Controls
Electronics &
Mechatronics

CERN

BEAMS

BE-CEM Group

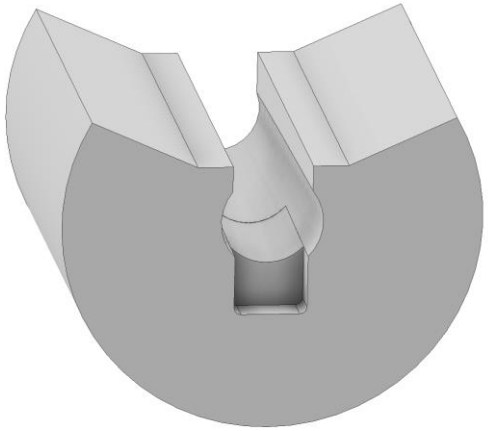
ATLAS Shielding JFC3 : Robotic Machining

AGENDA

1. Objectives & Issues
2. Proposed Solution
3. Partition of the Machining Tasks
4. Tool Orientation
5. Milling Techniques Comparison
6. Simulations

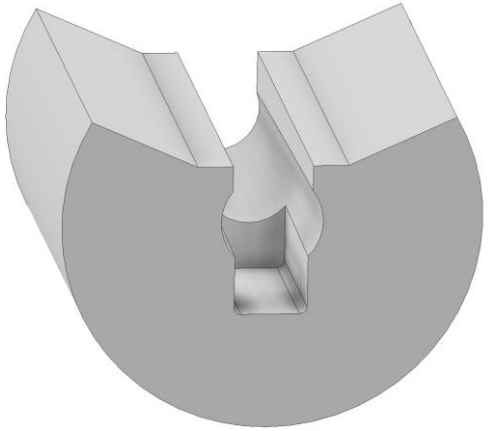
OBJECTIVES

- The main goal is to extend the pocket shown in the pictures from 235 mm to 1180 mm of depth
- Improve the material removal rate (previously settled around 4 kg/h)
- Develop a solution that does not involve constant commitment of several operators to perform the machining



ISSUES

- Avoid collisions between the robot and the shielding
- Plan trajectories that generate tool forces characterized by the smallest amplitude as possible in order to avoid the formation of vibrations on robot mechanical structure



PROPOSED SOLUTION

- Deploy a CNC-like control by generating the milling tool trajectories through a Computer-Aided Manufacturing (CAM) software
- Through Offline Programming (OLP) technique, generate robot instructions on the basis of simulations performed in the virtual workspace

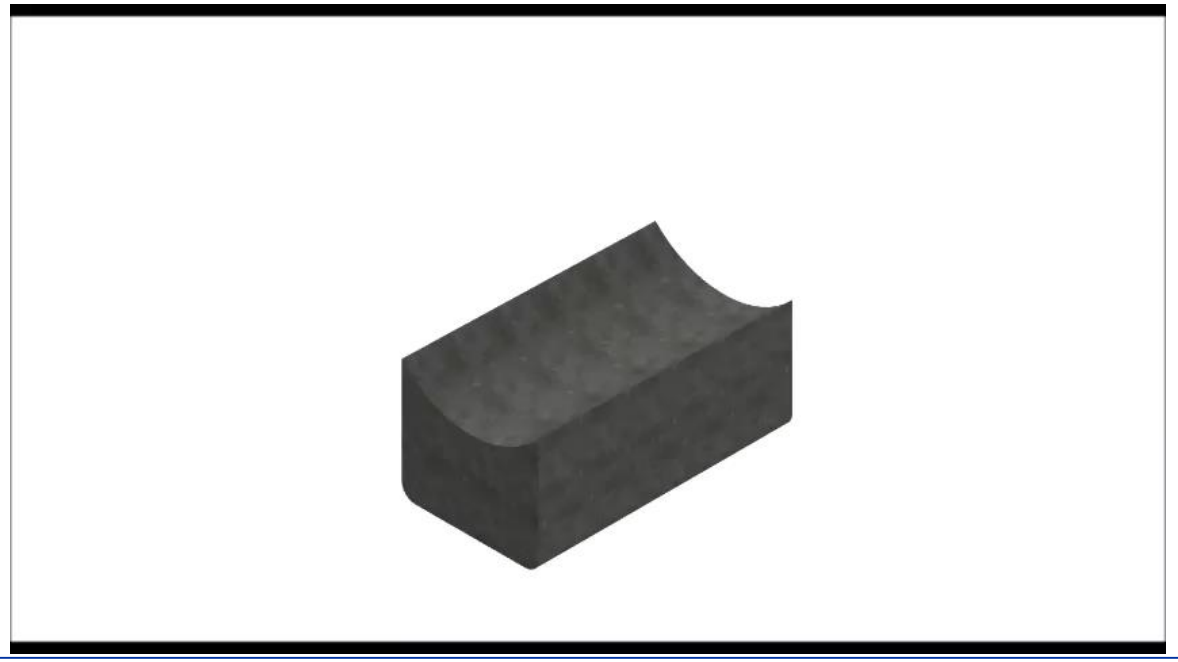
This strategy allows to:

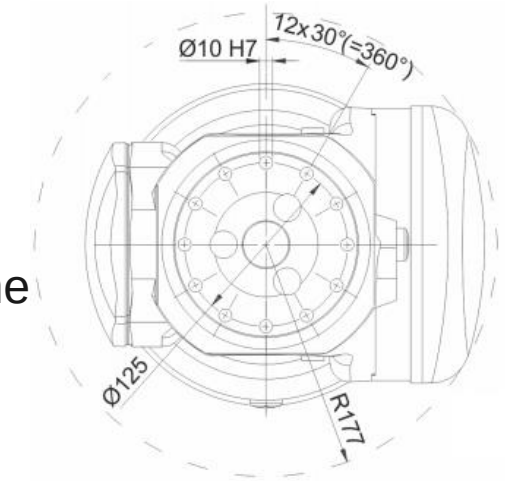
- Overcome issues related to vibrations of the mechanical structure thanks to an optimization of the milling settings
- Receive a visual feedback of robot behavior during path following in order to avoid collisions
- Employ only one person who supervises the correct execution of the machining

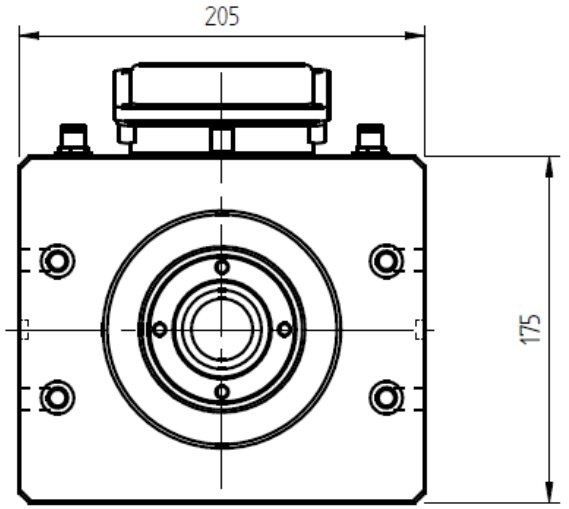
PARTITION OF THE MACHINING TASKS

Subdivision of the machining in several parts in order to avoid collisions by modifying the inclination of the tool at the start of every machining.

The size of the single portions of material to be removed has been chosen considering the volume of the elements that could collide with the walls, i.e. spindle and robot flange.

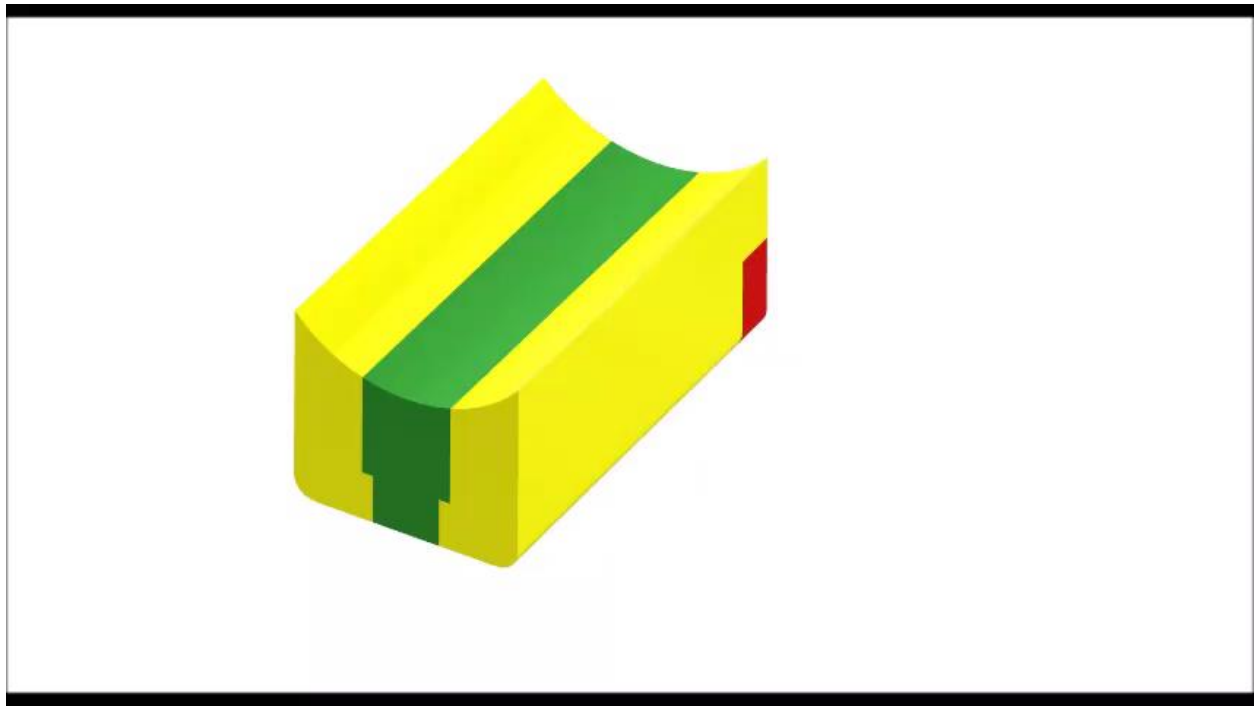


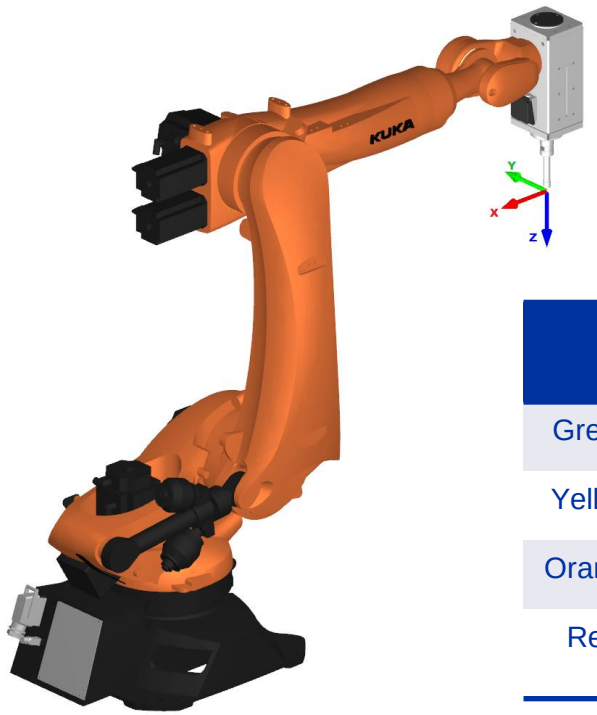




TOOL ORIENTATION

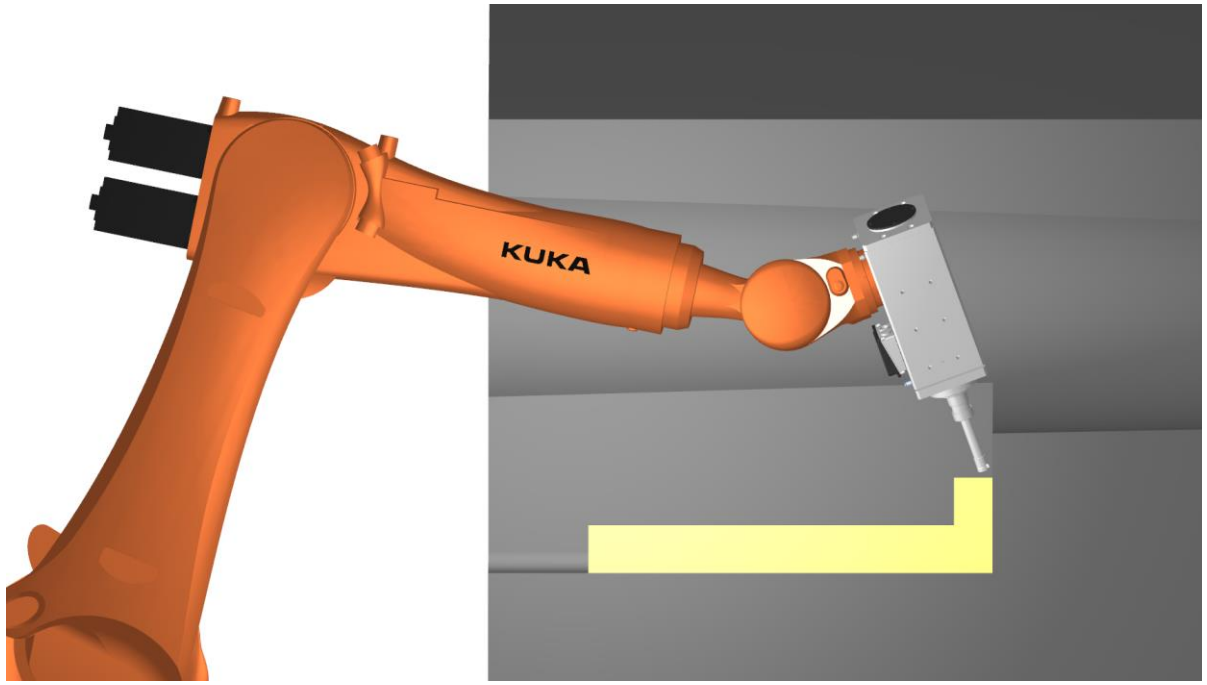
Regarding the postures that the robot will adopt during each machining, for the reasons discussed before, different orientations of the tool have been adopted in relation to the portion of material to remove.
In the Tab below are illustrated the rotation of the tool around the axis in home position (see the figure).

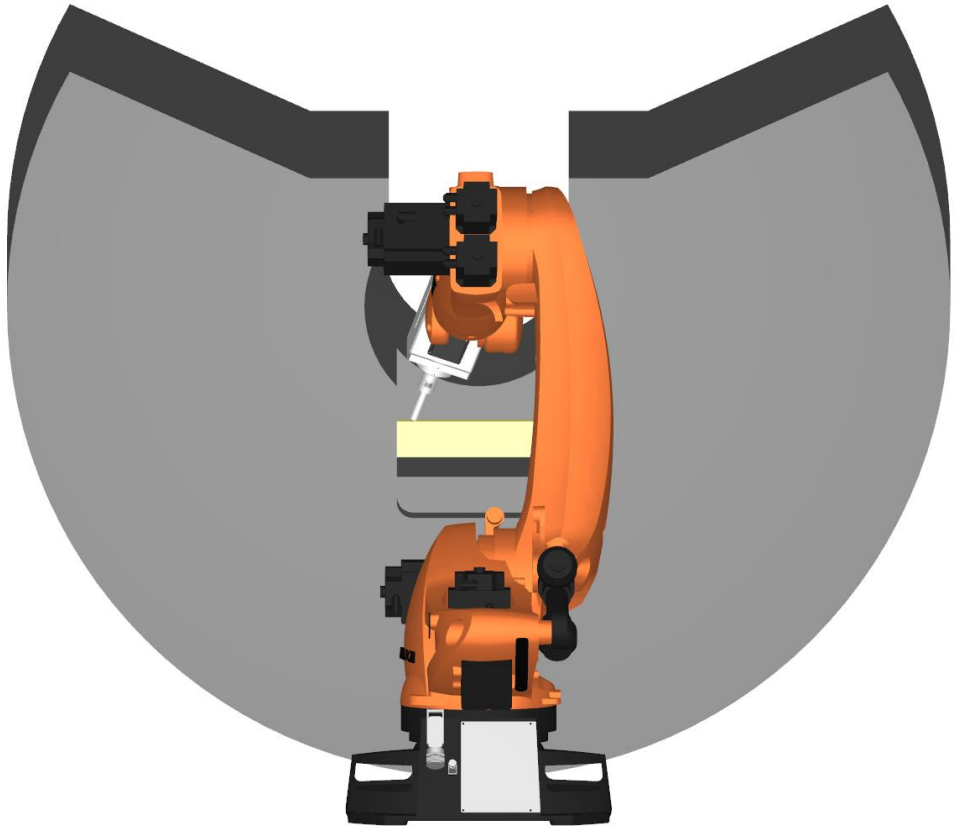




	Rotation around X	Rotation around Y
Green	0°	0°
Yellow	±20°	0°
Orange	0°	-20°
Red	±20°	-20°

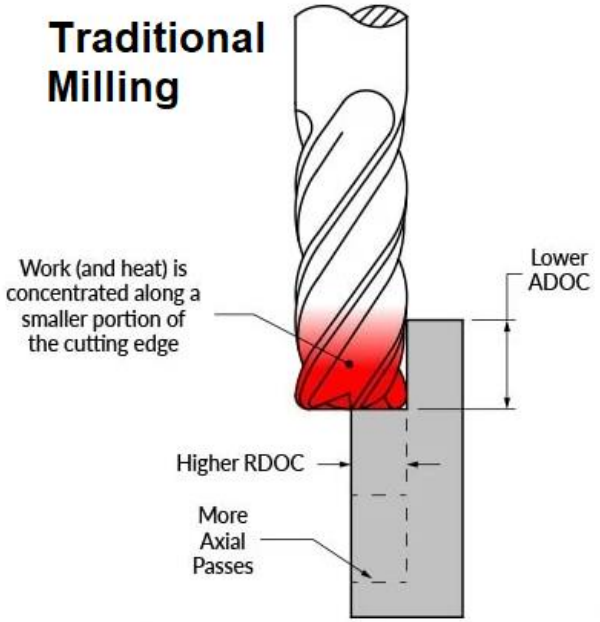
TOOL ORIENTATION (2)

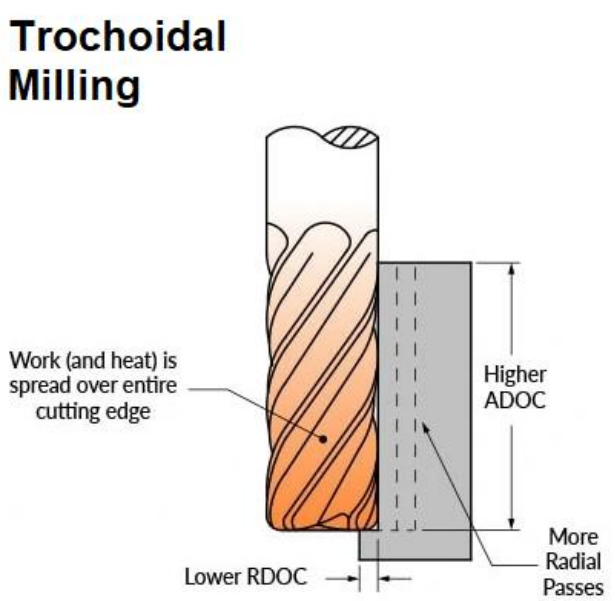




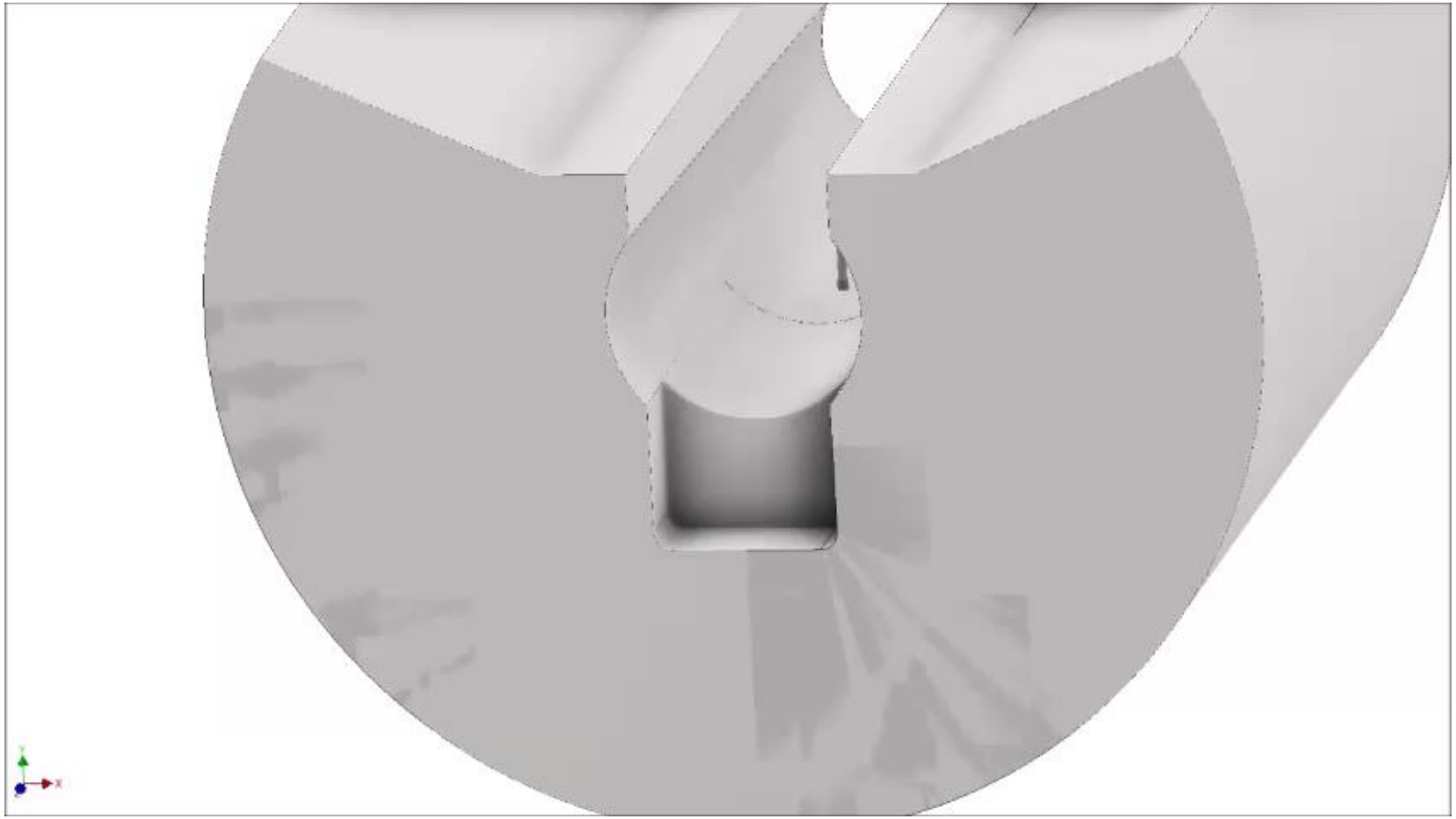
MILLING TECHINIQUES COMPARISON

	Trochoidal Milling	Traditional Milling
Cutting Diameter	20 mm	30 mm
Number of Teeth	4	2
Spindle Speed	2150 rpm	1100 rpm
Feed Rate per Tooth	0.1 mm	0.12 mm
Cutting Feed Rate	860 mm/min	265 mm/min
Radial Depth of Cut	3 mm	10 mm
Axial Depth of Cut	10 mm	5 mm
Material Removal Rate	25.8 cm^3/min 11.3 kg/h	13.3 cm^3/min 5.8 kg/h
Machining Time	109 h	212 h

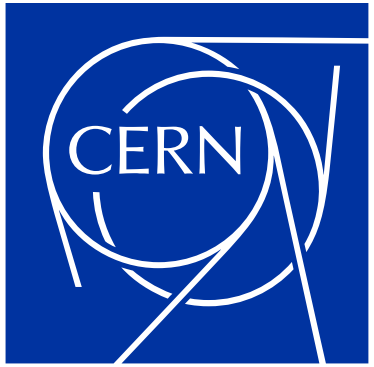




SIMULATIONS (1)



SIMULATIONS (2)



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