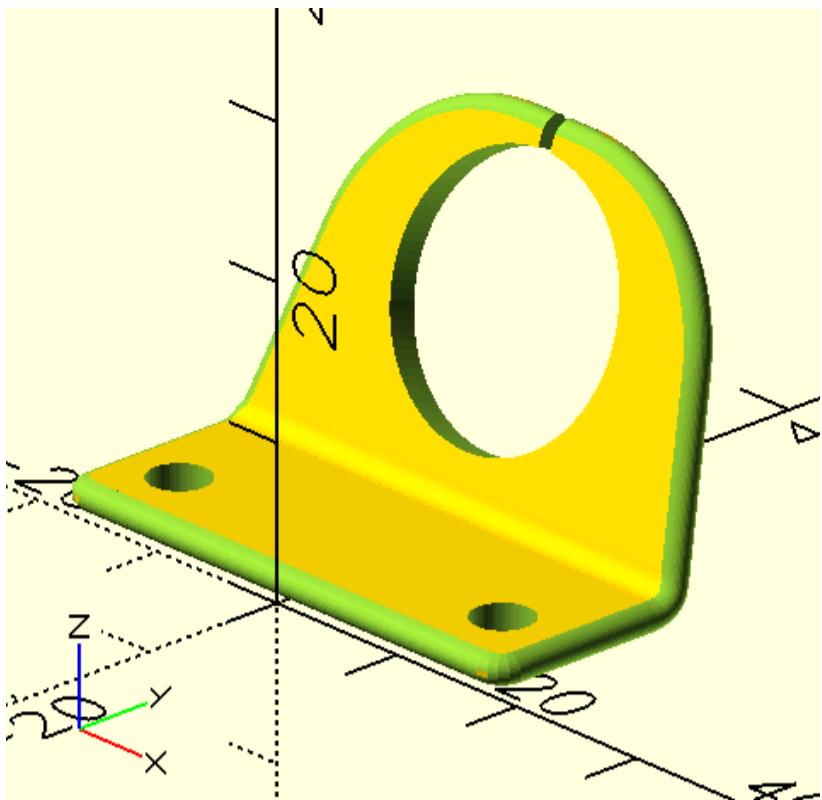
l2=[wrap_around(p,path) for p in l1]
l3=surface_offset(l2,2)

sol=solid_from_2surfaces(l2,l3)
sol1=translate([0,0,-3],linear_extrude(circle(9,[0,28],s=100),10))
sol1=[wrap_around(p,path) for p in sol1]

slit=rot('x70',translate([-5,15,-17],linear_extrude(square([1,20]),10)))
cyl1=cylinder(d=4,h=5)
# creating fillet
l1=surface2sec(l2)[0]
l2=surface2sec(l3)[0]
l3=mid_line(l1,l2)
l4,l5=surface_offset([l1,l2])
s1=[interpolation_bspline_open(p,20,2) for p in cpo([l4,l3,l5])]
s2=surface_offset(s1,2)
sol2=solid_from_2surfaces(s1,s2)
sol2=sol2+[sol2[0]]
fileopen(f'''

//color("blue")for(p=[[l1,l2,l3,l4,l5]):p_line3dc(p,.2,1);

difference(){
{swp(sol)}
{swp(sol1)}
{swp(slit)}
{swp_c(sol2)}
for(i=[-27/2,27/2])
translate([i,5,-2])
{swp(cyl1)}
}
''' )
```



align_sol

```
In [123... # example of function align_sol(sol,angl)

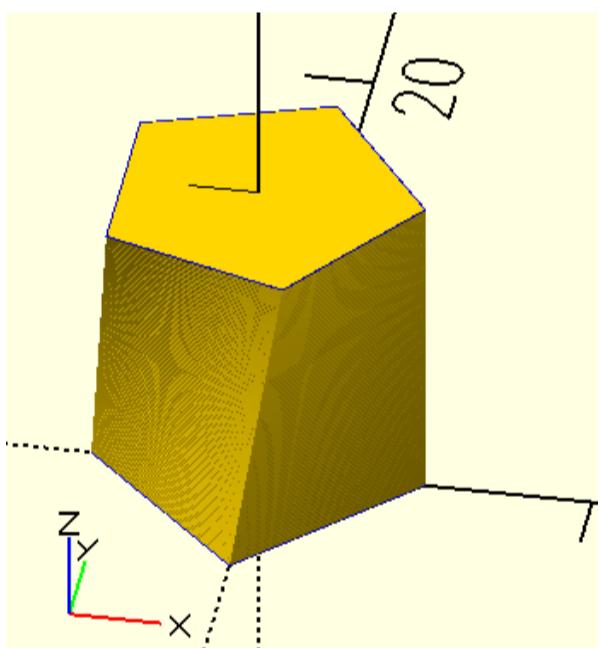
sqr1=circle(5,s=5)
pent1=circle(5,s=6)

sqr1=c2t3(sort_points(pent1,sqr1))
pent1=translate([0,0,10],pent1)
sol=[sqr1]+[pent1]
sol=align_sol(sol,1)
sol=slice_sol(sol,100)

fileopen(f'''

{swp(sol1)}
color("blue")p_line3dc({sol[0]},.05);
color("blue")p_line3dc({sol[1]},.05);

''' )
```



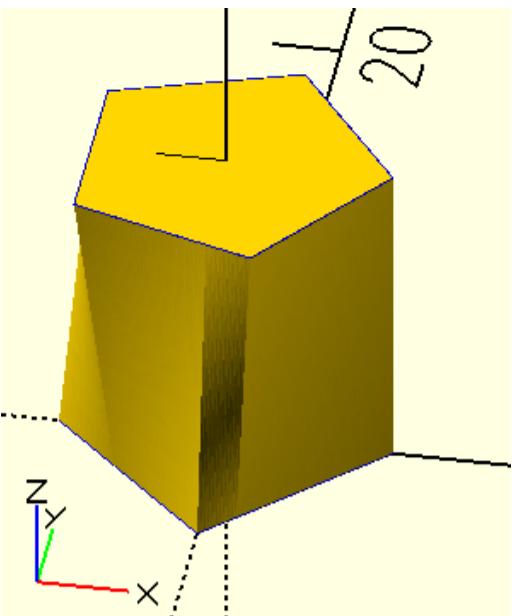
```
In [124... # example of function align_sol(sol,angl)

sqr1=c2t3(equidistant_pathc(circle(5,s=5),200)[:200])
pent1=equidistant_pathc(circle(5,s=6),200)[:200]
pent1=translate([0,0,10],pent1)
sol=[sqr1]+[pent1]
sol=align_sol_1(sol)
sol=slice_sol(sol,10)

fileopen(f'''

{swp(sol1)}
color("blue")p_line3dc({sol[0]},.05);
color("blue")p_line3dc({sol[1]},.05);

''' )
```



```
In [125... sqr1=circle(5,s=5)
pent1=circle(5,s=6)

sqr1,pent1=c2t3(equate_points(sqr1,pent1))
pent1=translate([0,0,10],rot('y-30',pent1))
sol=[sqr1]+[pent1]
sol=align_sol(sol,.1)
sol=slice_sol(sol,100)

fileopen(f'''

{swp(sol)}
color("blue")p_line3dc({sol[0]},.05);
color("blue")p_line3dc({sol[1]},.05);
color("magenta")p_line3dc({pent1},.05);

'''')
```

```
In [126... # example of function align_sol(sol, ang=10)
t0=time.time()

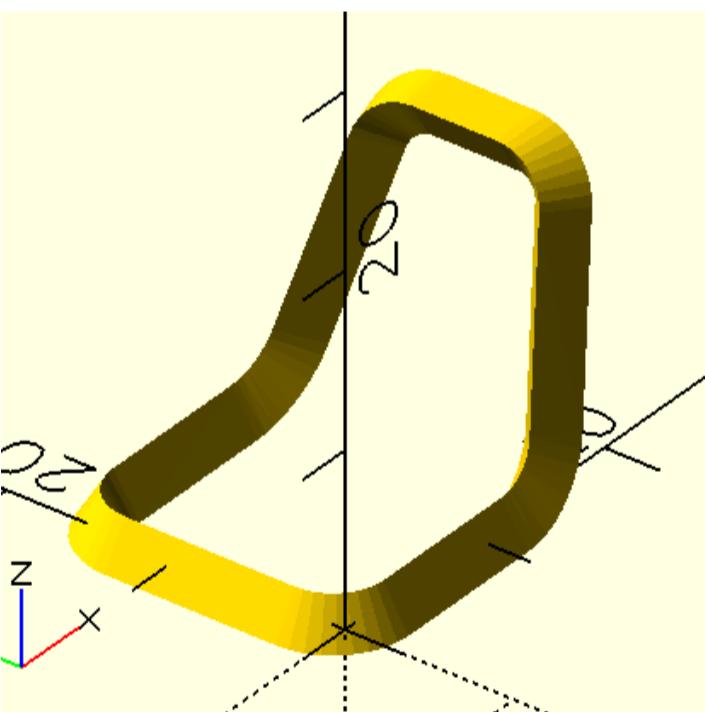
path=cr3dt([[0,0,0,3],[15,0,0,4],[5,3,15,3],[0,10,0,3],[-5,3,-15,4],[-15,0,0,3]],10)
sec=pts([[-1.5,-1.25],[3,0],[-1.5,2.5]])
sol=path_extrude_closed(sec,path,twist=1)
sol=align_sol(sol,1)

# sol=slice_sol_1(sol,200)
fileopen(f'''

//color("blue")for(p={sol})p_line3dc(p,.1,1);
{swp_c(sol)}

'''')
t1=time.time()
t1-t0
```

Out[126... 1.7522940635681152



```
In [127... # approach to align absolutely different shapes

sec=corner_radius(pts1([[0,0,1],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),30)
sec1=scl2d_c(corner_radius(pts1([[-15,0,2.4],[0,15,3],[30,0,3],[0,-15,2.4],[5,0,2.4],[0,20,7],[-40,0,7],[0,-20,2.4]]),10),.5)

sec2=c2t3(equidistant_pathc(sec,100))
sec3=translate([0,0,20],equidistant_pathc(sec1,100))
sol=[sec2,sec3]
sol=slice_sol(align_sol(sol),50)

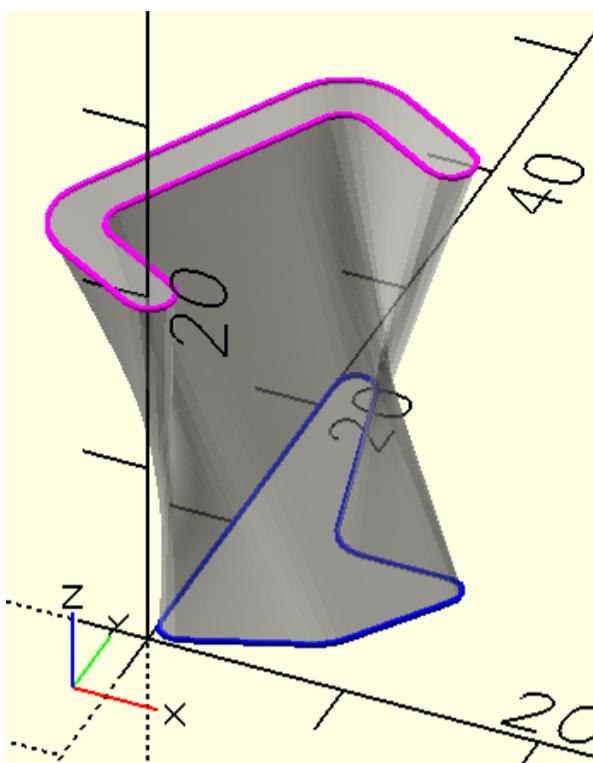
t0=time.time()
fileopen(f'''

color("blue")p_line3dc({sol[0]},.2,1);
color("magenta")p_line3dc({sol[-1]},.2,1);
%difference(){{
{swp(sol)}

//cube(10);
```

```
})
...
t1=time.time()
t1-t0
```

Out[127... 0.020687103271484375



align_sol_1

```
# example of function align_sol_1(sol)
t0=time.time()

sec=corner_radius(pts1([[0,0,1],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),20)
cp1=array(sec).mean(0)

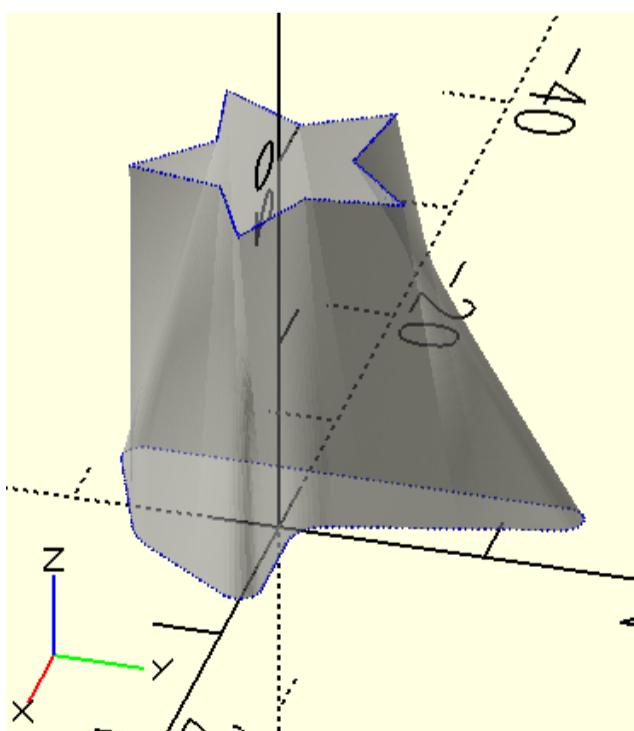
pent1=circle(7,s=6)
pent2=c3t2(rot(f'z{360/5/2}',circle(3.5,s=6)))
sec1=concatenate(cpo([pent1]+[pent2])).tolist()

sec=translate([-cp1,(equidistant_pathc(sec,200))]
sec1=translate([0,0,20],equidistant_pathc(sec1,200))
sol=slice_sol(align_sol_1([sec,sec1]),20)

fileopen(f''''
sec={sec};
sec1={sol[1]};
%{swp(sol)}
color("blue")points({sol[-1]},.1);
color("blue")points({sol[0]},.1);
//for(i=[0:len(sec)-1])translate(sec[i])linear_extrude(.1)text(str(i),.2);
//for(i=[0:len(sec1)-1])translate(sec1[i])linear_extrude(.1)text(str(i),.2);

''')
t1=time.time()
t1-t0
```

Out[128... 0.07004594802856445



In [129... # very fine merging of 2 very different shapes

```
t0=time.time()
sec=corner_radius(pts1([[0,0,1],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),20)
sec1=corner_radius(pts1([[0,0,1],[7,5,2],[5,7,3],[-5,7,2],[-7,5,3]]),20)
sec1=corner_radius(pts1([[-15,0,2.4],[0,15,3],[30,0,3],[0,-15,2.4],[5,0,2.4],[0,20,7],[-40,0,7],[0,-20,2.4]]),30)

s1=translate([0,0,20],equidistant_pathc(sec,1000))
```

```

s2=c2t3(equidistant_pathc(sec1,1000))
s3=slice_sol(align_sol_1([s2]+[s1]),100)

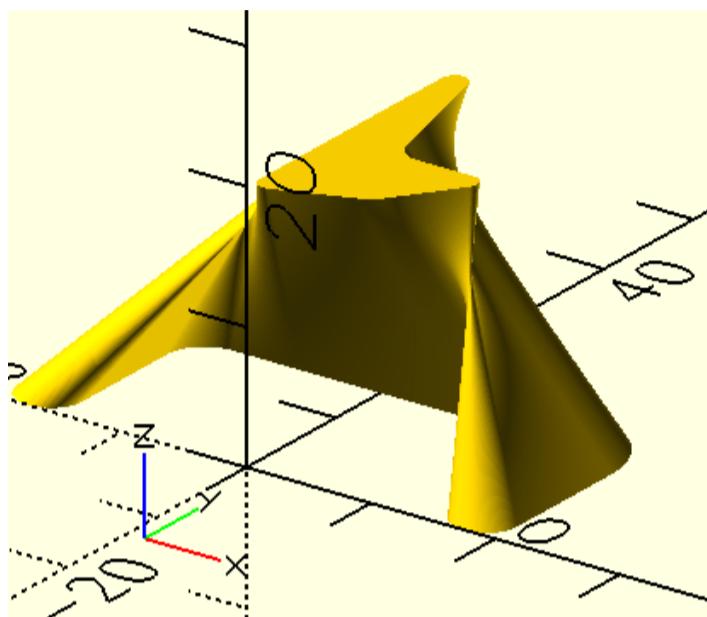
fileopen(f'''

swp({s3});

''')
t1=time.time()
t1-t0

```

Out[129... 1.033789873123169



end_cap

In [131... # example of function path_extrude_open and end_cap

```

i_t=time.time()
sec=corner_radius(pts1([[-1.5,-1.5,.5],[3,0,.5],[0,3,1.49],[-3,0,1.49]]),20)
path=rot('x-90',cr3dt([[0,0,0,0],[3,5,10,5],[17,-2,5,6],[1,-10,10,0]],20))
sol=rot('x90',path_extrude_open(sec,path))
sol=align_sol_1(sol)
# sol=slice_sol(sol,10)

e_cap=end_cap(sol,1,30)
f3=e_cap[0]
f4=e_cap[1]

fileopen(f'''

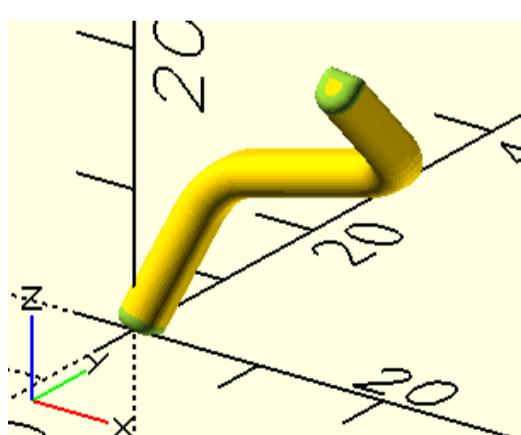
difference(){
{swp(sol)}
{swp_c(f3)}
{swp_c(f4)}
}

'''')
f_t=time.time()
f_t-i_t

```

/Users/sanjeevprabhakar/python_openscad/openscad2.py:7983: RuntimeWarning: invalid value encountered in divide
u4=(v4/norm(v4,axis=1).reshape(-1,1)).round(4)

Out[131... 2.4219610691070557



sec2vector

In [132... # example of function sec2vector(v1,sec)

```

i_t=time.time()
sec=corner_radius(pts1([[-1.5,-1.5,.5],[3,0,.5],[0,3,.5],[-3,0,.5]]),10)
v1=[1,2,-1]
vector1=[[0,0,0],v1]
sec1=sec2vector(v1,sec)

fileopen(f'''

// original section
p_line3dc({sec},.05);

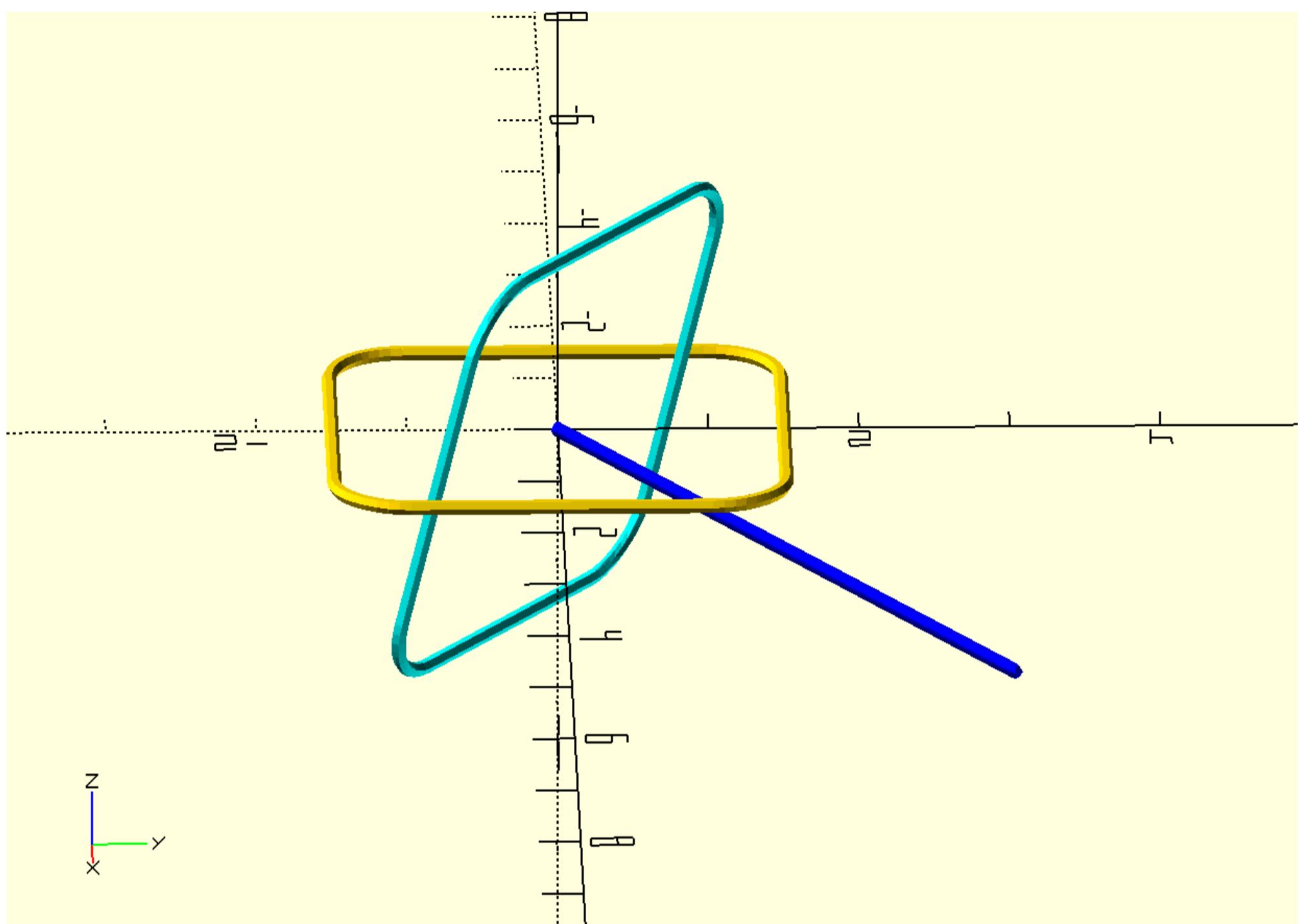
```

```
//aligned section in cyan color
color("cyan")p_line3dc({sec1},.05);

//vector with whom the section is expected to be aligned with in blue color
color("blue")p_line3d({vector1},.05);

...
f_t=time.time()
f_t-i_t
```

Out[132... 0.004910707473754883



cut_plane

```
# example of function cut_plane(nv, radius, thickness, trns)

t0=time.time()

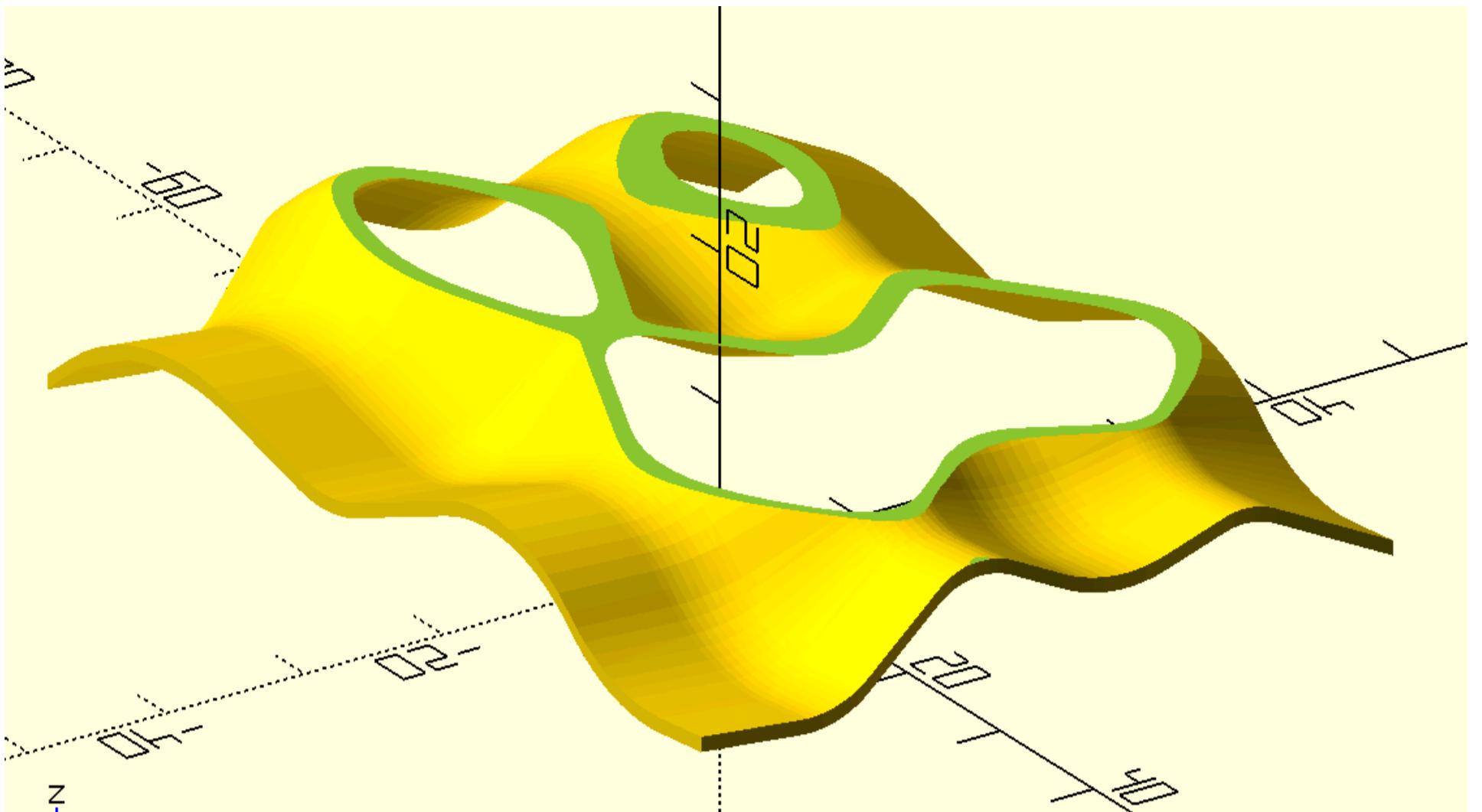
sec2=corner_radius(pts1([[-25,0],[10,5,5],[10,-3,10],[10,5,5],[10,-8,7],[10,1]]),10)
path2=cytz(corner_radius(pts1([[-35,5,0],[10,8,20],[20,-5,10],[20,8,20],[10,-9,20],[10,1,0]]),10))
surf2=surf_extrude(sec2,path2)
surf3=surf_extrudef(surf2,t=-1)

fileopen(f''

difference(){{
{swp(surf3)}
{swp(cut_plane([0,0,1],[100,100],10,14))}

...
t1=time.time()
total=t1-t0
total
```

Out[133... 0.0633847713470459



In [134...]

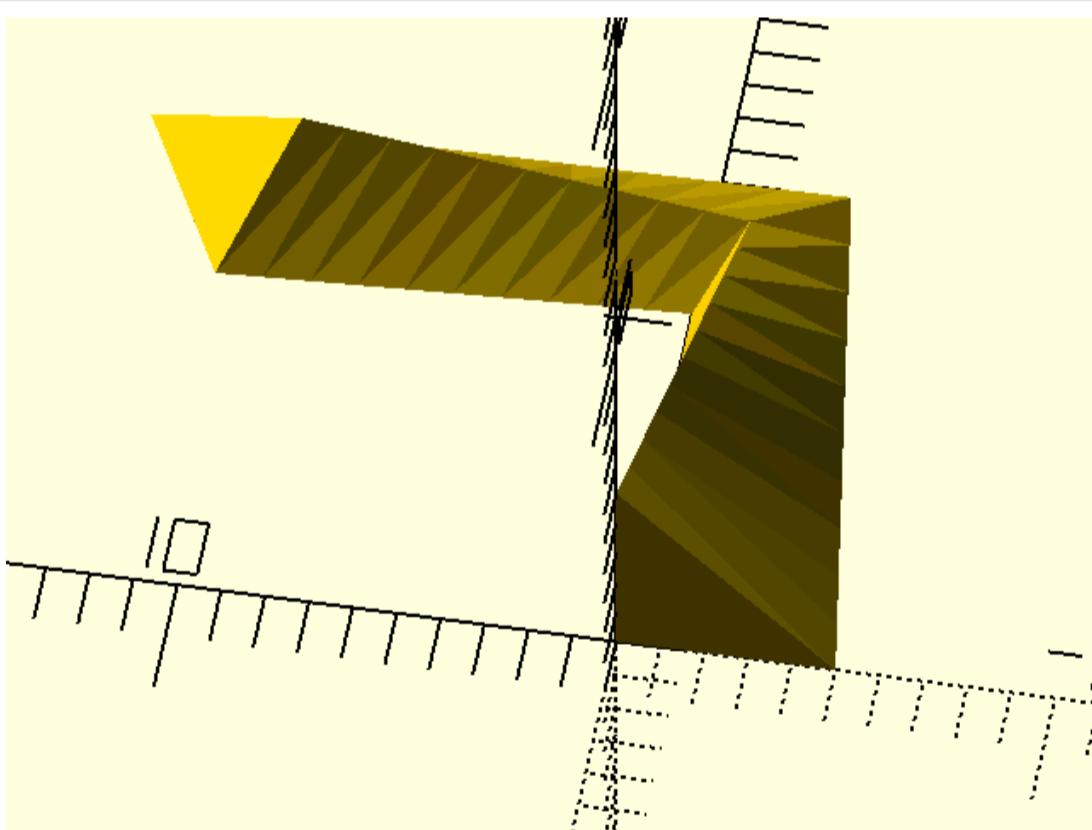
```

sec=[[0,0],[5,0],[0,5]]
path=[[0,0,0],[10,0,0],[5,10,5]]
sol=path_extrude_open(sec,path)
sol=align_sol_1(sol)
sol2=slice_sol(sol,10)
fileopen(f''''

difference(){{
{swe(sol2)}

//{swe(cut_plane([1,1,1],30,7,-3))}
}}
'''')

```



slice_sol

In [135...]

```

sec=turtle2d([[0,0],[5,0],[0,5],[-5,0]])
path=rot('x-90',[3,0,0],[0,0,10],[10,0,15],[10,0,25])
sol=rot('x90',path_extrude_open(sec,path))
# sol=align_sol(sol)
# sol2=slice_sol(sol,10)
txt1=dim_linear(sol[0][:2],2,1)
txt2=dim_linear(sol[0][1:3],2,1)

txt3=dim_linear(sol[1][:2],2,1)
txt4=dim_linear(sol[1][1:3],2,1)

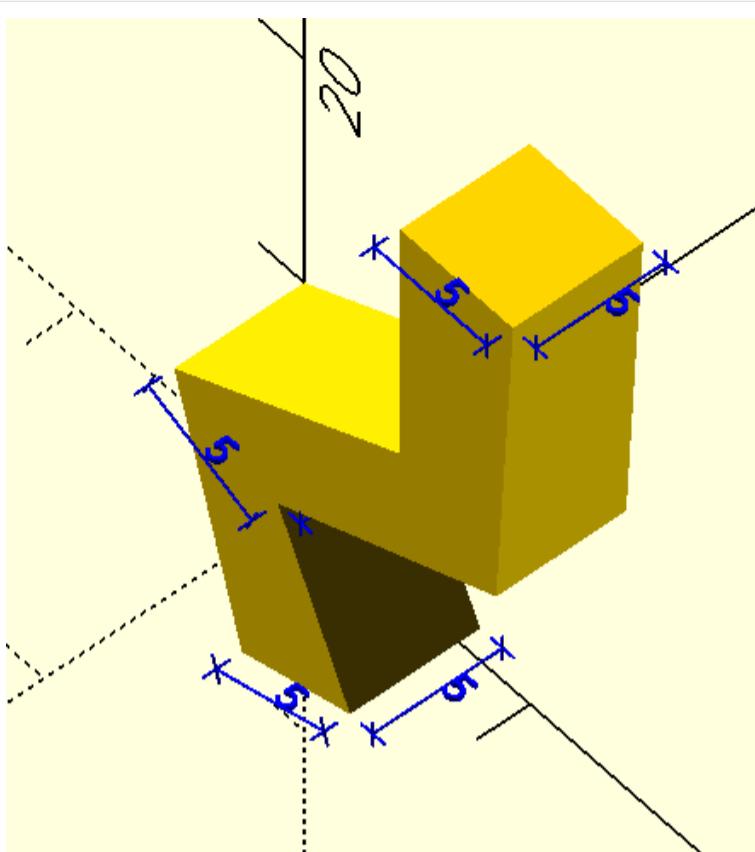
txt5=dim_linear(sol[-1][:2],2,1)
txt6=dim_linear(sol[-1][1:3],2,1)

fileopen(f'''

//color("blue")p_line3dc({sol[0]},.1,1);
//color("blue")p_line3d({cytz(path)},.1,1);
//color("cyan")points({cytz(path)},.5);
{txt1}{txt2}{txt3}{txt4}{txt5}{txt6}
{swe(sol)}
//color("magenta")for(p={sol})p_line3dc(p,.1,1);

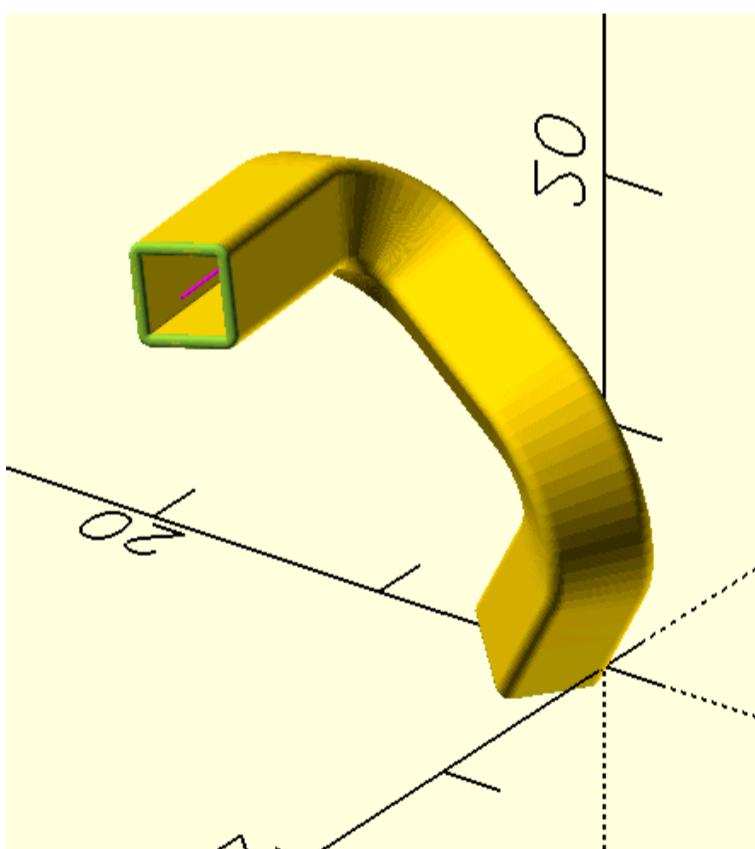
```

...)



```
In [136]: sec=corner_radius_with_turtle([[[-2,-2,.55],[4,0,.55],[0,4,.55],[-4,0,.55]],10)
path=rot('x0',corner_radius3d_with_turtle([[3,0,0],[-7,5,10,4],[15,-5,7,4],[-3,15,2]],20))
sol=path_extrude_open(sec,path)
sol=align_sol(sol,1)
sol2=slice_sol(sol,5)
sol3=align_sol(path_extrude_open(offset(sec,-.5),path),1)
sol4=swp_prism_h(sol2,sol3)
e1=end_cap(sol2,.25)
e2=end_cap_1(sol3,.25)
fileopen(f''''
color("magenta")p_line3d({path},.1,rec=1);
difference(){{
{swp_c(sol4)}
for(p={e1})swp_c(p);
for(p={e2})swp(p);
}}
''')
```

/Users/sanjeevprabhakar/python_openscad/openscad2.py:7982: RuntimeWarning: invalid value encountered in divide
u3=(v3/norm(v3, axis=1).reshape(-1,1)).round(4)



o_solid

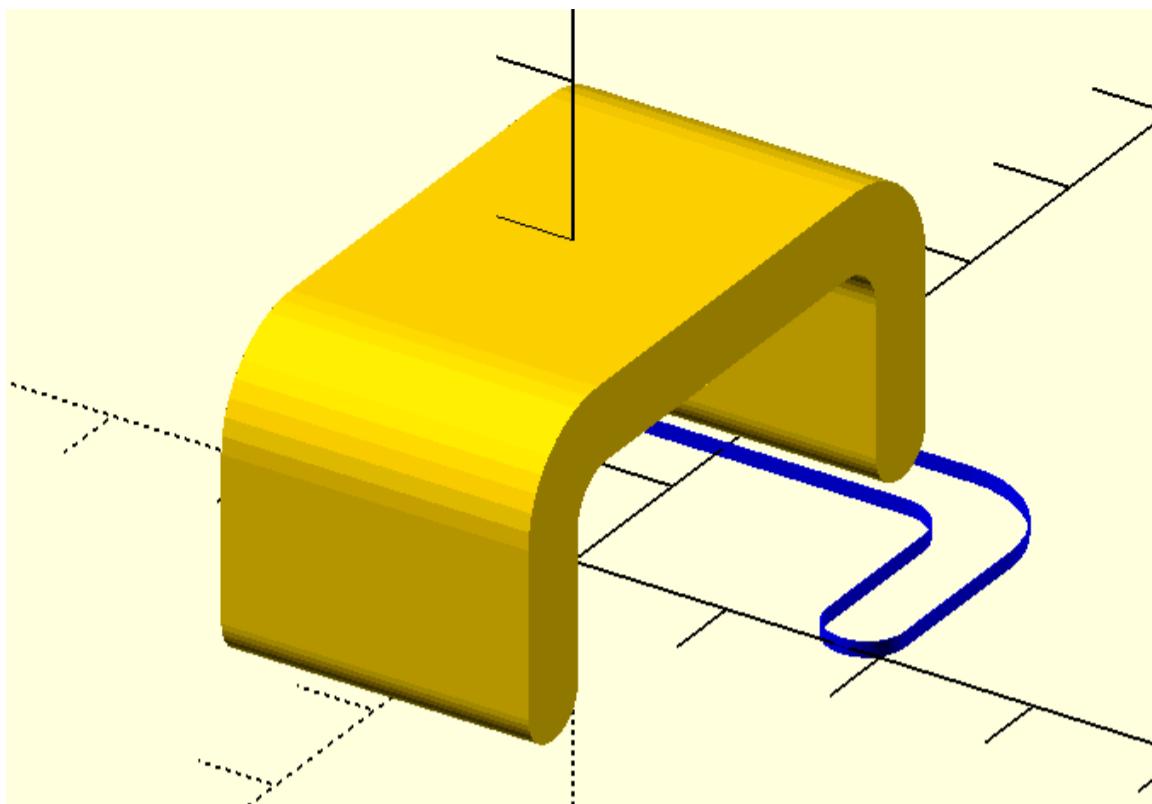
```
In [137]: # example of function o_solid(nv,sec,thickness,trns1,trns2,trns3)

# sec=corner_radius(pts1([[0,0,1],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),30)
# sec=corner_radius(pts1([[0,0,1],[7,5,2],[5,7,3],[-5,7,5],[-7,5,5]]),10)
sec=corner_radius(pts1([[-15,0,2.4],[0,15,3],[30,0,3],[0,-15,2.4],[5,0,2.4],[0,20,7],[-40,0,7],[0,-20,2.4]]),10)
# sec=corner_radius(pts1([[0,0,1],[10,0,1],[0,5,1],[-10,0,1]]),10)
# sec=circle(10)

sol=o_solid([1,0,0],sec,20,-10,0,0,theta=[0,0,0])
e1=end_cap(sol,2.5)
a1=sol[0][1:11]
txt1=dim_radial(a1,1,text_size=.5,outside=1)
fileopen(f''''
difference(){{
{swp(sol)}
for(p={e1})swp_c(p);
}}
```

```

    }
color("blue")p_line({sec},.05);
{txt1}
'''
```



```

In [139... t0=time.time()
sec=corner_radius(pts1([[-5,-5,1],[10,0,1],[0,10,1],[-10,0,1]]),5)
sec1=corner_radius(pts1([[-5,-5,1],[10,0,1],[0,10,1],[-10,0,1]]),5)

path=corner_radius(pts1([[-4,0],[4,0,1],[0,10,1],[-4,0]]),5)
# path=equidistant_path(path,100)
sol1=f_prism(sec,path)

sol2=o_solid([1,0,.1],circle(2,s=50),15,-7,0,10,[90,0,0])

fileopen(f'''
{swp(sol1)}
{swp(sol2)}

''')
t1=time.time()
t1-t0
```

Out[139... 0.026839017868041992

```

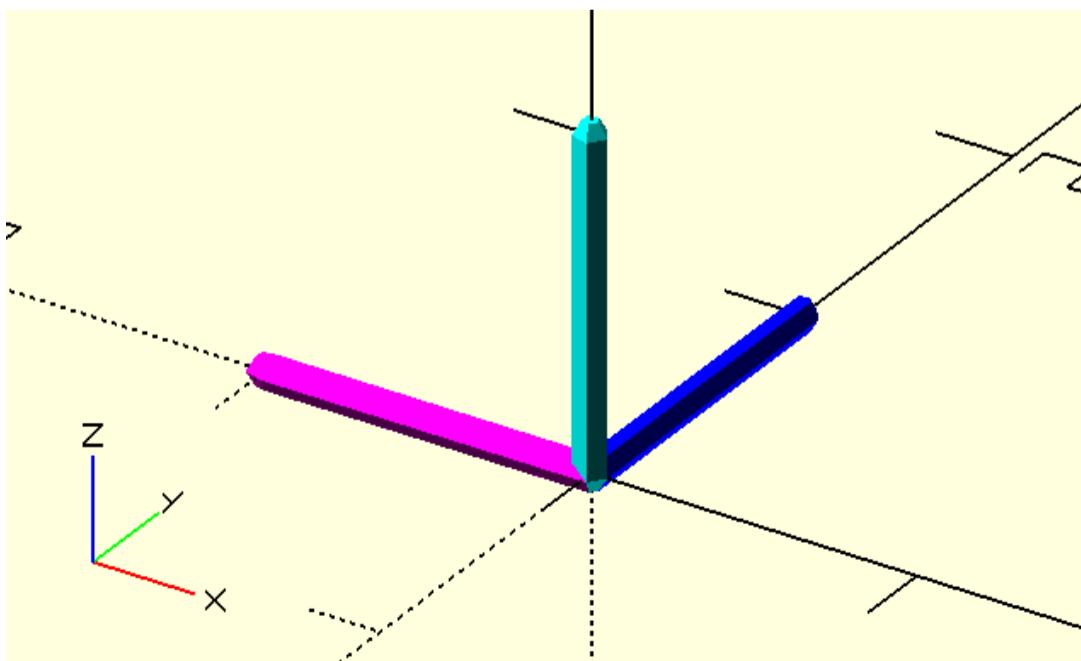
In [140... # example of defining normal vectors to a given vector 'v1'

v1=[1,1,sqrt(2)]
u1=v1/norm(v1)
ua=array([0,0,-1]) if u1[2]==0 else array([0,-1,0]) if (u1==[0,0,1]).all() else array([-1,0,0]) if (u1==[0,0,-1]).all() else array([u1[0],u1[1],0])
v2=cross(u1,ua)
u2=v2/norm(v2)
u3=array(axis_rot(u2,u1,-90))

u1,u2,u3=array([u1,u2,u3]).tolist()
fileopen(f'''

color("blue")p_line3d([[0,0,0],u1],.05);
color("magenta")p_line3d([[0,0,0],u2],.05);
color("cyan")p_line3d([[0,0,0],u3],.05);

'''')
```



```

In [141... fileopen(f'''

cylinder (d=30,h=30); // hub.
linear_extrude (height=30, twist=100, $fn=100)
```

```
for (a=[0:120:359]) rotate (a) translate ([15,-1]) square ([45,2]);
```

'''

ppplane

In [142...]

```
# points projected on a plane
t0=time.time()

p0=random.random([10,3])*(20-(-20))+(-20)
loc=[0,10,1]
v1=[2,3,4]

sec=pts([[-50/2,-50/2],[50,0],[0,50],[-50,0]])
plane1=translate(loc,o_solid(v1,sec,.001))

ip1=ppplane(p0,v1,loc)
lines1=array([p0,ip1]).transpose(1,0,2).tolist()

fileopen(f'''

//p_line({sec},.05);

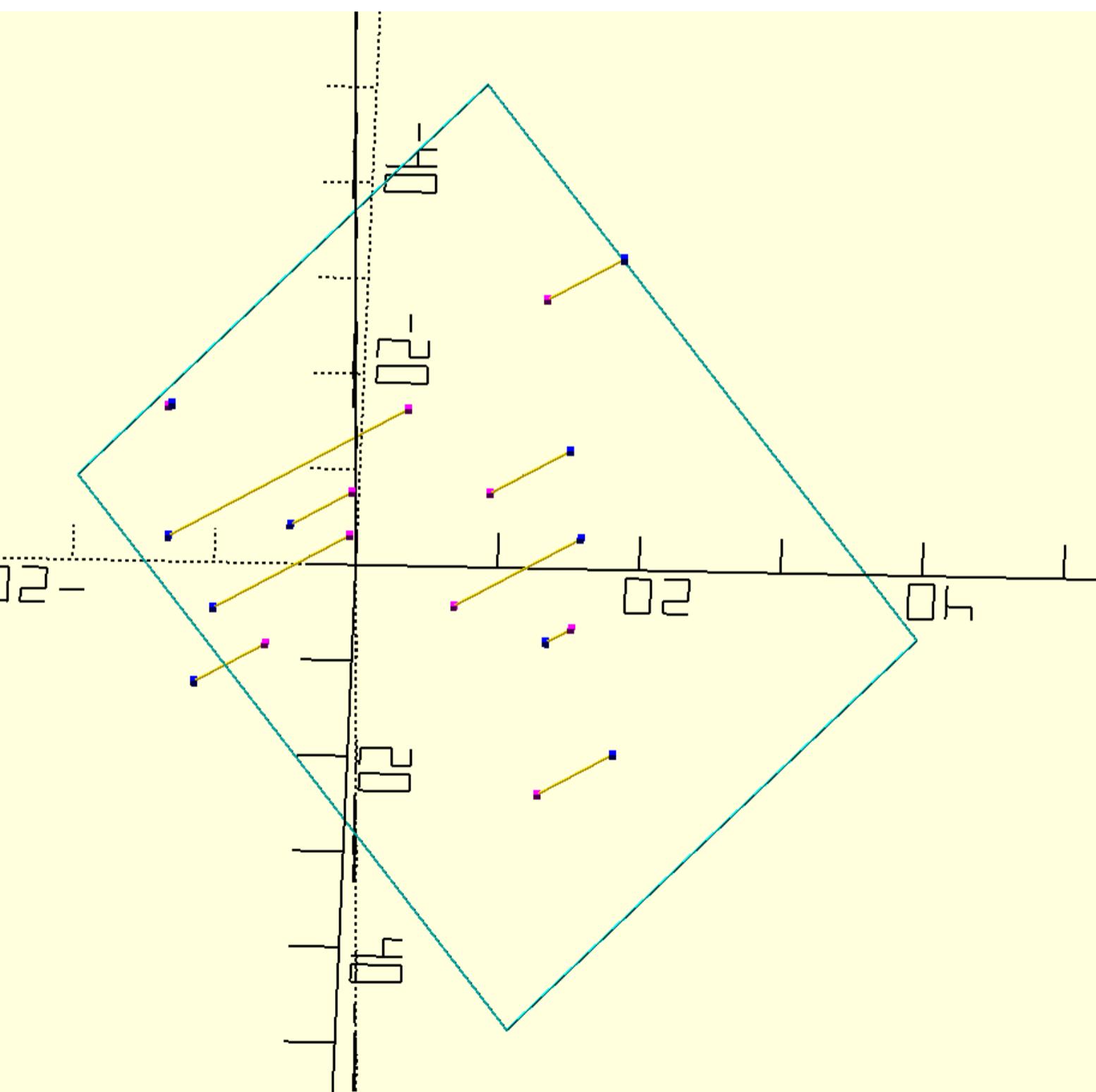
color("cyan")p_line3dc({plane1[0]},.1);
color("blue")points({p0.tolist()},{.5});

color("magenta")points({ip1},{.5});

for(p={lines1})p_line3d(p,.1);

''')
t1=time.time()
t1-t0
```

Out[142...]



ppesec

In [143...]

```
# points projected on an enclosed section in 3d space
t0=time.time()

p0=random.random([10,3])*(20-(-20))+(-20)
loc=[0,10,1]
v1=[2,3,4]

sec=pts([[-50/2,-50/2],[50,0],[0,50],[-50,0]])
```

```

plane1=translate(loc,o_solid(v1,sec,.001))

ip1=ppesec(p0,plane1[0])[0]
lines1=array(ppesec(p0,plane1[0])).transpose(1,0,2).tolist()
fileopen(f'''

//p_line({sec},.05);

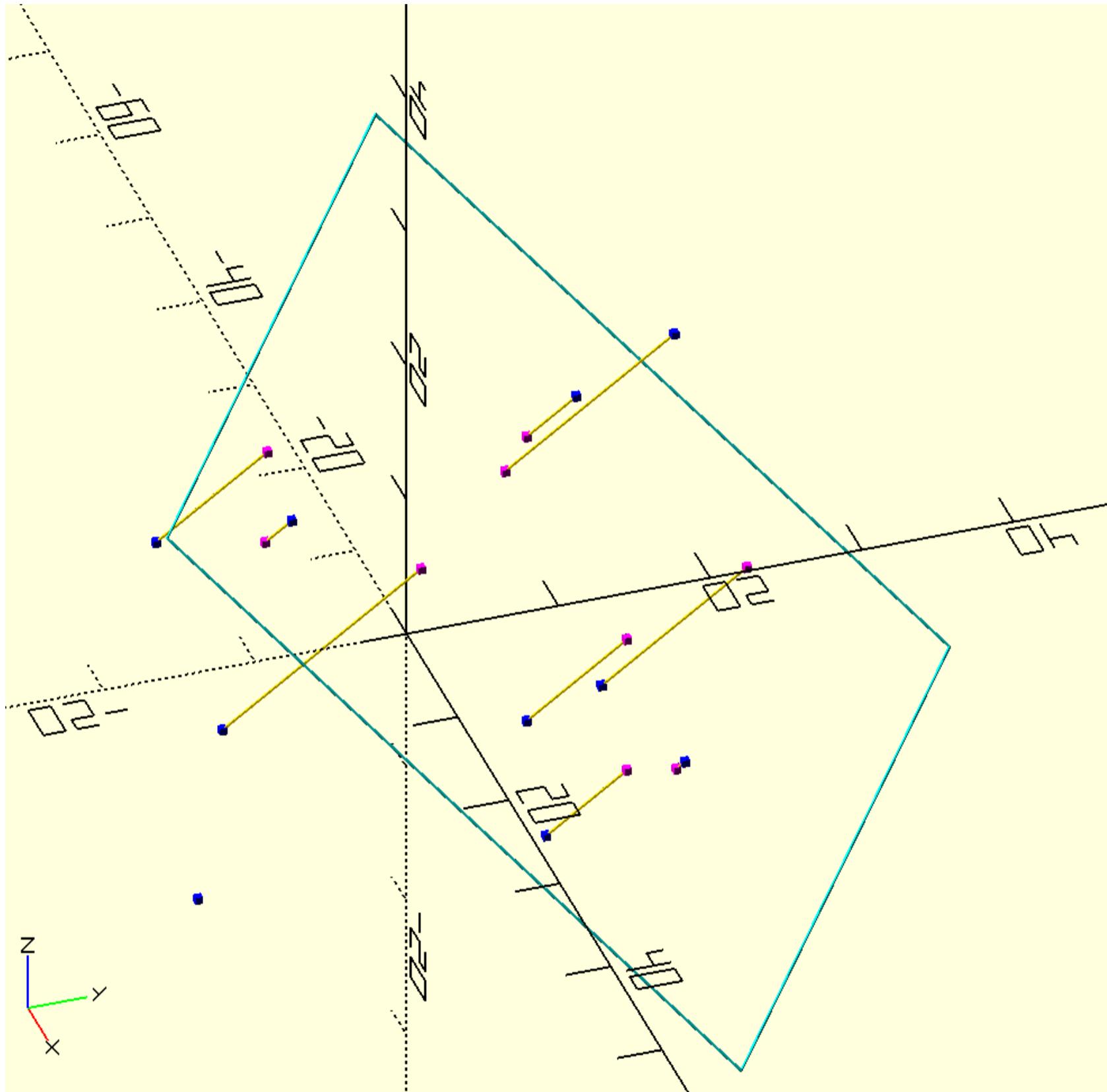
color("cyan")p_line3dc({plane1[0]},.1);
color("blue")points({p0.tolist()},.5);

color("magenta")points({ip1},.5);
for(p={lines1})p_line3d(p,.1);

''')
t1=time.time()
t1-t0

```

Out[143... 0.002599000930786133



In [144... # another example of points projected on an enclosed section in 3d space

```

t0=time.time()

p0=random.random([10,3])*(20-(-20))+(-20)
v1=[2,3,4]
sec=circle(10)
loc=[0,10,0]
plane1=translate(loc,o_solid(v1,sec,.001))

```

```

ip1=ppesec(p0,plane1[0])[0]
lines1=cpo(ppesec(p0,plane1[0]))
fileopen(f'''


```

```

//p_line({sec},.05);


```

```

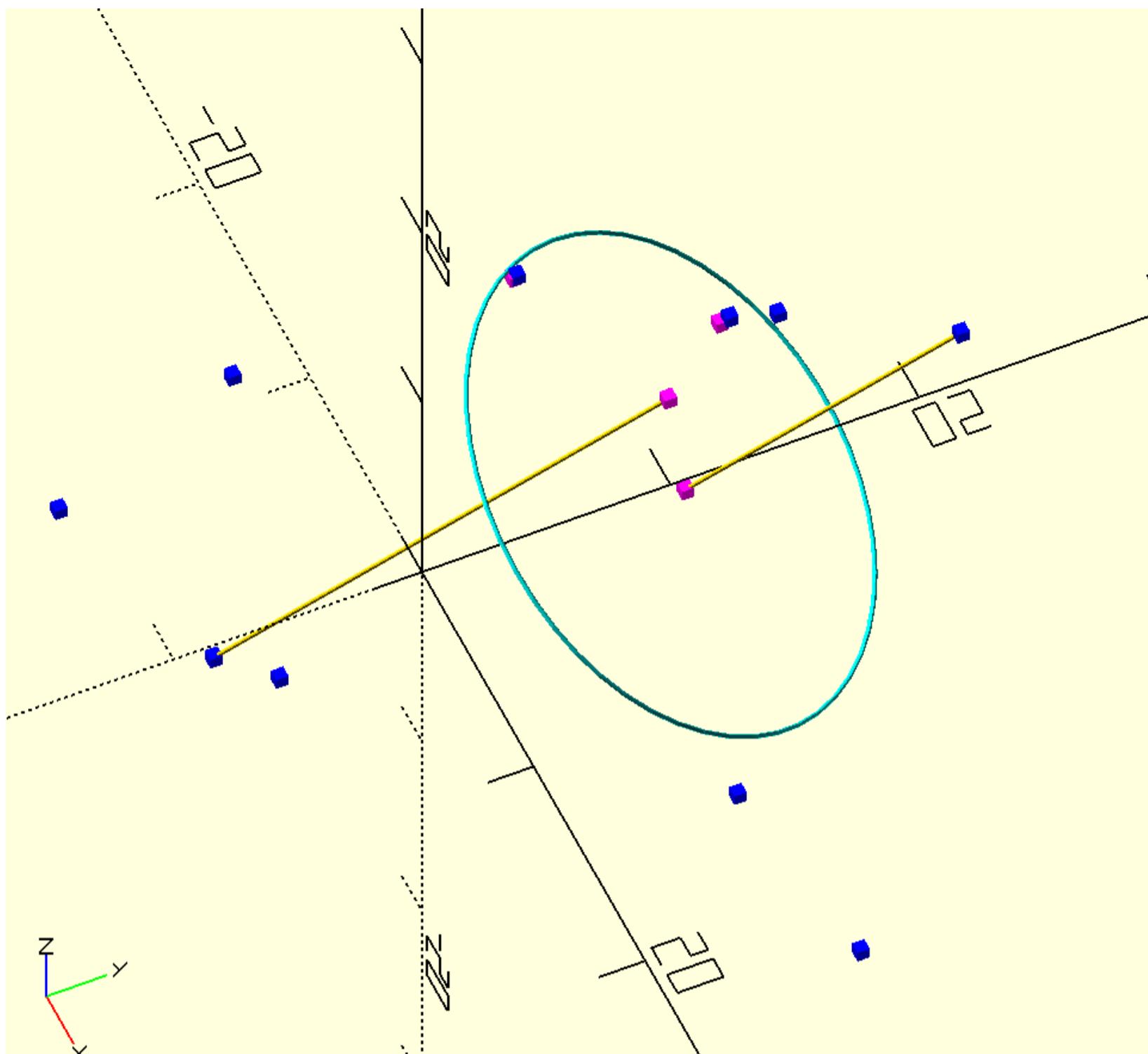
color("cyan")p_line3dc({plane1[0]},.1);
color("blue")points({p0.tolist()},.5);

color("magenta")points({ip1},.5);
for(p={lines1})p_line3d(p,.1);

''')
t1=time.time()
t1-t0

```

Out[144... 0.004487037658691406



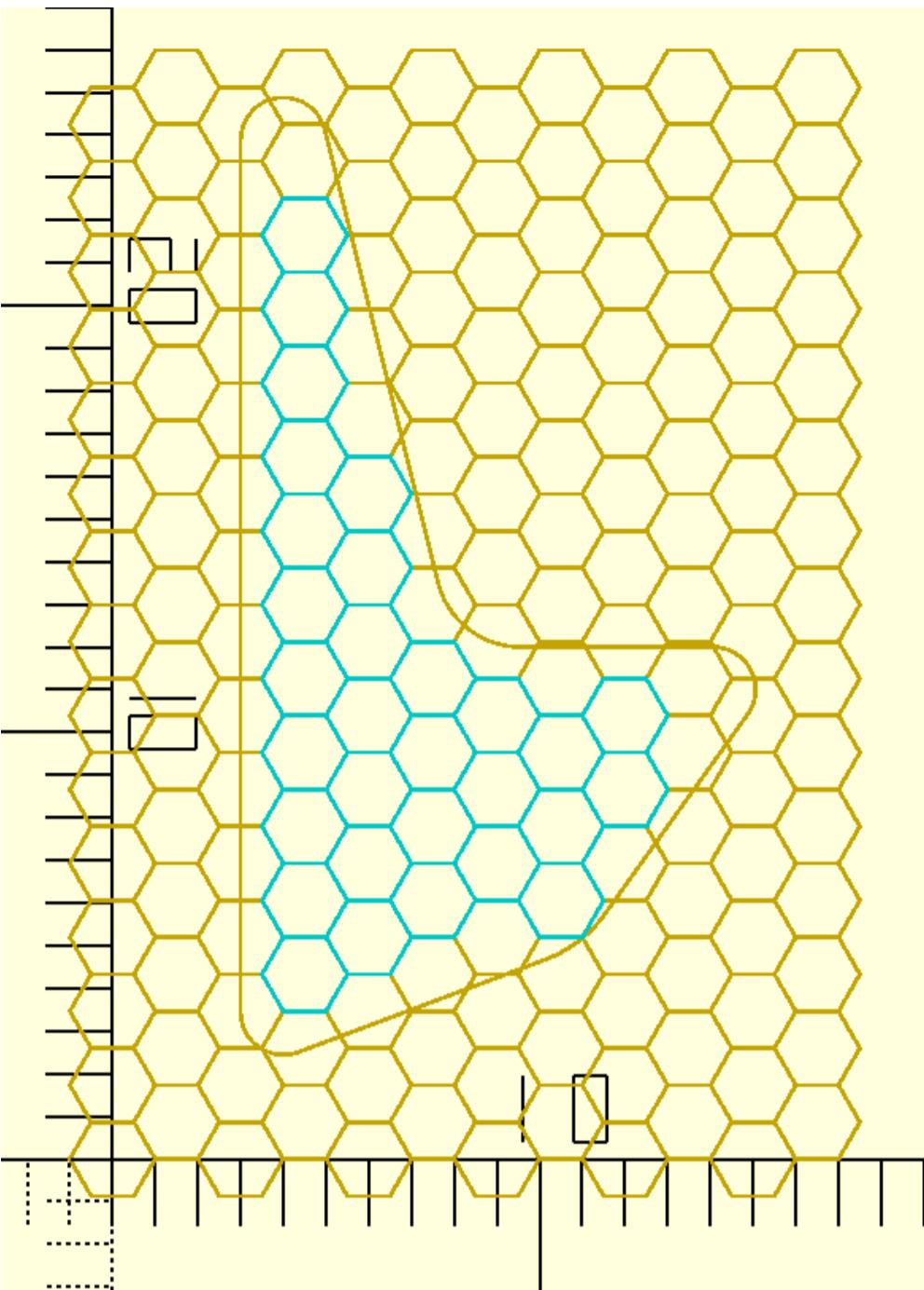
honeycomb

In [145... # honeycomb structure

```
sec4=honeycomb(1,6,15)
sec=corner_radius(pts1([[3,2,1],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),30)
pnts1=[p for p in sec4 if len(pies1(sec,p))==6]

fileopen(f''''
for(p={sec4})p_line(p,.1);
color("blue")p_line({sec},.1);
color("cyan")for(p={pnts1})p_line(p,.1);

'''')
```



```
In [146]: # honeycomb structure with intersection option
t0=time.time()

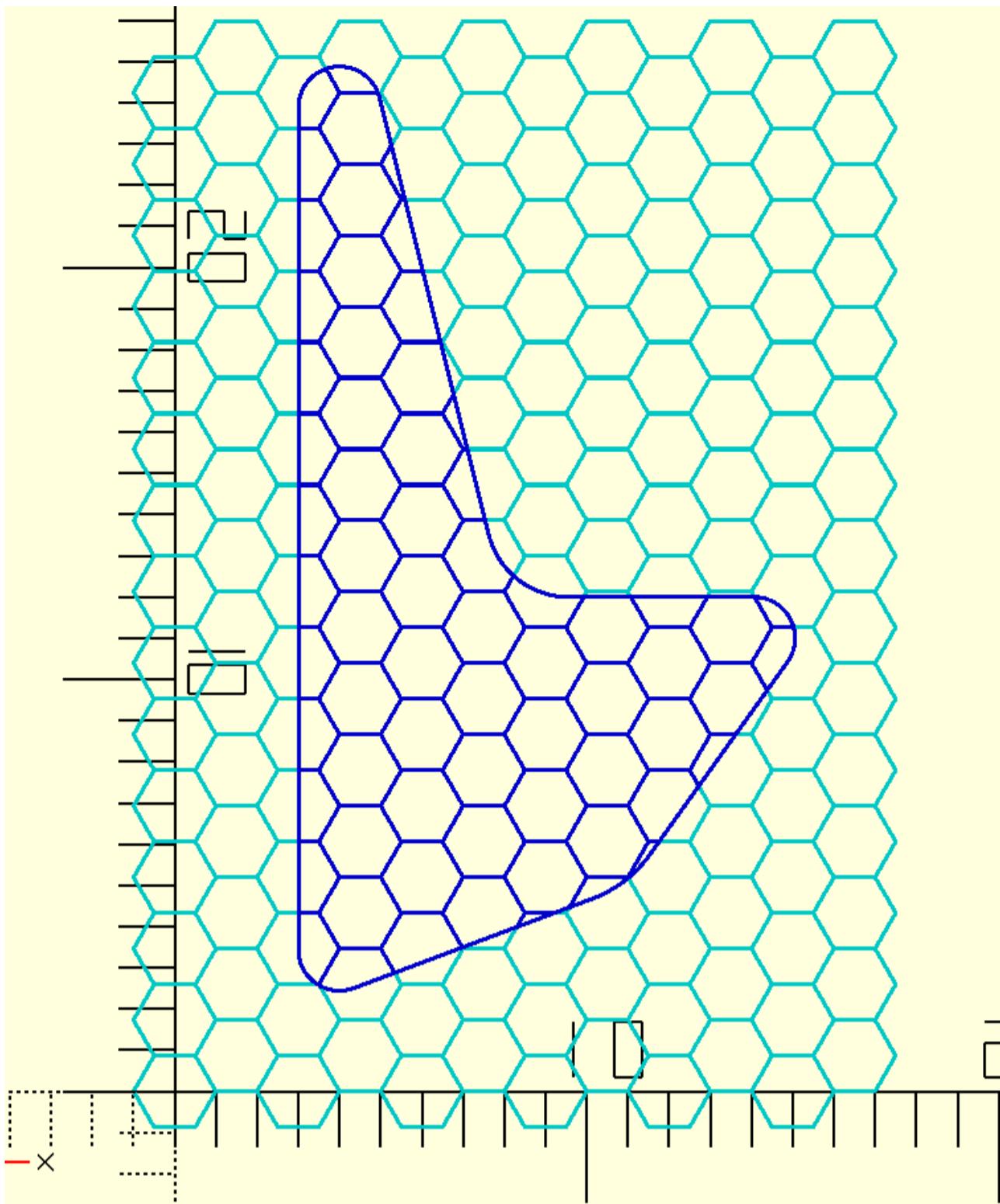
sec4=honeycomb(1,6,15)
sec=corner_radius(pts1([[3,2,1],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),30)
# pts1=[p for p in sec4 if len(pies1(sec,p))==6]

fileopen(f'''
color("cyan")linear_extrude(1)for(p={sec4})p_line(p,.1);

color("blue")
linear_extrude(1){{{
for(p={sec4}){{{
intersection(){{{
p_line(p,.1);
polygon({sec});
}}}
p_line({sec},.1);
}}}

'''')
t1=time.time()
t1-t0
```

Out[146]: 0.011888742446899414



chimney-panel-support

```
In [147]: # chimney panel support

sec=corner_radius(pts1([[0,5],[0,-5,3.5],[10,0,4],[2,1,1],[34,0,4],[1,3.5]]),10)
sec1=path_offset(sec,-3)
path=bezier([[-27.5,0,3]]+ arc_3p_3d([[-27,0,3],[0,0,0],[27,0,3]],100)+[[27.5,0,3]],100)
sol=path_extrude_open(sec,path)
sol1=path_extrude_open(sec1,path[1:-1])
sec2=corner_radius(pts1([[0,0],[25,0,.5],[0,4,.5],[-1,3,.5],[-1.5,0,.5],[-2,-3,1],[-20.5,0]]),10)
sol2=translate([0,-17,1],path_extrude_open(sec2,path[47:-47]))
sec3=corner_radius(pts1([[-6,-5,5],[12,0,5],[0,10.0001,5],[-12,0,5]]),10)
sol3=o_solid([0,0,1],sec3,5,0,0,-37)
sec4=corner_radius(pts1([[0,0],[5,0,10],[7,7,10],[14,0]]),20)
sec5=path_offset(sec4,-3)
sec6=sec4+flip(sec5)
sol4=translate([0,-25,1],path_extrude_open(sec6,path[16:30]))
sol5=translate([0,-25,1],path_extrude_open(sec6,path[-30:-16]))
sol6=translate([12,-25,2],rot('x90z-90',linear_extrude(sec6[20:-20],39)))

fileopen(f'''

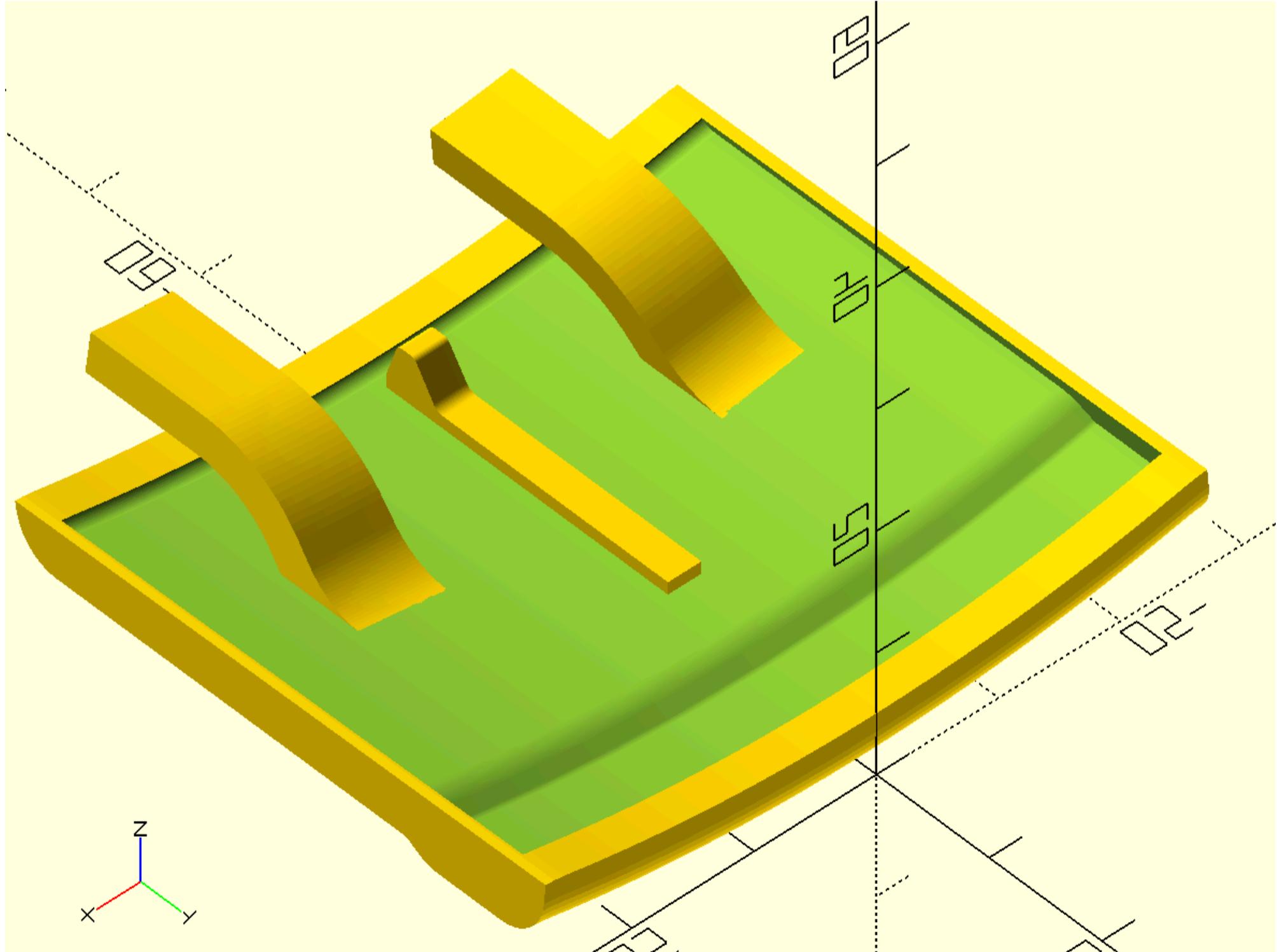
module chimeny_support(){{

difference(){
{swp(sol)}
{swp(sol1)}
{swp(sol3)}
}

{swp(sol2)}
{swp(sol4)}
{swp(sol5)}

}

difference(){
translate([0,0,28])
rotate([0,-90,0])
chimney_support();
//{swp(cut_plane([0,0,1],60,50,12,0,22))}
}
//support for 3d printing the part
//translate([-15,-55,0])
//cube([25,60,2]);
//translate([0,0,27])
//rotate([0,-90,0]){
////{swp(sol3)}
//{swp(sol6)}
//}
''' )
''' )
```

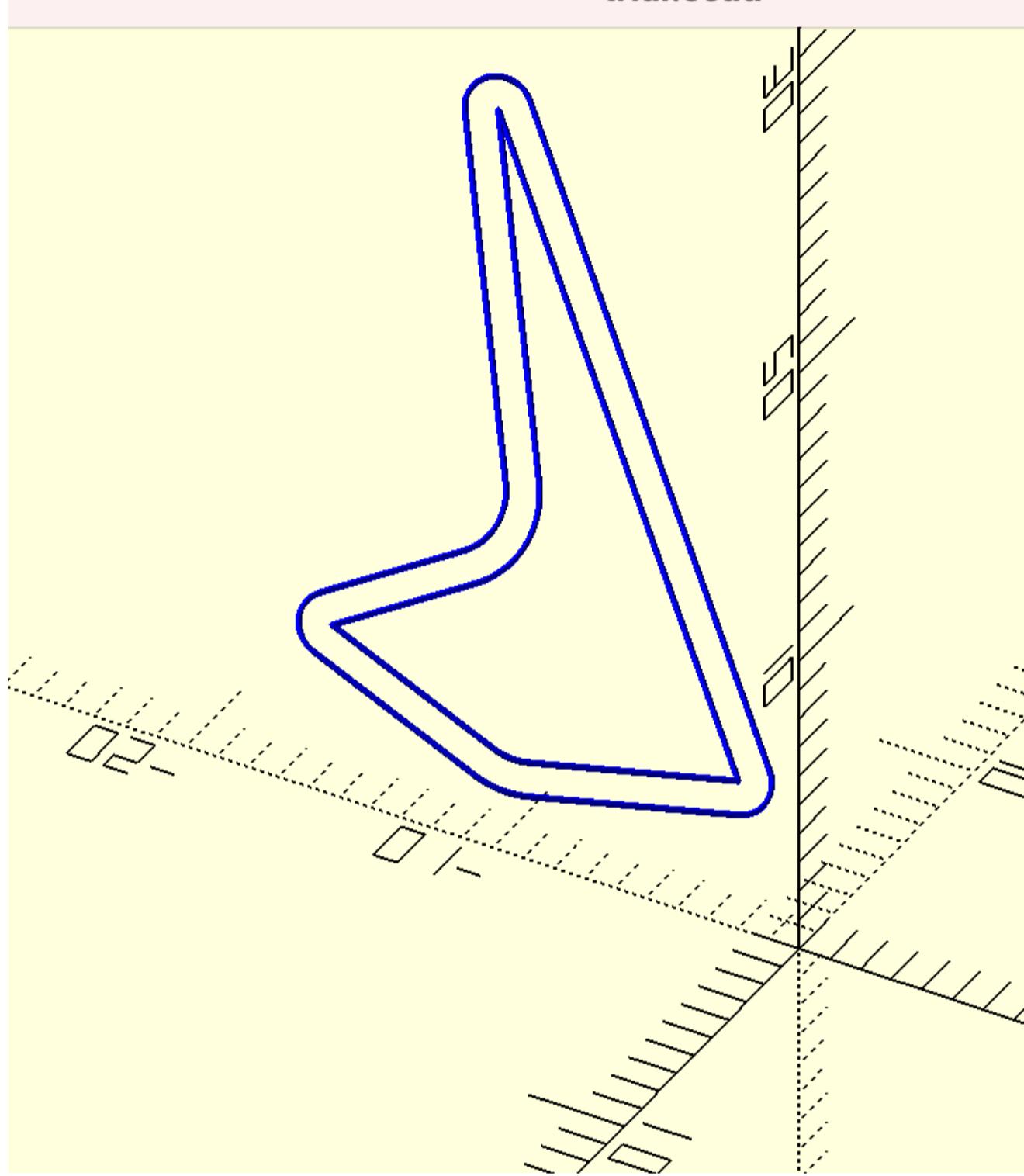


offset_3d

```
In [148...]
# example of offset_3d(sec,d)
sec=corner_radius(pts1([[3,2,1],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),30)
sec1=o_solid([2,3,5],sec,1,10)[0]
sec2=offset_3d(sec1,-1)

fileopen(f'''
```

```
color("blue")p_line3dc({sec1},.1);
color("magenta")p_line3dc({sec2},.1);
'''')
```



convert_3lines2fillet

```
In [149...]
# example of convert_3lines2fillet(pnt1,pnt2,pnt3,f=1.9,s=10)
t0=time.time()

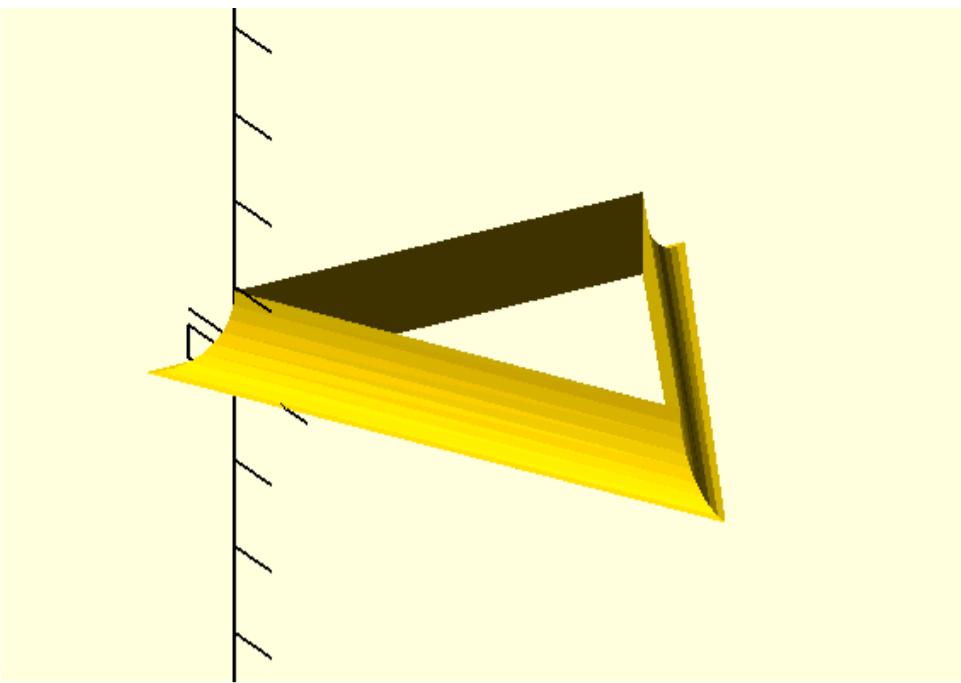
sec=[[0,0],[5,0],[2.5,5]]
sol=o_solid([0,0,1],sec,1,10)
line1=sol[0]
line2=sol[1]
line3=offset_3d(line1,1)
fillet1=convert_3lines2fillet(line3,line2,line1)
fillet1=fillet1+[fillet1[0]]
# fillet1=flip(cpo(fillet1)[1:])
fileopen(f'''

color("blue")p_line3dc({line1},.05);
color("cyan")p_line3dc({line2},.05);
color("magenta")p_line3dc({line3},.05);
{swp_c(fillet1)}

'''')
t1=time.time()
t1-t0
```

Out[149...]

0.007378101348876953



sunflower

```
In [150...]: # example of offset_3d when the section is not in 1 plane
# example of path_extrude2msec(sec_list, path)
t0=time.time()

t=1.1 # thickness
s=10 # number of sides of the star
d=20 # outer diameter of the star
h=50 # height of the star prism
cir1=circle(d,s=(s+1))
cir2=c2t2(rot(f"z{360/(s+1)/2}",circle(d/4,s=(s+1))))
sec1=array(c2t3([cir1,cir2]))
sec1=sec1.transpose(1,0,2).reshape(-1,3)
sec1=sec1
sec1=[[sec1[i]+[0,0,1]].tolist() if i%2==0 else (sec1[i]+[0,0,t]).tolist() for i in range(len(sec1)) ]
sec1=m_points(corner_radius(sec1,20),1.1)
sol1=linear_extrude(sec1,h)

line1=corner_radius(pts1([-20,0],[20,15,30],[20,-15])),40
line2=cytz(line1)
surf1=surf_extrude(line1,line2)

ip1=ip_surf(surf1,sol1)
ip2=offset_3d(ip1,-2.01)

surf4=[ip2,ip1,translate([0,0,-t],ip1),translate([0,0,-t],ip2),ip2]
avg2=array(surf4).mean(0).mean(0)

sec3=circle(5)
path3=m_points_o(corner_radius(pts1([-4,0],[0,15,2],[3.5,4,2],[0,1])),5),.5
sol3=f_prism(sec3,path3)

path4=rot('z90x90',cytz([[i,3*sin(d2r(i*20))]] for i in linspace(0,20,44)))
sol4=sol2path(sol3,path4)
v1=array(nv(sol4[-1]))
avg1=array(sol4[-1]).mean(0)
surf4=translate(-avg2+[0,0,-.5],surf4)
surf4=sol2vector(v1,surf4,avg1)

arc1=arc_2p([0.01,0],[4.65,0],3,-1)
arc2=[rot(f'z{i}',arc1) for i in arange(0,360,360/50)]
arc2p=translate([0,0,5],arc2)
arc2=array([arc2,arc2p]).transpose(1,0,2,3)

arc3=arc_2p([0.01,0],[4.65,0],3,1)
arc4=[rot(f'z{i}',arc3) for i in arange(0,360,360/50)]
arc4p=translate([0,0,5],arc4)
arc4=array([arc4,arc4p]).transpose(1,0,2,3)

arc5=circle(4.5)
path5=arc_2p([0,0],[-4.5,2],10,-1)
sol5=f_prism(arc5,path5)

ip1=[ip_sol2sol(sol5,p,-1) for p in arc2]
ip2=[ip_sol2sol(sol5,p,-1) for p in arc4]

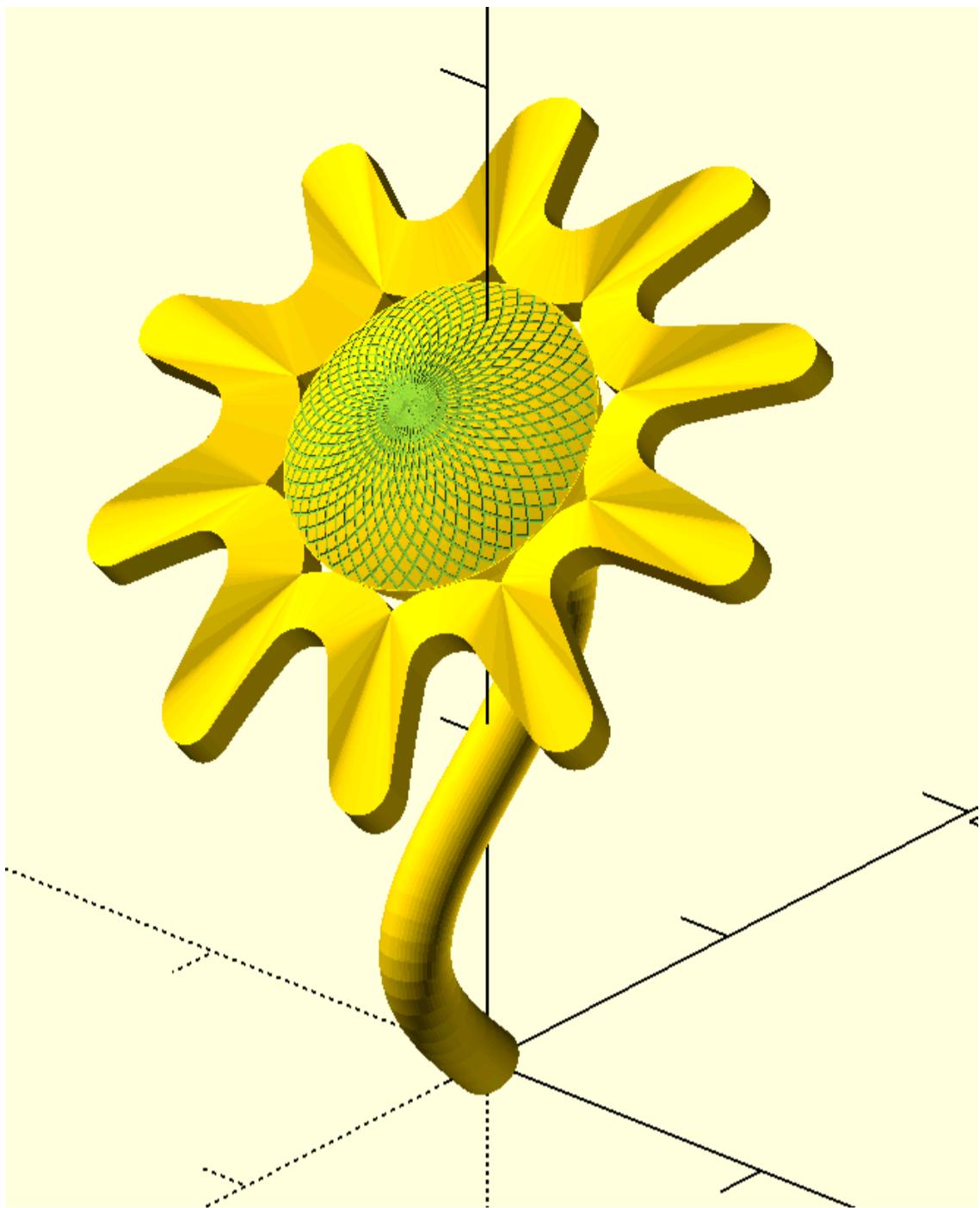
ip1=sol2vector(v1,ip1,avg1)
ip2=sol2vector(v1,ip2,avg1)
sol5=sol2vector(v1,sol5,avg1)

fileopen(f'''

{swp_c(flip(surf4))}
{swp(sol4)}
//color("blue")p_line3dc({sol4[-1]},.2);
//color("magenta")p_line3d({path4},.2);

difference(){{
{swp(flip(sol5))}
for(p={ip1})p_line3d(p,.05,rec=1);
for(p={ip2})p_line3d(p,.05,rec=1);
}};

t1=time.time()
t1-t0
```



sol2vector

```
In [151... # checking orientation of solid w.r.t. vector
t0=time.time()

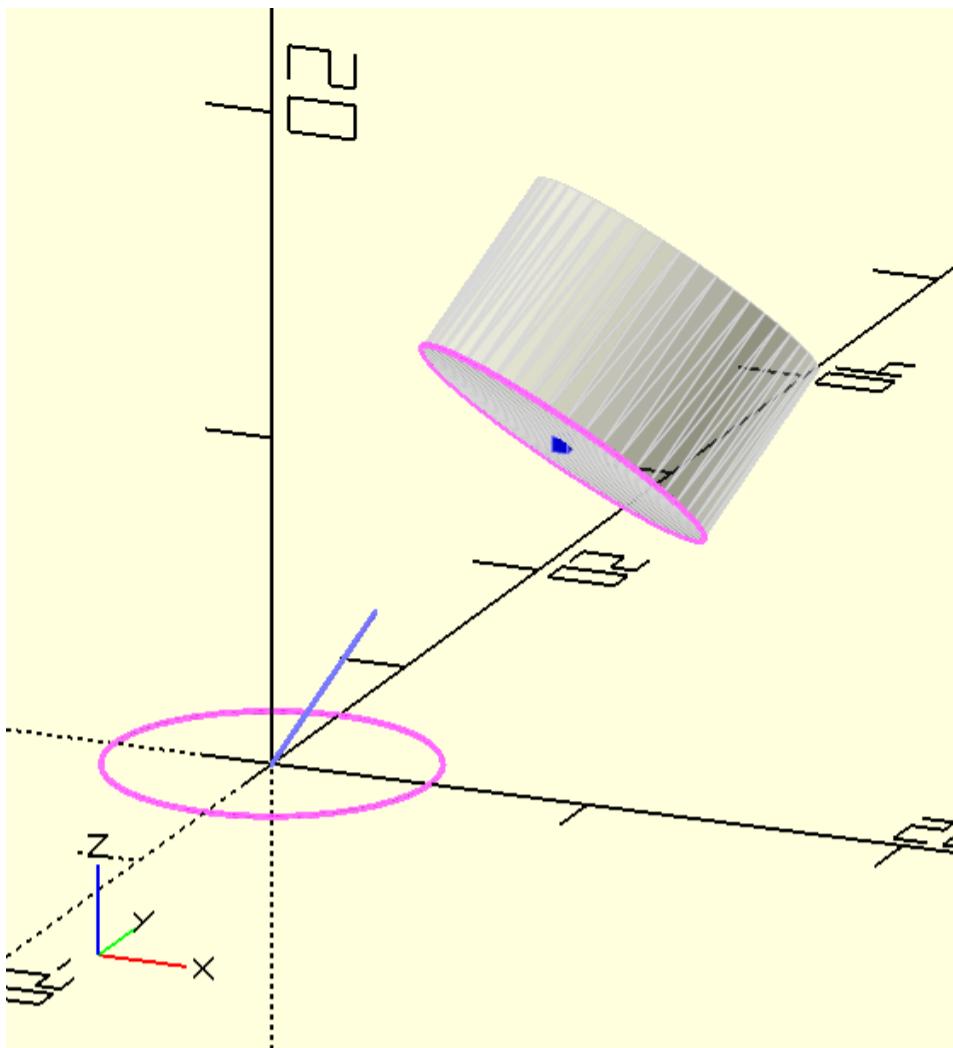
sol=linear_extrude(circle(5),6)
v1=[2,3,4]
loc=[5,10,7.5]
sol1=sol2vector(v1,sol,loc)

fileopen(f'''

%{swp(sol1)}
color("blue")points({[loc]},.5);
color("magenta")p_line3dc({sol[0]},.1);
color("magenta")p_line3dc({sol1[0]},.1);
color("blue")p_line3d({[[0,0,0],v1]},1);

''')
t1=time.time()
t1-t0
```

```
Out[151... 0.003815889358520508
```

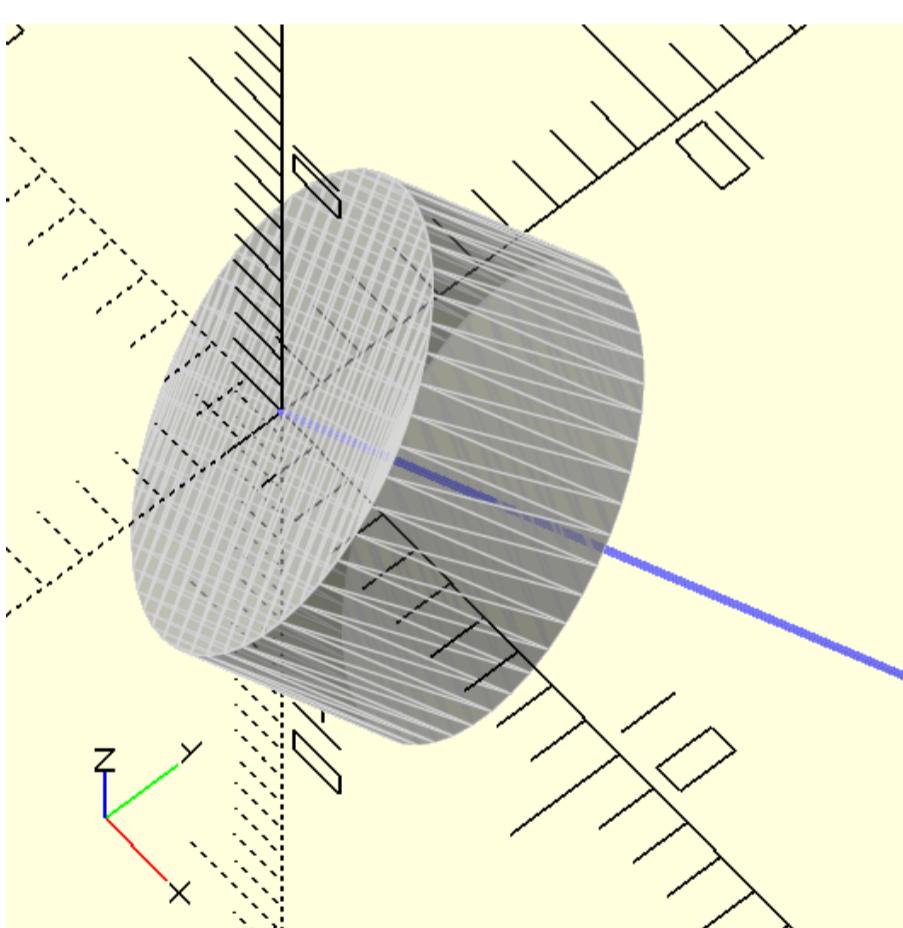


```
In [152]: # checking orientation of solid w.r.t. vector
t0=time.time()

sec=circle(5)
v1=(array([1,1,-1])*10).tolist()
sol=o_solid(v1,sec,5,0,0,0)

fileopen(f'''%{swp(sol)}
color("blue")p_line3d({[[0,0,0],v1]},.1);
''')
t1=time.time()
t1-t0
```

Out[152]: 0.003885984420776367



```
In [153]: # difficult fillet
t0=time.time()

sec1=circle(10,s=6)
pent1=circle(7,s=6)
pent2=c3t2(rot(f'z{360/5/2}',circle(3.5,s=6)))
sec2=concatenate(cpo([pent1]+[pent2])).tolist()

sec3=offset(sec2,-1.5)
sec4=offset(sec3,1)
path1=helix(20,30,1,5)
path2=[[0,0,10],[-30,20,13]]
sol=path_extrude_open(sec2,path1)
sol1=path_extrude_open(m_points1(sec3,50),path2)
sol2=path_extrude_open(m_points1(offset(sec3,.3),50),path2)
v1=array(path2[1])-array(path2[0])
u1=v1/norm(v1)
ip1=[ip_sol2line(sol,p)[-1] for p in cpo(sol1)]
```

```

ip2=translate(u1,ip1)
ip3=[ip_sol2line(sol,p)[-1] for p in cpo(sol2)]
fillet1=convert_3lines2fillet(ip3,ip2,ip1)
fillet1=fillet1+[fillet1[0]]
fileopen(f'''')

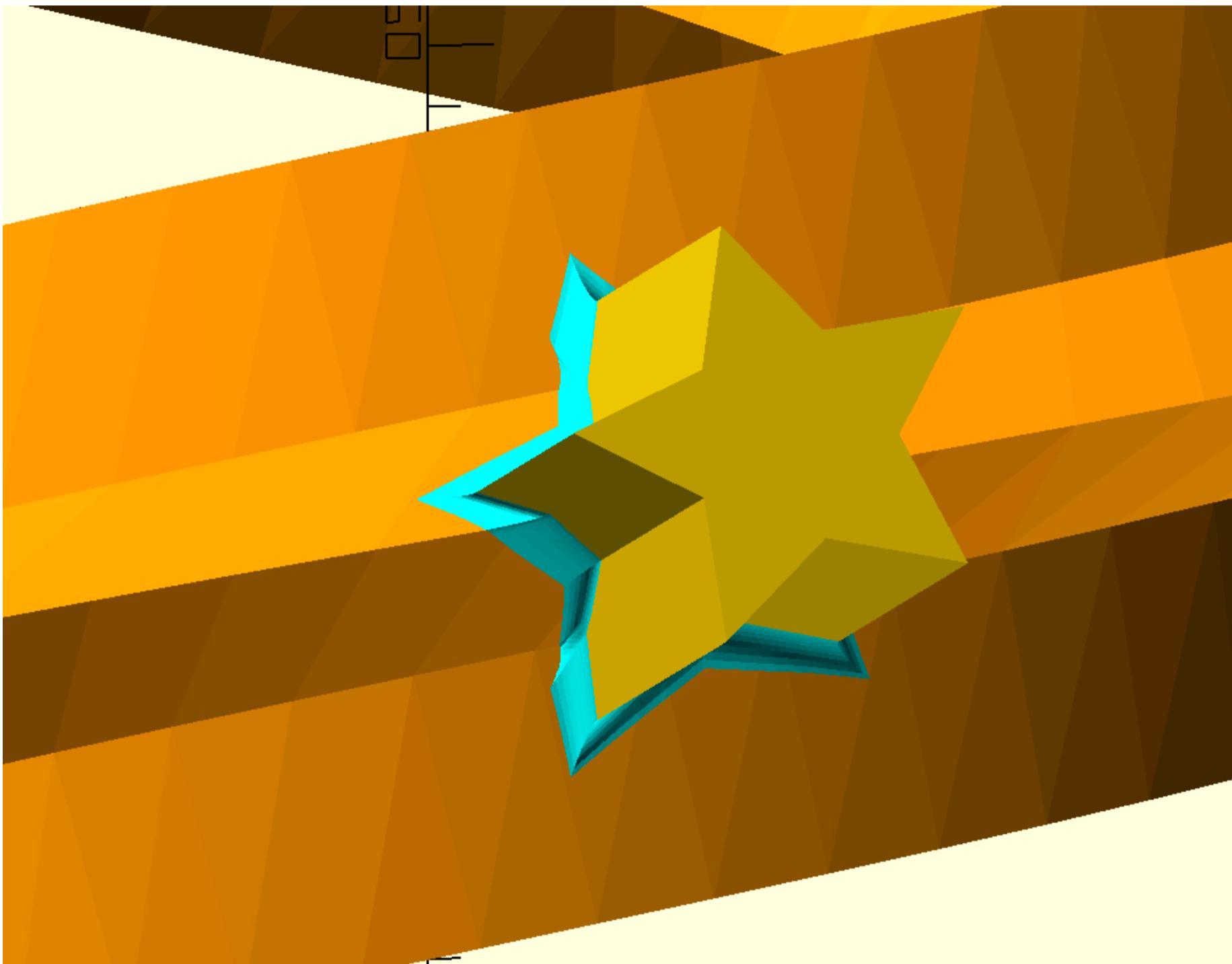
color("orange"){swp(sol)}
%{swp(sol1)}

//color("blue")p_line3dc({ip1},.05);
//color("blue")p_line3dc({ip2},.05);
//color("blue")p_line3dc({ip3},.05);
color("cyan"){swp(fillet1)}

'''')
t1=time.time()
t1-t0

```

Out[153... 0.09867286682128906



ip_sol2sol

```

In [154... # example of function ip_sol2line(sol,line)
t0=time.time()

sec=circle(10)
path=corner_radius(pts1([[-10+.1,0],[12,0],[-2,0,2],[0,10,3],[-10,0]]),5)
sol=prism(sec,path)

sol1=o_solid([1,0,1],circle(3),20,-5)

ip1=ip_sol2sol(sol,sol1,-1)
ip2=ip_sol2sol(sol,sol1,0)

fileopen(f''''

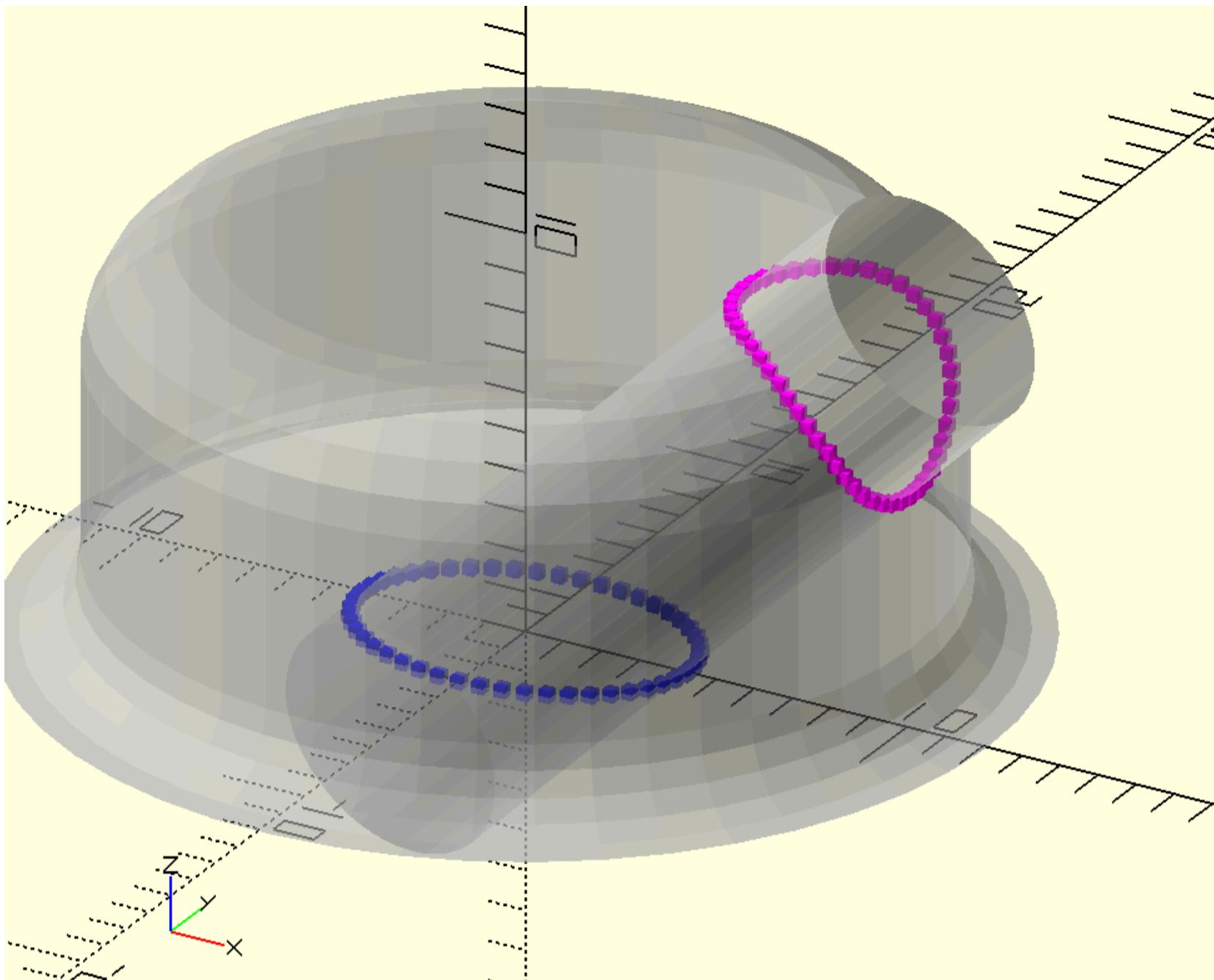
%{swp(sol)}
%{swp(sol1)}

color("magenta")points({ip1},.3);
color("blue")points({ip2},.3);

'''')
t1=time.time()
t1-t0

```

Out[154... 0.08783507347106934



ip_sol2line

In [155...]

```
# example of function ip_sol2line(sol,line)
t0=time.time()

sec=circle(10)
path=corner_radius(pts1([[-10+.1,0],[12,0],[-2,0,2],[0,10,3],[-10,0]]),5)
sol=prism(sec,path)

line=ls([[0,0,-1],[20,20,10]],10)

ip1=ip_sol2line(sol,line)[-1]
ip2=ip_sol2line(sol,line)[0]
```

```
fileopen(f'''
```

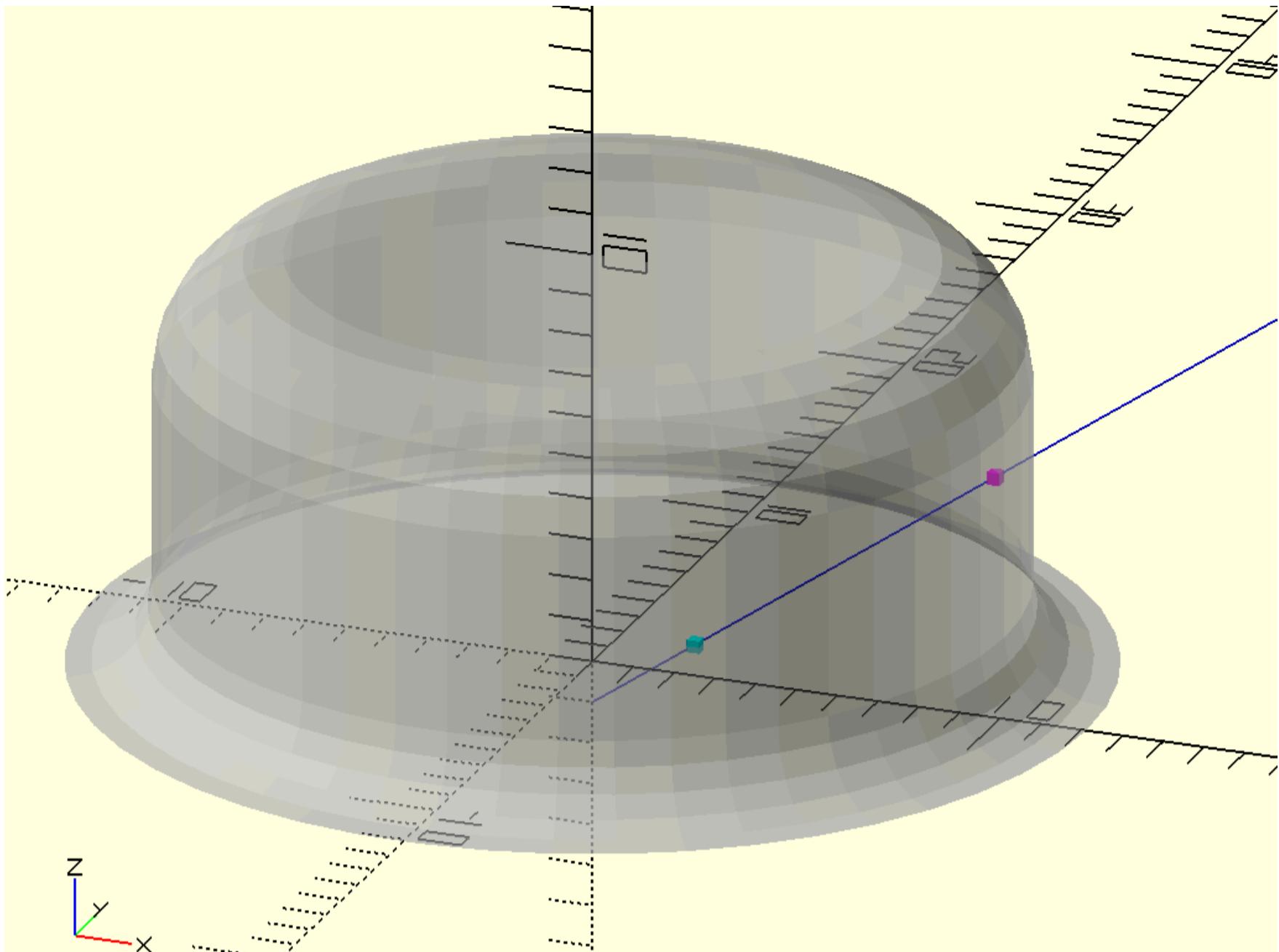
```
%{swp(sol)}
color("blue")p_line3dc({line},.05);
color("magenta")points({[ip1]},.3);
color("cyan")points({[ip2]},.3);
```

```
''')
t1=time.time()
t1-t0
```

```
ip1
```

Out[155...]

```
[7.135485751664292, 7.135485751664292, 2.924517163415361]
```



```
In [156]: t0=time.time()

s1=corner_radius_with_turtle([[0,0],[5,0],[0,5],[-5,0]],10)
s2=linear_extrude(s1,5)
s3=translate([1,2.5,-2.5],cylinder(r=1.75,h=10));
p1=corner_radius_with_turtle([[.5,0],[-.5,0,.5],[0,.5]],20)
s4=[translate([0,0,-x],linear_extrude(offset(s1,x),5+2*x)) for (x,y) in p1]
s5=[offset_solid(s3,y) for (x,y) in p1]
fileopen(f''''

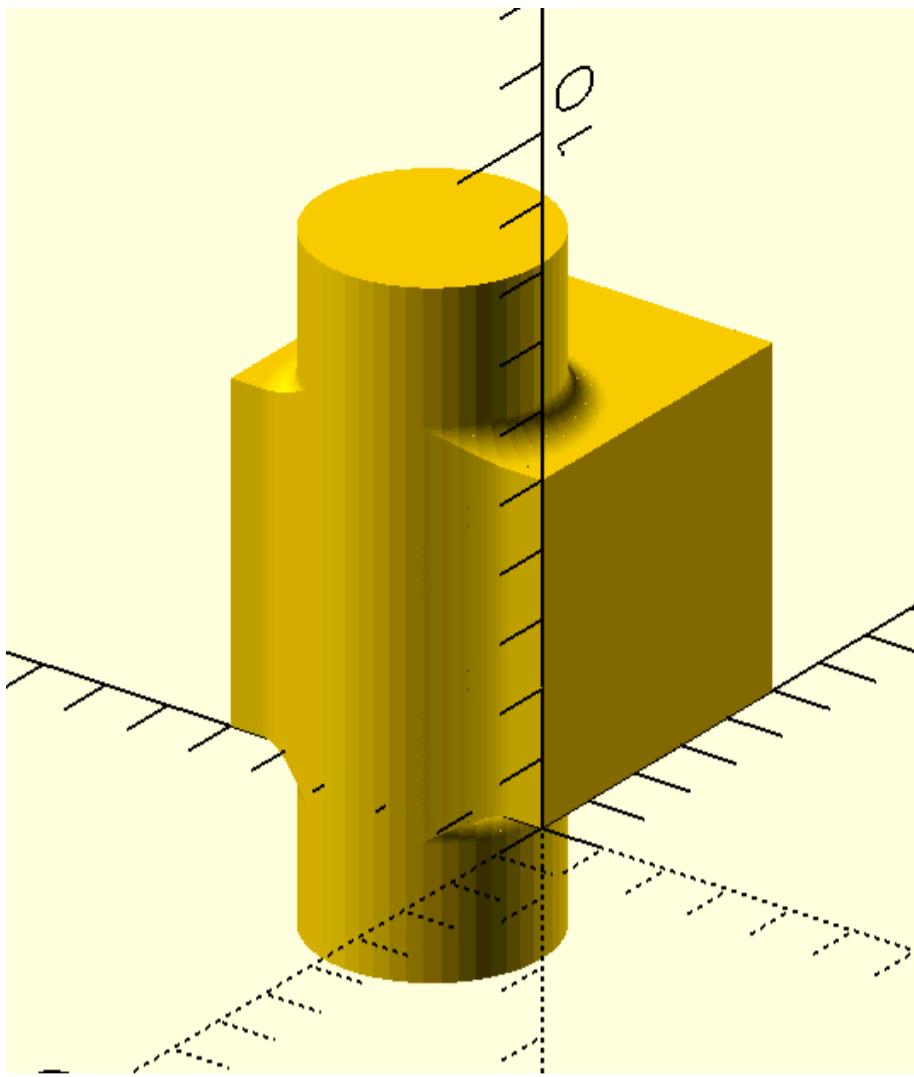
{swp(s2)}
{swp(s3)}

for(i=[0:19])
hull(){{}
intersection(){{
swp({s4}[i]);
swp({s5}[i]);
}}}

intersection(){{{
swp({s4}[i+1]);
swp({s5}[i+1]);
}}}
}}
''')

t1=time.time()
t1-t0
```

Out[156]: 0.24685907363891602



In [157...]

```
t0=time.time()
sec1=circle(10,s=6)
pent1=circle(7,s=6)
pent2=c3t2(rot(f'z{360/5/2}',circle(3.5,s=6)))
sec2=concatenate(cpo([pent1]+[pent2])).tolist()
sec2=corner_radius(array(c2t3(sec2))+[0,0,.5],15)
sec3=concatenate(cpo([pent1]+[pent2])).tolist()
sec3=offset(sec3,-1)
sec3=corner_radius(array(c2t3(sec3))+[0,0,.2],10)
path1=helix(20,30,1,5)
path2=[[0,0,10],[-30,20,13]]
sol=path_extrude_open(sec2,path1)
sol=path_extrude_open(equidistant_pathc(sec3,300),path2)

sol2=sol[22:33]
sol3=slice_sol(sol1,20)
sol4=path_extrude_open(equidistant_pathc(offset(sec3,1),300),path2)
sol4=slice_sol(sol4,20)

i_p1=ip_solid2sol(sol2,sol3[12:17],0)
i_p2=i_p_p(sol3,i_p1,1)
i_p3=ip_solid2sol(sol2,sol4[12:17],0)

i_p1,i_p2,i_p3=align_sol_1([i_p1,i_p2,i_p3])

fillet1=convert_3lines2fillet_closed(i_p3,i_p2,i_p1)
# fillet1=fillet_solid2sol(sol2,sol3[12:16],1,s=20)

fileopen(f'''

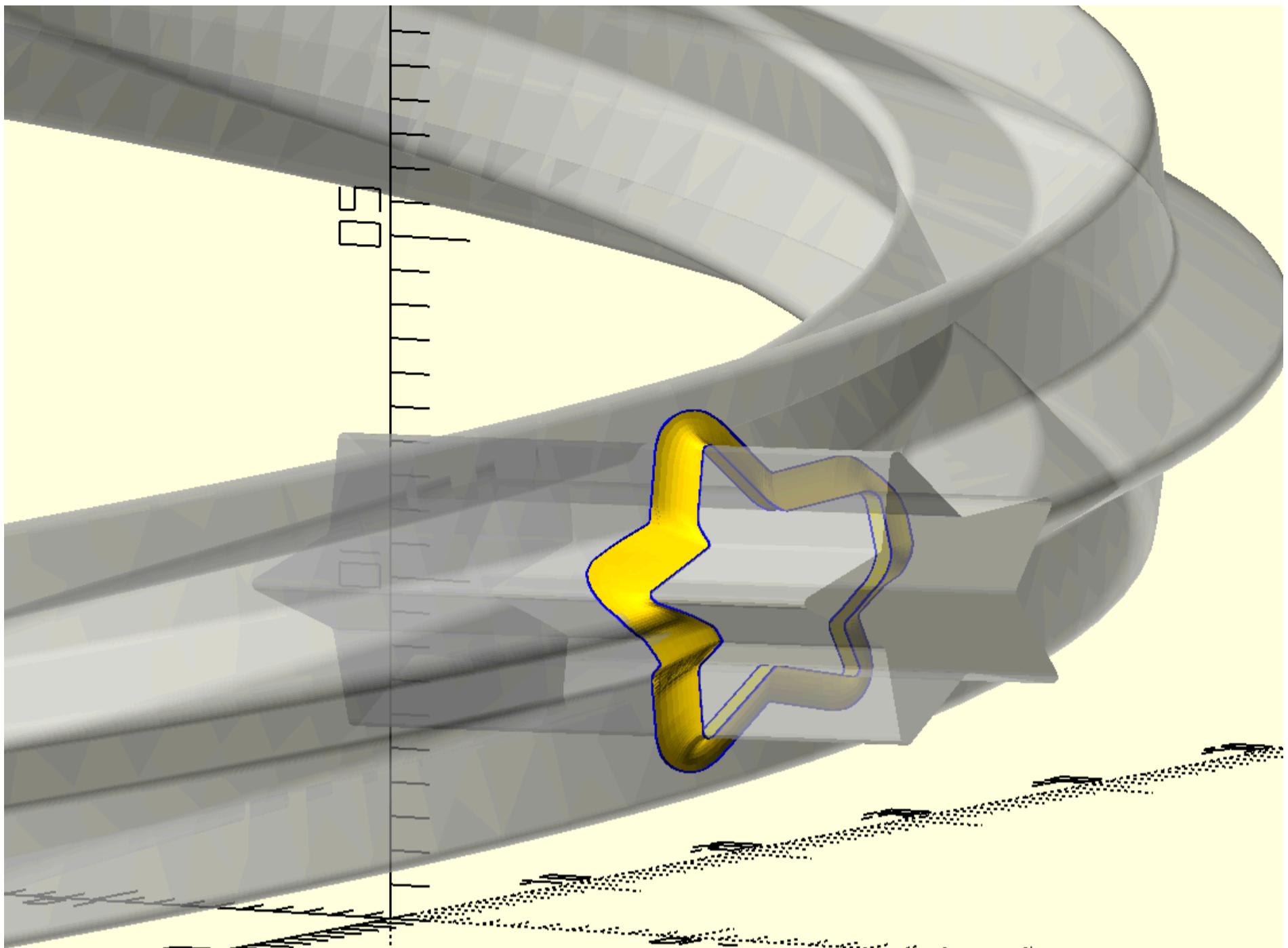
//color("blue")for(p={sol3[12:16]})points(p,.1);

{sweep(sol)}
{sweep(sol3)}
//color("blue")for(p={sol4[12:16]})p_line3dc(p,.1,rec=1);
color("blue")p_line3dc({i_p1},.05,rec=1);
color("blue")p_line3dc({i_p2},.05,rec=1);
color("blue")p_line3dc({i_p3},.05,rec=1);

{sweep_c(fillet1)}
'''')
t1=time.time()
t1-t0
```

Out[157...]

6.983971118927002



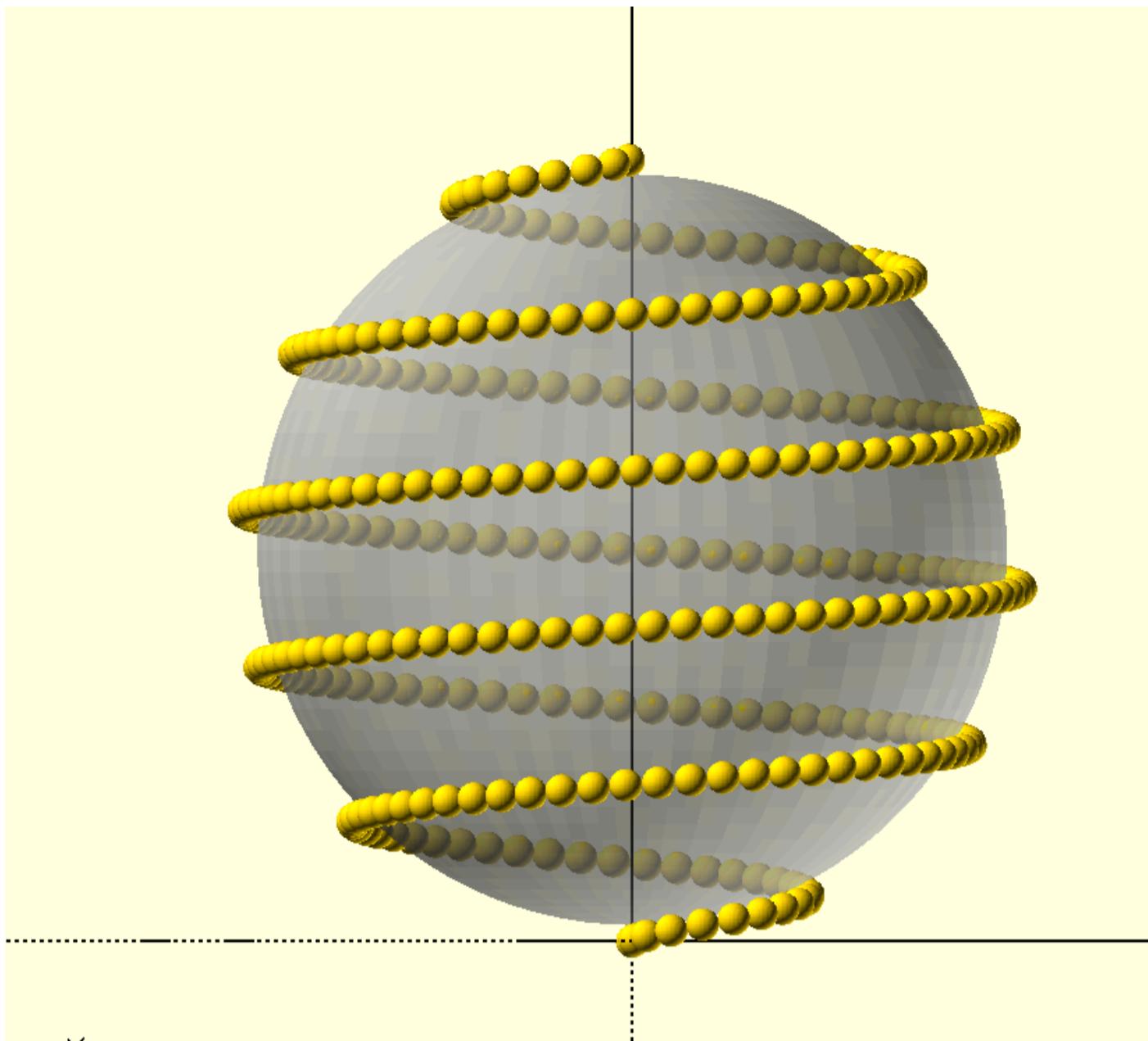
equidistant_path

```
In [158... t0=time.time()
path=helix(15,20/10,10,5)
# path1=[[0,0,p[2]] for p in path]
path1=helix(0,20/10,10,5)
sec=circle(10)
path2=arc(10,-90,90,[-10+.1,10],50)
sp1=prism(sec,path2)
sol1=[path1,path]
i_p1=ip_sol2sol(sp1,sol1,0)
i_p1=equidistant_path(i_p1,500)
d=l_len([i_p1[0],i_p1[1]])
sp2=translate([0,0,10],sphere(10-d/2))
sp3=sphere(d/2)

fileopen(f'''
    %{swp(sp2)}
    color("blue")p_line3d({i_p1},.05);
    for(p={i_p1})translate(p){swp(sp3)}

    ''')
t1=time.time()
t1-t0
```

Out[158... 0.8639099597930908



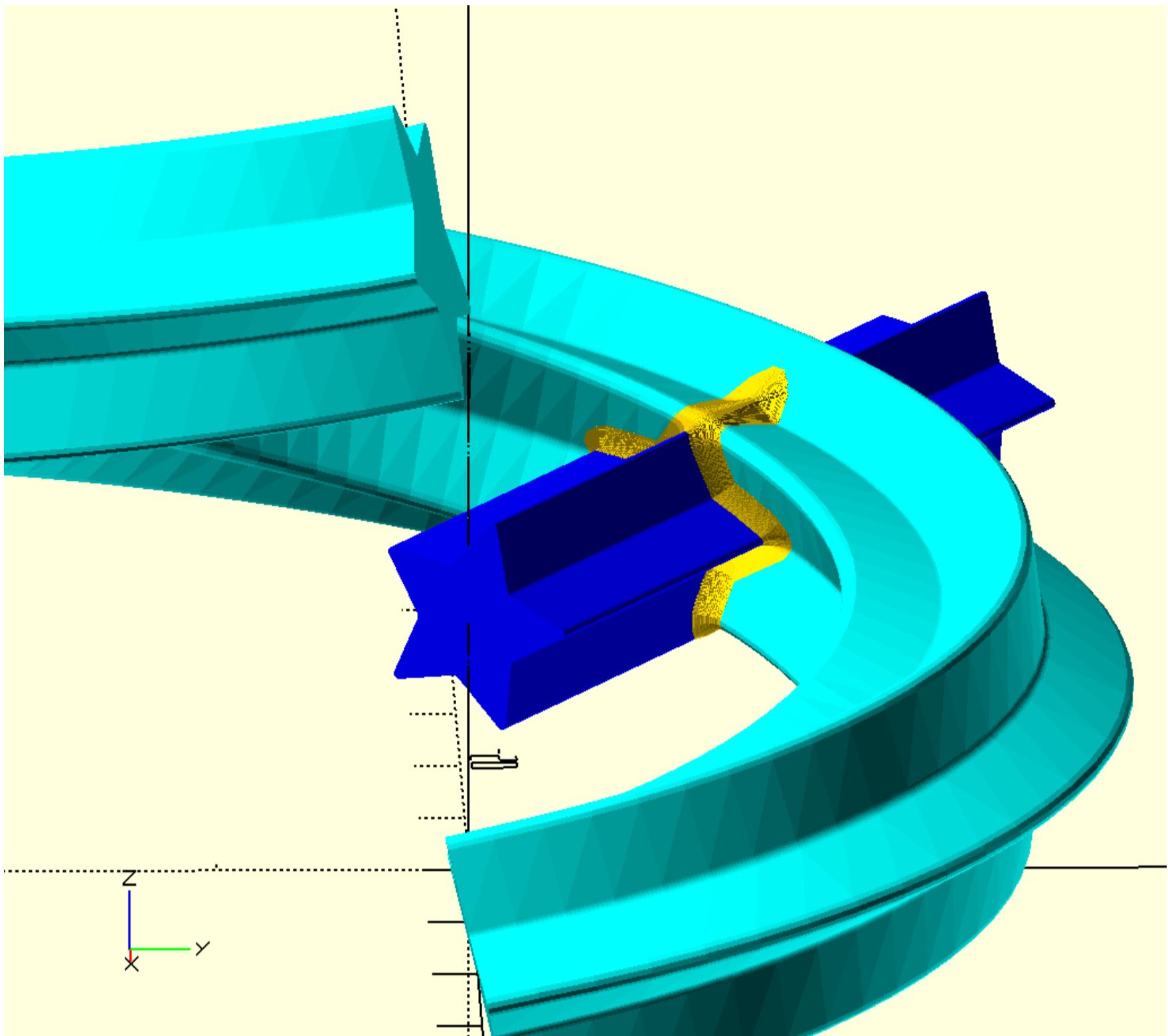
iterative-approach-towards-creating-fillets

In [165...]: # iterative approach towards creating fillets

```
t0=time.time()
sec1=circle(10,s=6)
pent1=circle(7,s=6)
pent2=c3t2(rot(f'z{360/5/2}',circle(3.5,s=6)))
sec2=concatenate(cpo([pent1]+[pent2])).tolist()
sec2=corner_radius(array(c2t3(sec2))+[0,0,.1],5)
sec3=concatenate(cpo([pent1]+[pent2])).tolist()
sec3=offset(sec3,-1)
sec3=corner_radius(array(c2t3(sec3))+[0,0,.1],5)
path1=helix(20,30,1,5)
path2=[[0,0,10],[-30,20,13]]
sol=path_extrude_open(sec2,path1)
sol1=path_extrude_open(sec3,path2)
sol2=sol[20:40]
# a=array([[1-cos(d2r(i)),1-sin(d2r(i))] for i in linspace(0,90,90)])*1
# b=[offset_sol(sol2,i) for i in a[:,0].round(2)]
# c=[offset_sol(sol1,i) for i in a[:,1].round(2)]
a=cr2dt([[1,0],[-1,0,1],[0,1]],50)
b=[ path_extrude_open(offset(sec3,x),path2) for (x,y) in a]
c=[ path_extrude_open(offset(sec2,y),path1[25:35],1) for (x,y) in a]
fileopen(f'''
for(i=0:49){
intersection(){
swp({b}[i]);
swp({c}[i]);
}
color("cyan"){swp(sol1)}
color("blue"){swp(sol)}

''' )
t1=time.time()
t1-t0
```

Out[165...]: 8.095863103866577



In [166]: # iterative approach for creating fillets, example-2

```
t0=time.time()
sec=circle(10)
path=corner_radius(pts1([[2,0],[-2,0,2],[-1,15,3],[-8,0]]),10)
s2=rot('z90',prism(sec,path))

sec1=corner_radius(pts1([[0,0,1],[5,0,1],[0,7,2],[-5,0,2]]),10)
path1=corner_radius(pts1([[-2,0],[2,0,2],[0,5,.3],[-.5,0]]),10)
s3=translate([6,0,12],rot('x90z90',prism(sec1,path1)))

p1=corner_radius_with_turtle([[1,0],[-1,0,1],[0,1]],20)

s4=[rot('z90',prism(sec,path_offset(path,x))) for (x,y) in p1]
s5=[translate([6,0,12],rot('x90z90',prism(sec1,path_offset(path1,y)))) for (x,y) in p1]

fileopen(f'''

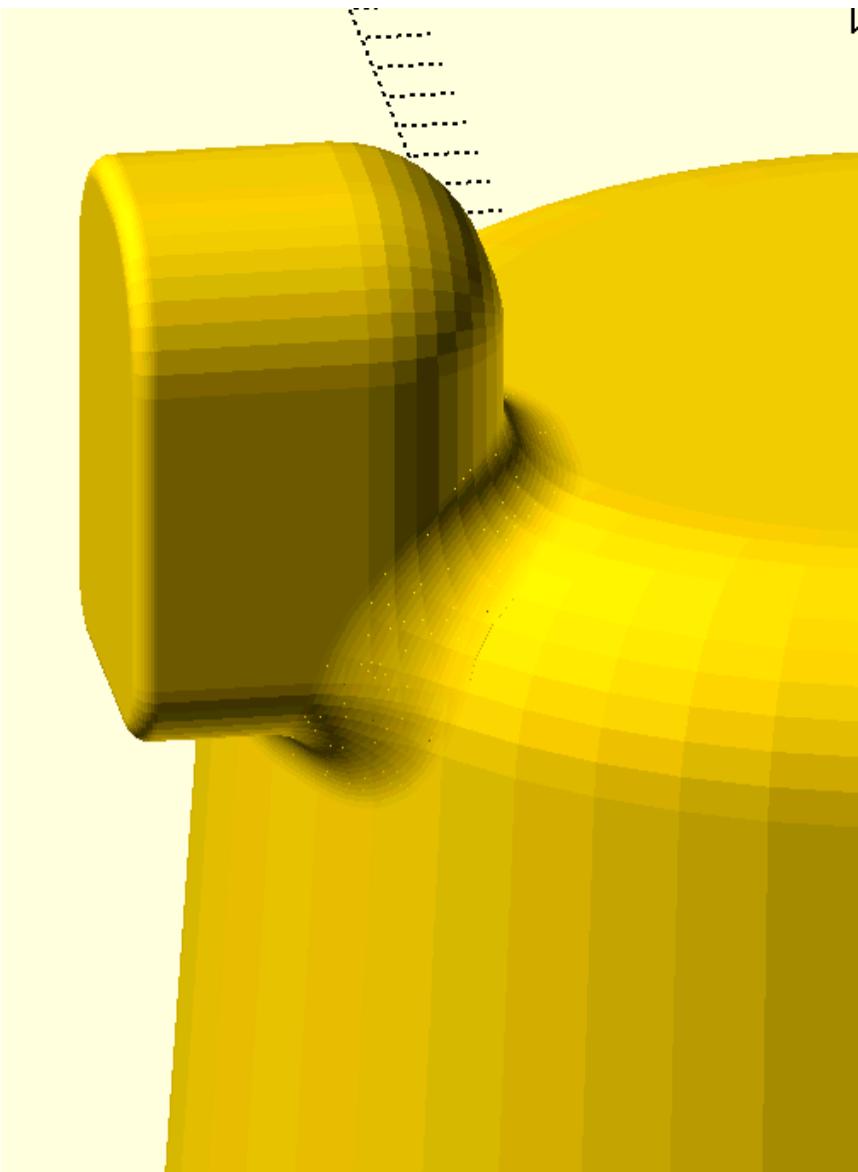
{swp(s2)}
{swp(s3)}

for(i=[0:19])
hull(){{
intersection(){{
swp({s4}[i]);
swp({s5}[i]);
}}}

intersection(){{
swp({s4}[i+1]);
swp({s5}[i+1]);
}}
}
}
''')

t1=time.time()
t1-t0
```

Out[166]: 8.41244626045227



```
In [167]: s2=linear_extrude(circle(10,s=200),30)
s3=translate([10,0,5],linear_extrude(circle(5,s=100),20))
p1=corner_radius_with_turtle([[1,0],[-1,0,1],[0,1]],20)

s4=[ translate([10,0,5-x],linear_extrude(offset(circle(5,s=100),x),20+2*x)) for (x,y) in p1]
s5=[linear_extrude(offset(circle(10,s=200),y),30) for(x,y) in p1]

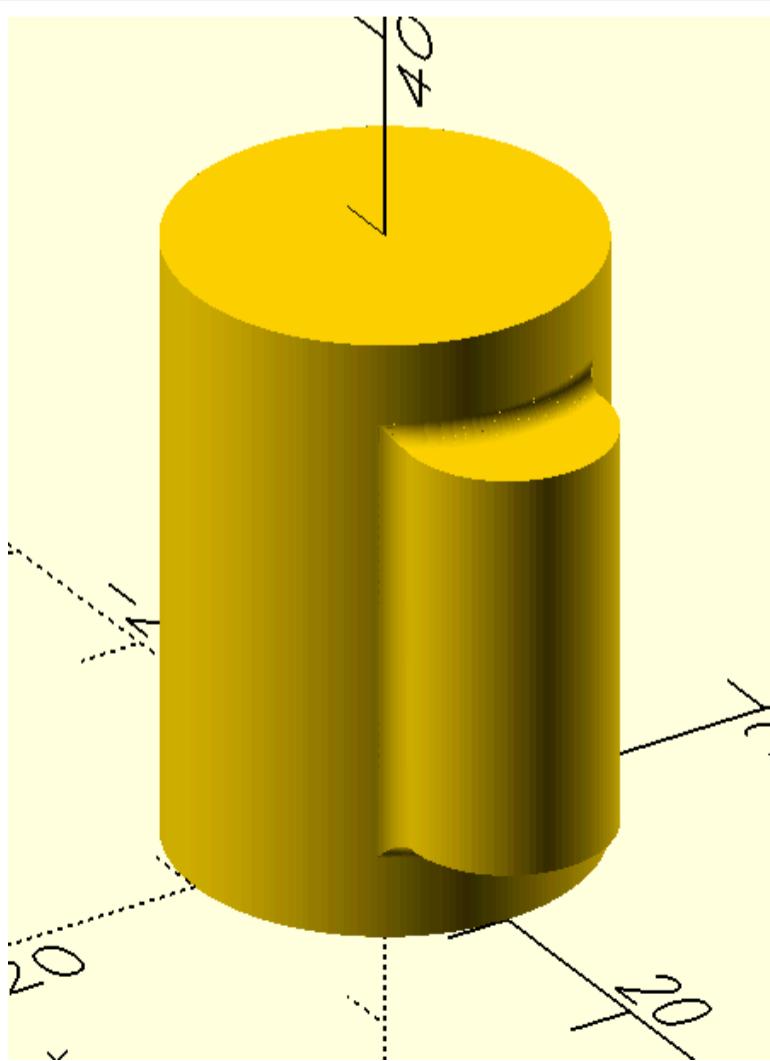
fileopen(f'''
```



```
{swp(s2)}
{swp(s3)}

for(i=[0:19])
hull(){{
intersection(){{
swp({s4}[i]);
swp({s5}[i]);
}}}

intersection(){{
swp({s4}[i+1]);
swp({s5}[i+1]);
}}
}
}
''' )
```



```
In [168]: t0=time.time()
```

```

s2=o_solid([0,1,0],circle(5),70,-35)
s3=o_solid([1,0,0],circle(5),70,-35)

p1=corner_radius_with_turtle([[1.5,0],[-1.5,0,1.5],[0,1.5]],20)

s4=[o_solid([0,1,0],circle(5+x),70,-35) for (x,y) in p1]
s5=[o_solid([1,0,0],circle(5+y),70,-35) for (x,y) in p1]

fileopen(f''''

{swp(s2)}
{swp(s3)}

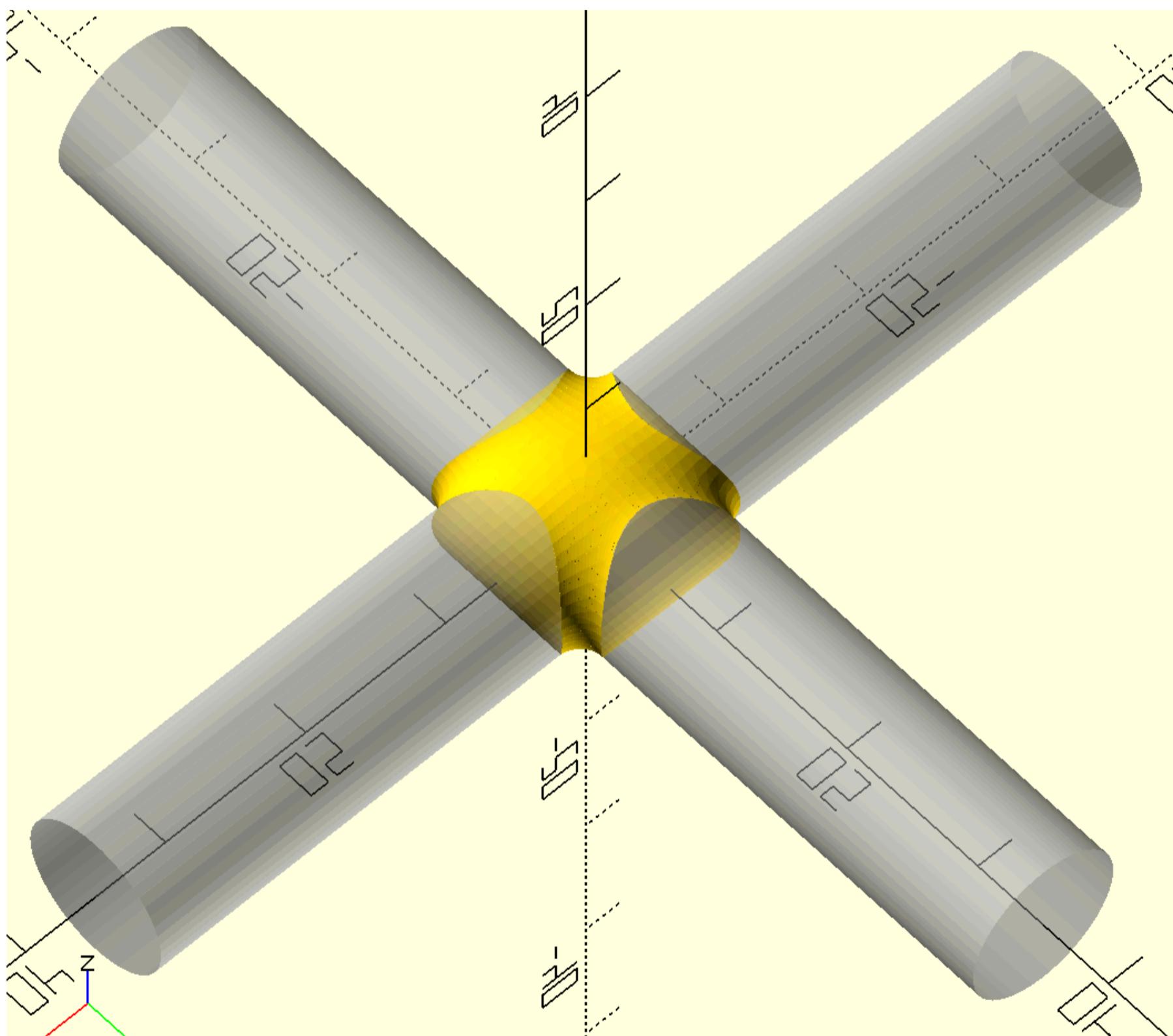
for(i=[0:19])
hull(){{}
intersection(){{
swp({s4}[i]);
swp({s5}[i]);
}}


intersection(){{
swp({s4}[i+1]);
swp({s5}[i+1]);
}}
}
}

t1=time.time()
t1-t0

```

Out[168... 0.07289886474609375



In [169... cyl1=linear_extrude(circle(5),20)
fileopen(f''''

{swp(cyl1)}
'''')

In [170... triangle=[[0,0],[5,0],[0,5]]
p=[0,3]
tx=triangulate_4p(triangle,p)

p0,p1,p2,p3=triangle+[p]

fileopen(f''''

```

color("blue")points({[p0,p1,p2,p3]},.2);
//p_line({tx},.05);
for(p={tx})p_line(p,.05);

```

```

color("magenta")p_line({cir_3p(tx[0][0],tx[0][1],tx[0][2],s=72)},.05);
color("cyan")p_line({cir_3p(tx[1][0],tx[1][1],tx[1][2],s=72)},.05);

...

```

```
tx
Out[170... [[[0, 5], [0, 3], [5, 0]], [[5, 0], [0, 3], [0, 0]]]
```

lexicographic_sort_xy

```

In [171... # example of function lexicographic_sort_xy(p)
t0=time.time()
a=random.random(50)*(20-5)+5
b=random.random(50)*(30-10)+10
p=array([a.round(1),b.round(1)]).transpose(1,0)

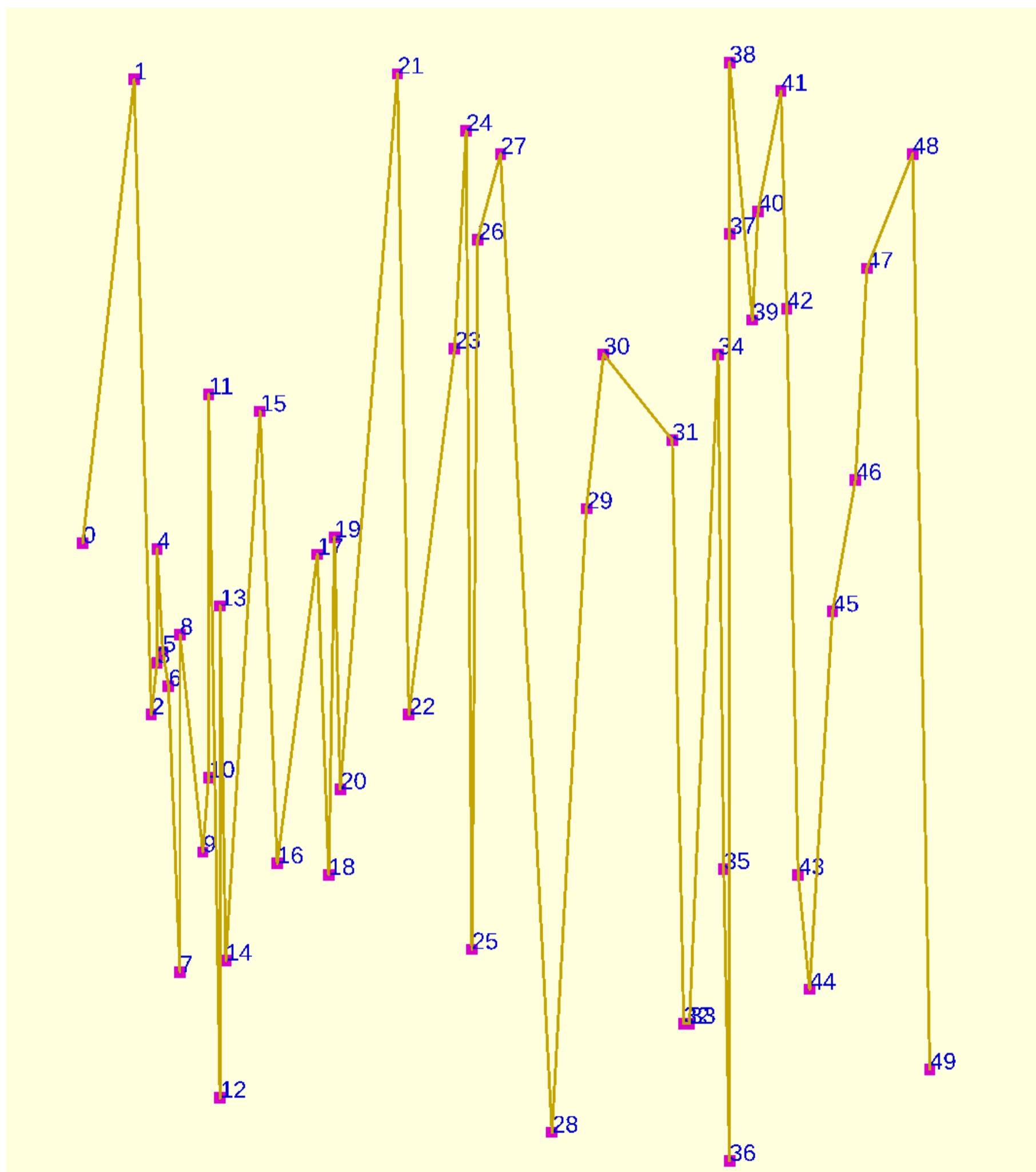
fileopen(f'''

p2={lexicographic_sort_xy(p)};
color("blue")for(i=[0:len(p2)-1])translate(p2[i])text(str(i),.3);
p_lineo(p2,.05);
color("magenta")points(p2,.2);

''')
t1=time.time()
t1-t0

```

```
Out[171... 0.004010915756225586
```



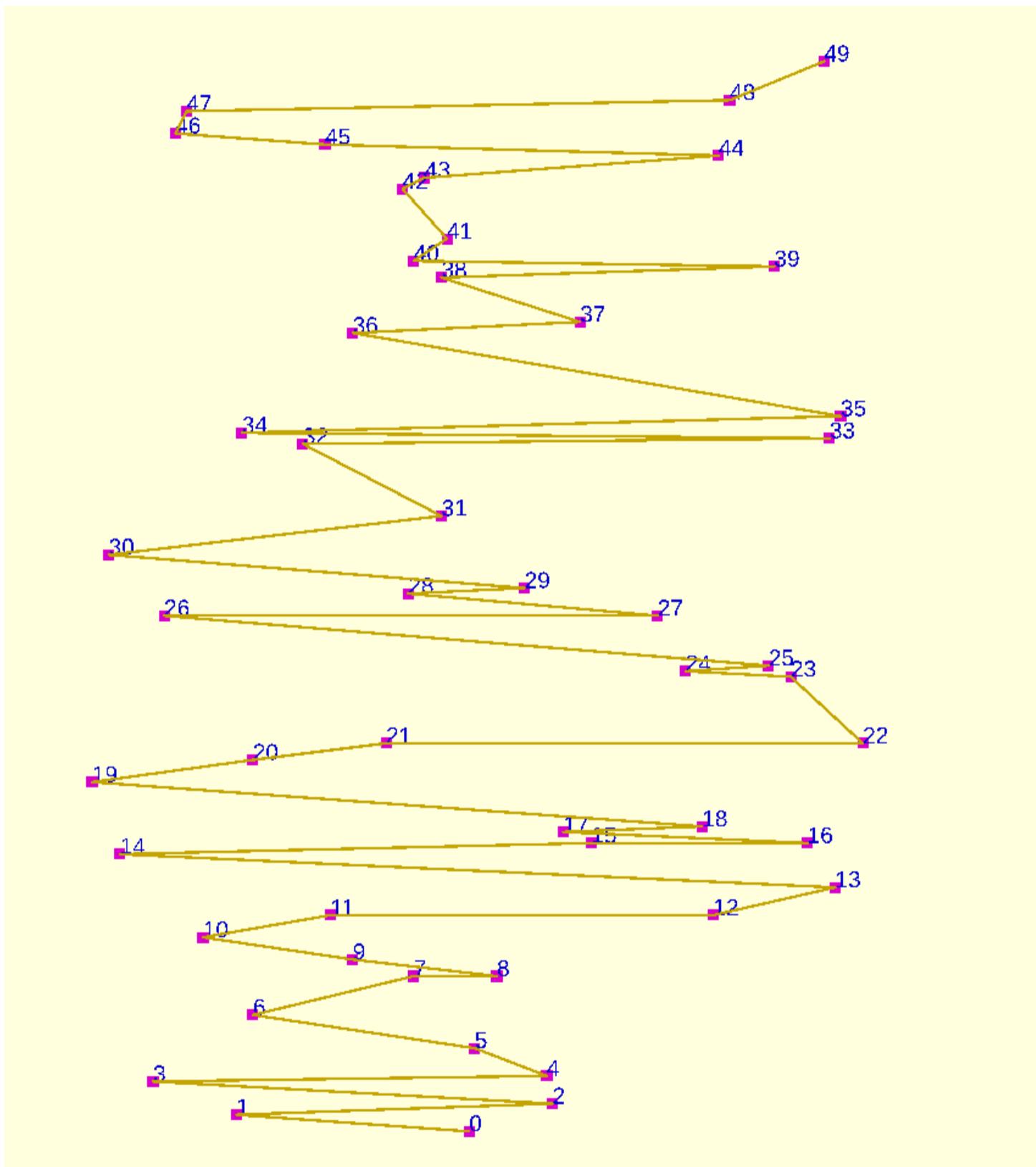
lexicographic_sort_yx

```
In [172... # example of function lexicographic_sort_yx(p)
t0=time.time()
a=random.random(50)*(20-5)+5
b=random.random(50)*(30-10)+10
p=array([a.round(1),b.round(1)]).transpose(1,0)

fileopen(f'''
p2={lexicographic_sort_yx(p)};
color("blue")for(i=0:len(p2)-1)translate(p2[i])text(str(i),.3);
p_lineo(p2,.05);
color("magenta")points(p2,.2);

''')
t1=time.time()
t1-t0
```

Out[172... 0.0019271373748779297



convex_hull

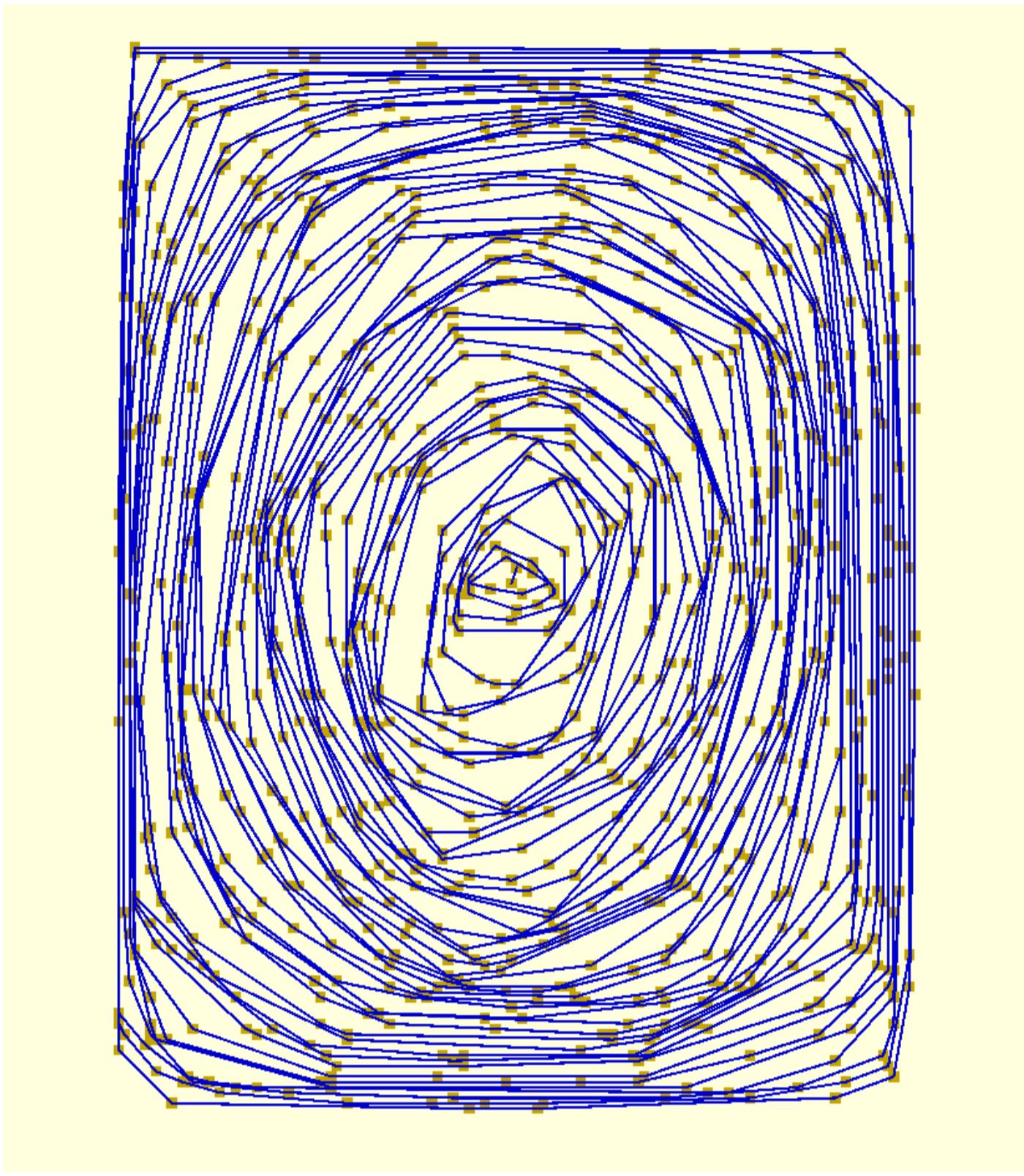
```
In [173... t0=time.time()
a=random.random(1000)*(20-5)+5
b=random.random(1000)*(30-10)+10
px=array([a.round(1),b.round(1)]).transpose(1,0).tolist()
p=px
sec=[]
while(p!=[]):
    p1=convex_hull(p)
    sec.append(p1)
    p=exclude_points(p,p1)
    if p==[]:
        break

fileopen(f'''
points({px},.2);
color("blue")for (p={sec})p_line(p,.05);

'''')
```

```
t1=time.time()
t1-t0
```

Out[173... 6.520414113998413



```
In [176... s_y=20+5/sin(d2r(45))
h_z=10/20*s_y
s_y1=(s_y**2-h_z**2)**0.5
sec=corner_radius(pts1([[20,s_y,5],[-20,20,5],[-20,-20,5],[20,-20,5]]),20)
sec1=offset(sec,5)

path=cr3dt([[0,0,h_z,0],[0,s_y1,-h_z,5],[0,s_y1,h_z,0]],20)

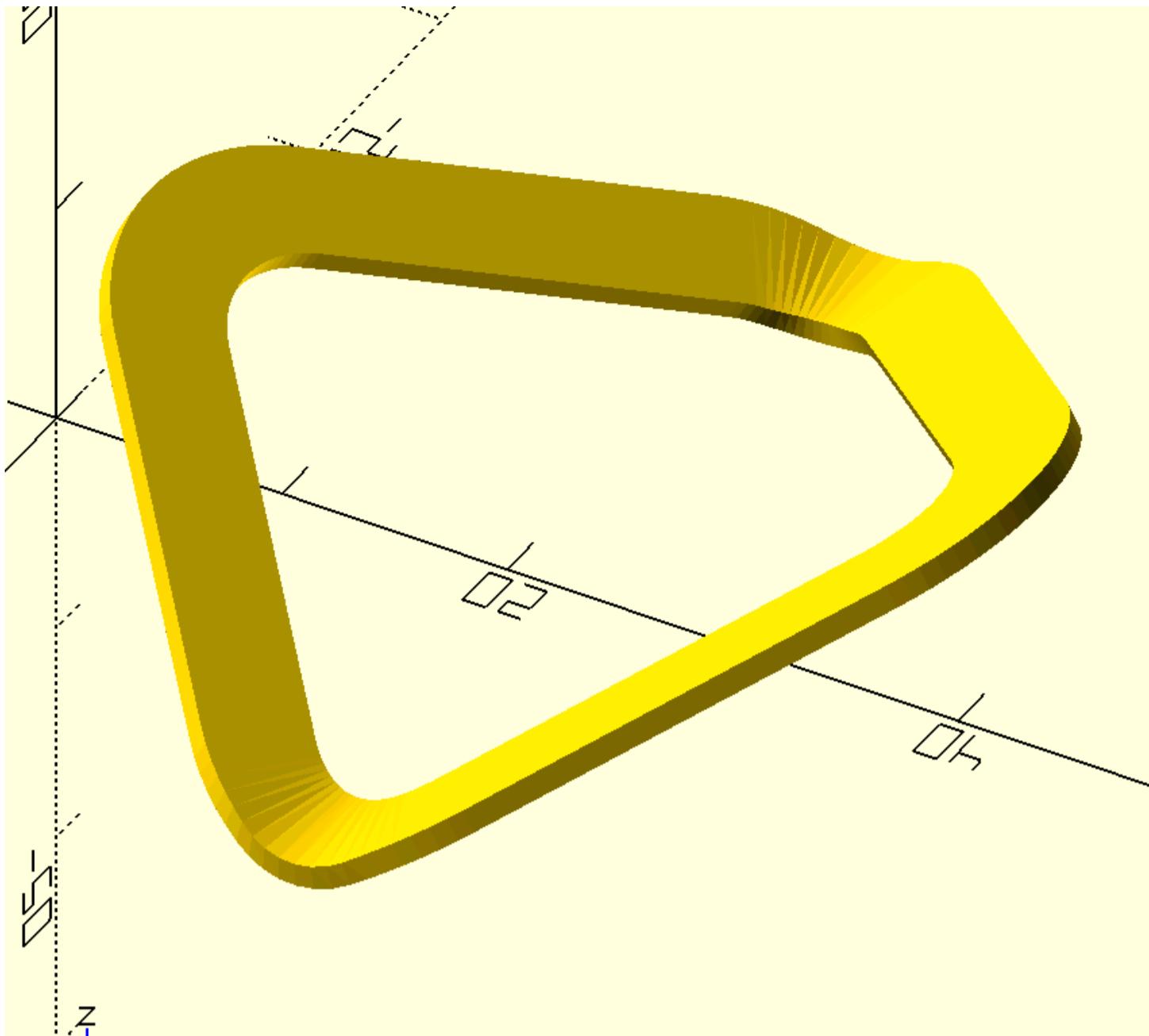
sec2=wrap_around(sec,path)
sec3=wrap_around(sec1,path)

surf1=[sec2,sec3]
surf2=surf_offset(surf1,-1)
sol=surf1+flip(surf2)+[surf1[0]]
d=s_y1/s_y*20
path2=cr3dt([[20,s_y1+.25,0,3.5],[-20,d,10,5],[-20,-d,-10,3.5],[20,-d,10,5]],20)

fileopen(f'''

//color("blue")for(p={cpo(sol)})p_line3dc(p,.05);
//color("magenta")p_line3dc({path2},.05);
{swp_c(sol)}

''' )
```



path_extrude_open

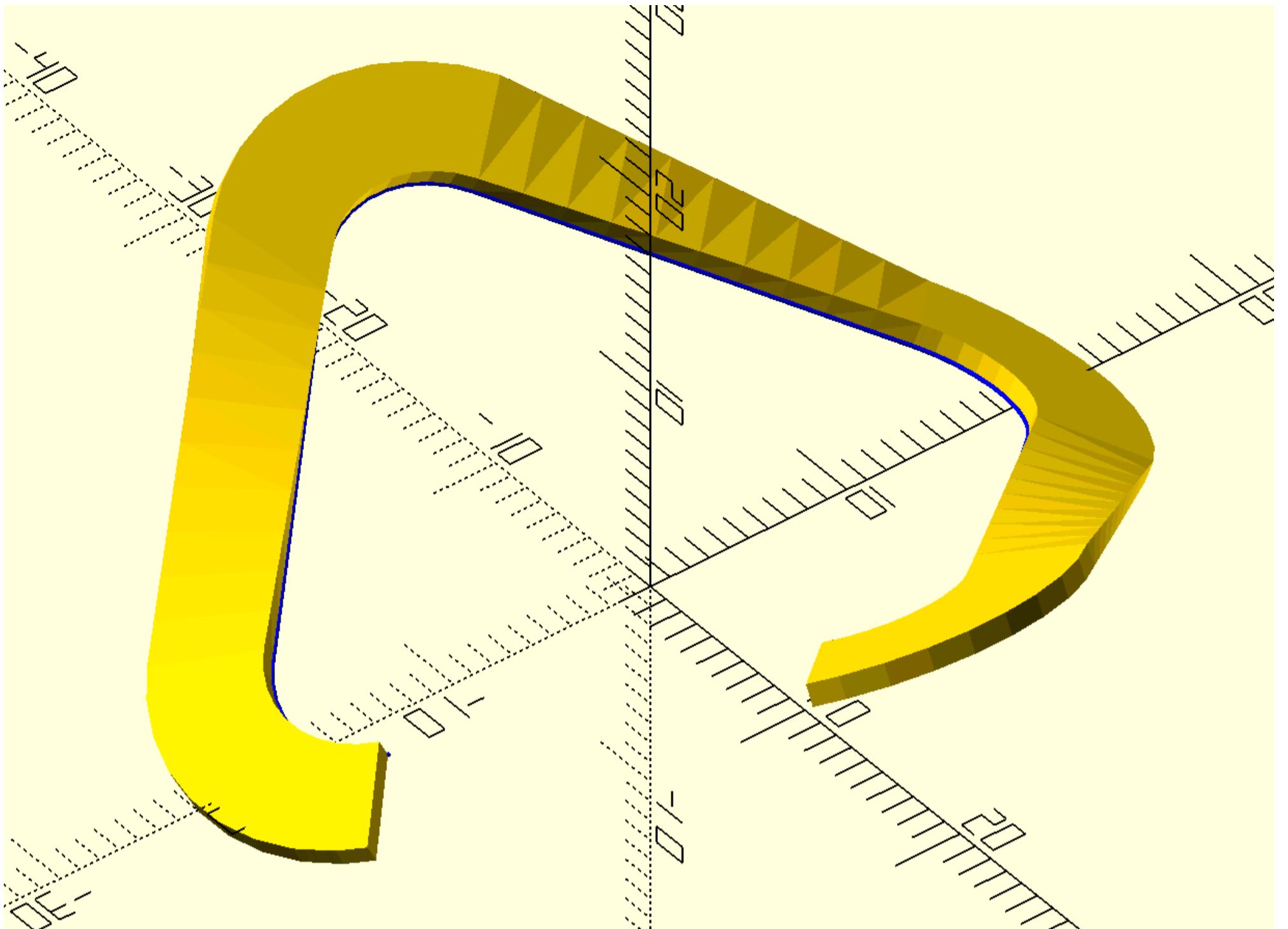
```
In [177]: # example of path_extrude_open(sec,path,twist=0) which adds a twist to the section
sec=pts([[0,0],[5,0],[0,1],[-5,0]])
path=cr3dt([[20,0,10,5],[-20,20,-10,5],[-20,-20,10,5],[20,-20,-10,5]],20)

sol=path_extrude_open(sec,path)
sol=slice_sol(sol,10)
fileopen(f''''

color("blue")p_line3d({path},.1);

{swp(sol)}

'''')
```



tangents_along_path

normals_along_path

orthos_along_path

In [178...]

```
# path=rot('x90.001',circle(10))
# path=cr3dt([[0,0,0,3],[15,0,0,4],[5,3,15,3],[0,10,0,3],[-5,3,-15,4],[-15,0,0,3]],10)
path=cr3dt([[20,0,10,5],[-20,20,-10,5],[-20,-20,10,5],[20,-20,-10,5]],20)
# path=helix(10,5,3,5.001)

# sec=pts([[-1.5,-1.25],[3,0],[-1.5,2.5]])
# sec=pts([[0,0],[5,0],[0,1],[-5,0]])
sec=[[0,0],[1,0],[0,1]]
sol=path_extrude_open(sec,path)
# sol=slice_sol(sol,10)
# sol=align_sol(sol,1)

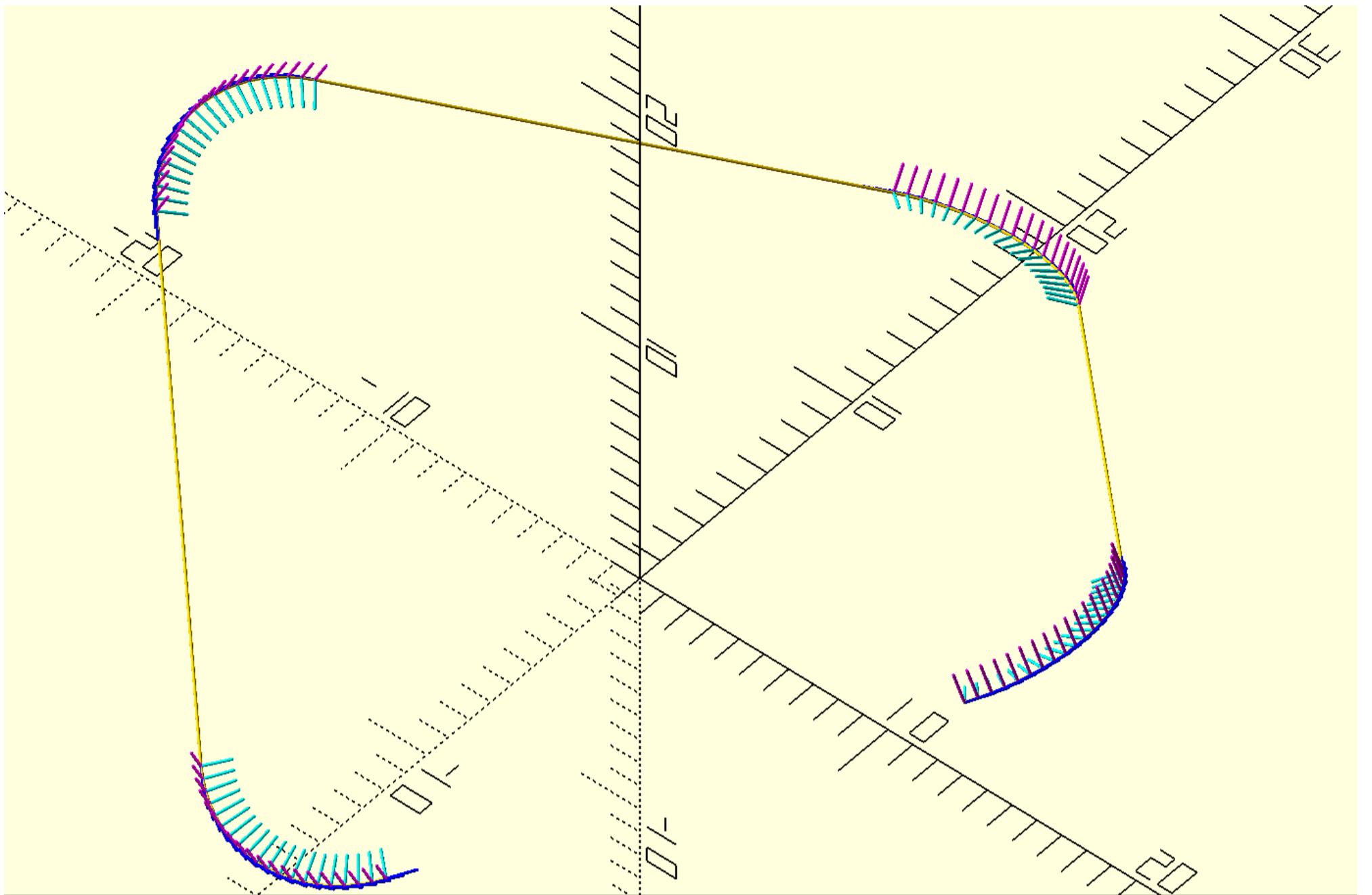
t_v1=tangents_along_path(path,1)
n_v1=normals_along_path(path,1)
o_v1=orthos_along_path(path,1)

fileopen(f'''

p_line3d({path},.05);
color("blue")for(p={t_v1})p_line3d(p,.05);
color("magenta")for(p={n_v1})p_line3d(p,.05);
color("cyan")for(p={o_v1})p_line3d(p,.05);

//{swp(sol)}

''' )
```



```
In [179]: # sec2=[[0,0,0],[2,0,0],[0,0,2]]
sec2=[[0,1,0],[2,3,0],[0,3,2]]

cir1=cir_3p_3d(sec2,100)
cp=cp_cir_3d(sec2)
fileopen(f'''

color("blue")points({sec2},.2);
p_line3dc({cir1},.05);

color("magenta")points({[cp]},.2);

''' )
```

cp_cir_3d

```
In [180]: # explanation of functions to draw circle from 3 points in 3d space
# function to get center of the circle drawn with 3 points. Note that the center of circle is different from the center of 3 points
# Also note that the centroid of the triangle is same as mean of the 3 points

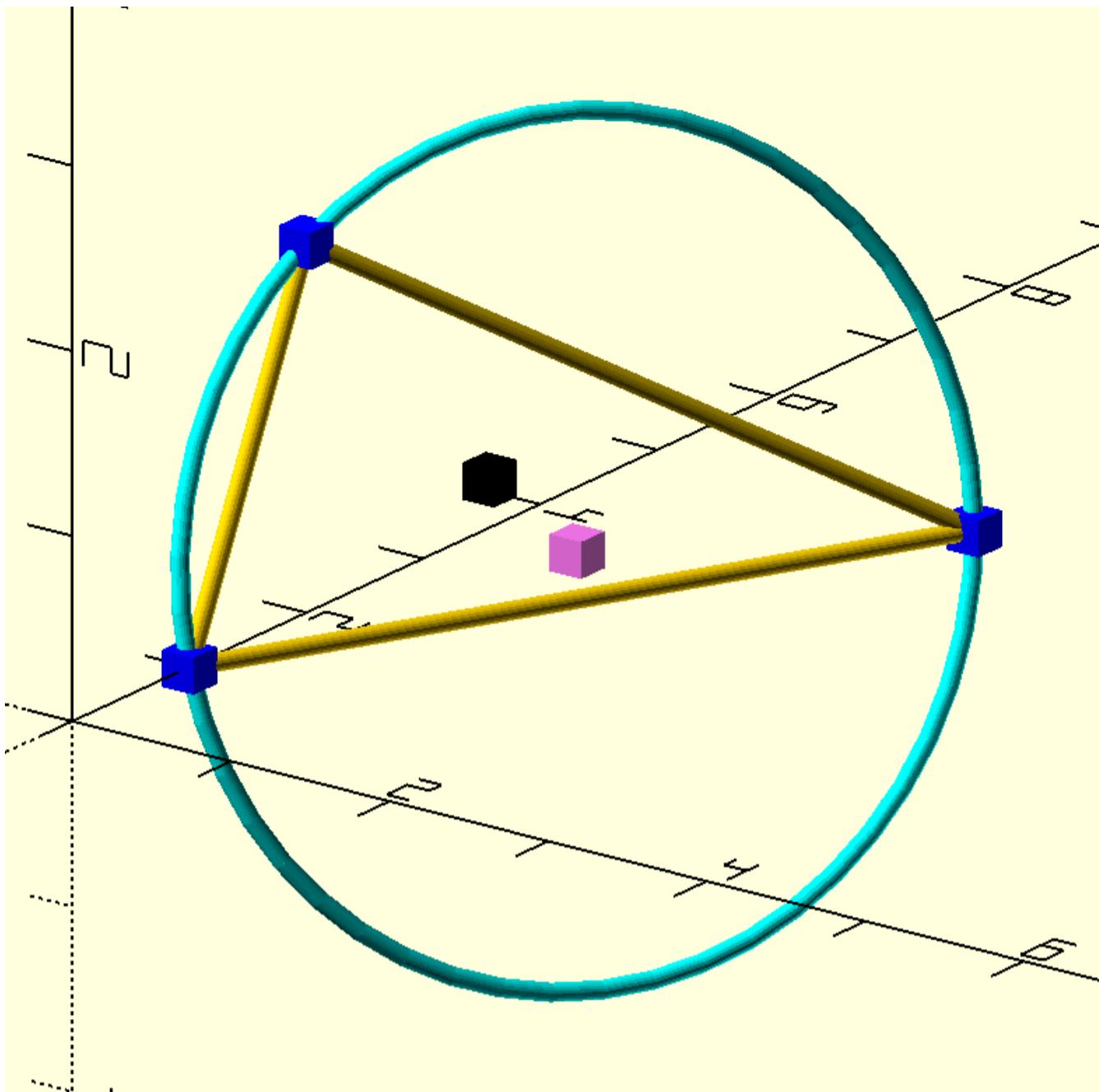
sec=[[0,1,0],[2,5,0],[0,2,2]] # 3 points in 3d space

cir1=cir_3p_3d(sec,50) #function to draw circle from 3 points in 3d space
cp=cp_cir_3d(sec) # function calculates the center of the circle
cp1=centroid_3p_3d(sec)
cp2=array(sec).mean(0).tolist()
fileopen(f'''

color("blue")points({sec},.2);
p_line3dc({sec},.05);

color("cyan")p_line3dc({cir1},.05); // circle drawn by 3 points input
color("violet")points({[cp]},.2); // center point of the circle containing the 3 points as input
color("magenta")points({[cp1]},.2); // centroid of a triangle
color("black")points({[cp2]},.2); // mean is the centroid

''' )
```



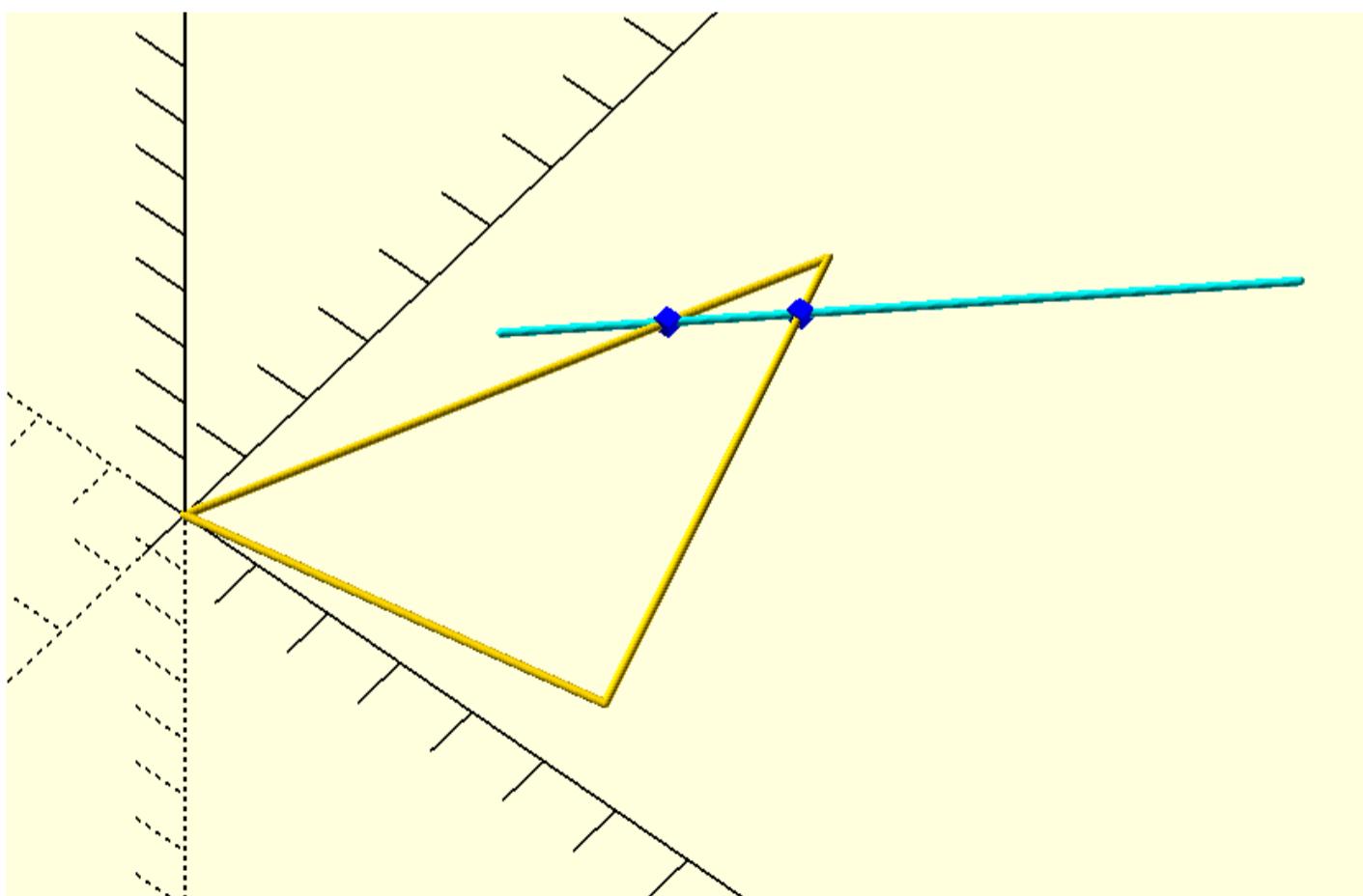
i_sec_ip

```
In [181]: # example of line to section intersection point function
line=[[1,4],[7,10]]
sec=[[0,0],[5,1],[3,7]]

i_p1=line_section_ip(line,sec)
fileopen(f''''

p_line3dc({sec},.05);
color("cyan")p_line3dc({line},.05);
color("blue")points({i_p1},.2);

'''')
```



i_line_planes

```
In [182]: # example of intersection line between 2 planes
t0=time.time()
```

```

p1=translate([-2,0,-8.22],[[2,4,5],[7,9,15],[1,10,5]])

p2=translate([-3,0,-5],[[5,10,3],[5,-7,5],[-10,5,10]])

i_p1=i_line_planes(p2,p1)

fileopen(f'''

p_line3dc({p1},.05);
color("cyan")p_line3dc({p2},.05);

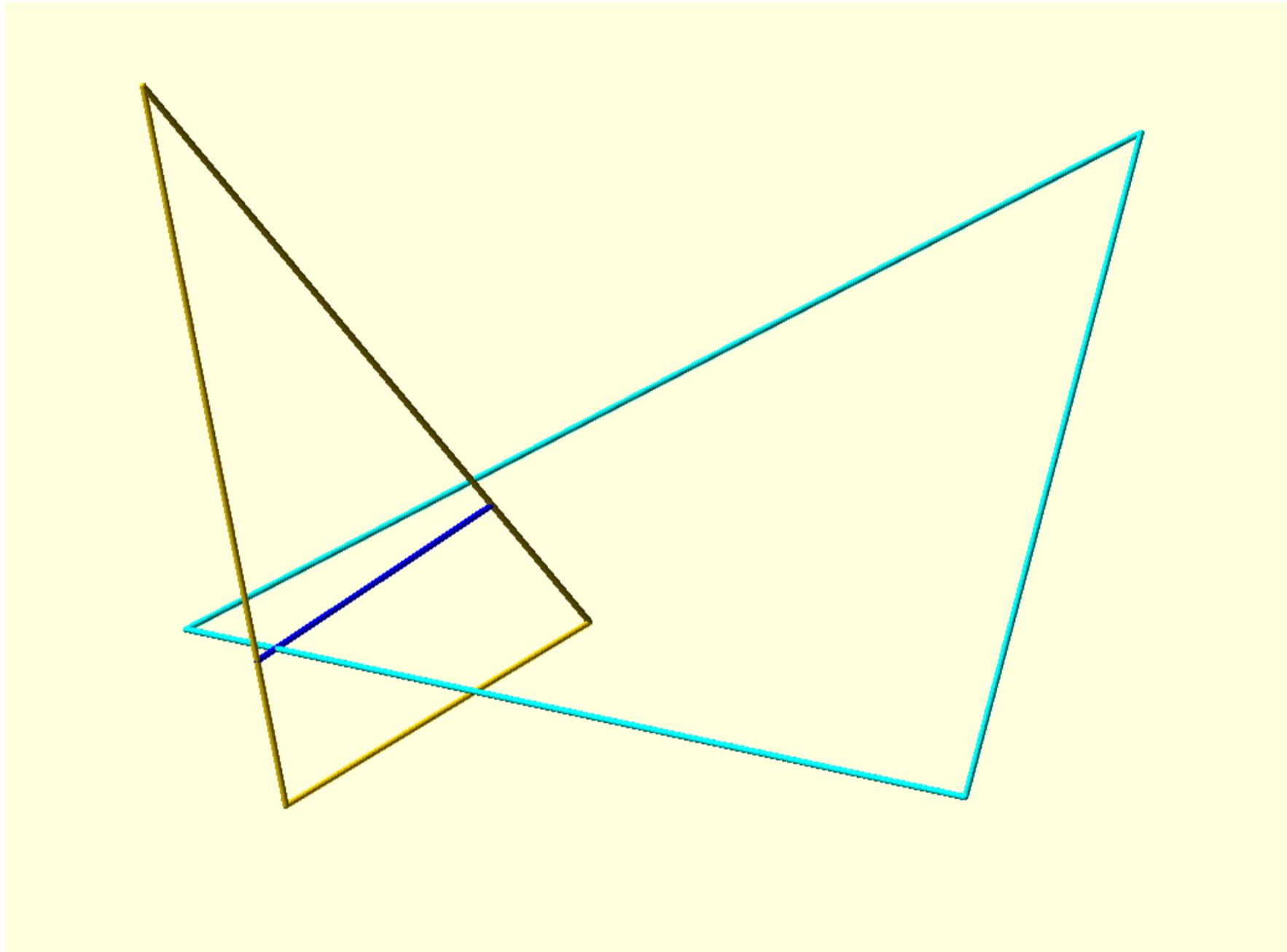
color("blue")p_line3d({i_p1},.05);

''')

t1=time.time()
t1-t0

```

Out[182... 0.007771968841552734



surface_for_fillet

```

In [183... # example of function surface_for_fillet(sol1=[],sol2=[],factor1=50,factor2=10,factor3=1,factor4=100,dia=40)
t0=time.time()

sec=circle(10)
path=corner_radius(pts1([[-8,0],[10,0],[-2,0,2],[-1,15,3],[-8.9,0]]),10)
path=equidistant_path(path,100)
sol1=rot('z90',prism(sec,path))

sec1=corner_radius(pts1([[0,0,1],[5,0,1],[0,7,2.3],[-5,0,2.3]]),10)
path1=corner_radius(pts1([[-2.4,0],[2.4,0,2],[0,5,.3],[-.5,0]]),10)
path1=equidistant_path(path1,30)
sol2=translate([6,0,12],rot('x90z90',prism(sec1,path1)))

sol3=surface_for_fillet(sol1,sol2,100,20,4,23,8)
ip2=ip_sol2sol(sol2,sol3)

fillet1=il_fillet(ip2,sol2,sol3,-1,1)
fillet1=fillet1+[fillet1[0]]
fileopen(f'''

{swe_swp(sol1)}
{swe_swp(sol2)}
color("cyan")for(p={sol2})p_line3dc(p,.01,rec=1);
color("cyan")for(p={cpo(sol2)})p_line3d(p,.01,rec=1);

color("blue")for(p={sol3})p_line3dc(p,.01,rec=1);
color("blue")for(p={cpo(sol3)})p_line3d(p,.01,rec=1);
color("magenta")p_line3dc({ip2},.2,rec=1);

{swe_swp_c(fillet1)}
```

```
color("green")for(p={fillet1})p_line3dc(p,.02,rec=1);
color("green")for(p={cpo(fillet1)})p_line3dc(p,.02,rec=1);

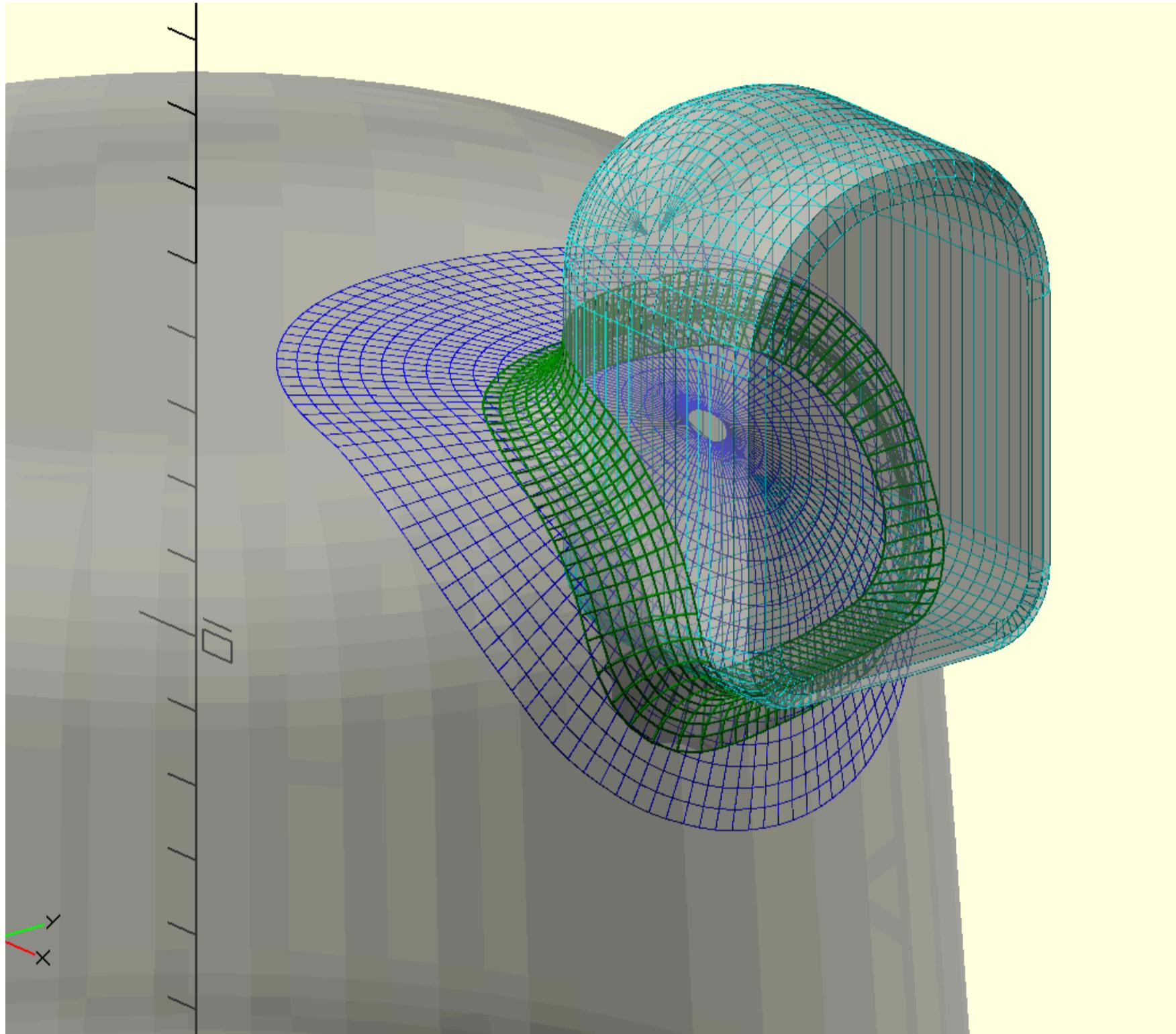
'''
```

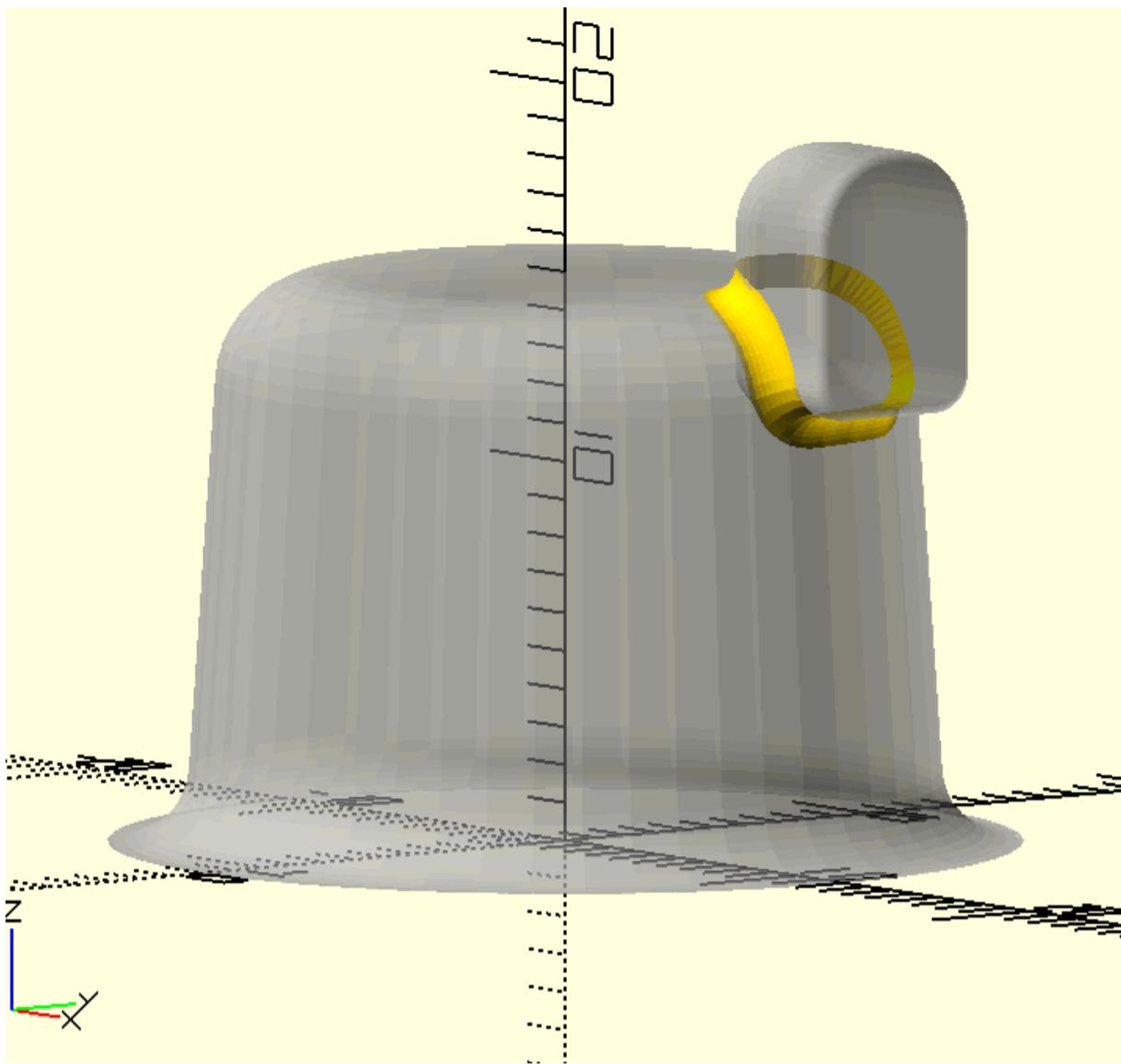
```
t1=time.time()
```

```
t1-t0
```

```
/Users/sanjeevprabhakar/python_openscad/openscad2.py:4497: RuntimeWarning: invalid value encountered in divide
  t=einsum('kl,ijkl->ijk',cross(p01,p02),la[:, :,None]-p0)/(einsum('ijl,kl->ijk',(-lab),cross(p01,p02))+.00000)
/Users/sanjeevprabhakar/python_openscad/openscad2.py:4498: RuntimeWarning: divide by zero encountered in divide
  u=einsum('ijkl,ijkl->ijk',cross(p02[None,None,:,:],(-lab)[:, :,None,:]),(la[:, :,None,:]-p0[None,None,:,:]))/(einsum('ijl,kl->ijk',(-lab),cross(p01,p02))+.00000)
/Users/sanjeevprabhakar/python_openscad/openscad2.py:4499: RuntimeWarning: divide by zero encountered in divide
  v=einsum('ijkl,ijkl->ijk',cross((-lab)[:, :,None,:],p01[None,None,:,:]),(la[:, :,None,:]-p0[None,None,:,:]))/(einsum('ijl,kl->ijk',(-lab),cross(p01,p02))+.00000)
/Users/sanjeevprabhakar/python_openscad/openscad2.py:4499: RuntimeWarning: invalid value encountered in divide
  w=einsum('ijkl,ijkl->ijk',cross((-lab)[:, :,None,:],p01[None,None,:,:]),(la[:, :,None,:]-p0[None,None,:,:]))/(einsum('ijl,kl->ijk',(-lab),cross(p01,p02))+.00000)
/Users/sanjeevprabhakar/python_openscad/openscad2.py:4500: RuntimeWarning: invalid value encountered in add
  condition=(t>=0)&(t<=1)&(u>=0)&(u<=1)&(v>=0)&(v<=1)&(u+v<1)
```

```
Out[183... 4.154107093811035
```



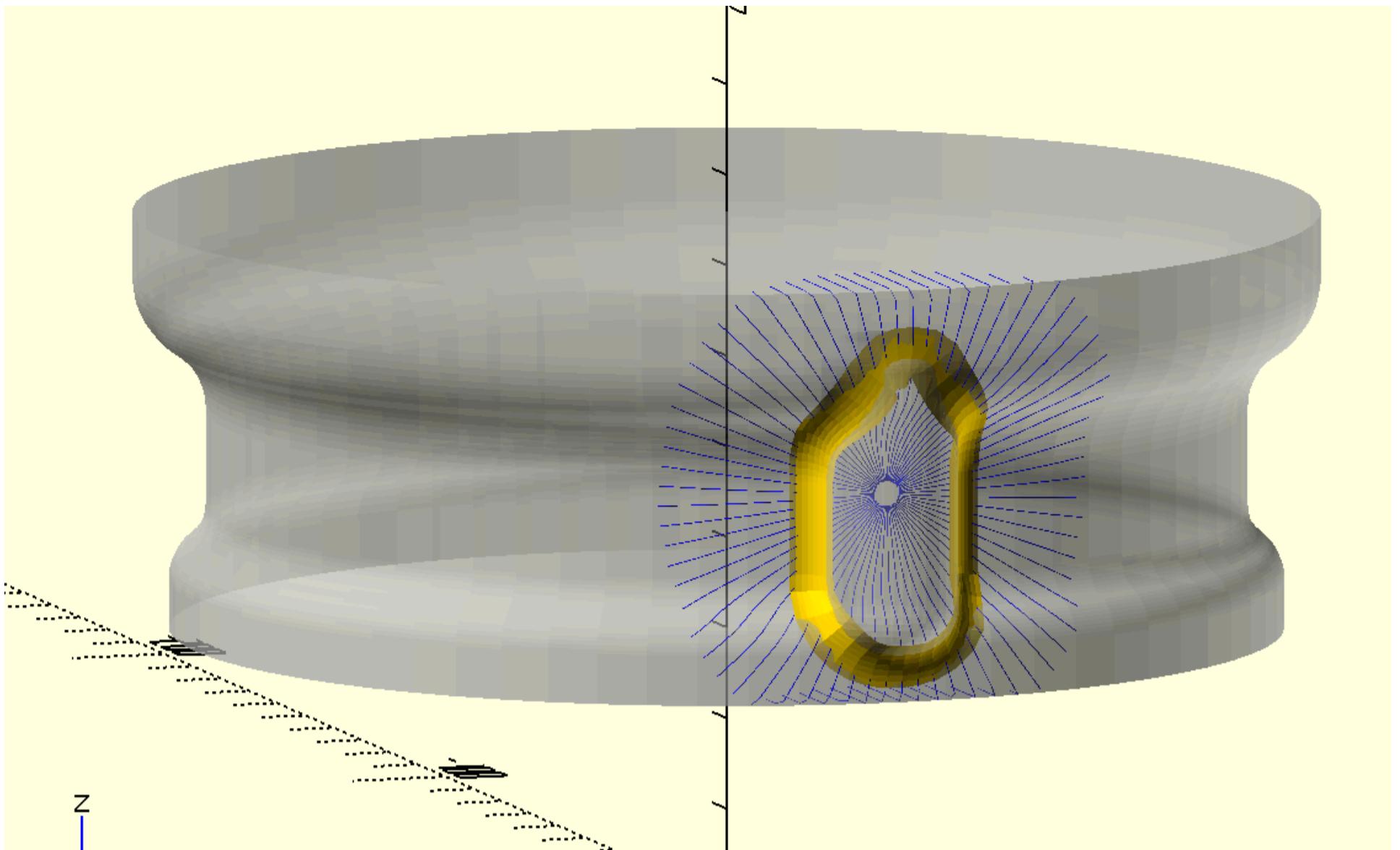


```
In [184...]  
t0=time.time()  
sec1=circle(55,s=70)  
path1=corner_radius(pts1([[-50,30],[56,0],[0,8,5],[-4,3,5],[0,18,10],[8,5,10],[0,12],[-50,0]]),10)  
sol1=rot('z0',f_prism(sec1,path1))  
  
sec2=circle(7.5)  
path2=corner_radius(pts1([[-5,0],[5,0,5],[0,35,3],[-4,0]]),10)  
sol2=translate([58,0,35],f_prism(sec2,path2))  
  
surf1=surface_for_fillet(sol1,sol2,70,20,5,200,50)  
  
fillet1=fillet_sol2sol(sol2,surf1,4)  
fileopen(f'''  
%{swp(sol1)}  
%{swp(sol2)}  
  
color("blue")for(p={cpo(surf1)})p_line3d(p,.05);  
{swp_c(fillet1)}  
'''')  
t1=time.time()  
total=t1-t0  
total
```

/Users/sanjeevprabhakar/python_openscad/openscad2.py:2391: RuntimeWarning: invalid value encountered in arcsin
a=arcsin(r1/d1)*180/pi

Out[184...]

1.4998891353607178



i_line_fillet

```
In [185...]
i_t=time.time()
sec1=circle(55)
path1=corner_radius(pts1([[-50,0],[50,0,.2],[0,30,3],[6,1,3],[0,6,3],[-4,2,3],[0,22,6],[8,2,6],[0,10,.2],[-50,0]]),10)
# path1=equidistant_path(path1,200)
sec2=circle(7.5)
path2=corner_radius(pts1([-5,0],[5,0,5],[0,35,2],[-5,0])),10)
path2=equidistant_path(path2,50)
sol1=f_prism(sec1,path1)
sol2=translate([57.5,0,37],f_prism(sec2,path2))
sol2=axis_rot_o([0,0,1],sol2,180)
p1=ip_sol2sol(sol1,cpo(sol2))
p2=ip_sol2sol(sol1,cpo(sol2),-1)
p3=flip(p1)+p2

fillet1=i_line_fillet_closed(p3,sol1,sol2,-3,3)

fileopen(f'''

%{swp(sol1)}
%{swp(sol2)}

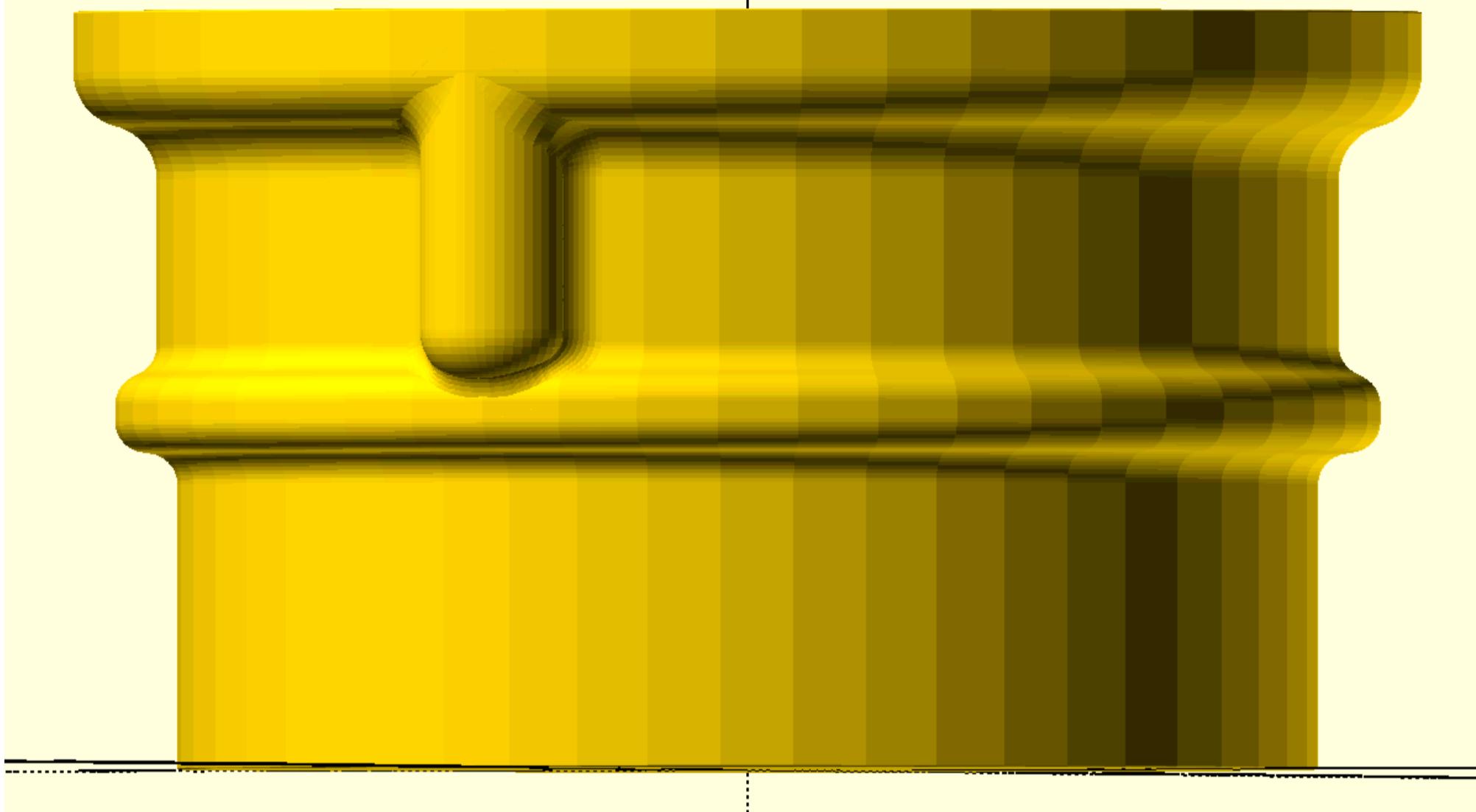
//color("blue")for(p={cpo(sol2)})p_line3d(p,.1,rec=1);
color("magenta")points({p1},.3);
color("magenta")points({p2},.3);
color("cyan")p_line3dc({p3},.1,rec=1);
{swp_c(fillet1)}

'''')

f_t=time.time()
f_t-i_t
# len(p1),len(p2),len(p3)
```

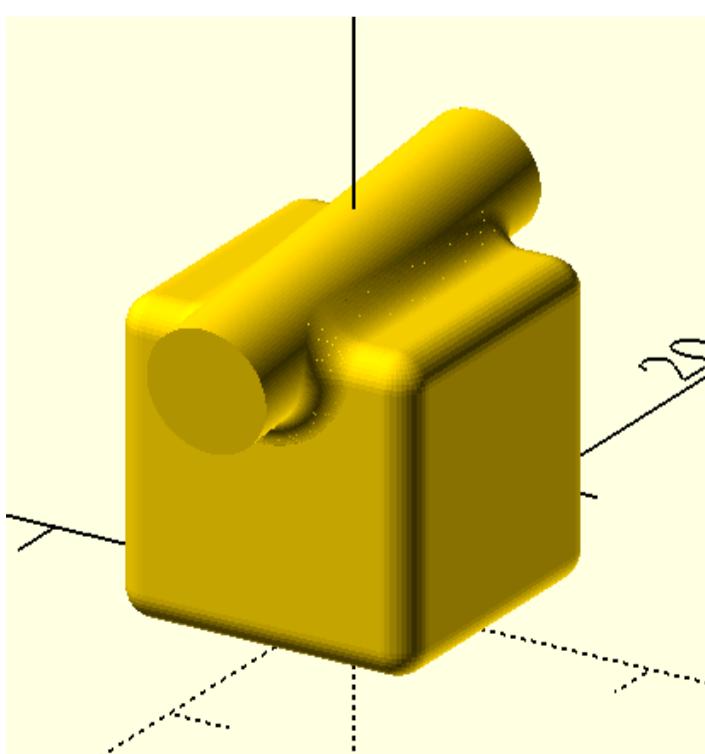
Out[185...]

10.252601861953735



```
In [186]:  
i_t=time.time()  
sec=corner_radius(pts1([[-5,-5,1],[10,0,1],[0,10,1],[-10,0,1]]),10)  
path=corner_radius(pts1([[-4,0],[4,0,1],[0,10,1],[-4,0]]),10)  
  
sol1=prism(sec,path)  
sol2=o_solid([1,0,.1],circle(2,s=100),15,-7,0,10,[-90,0,0])  
# sol2=slice_sol(sol2,2)  
l1=corner_radius_with_turtle([[1,0],[-1,0,1],[0,1]],20)  
a=[prism(sec,path_offset(path,x)) for (x,y) in l1]  
b=[offset_sol(sol2,y) for (x,y) in l1]  
  
fileopen(f'''  
  
{swp(sol1)}  
{swp(sol2)}  
for(i=0:len({a})-2){  
hull(){  
intersection(){  
swp({a}[i]);  
swp({b}[i]);  
}  
intersection(){  
swp({a}[i+1]);  
swp({b}[i+1]);  
}  
}  
'''  
f_t=time.time()  
f_t-i_t
```

Out[186]: 5.79828405380249



```
In [ ]: import sys  
set_printoptions(threshold=sys.maxsize)
```

align_sol_1

In [187...]

```
# merging 2 different shapes
t0=time.time()

sec=corner_radius(pts1([[1.5,8,.9],[2,0,.9],[0,-3,1.4],[3,0,1.4],[0,4,1.9],[-5,0,2.5],[0,6,2.5],
[7,0,2.5],[0,-4,.9],[-2,0,.9],[0,3,1.4],[-3,0,1.4],[0,-4,1.9],
[5,0,2.5],[0,-6,2.5],[-7,0,2.5]]),20)

cp1=array(c2t3(sec)).mean(0)+[0,0,10]
sec=translate(cp1,sec)
sec=c2t3(pts([[-5,-10],[10,0],[0,20],[-10,0]]))

sec=equidistant_pathc(sec,300)
sec1=equidistant_pathc(sec1,300)

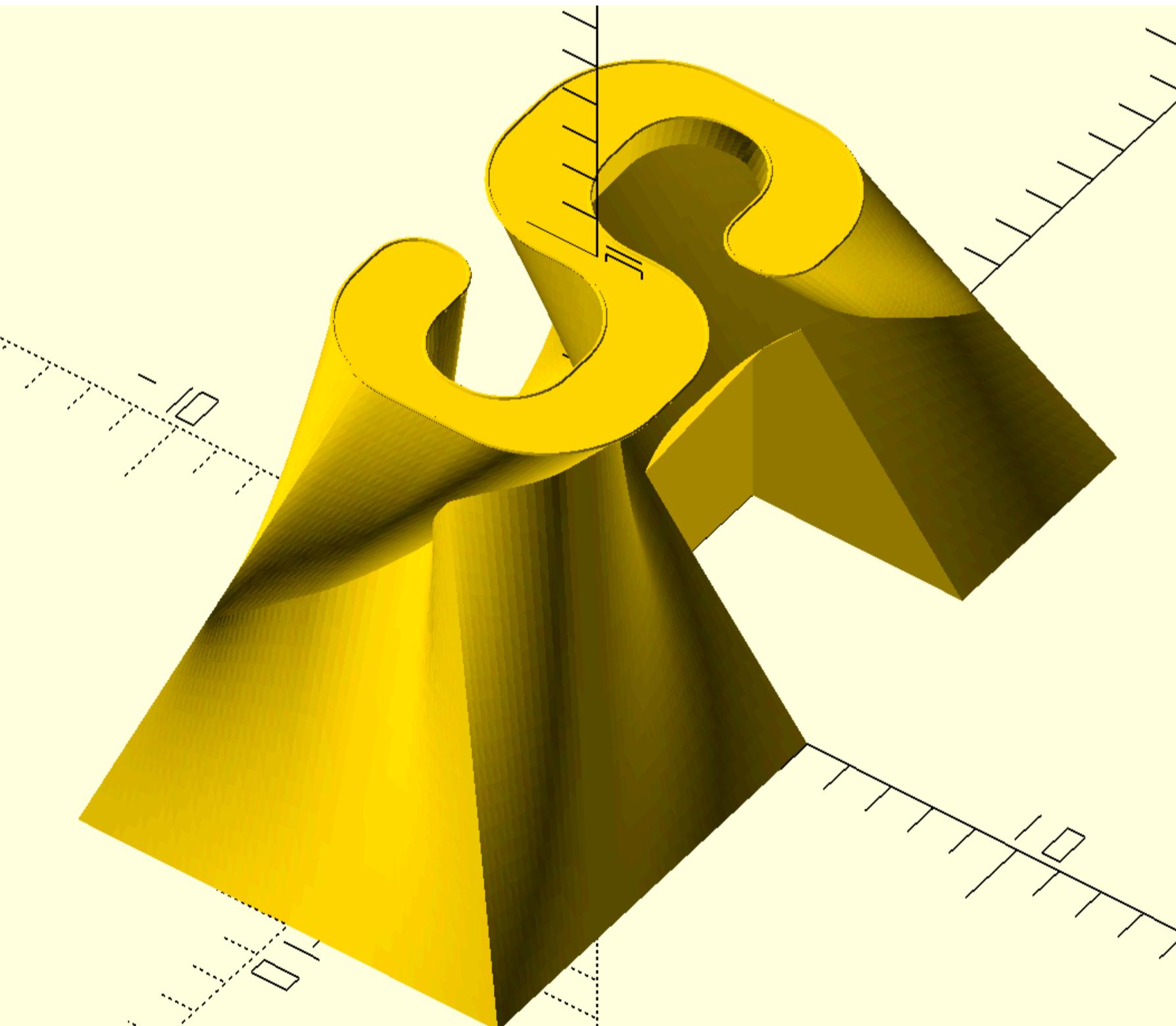
sol=align_sol_1([sec1,sec])
sol=slice_sol(sol,30)
sol1=array(sol).reshape(-1,3)

fileopen(f'''
difference(){
    {swp(sol)}
    translate([0,0,-.01])cube(5);
}

color("blue")p_line3dc({sol[-1]},.05);
''')

t1=time.time()
t1-t0
```

Out[187...]

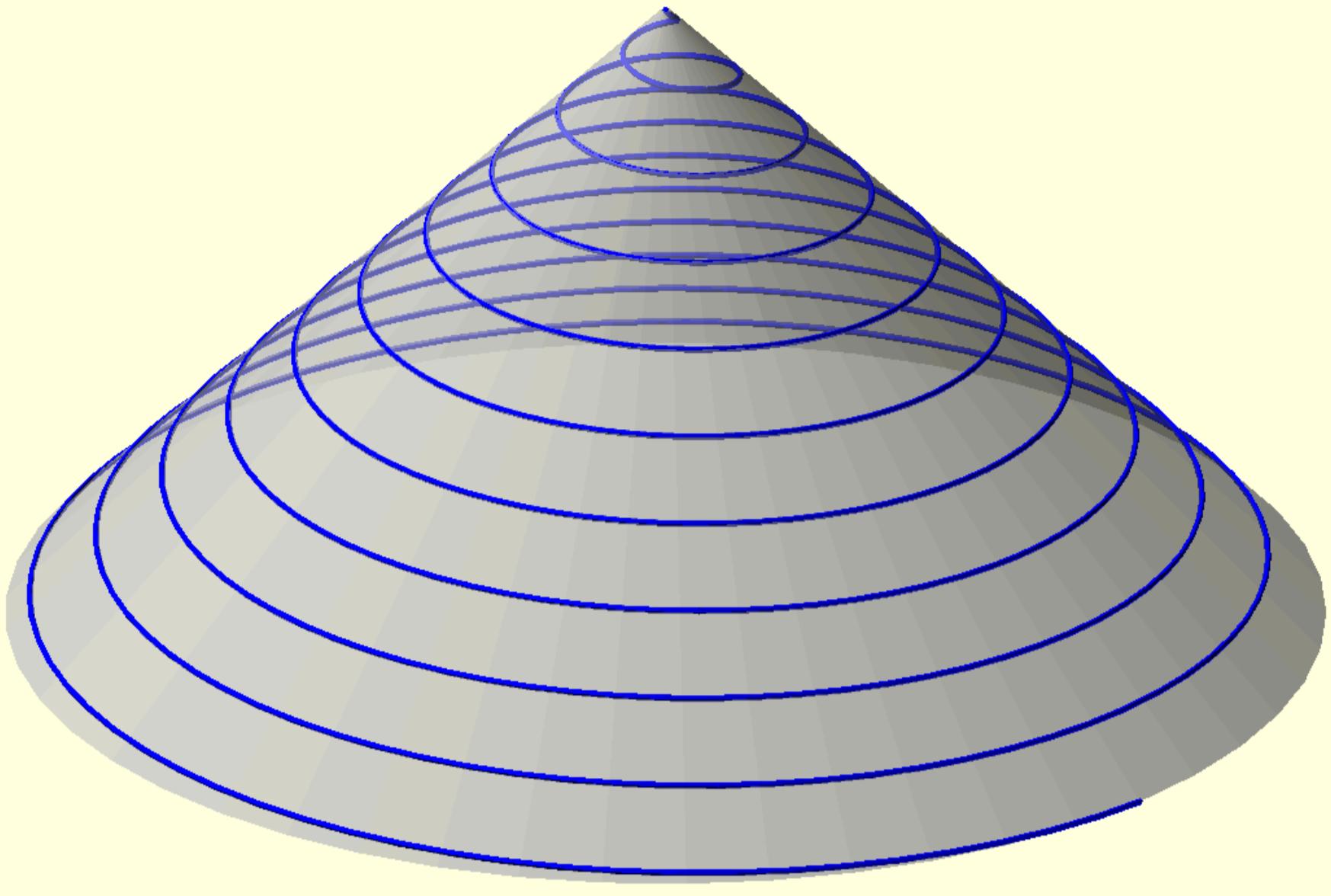


coil-example

In [188...]

```
coil=array([i/360*array([cos(d2r(i)),sin(d2r(i)),-1]) for i in linspace(0,3600,720)]).tolist()
cyl1=translate([0,0,-10],cylinder(r1=10,r2=0.1,h=10))
fileopen(f'''
translate([0,0,10]){{{
color("blue")p_line3d({coil},.05);
%{swp(cyl1)}'''
```

```
}}  
'''
```



```
In [189... x,y=sympy.symbols('x y')
```

```
f1=sympy.lambdify(x,10*sympy.cos(x),'numpy')  
f2=sympy.lambdify(x,10*sympy.sin(x),'numpy')  
  
a=linspace(0,2*pi,100)  
cir1=array([f1(a),f2(a)]).transpose(1,0).tolist()  
  
fileopen(f'''  
    include<dependencies.scad>  
    color("blue")p_line({cir1},.05);  
  
'''')
```

```
In [192... v1x,v1y,v2x,v2y,p0x,p0y,p1x,p1y,t1,t2=sympy.symbols('v1x,v1y,v2x,v2y,p0x,p0y,p1x,p1y,t1,t2')
```

```
p0,v1=array([[2,3],[4,5]])  
p1,v2=array([[10,7],[-3,7]])  
  
# p0+v1*t1=p1+v2*t2  
# v1*t1-v2*t2=p1-p0  
# v1x*t1-v2x*t2=(p1-p0)*x  
# v1.y*t1-v2.y*t2=(p1-p0).y  
  
sympy.linsolve([v1x*t1-v2x*t2-(p1x-p0x),v1y*t1-v2y*t2-(p1y-p0y)],t1,t2)
```

```
Out[192... $displaystyle \left( \left( -\frac{p_0 x v_2 y + p_0 y v_2 x + p_1 x v_2 y - p_1 y v_2 x}{v_1 x v_2 y - v_1 y v_2 x}, -\frac{p_0 x v_1 y + p_0 y v_1 x + p_1 x v_1 y - p_1 y v_1 x}{v_1 x v_2 y - v_1 y v_2 x} \right) \right)
```

```
In [194... # p0+v1*t1=p2+v2*t2+v3*t3  
# v1*t1-v2*t2-v3*t3=p2-p0
```

```
v1x,v1y,v1z,v2x,v2y,v2z,v3x,v3y,v3z,p0x,p0y,p0z,p2x,p2y,p2z,t1,t2,t3= \  
sympy.symbols('v1x,v1y,v1z,v2x,v2y,v2z,v3x,v3y,v3z,p0x,p0y,p0z,p2x,p2y,p2z,t1,t2,t3')  
  
f=sympy.linsolve([v1x*t1-v2x*t2-v3x*t3-(p2x-p0x),v1y*t1-v2y*t2-v3y*t3-(p2y-p0y),v1z*t1-v2z*t2-v3z*t3-(p2z-p0z)],t1,t2,t3)
```

axis_rot_o

```
In [195... t0=time.time()  
sec=corner_radius(pts1([[-5,-5,1],[10,0,1],[0,10,1],[-10,0,1]]),10)
```

```
path=corner_radius(pts1([[-4,0],[4,0,1],[0,10,1],[-4,0]]),10)
```

```
sol1=axis_rot_o([0,1,0],prism(sec,path),90)
```

```
fileopen(f'''
```

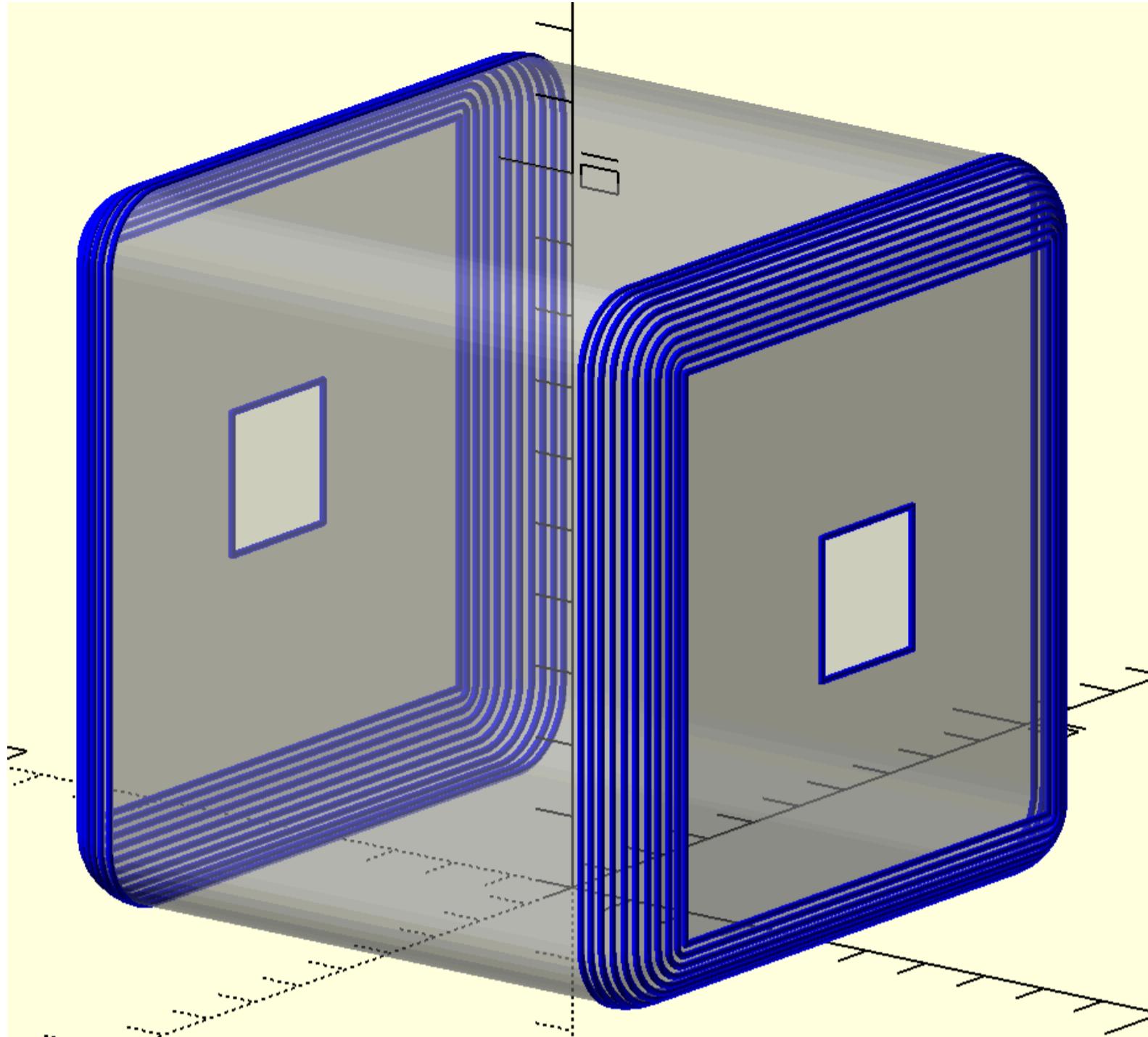
```
%{swp_c(sol1)}  
color("blue")for(p={sol1})p_line3dc(p,.1);
```

```
'''')
```

```
t1=time.time()
```

```
t1-t0
```

Out[195... 0.29108190536499023



In [196... a=random.random(1000)*(10-1)+1
b=random.random(1000)*(10-3)+3

handling-trolley

```
# frame
sec1=circle(12.5)
path1=c2t3(corner_radius(pts1([[0,0,5],[900,0,5],[0,600,5],[-900,0,5]]),10))

sol1=path_extrude_closed(sec1,path1)

path2=cr3dt([[600,0,0,5],[0,600,0,5],[0,0,500,5],[0,-600,0,5]],10)
sol2=align_sol_1(path_extrude_closed(sec1,path2))

sol3=translate([-100,0,0],sol2)

# hinge supports
fillet1=flip(fillet_line_circle([[0,75],[200,75]],circle(40,[100,120]),20,1))
fillet2=fillet_line_circle([[0,75],[200,75]],circle(40,[100,120]),20,3)
arc1=arc_long_2p(fillet1[-1],fillet2[0],40,-1)
sec2=[[0,0],[200,0],[200,75]]+fillet1+arc1+fillet2+[[0,75]]
sol4=translate([450,250,465],rot('x90',linear_extrude(sec2,20)))
sol5=translate([450,350,465],rot('x90',linear_extrude(sec2,20)))

# long arm
x1=o_solid([-1,0,0],circle(30),1800,-900,290,590,[0,0,0])
x2=o_solid([-1,0,0],circle(25),1800,-900,290,590,[0,0,0])
sol6=swp_prism_h(x1,x2)
# sol6=axis_rot_1(sol6,[0,1,0],[550,290,590],10)

# frame
sol7=o_solid([0,1,0],circle(12.5),600,0,100)
sol8=o_solid([0,1,0],circle(12.5),600,0,200)

# cylinder body
x3=o_solid([0,0,1],circle(40),300,135,150,-290)
x4=o_solid([0,0,1],circle(35),300,135,150,-290)
sol9=swp_prism_h(x3,x4)
# sol9=axis_rot_1(sol9,[0,1,0],[150,290,100],1)

# cylinder bottom cover
x5=o_solid([0,0,1],circle(40),20,135,150,-290)
# x5=axis_rot_1(x5,[0,1,0],[150,290,100],1)

# hinge of cylinder
sec1=corner_radius(pts1([-20,-35,20],[40,0,20],[0,70],[-40,0]))
sol10=o_solid([0,1,0],sec1,20,-10+290,150,125-20)
# sol10=axis_rot_1(sol10,[0,1,0],[150,290,100],2)

# piston
x6=o_solid([0,0,1],circle(35),20,175,150,-290)
# x6=axis_rot_1(x6,[0,1,0],[150,290,100],1)
```

```

# piston rod
x7=o_solid([0,0,1],circle(15),350,175,150,-290)
# x7=axis_rot_1(x7,[0,1,0],[150,290,100],1)

# cylinder top cover
x8=o_solid([0,0,1],circle(40),20,425,150,-290)
# x8=axis_rot_1(x8,[0,1,0],[150,290,100],1)

# c-clamp for hinge support
sec1=corner_radius(pts1([[-20,0,20],[40,0,20],[0,260,20],[-40,0,20]]),10)
sec1=equidistant_pathc(sec1,300)
sec2=offset(sec1,-19)

path1=corner_radius(pts1([[0,100],[0,-100,10],[70,0,10],[0,120]]),10)
path1=equidistant_path(path1,300)
path1=translate([0,0,0],rot('x90z90',path1))
fold1=wrap_around(sec1,path1)

fold2=wrap_around(sec2,path1)
surf1=[fold1]+[fold2]
surf2=surf_offset(surf1,-5)
sol11=[surf1[1]]+[surf1[0]]+[surf2[0]]+[surf2[1]]
sol11=translate([150,255,520],sol11)
# sol11=axis_rot_1(sol11,[0,1,0],[550,290,590],10)
# sol11=axis_rot_1(sol11,[0,1,0],[170,290,670],-9)

# c-clamp for counterweight
x9=[surf1[1]]+[surf1[0]]+[surf2[0]]+[surf2[1]]
x9=translate([850,255,520],x9)

# catcher
arc1=c2t3(arc(200,-90,90,s=100))

sol12=path_extrude_open(circle(10),arc1)
sol12=translate([-1090,290,590],sol12)
# sol12=axis_rot_1(sol12,[0,1,0],[550,290,590],10)

# hinge pin c-clamp
sol13=o_solid([0,1,0],circle(5),100,240,150,590)
# sol13=axis_rot_1(sol13,[0,1,0],[550,290,590],10)

# hinge pin cylinder mounting
sol14=o_solid([0,1,0],circle(5),100,240,150,90)

# hinge pin long arm
sol15=o_solid([0,1,0],circle(5),140,220,550,590)

# hinge pin counterweight
x10=o_solid([0,1,0],circle(5),100,240,850,590)

# rod for counterweight
x11=o_solid([0,0,1],circle(15),300,225,850,-290)

# counterweight
s1=corner_radius(pts1([[100,20],[-120,0,19],[0,-40,19],[120,0]]),10)+arc_long_2p([100,-20],[100,20],100,1,50)

x12=o_solid([0,0,1],s1,100,235,850,-290,[90,0,0])

# support for counterweight
x13=o_solid([0,0,1],circle(100),10,225,850,-290)

# trolley wheel
s1=circle(15)
p1=rot('x90',circle(50))
wh=path_extrude_closed(s1,p1)
wh=align_sol_1(wh)
s2=circle(4)
p2=[[-50,0,0],[50,0,0]]
spk=[axis_rot([0,1,0],path_extrude_open(s2,p2),i) for i in linspace(0,360,6)[:-1]]


fileopen(f'''


// frame
swp_c({sol1});
swp_c({sol2});
swp_c({sol3});
swp({sol7});
swp({sol8});

// hinge supports
swp({sol4});
swp({sol5});

for(i=[20,80])
translate([-400,i,-500])
swp({sol4});
swp_c({sol6});

//cylinder body
sol9={sol9};
%swp_c(sol9);
//cylinder bottom cover
x5={x5};
swp(x5);

//hinge for cylinder
swp({sol10});

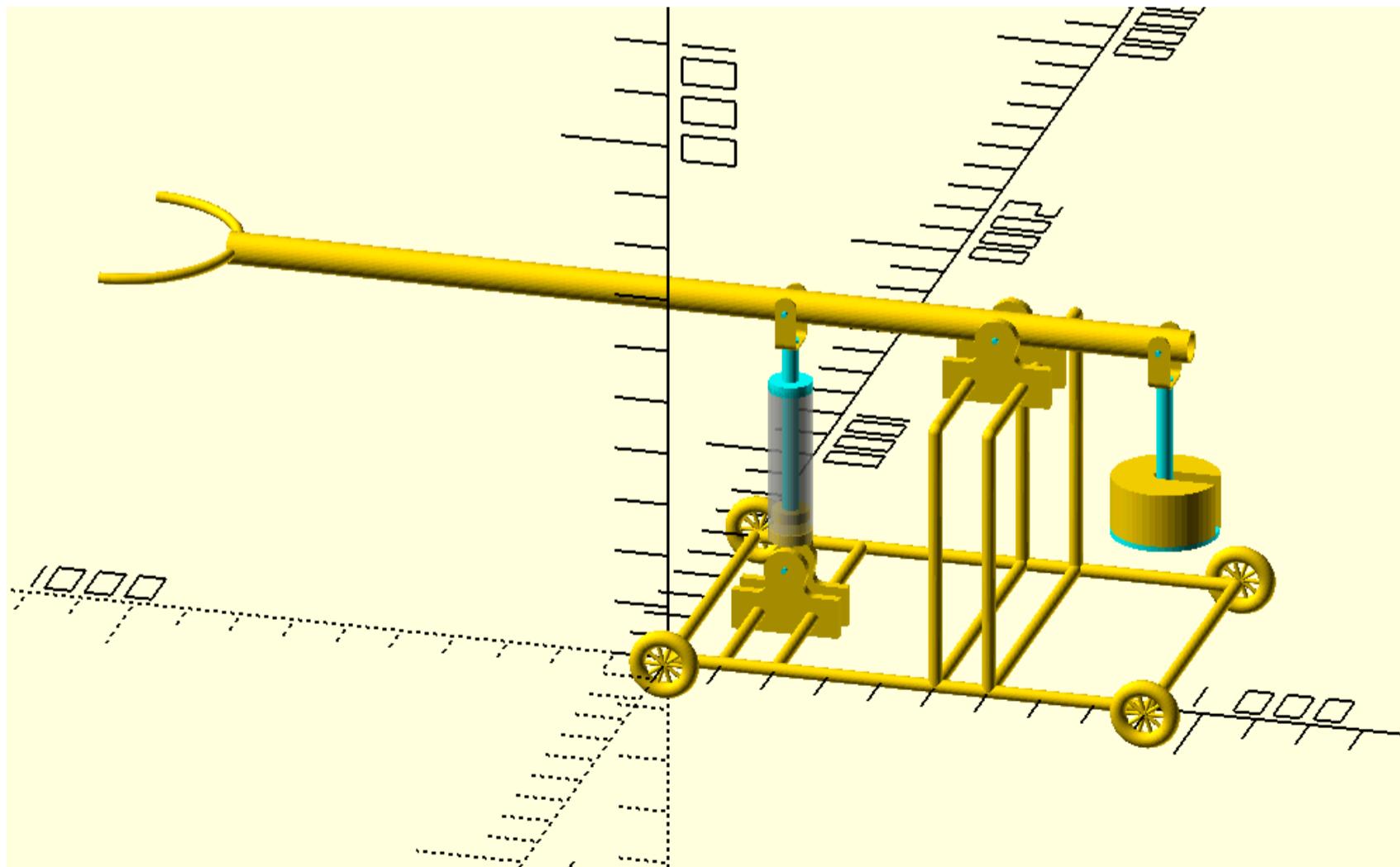
//piston
x6={x6};
swp(x6);

```

```

color("cyan")
union(){{  
//piston rod  
x7={x7};  
swp(x7);  
  
//cylinder top cover  
x8={x8};  
swp(x8);  
}  
  
// c-clamp for pivot point hinge support  
sol11={sol11};  
swp(sol11);  
  
// catcher  
sol12={sol12};  
swp(sol12);  
  
//hinge pin  
sol13={sol13};  
color("cyan")swp(sol13);  
  
//hinge pin cylinder  
sol14={sol14};  
color("cyan")swp(sol14);  
  
//hinge pin long arm  
sol15={sol15};  
color("cyan")swp(sol15);  
  
//c-clamp for counterweight  
x9={x9};  
swp(x9);  
  
// hinge pin counterweight  
x10={x10};  
color("cyan")swp(x10);  
  
// rod for counterweight  
x11={x11};  
color("cyan")swp(x11);  
  
//counterweight  
x12={x12};  
swp(x12);  
  
//counterweight  
x13={x13};  
color("cyan")swp(x13);  
  
//trolley wheels  
for(j=[0,900])  
for(i=[-30,630])  
translate([j,i,0]){{  
swp_c({wh});  
for(p={spk})swp(p);  
}  
}
)

```



r_sec

In [201...]

```
# example of function r_sec(r1,r2,cp1,cp2)  
t0=time.time()
```

```

line=[[1,2],[5,-6]]
r1,r2=5,1

sec1=r_sec(r1,r2,line[0],line[1])

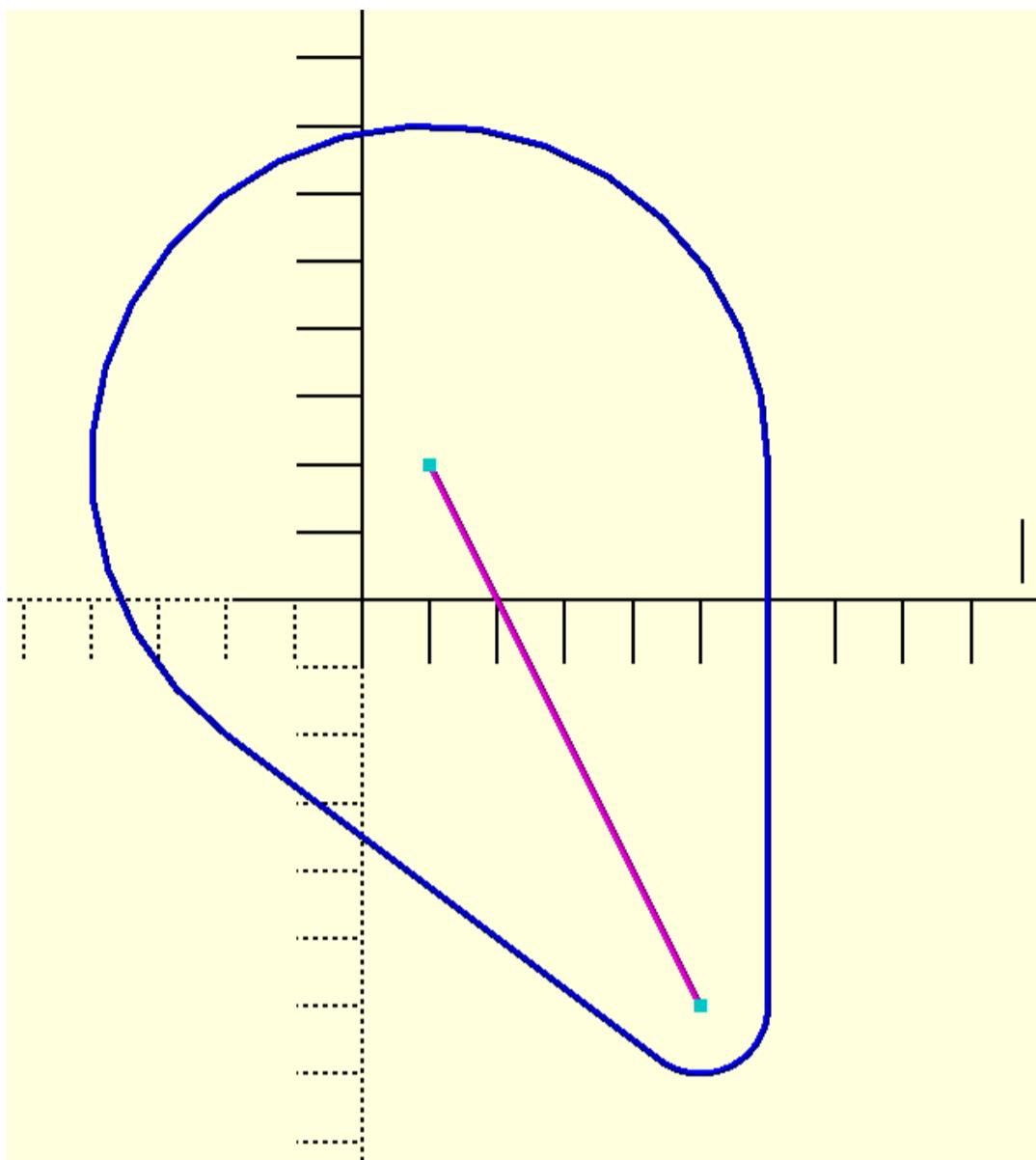
fileopen(f'''

color("blue")p_line3dc({sec1},.1);
color("magenta")p_line3d({line},.1);
color("cyan")points({line},.2);

''' )
t1=time.time()
t1+=t0

```

Out[201... 0.0026597976684570312



3d-knots

```

In [202... # 3d knots various types
t0=time.time()
# trefoil knot

path=[[10*(sin(t)+2*sin(2*t)),
      10*(cos(t)-2*cos(2*t)),
      -10*sin(3*t)] for t in d2r(arange(0,360))]

# circular sin theta knot

# path=[[60*(cos(t)),
#        60*(sin(t)),
#        20*sin(4*t)*cos(4*t)] for t in d2r(arange(0,360))]

# random knot

# path=[[20*(-0.22*cos(t) - 1.28*sin(t) - 0.44*cos(3*t) - 0.78*sin(3*t)),
#        20*(-0.1*cos(2*t) - 0.27*sin(2*t) + 0.38*cos(4*t) + 0.46*sin(4*t)),
#        20*(0.7*cos(3*t) - 0.4*sin(3*t))] for t in d2r(arange(0,360))]

# torus knots

# path=[[10*cos(3*t)*(3+cos(4*t)),
#        10*sin(3*t)*(3+cos(4*t)),
#        10*sin(4*t)] for t in d2r(arange(0,360))]

# cinquefoil torus knots
# a,p,q=3,11,12
# d=10

# explanation
# radius of the torus = a*d
# section radius of the torus = d
# p in number of cycles of the wrapping coil over torus
# q in the number of turns of the wrapping coil over torus

# path=[[d*cos(p*t)*(a+cos(q*t)),
#        d*sin(p*t)*(a+cos(q*t)),
#        -d*sin(q*t)] for t in d2r(arange(0,360,.25))]

# Lissajous knots

# path=[[10*cos(3*t+5),
#        10*sin(3*t+5),
#        10*cos(3*t+10)] for t in d2r(arange(0,360,.25))]
```

```

# 10*cos(3*t+10),
# 10*cos(3*t+2)]for t in d2r(arange(0,360))]
r=4
sec=circle(r)
sol=align_sol_1(path_extrude_closed(sec,path))

# sec1=circle(d-r)
# path1=c2t3(circle(a*d))
# sol1=path_extrude_closed(sec1,path1)

# sol2=o_solid([0,0,-1],circle(38),2,10)
# sol3=o_solid([0,0,-1],circle(20),2,10)
# sol2=swp_prism_h(sol2,sol3)

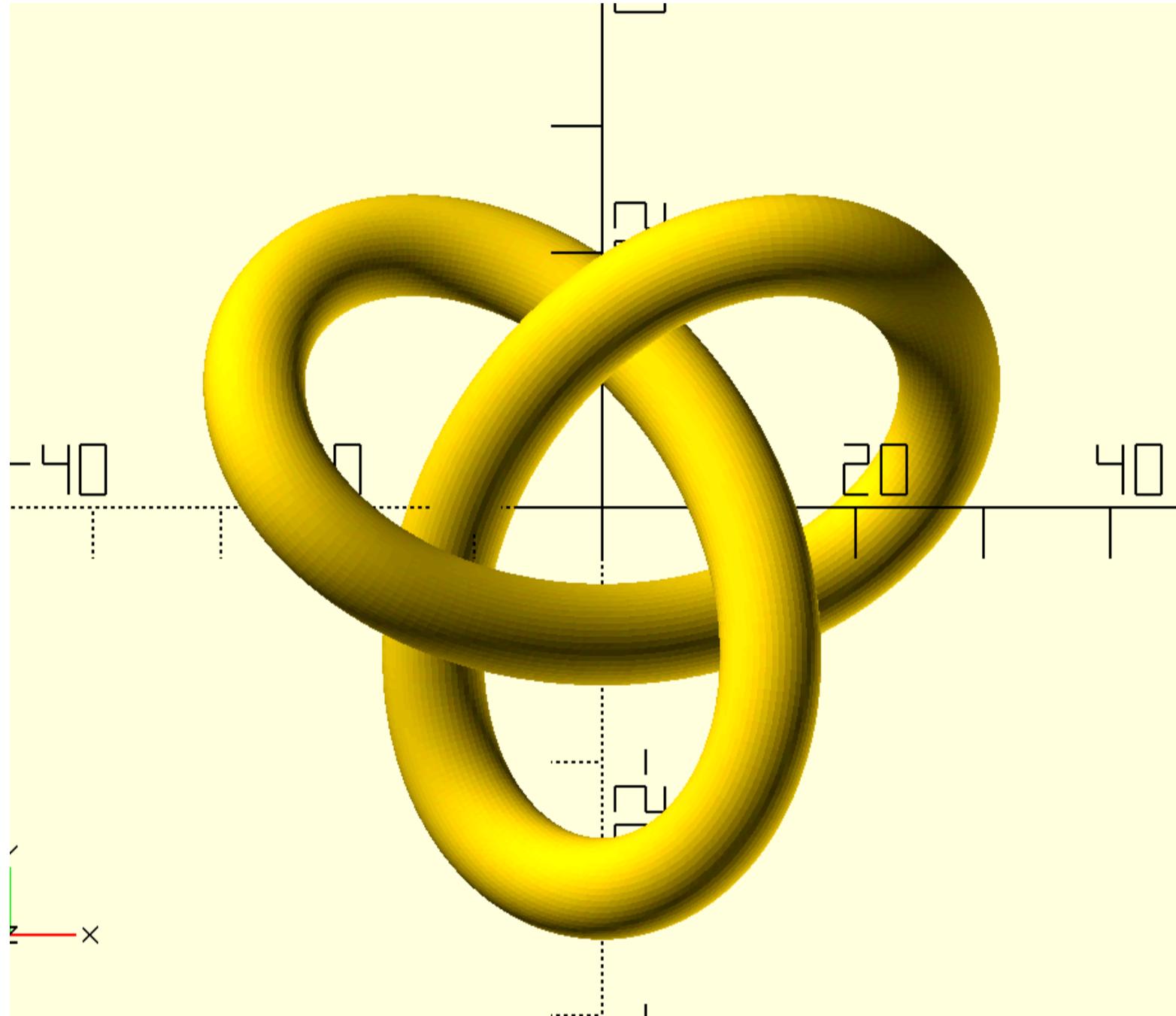
sol1=o_solid([0,0,1],pts([[-50,-50],[100,0],[0,100],[-100,0]]),2,-15)
fileopen(f'''

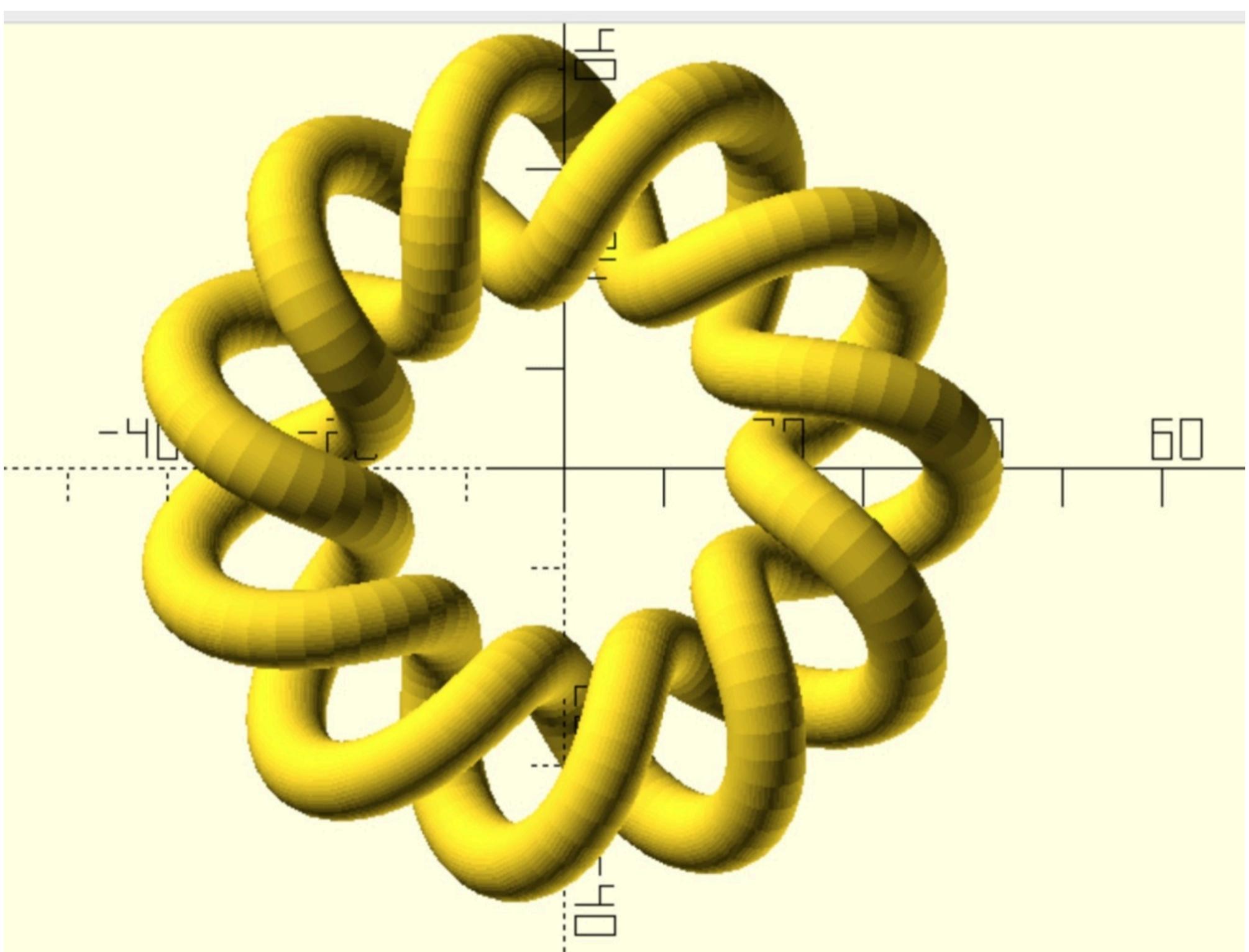
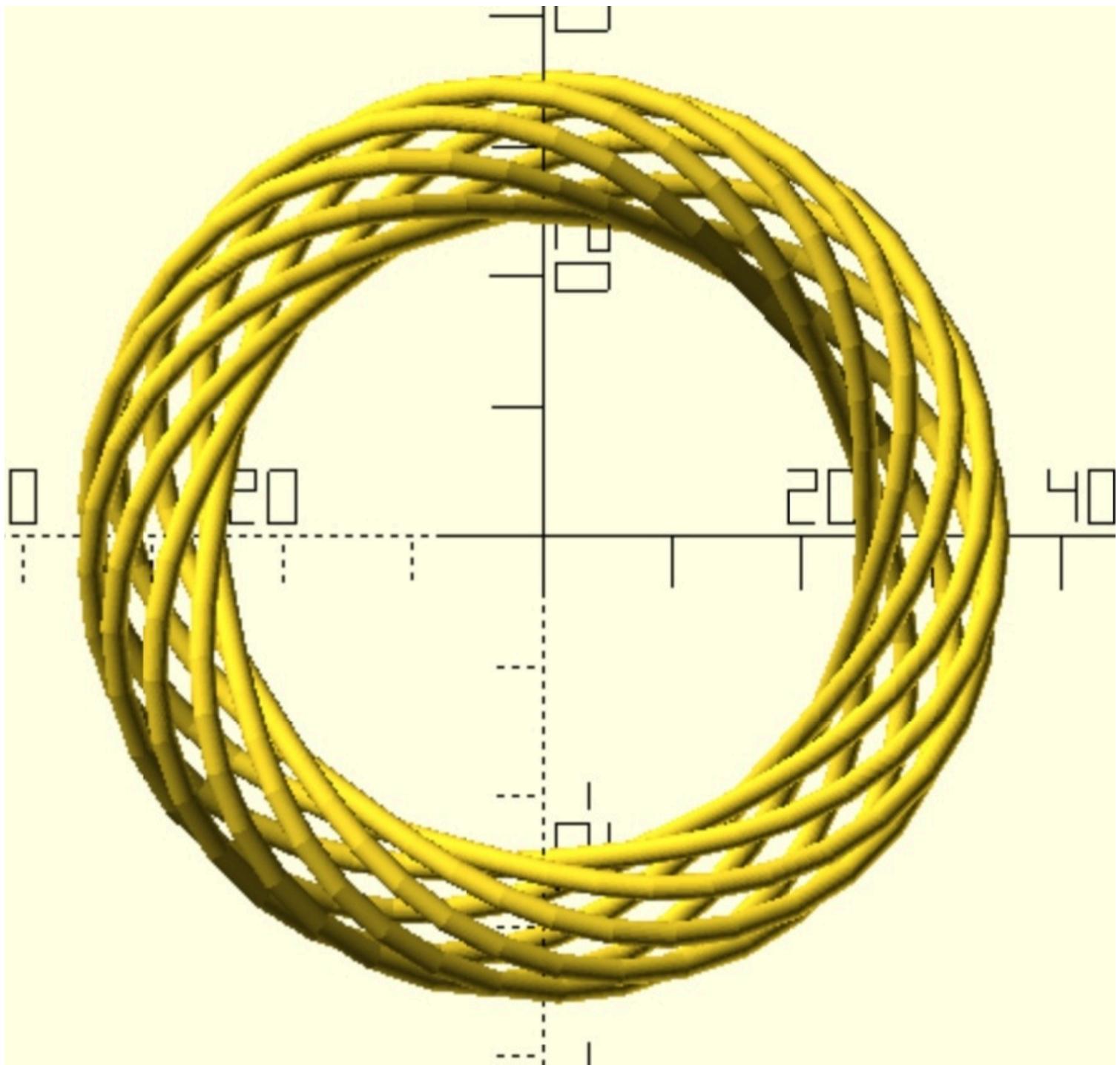
//difference(){{
{swp_c(sol)}
{swp(sol1)}
//{swp(cut_plane([0,-1,0],[100,100],100))}
//} }

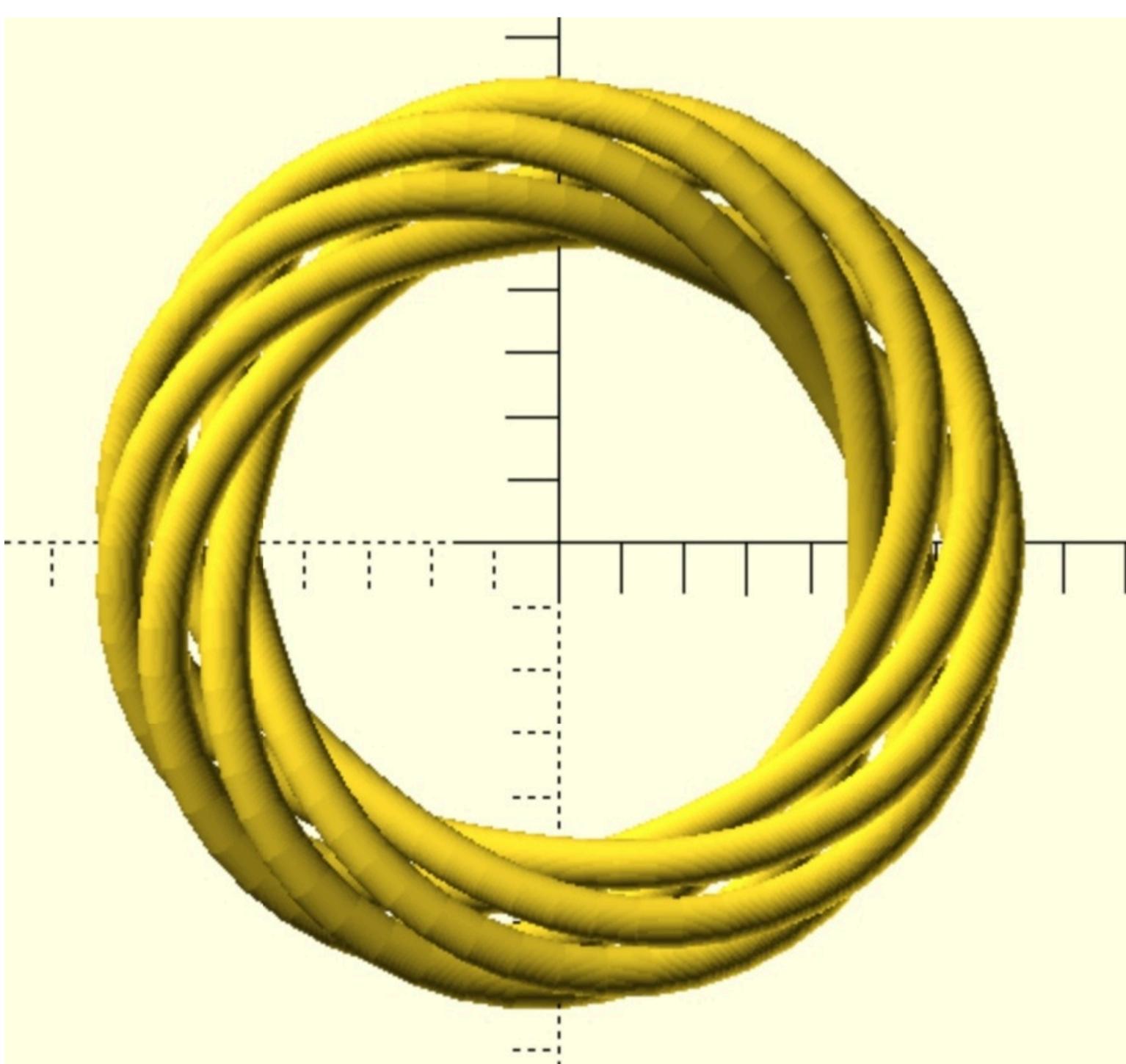
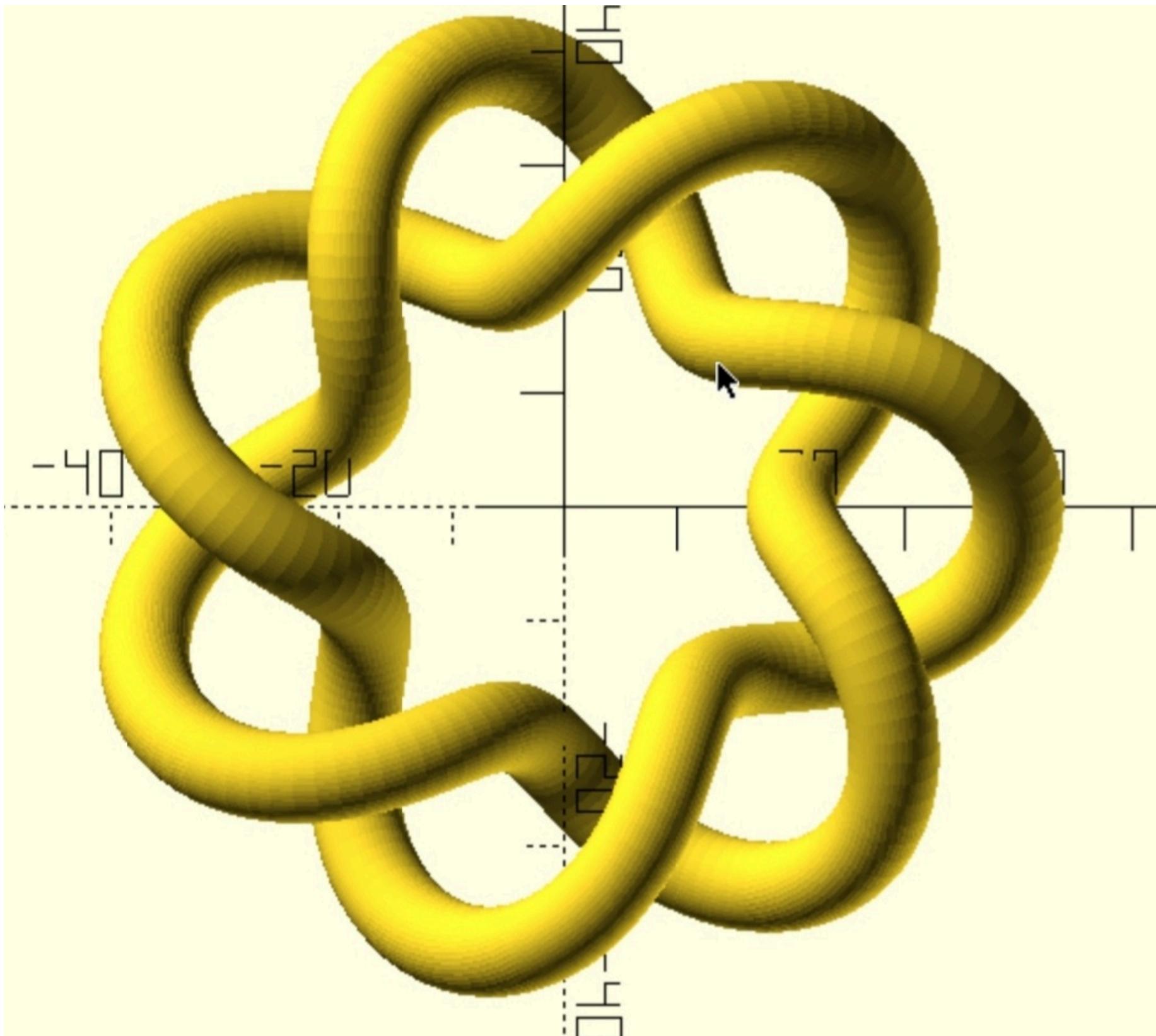
''' )
t1=time.time()
t1-t0

```

Out[202... 1.6599159240722656

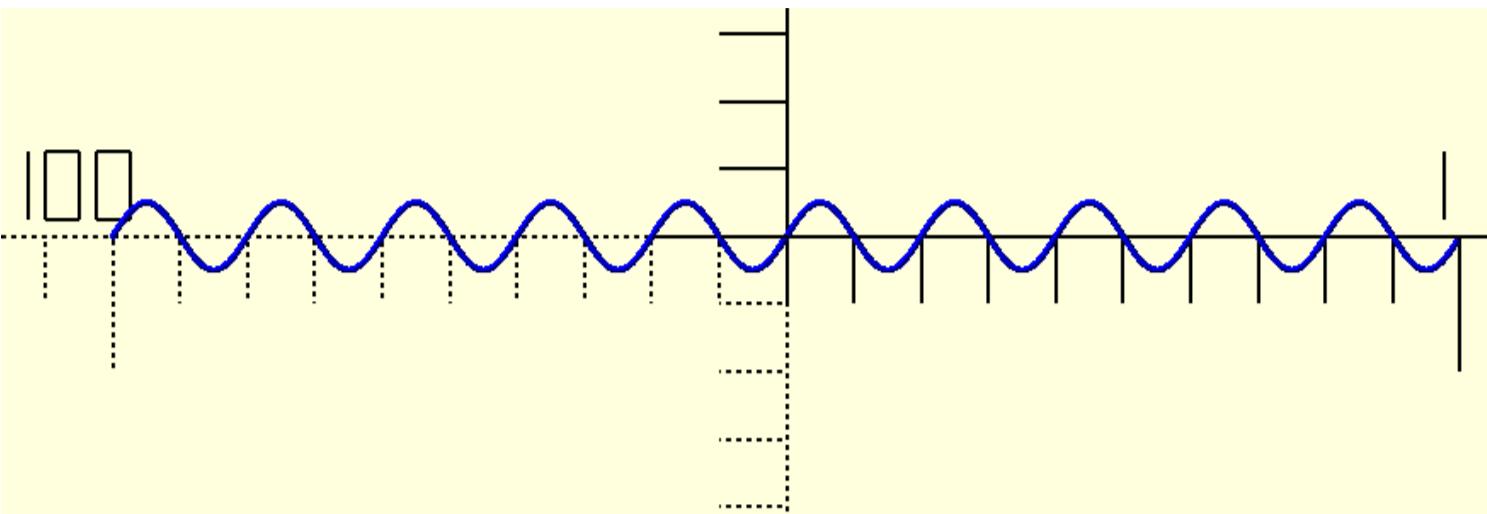






```
In [203...]
# sinwave
# length=200
# starting_point=-100
# number_of_waves=10
# amplitude=5
# a=[[r2d(i)/360*length+starting_point,amplitude*sin(number_of_waves*i)] for i in d2r(arange(0,360))]
a=translate_2d([-100,0],sinewave(200,10,5,100))
fileopen(f'''')
color("blue")p_line3d({a},1);

''')
```



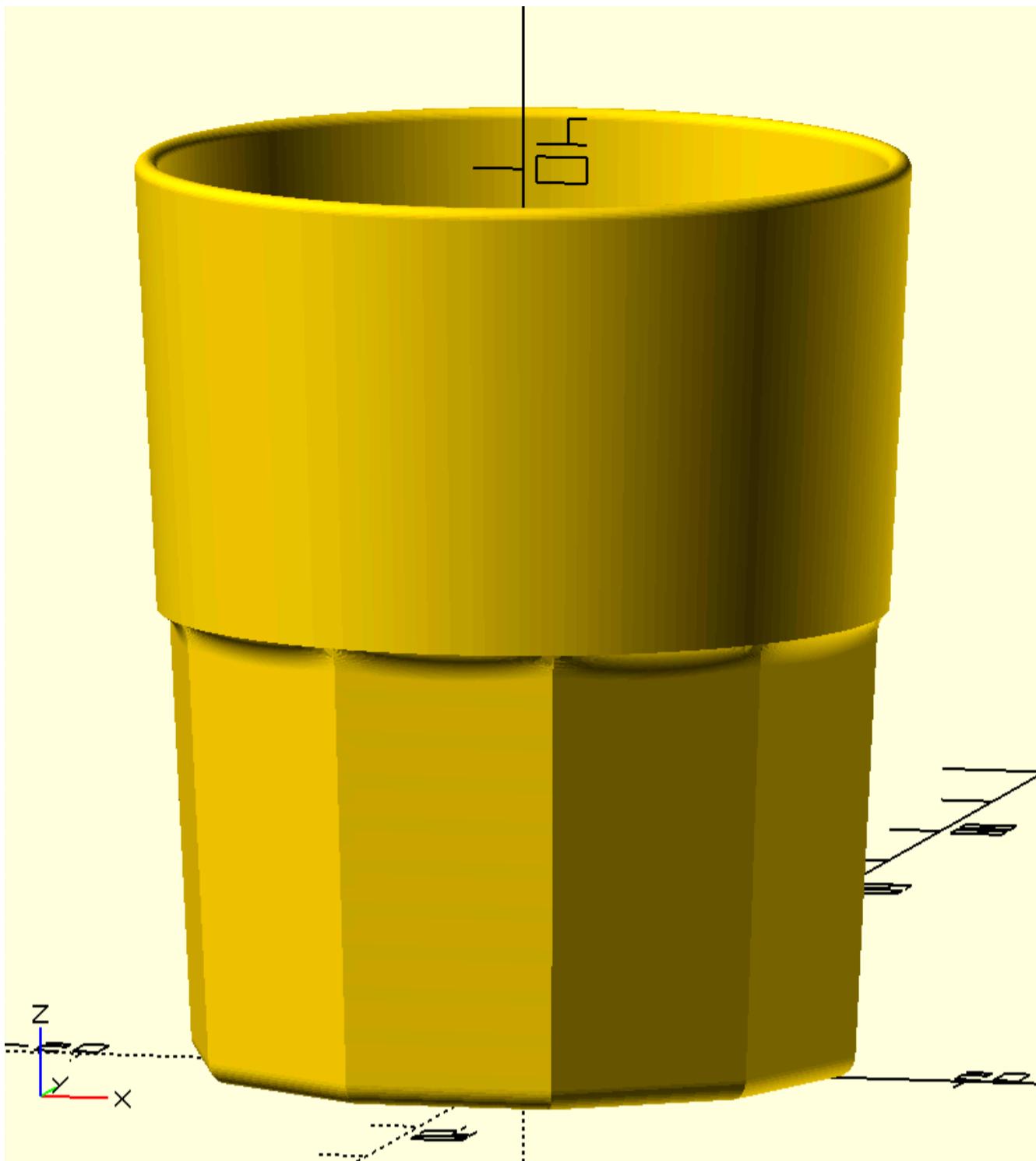
glass-model

```
In [204...]
# glass model
r=15
a1=1/20 #taper of the glass
h1=20
h2=20
s1=10
cir1=circle(r,s=s1+1)
path1=corner_radius(pts1([[-1,0],[1,0,1],[a1*h1,h1]]),10)
sol1=prism(cir1,path1)
sol1=align_sol_1([equidistant_pathc(p,200) for p in sol1])
sol1=slice_sol(sol1,30)

cir2=circle((r+a1*h1)/cos(d2r(360/(s1+1)/4)),s=201)
path2=corner_radius(pts1([[0,h1+.25],[a1*h2,h2,.49],[-1,0,.49],[-a1*h2,-h2,.5],[-.5,-.5,.5],[-a1*(h1-3),-(h1-3),1],[-2,0]]),10)
sol2=prism(cir2,path2)
sol3=sol1+sol2
p0=sol1[-1]
p1=sol2[0]
p2=sol1[-2]
fill=convert_3lines2fillet(p2,p1,p0,s=30)
fill=fill+[fill[0]]
sec=square(100,center=True)
cut1=o_solid([0,-1,0],sec,100,theta=[0,0,10])
fileopen(f'''')

difference(){{
union(){{
{swp(sol3)}
{swp_c(fill)}
}}
}

{swp(cut1)}
}}
'''')
```



rot

```
In [205... line=[[0,0,0],[10,0,0]]
line1=rot('z30x90',line)

pnt=[20,0]
pnt1=rot('z45',pnt)
fileopen(f'''

p_line3d({line},1);
color("blue")p_line3d({line1},1);
color("magenta")points({[pnt]},1);
color("magenta")points({[pnt1]},1);

'''')
```

ang(x,y)

```
In [206... # example of function ang(x,y)
pnt=[20,0]
pnt1=rot('z125',pnt)
ang(pnt1[0],pnt1[1])
```

Out[206... 125.0

l_len

```
In [207... l_len([[0,0,0],[10,0,0]])
```

Out[207... 10.0

l_lenv

```
In [208... l_lenv([[0,0,0],[10,0,0],[10,5,0],[0,5,0]])
```

Out[208... 30.0

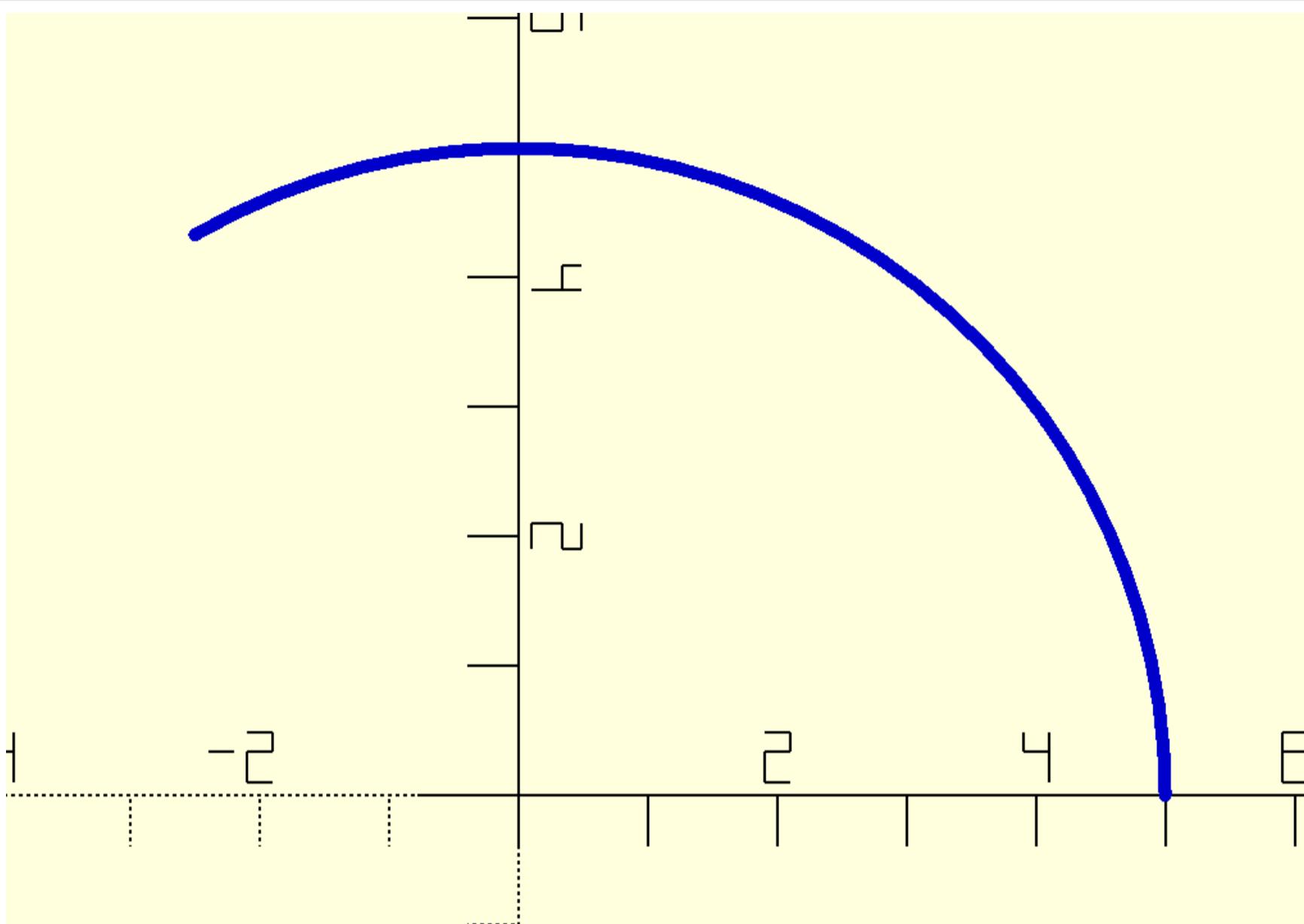
l_lenv_o

```
In [209... l_lenv_o([[0,0,0],[10,0,0],[10,5,0],[0,5,0]])
```

Out[209... 25.0

arc

```
In [210... arc1=arc(radius=5,start_angle=0,end_angle=120,cp=[0,0],s=30)
fileopen(f''''
color("blue")p_lineo({arc1},.1);
'''')
```



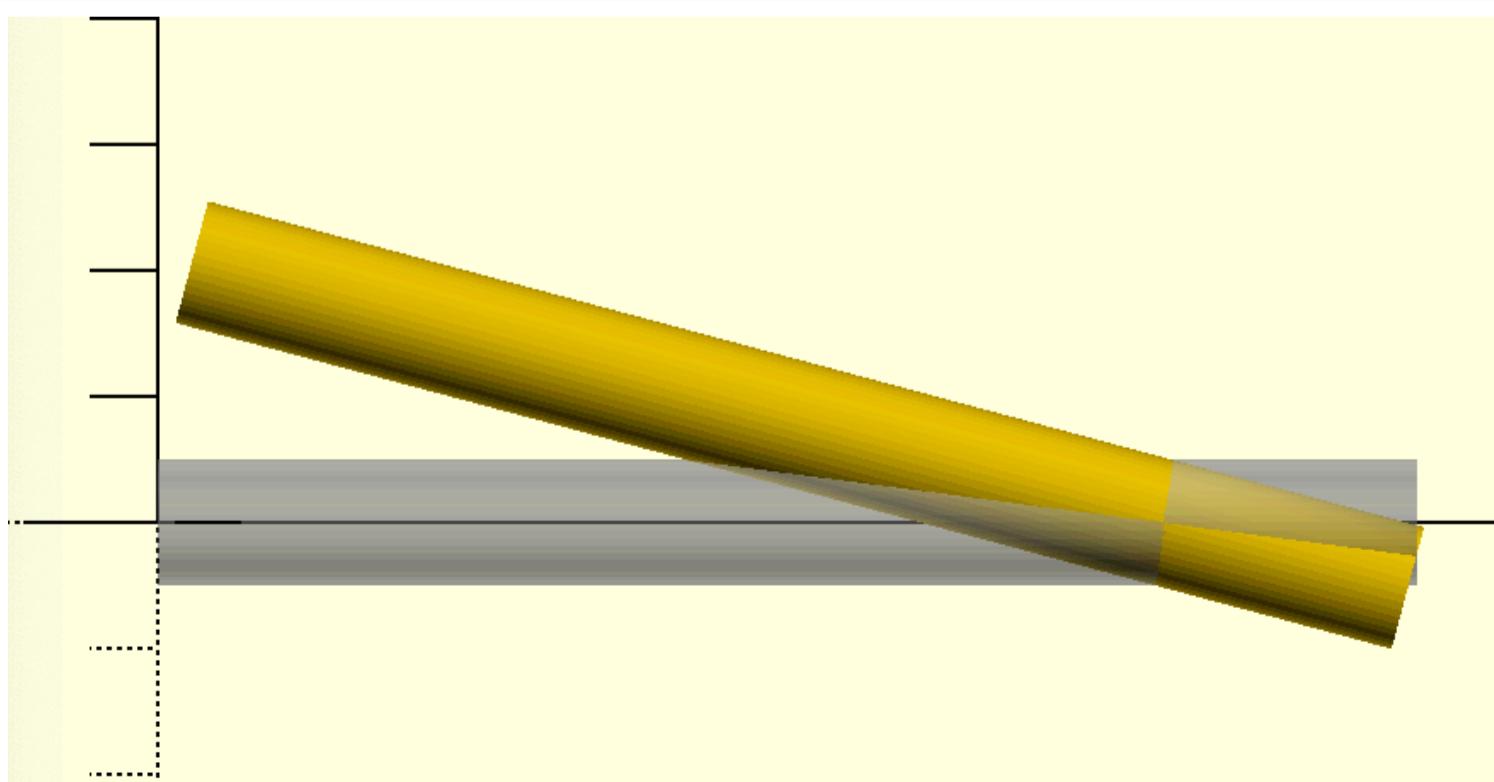
pts

```
In [211... # calculates the cumulative sum of points
pts([[0,0],[4,0],[2,3],[5,-8]])
```

```
Out[211... [[0, 0], [4, 0], [6, 3], [11, -5]]]
```

axis_rot_1

```
In [212... sol=o_solid([1,0,0],circle(5),100)
sol1=axis_rot_1(sol,[0,1,0],[80,0,0],15)
fileopen(f''''
%{swp(sol)}
{swp(sol1)}
'''')
```



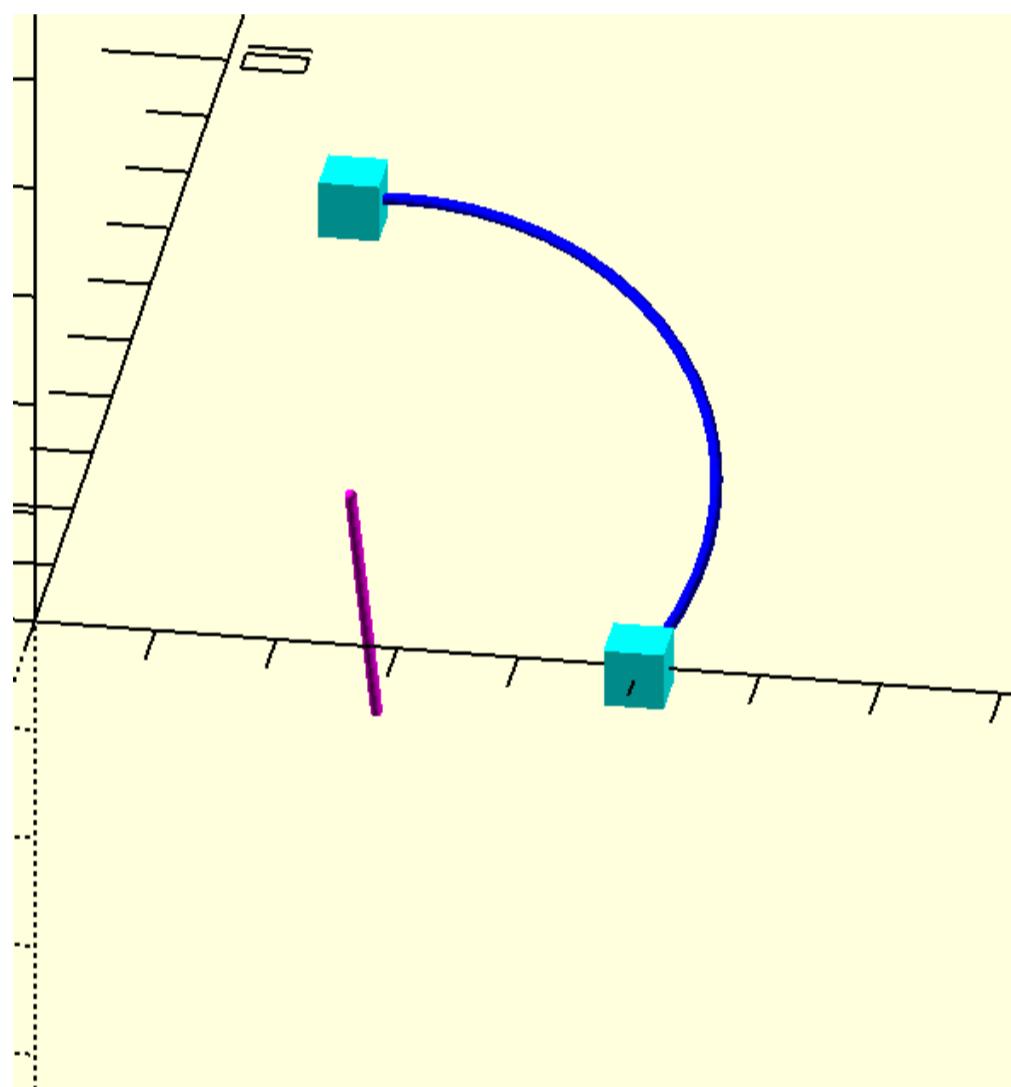
arc_2p_3d

arc_2p_3p_cp

In [213...]

```
'''  
    draws an arc through 2 points  
    n1: normal vector to define plane on which the arc will be drawn  
    r: radius of the arc  
    cw: '1' stands for clockwise and '-1' stands for counter-clockwise  
    's' is the number of segments of the circle  
p0=[5,0,0]  
p1=[2,4,2]  
p2=[0,0,0]  
n1=nv([p0,p1,p2])  
n2=(array(n1)*3).tolist()  
arc1=arc_2p_3d(n1,p0,p1,3,-1)  
cp=arc_2p_3d_cp(n1,p0,p1,3,-1)  
n_line=[cp,(array(cp)+array(n2)).tolist()]  
  
fileopen(f'''  
  
color("blue")p_line3d({arc1},.1);  
color("magenta")p_line3dc({n_line},.1);  
color("cyan")points({[p0,p1]},.5);  
'''  
n1
```

Out[213...]



c2t3

In [214...]

```
# function to convert 2d to 3d, it just adds the z-coordinate to the points list  
# example:  
list=c2t3([[1,2],[3,4],[6,7]])  
list
```

Out[214...]

```
[[1, 2, 0], [3, 4, 0], [6, 7, 0]]
```

c3t2

In [215...]

```
# function to convert 3d to 2d, it just removes the z-coordinate from the points list  
# example:  
list=c3t2([[1,2,3],[3,4,5],[6,7,8]])  
list
```

Out[215...]

```
[[1, 2], [3, 4], [6, 7]]
```

nv

In [216...]

```
# given 3 points ['p1','p2','p3] function calculates unit normal vector  
# example:  
p1,p2,p3=[1,0,0],[0,10,0],[-5,0,0]  
nv([p1,p2,p3]) #=> [0.0, 0.0, -1.0]
```

Out[216...]

```
[0.0, 0.0, -1.0]
```

cytz

```
In [217... #     function to convert the y co-ordinates to z co-ordinates e.g.[x,y]>[x,0,y]. 2d to 3d coordinate system
list=cytz([[1,2],[3,4],[6,7]])
list
```

```
Out[217... [[1, 0, 2], [3, 0, 4], [6, 0, 7]]]
```

d2r

```
In [218... # function to convert from degrees to radians
d2r(90)
```

```
Out[218... np.float64(1.5707963267948966)
```

r2d

```
In [219... # function to convert from radians to degrees
r2d(1.57079)
```

```
Out[219... np.float64(89.99963750135457)
```

flip

```
In [220... # function to flip the sequence of a list or a list of points
#     example:
list=[1,2,3,4,5]
flipped_list1=flip(list) #=> [5, 4, 3, 2, 1]

list=[[1,2,3],[4,5,6],[7,8,9]]
flipped_list2=flip(list) #=> [[7, 8, 9], [4, 5, 6], [1, 2, 3]]
flipped_list1, flipped_list2
```

```
Out[220... ([5, 4, 3, 2, 1], [[7, 8, 9], [4, 5, 6], [1, 2, 3]])
```

gcd

```
In [221... # calculates the greatest common divisor of 2 numbers 'a','b'
gcd(12,15)
```

```
Out[221... 3
```

lcm

```
In [222... # calculates the least common multiple of 2 numbers 'a','b'
lcm(12,15)
```

```
Out[222... 60.0
```

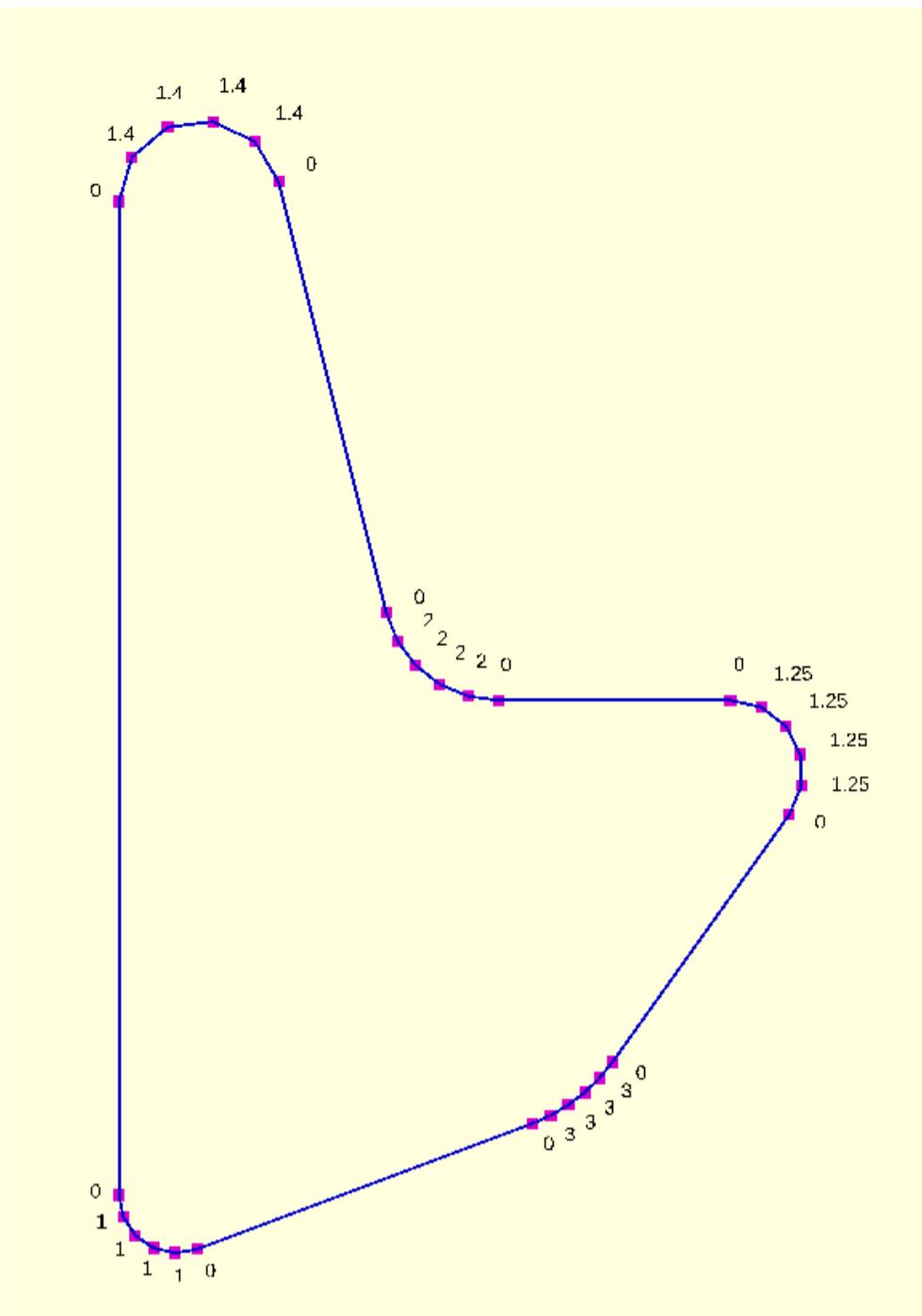
list_r

```
In [223... #     function list the corner radiuses of a given section (only where the radius is specified)
#     example:
sec=corner_radius(pts1([[0,0,1],[8,3,3],[5,7,1.25],[-8,0,2],[-5,20,1.4]]),5)
r1=list_r(sec)
fileopen(f'''

sec={sec};
r1={r1.tolist()};
color("blue")p_line({sec},.05);
color("magenta")points({sec},.2);
color("black")for(i=[0:len(sec)-1])translate({offset(sec,.5)}[i])text(str(r1[i]),.25);

''' )
r1
```

```
Out[223... array([0. , 1. , 1. , 1. , 0. , 0. , 3. , 3. , 3. , 3. ,
       0. , 0. , 1.25, 1.25, 1.25, 1.25, 0. , 0. , 2. , 2. , 2. ,
       2. , 0. , 0. , 1.4 , 1.4 , 1.4 , 1.4 , 0. ])]
```



ls(line,n)

```
In [224... # function to draw number of points 'n' in a line 'line'
#   example:
line=[[0,0],[10,0]]
line1=ls(line,5) #=> [[0.0, 0.0], [2.0, 0.0], [4.0, 0.0], [6.0, 0.0], [8.0, 0.0], [10.0, 0.0]]
line1
```

```
Out[224... [[0.0, 0.0], [2.0, 0.0], [4.0, 0.0], [6.0, 0.0], [8.0, 0.0]]]
```

max_r(sec)

```
In [226... # function calculates the maximum radius in a given closed section
#   example:
sec=cr2dt([[0,0,.2],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]],20)
max_r(sec) #=> 3.0
```

```
Out[226... np.float64(3.0)]
```

arc_long_2p_3d

```
In [227... # draws a long arc through 2 points
#   n1: normal vector to define plane on which the arc will be drawn
#   r: radius of the arc
#   cw: '1' stands for clockwise and '-1' stands for counter-clockwise
#   's' is the number of segments of the circle

p0=[5,0,0]
p1=[2,4,2]
p2=[0,0,0]
n1=nv([p0,p1,p2])
n2=(array(n1)*3).tolist()
arc1=arc_long_2p_3d(n1,p0,p1,10,-1)

cp=arc_2p_3d_cp(n1,p0,p1,10,1)
n_line=[cp,(array(cp)+array(n2)).tolist()]

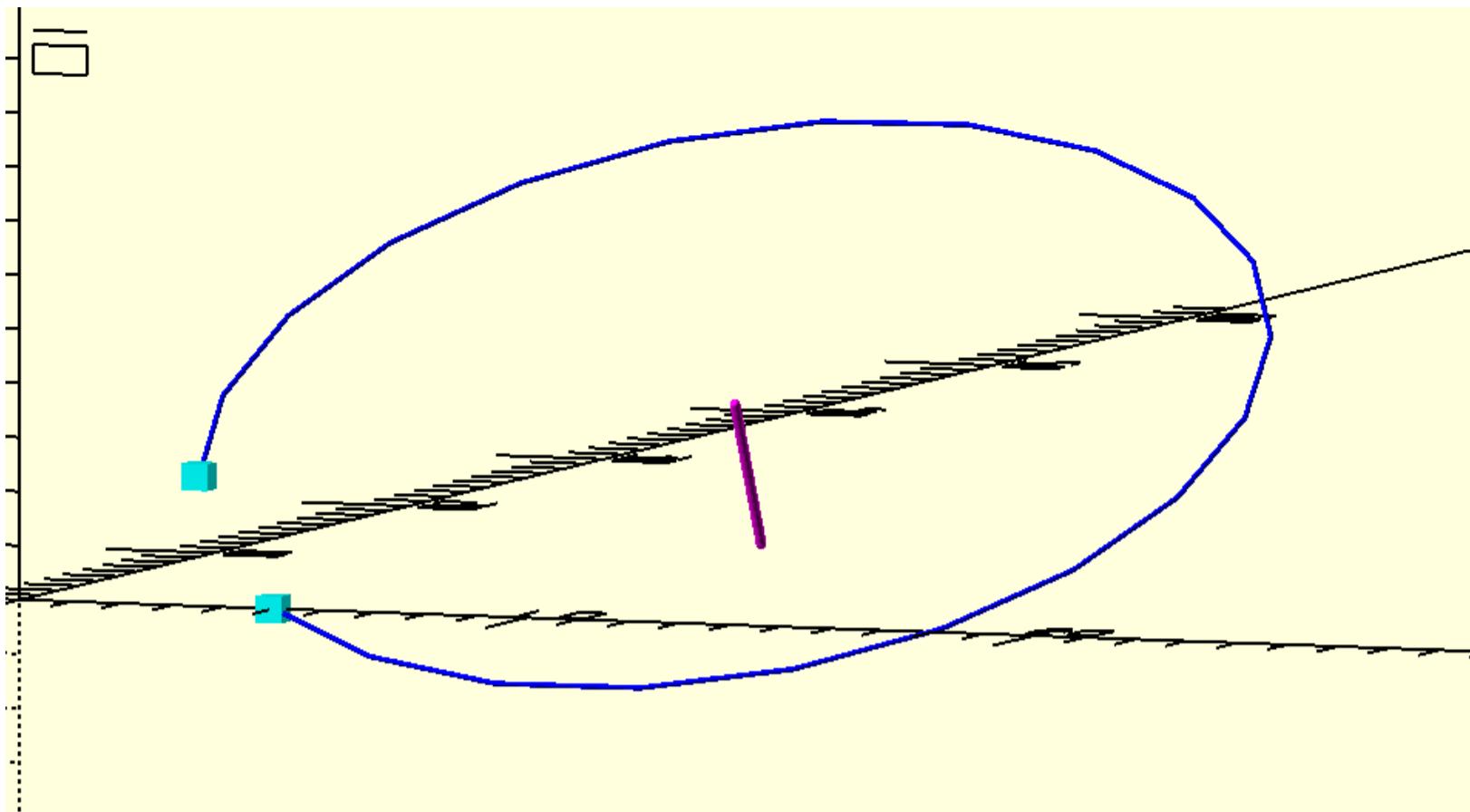
fileopen(f'''
```

color("blue")p_line3d({arc1},.1);

color("magenta")p_line3dc({n_line},.2);

color("cyan")points({[p0,p1]},.5);

```
''' )
```



```
In [228]: t0=time.time()

sec=pts([[0,0],[5,0],[0,5],[-5,0]])
path=corner_radius(pts1([[-2.5,0],[2.5,0,0.25],[0,5.01,0.25],[-2.5,0]]),10)
sol=f_prism(sec,path)

v1=[2,0,7]
sec1=axis_rot([0,0,1],circle(1.5,s=100),90)
sol1=o_solid(v1,sec1,10,-1.5,-2.5,0)
sol2=[ip_sol2line(sol,p)[0] if ip_sol2line(sol,p)!=[] else p[1] for p in cpo(sol1) ]

sol2=translate([.01,0,0.01],[sol1[0]]+[sol2])
fillet1=fillet_sol2sol(sol,sol2,.3,o=1)[:2]
fillet1=flip(fillet1)

sol3=[ip_sol2line(sol,p)[0] if ip_sol2line(sol,p)!=[] else p[1] for p in cpo(flip(sol1))]
sol3=[flip(sol1)[0]]+[sol3]
sol3=translate([0.01,0,-.01],sol3)
fillet2=fillet_sol2sol(sol,sol3,.3)[1:-2]

fillet3=fillet1+fillet2+[fillet1[0]]

fileopen(f'''

{swp(sol)}
{swp(sol1)}
{swp_c(fillet3)}
//{swp_c(fillet2)}
//color("blue")p_line3dc({fillet1[0]},.05);
//color("blue")p_line3dc({fillet2[0]},.05);

''' )
t1=time.time()
t1-t0
```

Out[228]: 0.3690171241760254

ang_2lineccw

```
In [229]: p0=[0,0]
p1=[5,2]
p2=[7,8]

fileopen(f'''

// case 1: counter-clockwise angle between line p1p0 and p1p2 is 229.76 degrees
color("blue")points({[p0,p1,p2]},.2);
color("cyan")p_line3d({[p0,p1,p2]},.1);
color("magenta")translate([0,-.5]){{{
translate({p0})text("p0",.5);
translate({p1})text("p1",.5);
translate({p2})text("p2",.5);
}}}

// case 2: counter-clockwise angle between line p0p1 and p0p2 is 27.01 degrees

translate([10,0,0]){{{
color("blue")points({[p0,p1,p2]},.2);
color("cyan")p_line3d({[p1,p0,p2]},.1);

color("magenta")translate([0,-.5]){{{
translate({p0})text("p0",.5);
translate({p1})text("p1",.5);
translate({p2})text("p2",.5);
}}}
}}}

ang_2lineccw(p1,p0,p2),ang_2lineccw(p0,p1,p2)
```

Out[229]: (229.76364169072616, 27.012665347938547)

ang_2linecw

In [230...]

```
p0=[0,0]
p1=[5,2]
p2=[7,8]

fileopen(f''

// case 1: clockwise angle between line p1p0 and p1p2 is 130.23 degrees
color("blue")points({[p0,p1,p2]},.2);
color("cyan")p_line3d({[p0,p1,p2]},.1);
color("magenta")translate([0,-.5)){{
translate({p0})text("p0",.5);
translate({p1})text("p1",.5);
translate({p2})text("p2",.5);
}};

// case 2: clockwise angle between line p0p1 and p0p2 is 332.98 degrees

translate([10,0,0)){{
color("blue")points({[p0,p1,p2]},.2);
color("cyan")p_line3d({[p1,p0,p2]},.1);

color("magenta")translate([0,-.5)){{
translate({p0})text("p0",.5);
translate({p1})text("p1",.5);
translate({p2})text("p2",.5);
}};

'''')
l_(ang_2linecw(p1,p0,p2)), l_(ang_2linecw(p0,p1,p2))
```

Out[230...]

(130.23635830927384, 332.98733465206146)

cir_2p

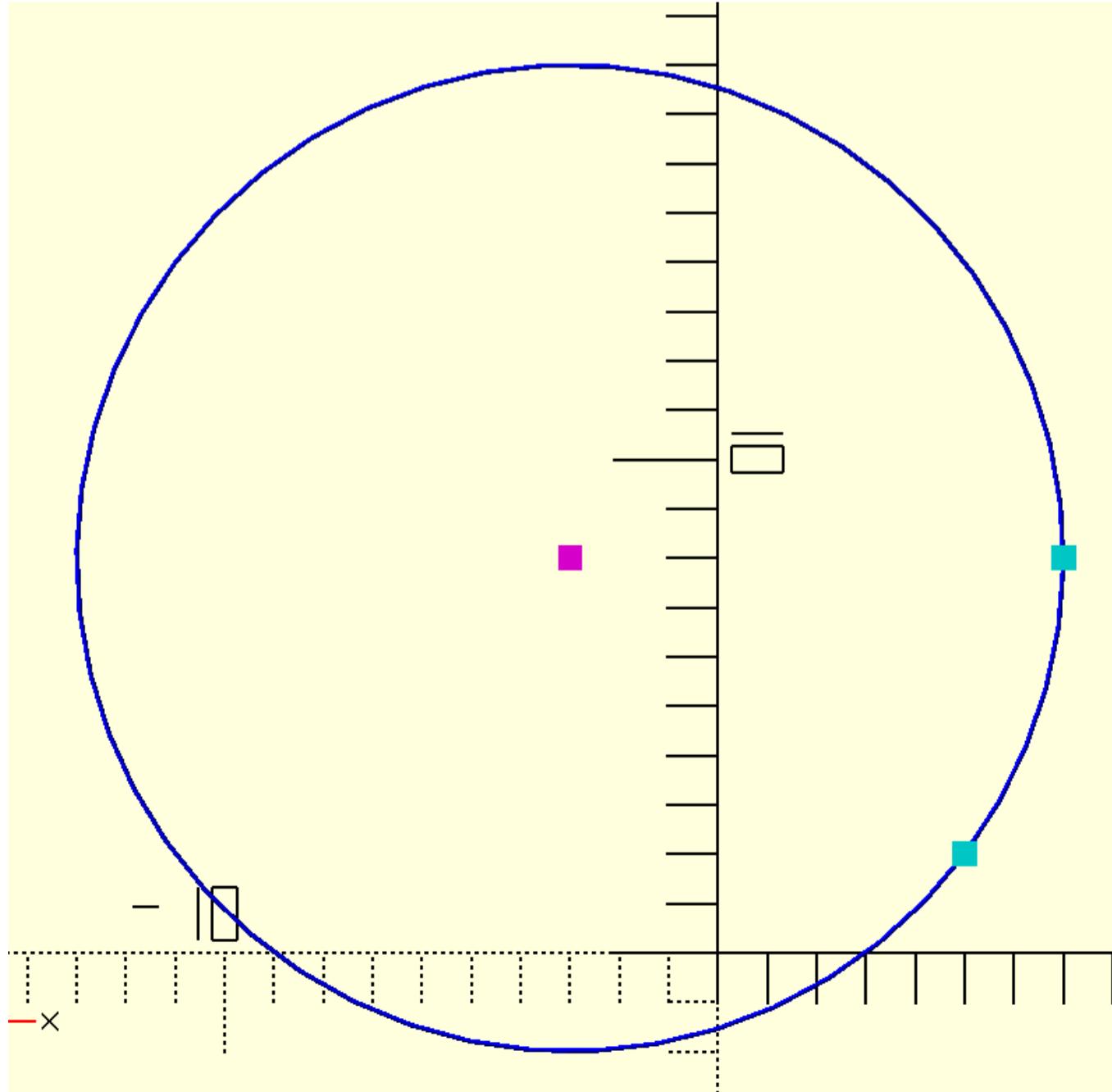
cp_arc

In [231...]

```
p1=[5,2]
p2=[7,8]
r=10
c1=cir_2p(p1,p2,r,cw=-1,s=50)
cp1=cp_arc(c1)
fileopen(f''

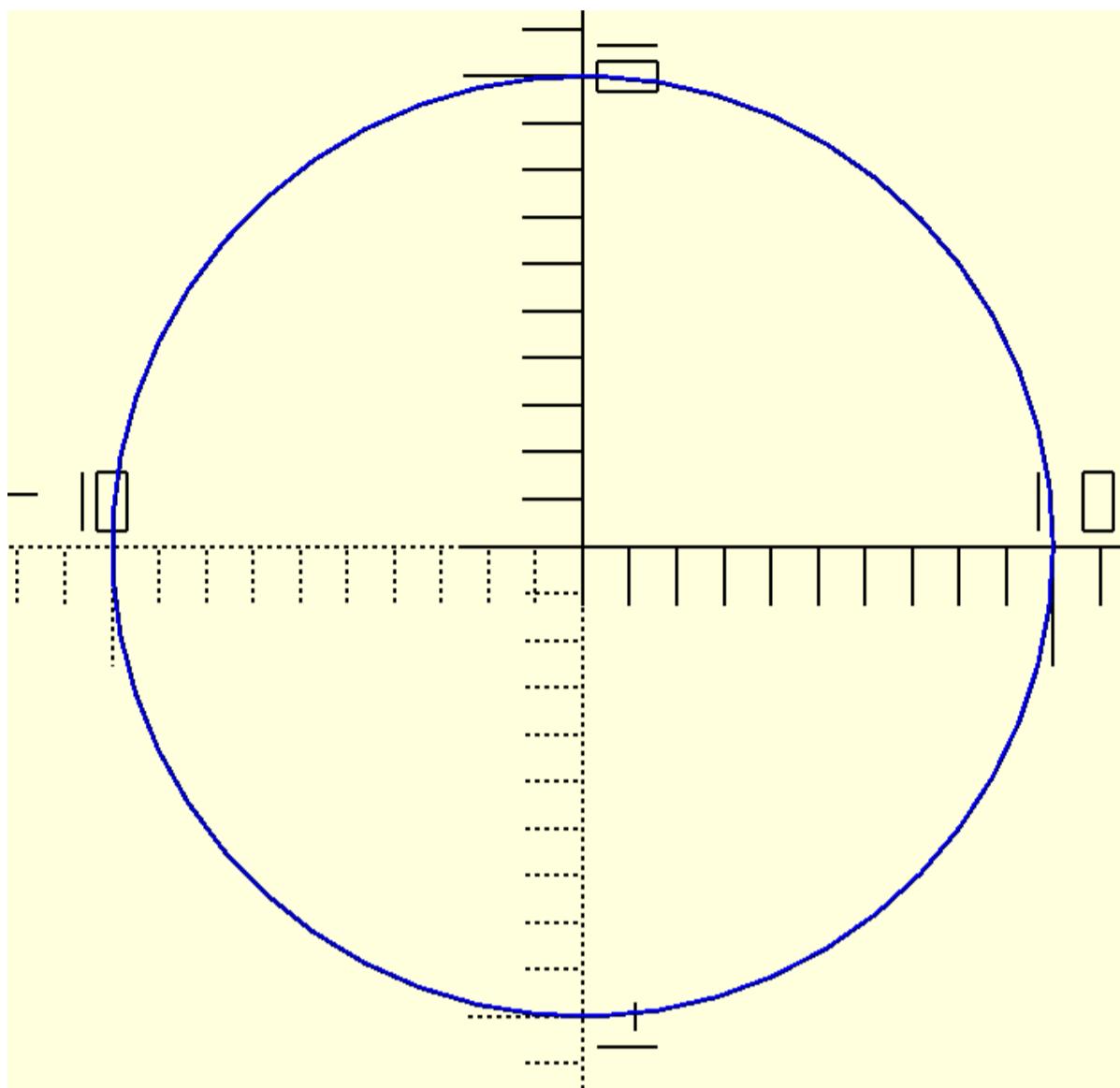
color("cyan")points({[p1,p2]},.5);
color("blue")p_line3dc({c1},.1);
color("magenta")points({[cp1]},.5);

'''')
```



circle

```
In [232... c1=circle(r=10,cp=[0,0],s=50)
fileopen(f''''
color("blue")p_line3dc({c1},.1);
'''')
```



CW

```
In [233... sec=corner_radius(pts1([[0,0,1],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),20)
cw(sec)
```

```
Out[233... -1
```

CWV

```
In [234... sec=corner_radius(pts1([[0,0,1],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),20)
array(cwv(sec))
```

```
Out[234... array([-1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1,
-1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1,
-1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1,
-1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1,
-1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1,
-1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1,
-1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1,
-1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1,
-1, -1, -1])
```

exclude_points

```
In [235... p0=[[0, 1, 2], [3, 4, 5], [6, 7, 8], [9, 10, 11], [12, 13, 14], [15, 16, 17],
[18, 19, 20], [21, 22, 23], [24, 25, 26], [27, 28, 29]]
p1=[[0,1,2], [9,10,11]]
p2=exclude_points(p0,p1)
p2
```

```
Out[235... [[3, 4, 5],
[6, 7, 8],
[12, 13, 14],
[15, 16, 17],
[18, 19, 20],
[21, 22, 23],
[24, 25, 26],
[27, 28, 29]]
```

intersections

```
In [236... sec=corner_radius(pts1([[0,0,1],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),10)
# sec=sec=corner_radius(pts1([[0,0,.1],[7,5,2],[5,7,2],[-5,7,2],[-7,5,3]]),20)
# sec=corner_radius(pts1([[-15,0,2.49],[0,15,3],[30,0,3],[0,-15,2.49],[5,0,2.49],[0,20,7],[-40,0,7],[0,-20,2.49]]),20)
# sec=circle(10)
# sec=pts([[0,0],[10,0],[0,10],[-10,0]])
```

```

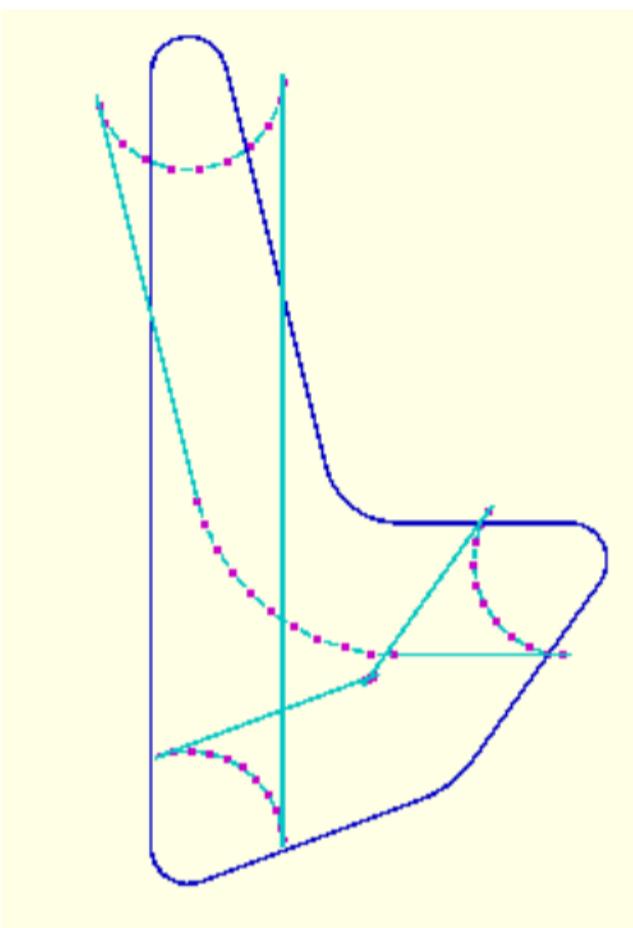
offset_line_segments=offset_segv(sec,-3.5)
intersection_points=intersections(offset_line_segments)

fileopen(f'''

color("blue")p_line({sec},.1);
color("cyan")for(p={offset_line_segments})p_line(p,.1);
color("magenta")points({intersection_points},.2);

''' )

```



In [237...]

```

c1=c2t3(circle(10))
c2=translate([0,0,10],circle(5,s=70))

c3=path2path1_closed(c2,c1)
sol=cpo(align_sol_1([c3,c2]))

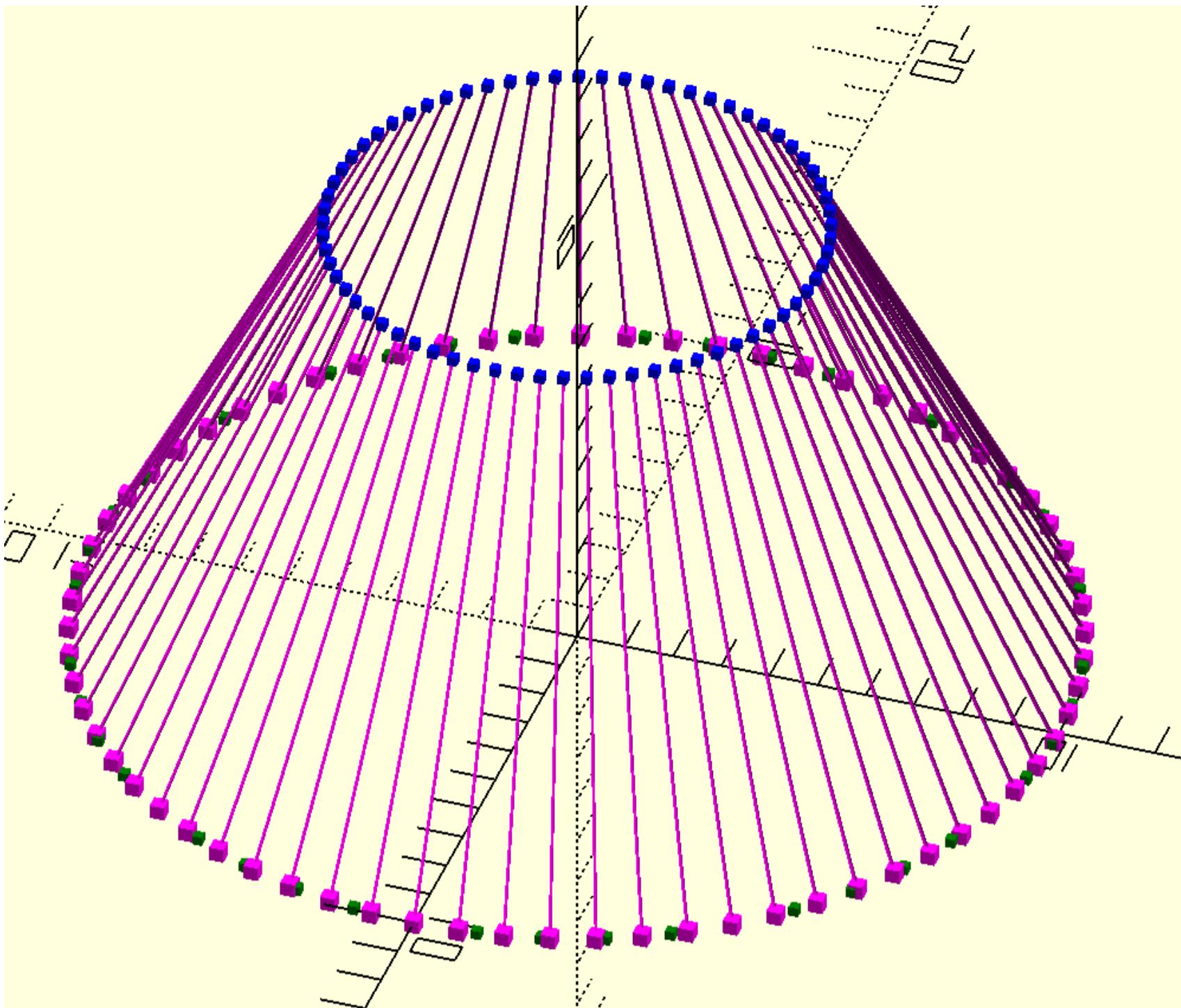
fileopen(f'''

color("blue")points({c2},.2);
color("cyan")points({c3},.2);
color("green")points({c1},.2);
color("magenta")points({circle(10,s=70)},.3);

color("magenta")for(p={sol})p_line3d(p,.05,rec=1);

''' )

```



sol2path

```
In [238...]
# example to extrude a solid along a path

# profile of the fan blade
t0=time.time()

p0=corner_radius(pts1([[0,0,.5],[20,-2,300],[20,-5,5],[5,5,4],[-5,5,5],[-20,0,300],[-20,-2,.5]]),20)

# blade profile smoothed with bezier
# sec=bezier(p0,300)
sec=equidistant_pathc(p0,300)

sol=linear_extrude(sec,45)
sol1=translate([45,0,0],rot('y-90',sol))
sol1=c2ro(sol1,1)
# zval=[p[0][2] for p in sol1]
# sol1=c3t2(sol1)

# generating helical path to extrude the profile
arc1=c2t3(arc(30,-10,0,s=2))
path=arc1+helix(30,120,.25,5)[3:]
path=bezier(path,100)

# code to extrude the solid along the given path
sol2=sol2path(sol1,path)
sol2=slice_sol_1(sol2,200)

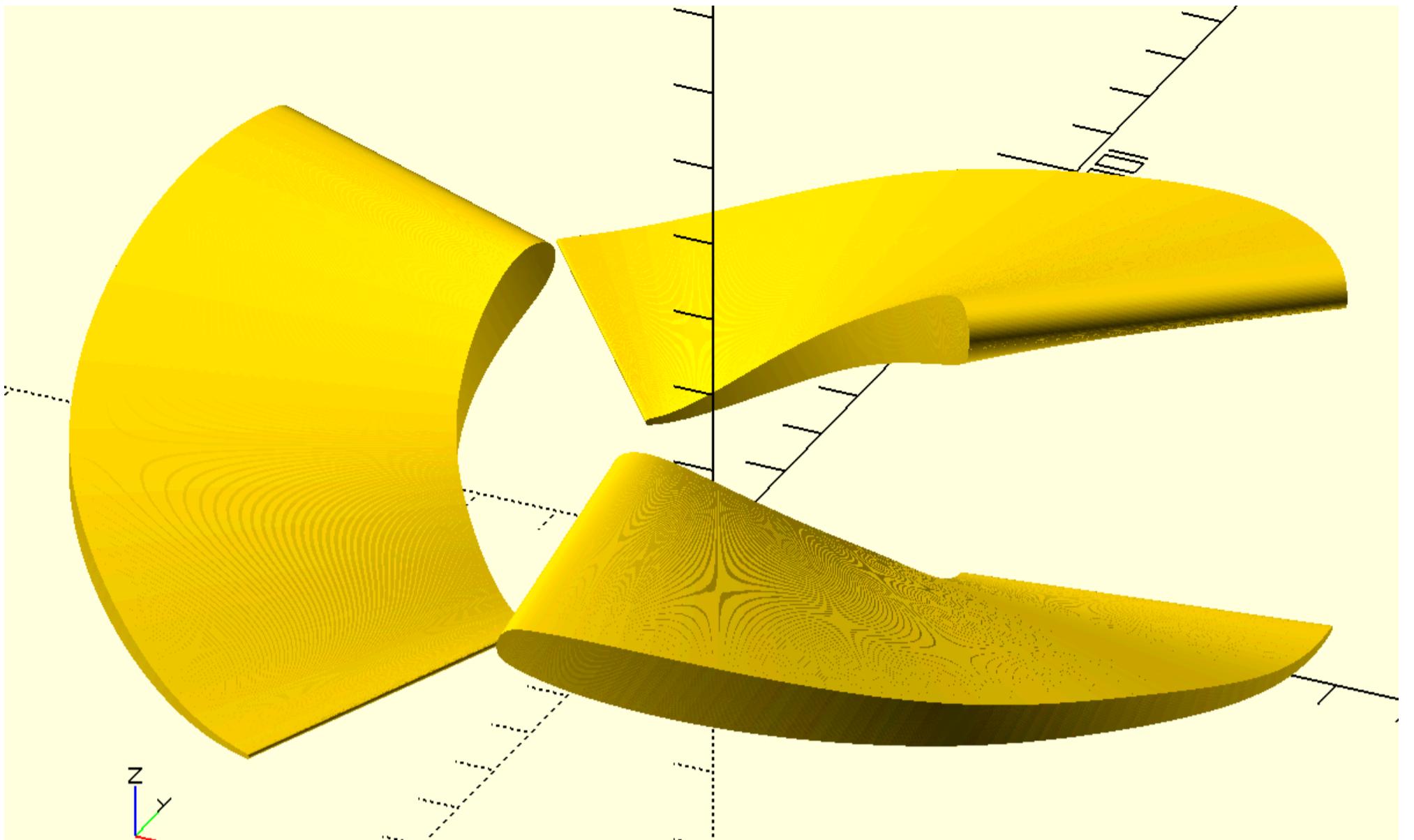
# file path needs to be modified
fileopen(f'''

difference(){
union(){
for(i=0:360/3:359)
rotate([0,0,i])
mirror([0,1,0]){{swp(sol2)}}
}}
//{swp(cut_plane([0,0,1],[1000,1000],100,20))}

color("blue")p_line3d({path},1,1);
'''')
t1=time.time()
t1-t0
```

Out[238...]

0.1638329029083252



In [239...]

```
# profile of the fan blade
t0=time.time()

p0=corner_radius(pts1([[0,0,.5],[20,-2,300],[20,-5,5],[5,5,4],[-5,5,5],[-20,0,300],[-20,-2,.5]]),20)

# blade profile smoothed with bezier
sec=bezier(p0,200)
# sec=equidistant_pathc(p0,300)

sol=linear_extrude(sec,45)
sol1=translate([45,0,0],rot('y-90',sol))
sol1=c2ro(sol1,1)
zval=[p[0][2] for p in sol1]
solx=c3t2(sol1)

sol2=[]
for p in solx:
    r1=array([l_len(p1) for p1 in seg(p)]).min()/5
    s1=corner_radius([[p[0][0],p[0][1],r1],[p[1][0],p[1][1],r1],[p[2][0],p[2][1],r1],[p[3][0],p[3][1],r1]],10)
    sol2.append(s1)

sol2=[translate([0,0,zval[i]],sol2[i]) for i in range(len(sol2))]

# generating helical path to extrude the profile
arc1=c2t3(arc(30,-10,0,s=3)[:1])
path=arc1+helix(30,120,.25,5)
path=bezier(pa2pb(path,zval),len(zval))
# path=bezier(path,len(zval))

# extrude a solid to a different path

sol3=sol2path(sol2,path)
sol3=slice_sol_1(sol3,200)

fileopen(f'''
```

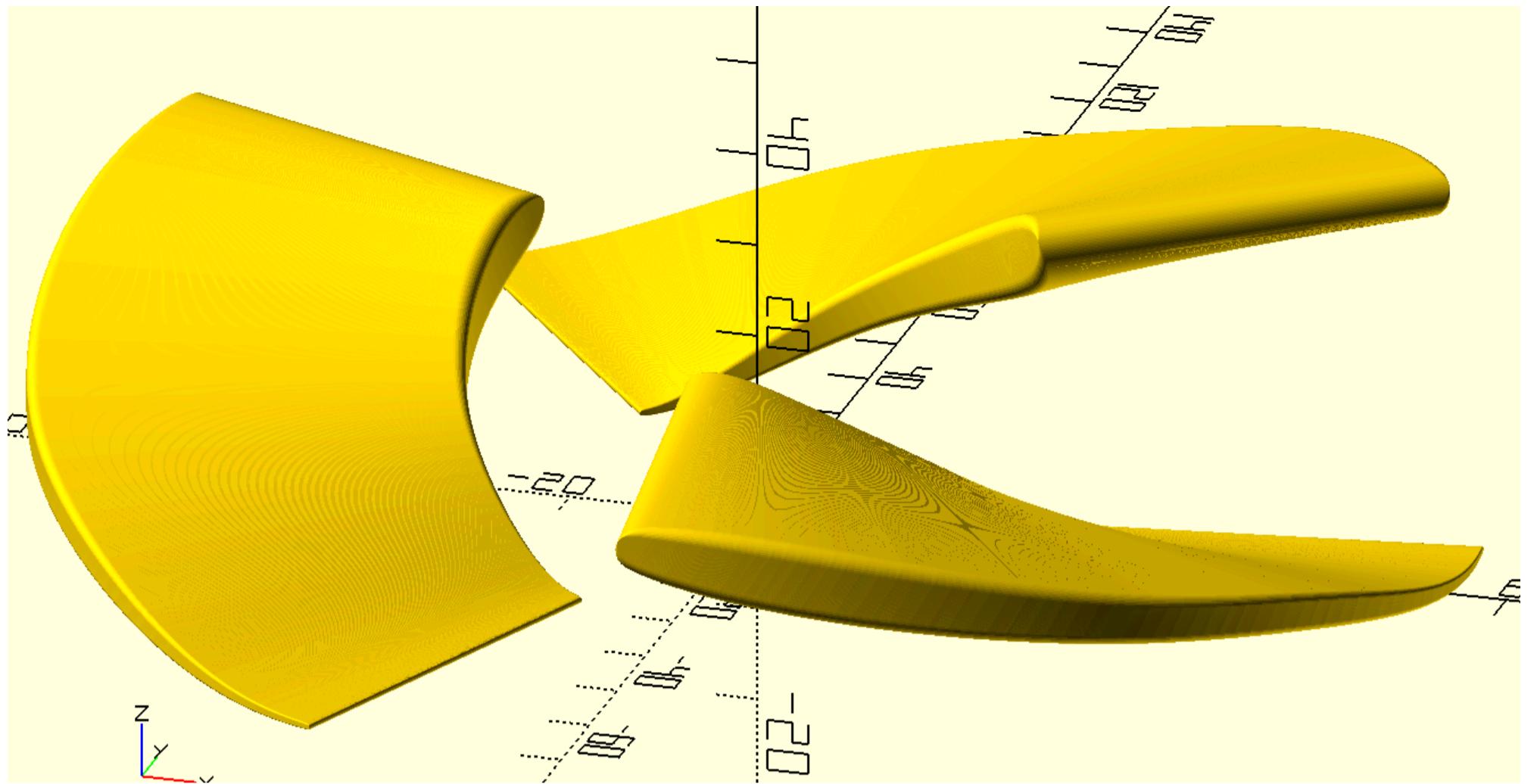
```
difference(){
union(){
for(i=[0:360/3:359])
rotate([0,0,i])
mirror([0,1,0]){\swp(sol3)}
}
//{\swp(cut_plane([0,0,1],[1000,1000],100,20))}
}
'''
```

```
t1=time.time()
```

```
t1-t0
```

Out[239...]

0.7387678623199463



```
In [240]: t0=time.time()

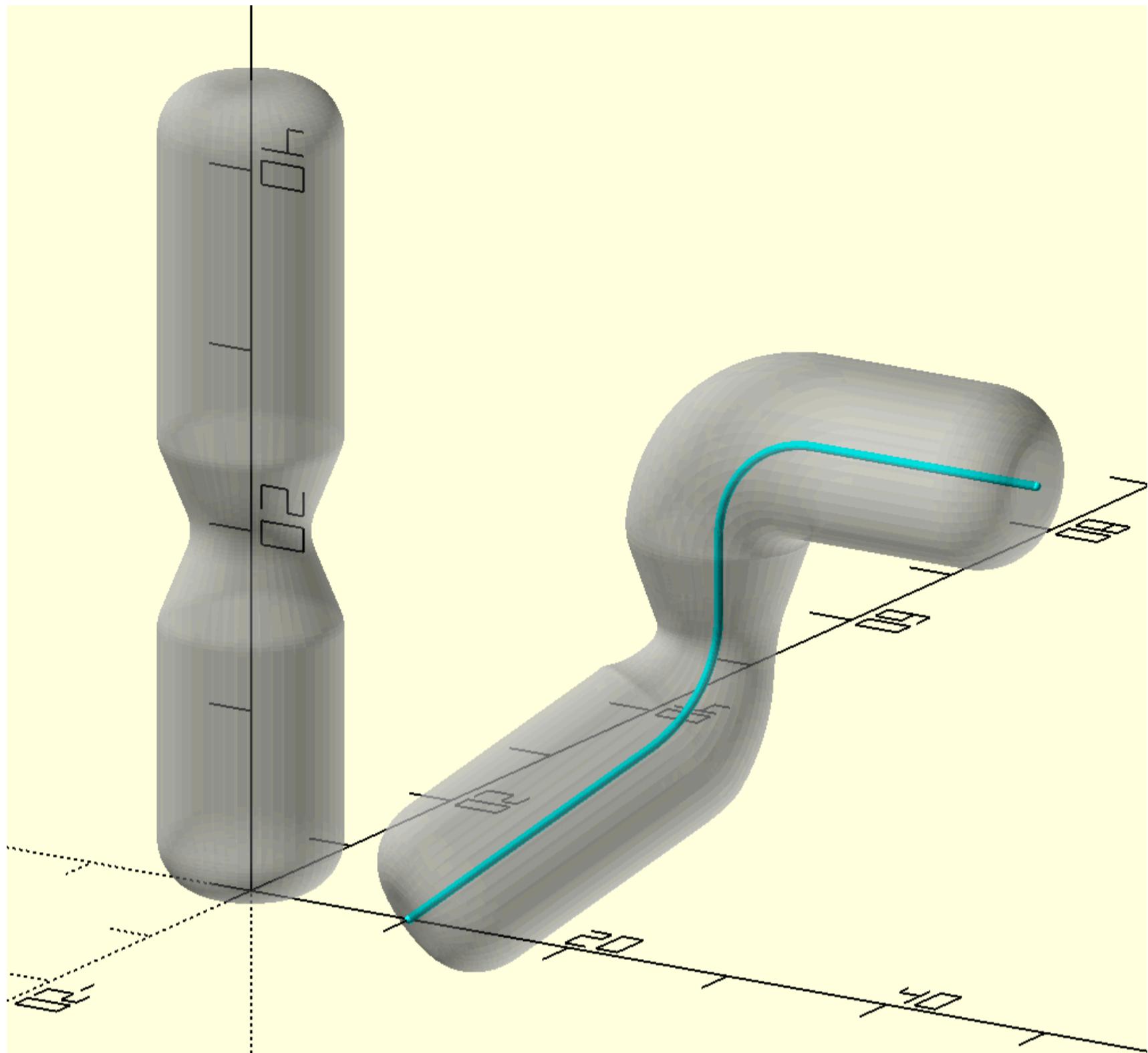
sec=circle(5)
path1=corner_radius(pts1([[-3,0],[3,0,3],[0,15,2],[-2,5,3],[2,5,2],[0,20,3],[-3,0]]),10)
path1=equidistant_path(path1,200)
sol=prism(sec,path1)
path=bspline_open(cr3dt([[10,0,0,0],[10,15,10,8],[0,0,15,6],[20,0,0,0]]),20),2,50)
sol2=sol2path(sol,path)

fileopen(f'''

%{swp(sol)}
%{swp(sol2)}
color("cyan")p_line3d({path},.5);
''')

t1=time.time()
t1-t0
```

```
Out[240]: 1.4232749938964844
```



```
In [241...]
sec=circle(5)
path=bezier(pts([5,0],[15,10],[-26,10],[0,10],[5,6],[5,15],[4,4])),50)
path1=rot('x90',corner_radius(pts1([[0,0],[0,45,15],[30,0]]),10))
sol=prism(sec,path)
sol1=sol2path(sol,path1)

fileopen(f'''

color("blue")p_line3d({path1},1);
{swp(sol1)}
'''')
```

rounding-various-rounded-cubes

```
In [242...]
t0=time.time()
p0=corner_radius(pts1([[0,0,1],[10,0,1],[0,10,1],[10,0,1],[0,10,1],[-20,0,1]]),10)
p1=corner_radius(pts1([[-3,0],[3,0,1],[0,10,1],[-3,0]]),10)
sol=prism(p0,p1)

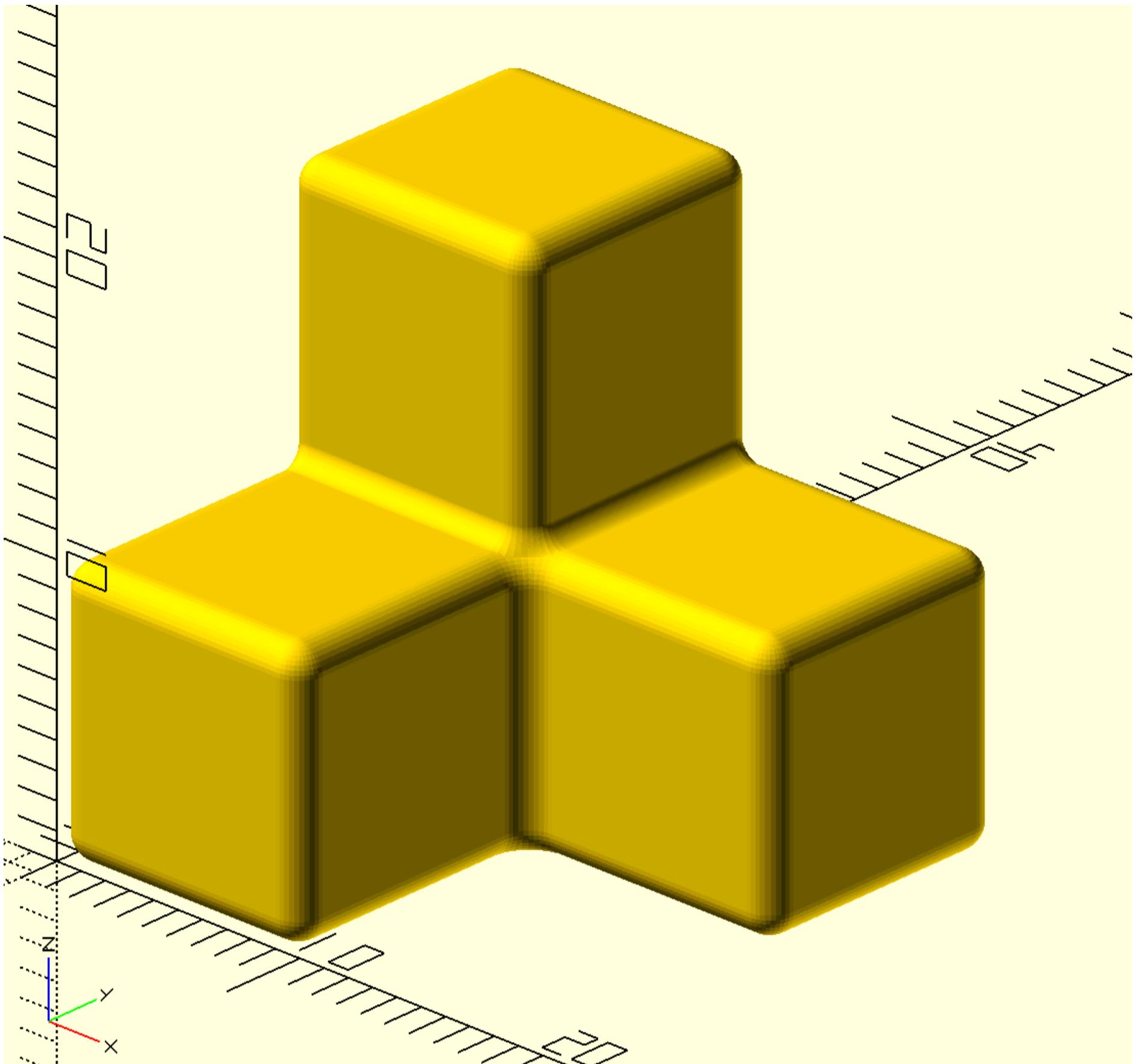
p2=corner_radius(pts1([[0,10,1],[10,0,1],[0,10,1],[-10,0,1]]),10)
p2=offset(p2,-.001)
p3=corner_radius(pts1([[0,8],[0,12,1],[-3,0]]),10)
sol1=prism(p2,p3)
f1=ip_fillet(sol,sol1,-.7,.7)
fileopen(f'''

{swp(sol)}
{swp(sol1)}
{swp(f1)}
''')

t1=time.time()
t1-t0
```

Out[242...]

1.3240759372711182



ip_triangle

In [243...]

```
t0=time.time()

sec=pts([[0,0],[5,0],[0,5],[-5,0]])
# sec=equidistant_path(sec,50)
sec=m_points1(sec,7)
path=corner_radius(pts1([[-2.49,0],[2.49,0,0.25],[0,5,0.25],[-2.49,0]]),10)
sol1=prism(sec,path)
v1=[2,0,8]
sec1=axis_rot([0,0,1],circle(1.5,s=100),90)
sol2=o_solid(v1,sec1,10,-1.5,-2.5,0)
p1=ip_sol2sol(sol1,sol2)
p2=ip_sol2sol(sol1,sol2,-1)

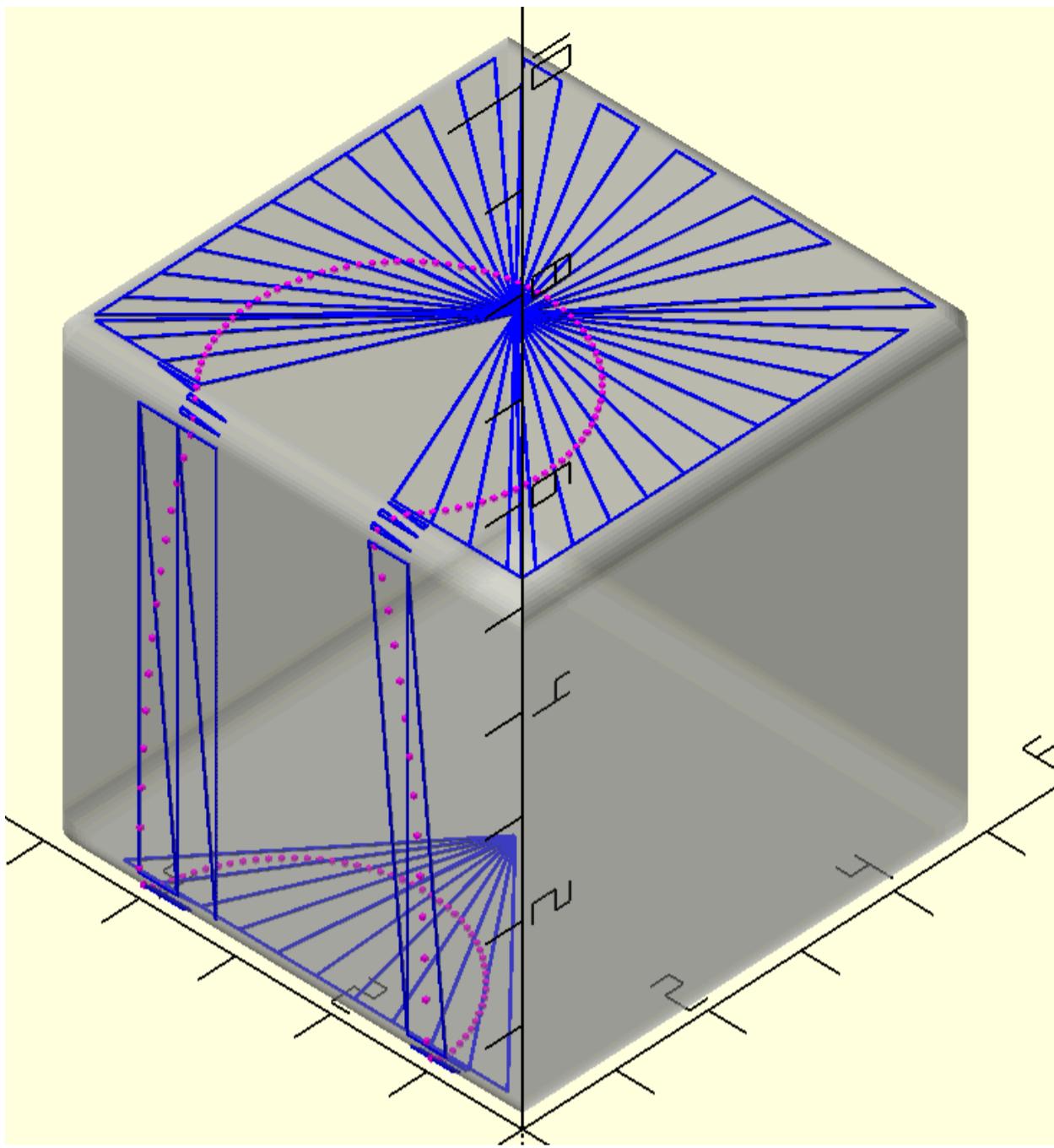
p3=flip(p1)+p2

tri_1=ip_triangle(p3,sol1)
fileopen(f'''%{swp(sol1)}
//%{swp(sol2)}
color("magenta")points({p3},.05);
color("blue")for(p={tri_1})p_line3dc(p,.04,rec=1);
''')
t1=time.time()
t1-t0
```

```
/Users/sanjeevprabhakar/python_openscad/openscad2.py:4497: RuntimeWarning: divide by zero encountered in divide
    t=einsum('kl,ijkl->ijk',cross(p01,p02),la[:, :,None]-p0)/(einsum('ijl,kl->ijk',(-lab),cross(p01,p02))+.00000)
/Users/sanjeevprabhakar/python_openscad/openscad2.py:4502: RuntimeWarning: invalid value encountered in multiply
    a=(la[:,None,:,None,:]+lab[:,None,:,None,:]*t[:,None,:,:None])
```

Out[243...]

0.18004989624023438



$$p_0 + v_0 t_0 = p_a + v_1 t_1 + v_2 * t_2$$

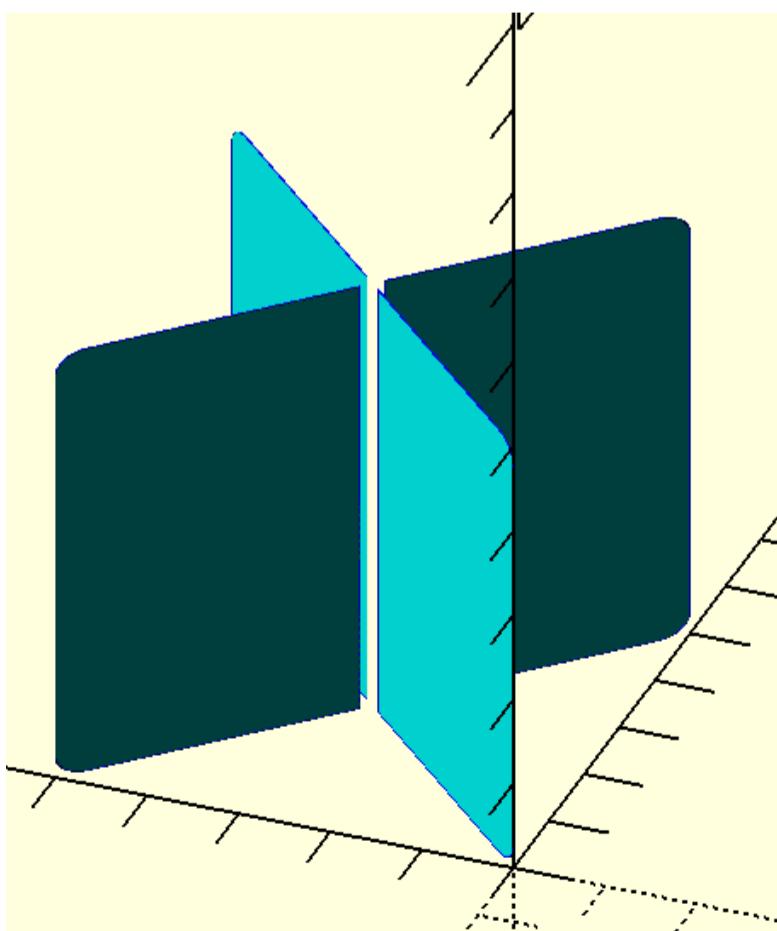
$$v_0 t_0 - v_1 t_1 - v_2 * t_2 = p_a - p_0$$

$$[v_0, -v_1, -v_2] * [t_0, t_1, t_2] = [p_a - p_0]$$

```
In [244...]: sec=pts([[0,0],[5,0],[0,5],[-5,0]])
path=corner_radius(pts1([[-2.4,0],[2.4,0,0.25],[0,5,0.25],[-2.4,0]]),10)
sol1=prism(sec,path)
fileopen(f'''
```

```
color("blue")for(p={cpo(sol1)})p_line3dc(p,.01,rec=1);
color("cyan")for(p={cpo(sol1)})polyhedron(p,[{orange(len(cpo(sol1)[0])).tolist()}]);
```

```
'''')
```



bspline

```
In [245...]: p0=pts2([[0,0,0],[10,-2,2],[0,10,3],[5,-3,-6],[-5,5,1],[0,7,-2],[0,0,5]])
p1=m_points1_o(p0,10)
c1=bezier(p0,100)
```

```

s1=bspline_open(p0,2,100)
fileopen(f"""

color("blue")points({p0},.5);
//color("magenta")points({p1},.4);
color("cyan")p_line3d({c1},.05,rec=1);

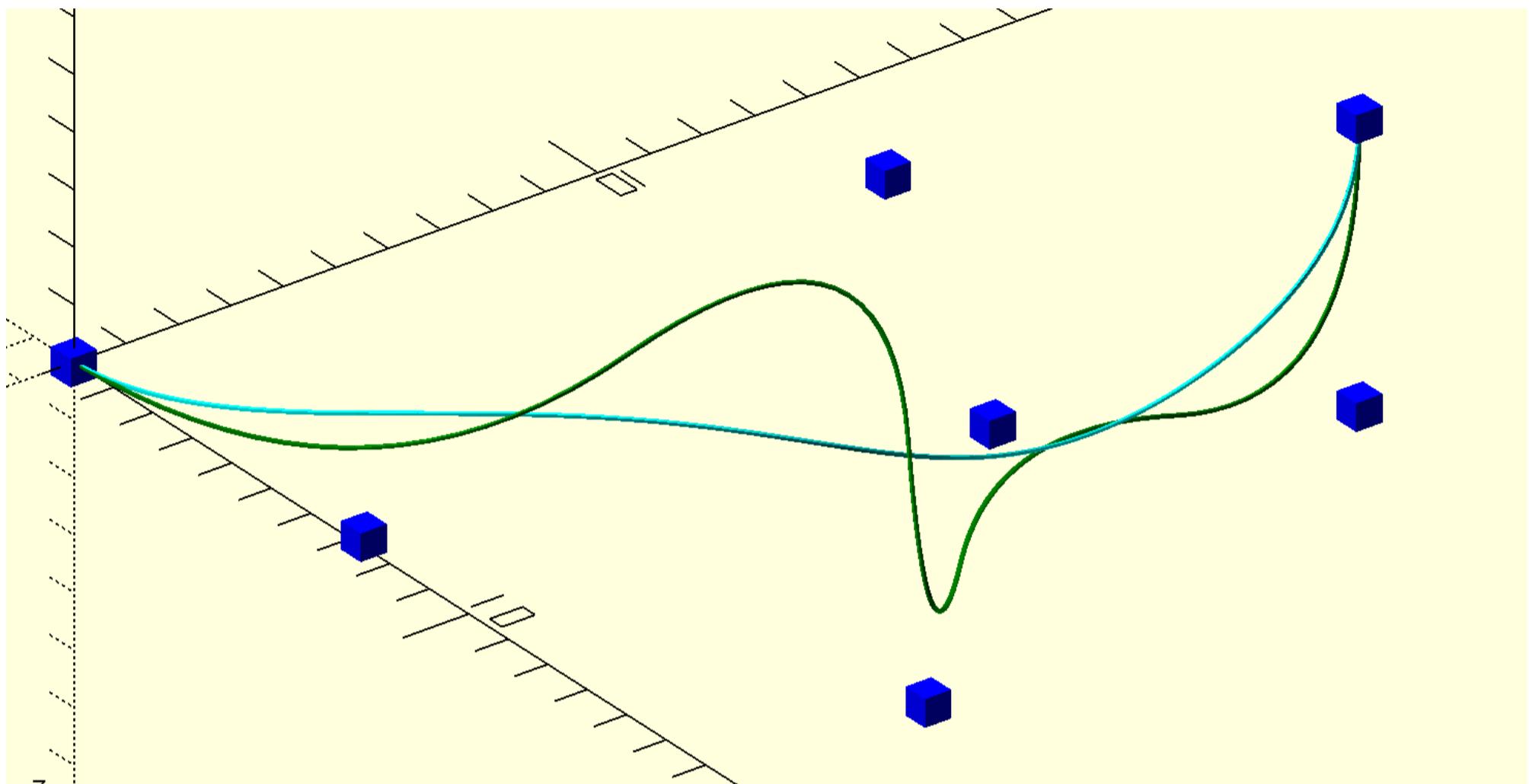
color("green")p_line3d({s1},.05,rec=1);

""")

(len(p0)-2)*20,len(s1),l_lenv_o(p0)/10

```

Out[245... (100, 100, 4.862074993748794)



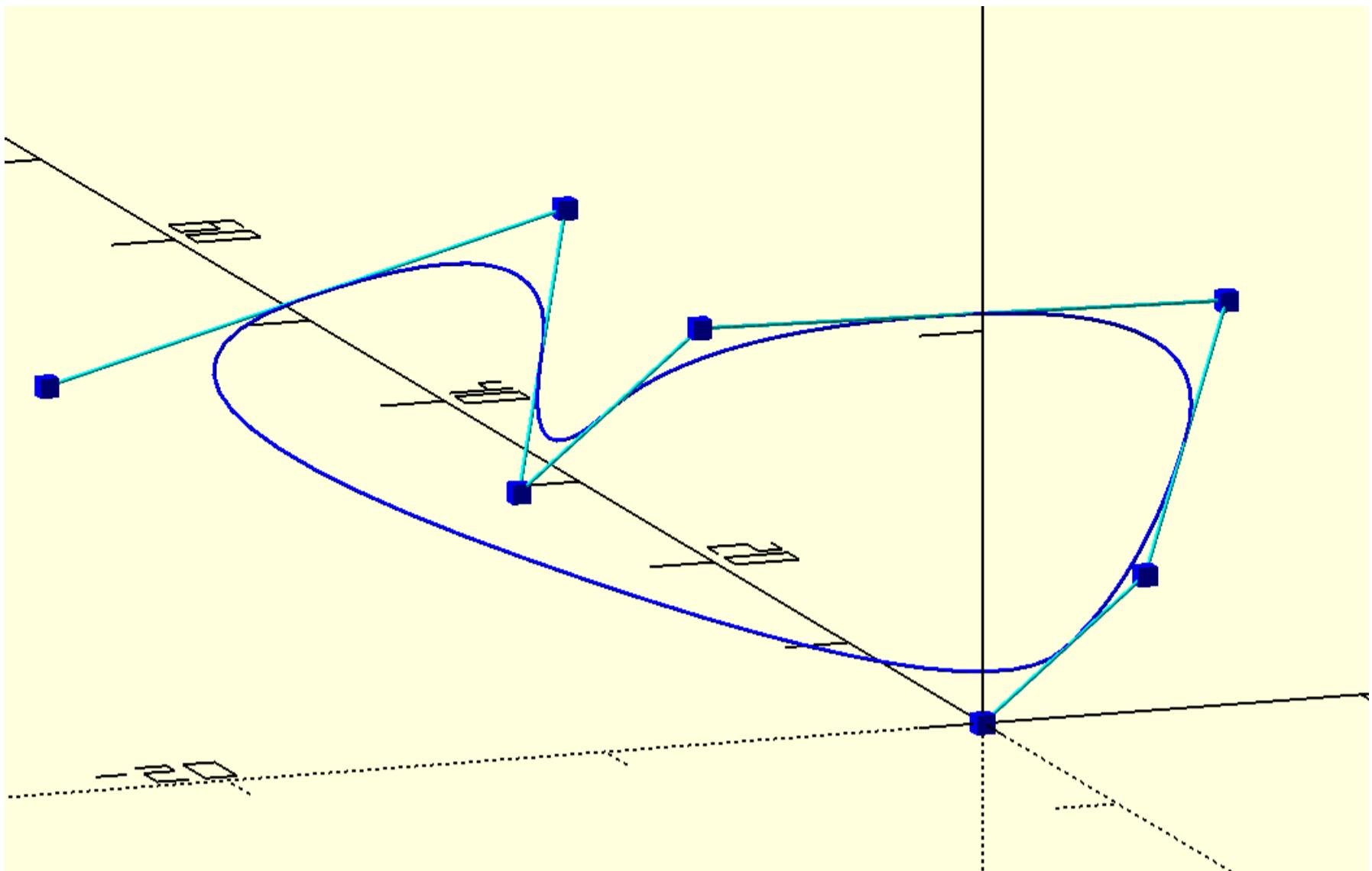
```

In [246... # bspline_closed function
px=pts2([[0,0,0],[5,2,3],[5,8,5],[-15,-3,1],[-3,5,-5],[3,5,6],[-13,-10,10]])

# b=bspline_open(px,2,100)
c=bezier(px,100)
d=bspline_closed(px,2,100)
fileopen(f"""

color("blue")points({px},.5);
color("cyan")p_line3d({px},.1);
color("blue")p_line3d({d},.1);

""")
```



```
In [247]: px=pts2([[0,0,0],[5,2,3],[5,8,5],[-15,-3,-2],[0,10,0],[7,0,6],[-3,5,-4]])
px=helix(10,5,15)
b=bspline_open(px,4,100)
c=bezier(px,100)

fileopen(f'''
color("blue")points({px},.5);
color("magenta")p_line3d({b},.1,rec=1);
//color("cyan")p_line3d({c},.1,rec=1);

''')
len(b)
```

Out[247]: 100

faces

```
In [248]: sec=pts([[0,0],[5,0],[0,5],[-5,0]])
# sec=equidistant_pathc(sec,50)
path=corner_radius(pts1([[-1,0],[1,0,0.25],[0,5,0.25],[-1,0]]),10)
sol1=prism(sec,path)
l,m,_=array(sol1).shape
v=array(sol1).reshape(-1,3).tolist()
f1=faces(l,m)

fileopen(f'''

polyhedron({v},{f1});

''' )
```

faces_1

```
In [249]: sec=pts([[0,0],[5,0],[0,5],[-5,0]])
# sec=equidistant_pathc(sec,50)
path=corner_radius(pts1([[-1,0],[1,0,0.25],[0,5,0.25],[-1,0]]),10)
sol1=prism(sec,path)
l,m,_=array(sol1).shape
v=array(sol1).reshape(-1,3).tolist()
f1=faces_1(l,m)

fileopen(f'''

polyhedron({v},{f1});

''' )
```

```
In [ ]: p0=[10,0,0]
p1=[5,2,3]
p2=[10,1,-10]

l1,p2=array([p0,p1]),array(p2)

v1=l1[1]-l1[0]
u1=v1/norm(v1)
v2=p2-l1[0]

v2sint=norm(cross(v1,v2))/norm(v1)
```

```

v2cost=(v1@v2)/norm(v1)
t1=v2cost/norm(v1)
p3=l_(a_(p0)*(1-t1)+a_(p1)*t1)
p2=l_(p2)

fileopen(f'''

color("blue")points({[p0,p1,p2,p3]},.3);
color("cyan")p_line3d({[p0,p1]},.1);
color("magenta")p_line3d({[p2,p3]},.1);

''')
v1=a_(p1)-a_(p0)
v2=a_(p3)-a_(p2)
u1=v1/norm(v1)
u2=v2/norm(v2)
t1,r2d(arccos(u1@u2)) # angle between the 2 lines

```

p2p_intersection_line

l_sec_ip_3d

|2|_intersection

```

In [250... i_t=time.time()
p0=[[1,2,1],[5,4,3],[2,8,5]]

p1=[[10,2,1],[5,1,3],[12,8,-5]]
line=p2p_intersection_line(p0,p1)
line1=l_sec_ip_3d(p0,line)
line2=l_sec_ip_3d(p1,line)

p2=l2l_intersection(line1,line2)

fileopen(f'''

color("blue")p_line3dc({p0},.1,rec=1);
color("magenta")p_line3dc({p1},.1,rec=1);
color("cyan")p_line3d({line1},.1,rec=1);
color("green")p_line3d({line2},.1,rec=1);
color("magenta")points({[p2]},.5);

''')
f_t=time.time()
f_t-i_t

```

Out[250... 0.22590279579162598

```

In [251... i_t=time.time()

# p0=translate([-2,0,-8.22],[[2,4,5],[7,9,15],[1,10,5]])
# p1=translate([-3,0,-5],[[5,10,3],[5,-7,5],[-10,5,10]])

p0=[[-2,5,0],[-5,0,0],[0,5,10]]
p1=[[0,-5,0],[0,10,0],[5,3,15]]

line=p2p_intersection_line(p0,p1)
line1=l_sec_ip_3d(p0,line)
line2=l_sec_ip_3d(p1,line)

line3=[mean(p0,0).tolist(),add(mean(p0,0),multiply(nv(p0),10)).tolist()]
line4=[mean(p1,0).tolist(),add(mean(p1,0),multiply(nv(p1),10)).tolist()]
line5=array([array(p0).mean(0)-cross(nv(p0),nv(p1)),array(p0).mean(0)+cross(nv(p0),nv(p1))]).tolist()
line6=array([array(p1).mean(0)-cross(nv(p0),nv(p1)),array(p1).mean(0)+cross(nv(p0),nv(p1))]).tolist()
line7=array([array(p0).mean(0),array(p0).mean(0)+cross(nv(p0),cross(nv(p0),nv(p1)))*15]).tolist()
line8=array([array(sl_int(p1,line3)[0]),array(sl_int(p1,line3)[0])-cross(nv(p1),cross(nv(p0),nv(p1)))*20]).tolist()
p2=sl_int(p1,line3)[0]
p3=l2l_intersection(line7,line8)
p4=array(p0).mean(0).tolist()
p5=sl_int1(p0,line4)[0]

fileopen(f'''

color("blue")p_line3dc({p0},.1,rec=1);
color("magenta")p_line3dc({p1},.1,rec=1);
//color("cyan")p_line3d({line},.1,rec=1);
//color("cyan")p_line3d({line1},.1,rec=1);
color("green")p_line3d({line2},.1,rec=1);
color("green")p_line3d({line3},.1,rec=1);
color("magenta")p_line3d({line4},.1,rec=1);
color("magenta")p_line3d({line5},.1,rec=1);
color([.2,.3,.7,.2])p_line3d({line6},.1,rec=1);
color([.1,.3,.9,1])p_line3d({line7},.1,rec=1);
color([.1,.3,.2,1])p_line3d({line8},.1,rec=1);
color([.3,.2,.6,1])points({[p2]},.3);
color([.3,.2,.1,1])points({[p3]},.3);
color([.1,.2,.9,1])points({[p4]},.3);
color([.5,.5,1,1])points({[p5]},.3);

polyhedron({p0},[[0,1,2]]);
polyhedron({p1},[[0,1,2]]);

''')
f_t=time.time()
f_t-i_t

```

```
line2
```

```
Out[251... [[6.661338147750939e-16, 8.333350150268757, 0.0],  
 [0.8064477384368733, 8.870973166188378, 2.4193432153106187]]
```

i_p_p

i_p_n

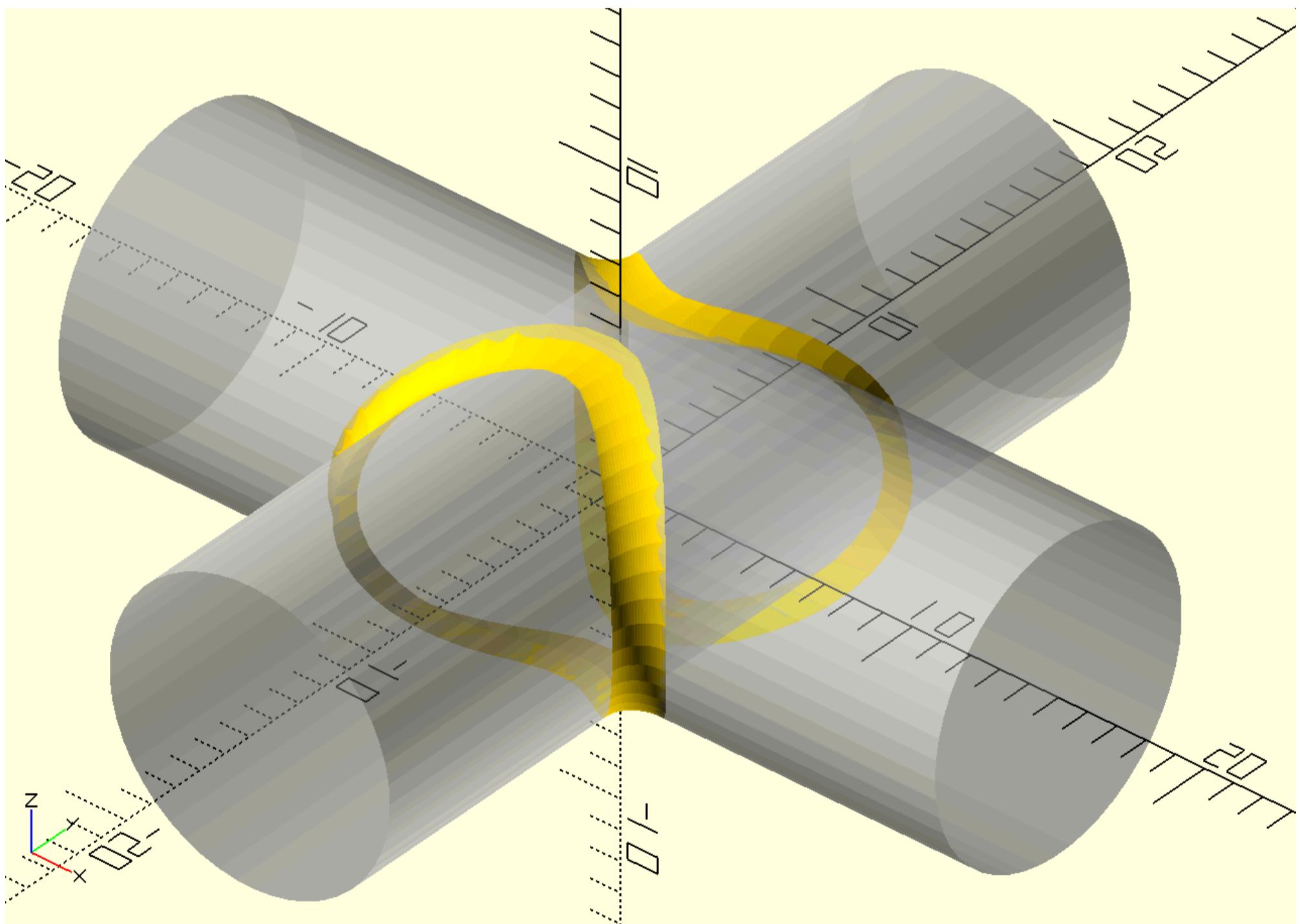
i_p_t

o_3d

ip_fillet

```
In [252... i_t=time.time()  
sol=o_solid([1,0,0],circle(5),30,-15)  
sol1=o_solid([0,1,0],circle(4.8),30,-15)  
sol1=slice_sol(sol1,2)  
fillet1=ip_fillet(sol,flip(sol1),1,1,o=-1,style=2)  
fillet1=fillet1+[fillet1[0]]  
fillet2=ip_fillet(flip(sol),sol1,1,1,o=-1,style=2)  
fillet2=fillet2+[fillet2[0]]  
fileopen(f'''  
  
    ${swp(sol)}  
    ${swp(sol1)}  
  
    {swp_c(fillet1)}  
    {swp_c(fillet2)}  
  
    ''')  
f_t=time.time()  
f_t-i_t  
# len(i_p),len(i_p1),len(i_p2)
```

```
Out[252... 0.22925186157226562
```



```
In [253... i_t=time.time()  
sec=corner_radius(pts1([[-5,-10,1],[10,0,1],[0,15,1],[-10,0,1]]),10)  
path=corner_radius(pts1([[-5,0],[5,0,1],[0,20,1],[-5,0]]),10)  
sol=prism(sec,path)  
sec1=circle(2,s=100)  
path1=bezier(pts2([[0,-4,2],[0,5,10],[10,1,20]]),20)  
sol1=path_extrude_open(sec1,path1)  
fillet1=ip_fillet(sol,sol1,-1,1,style=2)
```

```

fillet1=fillet1+[fillet1[0]]
# p1=ip_solid(sol,sol1,-1)

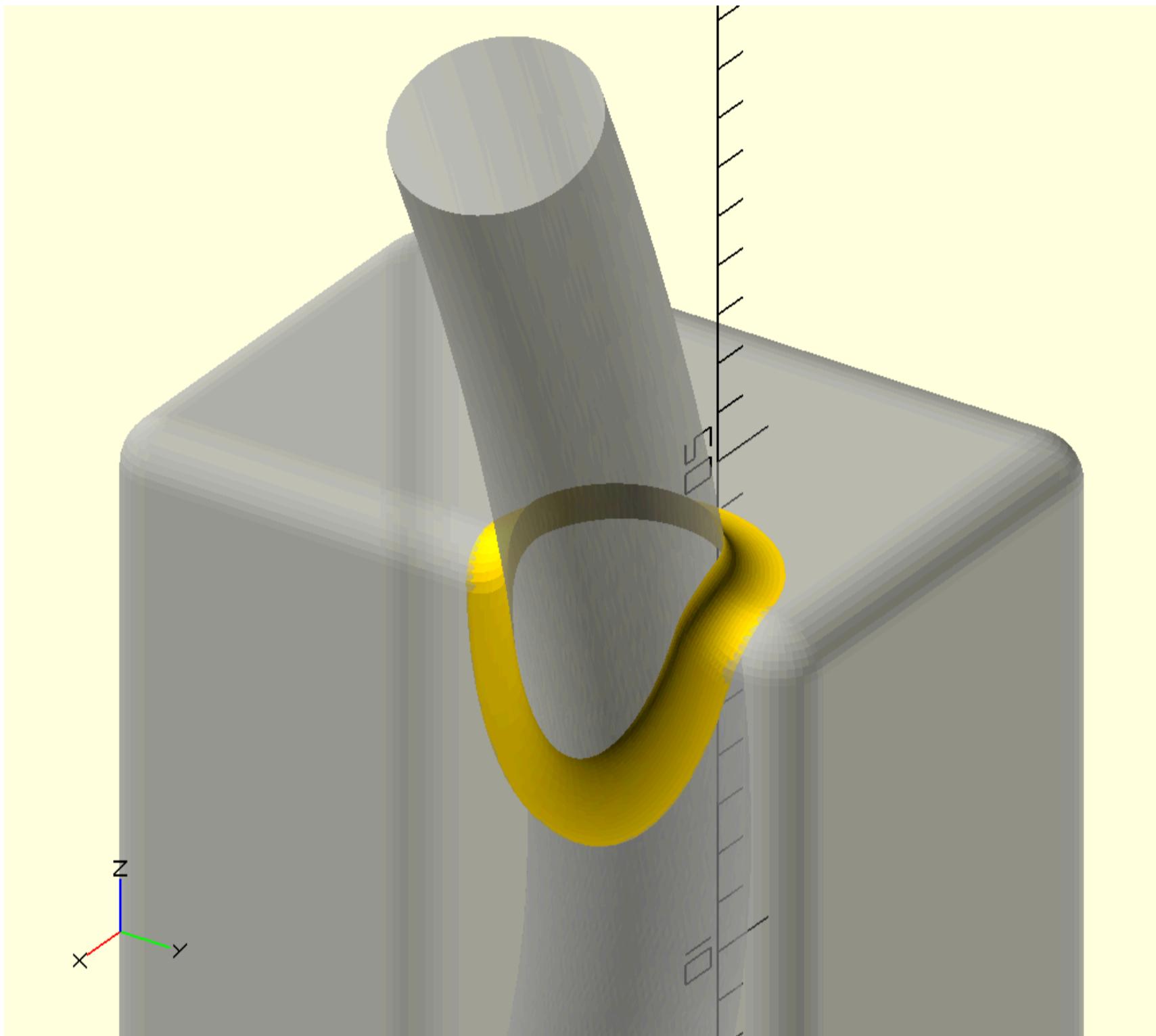
# p2=i_p_p(sol1,p1,1)
# p3=o_3d(p1,sol,-1)

# fillet1=convert_3lines2fillet_closed(p3,p2,p1)

fileopen(f'''')

```

Out[253... 3.589935064315796



```

In [254... i_t=time.time()
p1=[[0,-31],[21-5,0,.2],[2,10,4],[35,0,10],
     [5,22,5],[-5,22,10],[-35,0,4],[-2,10,.2],[-21+5,0]]

path1=corner_radius(pts1(p1),10)
sec1=circle(5,s=72)
sol1=f_prism(sec1,path1)

sec5=corner_radius(pts1([[-20,-7.5,2.45],[5,0,2.45],[0,10,3],[15,2,70],[15,-2,3],[0,-10,2.45],
    [5,0,2.45],[1,7.5,5],[-1,7.5,7],[-20,3,90],[-20,-3,7],[-1,-7.5,5]]),10)

sec5=equidistant_pathc(sec5,201)
sec6=scl2d_c(sec5,.6)
sol2=[c2t3(sec5)]+[translate([0,0,120],sec6)]
sol2=translate([0,41,0],rot('x90z190',sol2))

# p1=ip_surf(sol1,sol2)
# p2=i_p_p(sol2,p1,6)
# p3=o_3d(p1,sol1,6)
# fillet1=convert_3lines2fillet_closed(p1,p2,p3)
fillet1=ip_fillet(sol1,sol2,-6,6,style=2)
fillet1=fillet1+[fillet1[0]]
fileopen(f'''')

%{swp(sol1)}
%{swp(sol2)}
{swp_c(fillet1)}

''')

```

```
f_t=time.time()
f_t_i_t
# len(p1),len(p2),len(p3)
```

Out[254... 6.85608172416687

```
i_t=time.time()

p1=[[0,-31],[21-5,0,.2],[2,10,4],[35,0,10],
    [5,22,5],[-5,22,10],[-35,0,4],[-2,10,.2],[-21+5,0]]

path1=corner_radius(pts1(p1),10)
sec1=circle(5,s=72)
sol1=prism(sec1,path1)

sec5=corner_radius(pts1([[-20,-7.5,2.49],[5,0,2.49],[0,10,3],[15,2,70],[15,-2,3],[0,-10,2.49],
    [5,0,2.49],[1,7.5,5],[-1,7.5,7],[-20,3,90],[-20,-3,7],[-1,-7.5,5]]),10)

sec5=equidistant_pathc(sec5,200)
sec6=scl2d_c(sec5,.6)
sol2=[c2t3(sec5)]+[translate([0,0,120],sec6)]
sol2=translate([0,41,0],rot('x90z190',sol2))
p1=ip(sol1,sol2)

p2=ip(sol1,offset_sol(sol2,8))
# p2=sort_points(p1,p2)
# p2=sort_points(p1,p2)
p3=i_p_p(sol2,p1,8)
# p3=sort_points(p1,p3)

fillet1=convert_3lines2fillet_closed(p2,p3,p1,style=2)

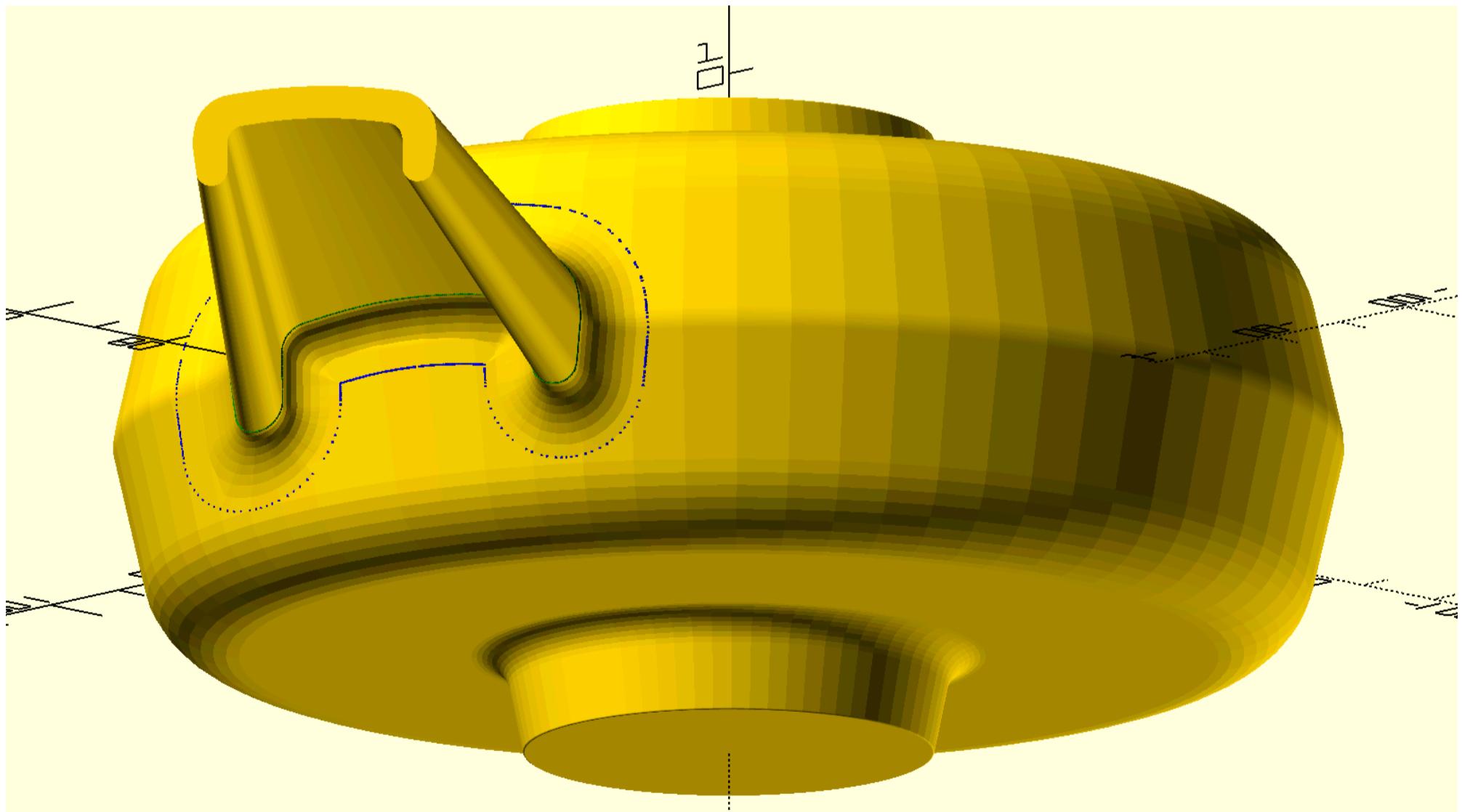
fileopen(f'''

{swp(sol1)}
{swp(sol2)}
//{swp(offset_sol(sol2,6))}
{swp_c(fillet1)}
color("blue")p_line3dc({p2},.2,rec=1);
color("green")p_line3dc({p3},.2,rec=1);

color("magenta")p_line3dc({p1},.2,rec=1);

''')
len(p1),len(p2),len(p3)
f_t=time.time()
f_t_i_t
```

Out[255... 5.002489805221558



```
# m10
t0=time.time()

sec1=arc(20,0,359,s=150)
path1=[[0,0],[-5,25]]

surf1=prism(sec1,path1)

sec2=corner_radius(pts1([[-25,0],[10,5,5],[10,-3,10],[10,5,5],[10,-8,7],[10,1]]),10)
path2=cytz(corner_radius(pts1([[-35,5,0],[10,8,20],[20,-5,10],[20,8,20],[10,-9,20],[10,1,0]]),10))
surf2=surf_extrude(sec2,path2)
surf3=surf_extrude(surf2)
# p1=ip_surf(surf2,surf1)
# p2=o_3d_surf(p1,surf2,2)
```

```

# p3=i_p_p(surf1,p1,2)
# # # p=fillet_surf2sol(surf2,surf1,2,10,0)
# fillet1=convert_3lines2fillet_closed(p1,p3,p2)

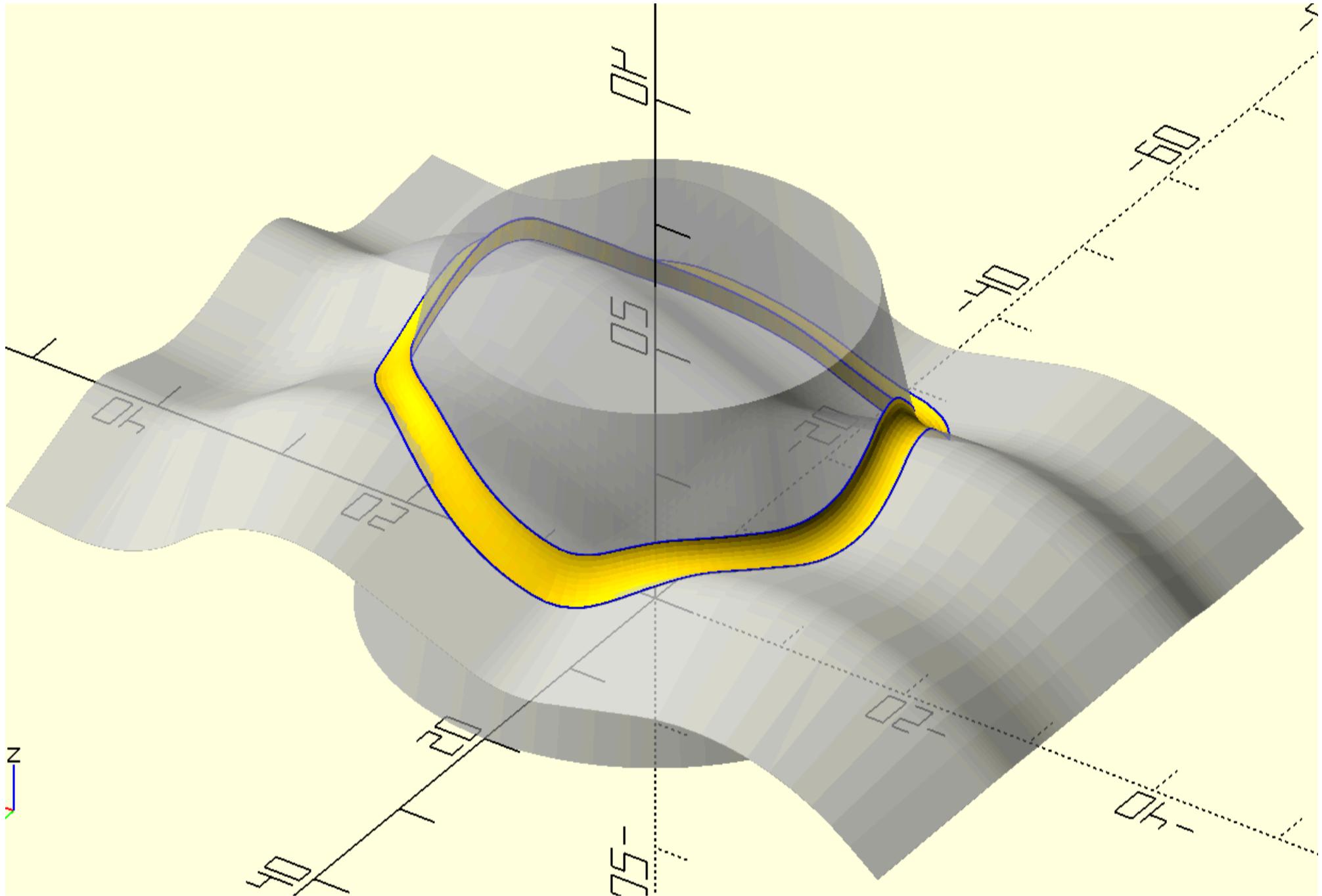
fillet1=ip_fillet_surf(surf2,surf1,-2,2,style=2)
fillet1=fillet1+[fillet1[0]]
fileopen(f'''

{swp(surf1)}
{swp_c(surf3)}
{swp_c(fillet1)}

'''')
t1=time.time()
total=t1-t0
total

```

Out[257... 2.0363190174102783



```

In [258... t1=time.time()

p1=[[0,-15,.5],[6,0,.3],[0,-16,.1],[1,-1,.1],[4,0,.2],[2,10,4],[35,0,10],
     [5,22,5],[-5,22,10],[-35,0,4],[-2,10,.2],[-4,0,.1],[-1,-1,.1],[0,-16,.3],
     [-6,0,.5]]
sec1=corner_radius(pts1(p1),10)
path1=c2t3(circle(10,s=72))
sol1=path_extrude_closed(sec1,path1)

sec3=circle(7,s=50)
path2=corner_radius(pts1([[2,0],[-2,31]]),10)

sol3=translate([51.2,0,12],prism(sec3,path2))
# px=ip_surf(sol1,sol3)
# py=i_p_p(sol3,px,3)
# pz=o_3d_surf(px,sol1,3)
# fillet1=convert_3lines2fillet_closed(px,py,pz)
fillet1=ip_fillet(sol1,sol3,-3,3,style=2)
fillet1=fillet1+[fillet1[0]]
f3=end_cap(sol3,2)[1]
fileopen(f'''

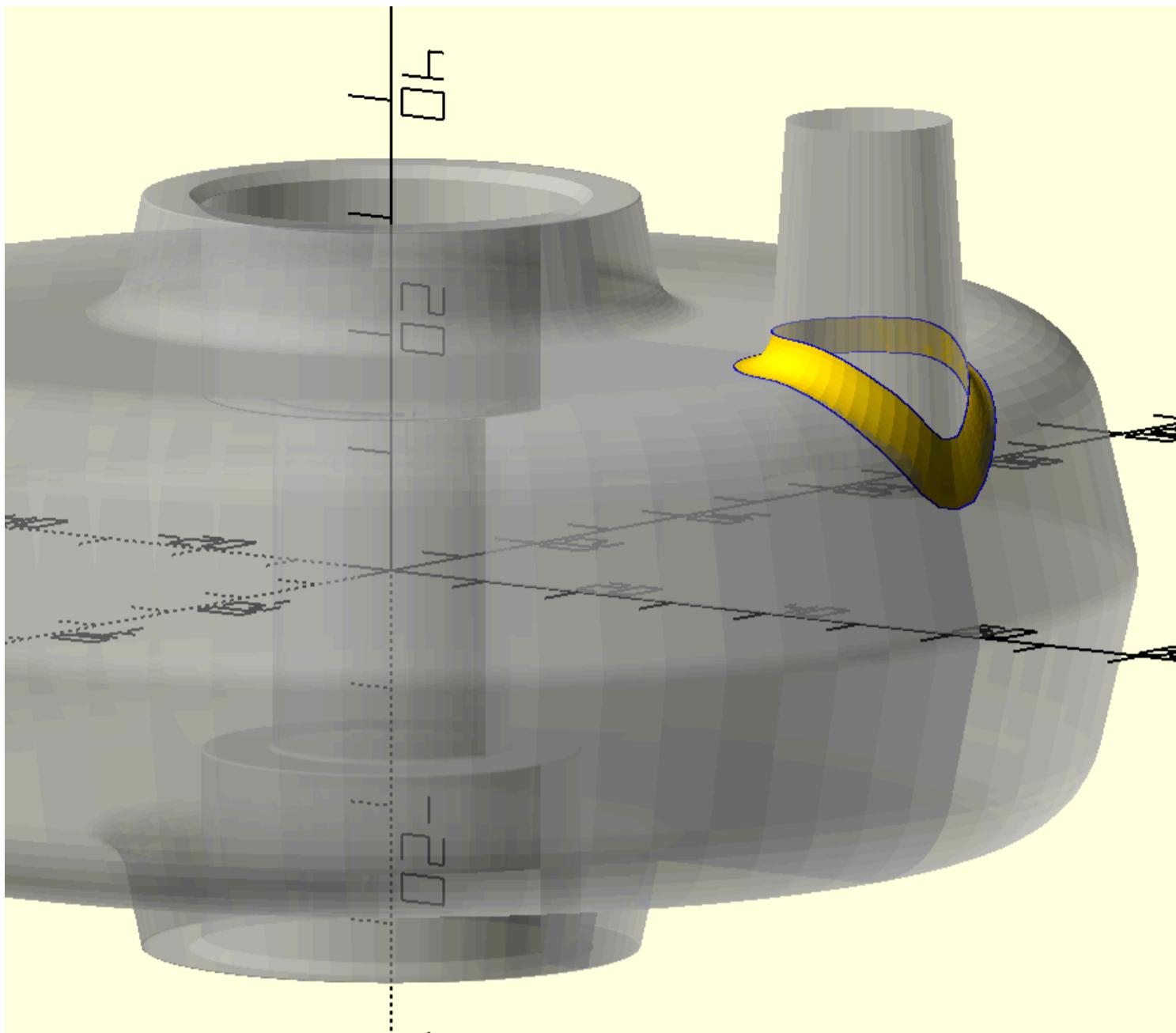
{swp_c(sol1)}
difference(){{
{swp(sol3)}
{swp_c(f3)}
}}
{swp_c(fillet1)}

//color("blue")for(p=[cpo(fillet1)[0],cpo(fillet1)[-2]])p_line3dc(p,.2);
'''')

t2=time.time()
t2-t1
# len(p1),len(p2),len(p3)

```

Out[258... 3.16654109954834



```
In [259... line=[[0,0],[10,0]]
pnts=[[5,1.5]]
d=2
perp_points_d(line,pnts,d),perp_distance_within_line(line,pnts)
```

```
Out[259... ([[5.0, 1.5]], [1.5])
```

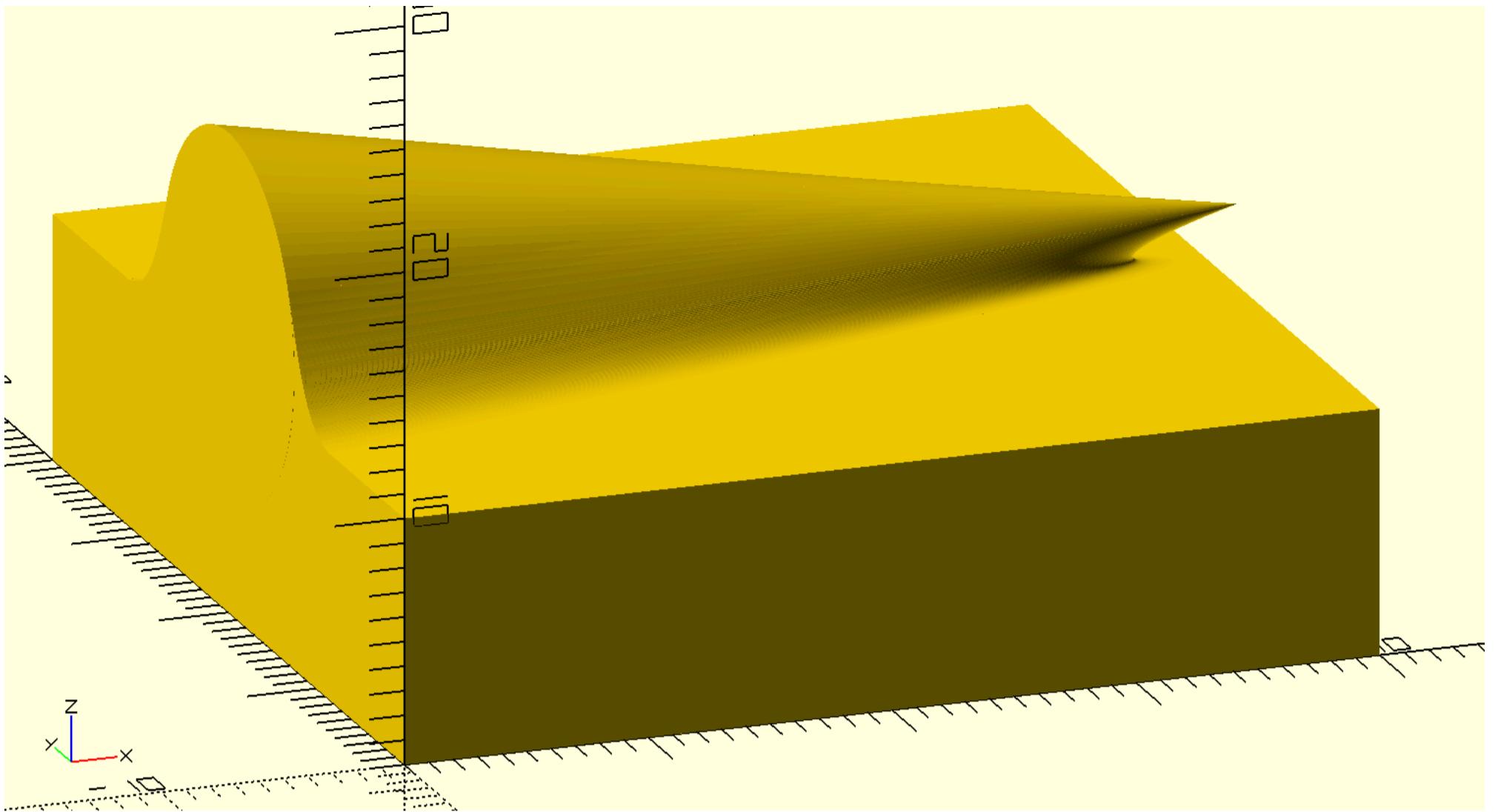
```
In [294... t0=time.time()
sec=corner_radius(pts1([[0,0],[40,0],[0,40],[-40,0]]),10)

sol1=linear_extrude(sec,10)

sol2=translate([0,20,12],rot('y90'),cylinder(r1=7.5,r2=0,h=40,s=100))
a=cr2dt([[5,0],[-5,0,5],[0,5]],50)
b=[ translate([0,0,-x],linear_extrude(sec,10+2*x)) for (x,y) in a]
c=[ translate([0,20,12],rot('y90'),cylinder(r1=7.5+y,r2=0,h=40,s=100))
    for (x,y) in a]
fileopen(f'''
a={a};
b={b};
c={c};
for(i=0:len(a)-2)
hull(){{{
intersection(){{{
swp(b[i]);
swp(c[i]);
}}}
intersection(){{{
swp(b[i+1]);
swp(c[i+1]);
}}}
}}
{swp(sol1)}
{swp(sol2)}
''')

t1=time.time()
t1-t0
```

```
Out[294... 0.08128786087036133
```



`partial_surface`

`shield`

```
In [295...]
i_t=time.time()
sec1=circle(55)
path1=corner_radius(pts1([[-50,0],[50,0,.2],[0,30,3],[6,1,3],[0,6,3],[-4,2,3],[0,22,6],[8,2,6],[0,10,.2],[-50,0]]),10)
# path1=equidistant_path(path1,200)
sec2=circle(7.5)
path2=corner_radius(pts1([-5,0],[5,0,5],[0,35,2],[-5,0])),10)
path2=equidistant_path(path2,50)
sol1=prism(sec1,path1)
sol2=translate([57.5,0,37],prism(sec2,path2))
sol2=axis_rot_o([0,0,1],sol2,180)

s1=shield(sol1,sol2,50,10,4,135)
v,f1=partial_surface(sol1,prism_center(sol2),50)

fileopen(f'''

%{swp(sol1)}
%{swp(sol2)}

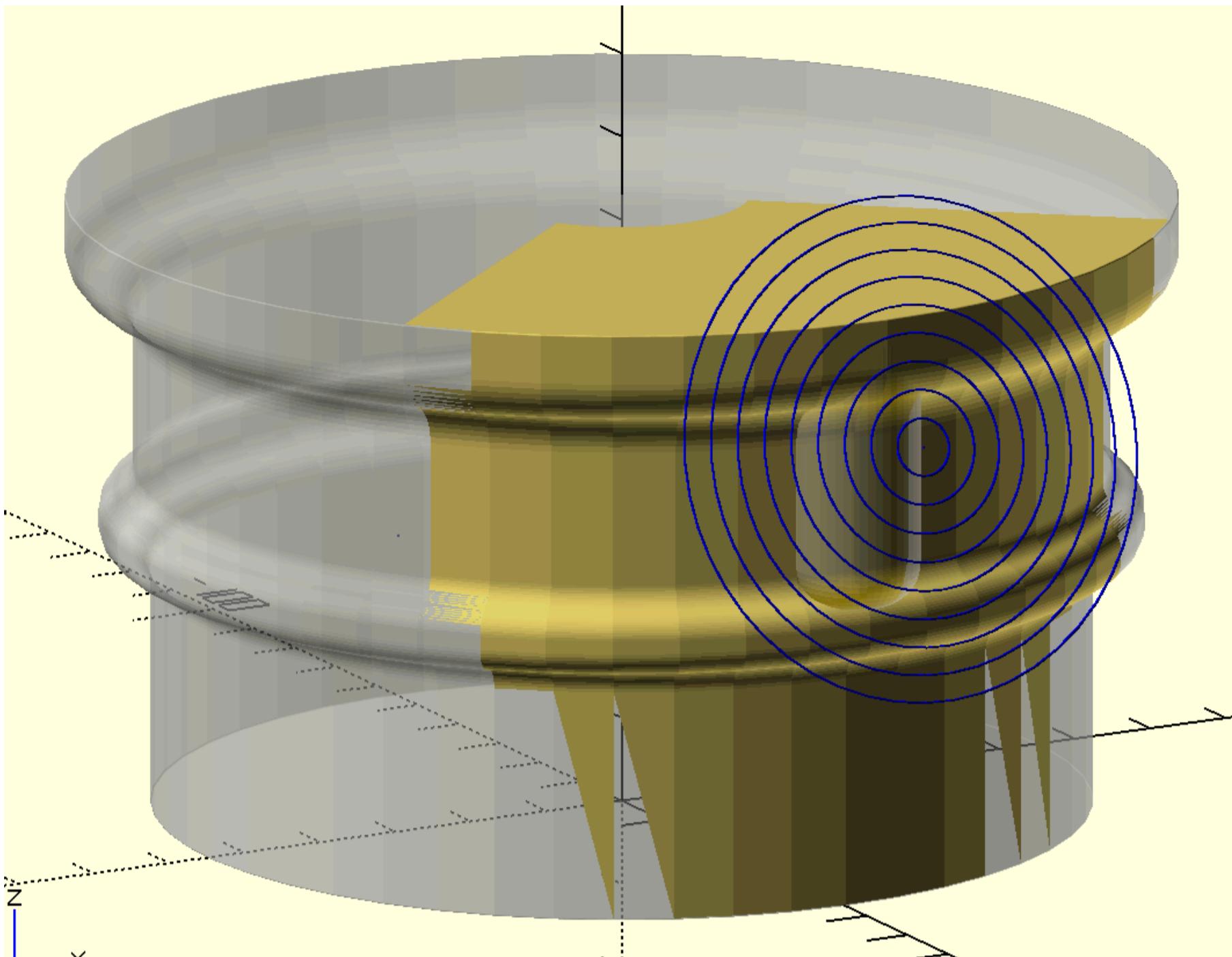
color("blue")for(p={s1})for(p1=p)p_line3dc(p1,.2,rec=1);
polyhedron({v},{f1});

'''')

f_t=time.time()
f_t-i_t
# len(p1),len(p2),len(p3)
```

Out[295...]

0.6005632877349854



```
In [297... # example of function surface_for_fillet(sol1=[],sol2=[],factor1=50,factor2=10,factor3=1,factor4=100,dia=40)
t0=time.time()

sec=circle(10)
path=corner_radius(pts1([[-8,0],[10,0],[-2,0,2],[-1,15,3],[-8.9,0]]),10)
path=equidistant_path(path,100)
sol1=rot('z90',prism(sec,path))

sec1=corner_radius(pts1([[0,0,1],[5,0,1],[0,7,2.3],[-5,0,2.3]]),10)
path1=corner_radius(pts1([[-2.4,0],[2.4,0,2],[0,5,.3],[-.5,0]]),10)
path1=equidistant_path(path1,30)
sol2=translate([6,0,12],rot('x90z90',prism(sec1,path1)))

i_p1=shield(sol1,sol2,100,20,4,23)
v,f1=partial_surface(sol1,prism_center(sol2),10)

fileopen(f'''

%{swp(sol1)}
%{swp(sol2)}
color("blue") for(p={i_p1})for(p1=p)p_line3dc(p1,.05,rec=1);
polyhedron({v},{f1});

'''')

t1=time.time()
t1-t0

# len(ip2),len(ip3),len(ip4)
```

Out[297... 0.8876800537109375

```
In [298... i_t=time.time()
sec1=circle(55)
path1=corner_radius(pts1([[-50,0],[50,0,.2],[0,30,3],[6,1,3],[0,6,3],[-4,2,3],[0,22,6],[8,2,6],[0,10,.2],[-50,0]]),10)
# path1=equidistant_path(path1,200)
sec2=circle(7.5)
path2=corner_radius(pts1([[-5,0],[5,0,5],[0,35,2],[-5,0]]),10)
path2=equidistant_path(path2,100)
sol1=prism(sec1,path1)
sol2=translate([57.5,0,37],prism(sec2,path2))
sol2=axis_rot_o([0,0,1],sol2,180)

v,f1=partial_surface(sol1,prism_center(sol2),30)

i_p1=ip_tri2sol(v,f1,cpo(sol2))
p1=[p[0] for p in i_p1]
p2=[p[-1] for p in i_p1]
p3=flip(p1)+p2

fillet1=i_line_tri_fillet(v,f1,sol2,p3,3,-3,s=20)

fileopen(f'''

%{swp(sol1)}
%{swp(sol2)}
//polyhedron({v},{f1});
```

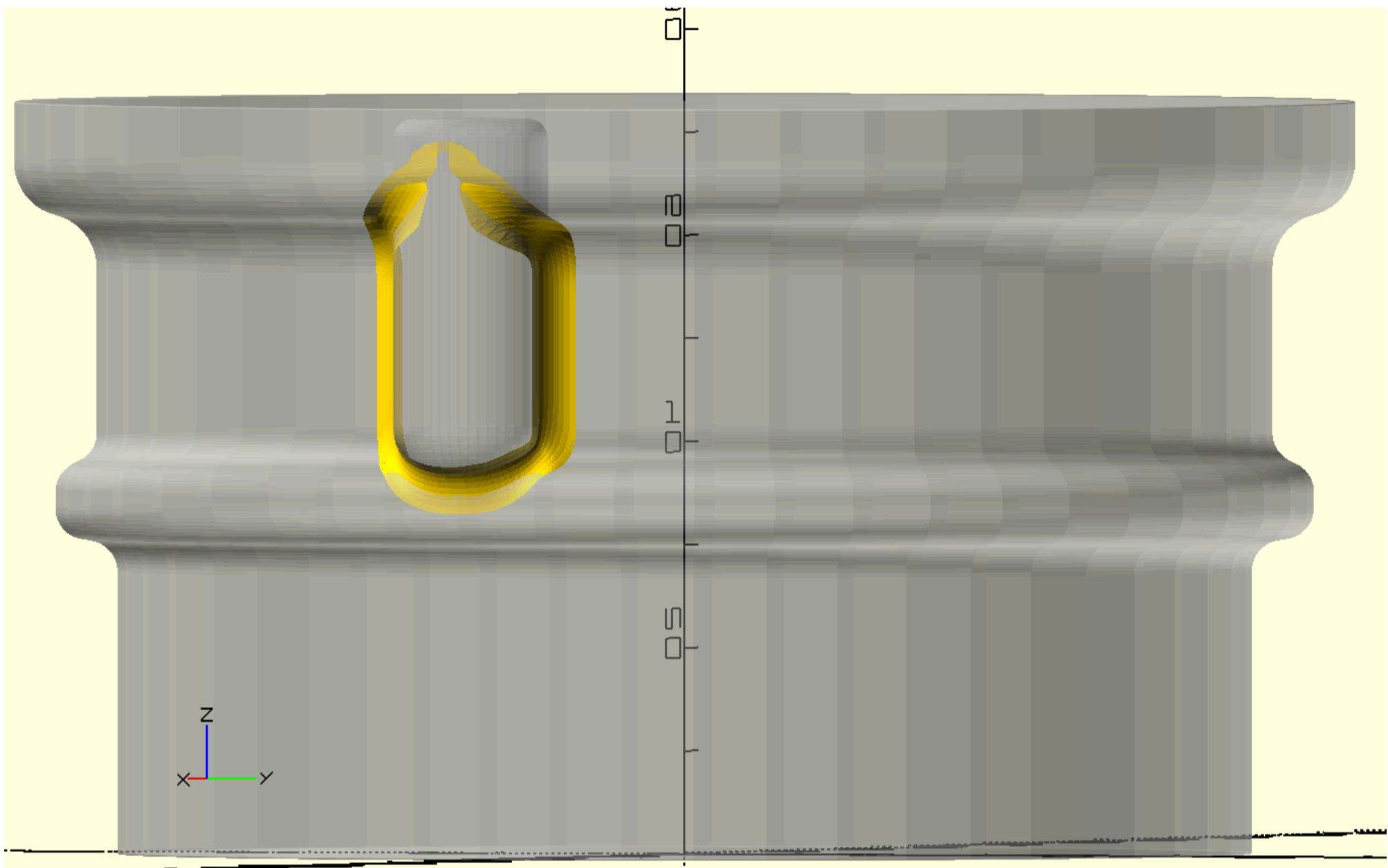
```

{swp_c(fillet1)}
''')

f_t=time.time()
f_t-i_t
# len(p3),len(p4),len(p5)

```

Out[298... 2.1945741176605225



```

In [299... t1=time.time()

p1=[[0,-15,.5],[6,0,.3],[0,-16,.1],[1,-1,.1],[4,0,.2],[2,10,4],[35,0,10],
    [5,22,5],[5,22,10],[-35,0,4],[-2,10,.2],[-4,0,.1],[-1,-1,.1],[0,-16,.3],
    [-6,0,.5]]
sec1=corner_radius(pts1(p1),10)
path1=c2t3(circle(10,s=72))
sol1=path_extrude_closed(sec1,path1)

sec3=circle(7,s=100)
path2=corner_radius(pts1([[2,0],[-2,31]]),10)

sol3=translate([51,0,12],prism(sec3,path2))
v,f1=partial_surface(sol1,prism_center(sol3),30)
p2=ip_tri2sol(v,f1,sol3)
p2=[p[0] for p in p2]
fillet1=i_line_tri_fillet(v,f1,sol3,p2,3,-3)

f3=end_cap(sol3,2)[1]
fileopen(f'''

%{swp_c(sol1)}
%difference(){{
{swp(sol3)}
{swp_c(f3)}
}}
{swp_c(fillet1)}
polyhedron({v},{f1});
color("blue")points({p2},.2);

''')

t2=time.time()
t2-t1
# len(p1),len(p2),len(p3)

```

Out[299... 1.1701881885528564

```

In [300... t0=time.time()
c1=circle(22.6,s=100)
c2=circle(6,rot2d(90,[26.27,0]))
c2,c3,c4=[rot2d(i,c2) for i in [0,120,240]]
a1=two_cir_tarc(c1,c2,7.5,s=20)
a2=two_cir_tarc(c2,c1,7.5,s=20)
a3=two_cir_tarc(c1,c3,7.5,s=20)
a4=two_cir_tarc(c3,c1,7.5,s=20)
a5=two_cir_tarc(c1,c4,7.5,s=20)
a6=two_cir_tarc(c4,c1,7.5,s=20)
sec=concave_hull(c1+c2+c3+c4+a1+a2+a3+a4+a5+a6,3)
s1=linear_extrude(sec,3)
c5=circle(33.75/2)
path=corner_radius_with_turtle([[1.88,3],[-1.88,0,1.88],[0,5.63],[-1.125,0],[0,3.75],
    [1.125,0],[0,7.5],[-1.125,0],[0,3.75],[1.125,0],[0,5.63]],20)

```

```

s2=prism(c5,path)
h=a_(s2).reshape(-1,3)[:,2].max()
s3=linear_extrude(circle(14.06),h)
s4=linear_extrude(circle(2.81,rot2d(90,[26.27,0])),3)
s4,s5,s6=[rot(f'z{i}',s4) for i in [0,120,240]]
e1=end_cap(s1,1)
e2=l_(concatenate([end_cap_1(p,1) for p in [s4,s5,s6]]))
e3=end_cap_1(s3,1)
e4=end_cap(s2,1)[-1]

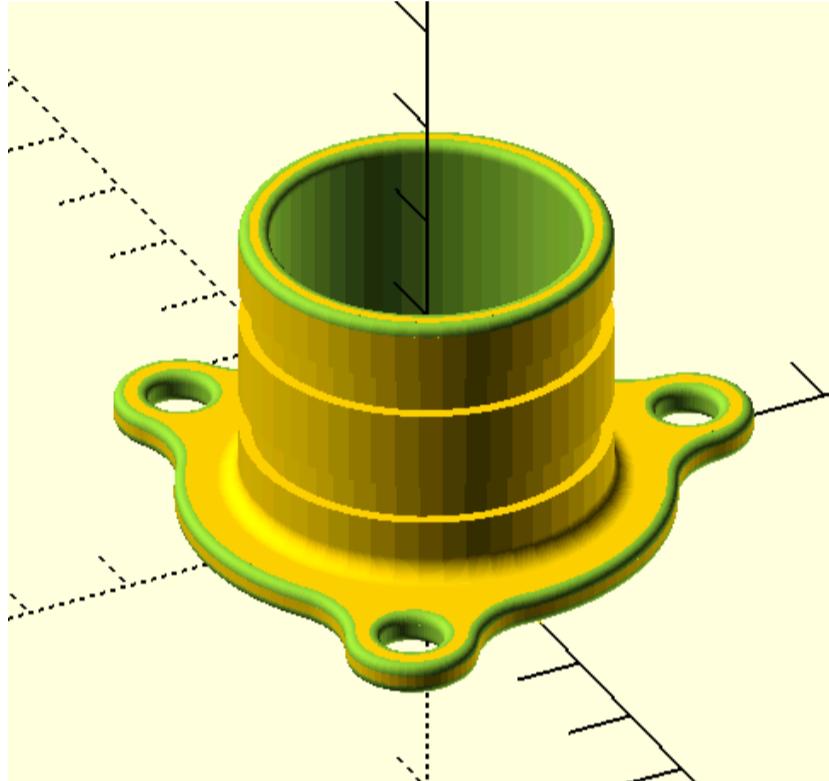
fileopen(f'''')

difference() {{
for(p={[s1,s2]})swp(p);
{swp(s3)}
for(p={[s4,s5,s6]})swp(p);
for(p={e1})swp_c(p);
for(p={e2})swp(p);
for(p={e3})swp(p);
{swp_c(e4)}
}>

''')
t1=time.time()
t1-t0

```

Out[300... 7.45582389831543



```

In [301... i_t=time.time()

sec1=r_sec(60,60,[-55/2,0],[55/2,0],s=50)[-1]
path1=corner_radius(pts1([[0,0],[0,8],[-14.5,0,2],[0,24,20],[-25,0]]),10)

sol1=prism(sec1,path1)
sol1=sol1+[sort_points(sol1[-1],[[0,0,24+8]])]
e6=end_cap(sol1[:2],2)
sec2=offset(sec1,-22.5)
path2=corner_radius(pts1([[0,-0.01],[0,24.01,12],[-12-25.5,0]]),10)
sol2=prism(sec2,path2)
sol2=sol2+[sort_points(sol2[-1],[[0,0,24]])]
e1=end_cap_1(sol2[:2],5)[0]
sec3=circle(8)
path3=corner_radius(pts1([[0,16],[0,27,2],[7,0,2],[0,5]]),10)
sol3=prism(sec3,path3)
e4=end_cap(sol3,2)
fillet1=ip_fillet_closed(sol1,sol3,-2,2,style=2)
fillet2=ip_fillet_closed(sol2,sol3,-2,-2,style=2)

sol4=translate([34.75,0,28],linear_extrude(circle(9),8))
e5=end_cap(sol4,2)[1]
fillet3=ip_fillet_closed(sol1,sol4,-2,2,style=2)

sol5=translate([0,0,16],linear_extrude(circle(4),32))

e2=end_cap_1(sol5,2)
sol6=translate([34.75,0,24],linear_extrude(circle(5),12))
e3=end_cap_1(sol6,2)
sol7=translate([0,52.5,0],linear_extrude(circle(4),8))
sol8=[translate([-55/2,0,0],rot(f'z{i}',sol7)) for i in [0,60,120,180]]
sol9=[translate([55/2,0,0],rot(f'z{i}',sol7)) for i in [0,-60,-120,-180]]
sol10=end_cap_1(sol7,1)
sol11=l_(concatenate([translate([-55/2,0,0],rot(f'z{i}',sol10)) for i in [0,60,120,180]]))
sol12=l_(concatenate([translate([55/2,0,0],rot(f'z{i}',sol10)) for i in [0,-60,-120,-180]]))
fileopen(f''''
//color("blue")p_line({sec1},.05);
//color("blue")p_lineo({path1},.2);

difference() {{
union() {{
difference() {{
{swp(sol1)}
{swp(sol2)}
for(p={sol8})swp(p);
for(p={sol9})swp(p);
{swp(e1)}
for(p={sol11})swp(p);
for(p={sol12})swp(p);
}}}
}}
```

```

{swp(sol3)}
{swp(sol4)}
}
{swp(sol5)}
for(p={e2})swp(p);
{swp(sol6)}
for(p={e3})swp(p);
for(p={e4})swp_c(p);
{swp(e5)}
for(p={e6})swp_c(p;
}

{swp_c(fillet1)}
{swp_c(fillet2)}
{swp_c(fillet3)}

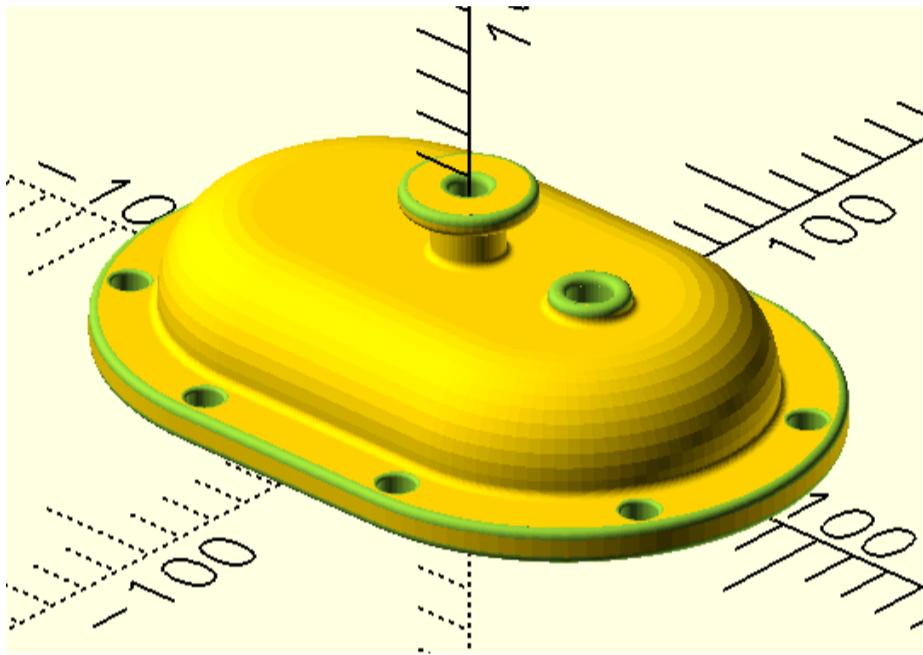
//color("blue")for(p={sol1[:2]})p_line3dc(p,.5,rec=1);
'')

```

f_t=time.time()
f_t-i_t

/Users/sanjeevprabhakar/python_openscad/openscad2.py:4498: RuntimeWarning: invalid value encountered in divide
u=einsum('ijkl,ijkl->ijk',cross(p02[None,None,:,:],(-lab)[:, :,None,:]),(la[:, :,None,:]-p0[None,None,:,:]))/(einsum('ijl,kl->ijk',(-lab),cross(p01,p02))
+.00000)

Out[301... 9.567402839660645



```

In [302... i_t=time.time()

a1=c2t3(arc_2p([0,0],[5,28],58,-1))
a2=flip(c2t3(arc_2p([-1,2],[3,28],56,-1)))

a3=[[-5,0,0],[0,0,3]]+a1[2:-1]+[[5,28,.9],[3,28,.9]]+a2[1:-1]+[[-1,2,2],[-5,2,0]]
path1=corner_radius(a3,10)
sec1=circle(43/2,s=50)
sol1=prism(sec1,path1)

c1=circle(7.75,[10,18])
p0=[0,8]
p1=p_cir_t(p0,c1)
p2=c1[19]
a4=arc_long_2p(p1,p2,7.75,-1,s=50)
path2=cytz([p0]+a4)
sec2=circle(2,s=30)
sol2=translate([18.7,0,-3],align_sol_1(path_extrude_open(sec2,path2)))

a5=[[-5,0,0],[0,0,5]]+a1[1:-1]+[[5,28,1],[3,28,0]]
path3=corner_radius(a5,10)
sol3=prism(sec1,path3)
fillet1=flip(ip_fillet_closed(sol1,sol2[:-10],-2,2,style=2))
fillet2=ip_fillet_closed(sol3,flip(sol2[30:]),2,2,style=2)

sol4=cut_plane([0,-1,0],[100,100],100)
fileopen(f''

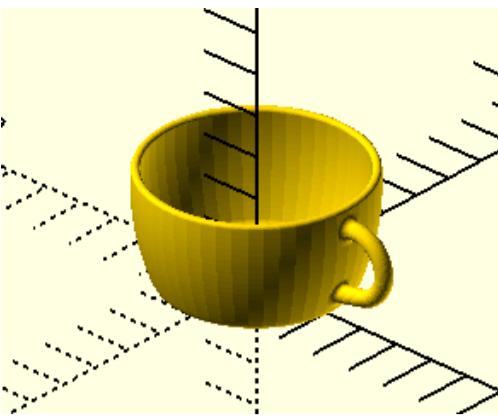
{swp(sol1)}
difference(){{
{swp(sol2)}
{swp(sol3)}
}}
{swp_c(fillet1)}
{swp_c(fillet2)}

'')

```

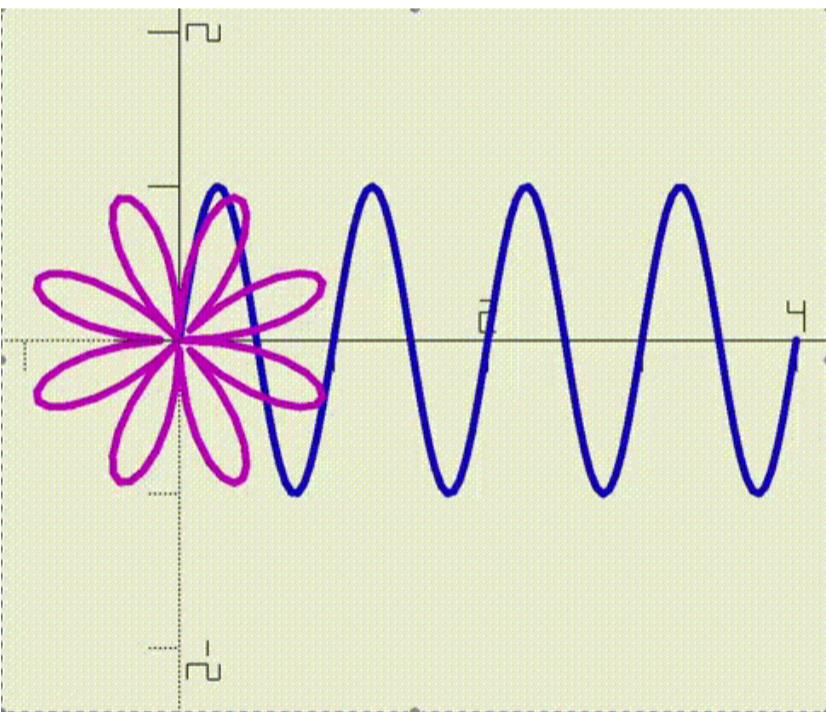
f_t=time.time()
f_t-i_t

Out[302... 3.66369891166687



```
In [303]: sec=corner_radius(pts1([[-2.5,-2.5,0],[5,0,2.5],[0,2.5,0.5],[5,0,0]]),10)  
fileopen(f'''  
color("blue")p_lineo({sec},.05);  
''' )
```

```
In [ ]: s=100  
x=2  
a=linspace(0,4,s)  
b=sin(d2r(720/x*a))  
  
theta=720/x*a  
c=cos(d2r(theta))  
d=sin(d2r(theta))  
e=array([[cos(d2r(i)),sin(d2r(i))] for i in linspace(0,360,s)])  
e=einsum('ij,i->ij',e,abs(b)).tolist()  
sw=array([a,b]).transpose(1,0).tolist()  
  
fileopen(f'''  
e={e};  
sw={sw};  
color("blue")p_lineo(loop(sw,0,100*$t),.05);  
color("magenta")p_lineo(loop(e,0,100*$t),.05);  
  
''' )
```



```
In [ ]: s=200  
x=2  
a=linspace(0,4,s)  
b=sin(d2r(270/x*a))  
  
theta=270/x*a  
c=cos(d2r(theta))  
d=sin(d2r(theta))  
e=array([[cos(d2r(i)),sin(d2r(i))] for i in linspace(0,360,s)])  
e=einsum('ij,i->ij',e,abs(b)).tolist()  
sw=array([a,b]).transpose(1,0).tolist()  
  
fileopen(f'''  
e={e};  
sw={sw};  
color("blue")p_lineo(loop(sw,0,200*$t),.05);  
color("magenta")p_lineo(loop(e,0,200*$t),.05);  
  
''' )
```

```
In [ ]: # 3d knots various types  
t0=time.time()  
# trefoil knot  
  
# path=[[10*(sin(t)+2*sin(2*t)),  
#        10*(cos(t)-2*cos(2*t)),  
#        -10*sin(3*t)] for t in d2r(arange(0,360))]  
  
# circular sin theta knot  
  
# path=[[60*(cos(t)),  
#        60*(sin(t)),  
#        20*sin(4*t)*cos(4*t)] for t in d2r(arange(0,360))]
```

```

# random knot

# path=[[20*(-0.22*cos(t) - 1.28*sin(t) - 0.44*cos(3*t) - 0.78*sin(3*t)),
# 20*(-0.1*cos(2*t) - 0.27*sin(2*t) + 0.38*cos(4*t) + 0.46*sin(4*t)),
# 20*(0.7*cos(3*t) - 0.4*sin(3*t))] for t in d2r(arange(0,360))]

# torus knots

# path=[[10*cos(3*t)*(3+cos(4*t)),
# 10*sin(3*t)*(3+cos(4*t)),
# 10*sin(4*t)] for t in d2r(arange(0,360))]

# cinquefoil torus knots
# a,p,q=3,3,16
# d=10

# explanation
# radius of the torus = a*d
# section radius of the torus = d
# p in number of cycles of the wrapping coil over torus
# q in the number of turns of the wrapping coil over torus

# path=[[d*cos(p*t)*(a+cos(q*t)),
# d*sin(p*t)*(a+cos(q*t)),
# -d*sin(q*t)] for t in d2r(arange(0,360,1))]

# Lissajous knots

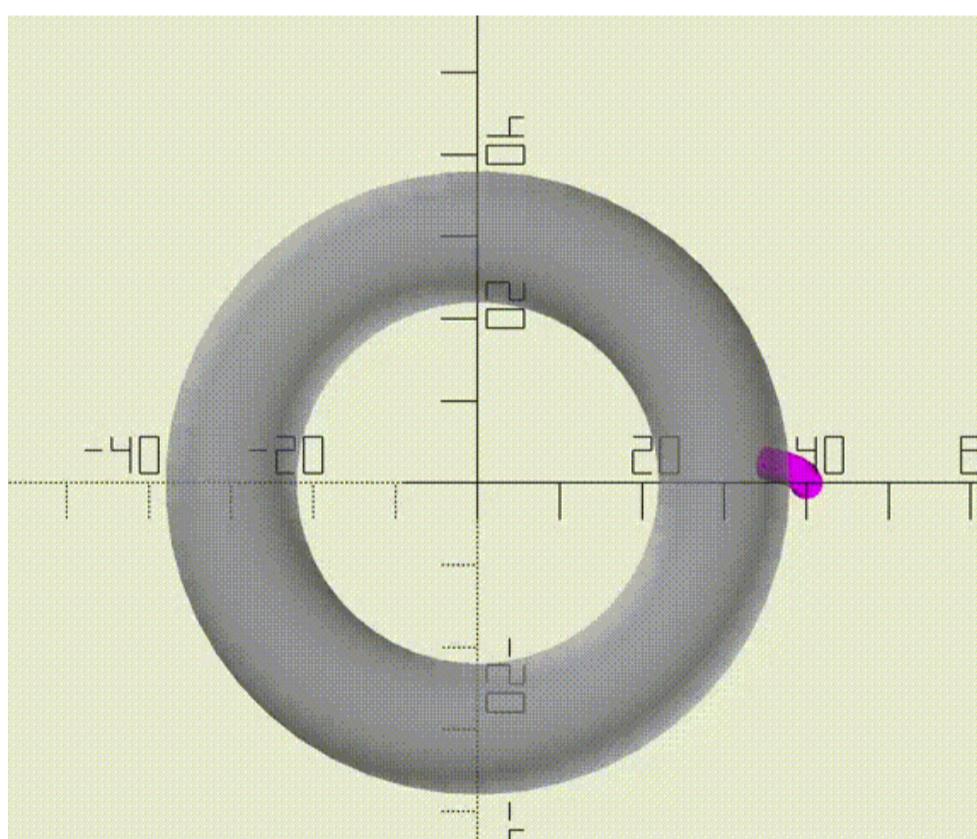
path=[[10*cos(3*t+5),
10*cos(3*t+10),
10*cos(3*t+2)] for t in d2r(arange(0,360))]
r=2
sec=circle(r)
sol=align_sol_1(path_extrude_closed(sec,path))

# sec1=circle(d-r)
# path1=c2t3(circle(a*d))
# sol1=path_extrude_closed(sec1,path1)

fileopen(f'''
//color("blue")p_line3d({path},4);
sol={sol};
//color("magenta")swp_c(loop(sol,0,360*t));
//color([.2,.5,.7,.3])
{swp_c(sol)}

//%{swp_c(sol1)}
''')
t1=time.time()
t1-t0

```



```

In [304...]
sec=circle(25)
path=corner_radius(pts1([[0,0,0],[0,15,1],[-6,50,1],[0,18,0]]),10)
sol=prism(sec,path)
sol1=prism(circle(24),path)
sol0=swp_prism_h(sol,sol1)
sec2=circle(15)
path2=cr3dt([[0,0,15,0],[-60,0,40,20],[0,0,30,0]],10)
sol2=path_extrude_open(sec2,path2,twist=1)
sol3=path_extrude_open(offset(sec2,-1),path2,twist=1)
sol02=swp_prism_h(sol2,sol3)
fillet1=ip_fillet_closed(sol,sol2,-5,5,style=2)

sec3=corner_radius(pts1([[0,0],[-2,1,.2],[2,1]]),10)
path3=helix(14,2.5,6,5)
sol4=path_extrude_open(sec3,path3)

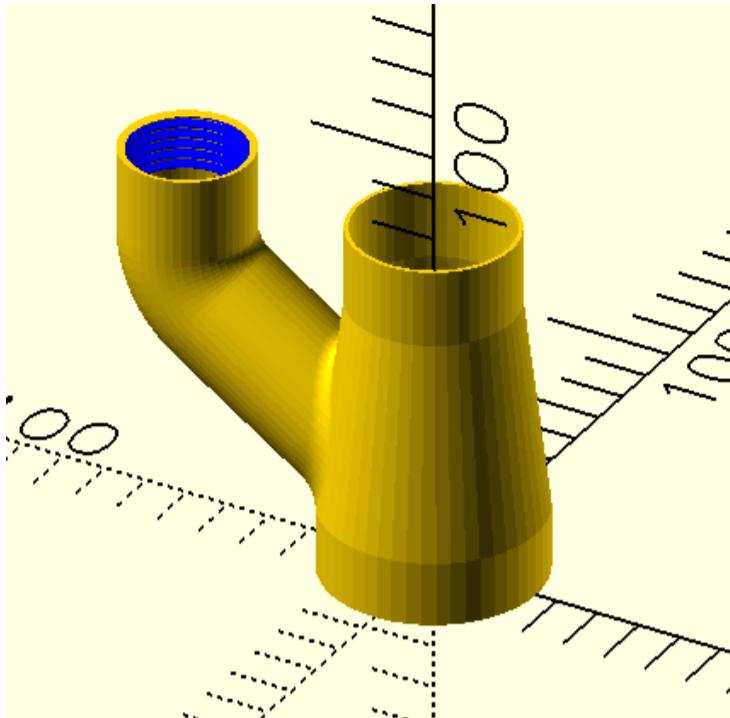
sol4=sol2vector([0,0,1],sol4,[-60,0,70])
fileopen(f'''
difference(){{
{swp_c(sol0)}
{swp(sol3)}}
}}
difference(){{
{swp_c(sol02)}
{swp(sol)}}
}}
```

```

    }
{swp_c(fillet1)}
intersection(){}
color("blue"){swp(sol4)}
{swp(sol3)}
}
}

''')

```



sinwave-box

```

In [305... i_t=time.time()
# sinwave glass
height=125
dia=100
width=pi*dia
factor=round(width/height,0)
sec=[[i,j,1*sin(d2r(i*360/height*3))*sin(d2r(j*360/width*3*factor))] for j in linspace(0,width,150) for i in linspace(0,height,100)]
# path=translate([0,100/pi/2,100/pi/2],rot('y90',arc(100/pi/2,0,400,s=200)))
path=rot('y90',arc(dia/2,0,400,s=200))

surf1=[wrap_around(p,path)[::-1] for p in sec]

surf2=offset_sol(surf1,-2)

sol1=rot('y-90',swp_prism_h(surf2,surf1))
sol2=rot('y-90',surf1[:2])

p0=sol1[2][:;-1]
p1=sol1[15][:;-1]
p2=offset_3d(p0,-15)
fillet1=convert_3lines2fillet_closed(p2,p1,p0,s=30)

sol3=flip(sol1)[:;-15]+flip(cpo(fillet1)[1:-1])

sol4=cut_plane([-1,0,0],[300,300],300,0,0,0)
fileopen(f'''
difference(){{{
{swp(sol3)}
//{swp(sol4)}}

}}}
''')
f_t=time.time()
f_t-i_t

```

Out[305... 4.131097793579102

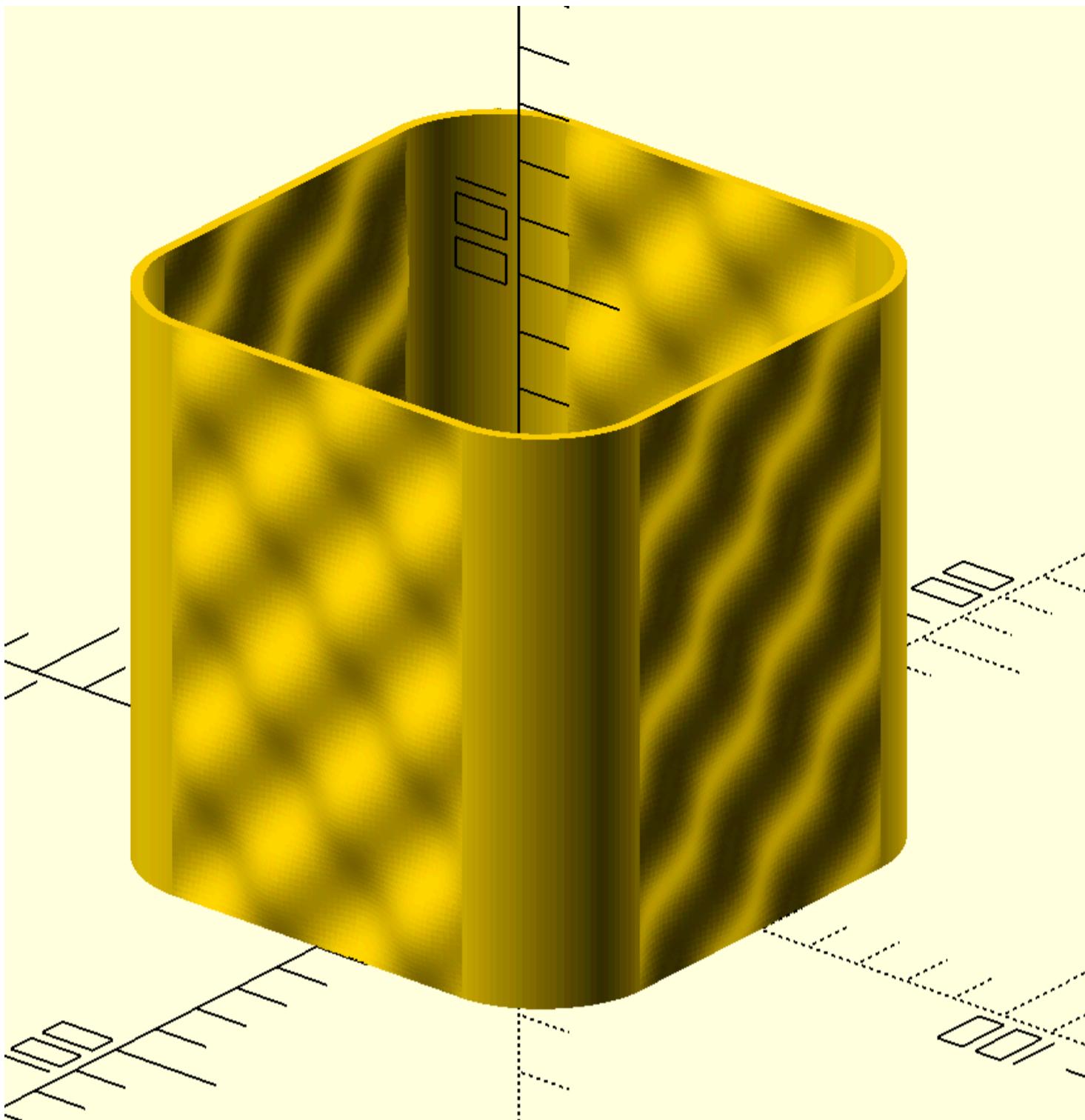
```

In [306... i_t=time.time()
# sinwave-box
w1=rot('x90',sinewave(100,2.5,1.5,100))
w2=rot('x90z0',sinewave(60,1.5,1.5,60))
s1=translate([50,-30,0],rot('y-90',surface_from_2_waves(w1,w2,1.5)))
s2=[cpo(rot(f'z{i}',s1)) for i in [0,90,180,270]]
l1=s2[0][-1]
l2=s2[1][0]
l3=translate([0,20,0],l1)
f1=cpo(convert_3lines2fillet(l1,l2,l3,s=30))[:;-1]
f2=[rot(f'z{i}',f1[1:-1]) for i in [0,90,180,270]]
s3=cpo(s2[0]+f2[0]+s2[1]+f2[1]+s2[2]+f2[2]+s2[3]+f2[3])
s4=offset_sol(s3,-2)
sol=s3+flip(s4)[:;-2]
l1=flip(s4)[-6]
l2=flip(s4)[-3]
l3=offset_3d(l2,-3)
f3=convert_3lines2fillet_closed(l3,l1,l2,s=20)
fileopen(f'''
union(){{{
{swp(sol)}
{swp_c(f3)}}

}}}
''')
f_t=time.time()
f_t-i_t

```

Out[306... 14.769158124923706



rot2d

translate_2d

```
In [307]: c1=circle(22.5)
c2=translate_2d([26.25,0],circle(6))
c3=[rot2d(i,c2) for i in [0,120,240]]

a1=t_cir_tarc(22.5,6,[0,0],[26.25,0],7.5)
p0,p1=a1[0],a1[-1]

a2=t_cir_tarc(22.5,6,[0,0],[26.25,0],7.5,side=1)
p2,p3=a2[0],a2[-1]
p4=rot2d(120,p0)

sec=arc_2p(p0,p1,7.5,cw=1)+arc_2p(p1,p2,6,cw=-1)+ \
arc_2p(p2,p3,7.5,cw=1)+arc_2p(p3,p4,22.5,cw=-1)

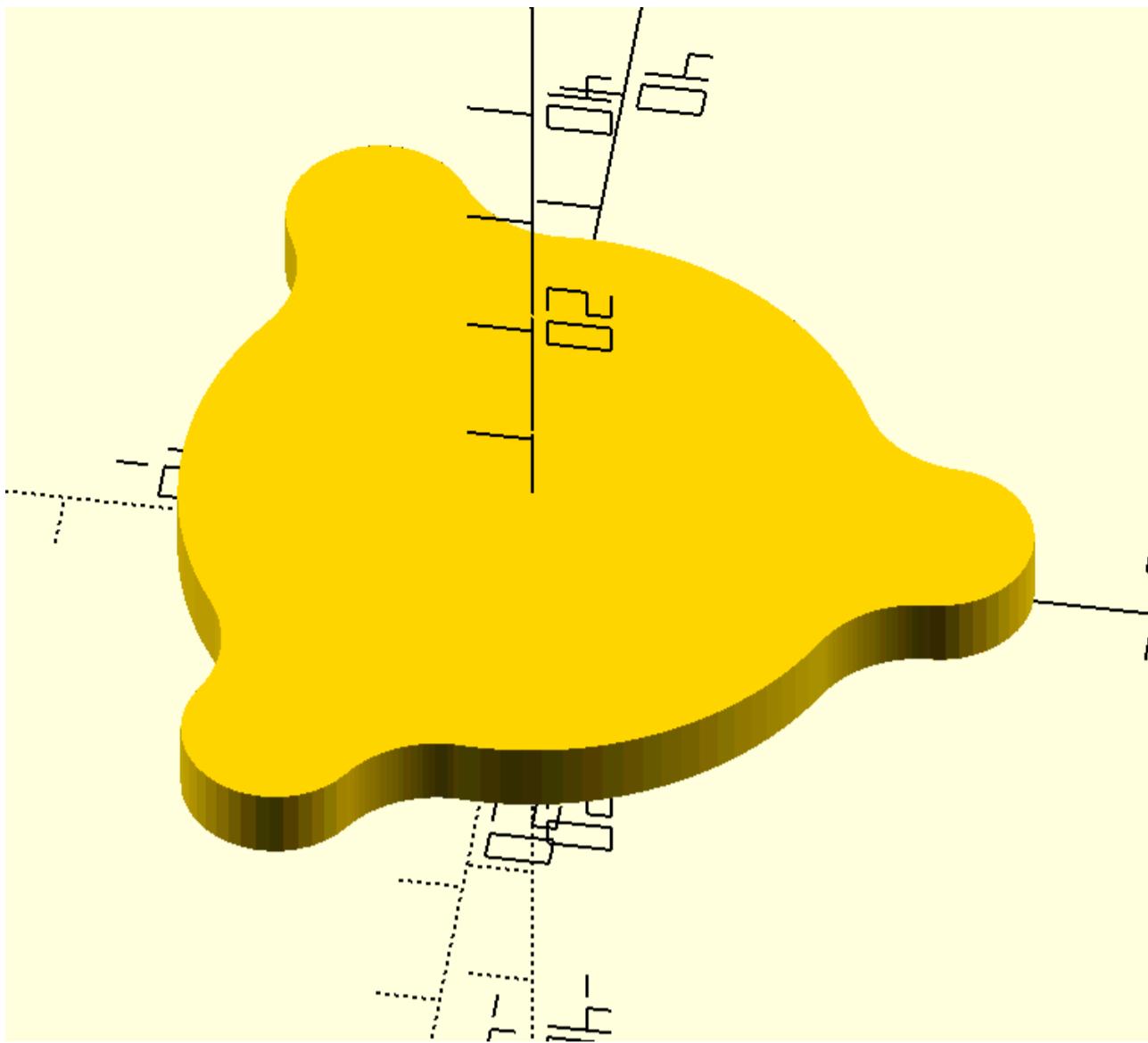
sec=[rot2d(i,sec) for i in [0,120,240]]

sec=remove_extra_points(concatenate(sec).round(5))

sol=linear_extrude(sec,5)

fileopen(f'''
//color("blue",.2)p_line3dc({c1},.3);
//color("magenta",.2)for(p={c3})p_line3dc(p,.3);

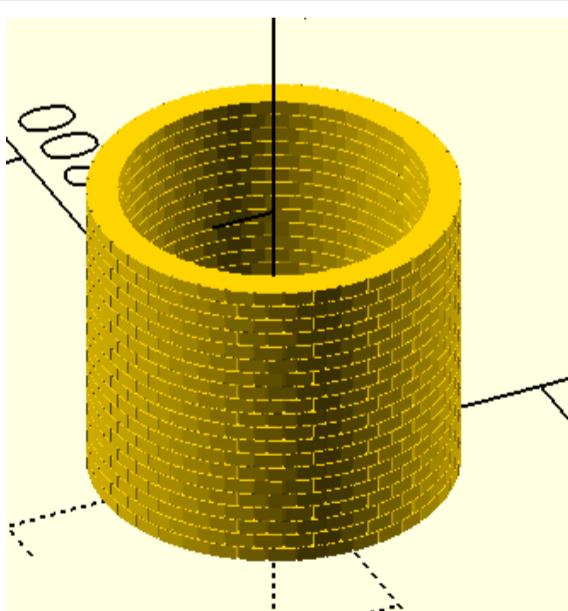
//color("cyan")p_line3dc({sec},.5);
//color("blue")points({[p4]},1);
{swept(sol)}
''' )
```



```
In [308...]
peri=400
height=100
sec=corner_radius(pts1([[0,0],[9,0],[0,1],[1,0]]),10)
sec=concatenate([translate_2d([i,0],sec) for i in arange(0,peri,10)]).tolist()

sec=translate([0,1,0],rot('x90z90',sec))
path=rot('y90',arc(401.07/(2*pi),0,360,s=100))
sec=rot('y-90',wrap_around(sec,path))
sec1=translate([0,0,5],sec)
sec2=offset_3d(sec1,-.5,2)
sec3=rot('z5',translate([0,0,5.5],sec))
sec4=offset_3d(sec3,-.5,2)
sec5=translate([0,0,5],sec3)
sec6=translate([0,0,5],sec4)
sec7=translate([0,0,11],offset_3d(sec,-.5,2))
sec8=translate([0,0,11],sec)

sol=[sec,sec1,sec2,sec4,sec3,sec5,sec6,sec7,sec8]
sol1=concatenate([ translate([0,0,i],sol) for i in range(0,110,11)]).tolist()
a=[0,5,5,5.5,5.5,10.5,10.5,11,11]
b=[10,10,9,9,10,10,9,9,10]
sol2=[translate([0,0,a[i]],offset(c3t2(sol[i]),-b[i],2)) for i in range(len(a))]
sol2=concatenate([ translate([0,0,i],sol2) for i in range(0,110,11)]).tolist()
sol3=swp_prism_h(sol1[:-2],sol2[:-2])
fileopen(f'''{swp_c(sol3)}'''')
```



```
In [ ]:
sec=corner_radius(pts1([[0,0],[70,0],[0,28],[-17.5,0,7],[0,24.5,17.5],
,[-35.01,0,17.5],[0,-24.5,7],[-17.5,0]]),20)

cp_1=cp_arc(sec[26:30])
c1=circle(10,cp_1)
c2=circle(2.5,[7.5,14])
c3=circle(2.5,[62.5,14])
sol1=linear_extrude(sec,16)
sol2=[translate([0,0,-.5],linear_extrude(p,17)) for p in [c1,c2,c3]]
sol3=translate([-5,-5,12.5],cube([18,40,20]))
sol4=translate([70-17.5,-5,12.5],cube([18,40,20]))
c4=circle(7.5,[-7.5,32.5])
p0=[0,0]
```

```

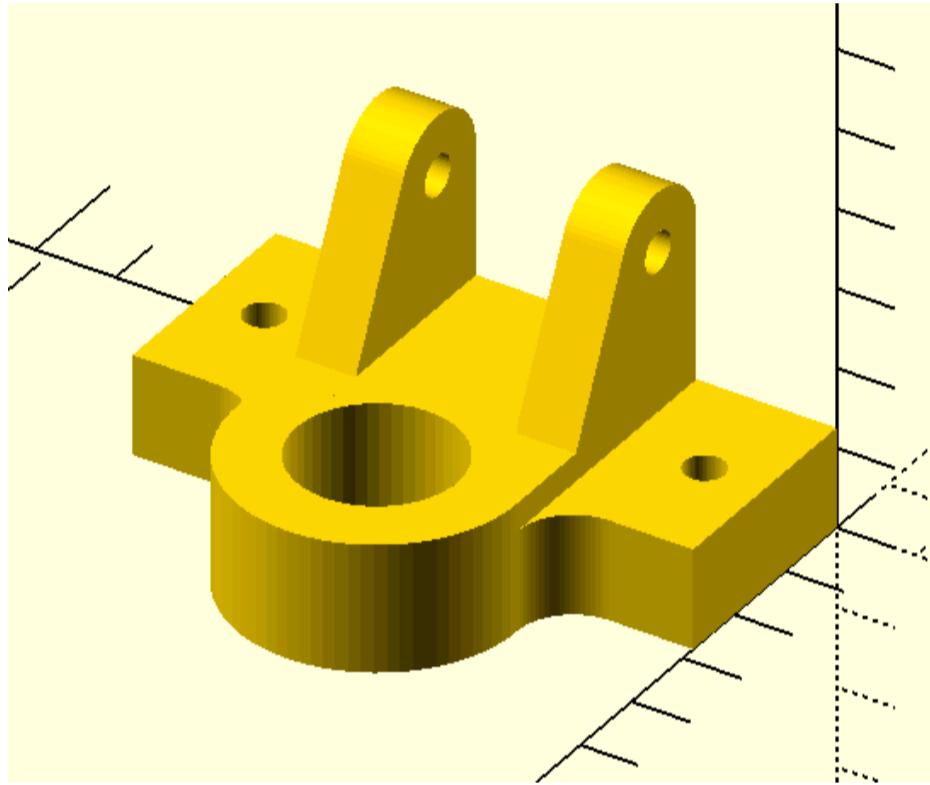
p1=p_cir_t(p0,c4)
p3=[-52.5+29,16]
p2=cir_p_t(c4,p3)
p4=[-52.5+17.5,16]
p5=[-52.5+17.5,0]
c5=circle(2.5,[-7.5,32.5])
sec1=[p0]+arc_2p(p1,p2,7.5,-1,30)+[p3,p4,p5]

sol5=linear_extrude(sec1,7.5)
sol6=translate([0,0,-.5],linear_extrude(c5,9))
fileopen(f'''
//color("blue")p_line3d({sec},.2,1);
//color("magenta")p_line3d({c1},.2,1);
//color("magenta")p_line3d({c2},.2,1);
//color("magenta")p_line3d({c3},.2,1);
//color("blue")points({[p0,p1,p2,p3,p4,p5]},.5);
//color("magenta")p_line3dc({sec1},.2,1);
for(i=[17.5,17.5+35-7.5])
translate([i+7.5,0,0])
rotate([90,0,-90])
difference(){{
{swp(sol5)}
{swp(sol6)}
}}}

difference(){{
{swp(sol1)}
for(p={sol2})swp(p);
{swp(sol3)}
{swp(sol4)}
}}}

''')

```



sinewave

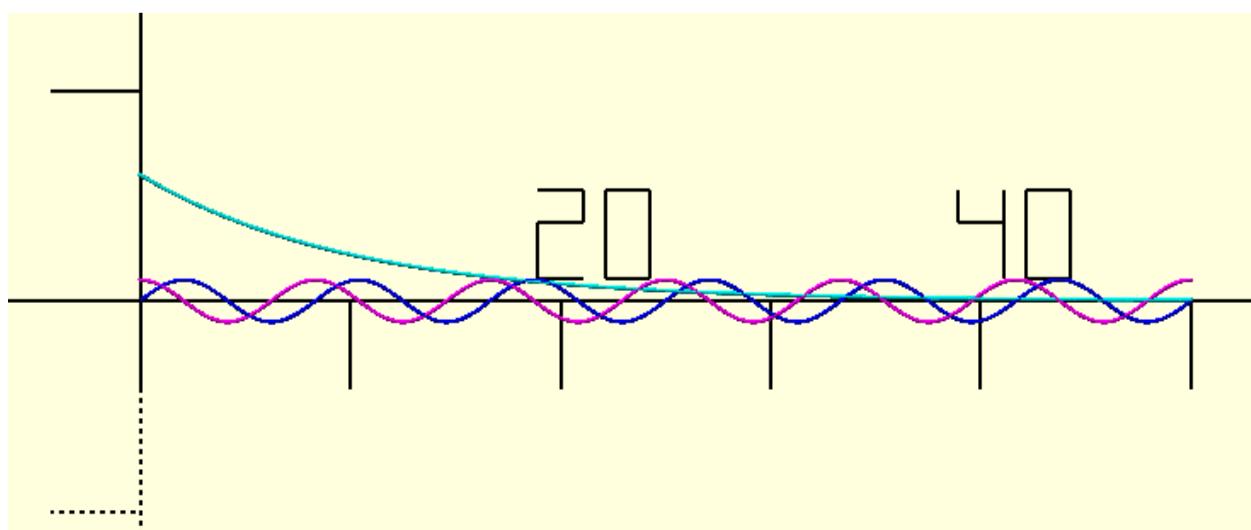
cosinewave

e_wave

```
In [ ]: wav1=sinewave(50,6,1,200)
wav2=cosinewave(50,6,1,200)
wav3=e_wave(50,6,.1,200)

fileopen(f'''
color("blue") p_line3d({wav1},.2);
color("magenta") p_line3d({wav2},.2);
color("cyan") p_line3d({wav3},.2);

'''')
```



```
In [ ]: wav1=sinewave(50,6,1,200)
wav2=sinewave(50,9,1,200)
```

```

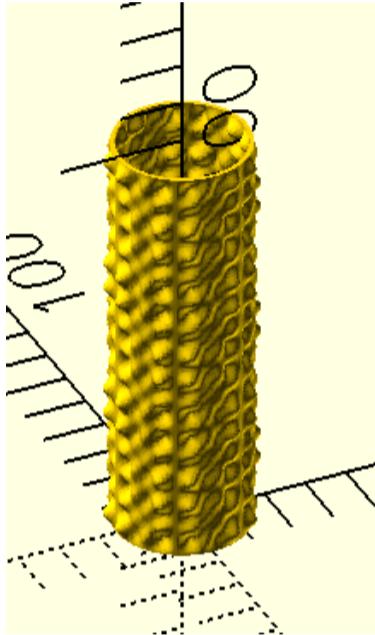
a=[[wav1[i][0] , wav1[i][1]*wav2[i][1] ] for i in range(len(wav1))]
# b=[[wav1[i][0] , wav1[i][1]*wav2[i][1] ] for i in range(len(wav1))]

b=rot('x90',a)
c=rot('x90z90',a)

surf_1=surface_from_2_waves(b,c,1)
surf_2=surf_extrude(surf_1,-.1)

path=circle(50/2/pi+.01,s=100)
path=path+path[:3]
path=rot('y90',path)
sol=[ wrap_around(p,path) for p in surf_1]
sol=rot('y-90',sol)
h=[[0,0,p[0][2]] for p in sol]
s=c3t2(sol)
s1=[offset(p,-.5) for p in s]
sol1=[translate(h[i],s1[i]) for i in range(len(s1))]
sol2=swp_prism_h(sol,sol1)
sol2=scl3d(sol2,2)
fileopen(f'''
{swp_c(sol2)}
'''')

```



SurfaceFrom3LinesInDifferentPlanes

```

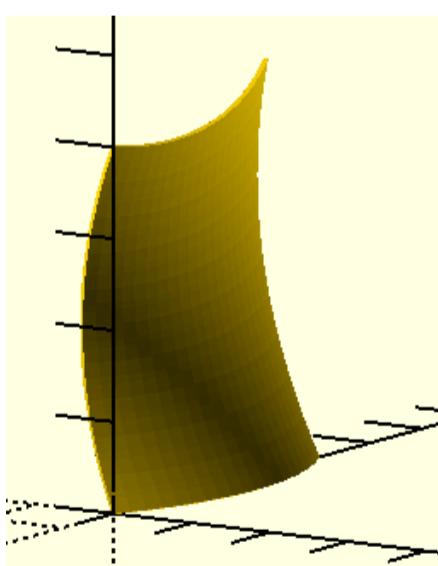
In [ ]: i_t=time.time()
w1=arc_3p_3d([[0,0,0],[5,20,0],[0,40,0]])
w2=arc_3p_3d([[0,0,0],[-4,0,20],[0,0,40]])
w3=arc_3p_3d([[0,0,40],[2,15,40],[0,30,45]])

surf_1=SurfaceFrom3LinesInDifferentPlanes(w1,w3,w2)
surf_2=surface_offset(surf_1,-1)
sol=solid_from_2surfaces(surf_1,surf_2)

fileopen(f'''
color("blue")for(p={sol})p_line3dc(p,.1,1);
{swp(sol)}
'''')

f_t=time.time()
f_t-i_t

```



```

In [ ]: # complex part with fillet
i_t=time.time()

c1=circle(20)
c2=circle(5,[25,0])
f_1=two_cir_tarc(c1,c2,10,0)
f_2=two_cir_tarc(c1,c2,10,1)
p0,p1,p2,p3,p4,p5=f_1[0],f_1[-1],[70,-5],[70,5],f_2[0],f_2[-1]

sec=[p3]+arc_2p(p4,p5,10,1)+arc_long_2p(p5,p0,20,-1,s=50)+ \
arc_2p(p0,p1,10,1)+[p2]

sec=remove_extra_points(array(sec).round(5))
sec=equidistant_path(sec,1000)
sol=translate([0,0,-25],linear_extrude(sec,50))
sol1=translate([40,0,0],rot('x90z180',sol))

```

```

ipa=ip_sol2sol(sol1,sol)
ipb=ip_sol2sol(sol1,sol,-1)

ipc=remove_extra_points(array(ipa+flip(ipb)).round(5))
fillet1=i_line_fillet(ipc,sol,sol1,-2,2,10)
fillet2=solid_from_fillet_closed(fillet1,-4)

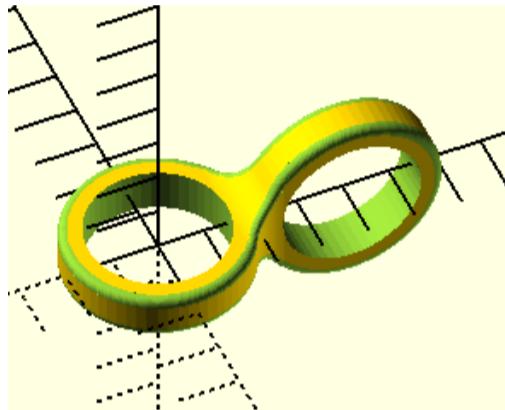
sol2=o_solid([0,0,1],circle(15),10,-5)
e1=end_cap_1(sol2,2)
sol3=o_solid([0,1,0],circle(15),10,-5,40)
e2=end_cap_1(sol3,2)
fileopen(f'''

difference(){{
intersection(){{
{swp(sol)}
{swp(sol1)}
}}
{swp_c(fillet2)}
{swp(sol2)}
{swp(sol3)}
for(p={e1})swp(p);
for(p={e2})swp(p);

}}
''')

f_t=time.time()
f_t-i_t

```



```

In [ ]: # mobile stand revised version
i_t=time.time()
sec=round_corners(pts1([[0,0,1.9],[150,0,1.9],[0,4,1.9],[-150,0,1.9]]),10)
path=round_corners(pts1([[1.9,0],[1.9,0,1.9],[0,120,1.9],[-1.9,0]]),10)

sol=prism(sec,path)
sol=rot('z90',sol)
sol=[equidistant_pathc(p,400) for p in sol]
path1=arc_2p([0,0],[150,0],500,1,150)
path1=translate([0,0,120],rot('x90z90',path1))

sol1=translate([0,0,-120+1.9],sol[-10:])
sol1=[wrap_around(p,path1) for p in sol1]

path2=arc_2p([0,0],[150,0],500,-1,150)
path2=translate([0,0,0],rot('x90z90',path2))
sol2=sol[:10]
sol2=[wrap_around(p,path2) for p in sol2]

sol3=[sol2[-1]]+[sol1[0]]
sol3=slice_sol(sol3,100)
sol4=sol2+sol3+sol1
sol4=translate([0,10,0],rot('y90z90',sol4))

path3=round_corners(pts1([[0,0],[127,0,6],[-50*cos(d2r(60)),50*sin(d2r(60))]]),10)
path3=rot('x90z90',path3)

sol5=[wrap_around(p,path3) for p in sol4]

sec=round_corners(pts1([[6,0,1.9],[150-12,0,1.9],[0,4,1.9],[-150+12,0,1.9]]),10)
path=round_corners(pts1([[0,0],[0,1.9,1.9],[-1.9,0]]),10)

sol=prism(sec,path)
sol=rot('z90',sol)
path=arc_2p([0,0],[150,0],300,1,150)
path=translate([0,0,50],rot('x90z90',path))

sol1=[wrap_around(equidistant_pathc(p,400),path) for p in sol]
sol2=translate([0,0,-50],equidistant_pathc(wrap_around(sol[0]),path),400)
sol2=[sol2]+sol1
sol2=translate([0,100,1],rot('z90x30',sol2))

sol6=[sol5[10]]+[sol5[90]]
sol7=[sol2[0]]+[sol2[1]]
fillet1=flip(ip_fillet_closed(sol6,sol7,-4,3.8,style=2))

fileopen(f'''
{swp(sol5)}
{swp(sol2)}
{swp_c(fillet1)}

''')

f_t=time.time()
f_t-i_t

```

points_inside_offset_surround

```

In [ ]: i_t=time.time()
sec=corner_radius(pts1([[0,0,1],[7,5,2],[5,7,3],[-5,7,2],[-7,5,3]]),10)

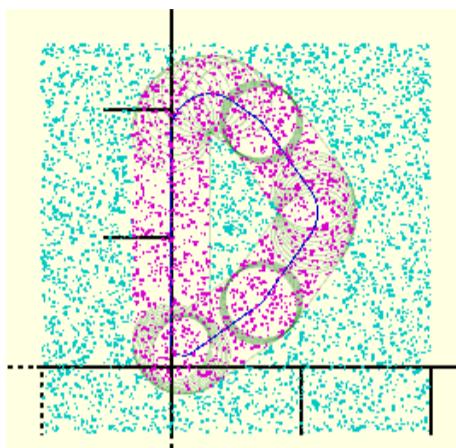
```

```

a=(random.random(5000)*(30-0)+(-10))
b=(random.random(5000)*(30-0)+(-5))
c=array([a,b]).transpose(1,0).tolist()
r=3
sec2=cs1(sec,r-.01)
p_0=points_inside_offset_surround(sec,c,r-.01)
fileopen(f'''
    color("blue")p_line3dc({sec},.1,1);
    color("cyan")points({c},.2);
    color("green",.1)for(p={sec2})p_line3dc(p,.1,1);
    color("magenta")points({p_0},.2);

    ''')
f_t=time.time()
f_t-i_t

```



```

In [ ]: od=150
id=75
n=16
t=3
sl_ang=50
sl_h=(od/2-id/2)*tan(d2r(sl_ang))
a=c2t3(circle(od/2,s=n+1))
b=rot(f'z{360/len(a)/2}',c2t3(circle(od/2,s=n+1)))
h=l_len(a[:2])/2
sol_1=[translate([0,0,i*h],a) if i%2==0
       else translate([0,0,i*h],b)
       for i in range(5)]
a=flip(c2t3(circle(od/2,s=n+1)))
b=flip(rot(f'z{-360/len(a)/2}',c2t3(circle(od/2,s=n+1))))
h=l_len(a[:2])/2
sol_2=[translate([0,0,i*h],a) if i%2==0
       else translate([0,0,i*h],b)
       for i in range(5)]

a=c2t3(circle(id/2,s=n+1))
b=rot(f'z{360/len(a)/2}',c2t3(circle(id/2,s=n+1)))
# h=l_len(a[:2])/2
sol_3=[translate([0,0,i*h],a) if i%2==0
       else translate([0,0,i*h],b)
       for i in range(5)]

a=flip(c2t3(circle(id/2,s=n+1)))
b=flip(rot(f'z{-360/len(a)/2}',c2t3(circle(id/2,s=n+1))))
# h=l_len(a[:2])/2
sol_4=[translate([0,0,i*h],a) if i%2==0
       else translate([0,0,i*h],b)
       for i in range(5)]

a=[seg(p)[-1] for p in cpo(sol_1)]
b=[seg(p)[-1] for p in translate([0,0,sl_h],cpo(sol_3))]

sol_5=array([a,b]).transpose(1,2,0,3,4).tolist()

a=[seg(p)[-1] for p in cpo(sol_2)]
b=[seg(p)[-1] for p in translate([0,0,sl_h],cpo(sol_4))]

sol_6=array([a,b]).transpose(1,2,0,3,4).tolist()

fileopen(f'''

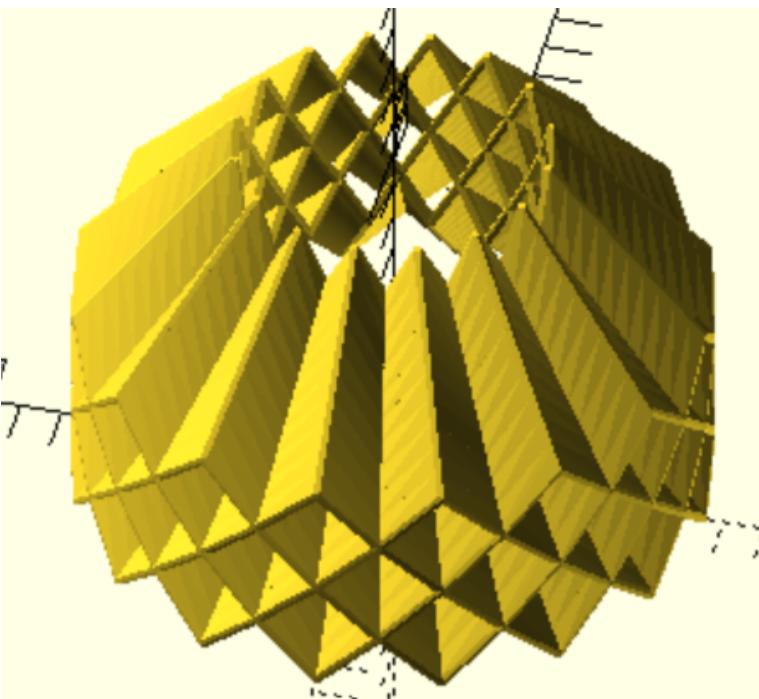
    for(p={sol_5})for(p1=p)
        let(
            a=slice_sol(p1,10)
            )
            for(i=[1:len(a)-1])
            hull(){{}
                p_line3d(a[i-1],{t/2},1);
                p_line3d(a[i],{t/2},1);
            }

            for(p={sol_6})for(p1=p)

            let(
                a=slice_sol(p1,10)
                )
                for(i=[1:len(a)-1])
                hull(){{}
                    p_line3d(a[i-1],{t/2},1);
                    p_line3d(a[i],{t/2},1);
                }

            ''')

```



```
In [ ]: sec=corner_radius(pts1([[-15,0],[0,-3,3],[30,0,3],[0,6.1,3],[-30,0,3]]),10)
cir1=circle(8,s=51)
cir1=c2t3(cir1)
cir2=translate([0,0,5],circle(10,s=51))
cir3=translate([0,0,10],circle(9,s=51))

sec=rot('z0',translate([0,0,50],equidistant_pathc(sec,50)))
sec=align_sec_1(cir1,sec)[1]
# sol_1=cpo(equidistant_path(p,50) for p in cpo([cir1,cir2,cir3,sec]))
sol_1=slice_sol_1([cir1,cir2,cir3,sec],50)
path1=corner_radius(pts1([[0,0,0],[1,25,10],rot2d(5,[40,0]))],20)
path1=rot('x90',equidistant_path(path1,50))
sol_1=sol2path(sol_1,path1)

sol_2=translate([0,0,-1],cylinder(r1=6,r2=12,h=50))
path2=corner_radius(pts1([[-15,10],[17,0,10],[3,18.5,8],rot('z5',[36,0]))],10)
path2=rot('x90',path2)
surf_1=surface_line_vector(path2,[0,20,0],1)
surf_2=translate([-10,0,10],surf_1)
sol_3=solid_from_2surfaces(surf_2,surf_1)

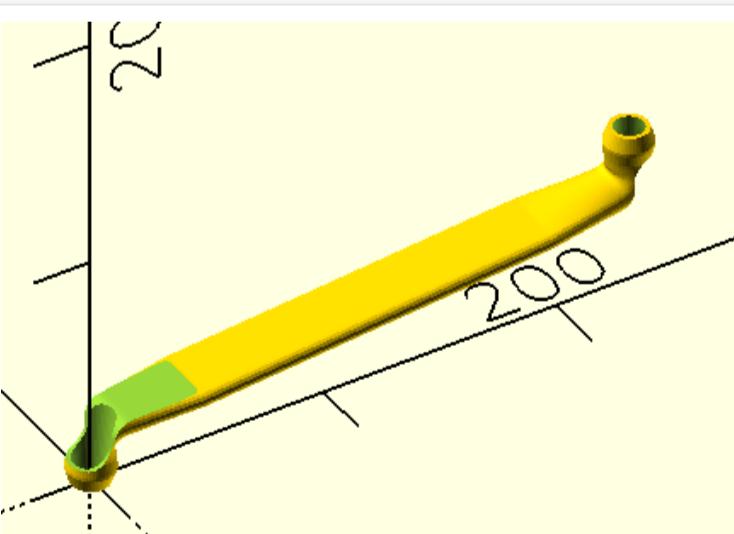
l_1=[path1[-1],(array(path1[-1])+array(rot('y-5',[150,0,0]))).tolist()]
p0=mid_point(l_1)

sol_1_1=axis_rot_1(sol_1,[0,1,0],p0,180)
sol_2_1=axis_rot_1(sol_2,[0,1,0],p0,180)
sol_3_1=axis_rot_1(sol_3,[0,1,0],p0,180)

sol_4=align_sol_1([sol_1[-1],flip(sol_1_1[-1])])
fileopen(f'''
//color("blue")p_line3d({{path1},.2,1);
//color("blue")p_line3d({{path2},.2,1);

union(){
difference(){
{swp(sol_1)}
{swp(sol_2)}
{swp(sol_3)}
}
difference(){
{swp(sol_1_1)}
{swp(sol_2_1)}
{swp(sol_3_1)}
}

{swp(sol_4)}
}
'''
```



```
In [ ]: it=time.time()
sec1=corner_radius(pts1([[-27.5,-2],[0,2,2],[6,0,.9],[0,-2,.9],
[14.5,0,.9],[0,2,.9],[6,0,.9],[0,-2],[2,0],[0,2,.9],
[6,0,.9],[0,-2,.9],[14.5,0,.9],[0,2,.9],[6,0,2],[0,-2]]),10)

path1=cr3dt([[0,0,20,0],[0,30,0,2],[0,0,30,0]],20)
s1=path_extrude_open(sec1,path1,twist=1)

sec2=corner_radius(pts1([[-27.5,6],[0,-6,2.4],[6,0,2.4],[0,6,2.4],[14.5,0,2.4],[0,-6,2.4],
[6,0,2.4],[0,6],[2,0],[0,-6,2.4],[6,0,2.4],[0,6,2.4],[14.5,0,2.4],
[0,-6,2.4],[6,0,2.4],[0,6]]))
path2=cr3dt([[0,0,0,0],[0,50,0,20],[0,0,50,0]],20)
```

```

s2=path_extrude_open(sec2,path2,twist=1)

sol1=[ equidistant_pathc(s1[i]+flip(s2[i]),300)+[s1[i][0]] for i in range(len(s1))]

sec3=corner_radius(pts1([[-27.5,-2],[0,2,2],[6,0,.9],[0,-2,.9],[19,0,.9],[0,2,.9],
[5,0,.9],[0,-2,.9],[19,0,.9],[0,2,.9],[6,0,2],[0,-2]]))

path3=cr3dt([[0,0,0,0],[0,0,30,2],[-30+2,0,0,0]],20)
s3=translate([0,30,50],rot('z90',path_extrude_open(sec3,path3,1)))

sec4=corner_radius(pts1([[-27.5,13],[0,-13,2.4],[6,0,2.4],[0,13,2.4],[19,0,2.4],
[0,-13,2.4],[5,0,2.4],[0,13,2.4],[19,0,2.4],[0,-13,2.4],[6,0,2.4],[0,13]]))

path4=cr3dt([[0,0,0,0],[0,0,50,20],[-50+2,0,0,0]],20)
s4=translate([0,50,50],rot('z90',path_extrude_open(sec4,path4,1)))

sol2=[ equidistant_pathc(s3[i]+flip(s4[i]),300)+[s3[i][0]] for i in range(len(s3))]

sec5=circle(27.5,s=100)
path5=corner_radius(pts1([[-15,-2],[15,0,2],[0,24,2],[-15,0]]),20)
sol3=prism(sec5,path5)
sol4=translate([0,50,50],rot('x90',sol3))
sec5=circle(15)
l1=[[-21.5,3],[21.5,3]]
a1=flip(fillet_line_circle(l1,sec5,3,1))
a2=fillet_line_circle(l1,sec5,3,1)
sec5=corner_radius(pts1([[-21.5,3,3],[0,5],[-6,0],[0,-8,5],[10,-15,3],
[35,0,3],[10,15,5],[0,8],[-6,0],[0,-5,3]]),10)
sec6=sec5+a1+arc_2p(a1[-1],a2[0],15,-1,50)[1:-1]+a2

path5=corner_radius(pts1([[-5,0],[5,0,2],[0,20,2.4],[-5,0]]),20)
sol5=translate([0,0,80],prism(sec6,path5))
sol5=[p+p[0] for p in sol5]
sol6=o_solid([0,0,1],circle(45/2,s=100),30,-5)
sol7=o_solid([0,1,0],circle(45/2,s=100),30,25,0,50)
sol8=o_solid([0,0,1],circle(5),30,75)
sol9=o_solid([1,0,0],pts([[-25,-25],[50,0],[0,50],[-50,0]]),2,-1,-40,10)

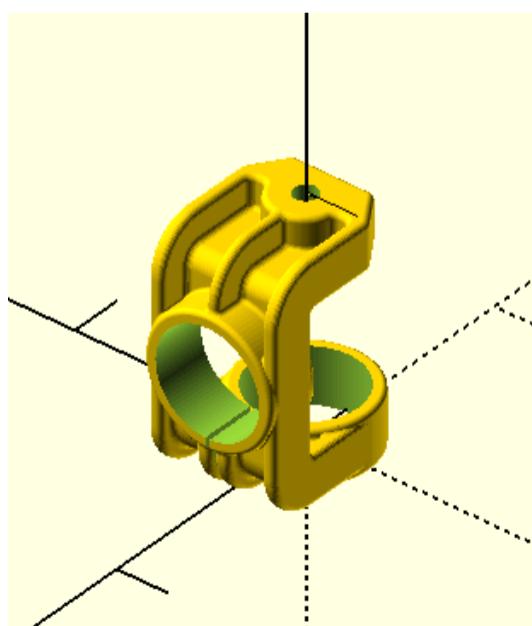
f1=ip_fillet(sol3,sol1,2,2,type=0)
f2=flip(ip_fillet(sol4,flip(sol1),-2,2))
f3=ip_fillet(sol4,sol2,2,2)
l1=translate([0,0,-.01],equidistant_path(s4[-1][50:-50],100))
l1=psos(sol5,[l1],[0,1,0])[0]
l2=translate([0,2,0],l1)
l3=o_3d(l1,sol5,-2)
f4=convert_3lines2fillet(l3,l2,l1)

l1=translate([0,0,.01],equidistant_path(s3[-1][50:-50],100))
l1=psos(sol5,[l1],[0,1,0])[0]
l2=translate([0,2,0],l1)
l3=o_3d(l1,sol5,-2)
f5=convert_3lines2fillet(l3,l2,l1)
fileopen(f''''

difference(){
union(){
{swp(sol5)}
{swp(flip(sol1))}
{swp(flip(sol2))}
{swp(sol3)}
{swp(sol4)}
{swp(f1)}
{swp(f2)}
{swp(f3)}
{swp(f4)}
{swp(flip(f5))}
}
{
{swp(sol6)}
{swp(sol7)}
{swp(sol8)}
{swp(sol9)}
}
})
''')

ft=time.time()
ft-it

```



```

In [ ]: i_t=time.time()
a=rot('y90',helix(3,35,5,360*5/300))
a_1=rot('z120y90',helix(3,35,5,360*5/300))
a_2=rot('z240y90',helix(3,35,5,360*5/300))

a2=bezier([[30,-5],[40,30],[60,50],[60,60],[40,107]],300)
b=equidistant_path(axis_rot_1(c2t3(a2),[1,0,0],[0,0,0],90),299)

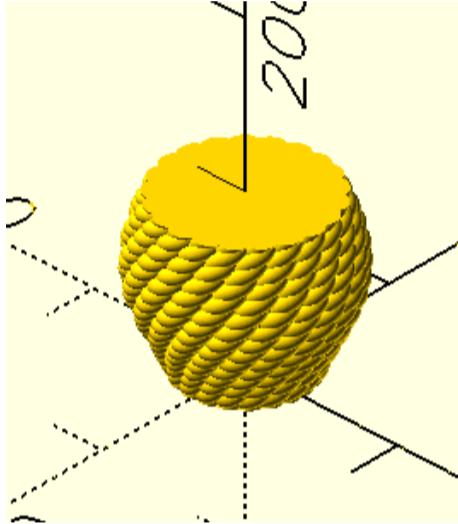
```

```

ba=[i for i in linspace(0,90,300)]
b=[rot(f'z{ba[i]}',b[i]) for i in range(len(b))]
c=extrude_wave2path(a,b)
c1=extrude_wave2path(a_1,b)
c2=extrude_wave2path(a_2,b)
d=align_sol_1(path_extrude_open(circle(4.5),c))
d1=align_sol_1(path_extrude_open(circle(4.5),c1))
d2=align_sol_1(path_extrude_open(circle(4.5),c2))
g=cylinder(r=200,h=100)
h=prism(circle(2),a2)
fileopen(f'''
    intersection(){{}
        union(){{
for(i=[0:17.25:360])
rotate([0,0,i])
{{{
{sdp(d)}
{sdp(d1)}
{sdp(d2)}
}}
{sdp(h)}
}}
{sdp(g)}
}}
    ''')

f_t=time.time()
f_t-i_t

```



car_seat

```

In [ ]: i_t=time.time()

h=[100,180,120,200]
r=[800,750,840]
r1=[420,75,350,100]
s=[780,300,tan(d2r(30))*480,420,100,75]
sec=pts([[0,780],[0,-300],[s[2],-480],[420,0],rot2d(30,[100,0]),
         ,rot2d(120,[75,0]))]

arcs1=[arc_2p(p1,p2,r,-1,20) for (p1,p2,r) in [[sec[-1],sec[2],420],[sec[2],sec[1],350]]]
arc2=two_cir_tarc(arcs1[0],arcs1[1],75,s=10)
arc3=fillet_line_circle(sec[:2],arcs1[1],100,3,s=10)
sec1=arc_2p(sec[-1],arc2[0],420,-1,20)+arc2[1:-1]+ \
arc_2p(arc2[-1],arc3[0],350,-1,s=20)+arc3[1:]
curve1=bezier([[210,0],[125,100],[150,150],[0,450]],20)
curve1=flip(equidistant_path(curve1,20))
p0=[translate([0,0,h[i]],sec[i]) for i in range(4)]
arcs1=[ arc_2p_3d(n1,p1,p2,r)for (n1,p1,p2,r) in [[[1,0,0],p0[0],p0[1],r[0]],
           [rot('z30',[1,0,0]),p0[1],p0[2],r[1]],
           [[0,1,0],p0[2],p0[3],r[2]]]]]

l1=[p0[0],c2t3(sec[0])]
arc1=fillet_line_internal_3d(l1,arcs1[0],150,option=1,s=10)
surf1=SurfaceFrom3LinesInDifferentPlanes(
    extend_arc3d(arcs1[2],15),extend_arc3d(flip(arcs1[0]),10),flip(arcs1[1]))

arc1=flip(arc1)+mirror_line(arc1,[0,0,1],[0,0,0])[1:]
arc2=arc_3p_3d([p0[1],c2t3(curve1[0]),mirror_line([p0[1]],[0,0,1],[0,0,0])[0]])
s1=surface_4_lines_enclosed(arcs1[0],
                            mirror_line(arcs1[0],[0,0,1],[0,0,0]),
                            arc1,arc2,[1,0,0],[0,0,1])
s2=convert_3lines2surface(arcs1[1],c2t3(curve1),mirror_line(arcs1[1],[0,0,1],[0,0,0]),s=20)
temp_1=surface_line_vector(sec[2:4],[0,0,200],1)
temp_2=surface_line_vector(sec[4:6],[0,0,185],1)
l1=c2t3(bezier(pts([[0,0],[30,0],[50,-50],[50,0],[50,50],[70,0]]),20))
l2=mirror_line(l1,[1,0,0],[0,0,0])
l1=translate(rot2d(120,[50,0]),translate(sec[4],rot('y90z30',flip(l2)+l1)))
l1,l2=[project_points_on_surface(l1,p,rot('z30',[1,0,0])) for p in [temp_1,temp_2]]
l1,l2=[equidistant_path(p,20) for p in [l1,l2]]
s3=surface_4_lines_enclosed(arcs1[-1],
                            mirror_line(arcs1[-1],[0,0,1],[0,0,0]),s2[-1],l1,[0,10,0],[0,0,1],s=20)
l3=equidistant_path([l1[0],l2[0]],10)
l3=project_points_on_surface(l3,surf1,[0,0,1])
l4=mirror_line(l3,[0,0,1],[0,0,0])
s4=surface_4_lines_enclosed(l3,l4,l1,l2,c2t3(rot2d(120,[10,0])),[0,0,1],s=10)
l1=flip(project_points_on_surface(c2t3(sec1),surf1,[0,0,1]))
surf2=s1[13:]+s2+s3+s4
surf2=cpo([bezier(p,70) for p in cpo(surf2)])
l1=path2path1(cpo(surf2)[0],l1)
s5=slice_sol([l1,cpo(surf2)[0]],10)
s5=[project_points_on_surface(p,surf1,[0,0,1]) for p in s5][:-1]
s6=flip(mirror_surface(s5,[0,0,1],[0,0,0]))
surf3=s5+cpo(surf2)+s6
surf3=[bezier(p,50) for p in cpo(surf3)]
surf4=surface_offset(surf3,30)
sol=solid_from_2surfaces(surf3,surf4)

```

```

l1=cpo(surf3)[0]
l2=cpo(surf4)[0]
l3=[mid_point(p) for p in cpo([l1,l2])][5:]
l4=mirror_line(l3,[0,0,1],[0,0,0])
l1=surf3[-1]
l2=surf4[-1]
l5=[mid_point(p) for p in cpo([l1,l2])]
surf5=s1[:13]+[equidistant_path(surf3[0],20)]
surf6=translate([30,0,0],surf5)
sol1=solid_from_2surfaces(surf5,surf6)
l1=arcs1[0][7:-4]
l2=arc1
l6=mirror_line(l1,[0,0,1],[0,0,0])
l6=translate([15,0,0],flip(l1)+l2+l6)
l7=[l3[0],l6[0]]
l8=mirror_line(l7,[0,0,1],[0,0,0])
pipe=l3+l5+flip(l4)
# pipe=min_d_points(pipe,5)
# pipe1=align_sol_1(path_extrude_closed(circle(15),pipe))
l1=cpo(surf3)[0]
l2=cpo(surf3)[10]
l3=equidistant_pathc(c3t2(l1[15:-5]+flip(l2[15:-5])),150)
l3=bezier_c(l3,50,-50,75)
l3_1=offset(l3,-20,2)
l3_2=offset(l3,-30,2)

l4=project_points_on_surface(c2t3(l3_1),surf4,[0,0,1],1)
l5=translate([0,0,-10],l4)
l6=project_points_on_surface(c2t3(l3_2),surf4,[0,0,1],1)
l6=translate([0,0,-12],l6)
sol2=cpo(convert_3lines2fillet(l4,l6,l5))[:-1]
sol3=mirror_surface(sol2,[0,0,1],[0,0,0])
l1=s3[0]+cpo(s3)[-1]+flip(s3[-1])+flip(cpo(s3)[0])
l1=bezier_c(l1,30,-10,50)
l2_1=offset_3d(l1,-50)
l2_2=offset_3d(l1,-70)

l3=project_points_on_surface(l2_1,surf4,[0,1,0],1)
l4=translate([0,10,0],l3)
l5=project_points_on_surface(l2_2,surf4,[0,1,0],1)
l5=translate([0,12,0],l5)
sol4=cpo(convert_3lines2fillet(l3,l5,l4))[:-1]

l1=s4[0]
l2=cpo(s4)[-1][1:-1]
l3=flip(s4[-1])
l4=flip(cpo(s4)[0])[1:-1]
l5=l1+l2+l3+l4
l5=ppplane(l5,rot('z120',[1,0,0]),l5[10])
l6=bezier_c(offset_3d(l5,-35),5,-20,60)
l6=project_points_on_surface(l6,surf4,rot('z120',[1,0,0]))
l7=translate(rot('z120',[10,0,0]),l6)
l8=bezier_c(offset_3d(l5,-50),5,-20,60)
l8=project_points_on_surface(l8,surf4,rot('z120',[1,0,0]))
l8=translate(rot('z120',[12,0,0]),l8)
sol5=cpo(convert_3lines2fillet(l6,l8,l7))[:-1]

l1=s2[0]
l2=cpo(s2)[-1][1:-1]
l3=flip(s2[-1])
l4=flip(cpo(s2)[0])[1:-1]
l5=l1+l2+l3+l4
l5=ppplane(l5,rot('z30',[1,0,0]),l5[10])
l6=offset_3d(l5,-50)
l6=bezier_c(l6,10,-30,s=60)
l6=project_points_on_surface(l6,surf4,rot('z30',[1,0,0]))
l7=translate(rot('z30',[10,0,0]),l6)

l8=[offset_3d(l5,-p) for p in linspace(70,200,20)]
l8=[bezier_c(p,10,-30,s=60) for p in l8]
l8=[project_points_on_surface(p,surf4,rot('z30',[1,0,0])) for p in l8]
l9=[translate(rot('z30',[12,0,0]),p) for p in l8]
sol6=cpo(convert_3lines2fillet(l6,l9[0],l7))[:-1]
sol6=flip(l8)+sol6+l9[1:]

s7=translate([30,0,0],s1)
l1=s7[0]
l2=cpo(s7)[-1][1:-1]
l3=flip(s7[-1])
l4=flip(cpo(s7)[0])[1:-1]
l5=l1+l2+l3+l4
l6=offset_3d(l5,-50)
l7=bezier_c(l6,11,-30,s=50)
l8=translate([10,0,0],l7)
l9=offset_3d(l5,-70)
l9=bezier_c(l9,11,-30,s=50)
l9=translate([12,0,0],l9)
sol7=cpo(convert_3lines2fillet(l7,l9,l8))[:-1]

s7=translate([30,0,0],s1)
l1=s7[0]
l2=cpo(s7)[-1][1:-1]
l3=flip(s7[-1])
l4=flip(cpo(s7)[0])[1:-1]
l5=l1+l2+l3+l4
l6=offset_3d(l5,-15)
l7=translate([-30,0,0],l6)
sol8=[l7,l6]
l8=[mid_point(p) for p in cpo(sol8)]
l8=l8[-15:]+l8[:35]
pipe=pipe+flip(l8)
solx=o_solid([0,1,0],pts([[0,0],[50,0],[0,50],[-50,0]]),80,515,-10,215,theta=[90,15,0])
soly=flip(mirror_surface(solx,[0,0,1],[0,0,0]))
fileopen(f'''
//color("blue")p_line3d(arcs1[0][7:-2],30);
//color("magenta")p_line3d(arc1,30);
//color("green")points(pipe,5);
//color("violet")p_line3d(sol[0],1);
//color("green")for(p=s6)p_line3d(p,1,1);

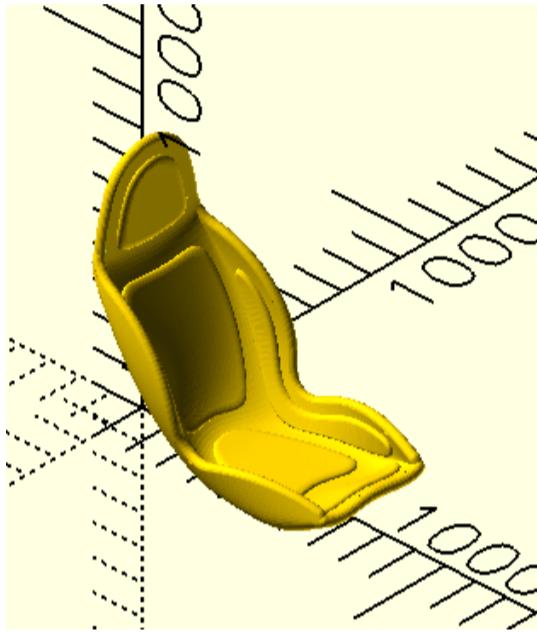
```

```

//color("indigo")p_line3d(l1,1,1);
//color("indigo")p_line3d(cpo(surf2)[0],1,1);
//p_line3d(l3,30);
//p_line3d(l4,30);
//p_line3d(l5[10:-10],30);
//p_line3d(l6,30);
//p_line3d(l7,30);
//p_line3d(l8,30);

rotate([90,0,0]){{{
difference(){{{
{swp(sol)}
{swp(solx)}
{swp(soly)}
}}}
//{swp(sol8)}
p_line3dc({pipe},30);
{swp(sol2)}
{swp(sol3)}
{swp(sol4)}
{swp(sol5)}
{swp(sol6)}
{swp(sol7)}
hull(){{p_line3d({l8},30);}}
}}}
'''')
f_t=time.time()
f_t-i_t

```



```

In [ ]: sec=circle(10,s=50)
path=corner_radius(pts1([[-3,0,0],[3,0,3],[3,5,7],[-5,20,100],[8,30,20],[-11,10,5],[0,10,0]]),50)
path=equidistant_path(path,100)
sol=prism(sec,path)

sec1=corner_radius(pts1([[-7.5,10,3],[15,0,3],[0,20,30],[-3,20,30],[0,10,4.4],[-9,0,4.4],[0,-10,30],[-3,-20,30]]),20)
sec1=equidistant_pathc(sec1,200)
a=rot('x90',sec1)
b=rot('x90',offset(sec1,1.5))
c=rot('x90',offset(sec1,-1.5))
d=rot('x90',offset(sec1,-3))
e=surround(equidistant_path([[],15],[0,55]),5),1,10)
e=rot('x90',equidistant_pathc(e,200))
e=align_sec_1(d,e)[-1]
e=slice_sol([d,e],5)[2:]
a=project_points_on_surface(a,sol,[0,1,0],1)
b=project_points_on_surface(b,sol,[0,1,0],1)
c=translate([0,-2,0],project_points_on_surface(c,sol,[0,1,0],1))
d=translate([0,-2,0],project_points_on_surface(d,sol,[0,1,0],1))
e=[translate([0,-2,0],project_points_on_surface(p,sol,[0,1,0],1)) for p in e]

s1=cpo([bspline_open(p,3,30) for p in cpo([b,a,c,d]+e)])
s2=translate([0,2.5,0],s1)
sol1=flip(s1)+s2
fileopen(f'''
//color("magenta")for(p={s1})p_line3d(p,.2,1);
difference(){{{
{swp(sol)}
for(i=[0,120,240])rotate([0,0,i])
{swp(sol1)}
}}}
'''')

```

```

In [ ]: i_t=time.time()

sec=pts([[-155/2,-101/2],[155,0],[0,101],[-155,0]])
rl=[15,15,15,15]
sec=corner_n_radius_list(sec,rl,11)
l1=norm(cp_arc(sec[:10]))
a=cp_arc(sec[:10])
theta=r2d(arctan(a[1]/a[0]))
l2=[rot2d(i,[0,0],[l1,0])) for i in [theta,180-theta,180+theta,-theta]]
l3=[surround(m_points1_o(p,2),15) for p in l2]
c1=circle(55/2,s=100)
la,lb,lc=seg(l3[0])[22],seg(l3[-1])[0],seg(l3[-2])[-1]
a1=fillet_intersection_lines(flip(la),lb,15)
a2=c32(mirror_line(c23(a1),[1,0,0],[0,0,0]))
a3=flip(fillet_line_circle(lc,c1,15,4))
a4=c32(mirror_line(c23(a3),[1,0,0],[0,0,0]))
a5=c32(mirror_line(c23(a3),[0,1,0],[0,0,0]))
a6=c32(mirror_line(c23(a4),[0,1,0],[0,0,0]))
s1=a1
sec1=flip(a1)+l3[0][23:]+a6+arc_2p(a6[-1],a5[-1],55/2,-1)+flip(a5)+ \
l3[1][22:]+a2+l3[2][23:]+a3+arc_2p(a3[-1],a4[-1],55/2,-1) \
+flip(a4)+l3[-1][22:]
sec1=equidistant_pathc(sec1,299)

```

```

path1=corner_radius(pts1([[-3,0],[2.9,0,3],[0,18,3],[-3,0]]),10)
sol1=prism(sec1,path1)
path2=corner_radius(pts1([[-3,0],[3,0,3],[0,12,3],[-3,0]]),10)
sol2=prism(sec1,path2)+[translate([0,0,12],circle(.2,s=len(sec)+1))]
sol3=linear_extrude(circle(55/2,s=100),45)
e2=end_cap(sol3,2)[1]
sol3_1=translate([0,0,0],linear_extrude(circle(42/2,s=100),45))
e1=end_cap_1(sol3_1,2)
csnk=translate([0,0,10],linear_extrude(circle(22/2,a),11))
csnk1=mirror_surface(csnk,[0,1,0],[0,0,0])
csnk2=mirror_surface(csnk,[1,0,0],[0,0,0])
csnk3=mirror_surface(csnk1,[1,0,0],[0,0,0])

td=translate([0,0,-1],linear_extrude(circle(14/2,a),20))
td1=mirror_surface(td,[0,1,0],[0,0,0])
td2=mirror_surface(td,[1,0,0],[0,0,0])
td3=mirror_surface(td1,[1,0,0],[0,0,0])

slot=o_solid([0,1,0],pts([[-30,0],[60,0],[0,20],[-60,0]]),8,-4,0,32)

l1=ip_sol2sol(prism2cpo(sol1),translate([0,0,4],offset_sol(sol3,-.1)))
l2=o_3d_rev(l1,prism2cpo(sol1),3)
l3=translate([0,0,3],l1)
f2=convert_3lines2fillet_closed(l3,l2,l1,style=2)

l1=ip_sol2sol(sol2,sol1,-1)
l2=o_3d_rev(l1,sol2,-3,dist=6)
l2=psos_v(prism2cpo(sol2),[l2],[0,0,-10],dist=3)[0]
l3=o_3d_rev(l1,sol1,3)
f1=convert_3lines2fillet_closed(l3,l2,l1,style=2)

path3=corner_radius(pts1([[5,12],[-5,0,3],[0,33]]),10)
s2=prism(circle(55/2,s=300),path3)
path4=corner_radius(pts1([[0,9],[0,3,3],[-5,0]]),10)
s3=prism(sec1,path4)
s2=align_sol_1(s3+s2)

v1=rot('y45z-90',[100,0,0])
sec2=corner_radius(pts1([[-4,0],[0,45,3],[8,0,3],[0,-45]]),10)
sec2=equidistant_path(sec2,200)
sec2=translate([0,-55/2+.5,0],rot('x90',sec2))
s3=flip(surface_line_vector(sec2,v1))

path3=corner_radius(pts1([[5,12],[-5,0,3],[0,35]]),10)
s4=prism(circle(55/2,s=49),path3)
path4=corner_radius(pts1([[0,9],[0,3,3],[-5,0]]),10)
s5=prism(sec1,path4)
s4=align_sol_1(s5+s4)
l1=psos_n(s4,sec2surface(sec2,1)[19:-1],-1)
l2=[p[0] for p in l1]+flip([p[-1] for p in l1])
l2=equidistant_path(l2,200)
l1=psos(s4,[l2],[0,0,-1])[0]
l1=psos_v(s4,[l1],[0,0,0])[0]
l2=o_3d_rev(l1,s3,-2,type=1)
l3=o_3d_rev(l1,s4,2)
f3=convert_3lines2fillet(l2,l3,l1,style=2)
sol4=translate([0,0,4],linear_extrude(sec,45-4))
fileopen(f''''

difference(){{
union(){{{
    {swp(sol1)}
    {swp(sol2)}
    {swp(sol3)}

{swp_c(f1)}
{swp_c(f2)}

intersection(){{{
    {swp(flip(f3))}
    {swp(sol4)}
}}}

intersection(){{{
    {swp(s3)}
    {swp(sol4)}
}}}

mirror([0,1,0])
{{ intersection(){{{
    {swp(flip(f3))}
    {swp(sol4)}
}}}

intersection(){{{
    {swp(s3)}
    {swp(sol4)}
}}}

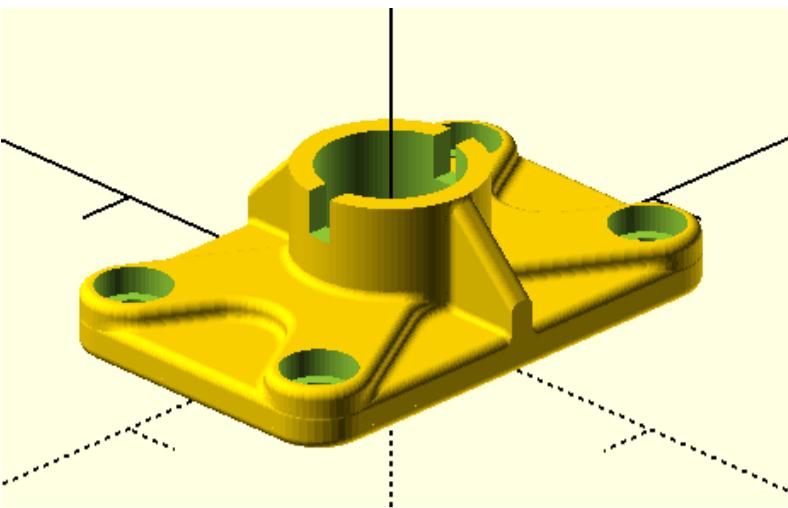
}}}

for(p=[[csnk,flip(csnk1),flip(csnk2),csnk3]])swp(p);
for(p=[[td,flip(td1),flip(td2),td3]])swp(p);
{swp(slot)}
{swp(sol3_1)}
for(p={e1})swp(p);
{swp(e2)}
}}


''')

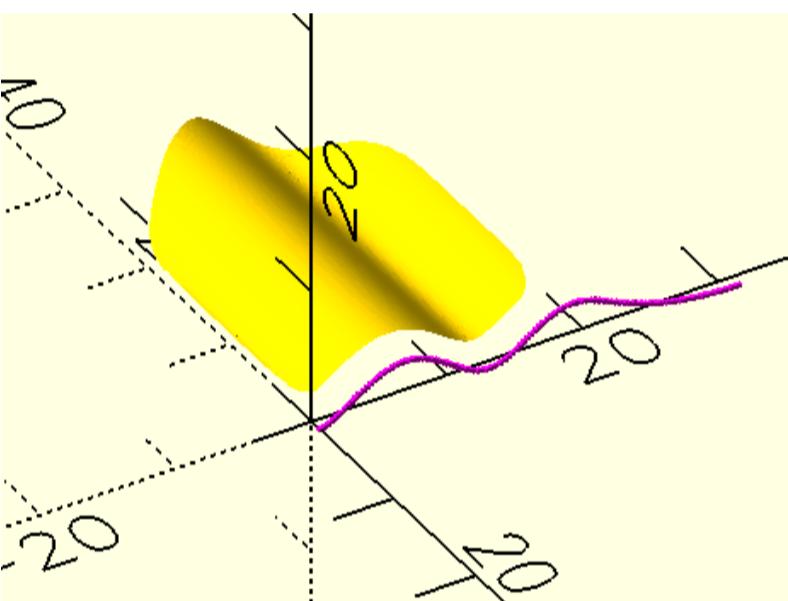
f_t=time.time()
f_t-i_t

```

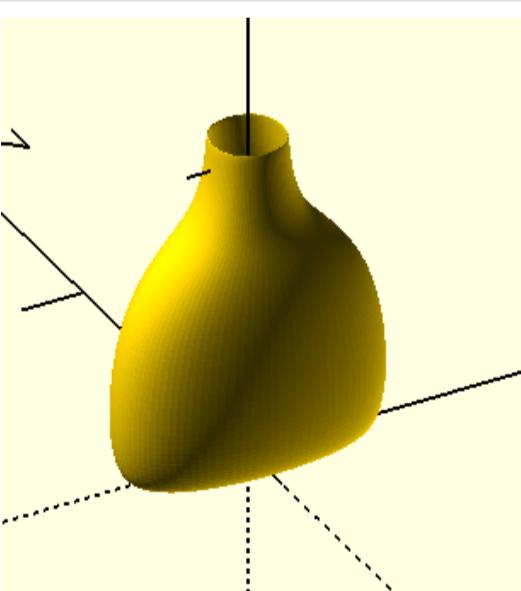


```
In [ ]: l1=pts([[0,0],[20,0],[0,20],[-10,10],[-10,-10]])
l1=bspline_closed(m_points1(l1,3),3,50)
l2=h_lines_sec(l1,100)
l2=[equidistant_path(p,100) for p in l2]
l2=translate([0.1,1,1],l2)
l2=rot('z90',l2)
path=pts([[0,0],[1,0],[5,5],[5,-5],[3,0],[5,5],[5,-5],[7,0]])
path=rot('x90z90',bspline_open(path,3,100))
path=translate([1,0,0],path)
path=equidistant_path(path,100)
l3=[wrap_y(p,path) for p in l2]

fileopen(f'''
{sweep_surf(l3[3:])}
//{sweep_surf(l2)}
color("magenta")points({path},.3);
''' )
```



```
In [ ]: a=pts([[-50,-25],[100,0],[0,50],[-100,0]])
b=pts([[-10,0],[10,0],[0,60],[-1,-1],[0,-58],[-10,0]])
c=prism(a,b)
a=pts([[-15,-15],[30,0],[0,30],[-30,0]])
b=pts([[0,80],[-2,30],[-1,0],[2,-32]])
d=prism(a,b)
sol=c[:3]+d+c[3:]
# sol=smoothing_by_subdivision_surf(sol,4,[1,0])
sol=bspline_surface(sol,3,3,100,200,[1,0])
fileopen(f'''
difference(){
    {sweep(sol)}
    //{sweep(cut_plane([0,-1,0],[1000,1000],500))}
}
''' )
```



```
In [ ]: sec=corner_radius(pts1([[0,0,1],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),20)

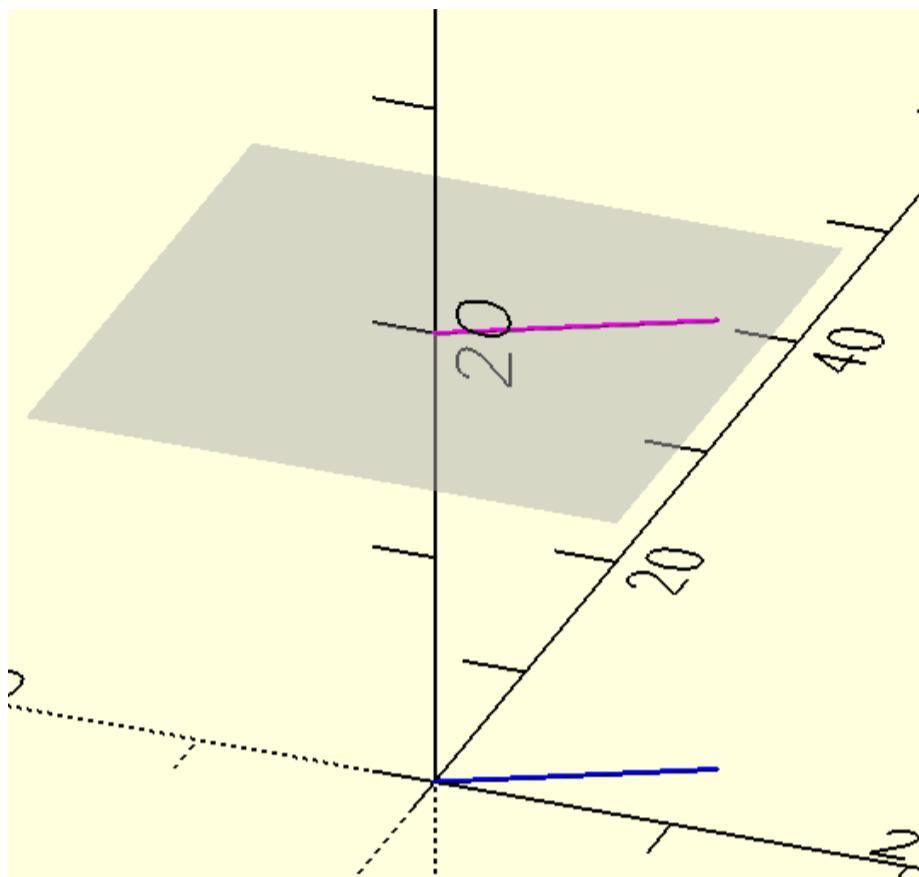
sec1=h_lines_sec(sec,60)
sec2=v_lines_sec(sec,40)

fileopen(f'''
color("cyan")for(p={sec1})p_line3d(p,.1,1);
color("magenta")for(p={sec2})p_line3d(p,.1,1);
color("blue")p_line3dc({sec},.1,1);
''' )
```

plos (project line on surface)

```
In [ ]: l1=[[0,0,0],[10,5,0]]
pl1=plane(nv=[0,0,1],size=[25,25],intercept=[0,0,20])
l2=plos(surf=pl1,line=l1,vect=[0,0,1],unidirection=0)

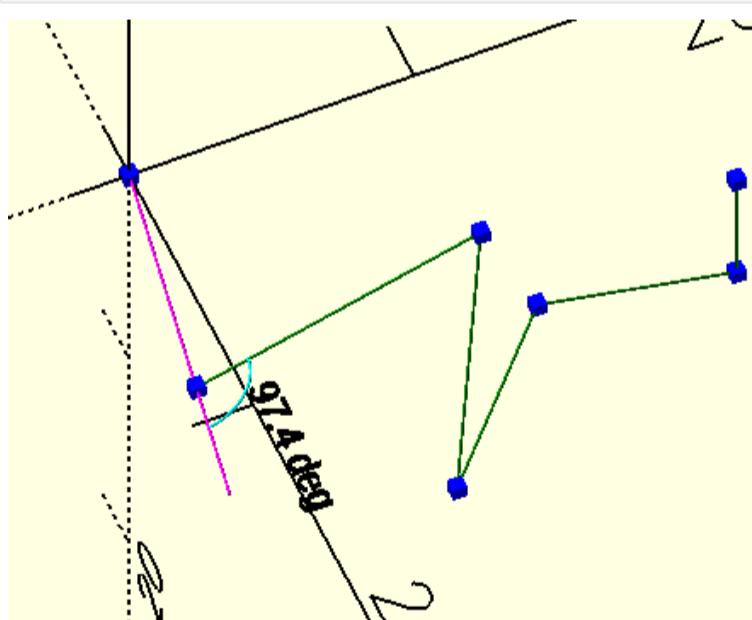
fileopen(f'''
    color("blue")p_line3d({l1},.2);
    %{swp_surf(pl1)}
    color("magenta")p_line3d({l2},.2);
    ''')
```



```
In [ ]: p0=pts2([[0,0,0],[10,-2,2],[-5,10,3],[5,-3,-6],[-5,5,1],[0,7,-2],[0,0,5]])
l1=line2length(p0[0:2],l_len(p0[0:2])*1.5)
l2=p0[1:3]
p1=polp(p0,.25)
n1=nv([l1[1],p0[1],p0[2]])
pl1=plane(n1,[50,50],p0[1])
c1=plos(pl1,translate(p0[1],rot('z-5',circle(2))),n1,0)
a1=lineFromStartTillPoint(c1,p1,.5)
fileopen(f'''

color("blue")points({p0+p1},.5);
color("green")p_line3d({p0},.1);
color("magenta")p_line3d({l1},.1);

color("cyan")p_line3d({a1},.1);
color("black")translate({a1[7]})linear_extrude(.2)text("{f"list_ang(p0)[1]:.1f} deg",1);
'''')
```



```
In [ ]: t0=time.time()
c1=circle(55/2)
c2=circle(3,[21,0])
s1=linear_extrude(c1,5)
s1=flip(sol2vector([1,0,0],s1,[50,0,0]))
s2=rot('z90',s1)
s3=rot('z135', translate([0,-20,0],s2))
s27=[flip(linear_extrude(rot2d(i,c2),5)) for i in linspace(0,360,7)[:-1] ]
s27=translate([50,0,0],sol2vector([1,0,0],s27))
s28=rot('z90',s27)
s29=rot('z135',translate([0,-20,0],s28))

path=corner_radius_with_turtle([[0,0],[0,50,2],[2,0]],10)
s4=rot('y90',prism(circle(30/2),path))
s5=rot('z90',s4)
path=corner_radius_with_turtle([[0,0],[0,30,2],[2,0]],10)
s6=axis_rot([-1,1,0],prism(circle(30/2),path),-90)
s7=o_solid([1,0,0],circle(12),55)
s8=rot('z90',s7)
s9=o_solid([-1,-1,0.0001],circle(12),35.01)
e1=end_cap_1(s27[0],1)
e1=l_(concatenate([axis_rot([1,0,0],e1,i) for i in linspace(0,360,7)[:-1]]))
```

```

e2=rot('z90',e1)
e3=rot('z135',translate([0,-20,0],e2))
e4=end_cap_1(s7,2)[1]
e5=rot('z90',e4)
e6=end_cap_1(s9,2)[1]
e7=end_cap(s1,2)
e8=end_cap(s2,2)
e9=end_cap(rot('z.001',s3),2)
l1=ip(s4[:2],s5[:2])
l10=translate([5,0,0],l1)
l11=translate([0,5,0],l1)
l2=ip(s6[:2],s4[:2])
l3=ip(s5[:2],s6[:2])
l30=translate([0,5,0],l3)
l31=translate([-5,-5,0],l3)
f1=convert_3lines2fillet(l10,l11,l1)
f2=convert_3lines2fillet(l30,l31,l3)
f3=rot('z135',f2)

fileopen(f'''

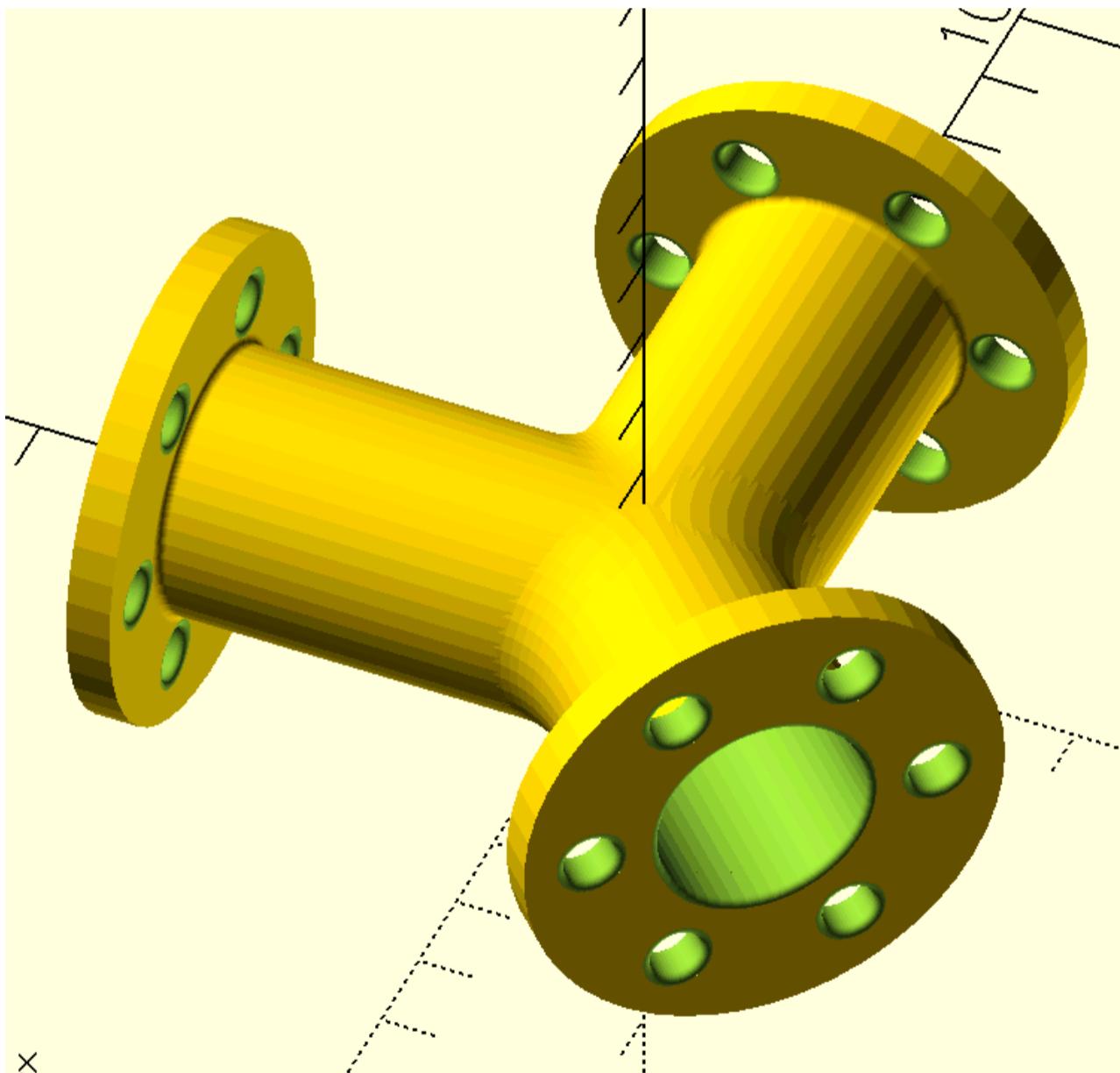
difference(){
for(p={[s1,s2,s3,s4,s5,s6]})swp(p);
for(p={[s7,s8,s9]})swp(p);
for(p={s27})swp(p);
for(p={s28})swp(p);
for(p={s29})swp(p);
for(p={e1})swp(p);
for(p={e2})swp(p);
for(p={e3})swp(p);
for(p={[e4,e5,e6]})swp(p);
for(p={e7})swp(p);
for(p={e8})swp(p);
for(p={e9})swp(p);

}

{swp(f1)}
{swp(f2)}
{swp(f3)}

'''')
t1=time.time()
t1-t0

```



```

In [ ]: i_t=time.time()
c1=circle(7.5,[-55-7.5,0],s=200)
c2=circle(7.5,[55+7.5,0],s=200)
c3=circle(10,s=200)
c4=circle(10,[-55-7.5,0],s=200)
c5=circle(10,[55+7.5,0],s=200)
c6=circle(15,s=200)
l1=[[-100,.001],[100,.001]]
l2=flip(path_offset(l1,-1.25))
p=line_multi_sections_ip(l1,[c1,c2,c3,c4,c5,c6])
q=line_multi_sections_ip(l2,[c1,c2,c3,c4,c5,c6])

sec1=arc_2p(p[1],p[2],7.5,1,s=20)+arc_2p(p[5],p[6],10,1,s=20)+ \
arc_2p(p[9],p[10],7.5,1,s=20)+arc_2p(p[11],q[3],10,-1,s=20)+ \
arc_2p(q[4],q[7],15,-1,s=20)+arc_2p(q[8],p[0],10,-1,s=20)

sec2=rot('x90',sec1)
sol1=surface_line_vector(sec2,[0,20,0],1)
l1=two_circle_tangent(c5,c6)
l2=trim_sec_ip(sec1,l1[0],l1[1])

```

```

sec3=remove_duplicates(l1+flip(l2))
sec31=offset(sec3,-2,2)
l1,l2=sec3[1:],sec31[1:]
l3=translate([0,0,2],l1)
l1,l2=c23([l1,l2])
sol2=flip(surface_line_vector(rot('x90',l1),[0,2,0],1))
sol3=translate([0,-2,0],rot('x90',convert_3lines2fillet(l3,l2,l1)))
l4=translate([0,-2,0],rot('x90',[l1[0],l1[-1]]))
l5=translate([0,0,-1],l4)
l6=translate([0,1,0],l4)
f1=cpo(convert_3lines2fillet(l5,l6,l4))[:-1]
f2=surface_offset(f1,-2)
sol4=solid_from_2surfaces(f2,f1)

l7=turtle2d([[ -75,-5],[22.5,0],[37.5,-10],[30,0],[37.5,10],[22.5,0]])
l8=mirror_line(l7,[0,1,0],[0,0,0])
l9=l7+flip(l8)
sol5=surface_line_vector(c23(l9),[0,0,20],1)
sol6=[m_points1(p,50) for p in sol1]
l10=ip_sol2sol(sol5,sol6)
l11=ip_sol2sol(sol5,sol6,-1)
sol6=[l10,l11]
l12=o_3d(l10,sol5,.5)
l13=translate([0,.5,0],l10)
f1=cpo(convert_3lines2fillet(l12,l13,l10))[:-1]
f2=surface_offset(f1,.5)
f3=solid_from_2surfaces(f1,f2)
f4=flip(mirror_surface(f3,[0,1,0],[0,0,0]))
f5=flip(mirror_surface(f3,[1,0,0],[0,0,0]))
f6=flip(mirror_surface(f4,[1,0,0],[0,0,0]))
fileopen(f'''')

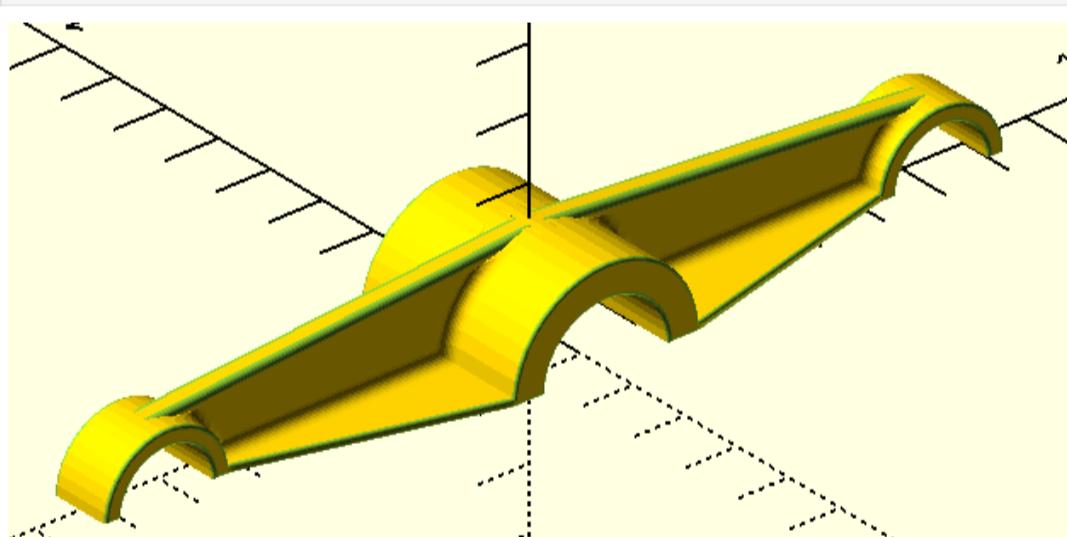
difference() {{
    {swp(flip(sol6))}
    {swp(f3)}
    {swp(f4)}
    {swp(f5)}
    {swp(f6)}
}>

{swp(sol3)}
mirror([0,1,0])
{swp(sol3)}
difference() {{
    {swp(sol2)}
    {swp(sol4)}
    mirror([0,1,0])
    {swp(sol4)}
}}
}

mirror([1,0,0]) {{
    {swp(sol3)}
    mirror([0,1,0])
    {swp(sol3)}
    difference() {{
        {swp(sol2)}
        {swp(sol4)}
        mirror([0,1,0])
        {swp(sol4)}
    }}
}}
}

'''')
f_t=time.time()
f_t-i_t

```



```

In [ ]: i_t=time.time()

c1=circle(20,s=100)
c2=offset(c1,-3)
l1=point_vector([-25,3.5],[25,0])
l2=point_vector([0,0], rot2d(110,[25,0]))
p0,p1= s_int1_first([l2]+seg(c1)+seg(c2))
p2,p3= s_int1_first([l1]+seg(c1)+seg(c2))
f1=fillet_line_circle_internal(l1,c2,r=6,s=30)

l3=homogenise(rot('x90' , f1+[p3]),pitch=0.5)
sol1=sphere(20,s=100)
sol2=sphere(17, s=100)
l3=plos(sol2, l3, [0,1,0])
c3=circle(3.5,[-2,0])
l4=point_vector([12.6,-20],[0,40])
f2=fillet_line_circle(l4,c3,r=15)
l5=point_vector([0,0],[-8,0])
p4=s_int1([l5]+seg(c3))[0]
p5=f2[0]
p6=s_int1(seg(f2)[:-1]+ seg(c2)[:-1])[0]

l7=lineFromStartTillPoint(c1,p0)+flip(trim_sec_ip(c2,f1[0],p1)) + f1 + \
trim_sec_ip(c1,p2,[-20,0])

```

```

l7=rot('x90', homogenise(l7,0.5,closed_loop=1 ))
sol3=surface_line_vector(l7,[0,-25,0],both_sides=1)

s1=flip(trim_sec_ip(c3,p5,p4))+lineFromStartTillPoint(f2,p6)
s1=homogenise(s1,0.5)
s1=plos(sol2,c23(s1),[0,0,1])
s1=plos_v_1(sol3,s1,[0,0,4],[0,1,0])
p7=s_int1_3d(seg(s1)[:-1]+seg(l3)[:-1])[0]
s2=lineFromStartTillPoint(s1,p7)+lineFromPointTillEnd( l3, p7)[2:]

l8=homogenise(rot('x90', f1+[p2]),pitch=0.5)
l8=plos(sol1,l8,[0,1,0])
p8=s_int1(seg(f2)[:-1]+ seg(c1))[0]

s3=flip(trim_sec_ip(c3,p5,p4))+lineFromStartTillPoint(f2,p8)
s3=homogenise(s3,0.5)
s3=plos(sol1,c23(s3),[0,0,1])
p9=s_int1_3d(seg(s3)[:-1] + seg(l8)[:-1])[0]
s4=lineFromStartTillPoint(s3,p9) + lineFromPointTillEnd(l8,p9)
s2=s2+flip(mirror_line(s2,[0,1,0],[0,0,0]))[1:-1]
s4=s4+flip(mirror_line(s4,[0,1,0],[0,0,0]))[1:-1]

sol4=translate([0,0,p9[2]],linear_extrude(c32(s4), 25))

s1=s2
s2=path2path1(s1,s4)
s2=plos_v(sol1,s2,[0,0,4])
s3=mid_line(s1,s2)
s4=offset_3d_sec(s1,-1.5)
s5=o_3d(s2,sol1,-1.5)

sol5=lines_filletts_solid(s4,s1,s3,s2,s5,20,-1.5)
sol5=flip(sol5+[sol5[0]])
fileopen(f'''
//color("blue") for(p= {c1, c2, c3, l4}) p_line3d(p , 0.3);
//color("cyan") points({p0, p1, p2, p3, p4, p5, p6, p7, p8, p9}, 0.5);
//color("magenta") for(p={s1, s2, s3, s4, s5}) p_line3d(p, 0.31);
resize([40,30,15])
difference(){
intersection(){
{swp(sol1)}
{swp(sol3)}
}
{swp(sol4)}
{swp_c(sol5)}
}
'''')
f_t=time.time()
f_t-i_t

```

