



Components for the Machine-Interface Regions

Miguel Lino Diogo dos Santos On Behalf of HL-LHC WP8
(Collider-Experiment Interface)



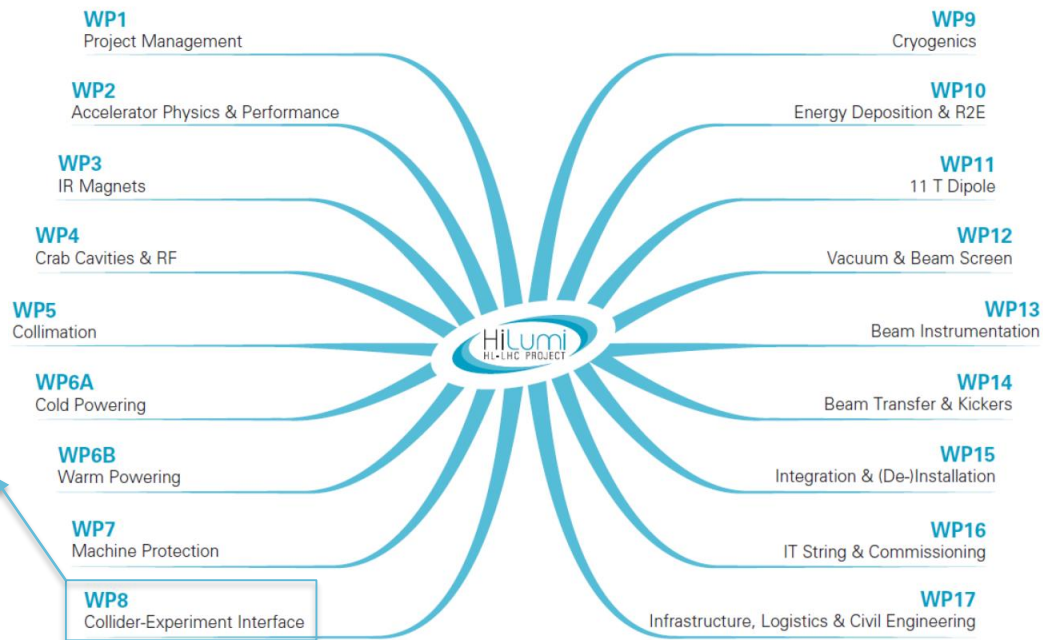
CERN_3rd HiLumi Industry Day_22-May-017_Warrington, United Kingdom

Components for the Machine-Interface Regions

- WP8 Collider-experiment Interface
- Introduction to absorbers in HL-LHC
- Components, technologies and competences
- Acquisition strategy
- Remarks

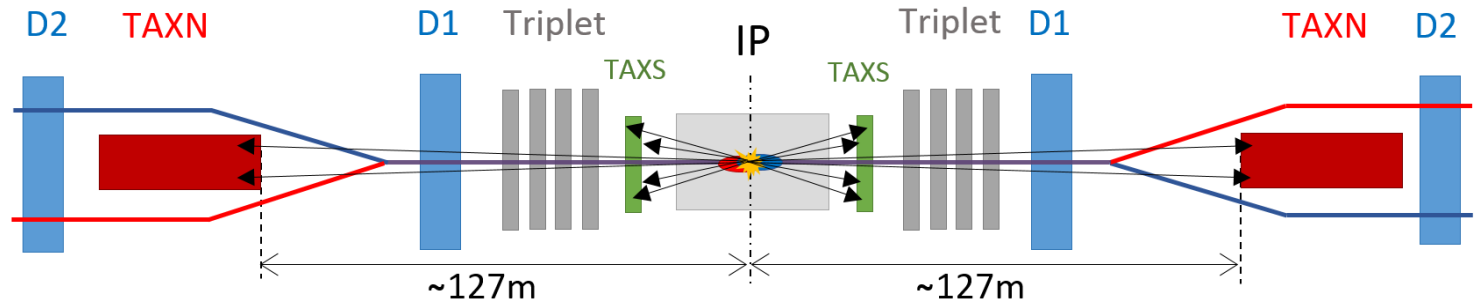
WP8 Collider-Experiment Interface

Evaluate and act on the effect of beam induced dose rate, integrated dose and activation upon the LHC machine components, detectors and materials in the experimental areas for the HL-LHC.



Introduction to Absorbers in the HL-LHC

- The absorber is mainly composed of one or more blocks of **high thermal conductive** and **high density materials** chosen for the absorption of radiation.
- It's function is to **protect the surrounding equipment from stray particles** were they can disturb the correct functioning of the equipment.



- The Proton (or ion) bunches colliding produce a shower of charged and neutral particles (like pions+/-, protons, neutrons, gammas etc.).
- Absorbers are deployed strategically to **protect superconducting magnets** from this created stray radiation to **prevent them from quenching**.

Introduction to Absorbers in the HL-LHC



- TAXS (currently TAS)

2 absorbers **ATLAS**

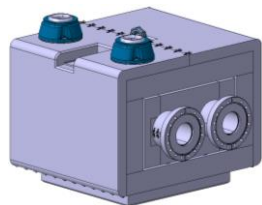
2 absorbers **CMS**



- TAXN (currently TAN)

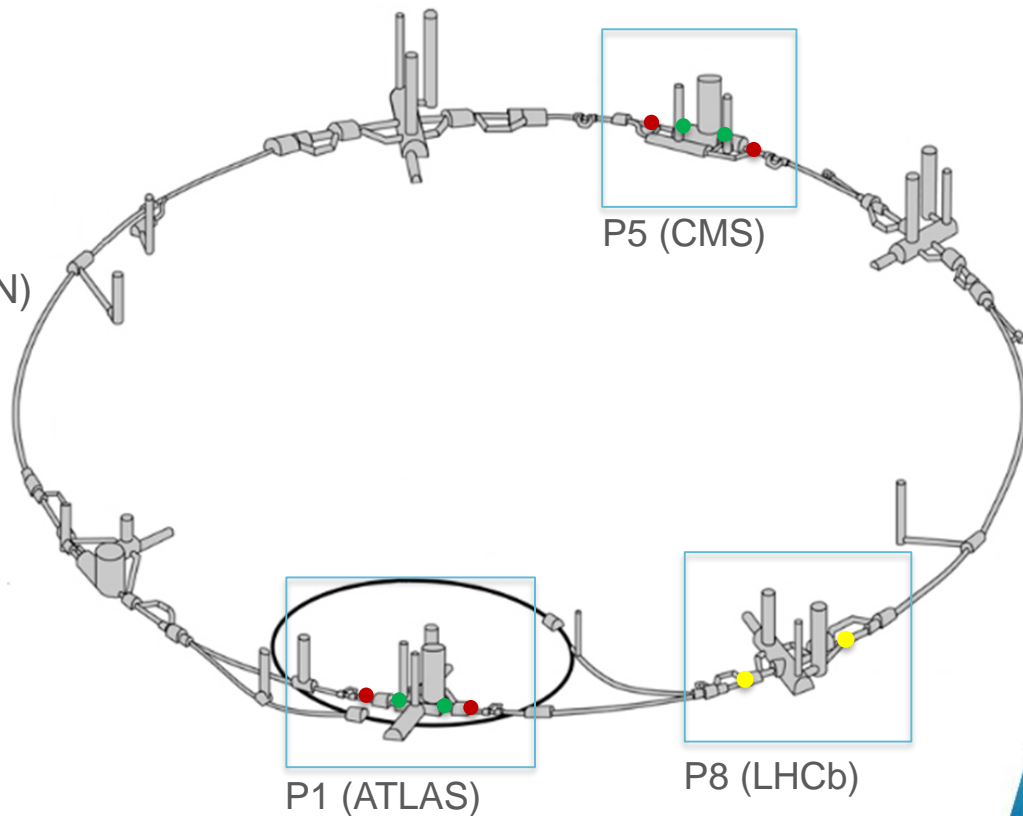
2 absorbers **ATLAS**

2 absorbers **CMS**



- TANB

2 absorbers **LHCb**



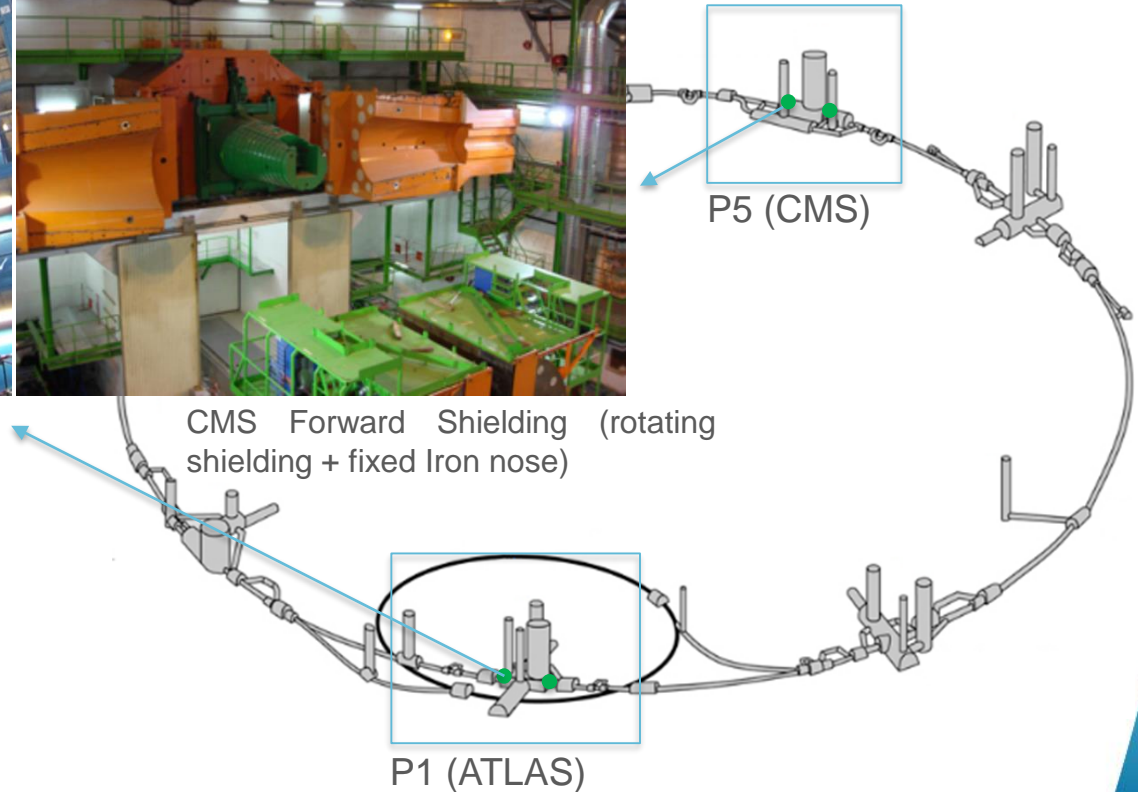
Introduction to Absorbers in the HL-LHC



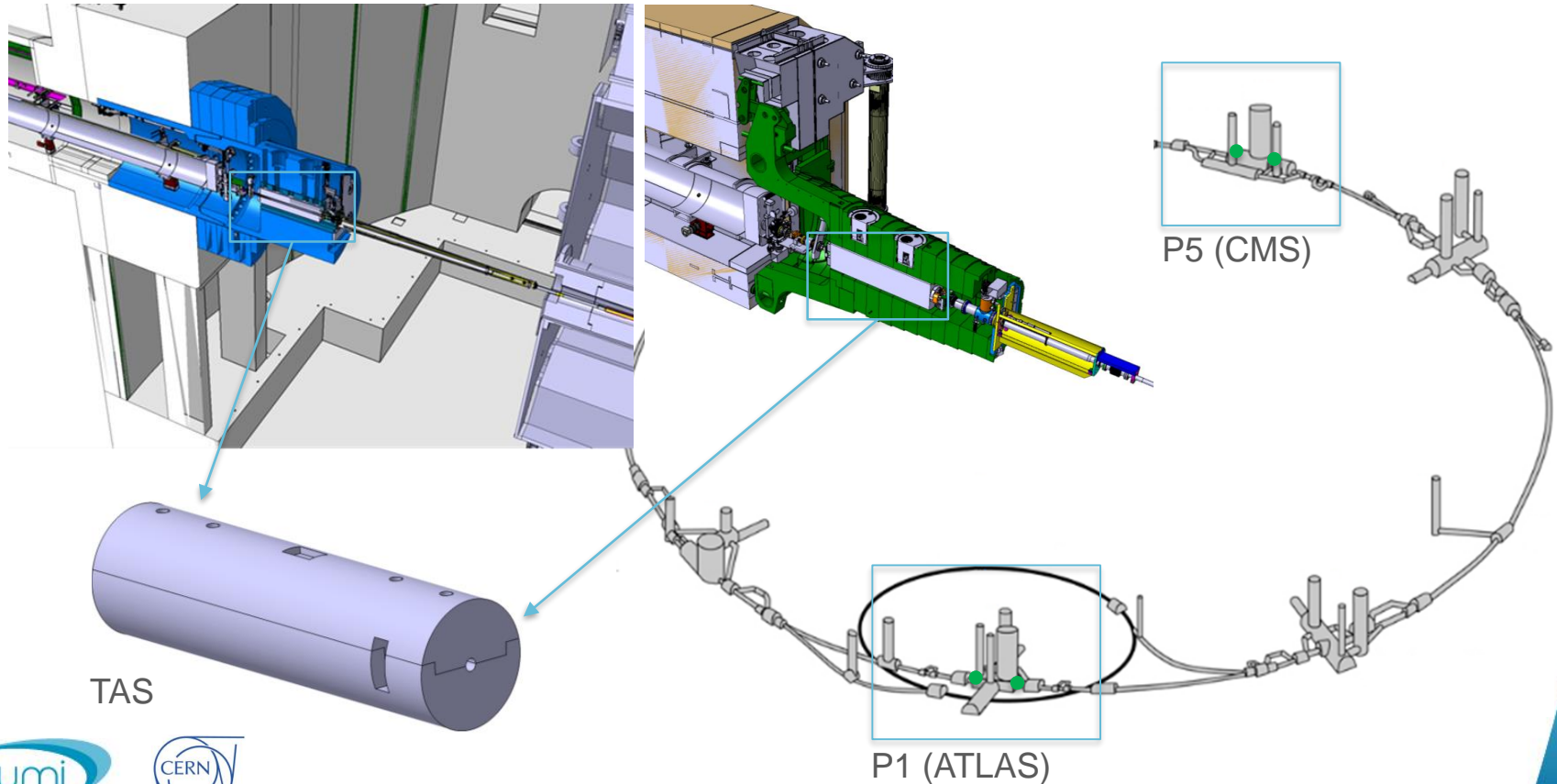
ATLAS Forward Shielding (Octagonal shielding (JFS), cylindrical shielding (JFC))



CMS Forward Shielding (rotating shielding + fixed Iron nose)



Introduction to Absorbers in the HL-LHC



TAS

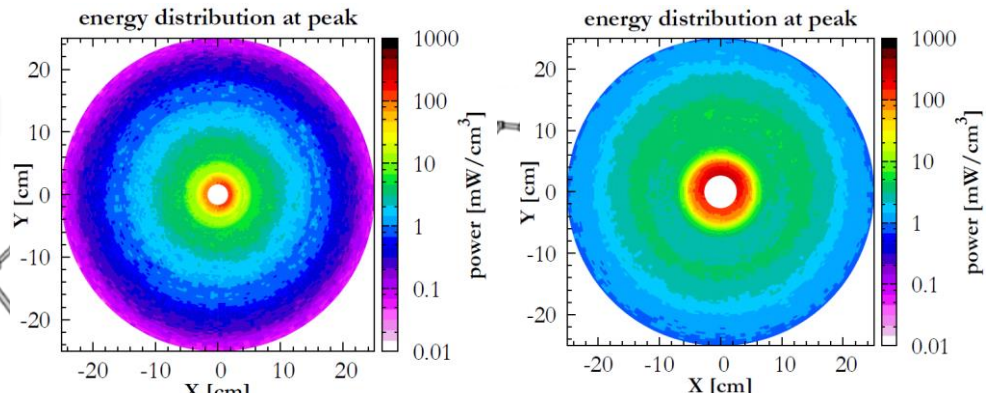
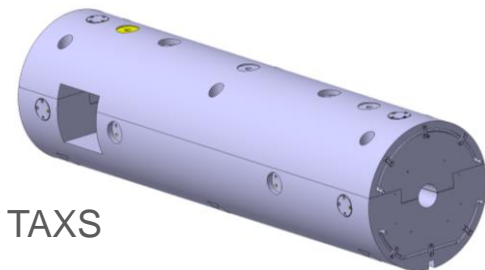
P5 (CMS)

P1 (ATLAS)

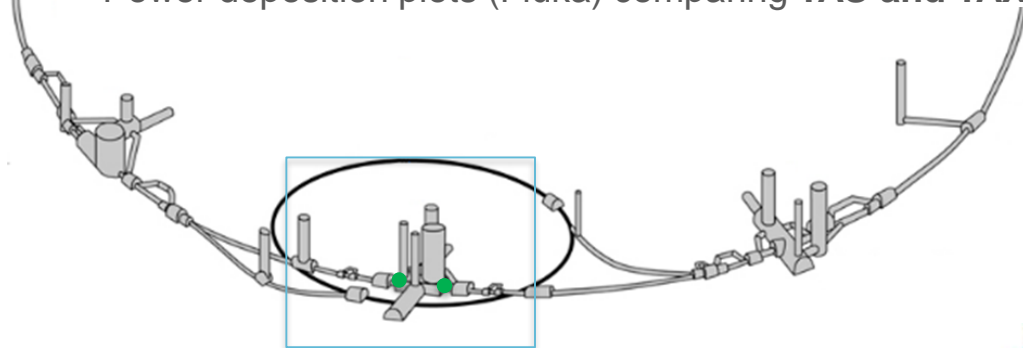
Introduction to Absorbers in the HL-LHC

Experiment	Peak Luminosity [$\text{cm}^{-2} \text{s}^{-1}$]		IP
	HL-LHC	LHC	
ATLAS	5×10^{34}	2×10^{34}	1
CMS	5×10^{34}	2×10^{34}	5
ALICE	1×10^{31}	1×10^{31}	2
LHCb	2×10^{33}	4×10^{32}	8

- 750W of power deposition in TAXS
- TAXS will replace TAS at the limit between cavern and LHC tunnel in ATLAS and CMS



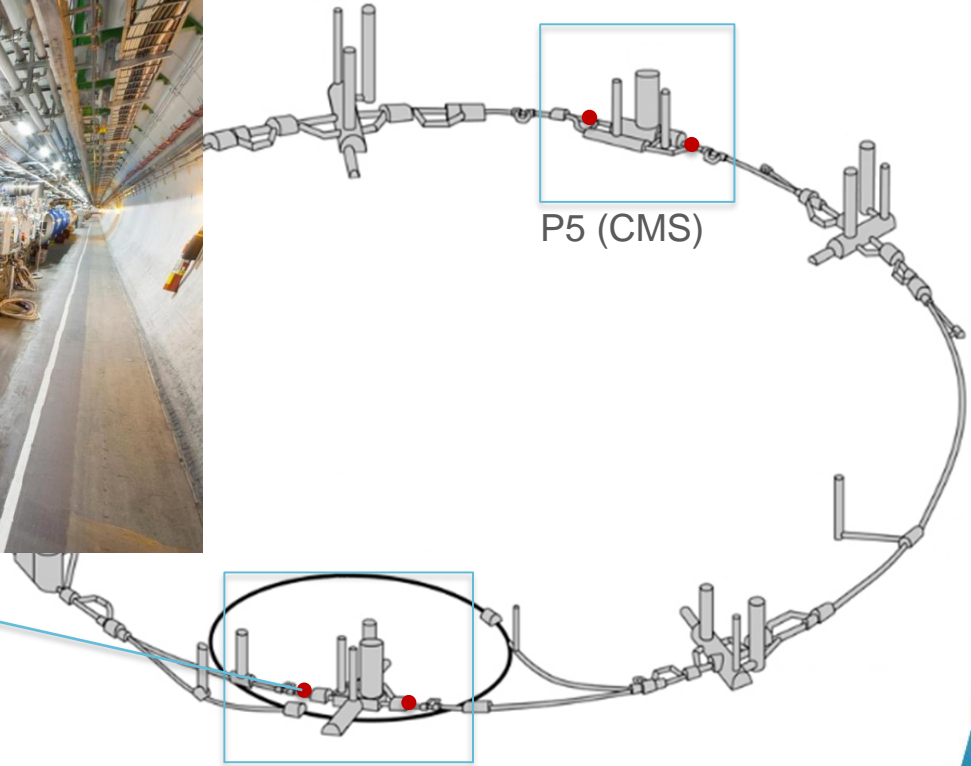
Power deposition plots (Fluka) comparing **TAS** and **TAXS**



Introduction to Absorbers in the HL-LHC



TAN



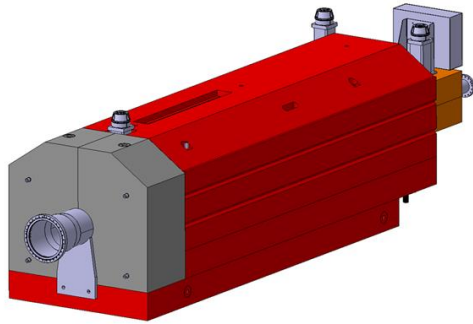
P5 (CMS)

P1 (ATLAS)

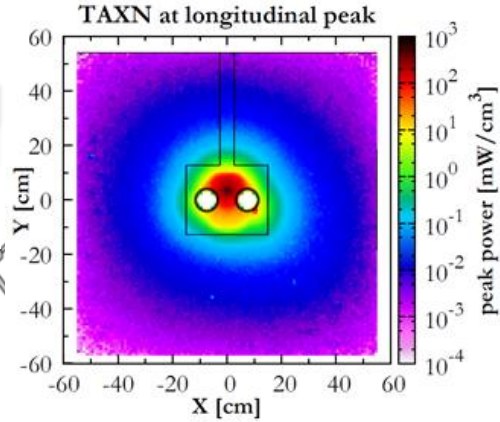
Introduction to Absorbers in the HL-LHC

Experiment	Peak Luminosity [$\text{cm}^{-2} \text{s}^{-1}$]		IP
	HL-LHC	LHC	
ATLAS	5×10^{34}	2×10^{34}	1
CMS	5×10^{34}	2×10^{34}	5
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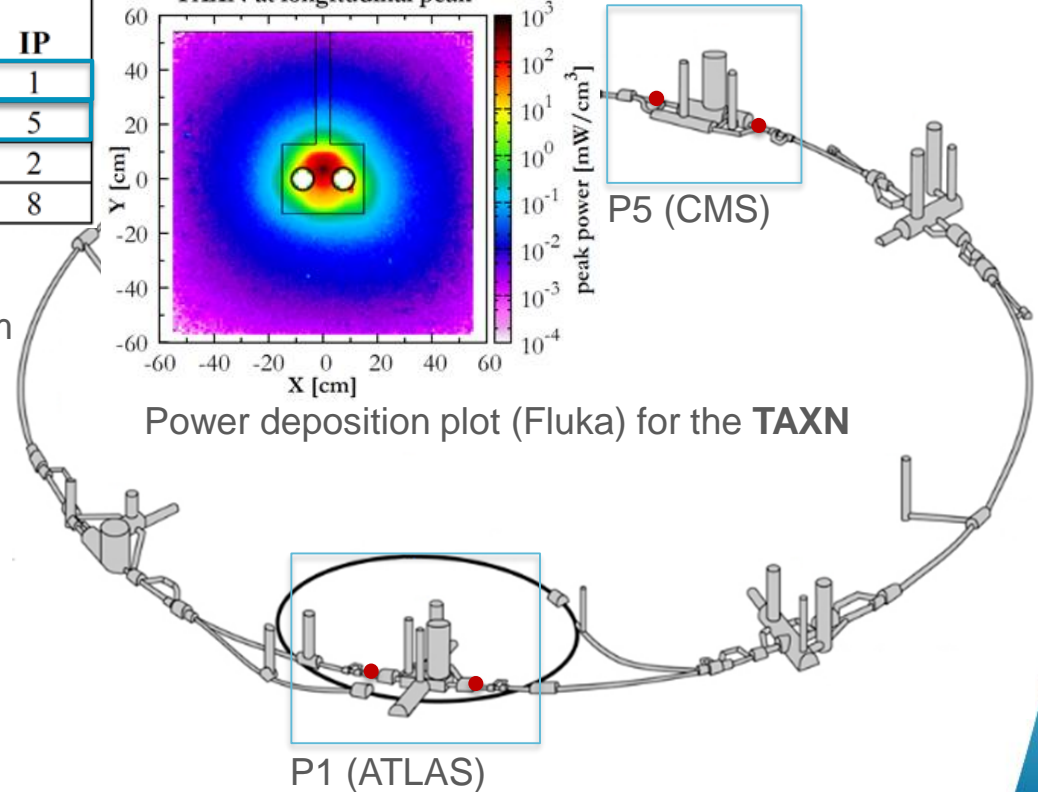
- 1500W of power deposition in TAXN
- TAXN will replace TAN, located 127m from either side of IP1 and 5



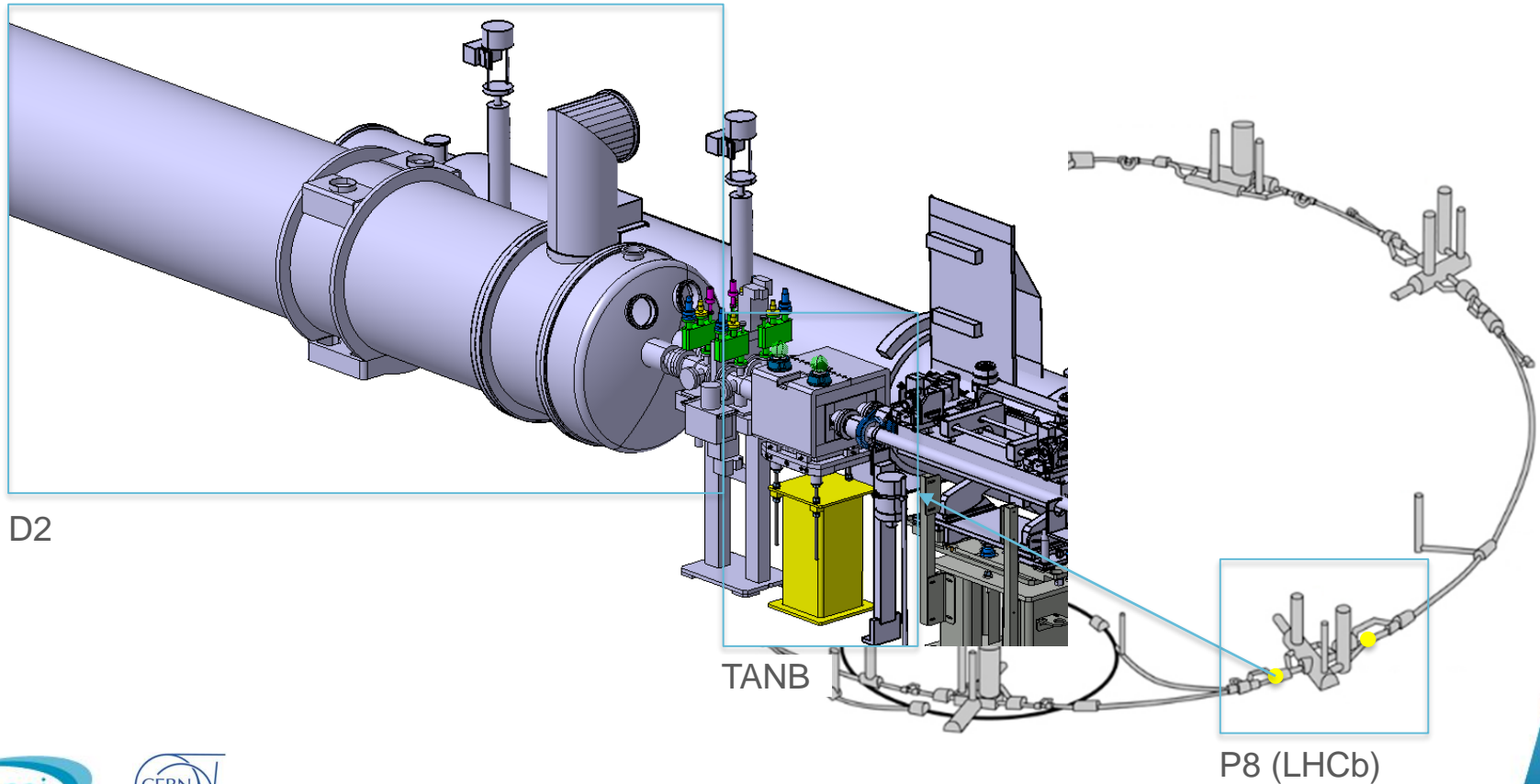
TAXN



Power deposition plot (Fluka) for the TAXN



Introduction to Absorbers in the HL-LHC



D2

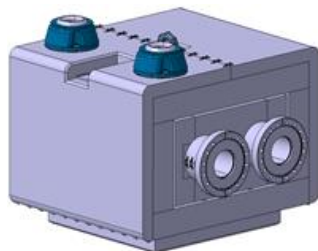
TANB

P8 (LHCb)

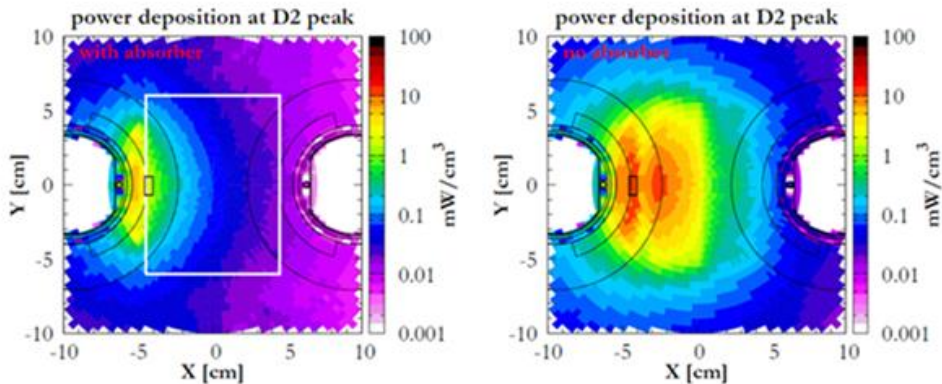
Introduction to Absorbers in the HL-LHC

Experiment	Peak Luminosity [$\text{cm}^{-2} \text{s}^{-1}$]		IP
	HL-LHC	LHC	
ATLAS	5×10^{34}	2×10^{34}	1
CMS	5×10^{34}	2×10^{34}	5
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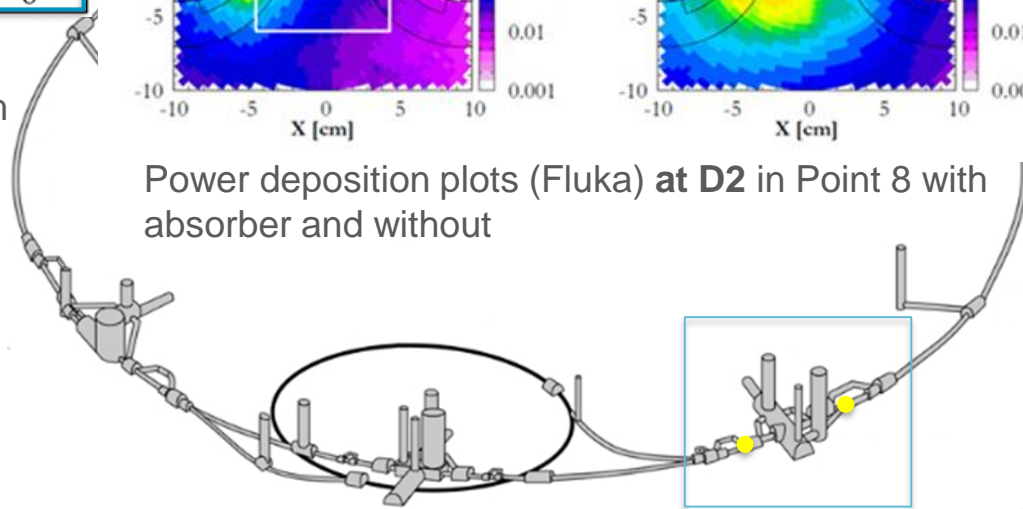
- 25W of power deposition in TANB.
- The TANB absorbers will be at 120m, from either side of IP8.



TANB



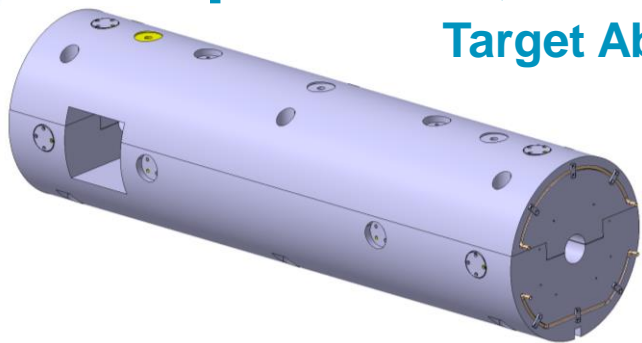
Power deposition plots (Fluka) at D2 in Point 8 with absorber and without



P8 (LHCb)

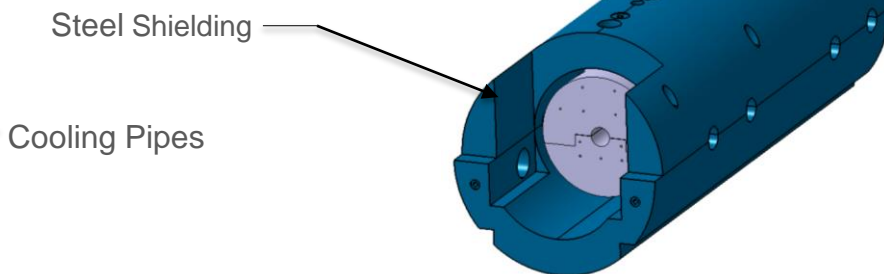
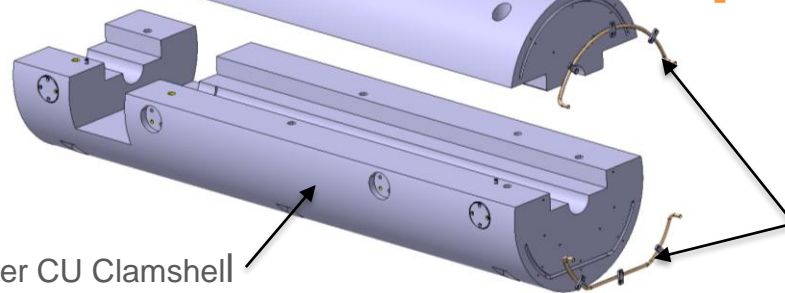
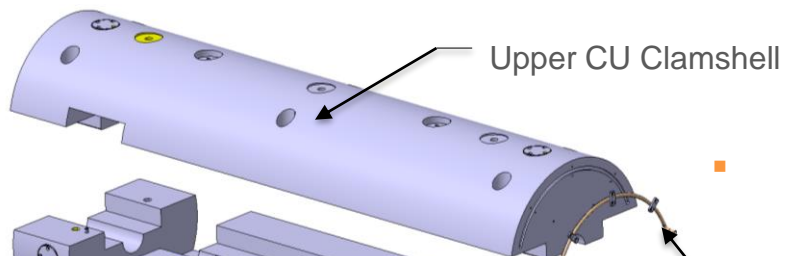
Components, Technologies and Competences

Target Absorber Secondary's (TAXS)



- 4 x 3.2 tonnes TAXS in Cu ETP
- 4 x Vacuum chambers in Cu OFHC (\varnothing 60mm)
- 2 Steel shields (for the 2 ATLAS TAXS)
- Each TAXS will be equipped with:
 - Radiation hard heating elements and thermocouples
 - Radiation hard remote and survey alignment system
 - Dedicated water cooling circuit

- Dimensions: \varnothing 500mm; length: 1800mm



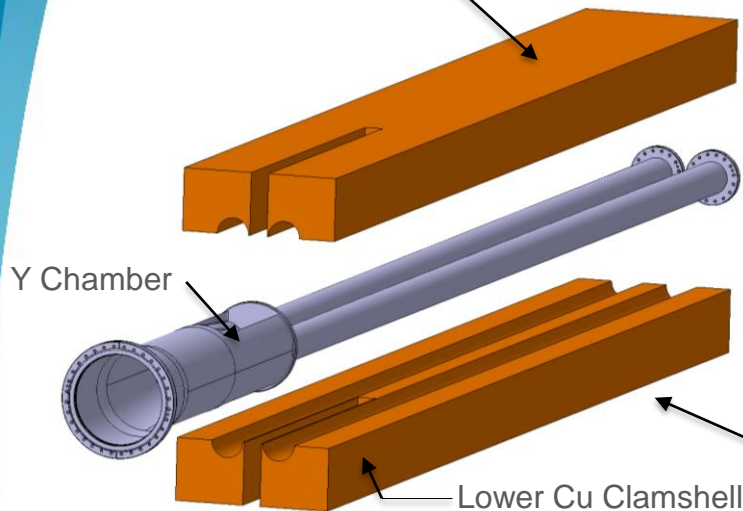
Lower CU Clamshell

Cooling Pipes

Components, Technologies and Competences

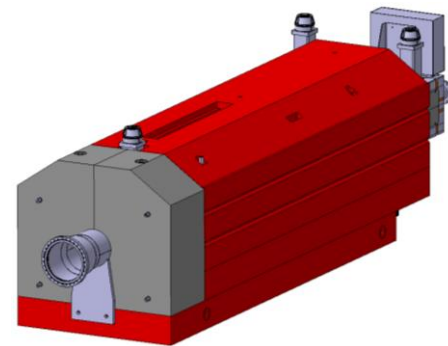
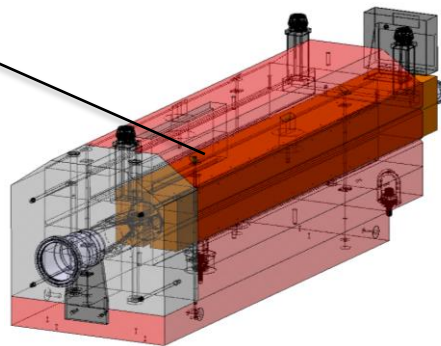
Target Absorber Neutrals (TAXN)

Upper Cu Clamshell



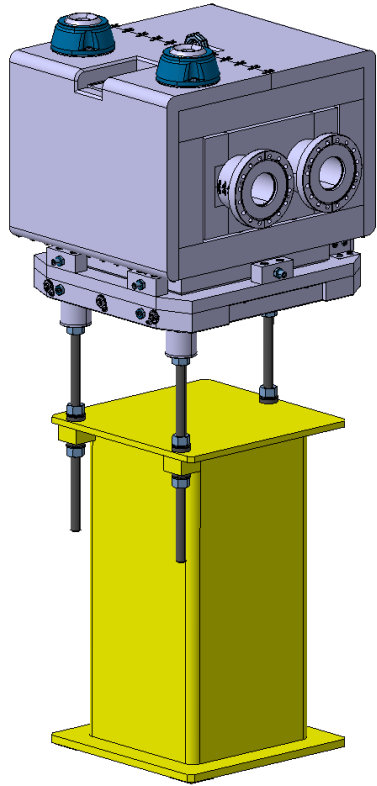
- 4 x 30Tonnes TAXN in Cu ETP
- 4 x Vacuum Y chambers in Cu OFHC
- Steel shielding reused from the TAN → Less waist and cost
- Each TAXN will be equipped with:
 - Radiation hard heating elements and thermocouples
 - Radiation hard remote handling → Integrated detectors
 - Dedicated water cooling circuit
 - Motorized alignment supports

- Copper absorber weight: ~4 Ton
- Dimensions : Length 3600mm, Width 350mm, High:350mm

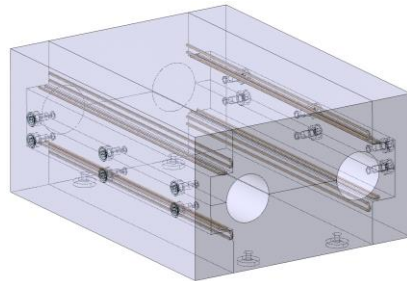


Components, Technologies and Competences

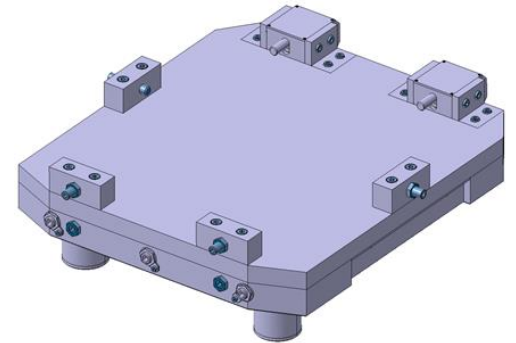
Target Absorber Neutrals (TANB)



- 2 x 800 kg TANB in Tungsten with stainless steel shielding
- 4 x Vacuum chambers in Cu OFS (\varnothing 63mm)
- Each TANB will be equipped with:
 - Radiation hard heating elements and thermocouples
- Supports provided by CERN
- New alignment 6DOF plate proposed for faster and easier alignment of the TANB

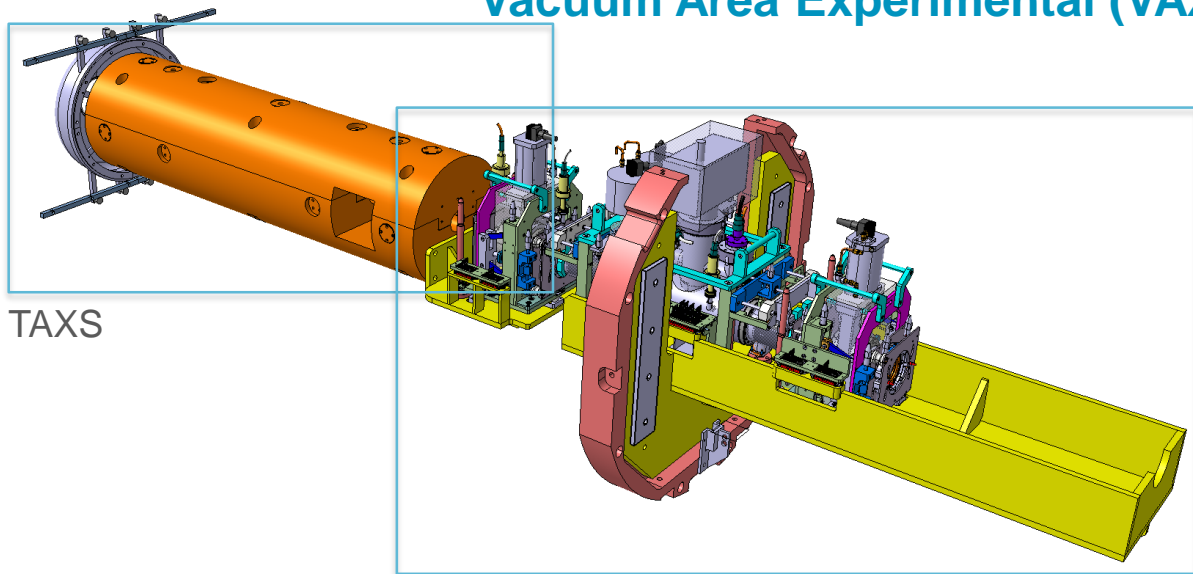


- Weight ~500kg divided in 4 parts
- Absorber dimensions: Length 440mm, Width 340mm, High:200mm



Components, Technologies and Competences

Vacuum Area Experimental (VAX)



TAXS

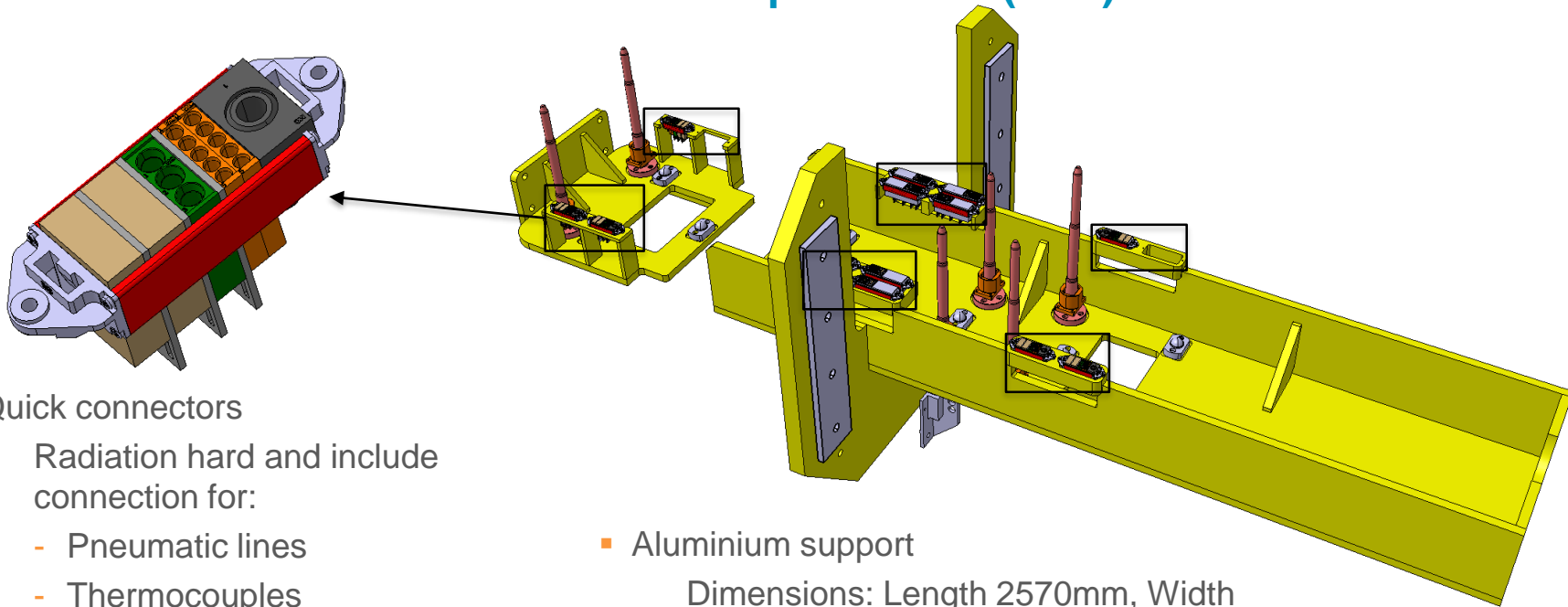
VAX

- 4 VAX, 2 on CMS 2 on ATLAS
- Each Vax will be equipped with:
 - Vacuum Pumps
 - Ion Pumps
 - Gate Valves
 - Quick connectors
- Will partially change surrounding shielding (JFC3) → Will require in situ machining

VAX modules placed on the cavern side for the HL-LHC instead of the current LHC location at tunnel side.
→ This facilitates the access to the VAX module and allows full exploitation of existing BPM's and addition of new ones on the experiment side.

Components, Technologies and Competences

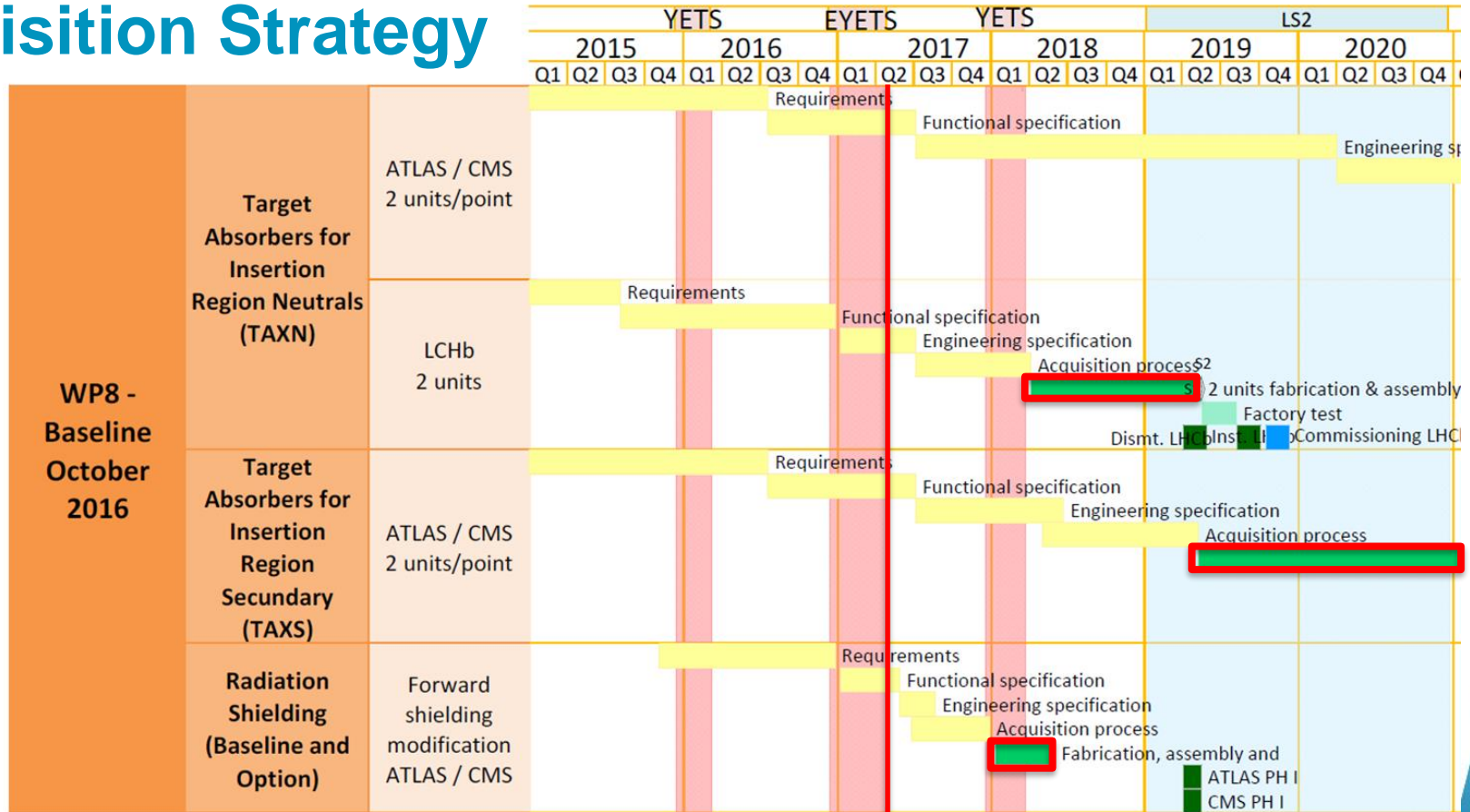
Vacuum Area Experimental (VAX)



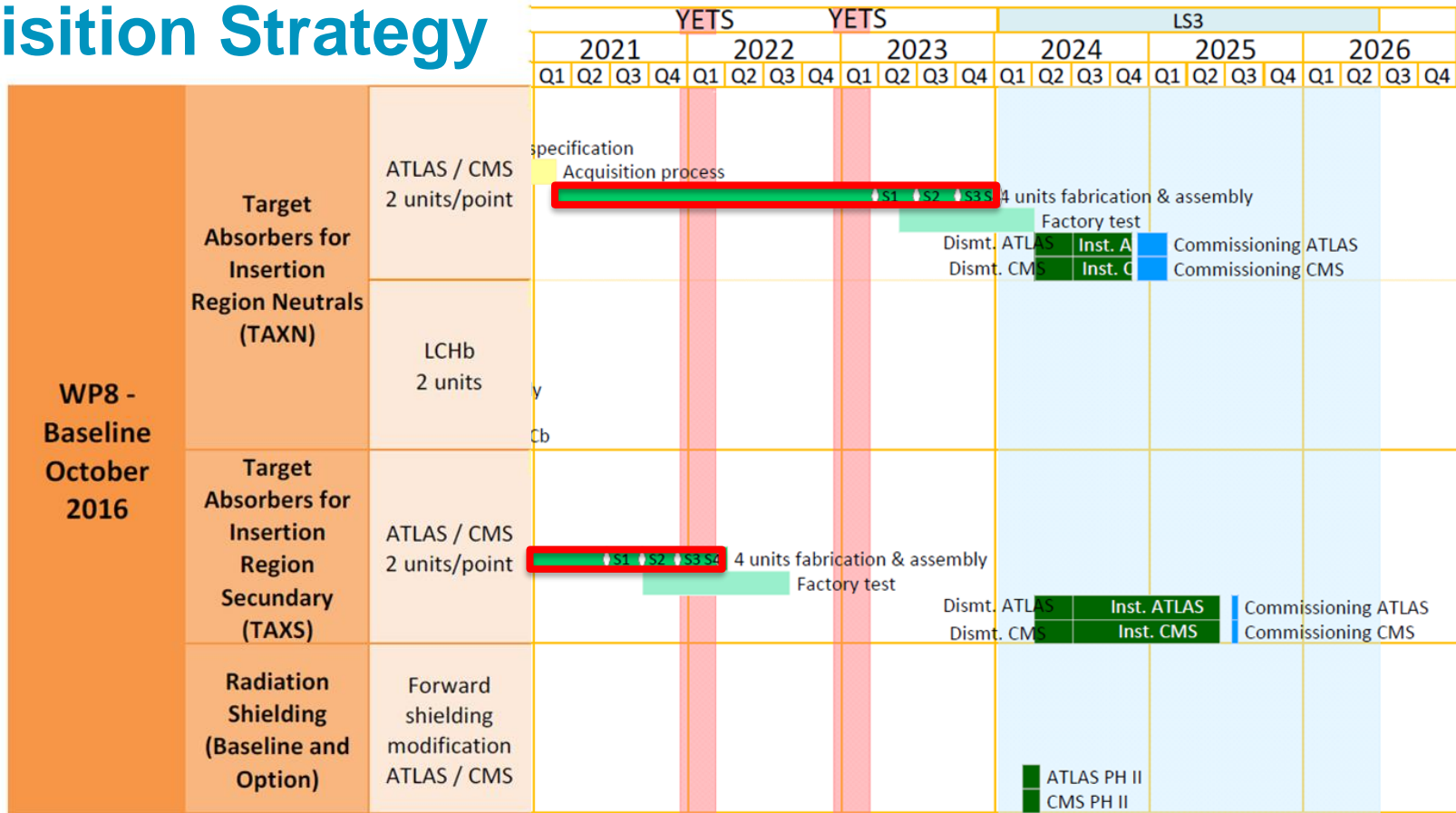
- Quick connectors
 - Radiation hard and include connection for:
 - Pneumatic lines
 - Thermocouples
 - Vacuum valves actuators

- Aluminium support
 - Dimensions: Length 2570mm, Width (max.) 1030mm, Height (max.) 955mm

Acquisition Strategy



Acquisition Strategy



Remarks

30 T of ETP Copper: 4 TAXS and 4 TAXN
1T of tungsten: 2 TANB
OFHC Copper 12 vacuum chambers
4 VAX Aluminium supports
SS304L alignment plate (prototype)
Bakeout:
 Radiation hard heating elements
 and thermocouples
Water cooling
Remote handling:
 16 radiation hard hi torque motors
 +encoders, feedback system
 Radiation hard actuators
Radiation hard connectors

For the industry it means



Large precision machining capabilities
In situ machining
Aluminium welding capabilities
Exotic materials
Heavy loads handling
Floor space
Single piece/small series production
Radiation hard components
Remote handling
Connectors
Control and testing
Design done at CERN
Manufacturing drawings done by CERN



Thank you for your attention



Components, Technologies and Competences

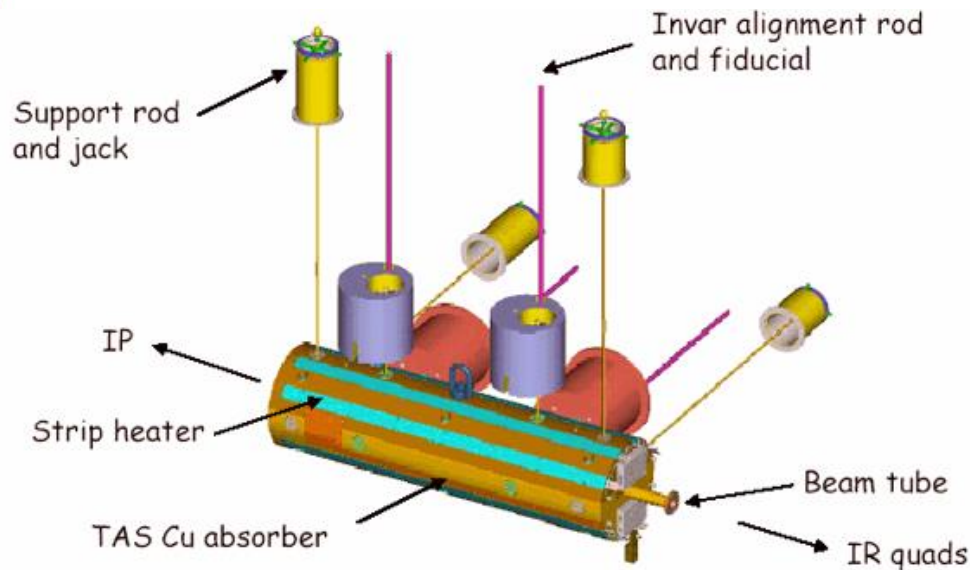
Target Absorber Secondary's (TAXS)

- ALARA, reduce exposure time for major operations

Remote survey and alignment (motorized system) avoid the need to access the top of the shielding reducing radiation exposure

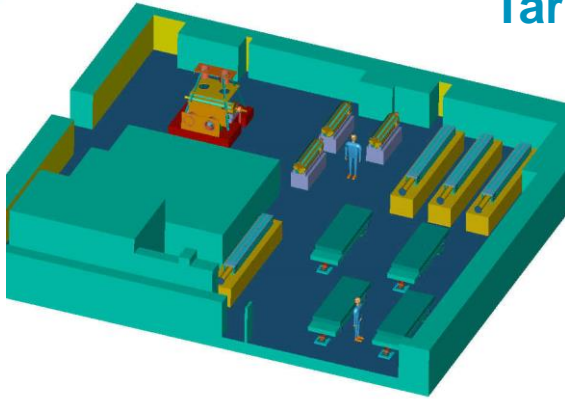
The system could include:

- Radiation hard, hi torque motors (4 per each absorber, 16 Total) with encoders
- Feedback system (potentiometers) for the position readout → **3.2 Ton object!**
- Mechanical reference positions in case of problems (re-calibration of encoders, etc.)

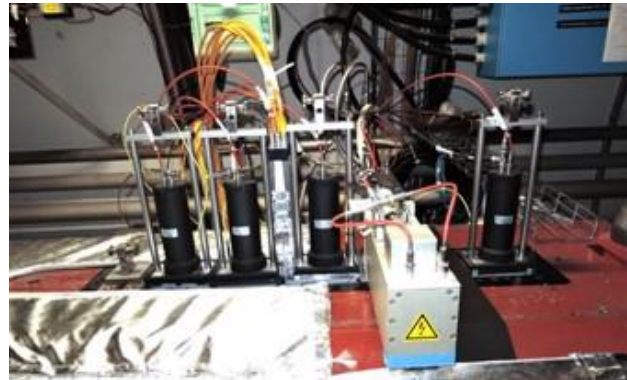


Components, Technologies and Competences

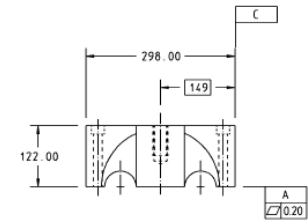
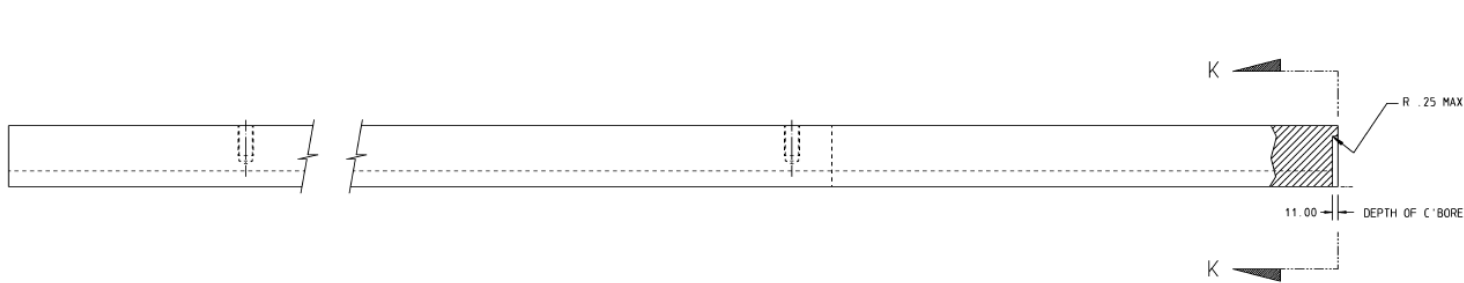
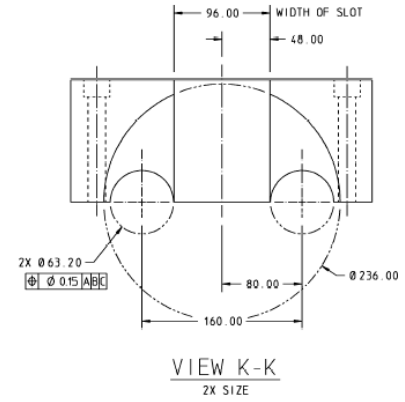
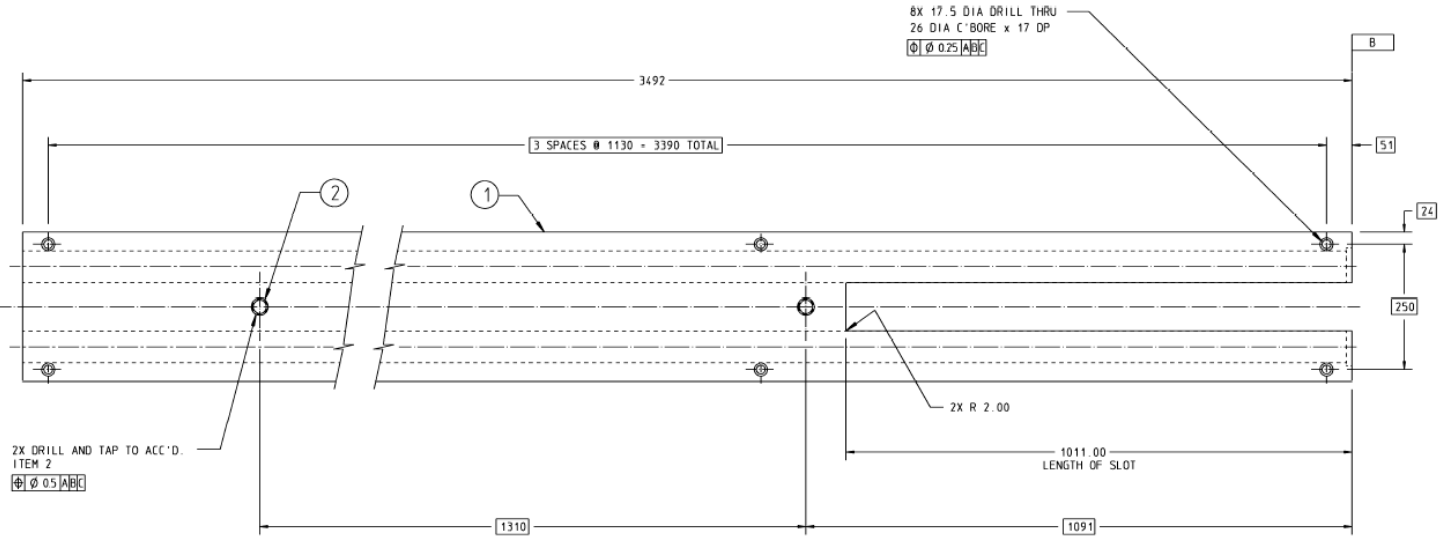
Target Absorber Neutrals (TAXN)



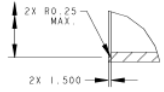
- Lifting and Handling:
 - 30 Ton overhead crane
 - Floor load capability
 - Open floor space
- Office and Clean room
- Vacuum testing Resources, Metrology resources



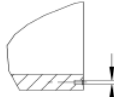
- Radiation hard remote handling for interchangeability of forward detectors → TAXN region will be activated!



2X $\phi 58.05$
 $\phi 57.25$
 $\sqrt{0.20D}$

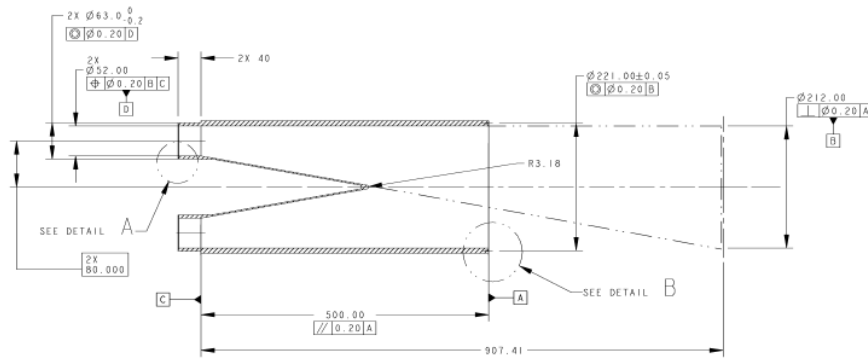


DETAIL A
SCALE 1/1

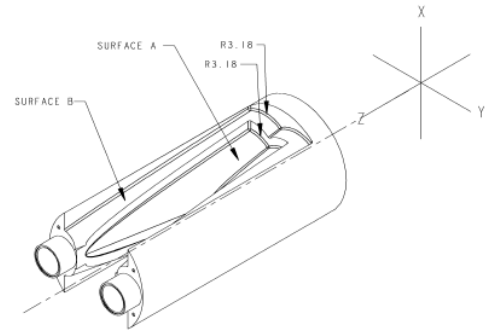


DETAIL B
SCALE 1/1

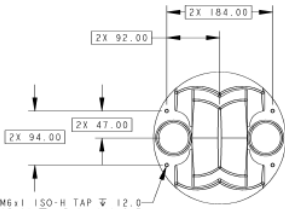
4X $\phi 2.381^{+0.016}$
 $\phi 5.00$
CHAMFER 45° X 0.500



SECTION A - A

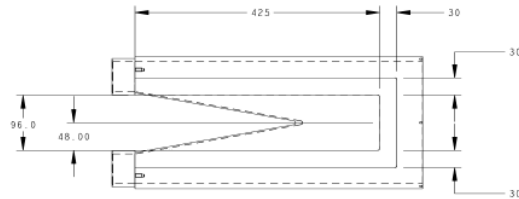
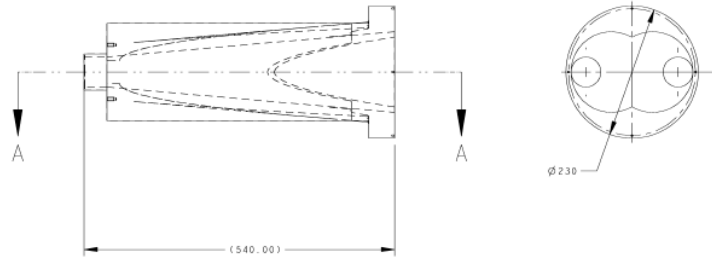


SURFACE A GENERATED BY OFFSETTING INNER CONE SHAPED CUT SURFACES AND TRANSITIONAL INNER ROUND 3.18 BY 12.00 mm ALONG Z AXIS.
SURFACE B GENERATED BY OFFSETTING SURFACE A BY 20 mm IN NORMAL DIRECTION.



3 DRILL M6x1 ISO-H TAP $\Psi 12.0$
(5.01) $\Psi 15.0$ - (4)HOLE

$\phi 10.20$ B



Components, Technologies and Competences

Target Absorber Neutrals (TANB)

- ALARA, reduce exposure time for major operations:
Faster and easier alignment: New alignment 6DOF interface plate is being proposed for the TANB.
 - Simple and robust and flexible design (easy adaptability to other machine elements)
 - Alignment adjustments done by means of 7 frontal screws + 2 lateral screws → Reduced time of exposure to active components
 - Possibility of adapting easily for remote adjustment
 - Large range of adjustment stroke

→ Prototype to be made in stainless steel 304L in coming months!

