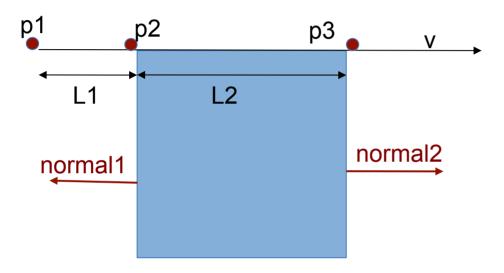
# Shapes Conventions Distance & Safety

## Convex shape with flat surfaces, conventions for 'scratching' directions

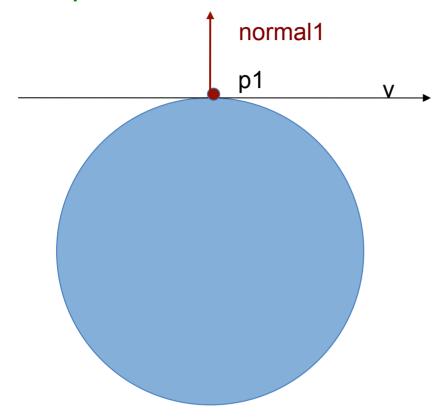


p1 : DistanceToIn(p1,v) = L1

p2 : DistanceToIn (p2,v) = 0, (normal1,v) < 0DistanceToOut(p2,v) = L2, (normal1,v) < 0

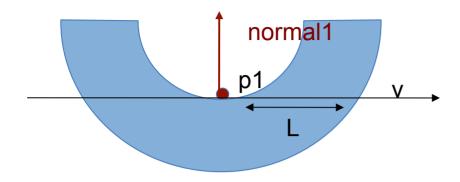
p3 : DistanceToIn (p3,v) = Infinity, (normal2,v) > 0DistanceToOut(p3,v) = 0, (normal2,v) > 0

### Convex shape with curved surfaces, conventions for 'scratching' directions



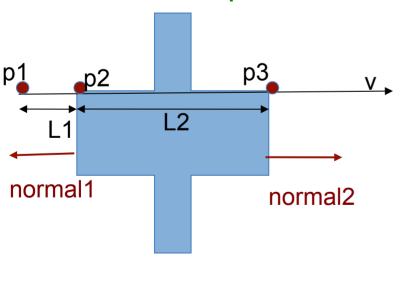
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p1 : DistanceToIn (p1,v) = Infinity, (normal1,v) = 0
DistanceToOut(p1,v) = 0, (normal1,v) = 0
```

#### Concave shape with curved surfaces, 'scratching' directions



P1 : DistanceToIn (p1,v) = 0, (normal1,v) = 0DistanceToOut(p1,v) = L, (normal1,v) = 0

#### Concave shape with flat surfaces, 'scratching' directions

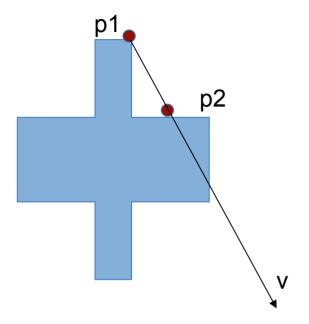


p1 : DistanceToIn(p1,v) = L1, not Infinity

p2 : DistanceToIn (p2,v) = 0, (normal1,v) < 0DistanceToOut(p2,v) = L2, (normal1,v) < 0

p3 : DistanceToIn (p3,v) = Infinity, (normal2,v) > 0DistanceToOut(p3,v) = 0, (normal2,v) > 0

## Concave shapes, 'reentering' directions



p1 : DistanceToIn(p1,v) = L1, not Infinity

# Conventions. DistanceToIn(p,v)

DistanceToIn(p,v) return the exact distance (double) to the surface of the shape for given point p and direction v. Normal is pointing outwards shape.

	Geant4	USolids	VecGeom	ROOT
Point p is <b>Outside</b> No intersection Between shape and ray(p +v*t)	Infinity	Infinity	Infinity	Infinity
Point p is <b>Outside</b> Intersection Between shape and ray(p +v*t)	Distance	Distance	Distance	Distance
Point p is <b>on Surface</b>	0, if 'entering shape', normal.dot(v) < 0 for convex shapes  Infinity for convex shapes or Distance to next Intersection for concave shapes, if 'leaving shape', normal.dot(v) >= 0 for convex shapes	0, if 'entering shape', normal.dot(v) < 0 for convex shapes  Infinity for convex shapes or Distance to next Intersection for concave shapes, if 'leaving shape' normal.dot(v) >= 0, for convex shapes	O, if 'entering shape'  Infinity for convex shapes or Distance to next Intersection for concave shapes, if 'leaving shape'	0, if 'entering shape', normal.dot(v) < 0 for convex shapes  Infinity for convex shapes or Distance to next Intersection for concave shapes, if 'leaving shape', normal.dot(v) >= 0 for convex shapes
Point p is <b>Inside</b> "Wrong side"	No general rule(?), depends on shape	0	-Distance	
If Distance(p,v) <halftolerance< td=""><td>0</td><td>0</td><td>Distance</td><td></td></halftolerance<>	0	0	Distance	

## Conventions. DistanceToOut(p,v)

DistanceToOut(p,v) return the exact distance (double) to the surface of the shape for given point p, and direction v. Normal is pointing outwards shape. ROOT **USolids** Geant4 VecGeom Point p is Inside Infinity, as default Infinity, as default Infinity, as default Infinity, as No intersection default value value value value Between shape and ray(p+v\*t). "wrong result" Point p is Inside Distance Distance Distance Distance Intersection Between shape and ray(p+v\*t) 0, if 'leaving shape' Point p is on Surface 0, if 'leaving' shape, **0**, if 'leaving' shape, **0**, if 'leaving' shape, normal.dot(v) >= 0normal.dot(v) >= 0, for normal.dot(v) >= 0 for for convex shape convex shape convex shape DistanceTo next DistanceTo next boundary, if boundary, if 'entering DistanceTo next DistanceTo next boundary, if 'entering' boundary, if 'entering' 'entering' shape, shape' normal.dot(v) < 0 forshape, normal.dot(v) < 0shape .normal.dot(v) < 0convex shape for convex shaper for convex shape Point p is Outside No general rule(?), 0-Distance "Wrong side" depends on shape If Distance(p,v)<halfTolerance Distance  $\mathbf{O}$ 

# Conventions. SafetyFromOutside(p)

SaferyFromOutside estimates isotropic distance to the surface of the shape from Outside. This must be either accurate or an underestimate.

	Geant4	USolids	VecGeom	ROOT
Point p is <b>Outside</b>	Safety	Safety	Safety	Safety
Point p is <b>on Surface</b>	0	0	0	0
Point p is <b>Inside</b> "Wrong side"	0	0	-Safety	-Safety

# Conventions. SafetyFromInside(p)

SaferyFromInside(p) estimates isotropic distance to the surface of the shape from Inside point p. This must be either accurate or an underestimate.

	Geant4	USolids	VecGeom	ROOT
Point p is <b>Inside</b>	Safety	Safety	Safety	Safety
Point p is on Surface	0	0	0	0
Point p is <b>Outside</b> "Wrong side"	0	0	-Safety	-Safety