Practical Work – Delmia

Lecture 1

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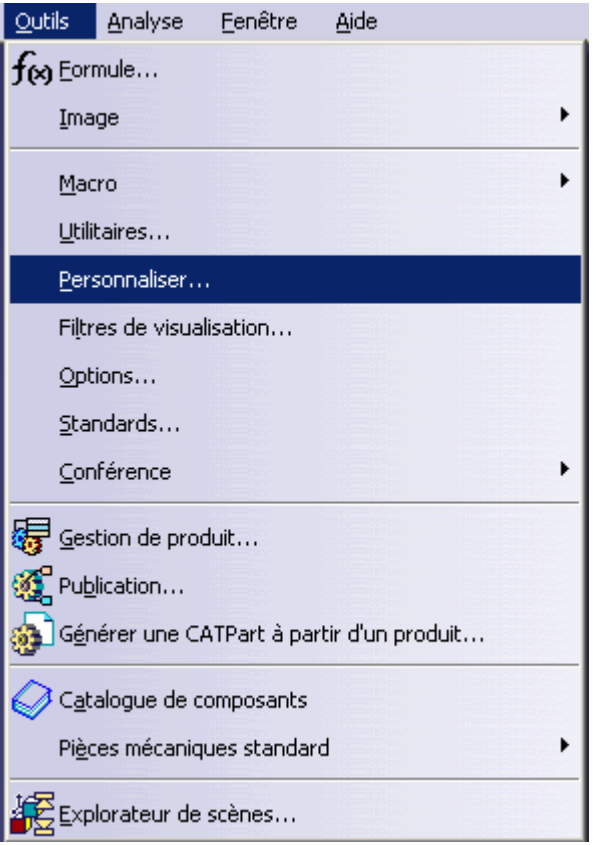
Definition of the language for the user interface

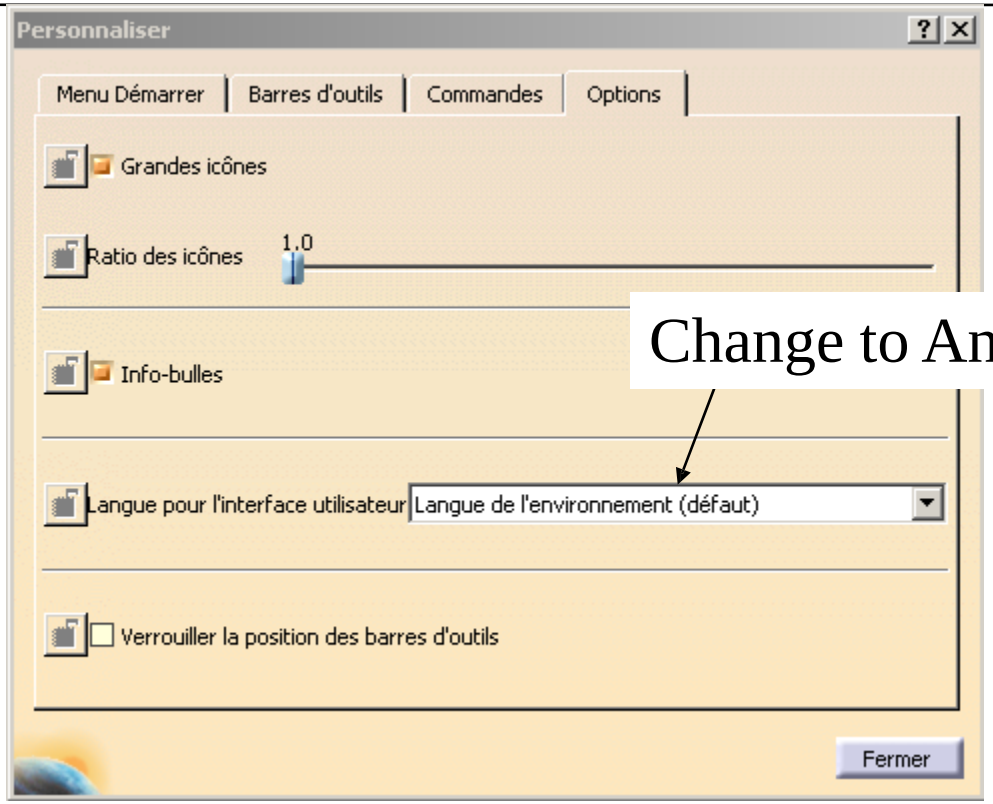
- Native languages
  - English, French, German, Italian, Japanese, Simplified Chinese, Korean

- To change from French to English
  - Outils / Personnaliser / Options / Langue de l'interface utilisateur

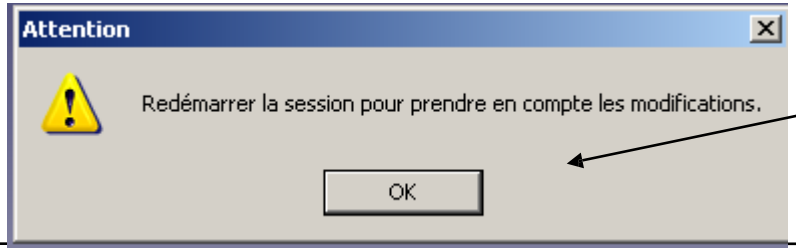
- To change from English to French
  - Tools / Customize / Options / User Interface Language

Definition of the language for the user interface





Change to Anglais



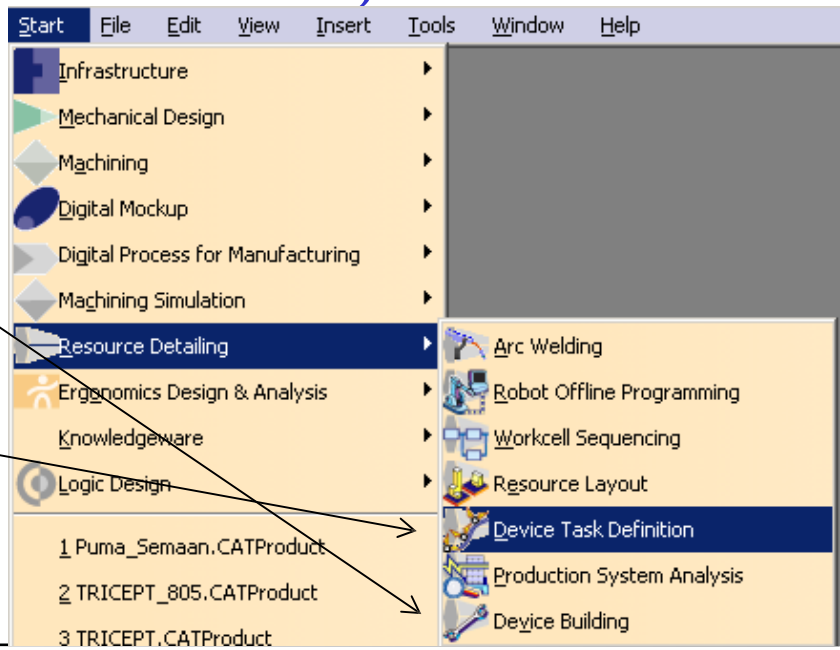
Restart CATIA

Mouse usage

Use this mouse button	Whenever you read
	Select (menus, commands, etc.)
	Click (icons, dialog box buttons, tabs, location in the document window)
	Double-click
	Shift-click
	Ctrl-click
	Check (check boxes),
	Drag
	Drag and drop (icons onto objects, objects onto icons)
	Drag
	Move
	Right click (to select contectual menu)

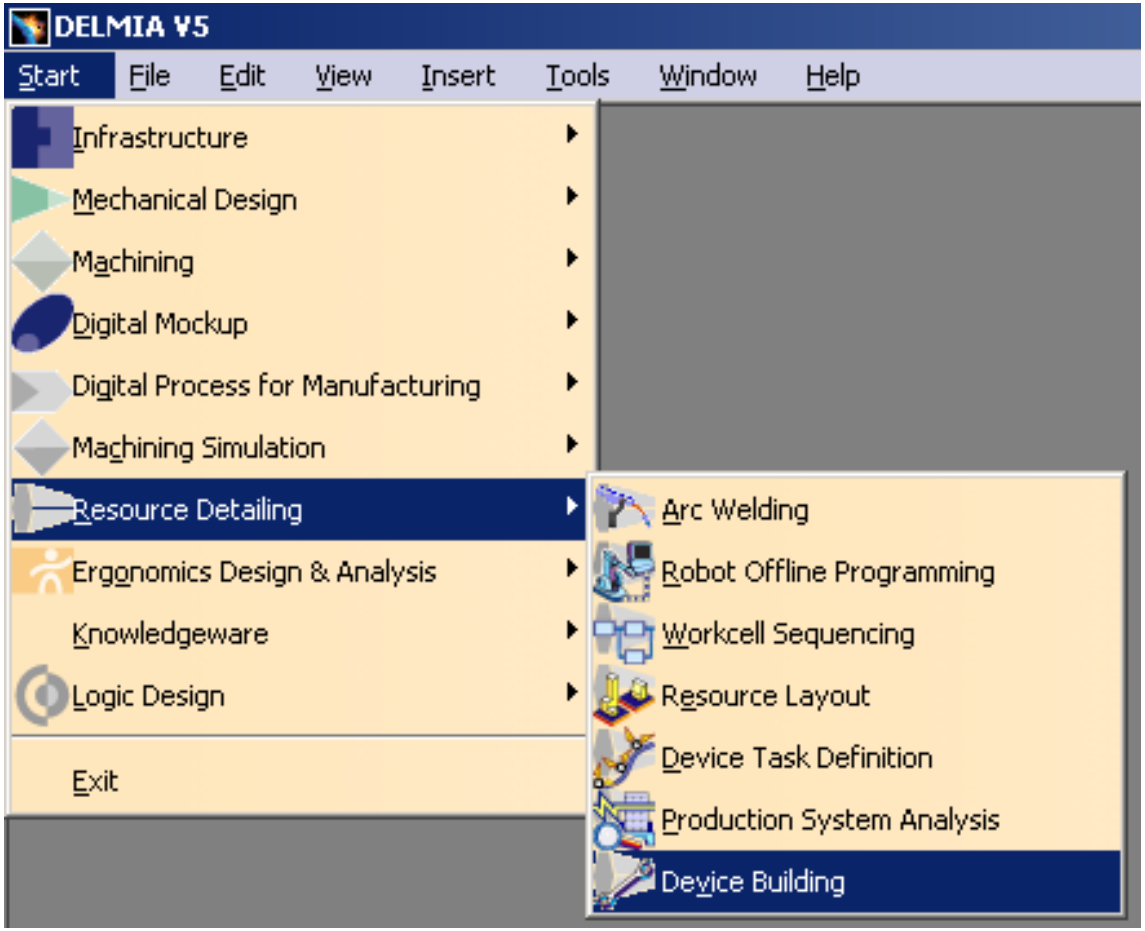
Outline of the lecture

- Create a robot from CAD parts
  - Create direct kinematics
  - Create inverse kinematics
  - Analyze the DH parameters
  - Create robot properties (velocity and acceleration)
- Create a tool
- Create a robotic cell



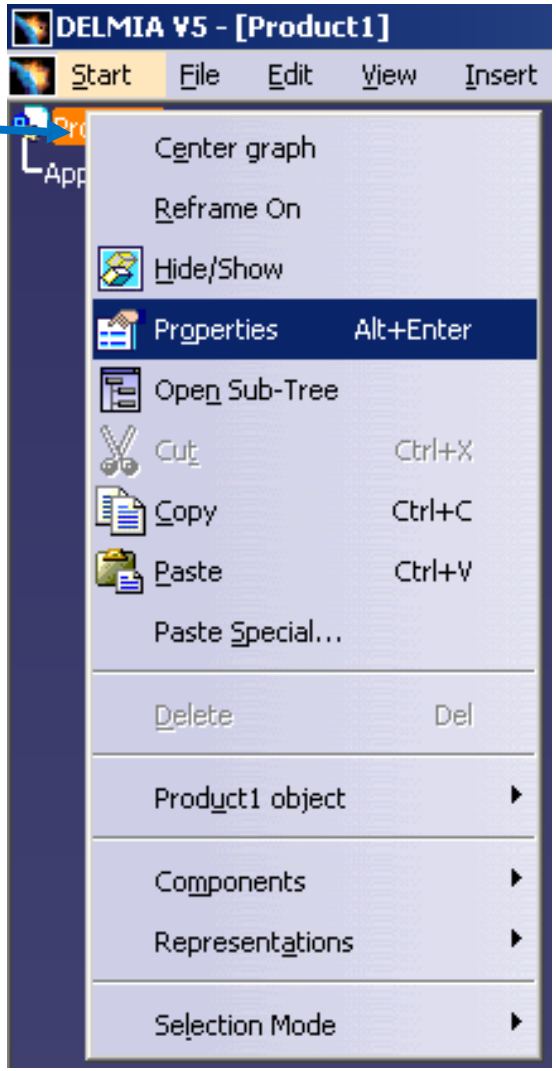
Product creation

- Start / Resource Detailing / Device Building



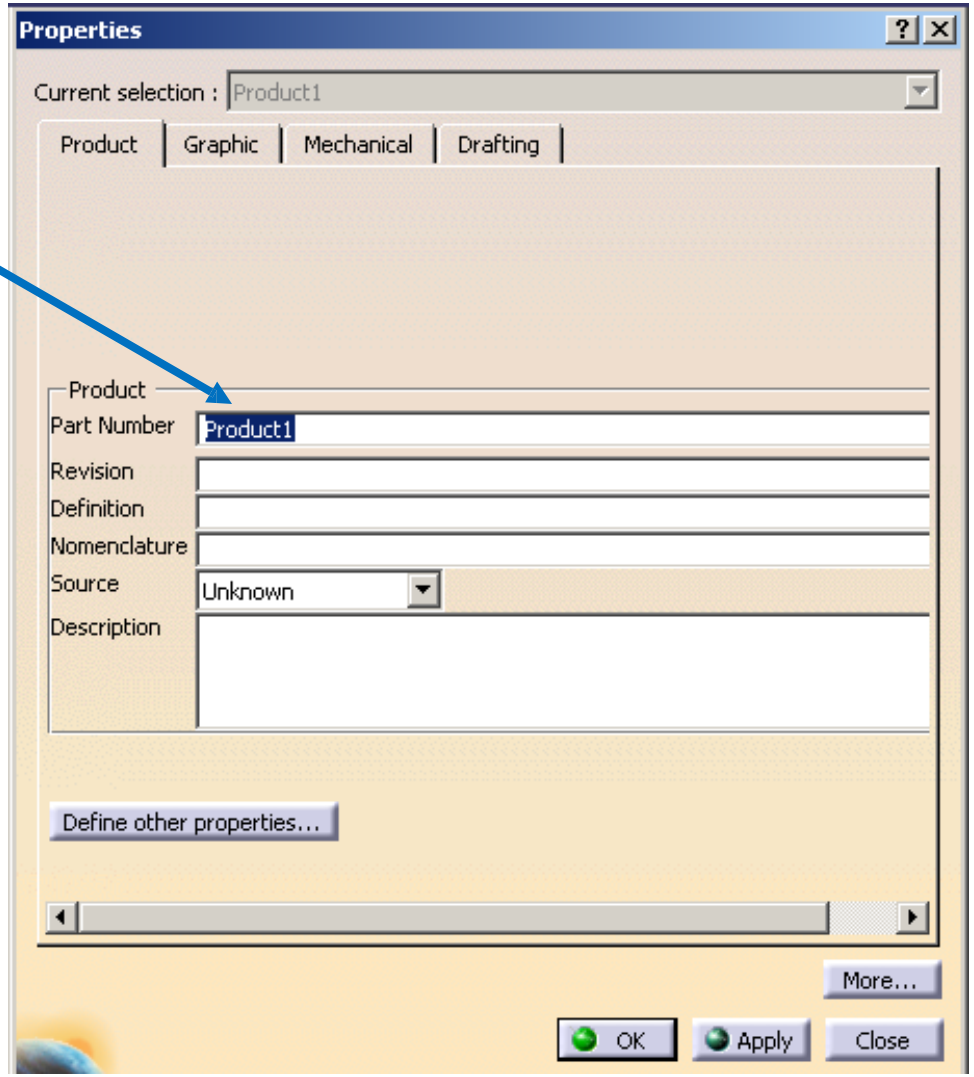
Product creation

- Rename the product
  - Right click on product
  - Properties



Product creation

- Type a product name
  - PUMA_PW

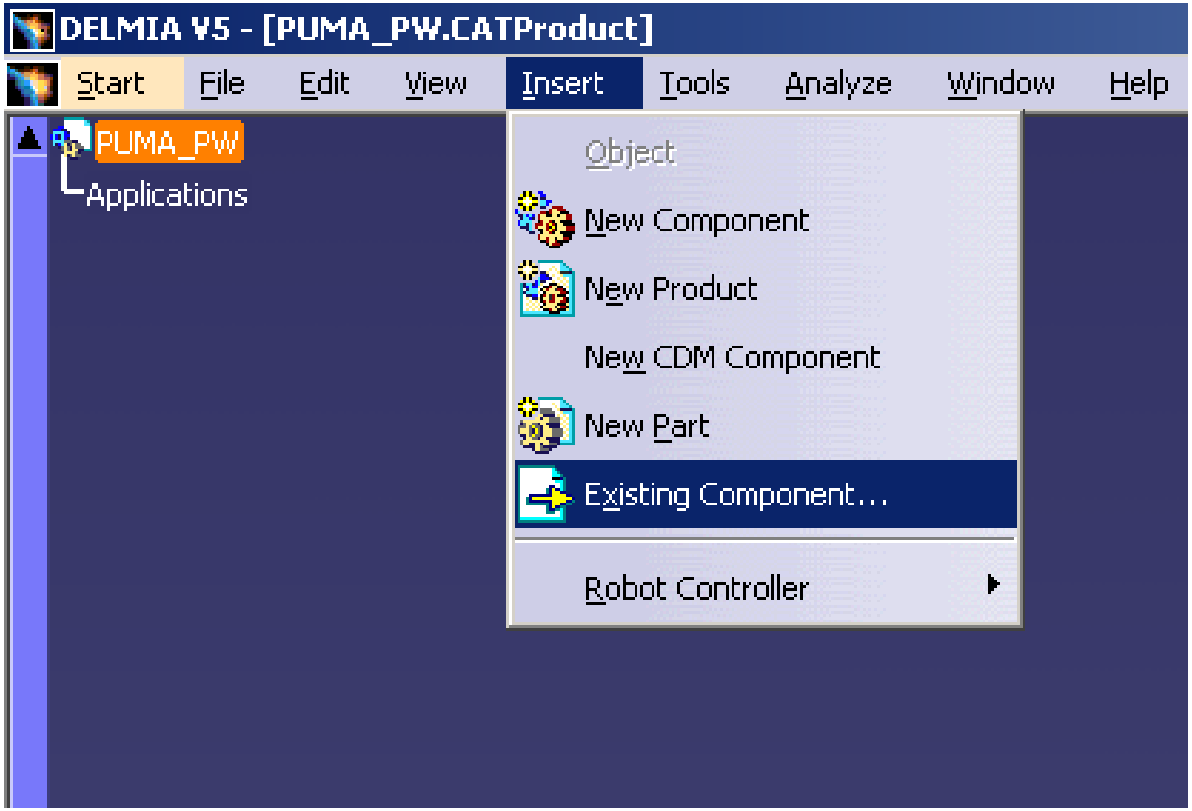


Part creation

- Parts are already created, you have to download it on http://pagesperso.ls2n.fr/~chablat-d/EMARO/Delmia.html
- The location of the parts in the assembly defines the Home pose of the robot.
- You have to define the joints between each parts from the base to the end-effector.
- Respect all the times the link between the father and the son.

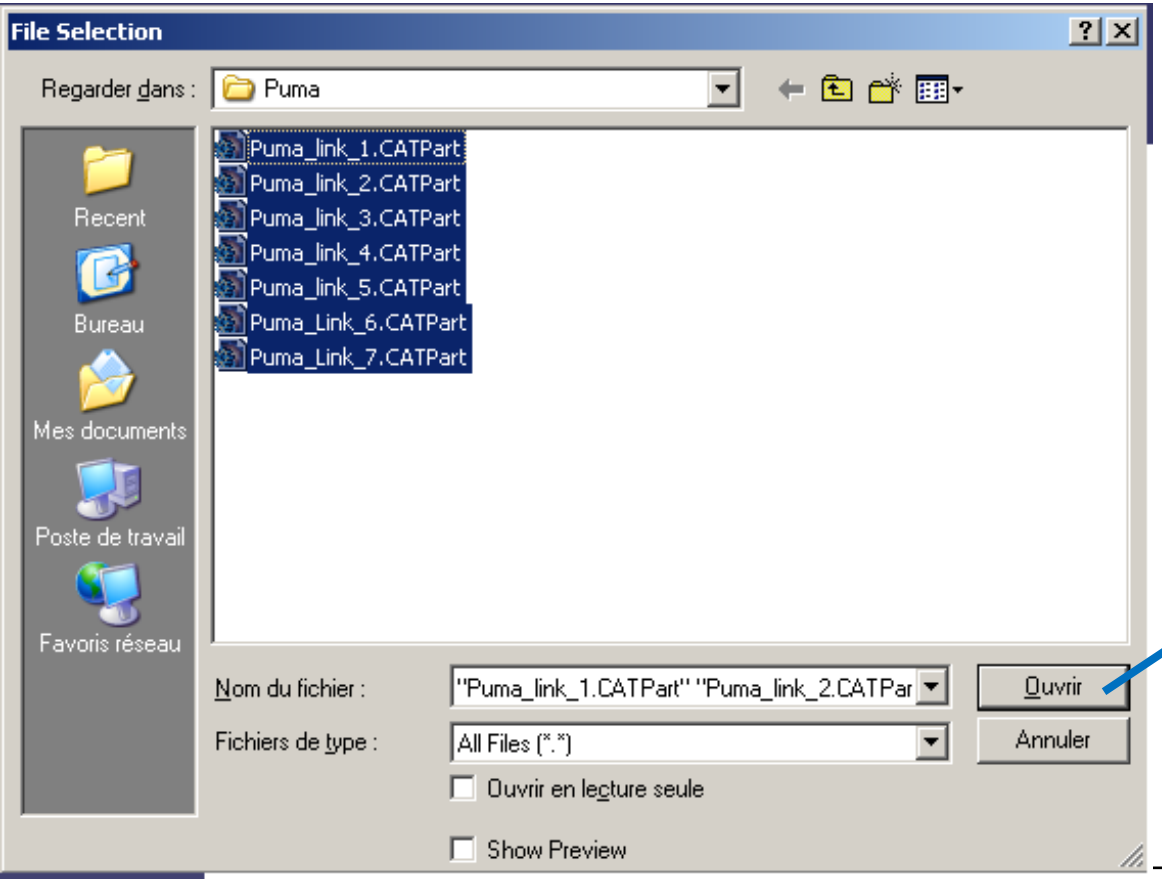
Insert the parts of the robot

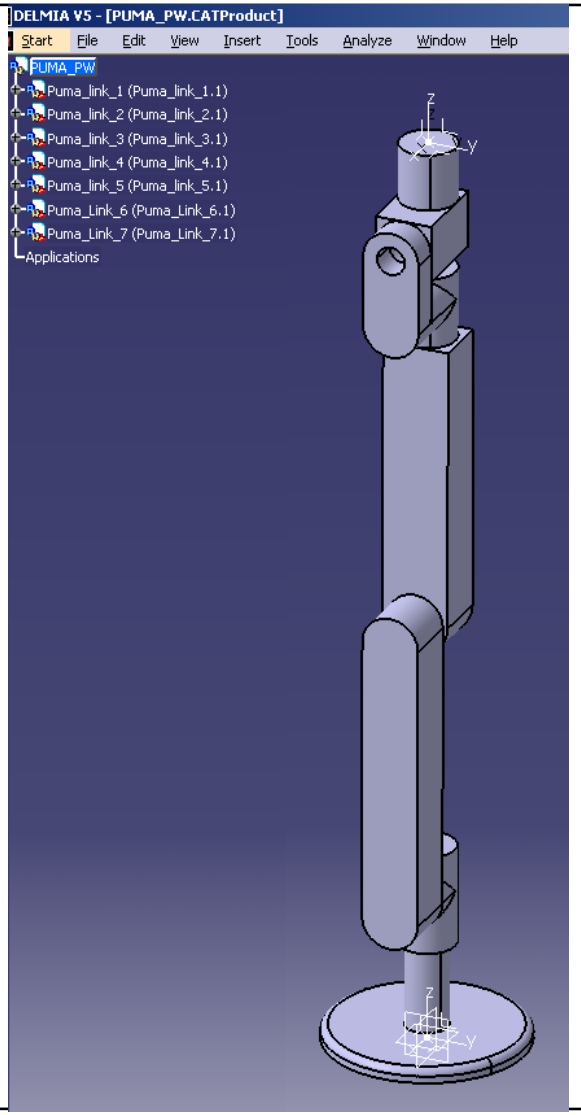
- Click on product “PUMA_PW”
- Insert / Existing Components



Insert the parts of the robot

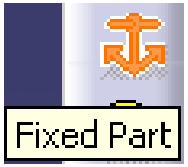
- Go to folder “Puma” and select all parts
- Open





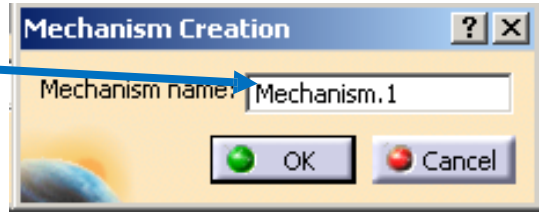
Mechanism Creation

- Click on the “fixed part ” button
- Click on “new mechanism”



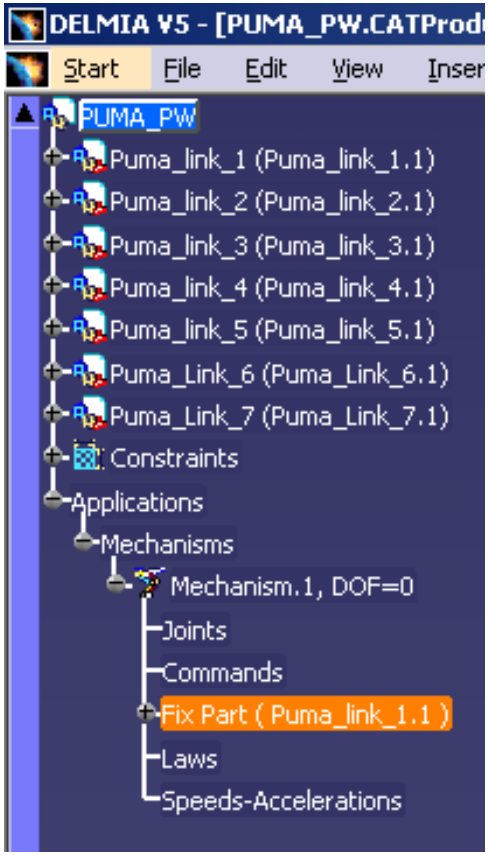
- Choose a name for your mechanism:

  “Puma_robot”



- Click on “Puma_link_1.1”

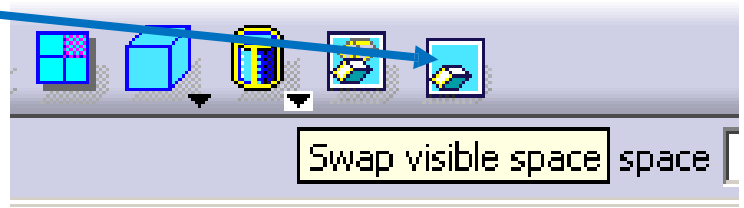
  to select it as “Fix Part”



Hide and Swap Commands

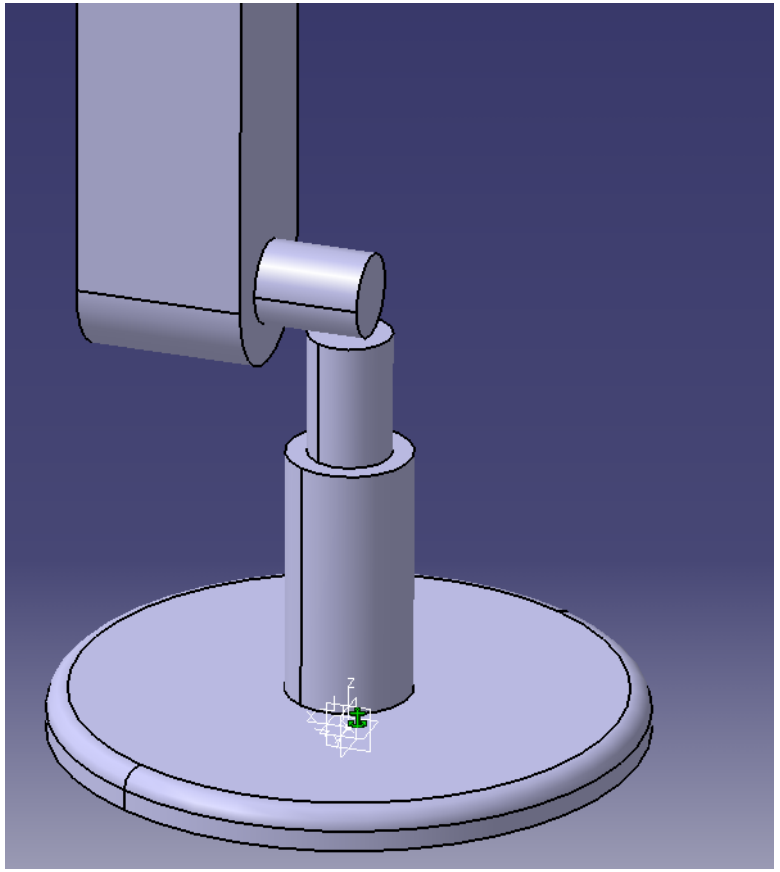
- To hide/show a part, right click on it then click Hide/Show

- Use the “swap visible space” button to swap between the hidden and visible spaces



Create Kinematic Joints

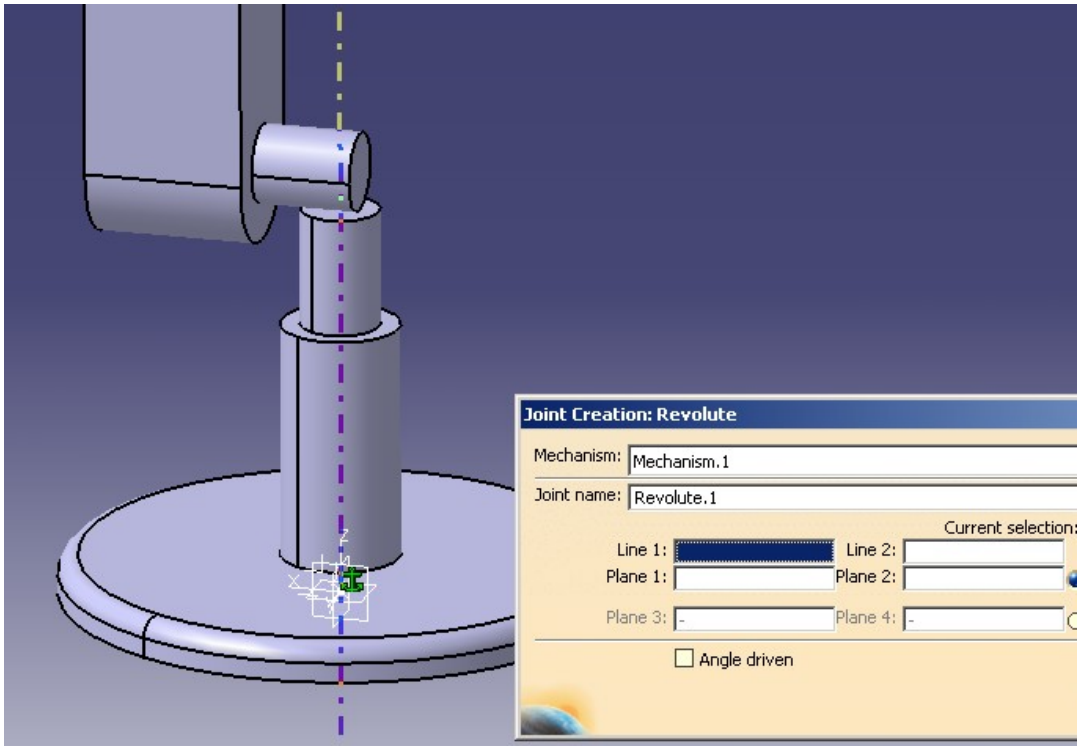
- To create a Revolute Joint between “Puma_link_1” and “Puma_link_2”
  - Hide “Puma_link_2”



Create Kinematic Joints

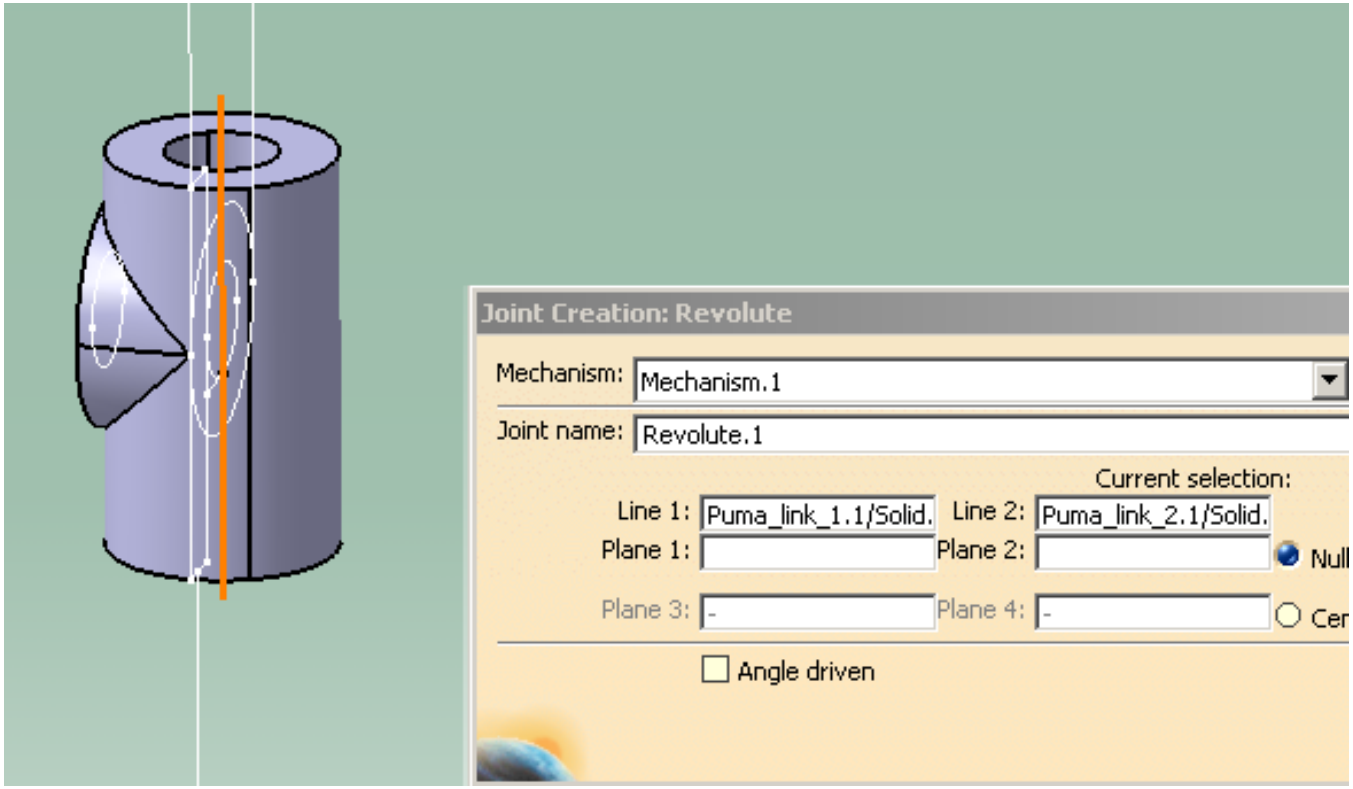
- Click on the “Revolute Joint” button

- Select the axis of “Puma_link_1” as Line 1



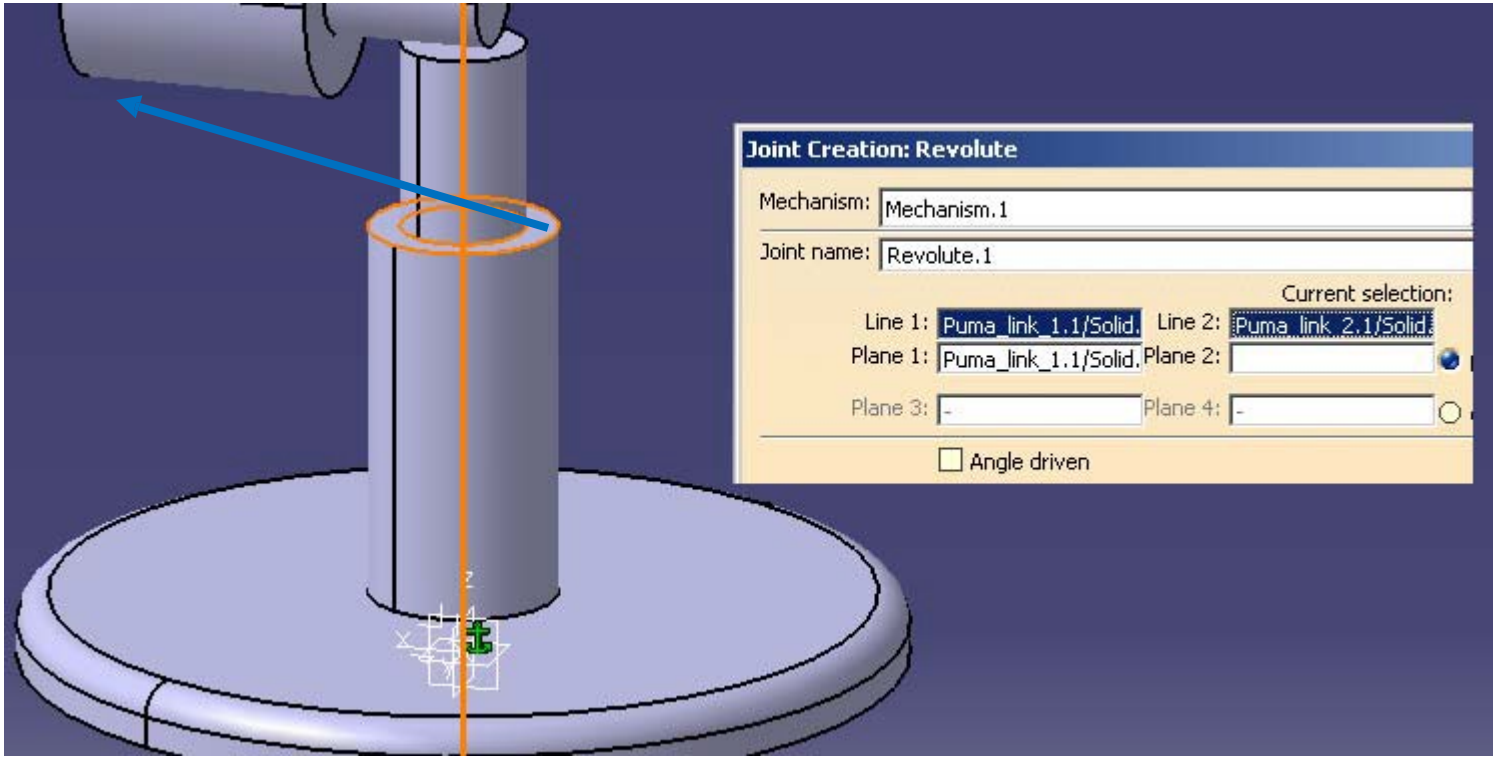
Create Kinematic Joints

- Click on the “swap visible space” button
- Select the axis of “Puma_link_2” as Line 2



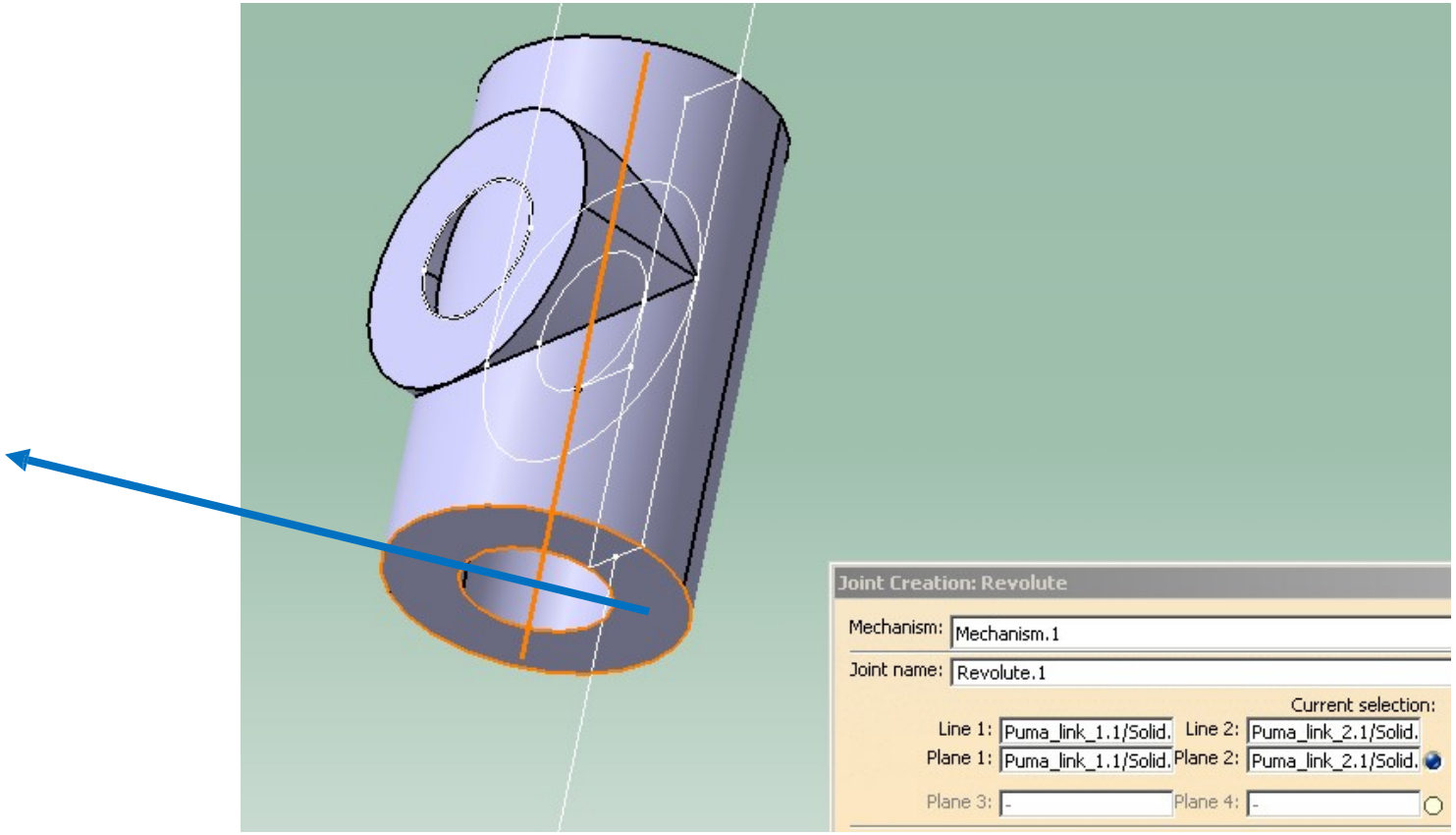
Create Kinematic Joints

- Click on the “swap visible space” button
- Select Plane 1 on “Puma_link_1” as follows:



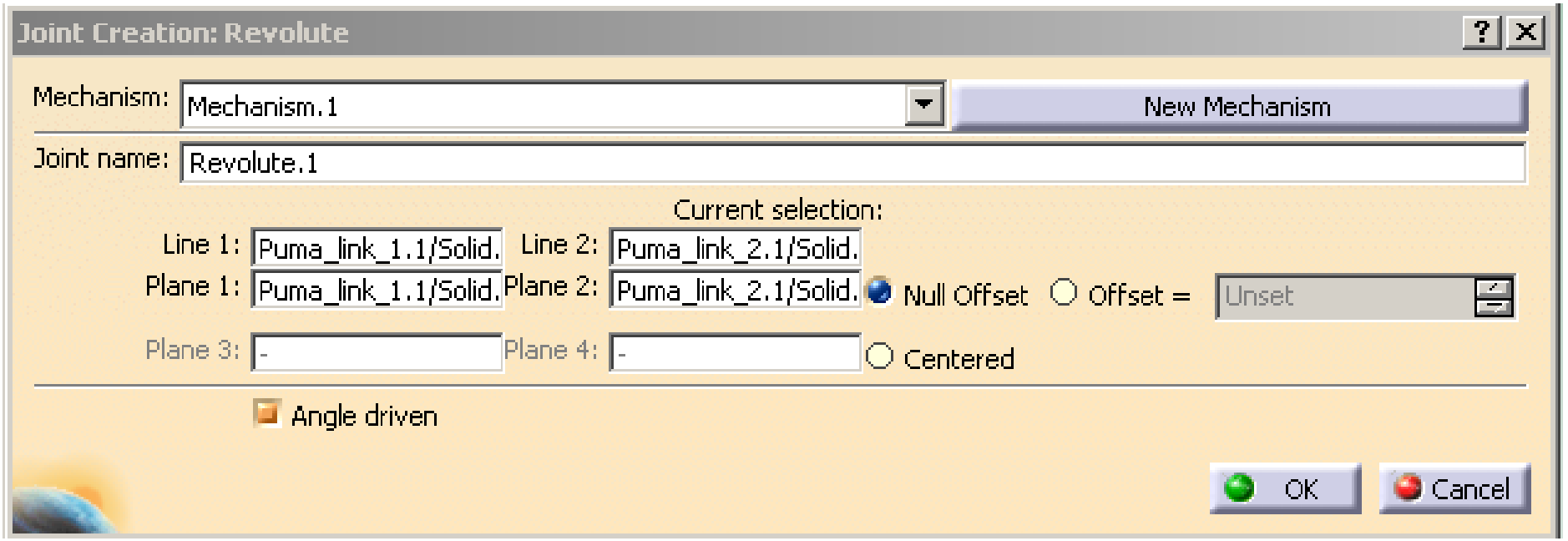
Create Kinematic Joints

- Again, click on the “swap visible space” button
- Select Plane 2 on “Puma_link_2” as follows:



Create Kinematic Joints

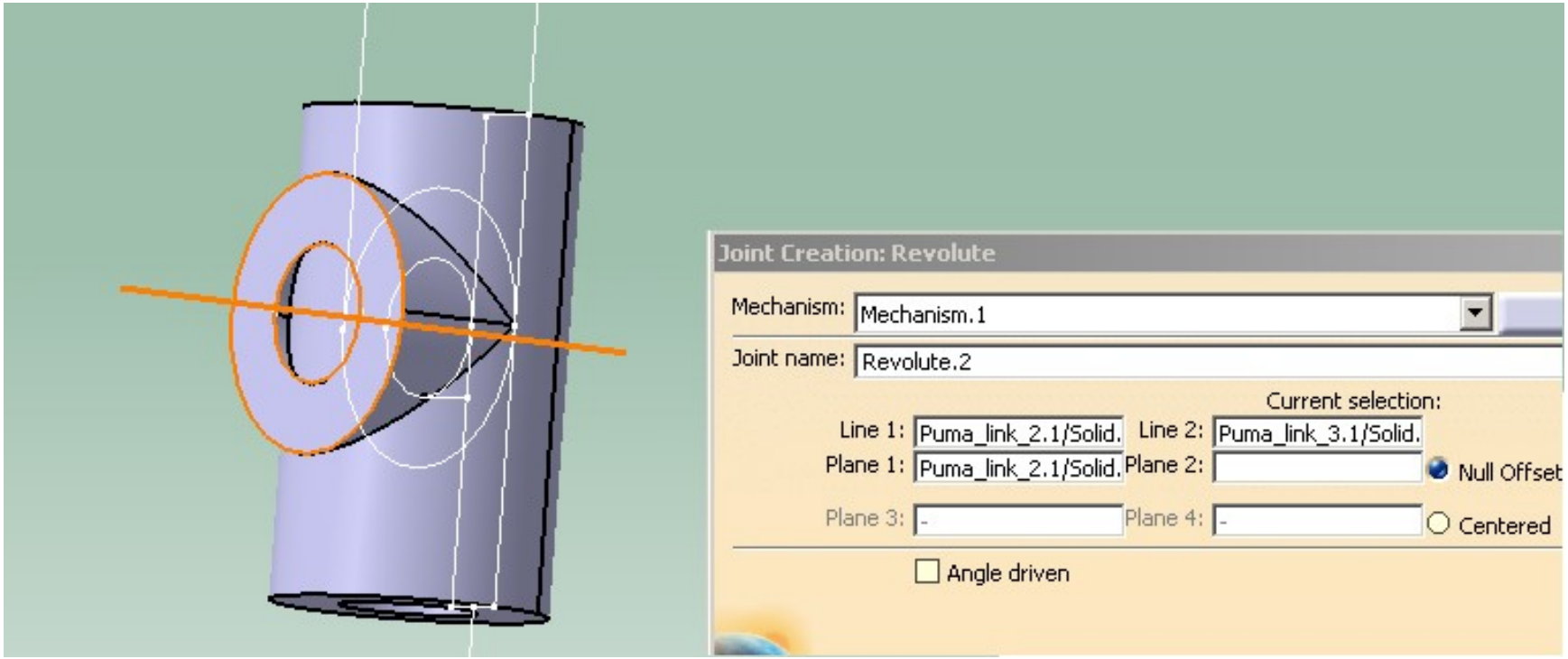
- Finally, to create the Revolute joint:
  - Activate the angle driven option and click OK



  - You may get an information box informing you that the mechanism can be simulated

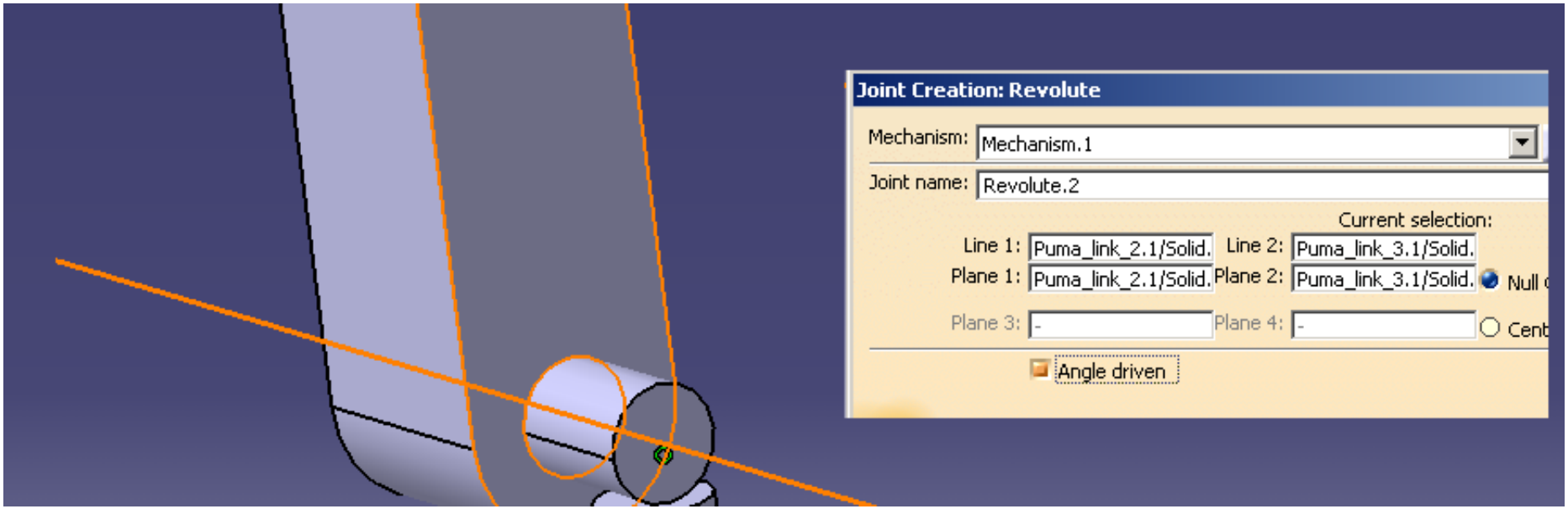
Create Kinematic Joints

- Similarly, create Revolute joint 2 between “Puma_link_2” and “Puma_link_3”



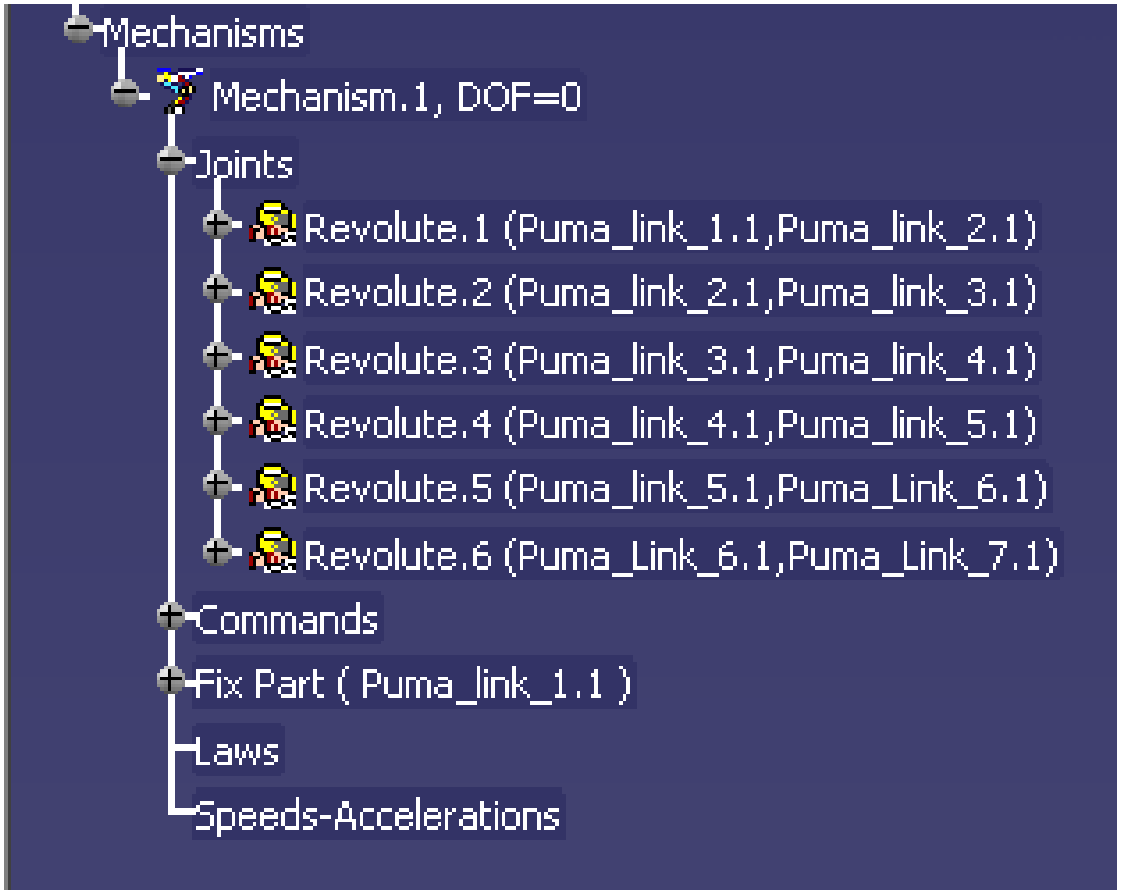
Create Kinematic Joints

- Revolute joint 2



Create Kinematic Joints

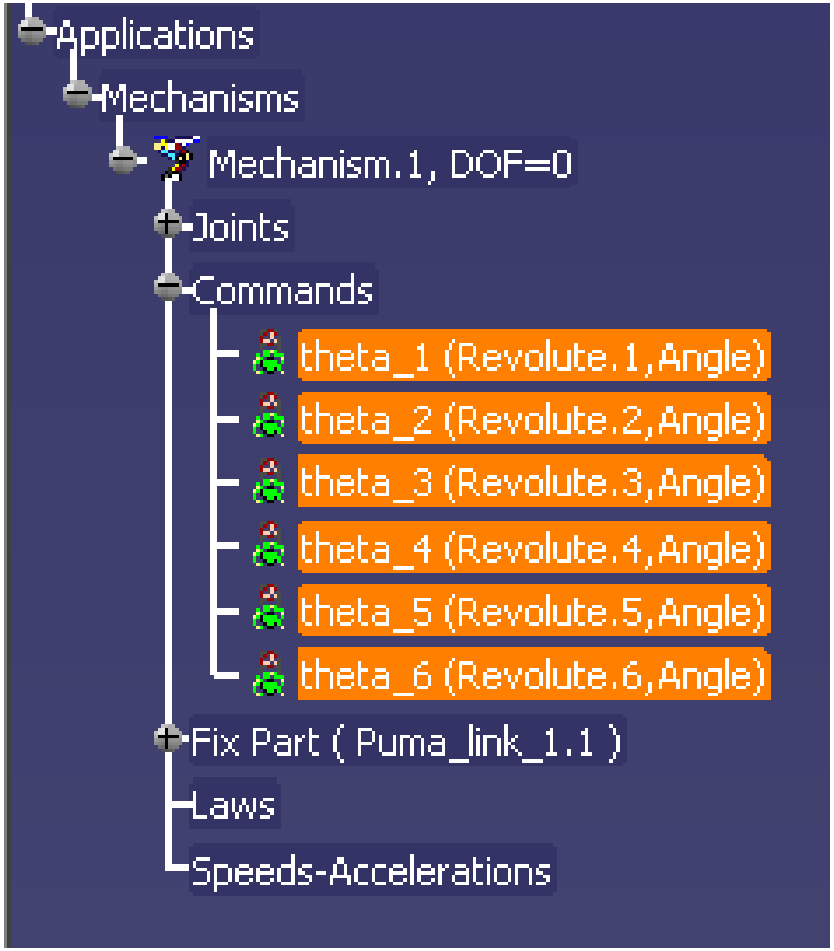
- Similarly, create six revolute joints as follows:



- Hide Constraints in the specification's tree

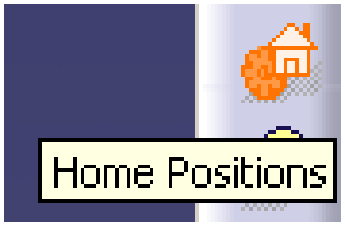
Create Kinematic Joints

- Rename the six commands as “theta_1,…,theta_6”

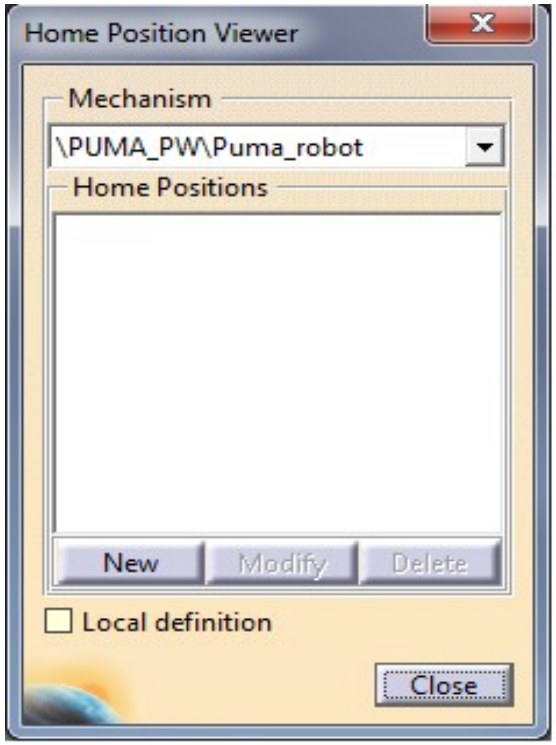


Define Home Positions

- Now, we are going to control each joint :
- Click on “Home Positions” button

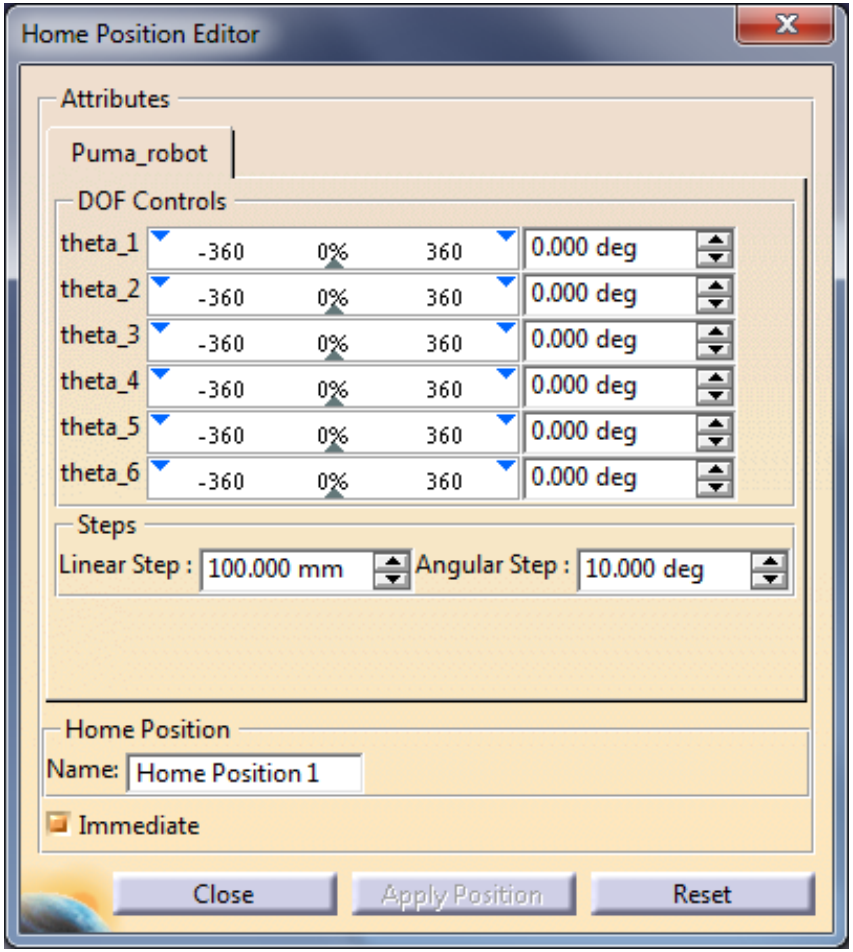


- Click “New”



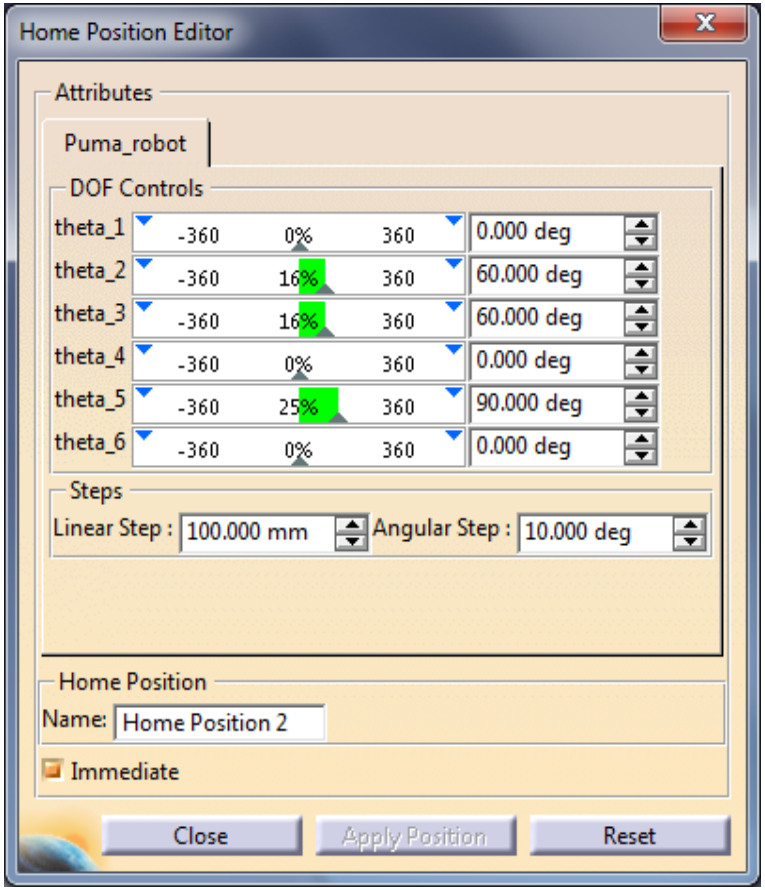
Define Home Positions

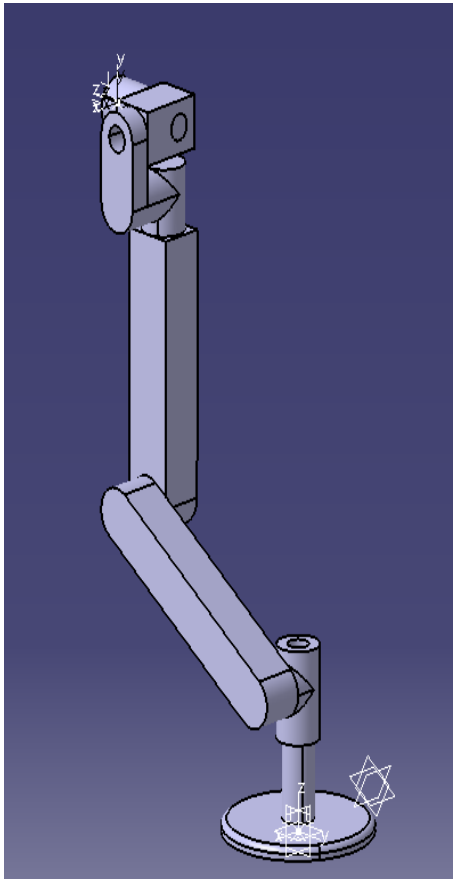
- Set the initial Position of the robot as “Home Position 1”



Define Home Positions

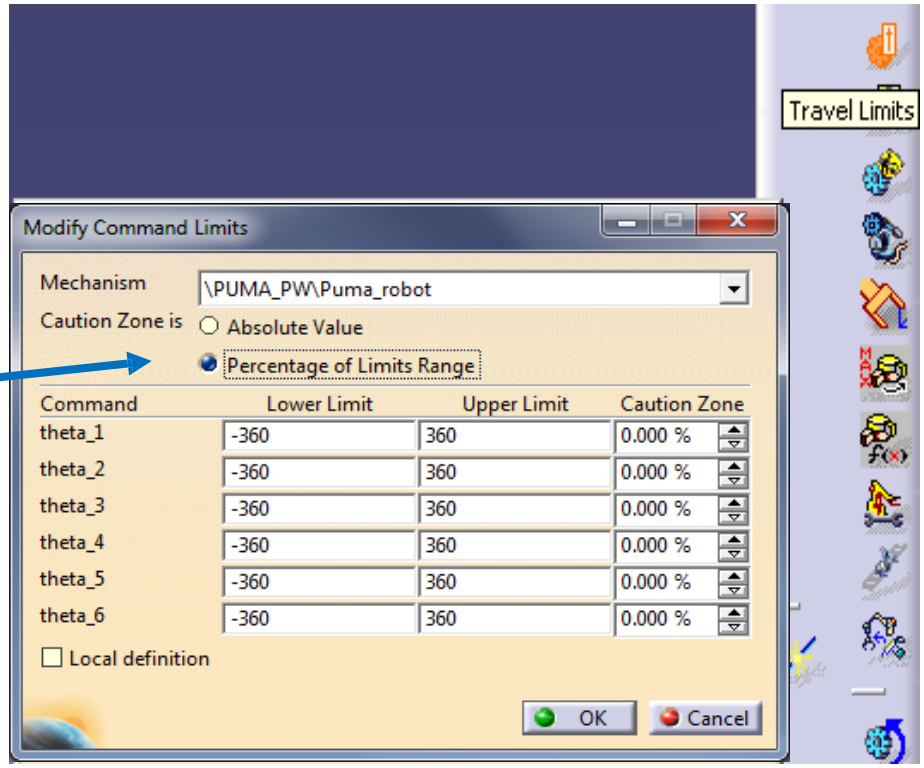
- See the maximal command values to avoid collision and noted it
- Select arbitrary command values for “Home Position 2”





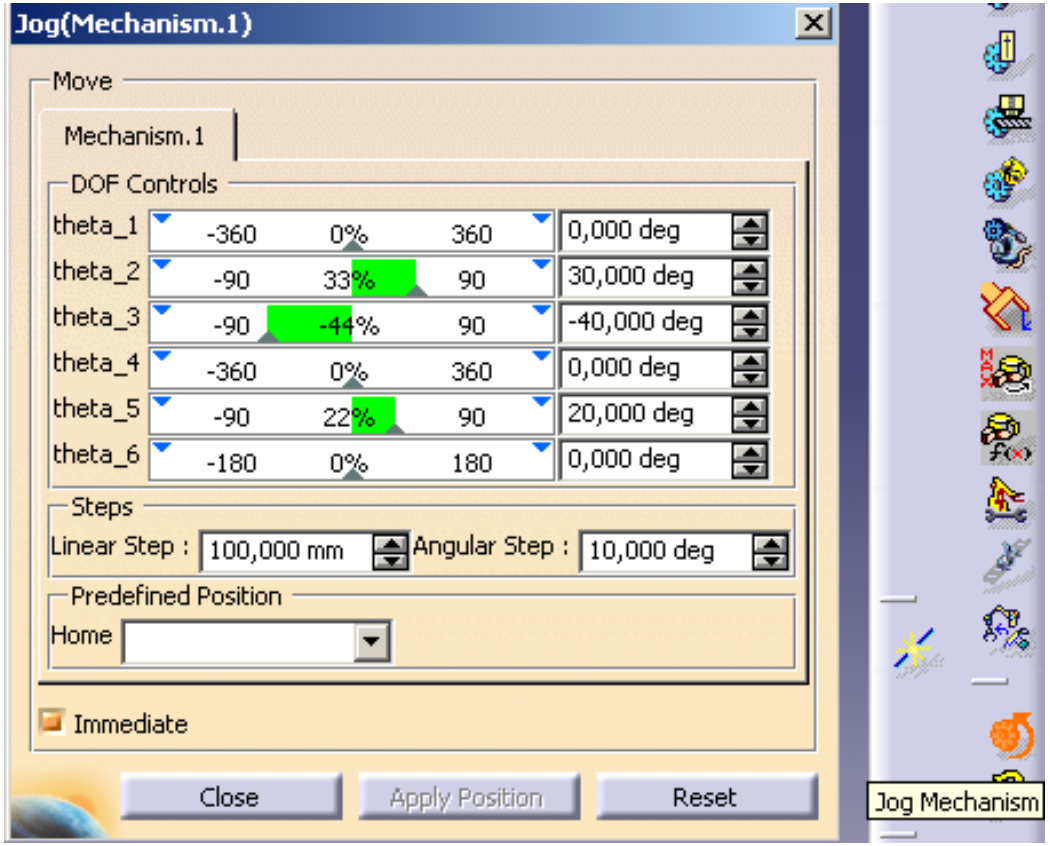
Define Joint Limits

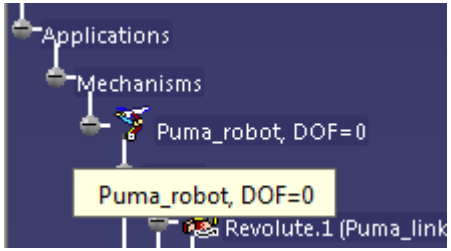
- Delmia can fixed command values limits
- With “Travel Limits” button, define some joint limits for the robot to avoid collisions.
- Look at the difference between this two representations



Jog Mechanism

- Now you can jog the mechanism by using “Jog” button and select Puma_robot



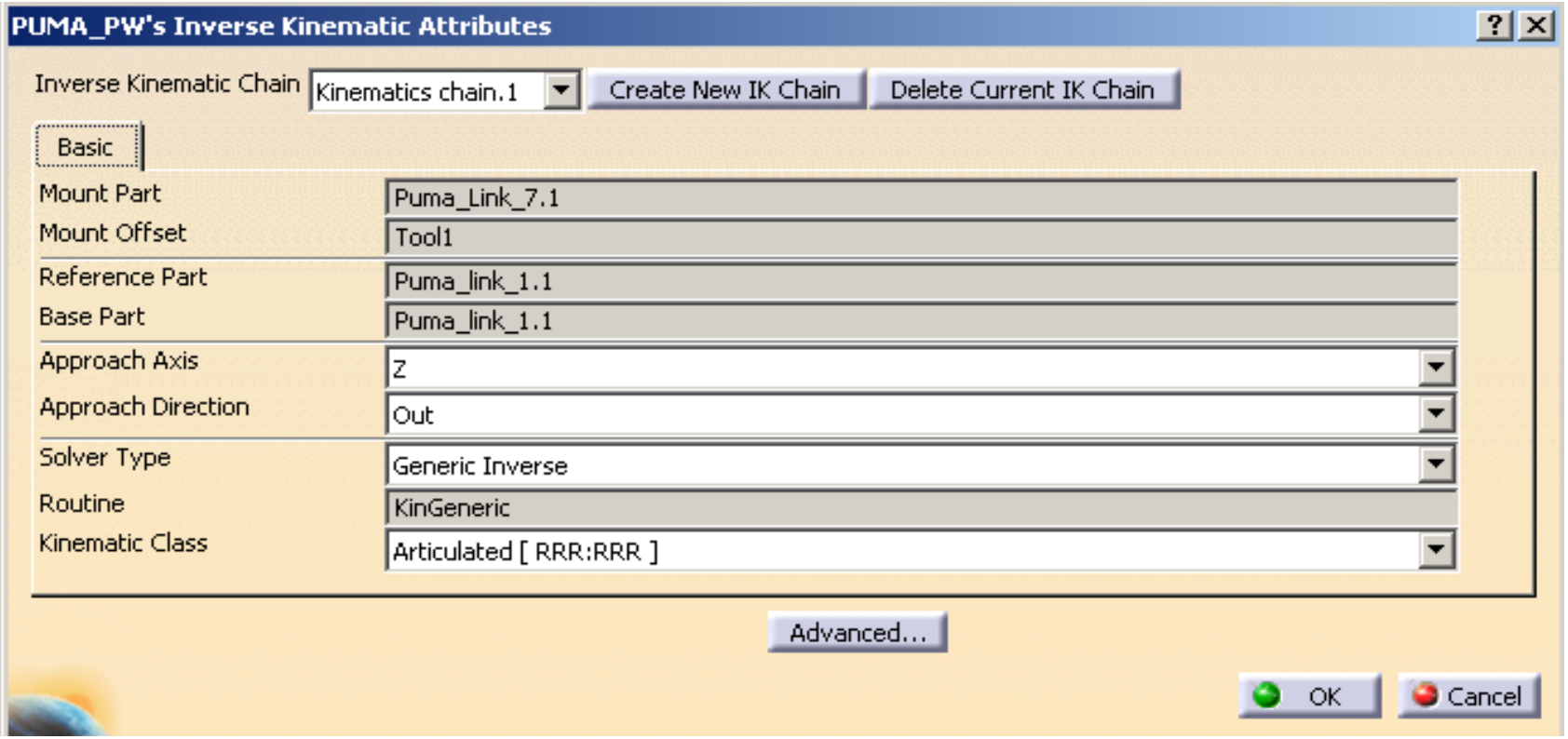


- Return to Home Position 1

Inverse Kinematics

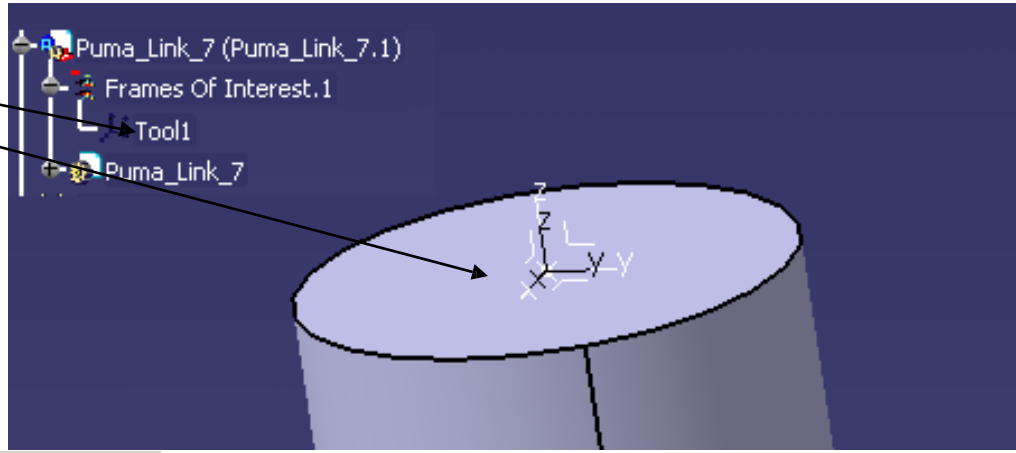
- Click on “Inverse Kinematics” button 

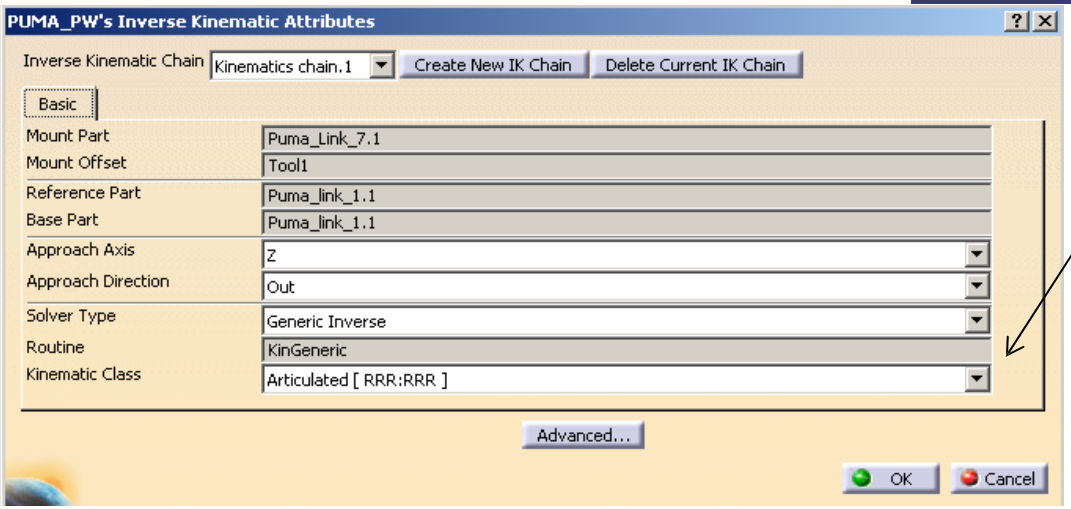
- Select product “PUMA_PW”
- Set the robots inverse kinematics attributes as follows:



Inverse Kinematics

- "Tool1" is a frame already created in "Puma_Link_7"

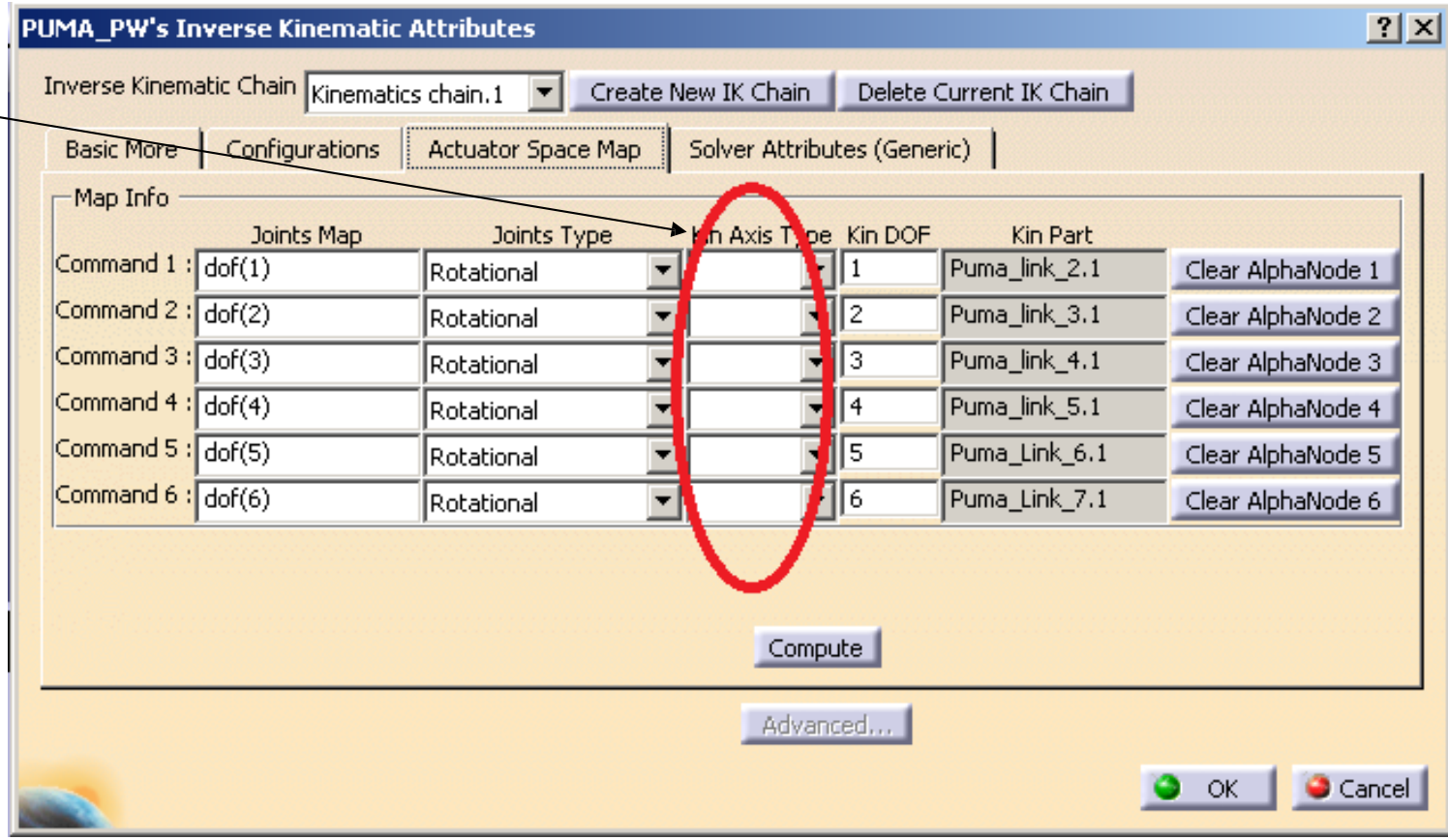




Note : only architecture with spherical wrist can be recognized. In the other cases, we have an iterative solver.

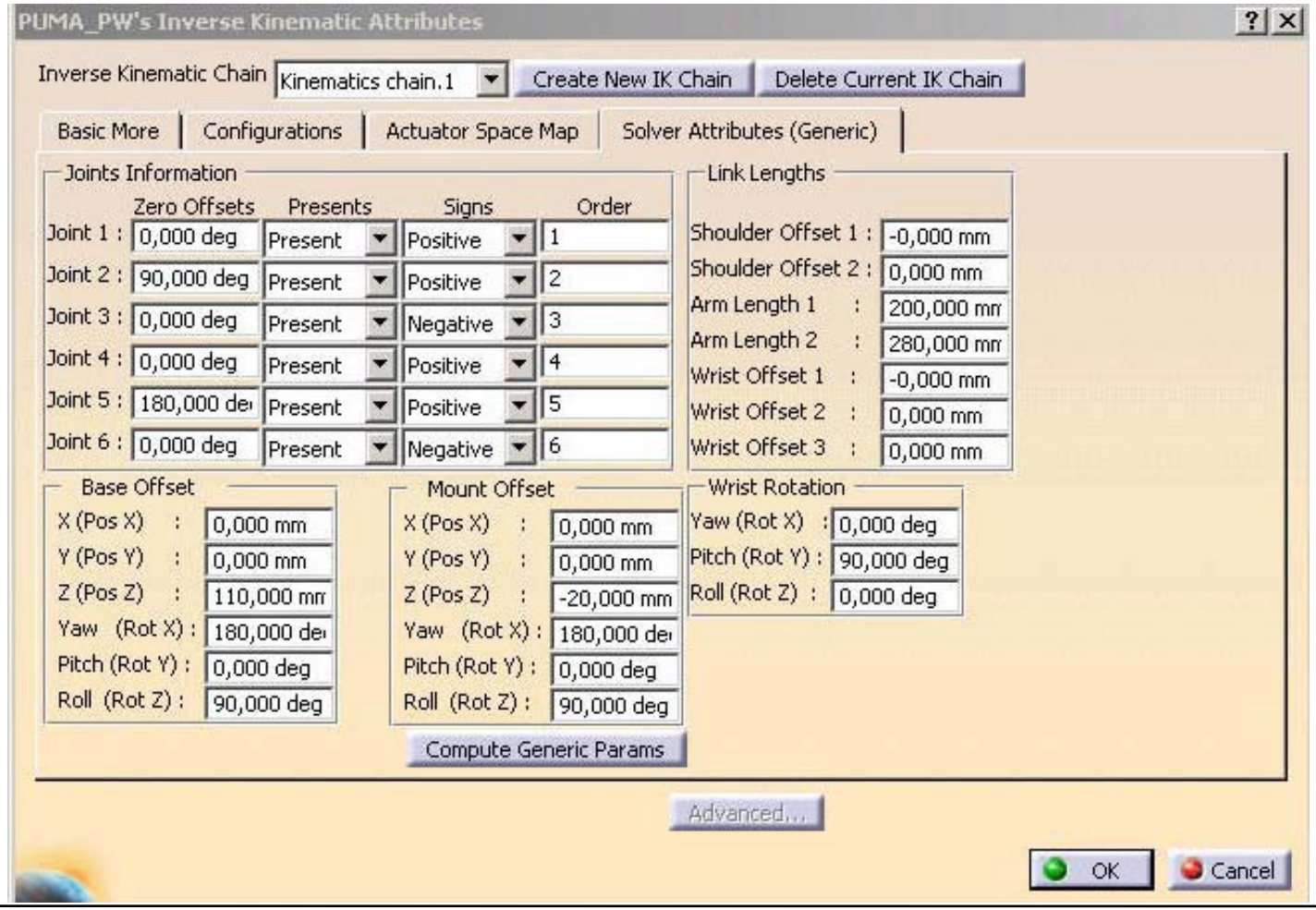
Inverse Kinematics

- Click on “Advanced” button and set the rotational axes in “Actuator Space Map”



Inverse Kinematics

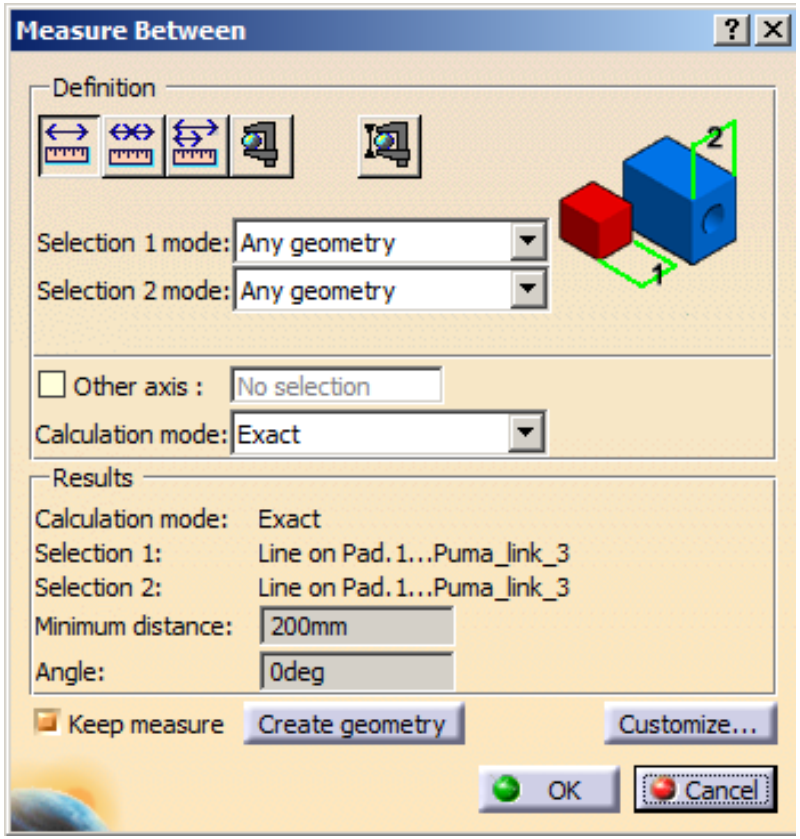
- "Solver Attributes (Generic)"

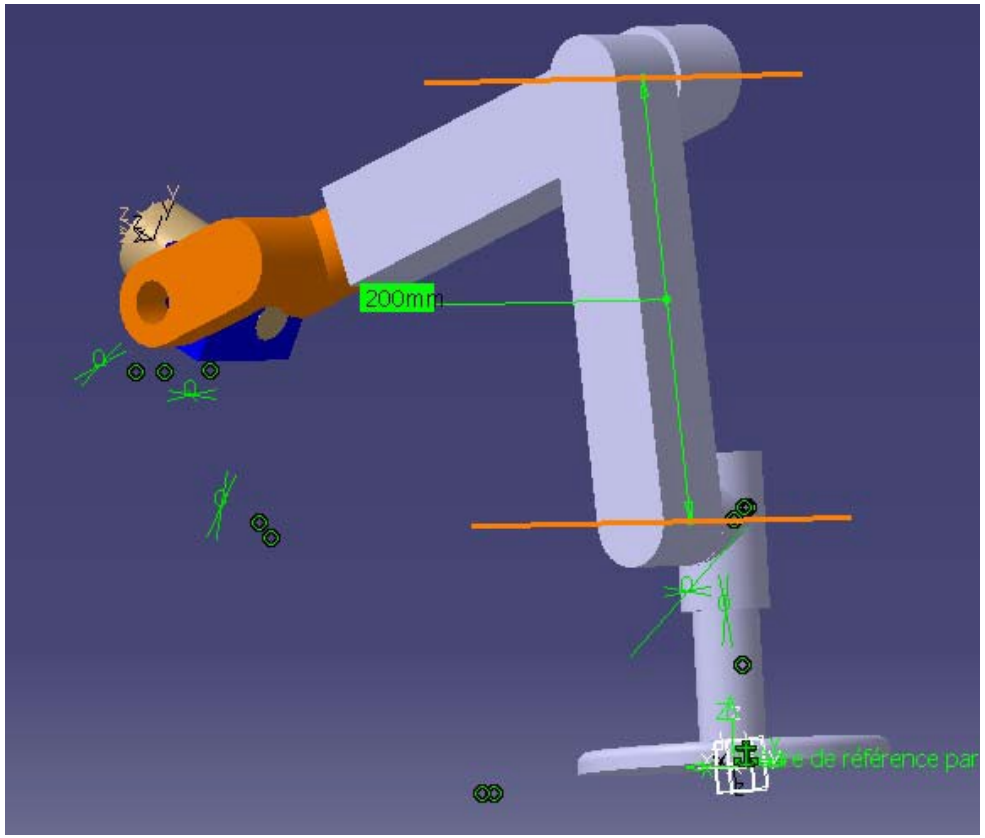


<u>Assignments for the next lecture :</u>
Isolate the Denavit Hardenberg parameters of the Puma's robot.

Checking geometric parameters

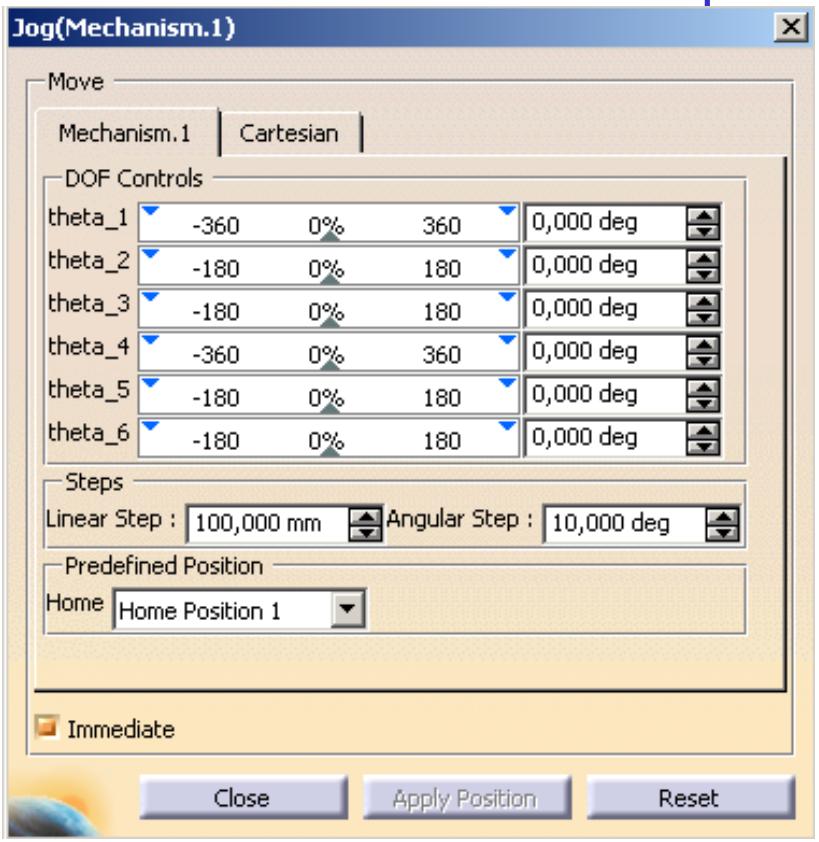
- Using the «Measure Between» button, you can check the geometric parameters of the robot.





Inverse Kinematics

- Now click “Jog” mechanism and select “Home position 1” as predefined position

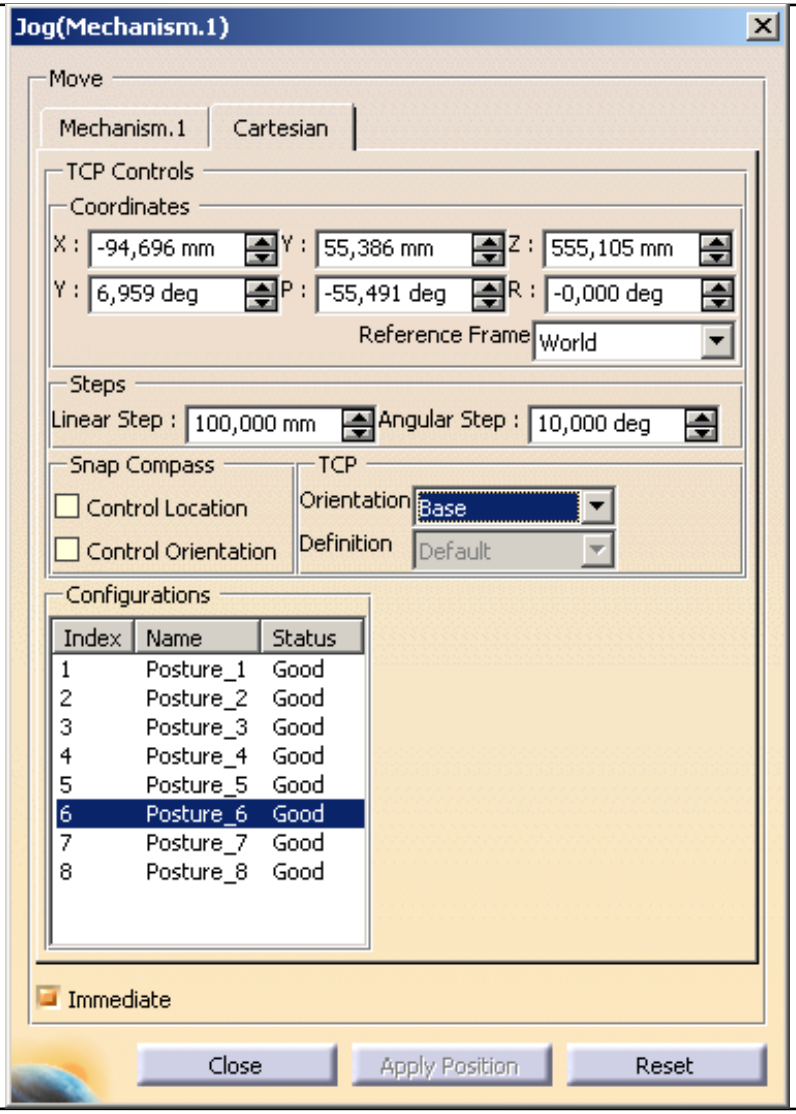


- Now click on “Cartesian” and try to change the TCP (Tool Center Point) coordinates. What can you conclude?

Inverse Kinematics

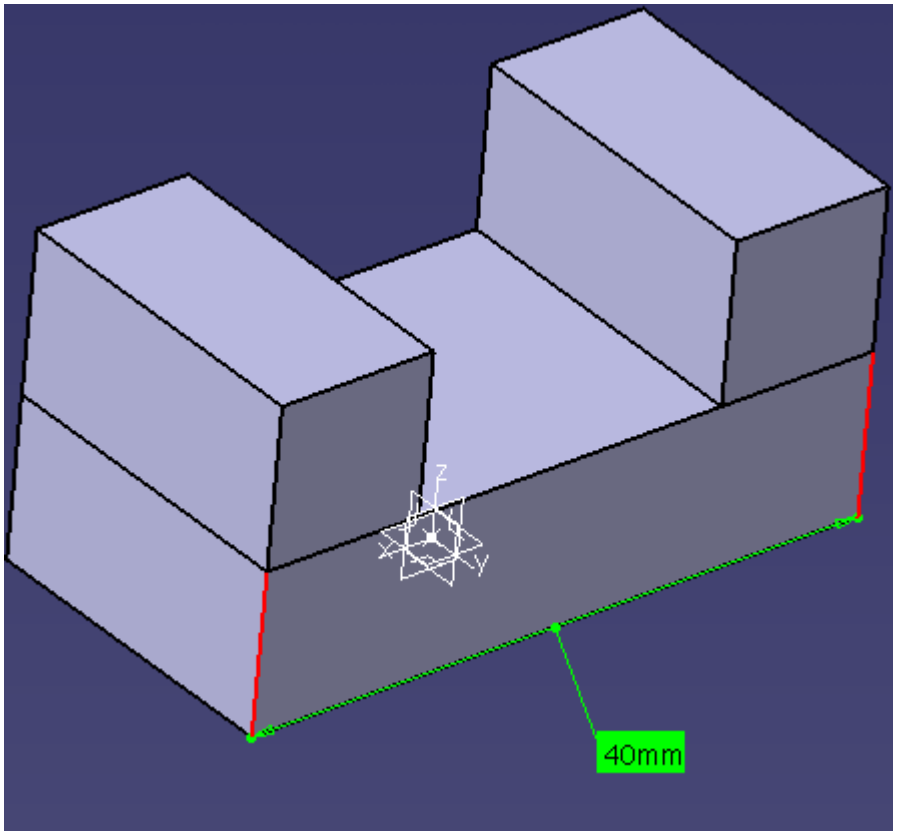
- Now start from “Home position 2”

- Manipulate your mechanism by:
  - Testing joint limits for the different postures
  - Testing singular positions
  - Changing postures
  - Changing orientation



Create a tool

- Now we will create this product:



- Save “Puma_robot.CATProduct”
- Create a new product and save it as “Gripper.CATProduct”
- From the web site, insert “Griper_base”, “Griper_Moving_Part_1” “Griper_Moving_Part_2” from folder “Griper.zip” into your folder “Puma”

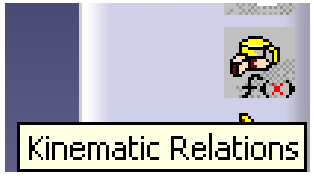
Create a tool

- Check that the current workbench is Device Building 

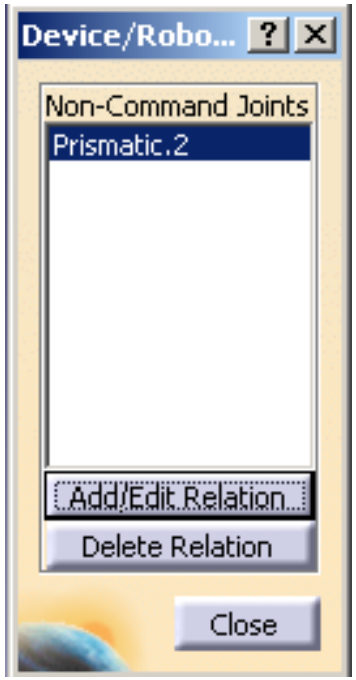
- Rename your product as “Griper” and insert the new three parts.
- Create a new mechanism with “Griper_base” as fixed part.
- Create a prismatic joint between “Griper_base” and “Griper_Moving_Part_1” with length driven
- Create a prismatic joint between “Griper_base” and “Griper_Moving_Part_2” without length driven

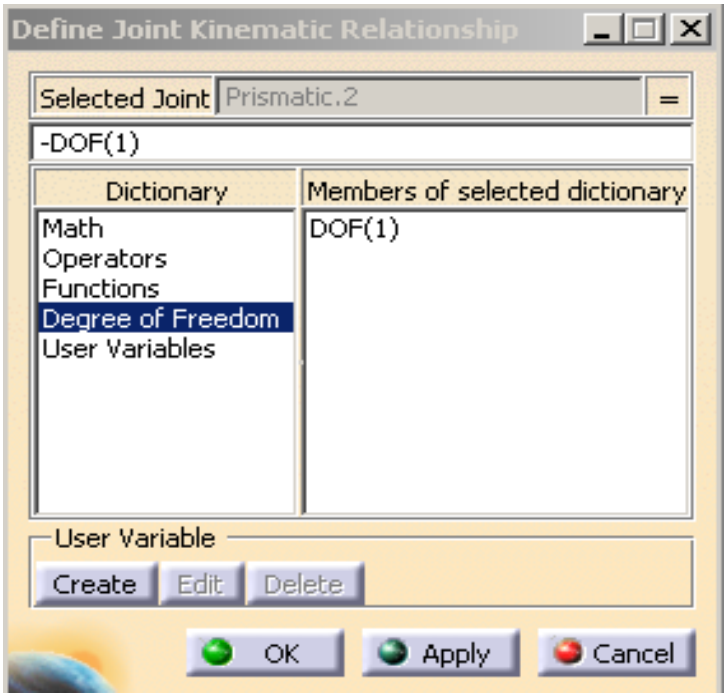
Create a tool

- Click on “Kinematic Relations” button



- Add a kinematic relation for the second prismatic joint as follows:

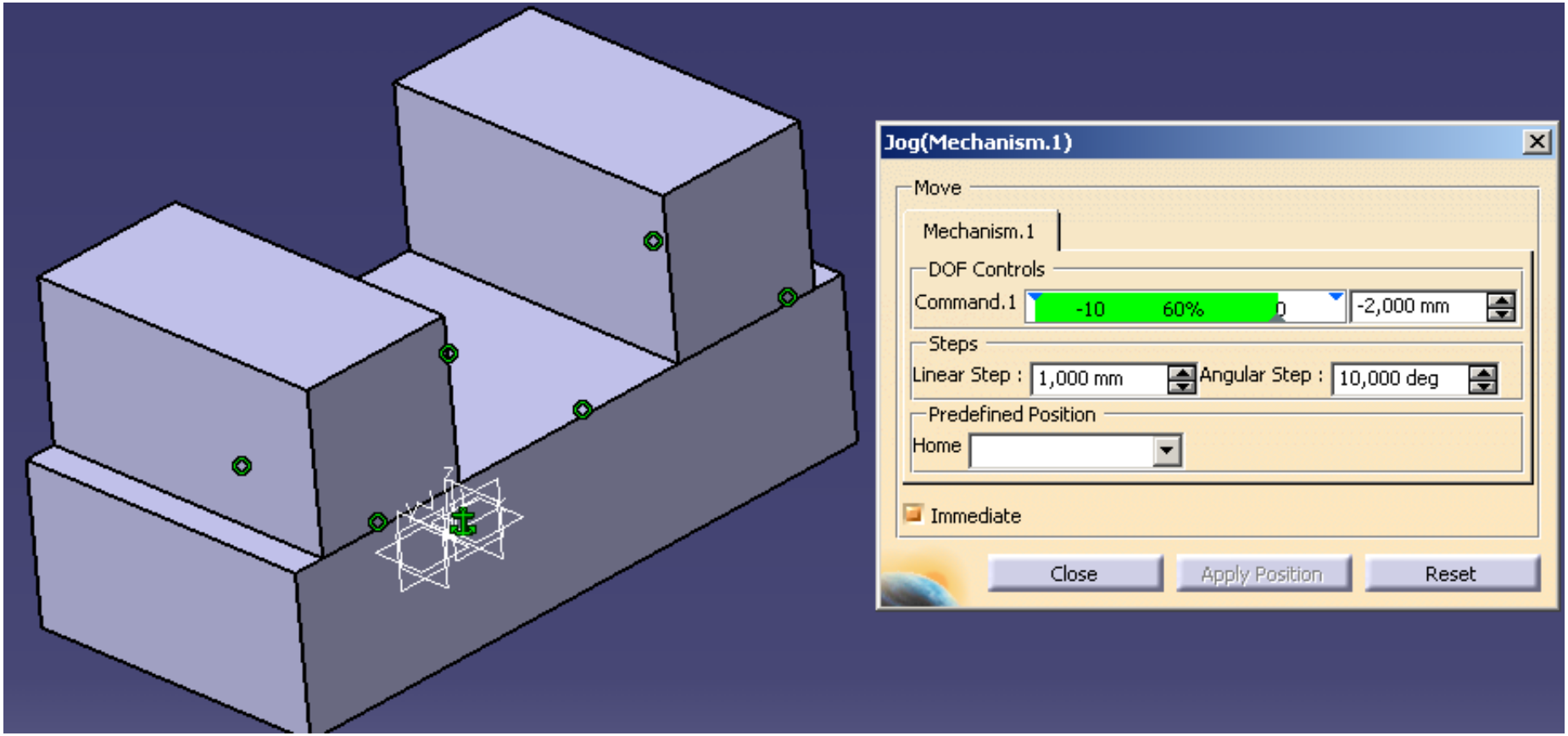




- Define appropriate joint limits such that the moving parts cannot collide and cannot go out of the base limits.

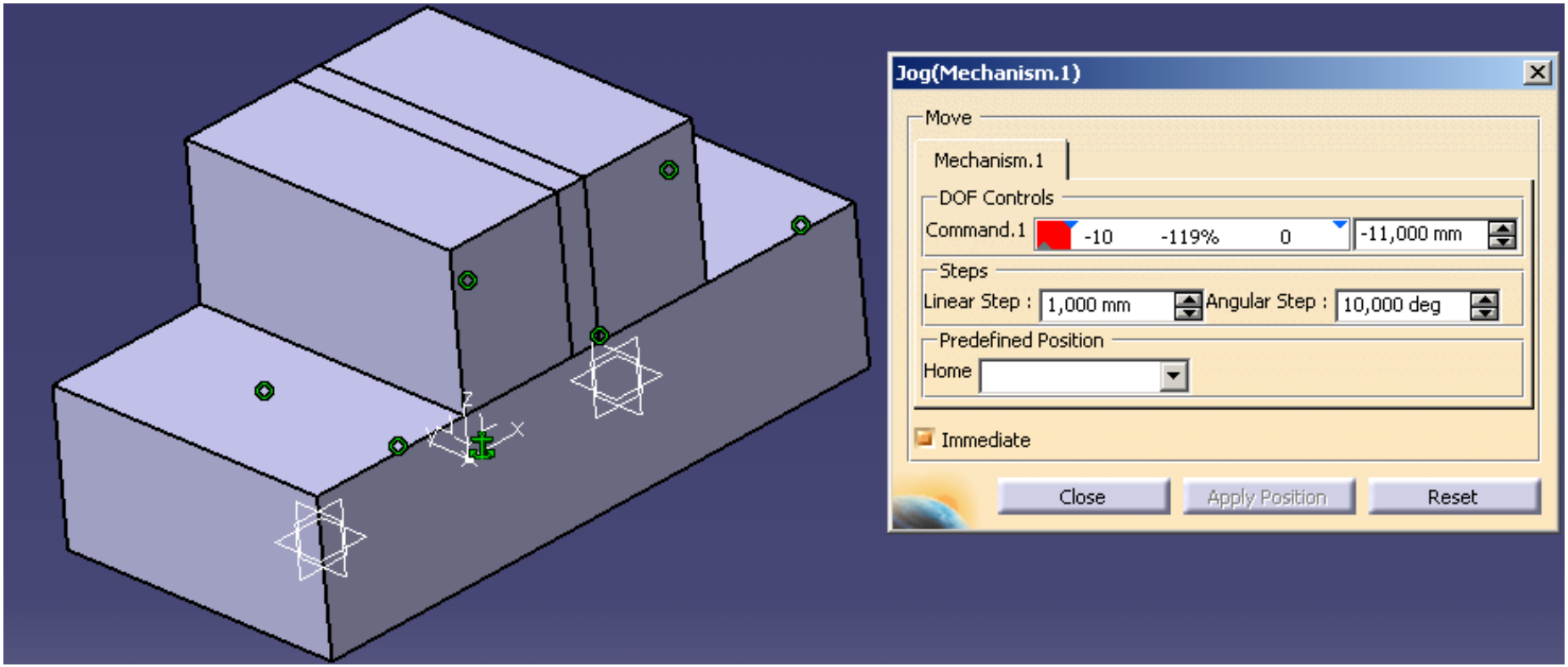
Create a tool

- Jog your mechanism



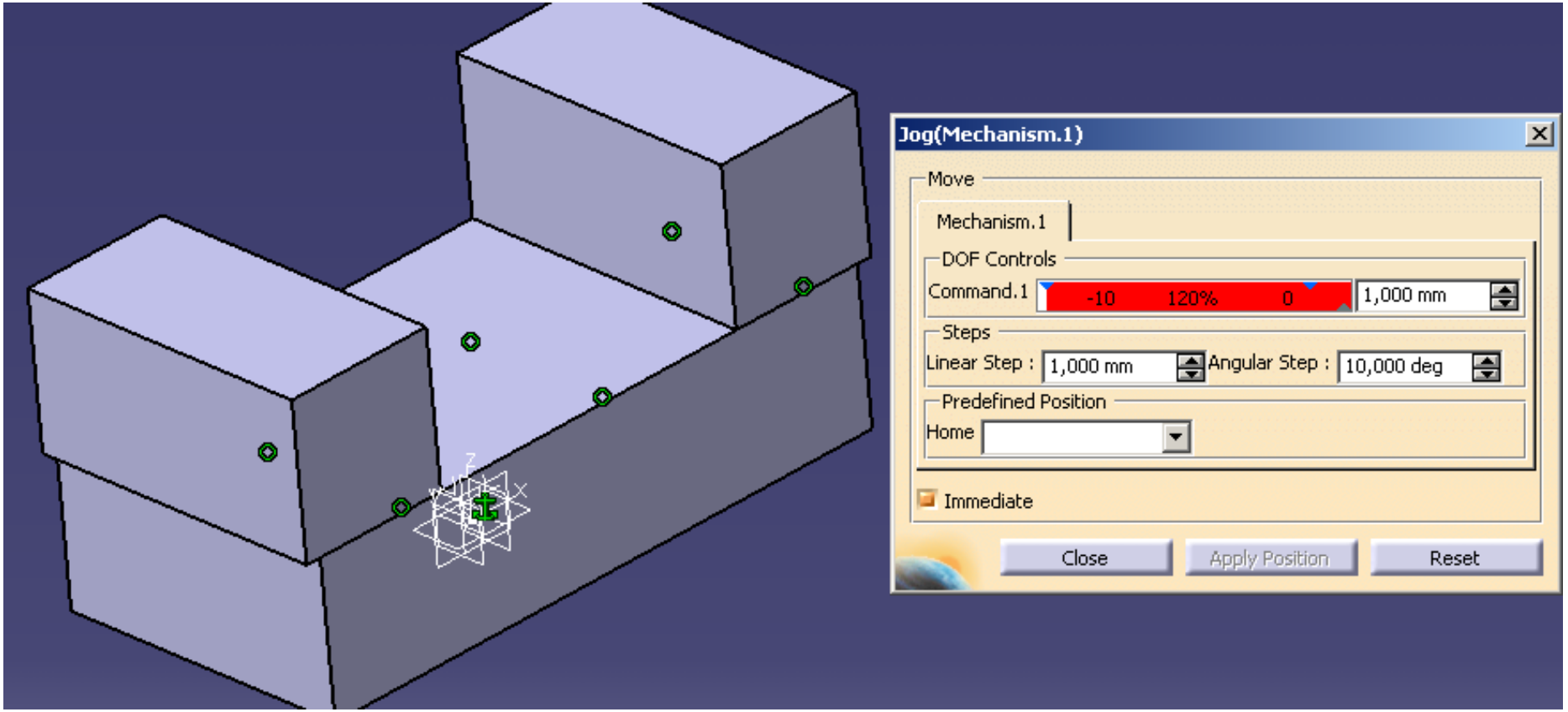
Create a tool

- The red color means that we are out of joint limits



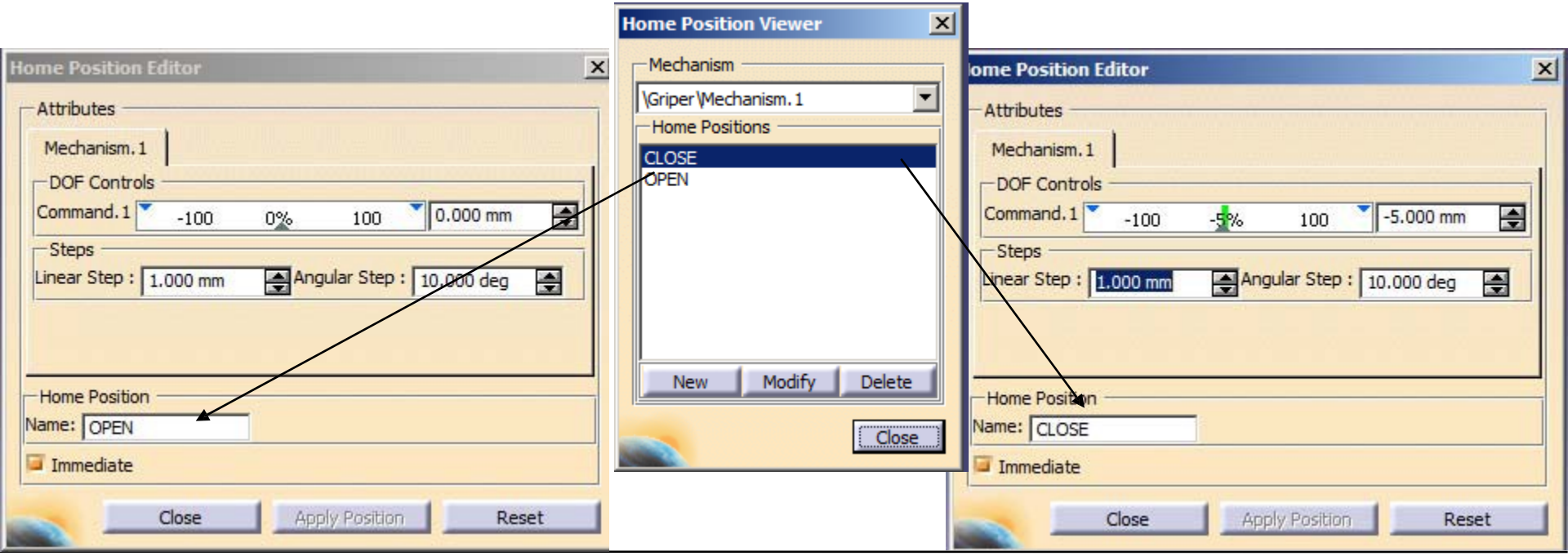
Create a tool

- The red color means that we are out of joint limits



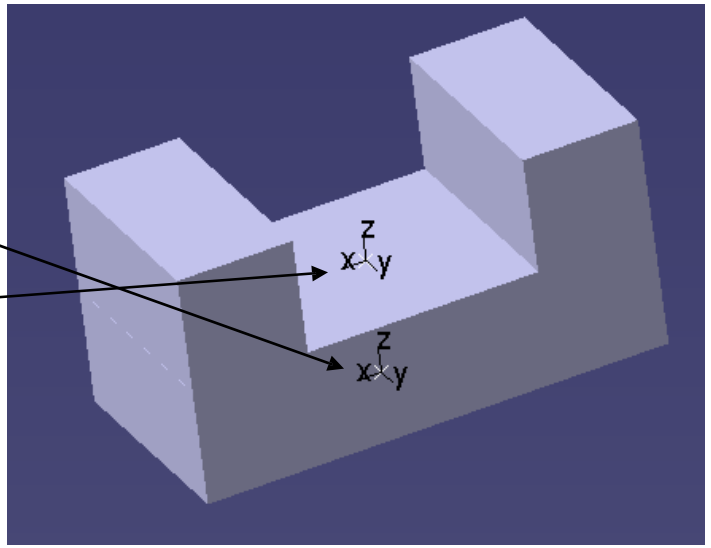
eate «OPEN» and «CLOSE» postures

- Why?
  - Define position of the actuator to be used in the robot programming.
- Use Home position 

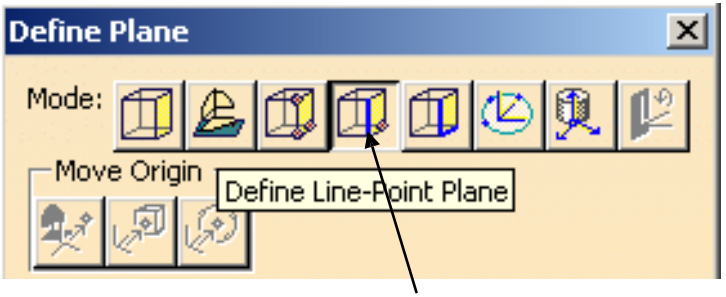


Create Points of Interest

- Create points able to be used as a TCP frame
- Click on “Frames Of Interest”  and select the Griper_base part



- Then use the “Frame Type”  button to:
  - Create a Frame of Interest as “Base”
  - Create a Frame of Interest as “Tool”

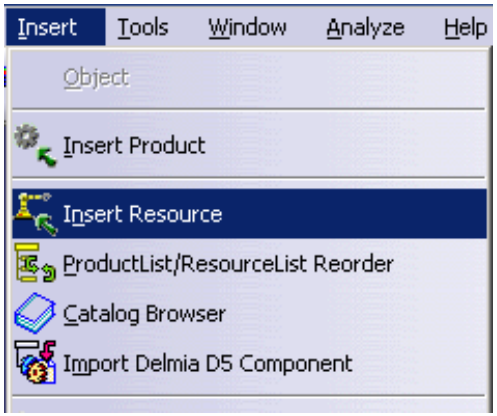


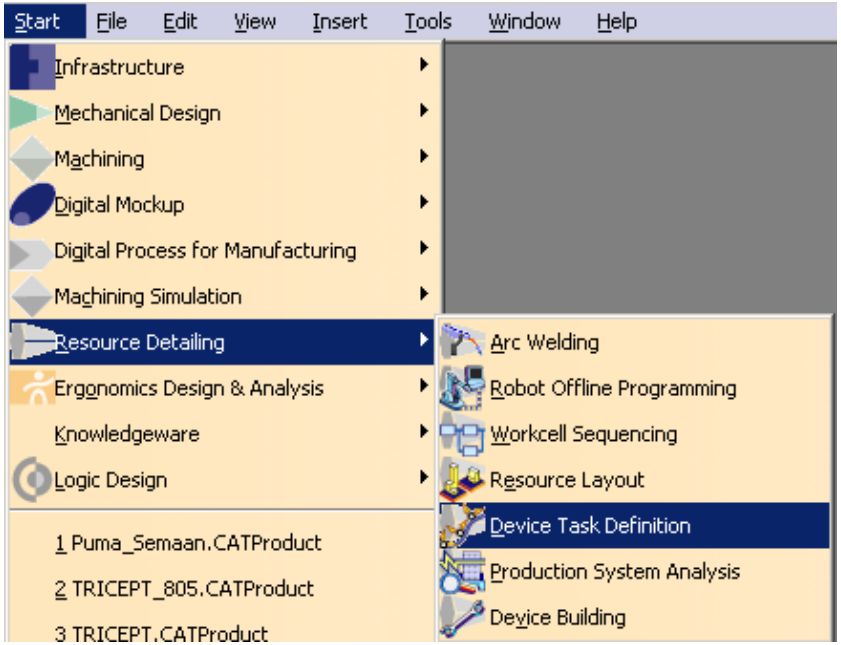
- Select the “Define Line-Point Plane” Mode to define these two frames.

Create a robotic cell

Start the workbench : Device Task Definition

- A new file is created as « Process »
- Insert « Puma » and « Gripper » as Ressources

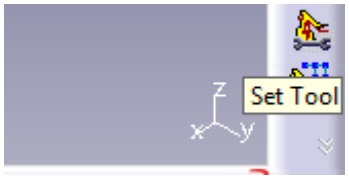




- Note: Make sure to have all the files of « Puma » and « Gripper » in the same folder.
- Save your « Process » file in this folder.

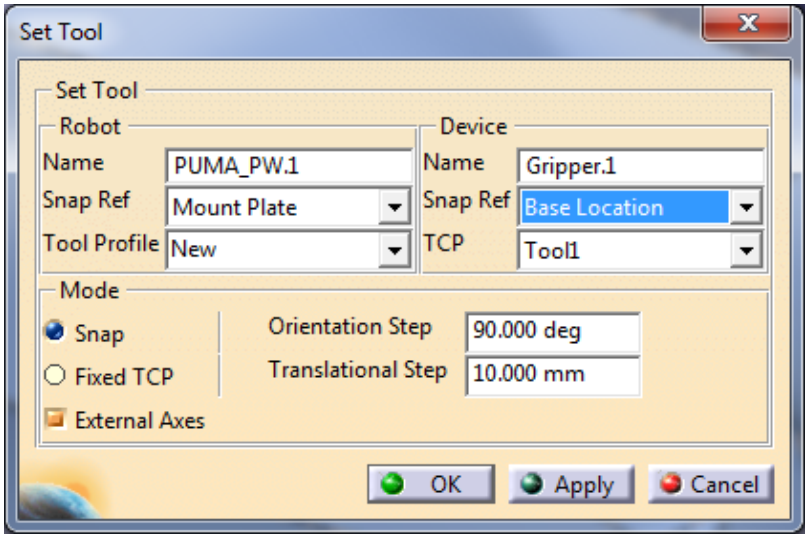
Mount Tool

- Associate the tool with the robot « Set Tool »

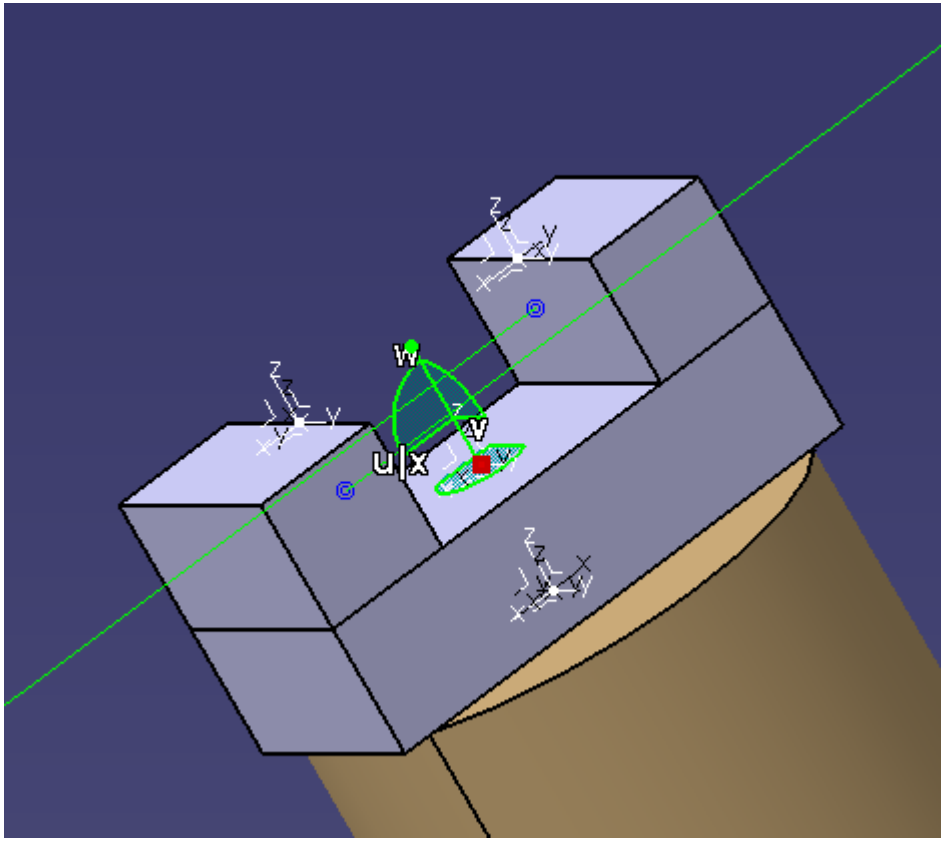


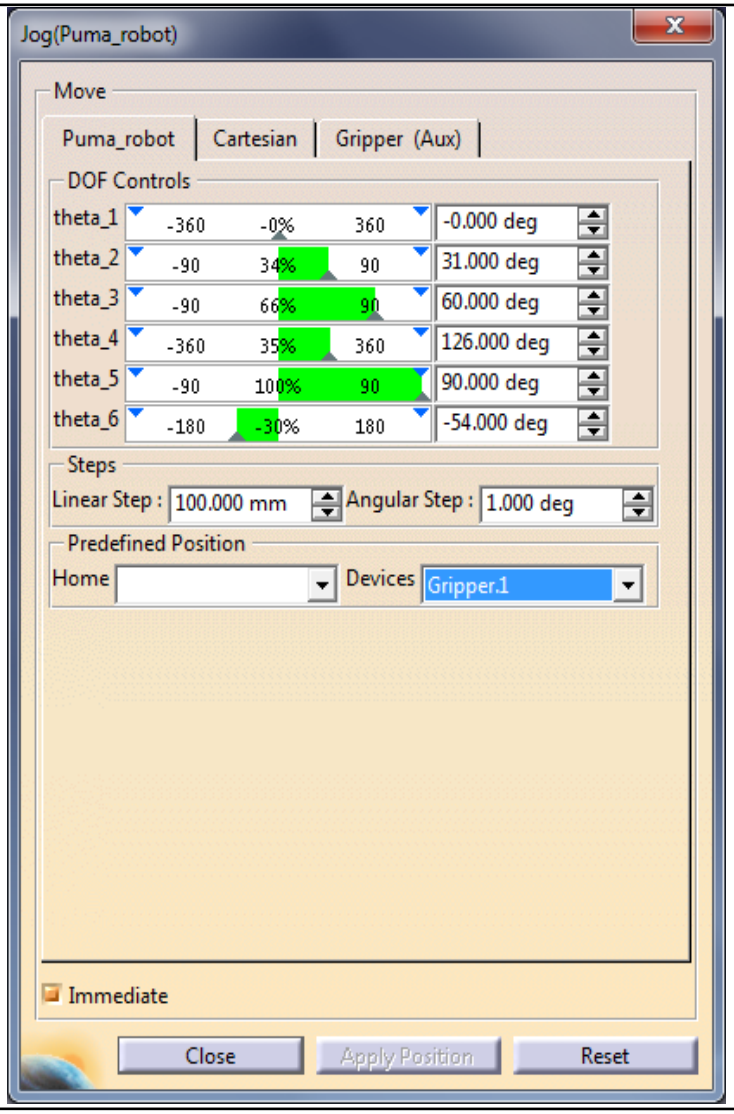
- Change the location of the TCP (Tool Center Point)

- The location of the TCP depends on the Tool definition



Jog device

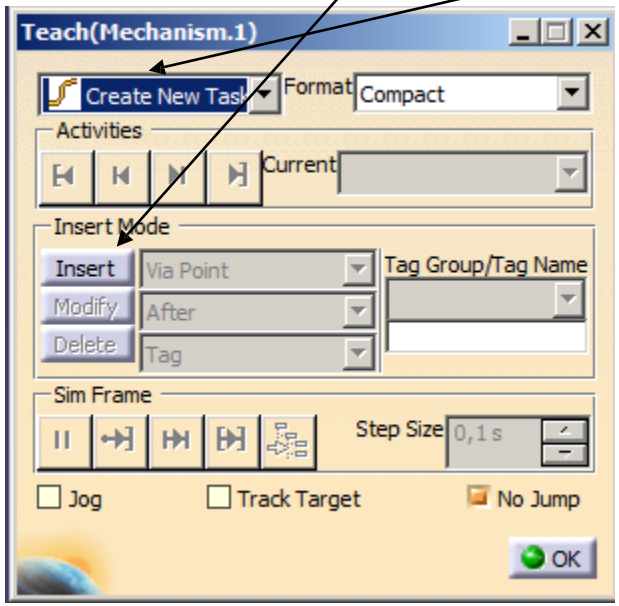



Jog(Puma_robot)
Move
Puma_robot
Cartesian
Gripper (Aux)
DOF Controls
theta_1 -360 -0% 360 -0.000 deg
theta_2 -90 34% 90 31.000 deg
theta_3 -90 66% 90 60.000 deg
theta_4 -360 35% 360 126.000 deg
theta_5 -90 100% 90 90.000 deg
theta_6 -180 -30% 180 -54.000 deg
Steps
Linear Step : 100.000 mm
Angular Step : 1.000 deg
Predefined Position
Home
Devices
Gripper.1
Immediate
Close
Apply Position
Reset

Example of task definition

- Click on « Teach a device » 

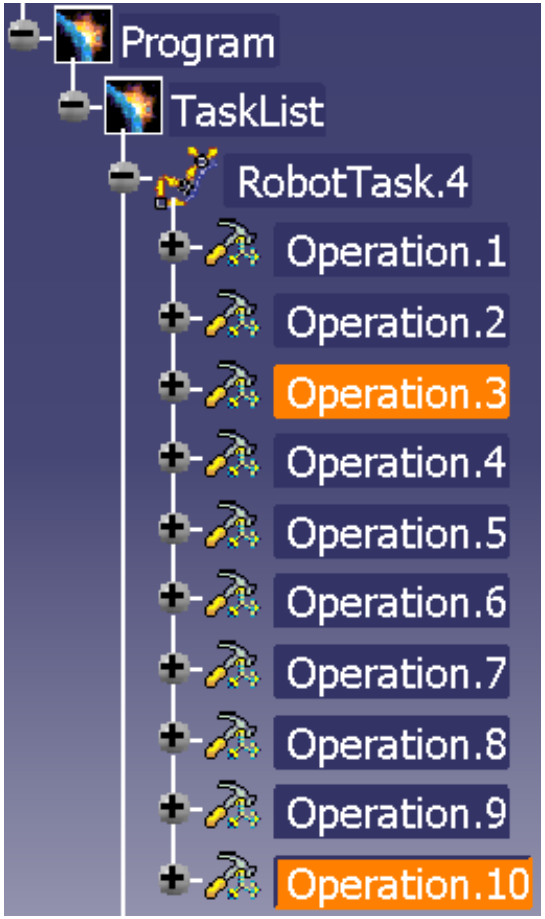
then, « Create New Task »
- You can insert frames in the new task by moving the robot and clicking on Insert.



Example of task definition

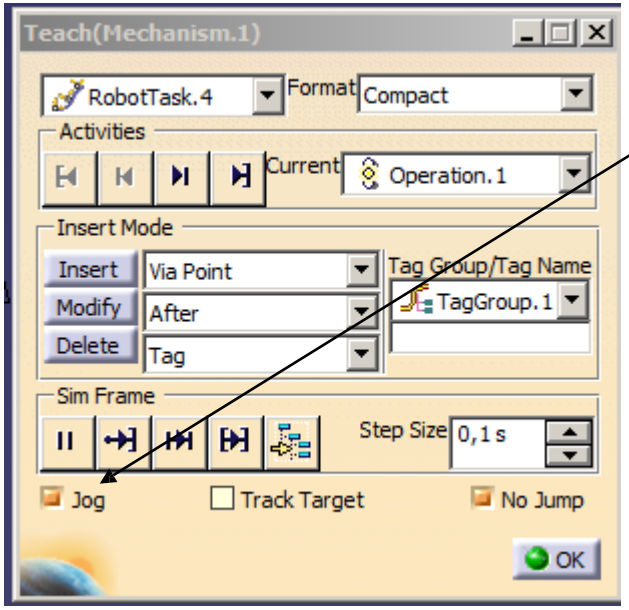
- Insert 10 frames in the task you have created an Play the continuous path.

- Questions?
  - Why does the robot change posture?
  - Can we define the posture?
  - Can we have different kind of motion planning?

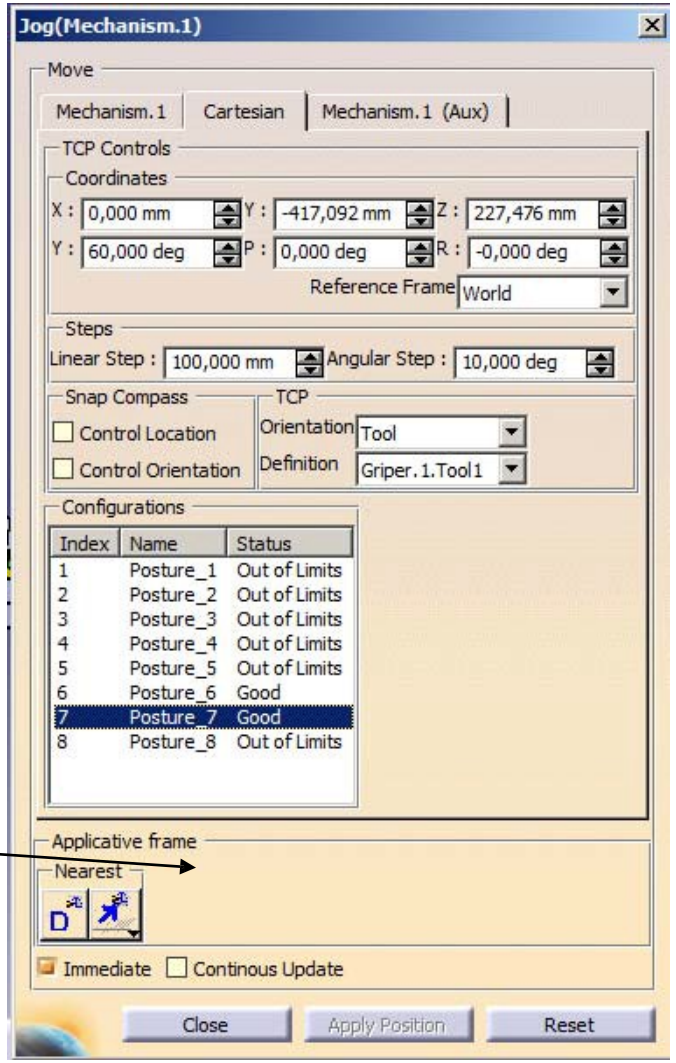


Example of task definition

- Activate the « Jog » option

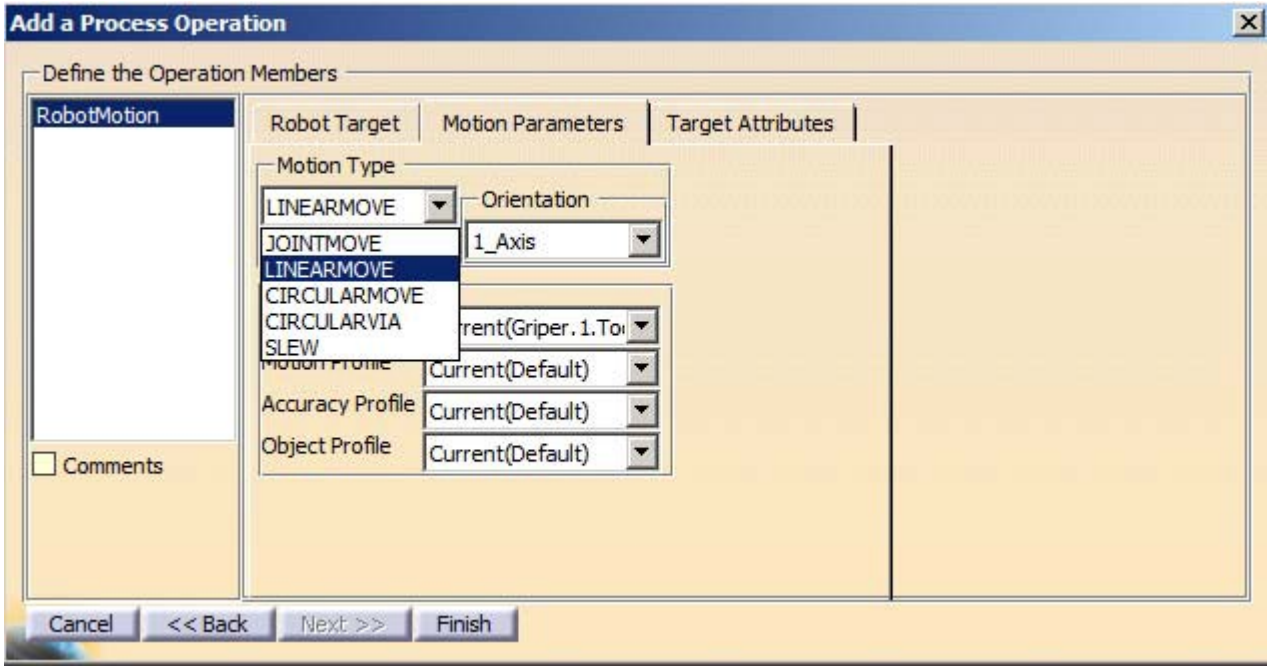


- Select the posture



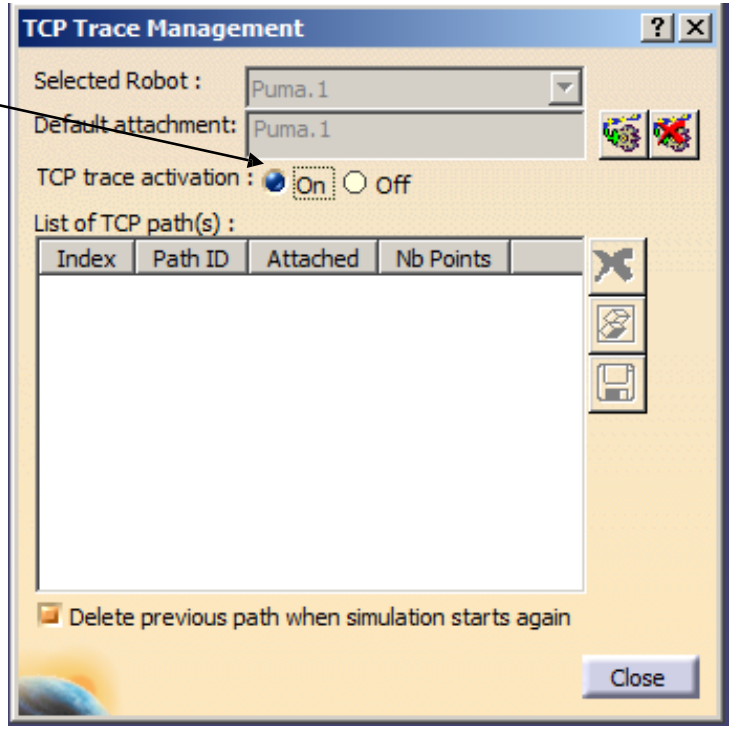
Define the Motion Type

- Between two frames, the motion can be:

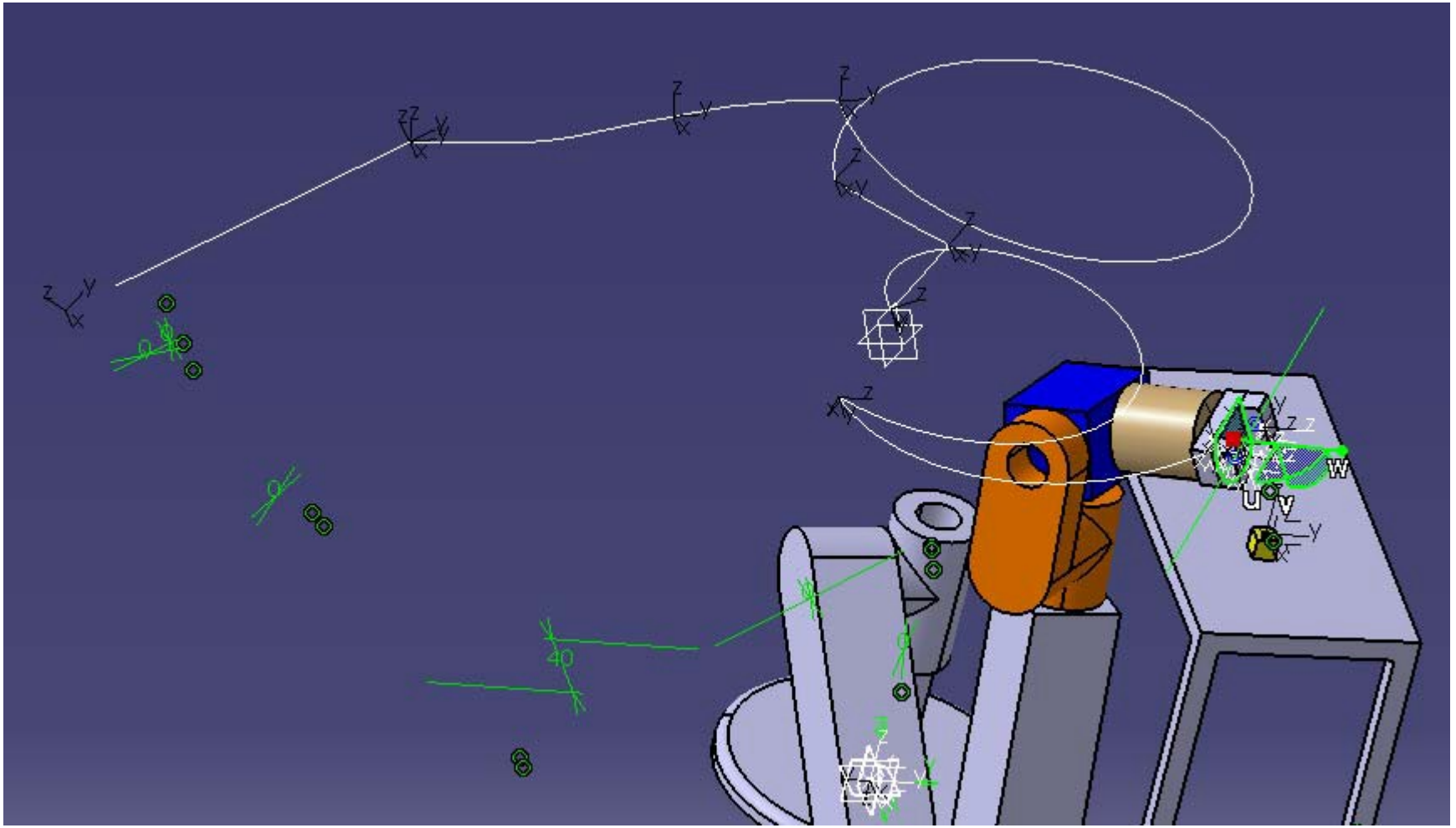


Analyse the motion

- Describe the motion, « TCP Trace » 
- Set « On » the TCP trace activation, then replay the task to visualize the trace of the TCP.



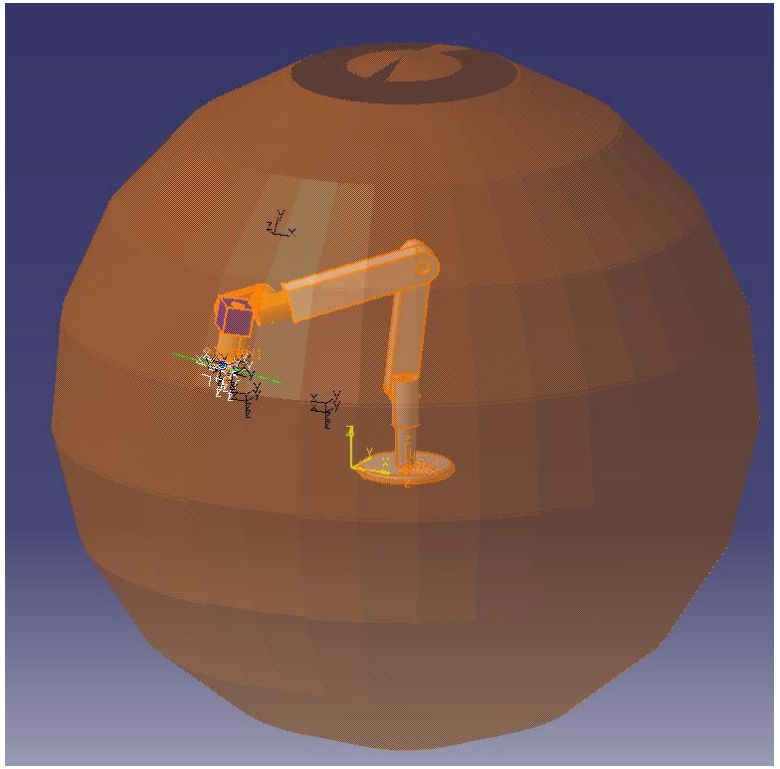
Example of TCP trace



Display the workspace

- We can display the workspace envelop thank to the definition of the joint limits. 

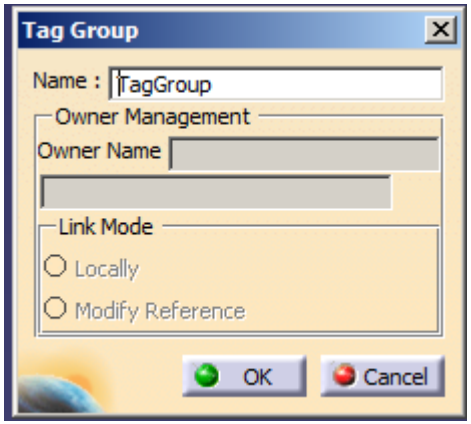
- We can change joint limits to see the impact.

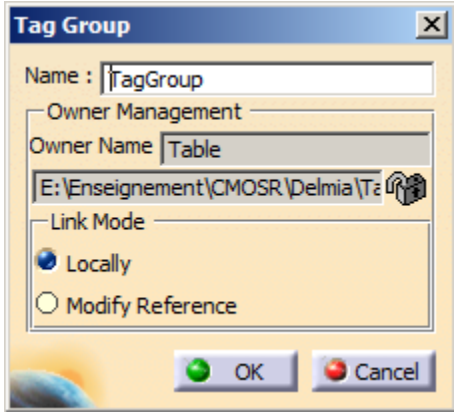


Define Pick and Place activity

- Insert the « Environment » as Product
- The objective now is to create the frames to pick and to place.
- Create a Tag group using the “ New Tag Group ” 

button and make a link with the Table



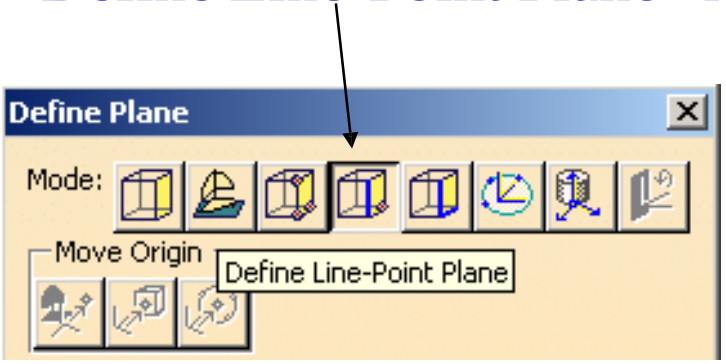


- Note: if the table moves, the frame will keep attached to it.

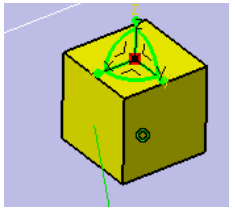
Define Pick and Place activity

- In the previous Tag Group create two frames by using the “New Tag” button.

- One frame will be located on each of the two cubes of the Table.
- Use the “Define Line-Point Plane” Mode

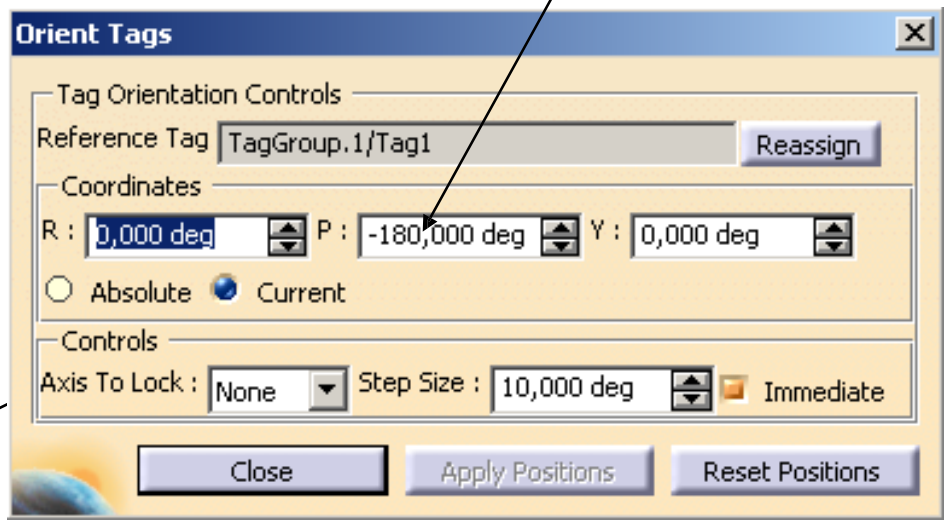


- Then, select the point on the top of each cube and a line.



Define Pick and Place activity

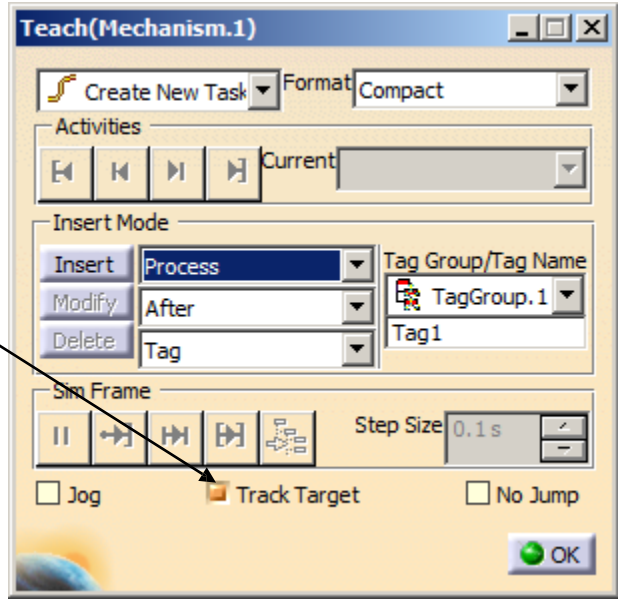
- Using the “Modify Tags Orientations”  button, change the orientation of each of the two frames to have the Z-direction to the bottom



- Note: activate the “current” option in order to make the rotation around the current point

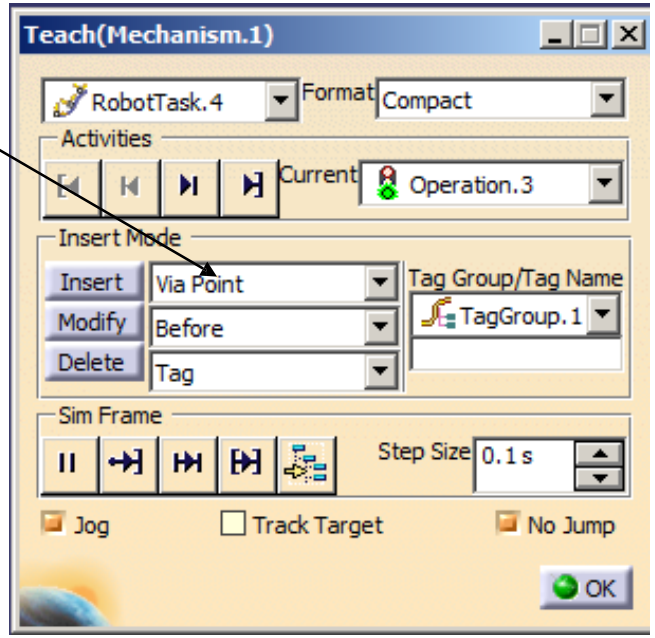
Define Pick and Place activity

- Create trajectory by using « Teach a device » 
- Select the Puma robot and create a new task
- Define the new point as “Process”
- Activate “Track Target” and click on the first Frame



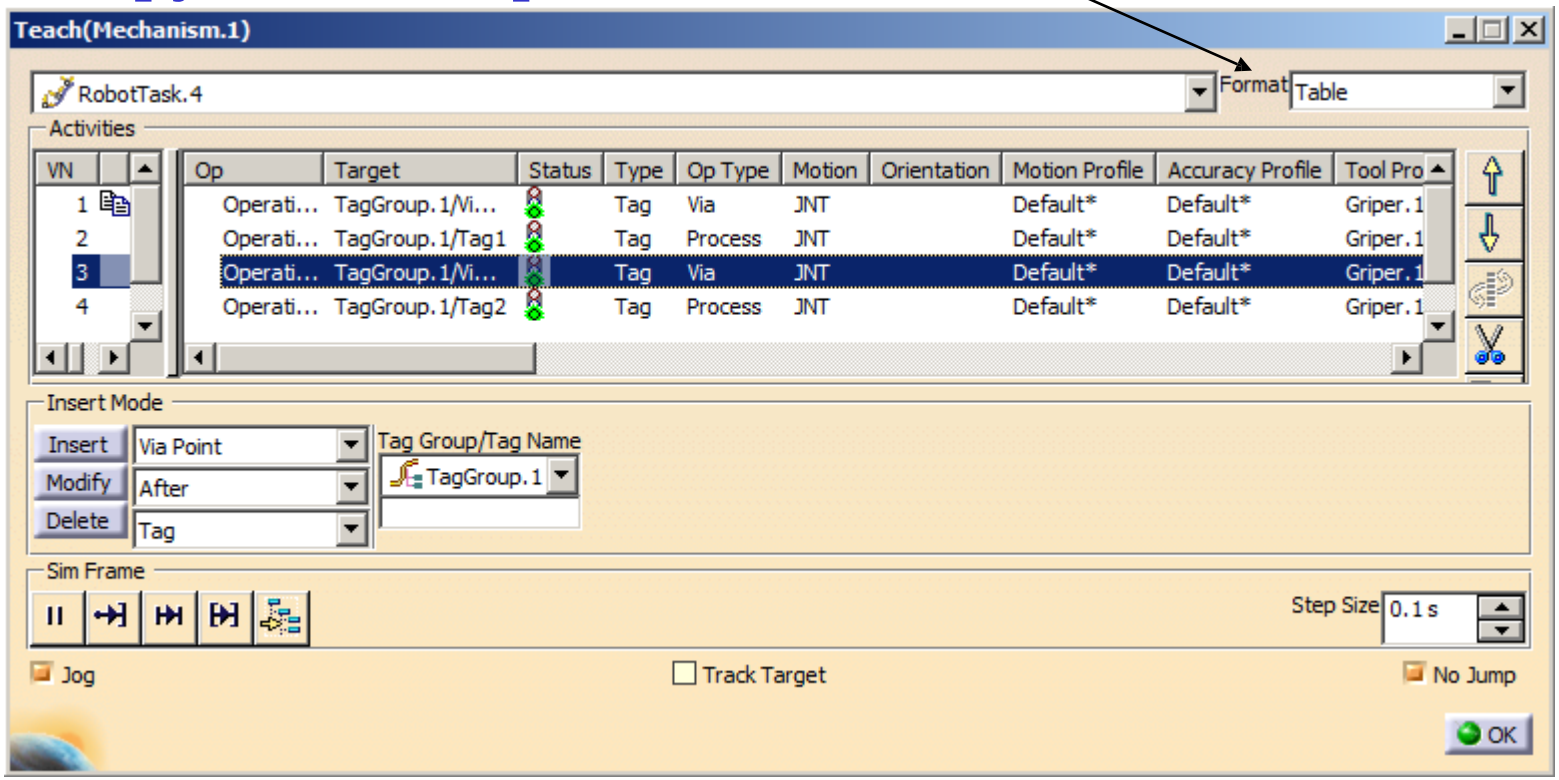
Define Pick and Place activity

- Add via point to have different trajectory close to the table.
- We will be able to change the type of motion and the speed of the robot
- Put the robot in the first and second posture
- Add via point before and after each one.
- We can make a copy of an operation point.



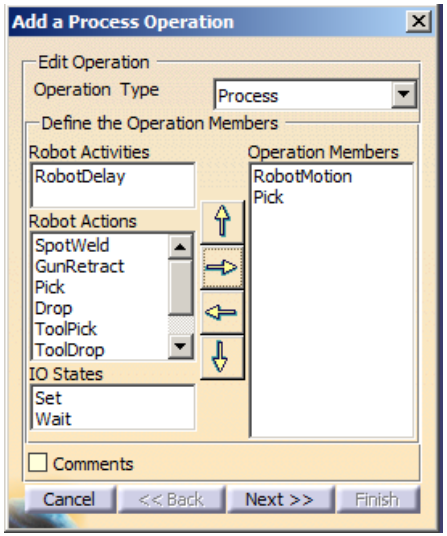
Define Pick and Place activity

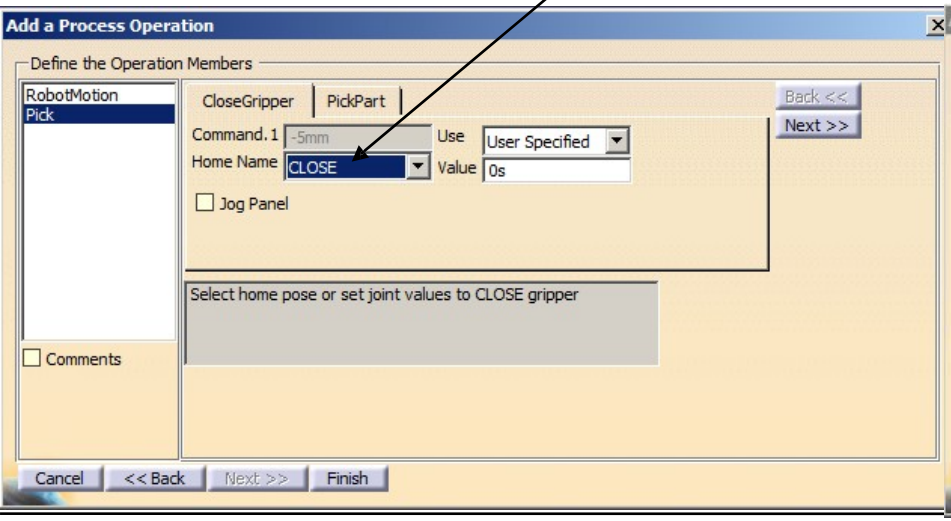
- Change the option of Format from Compact to Table
- Copy the first operation and Paste after the second one

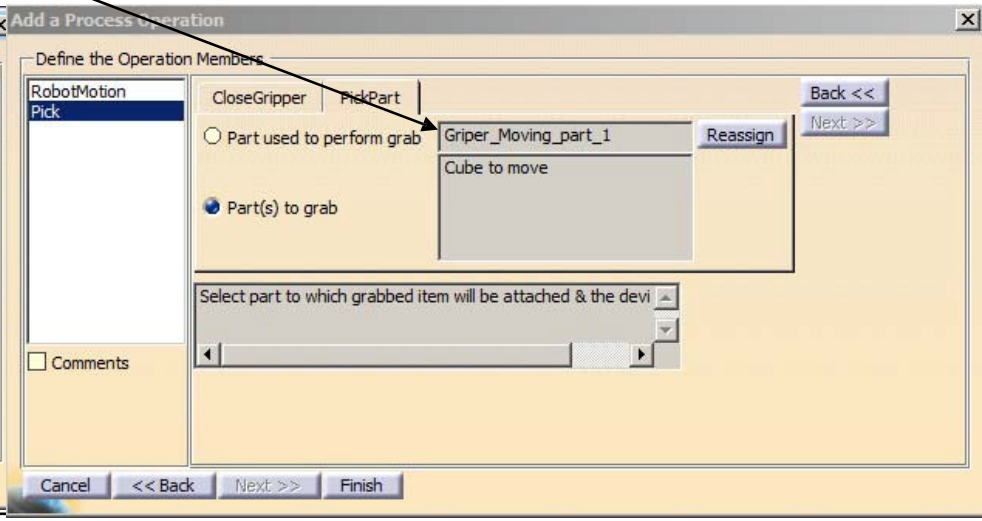


Define the Process operation PICK

- Edit the operation 1
- Add a robot action « Pick »
- Define the Home name (Close) of the Griper
- Define the part to pick

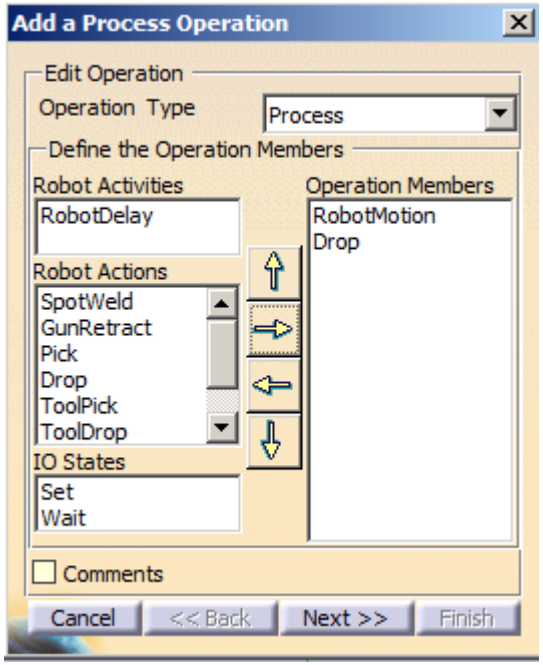


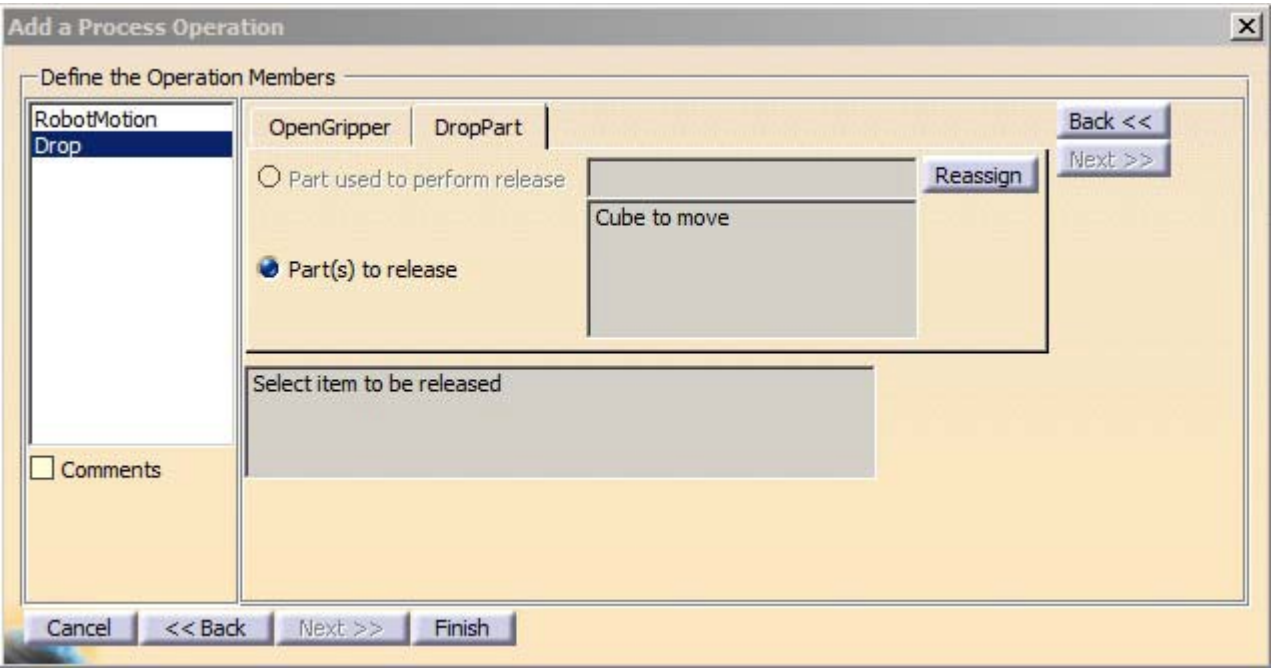




Define the Process operation DROP

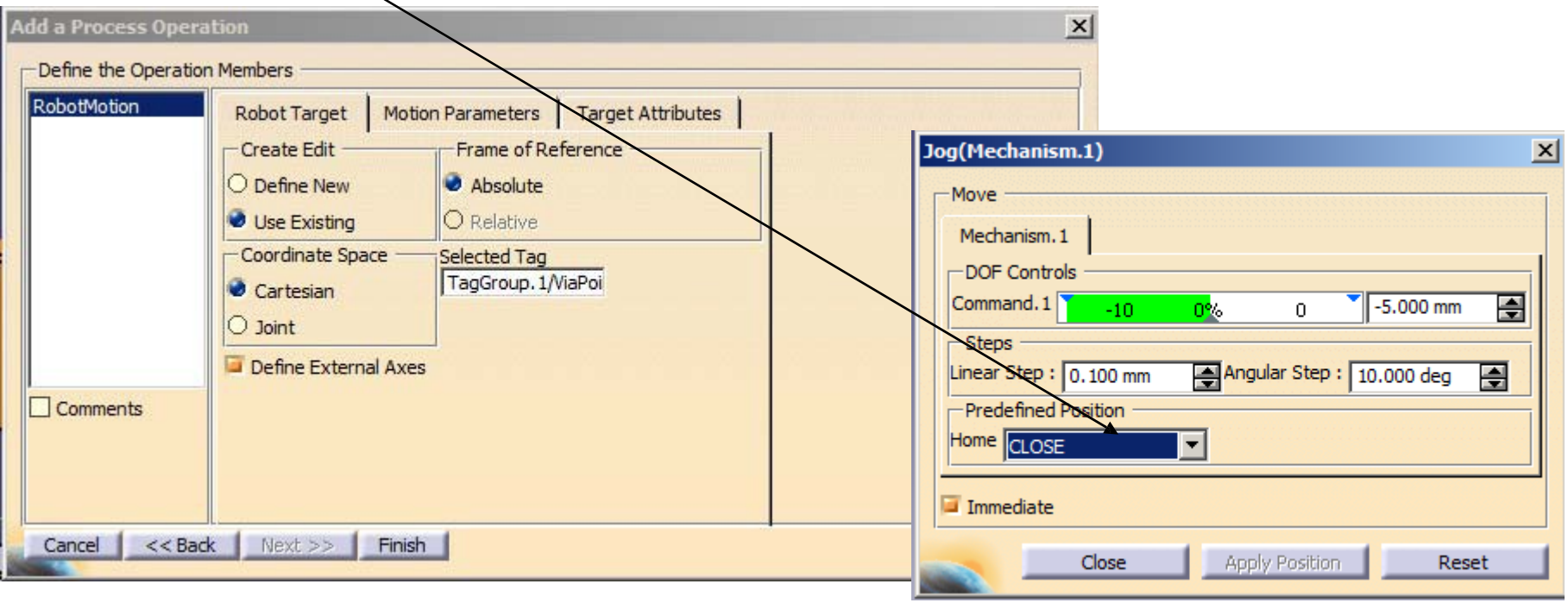
- Edit the operation 2 to add the DROP action
- Select the «Part to move» to be released





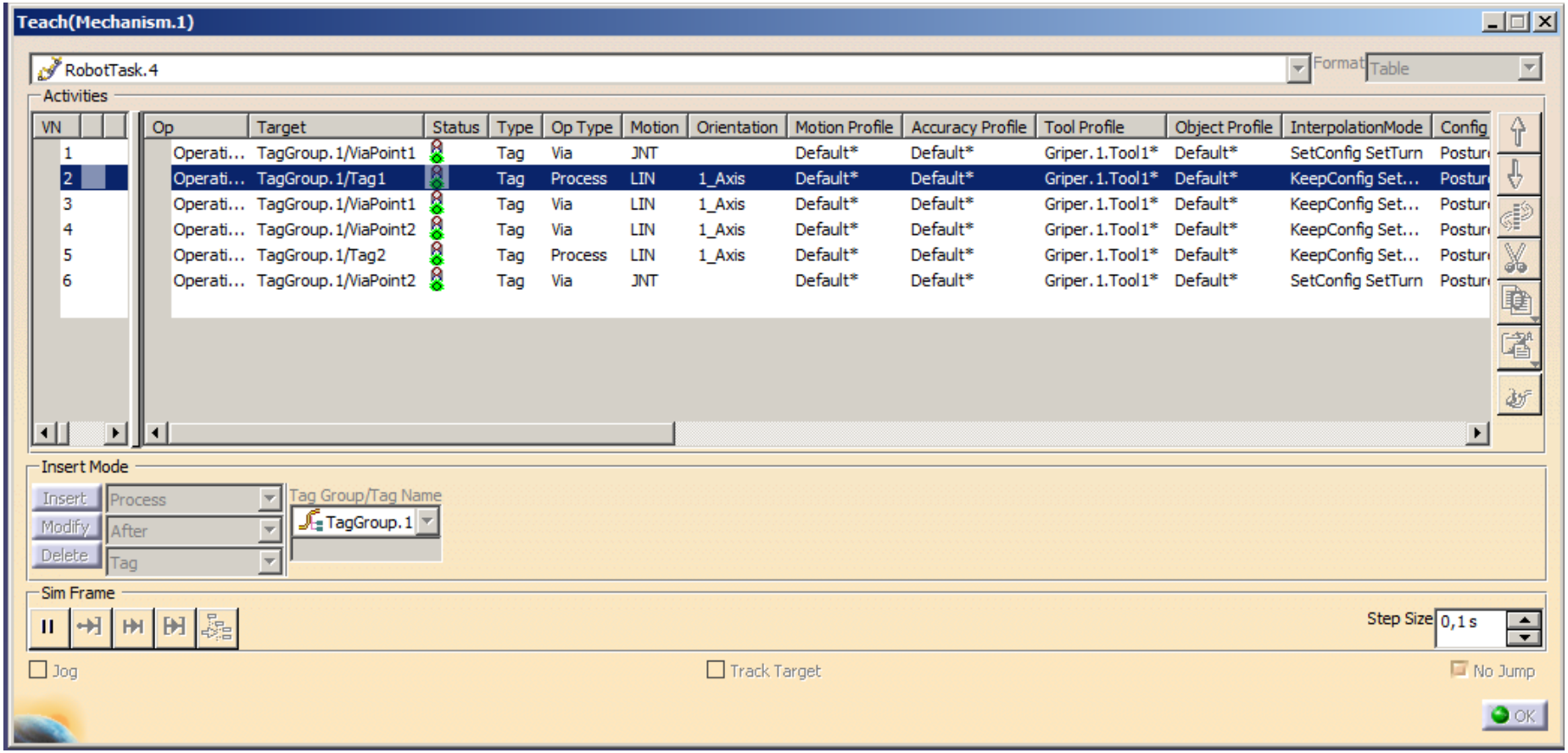
Define the Griper pose

- During the motion, keep the Griper CLOSE
- Edit each via point and modify the external axis to be CLOSE



Change motion type

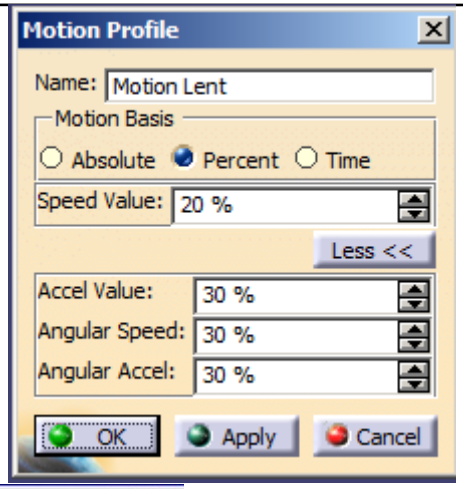
- Change JNT motion to LIN motion

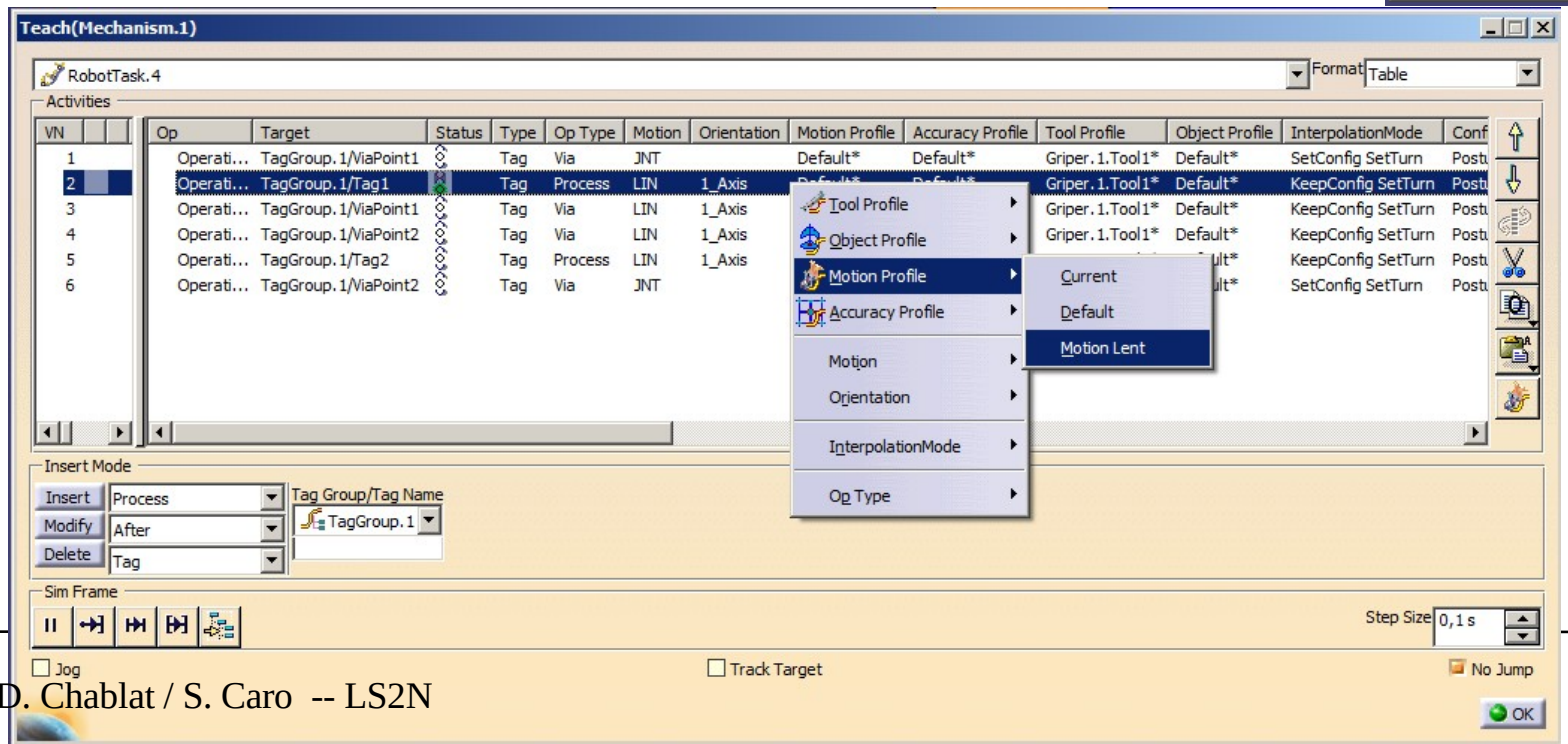


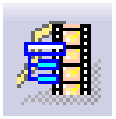
Create an New Motion Profile

- To adjust the speed close to the table 

- Apply for the task





Launch the simulation of the task 

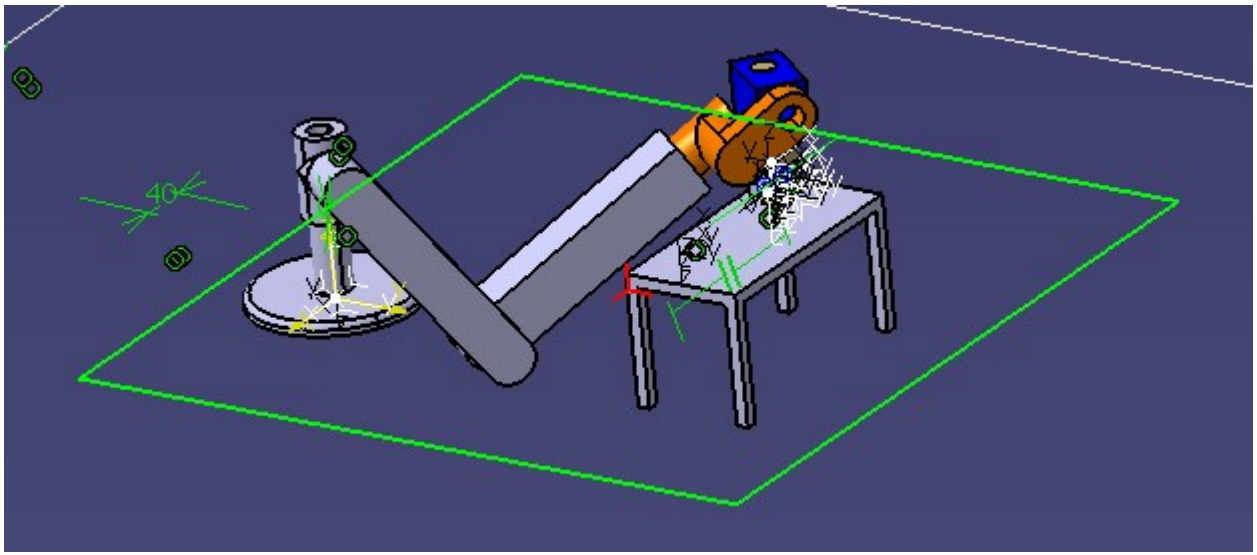
- Select the task
- We have a process simulation toolbar

- A control simulation toolbar

- To have real time rendering, use 

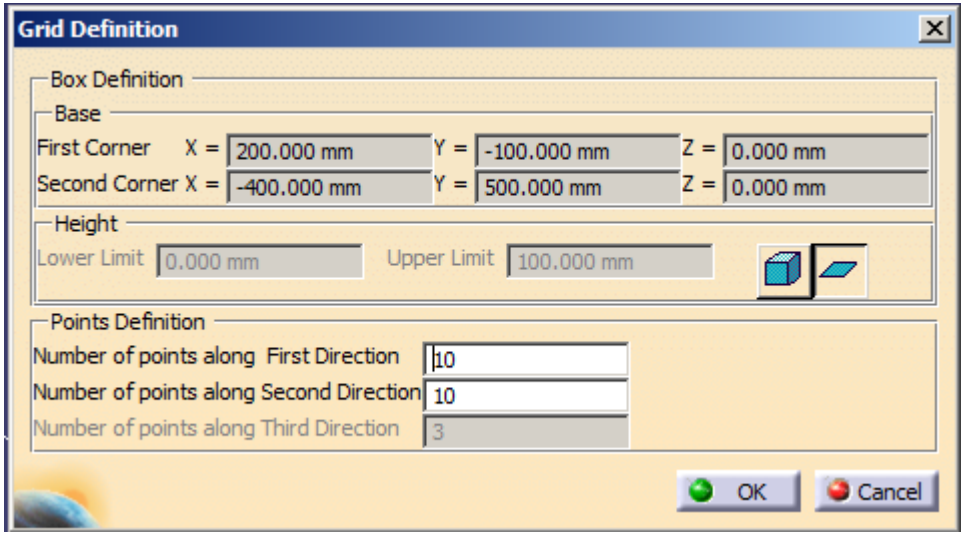
Make optimal Path placement

- Goal: find a set of base placements for the robot that are able to make the same task
- Define a zone where the robot can be located



Make optimal Path placement

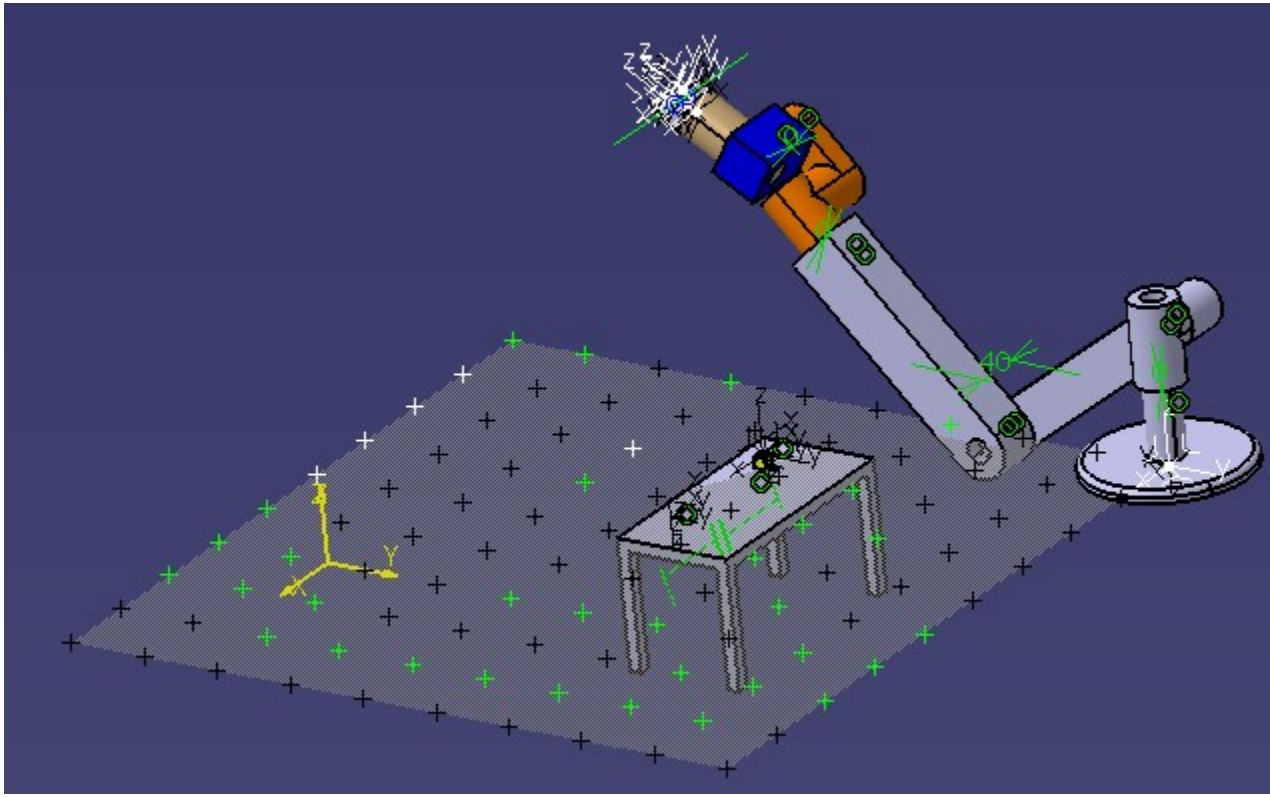
- Define the grid property



- By default, it is only a plane but we can have a volume
- We can change the number of points to be tested

Make optimal Path placement

- Change the location and simulate
- What is changed?



- Note: the orientation of the first axis is fixed!

Swept volume

- We can same the volume swept by the robot or some parts of the robot