HL-LHC LSSR5 integration - Alignment

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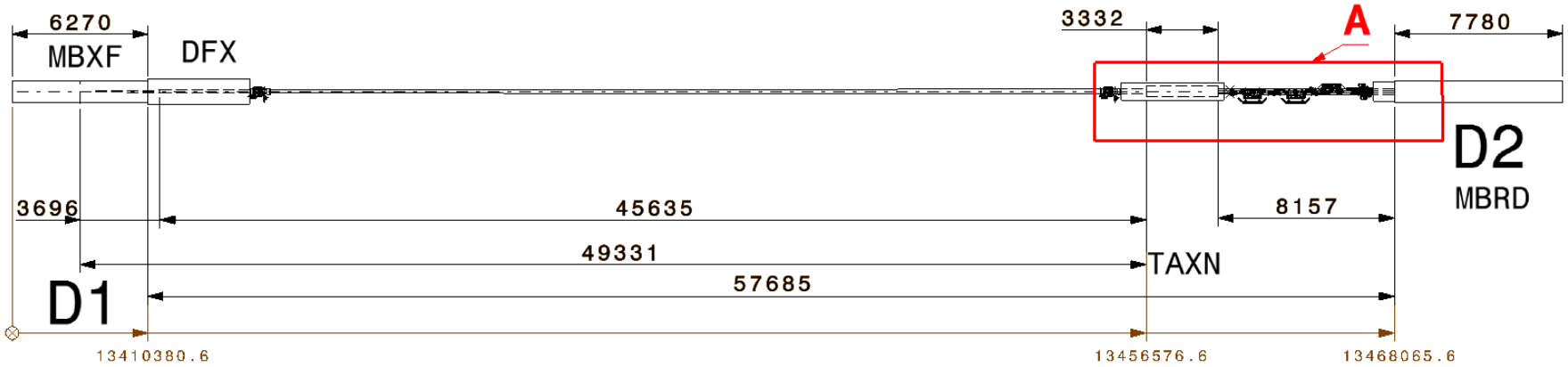
OUTLINE

- Introduction: HI-LUMI LSSR5.
- Vacuum chamber dimensions study.
- Bellow dimensions study.
- Alignment equipment.
- Questions.

Introduction:
HI-LUMI LSSR5

Introduction: HI-LUMI LSSR5

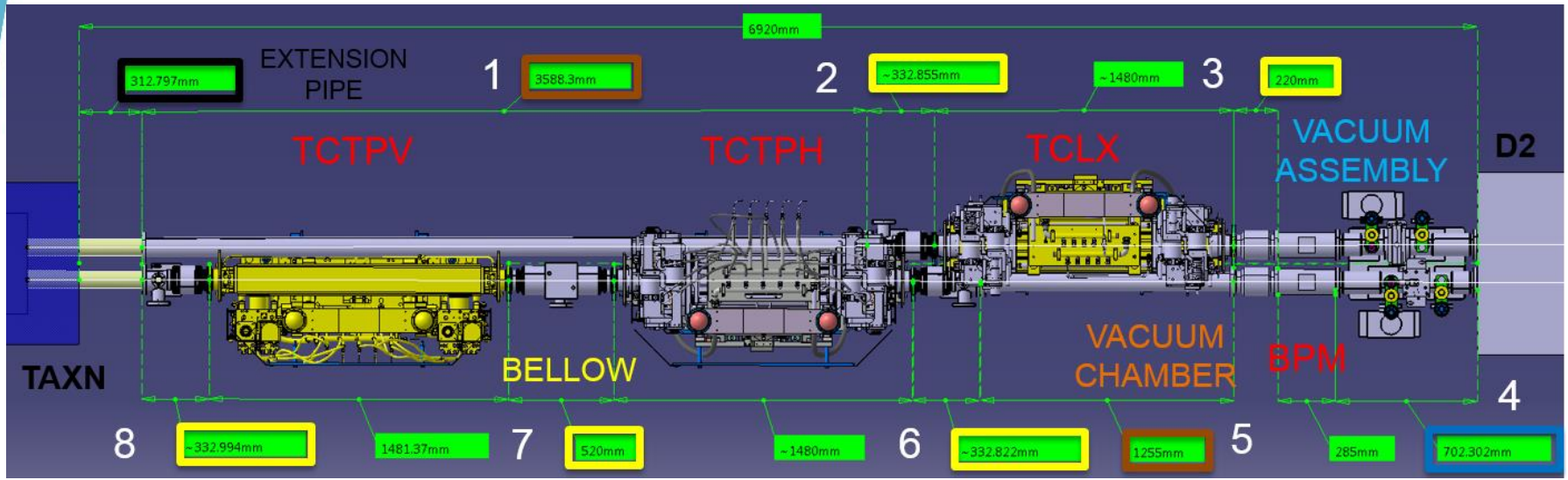
- Working on the LSSR5 integration establishing the vacuum equipment needed:
  - Valves, bellows
  - Vacuum Assemblies
  - Gauges
  - Vacuum chamber → setting the dimensions
  - ...



Introduction: LSSR5 – between TAXN and D2

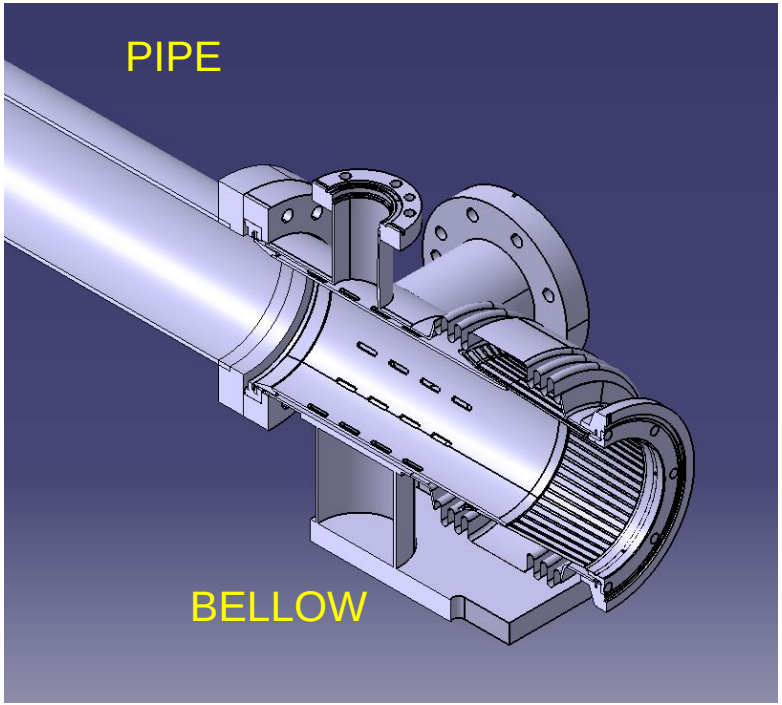
5th axis = +/- 10 mm lateral displacement ➔ specific bellows (VMT type)

Detail A



Introduction: LSSR5 – bellow-pipe transition

- Vacuum chamber inner diameter must be set to determine:
  - If new bellows has to be design.
  - Collisions between components.

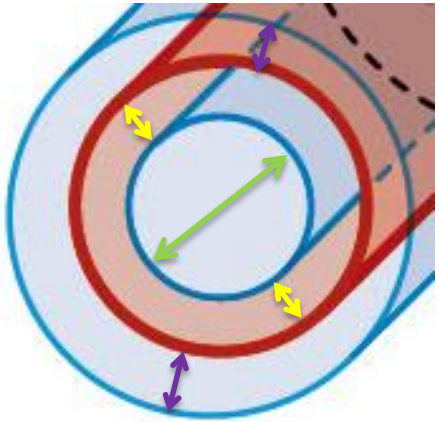


What is required to set the dimensions of the vacuum chamber?

Vacuum chamber dimensions study

Vacuum chamber dimensions study

- Inputs:
  - **Beam aperture**: 85 mm.
- Data required for tolerance:
  - **Pipe mechanical tolerance**[&].
  - **Pipe alignment accuracy**.



PIPE		
Aperture	85	[mm]
Mechanical tolerance (2x)	0.9	[mm]
Alignment accuracy (2x)	2	[mm]
Inner pipe diameter	**91**	[mm]
Thickness (2x)	3	[mm]
Outter pipe diameter	**97**	[mm]
Bake-out jacket thickness	25	[mm]
Diameter with bakeout jacket	147	[mm]

Assumed*

Minimum value

- **Which is the alignment tolerance accuracy?**

85 + yellow + yellow = 85+0.9+0.9 = 86.8
86.8 + purple + purple = 90.8 ➔ 91 mm

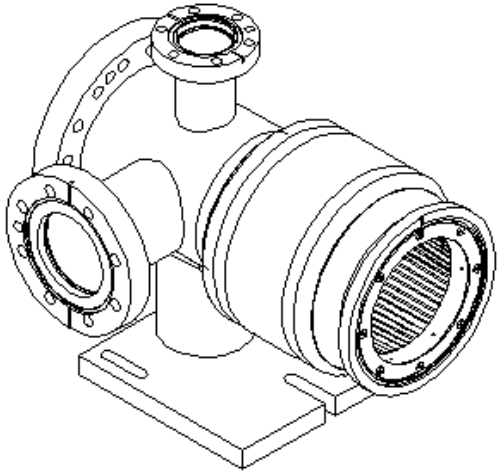
[&] Mech Tol. = Cylindricity = concentricity+straightness+parallelism = 1.8 mm

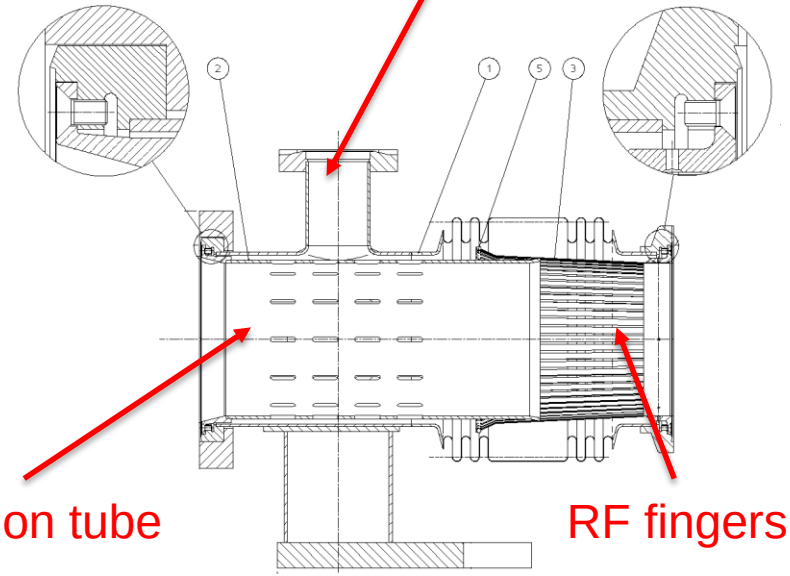
* Today for LHC = 3 mm

Bellow dimensions study

Bellow optimization

Wen need to fit the inner diameter of the vacuum chamber with the inner diameter of RF bridge of the bellow in order to have no transition (tapering) between them.





RF bridge = transition tube + RF fingers

Transition tube joint

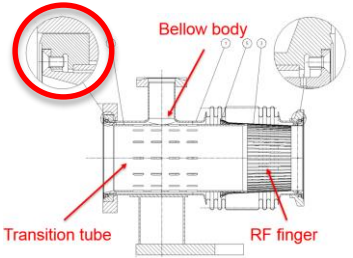
ACTUAL BELLOW (Trans. tube side)		
Outter diameter bellow	103	[mm]
Bellow thickness (2x)	1.5	[mm]
Space between bellow and pipe support (2x)	0.75	[mm]
Pipe support thickness* (2x)	2.55	[mm]
c*	0.6	[mm]
Trans. tube thickness (2x)	2	[mm]
Tolerance inner diameter	0.1	[mm]
Inner Trans. tube diameter	**90.00**	[mm]
Inner Trans. tube diameter	**94.00**	[mm]

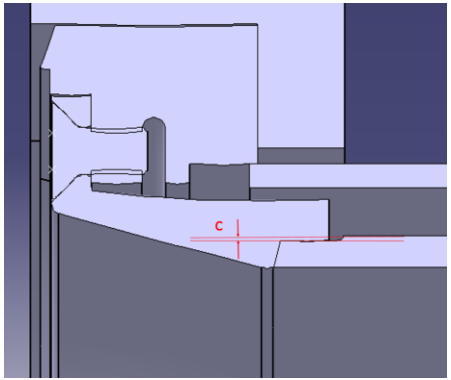
*See drawing

OPTIMIZED BELLOW (Trans. tube side)			
Outter diameter bellow	103	[mm]	
Bellow thickness (2x)	1.5	[mm]	
Space between bellow and pipe support (2x)	0.75	[mm]	
Pipe support thickness* (2x)	1.5	[mm]	(2x) -1.05
c*	0.5	[mm]	(2x) -0.1
Trans. tube thickness (2x)	1.5	[mm]	(2x) -0.5
Tolerance inner diameter	0.1	[mm]	
Inner Trans. inner diameter	**93.00**	[mm]	
Inner Trans. outer diameter	**96.00**	[mm]	

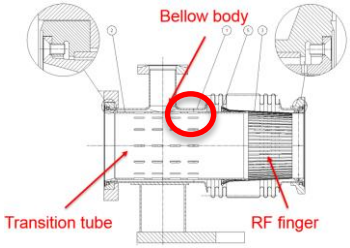
*See drawing

→ Max. inner diameter in transition tube joint



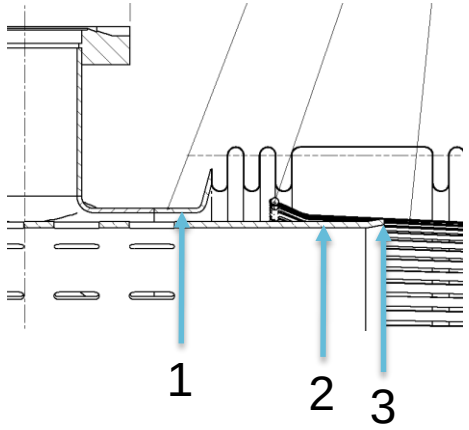


Transition tube



	ACTUAL TRANS. TUBE		
1	Inner diameter bellow	100	[mm]
2	Inner Trans. tube diameter	90	[mm]
3	Outer largest diameter transition tube	96	[mm]
	Max. space poss. Gained	2	[mm]

	OPTIMIZED TRANS. TUBE		
1	Inner diameter bellow	100	[mm]
	Max. space poss. Gained	2	[mm]
2	Outer largest diameter transition tube	98	[mm]
	Max. inner diameter trans.tube	**92.00**	[mm]

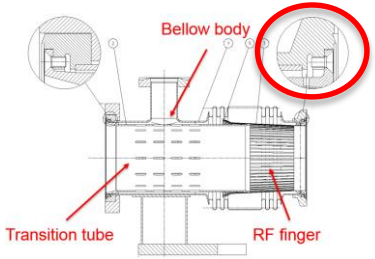


Max. inner diameter in transition tube

RF Finger joint

ACTUAL BELLOW (RF side)		
Outter diameter bellow	103	[mm]
Bellow thickness (2x)	1.5	[mm]
Space between bellow and RF finger (2x)	1.95	[mm]
Flange RF finger thickness (2x)	2.75	[mm]
RF finger thickness (2x)	0.3	[mm]
Tolerance inner diameter	0.1	[mm]
Inner bellow diameter	**90.00**	[mm]

OPTIMIZED BELLOW (RF side)			
Outter diameter below	103	[mm]	
Bellow thickness (2x)	1.5	[mm]	
Space between bellow and RF finger (2x)	0.75	[mm]	(2x) -1.25
Flange RF finger thickness (2x)	1.5	[mm]	(2x) -1.15
RF finger thickness (2x)	0.3	[mm]	
Tolerance inner diameter	0.1	[mm]	
Inner RF finger diameter	**94.9**	[mm]	



Max. inner diameter in RF finger joint

Conclusions
Bellow optimization and vacuum chamber study

RESULTS TABLE		
Pipe Mechanical tolerance (2x)	0.9	[mm]
Pipe Alignement accuracy (2x)	2	[mm]
Min. Inner pipe diameter	**91**	[mm]
Inner RF finger diameter	**95**	[mm]
Trans tube. Mechanical tolerance	1.175	[mm]
Max. inner diameter trans.tube	**92**	[mm]
Max vacuum module alignment accuracy*	**4.65**	[mm]

*For those vacuum modules that need to be aligned

PIPE	BELLOW
Beam aperture	Inner diameter pipe
Pipe mechanical tol.	Bellow mechanical tol.
+ Pipe alignment tol.	- Beam aperture
Inner diameter pipe	**Vacuum module Alignment accuracy**

Objective → to not have diameter transition between vacuum chamber and bellow:

- Min inner diameter → 91 mm
- Max inner diameter → 92 mm
- Max vacuum module alignment accuracy* → 2.32 mm

TARGET :

ID91, Alignement +/- 1.8 mm

ID92, Alignement +/- 2.3 mm

All the tolerances shown are in radius

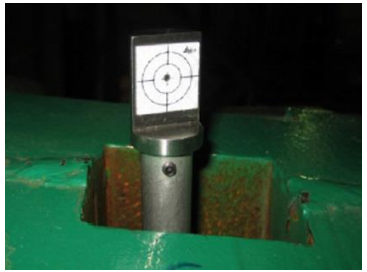
Alignment equipment

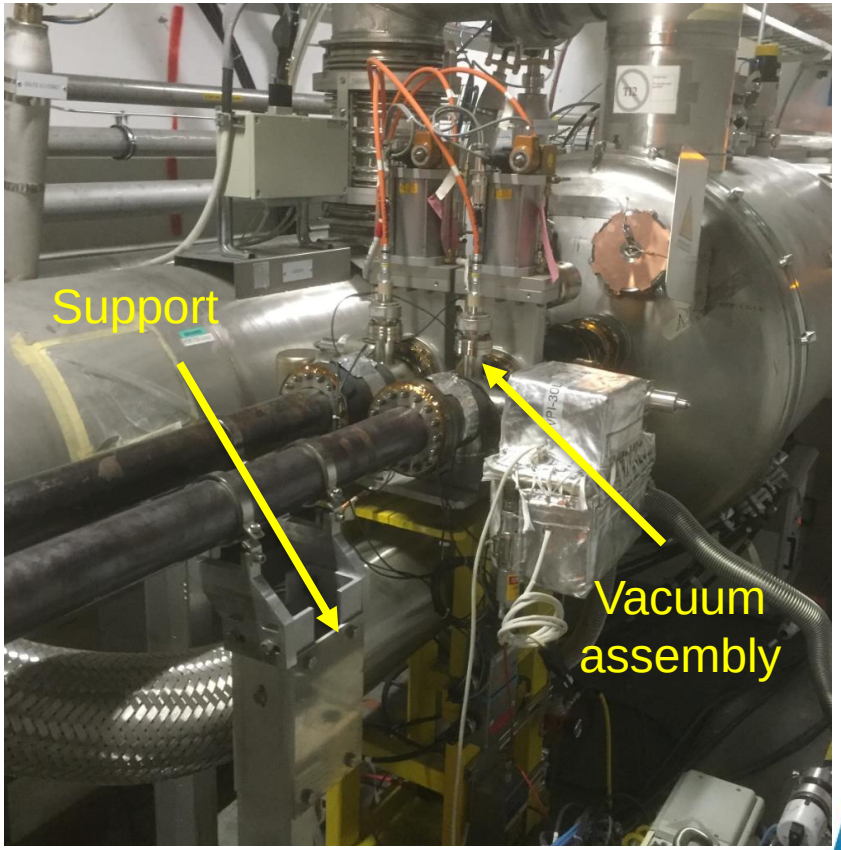
Alignment equipment

- In addition to vacuum chambers (VC), we have to align bellows (VMT), Supports (VHL) and vacuum assemblies (VA).
- For future design, improvement in alignment is needed. Today our alignment specification is 3 mm.

- **What are the standard tools & means used to align an equipment?**

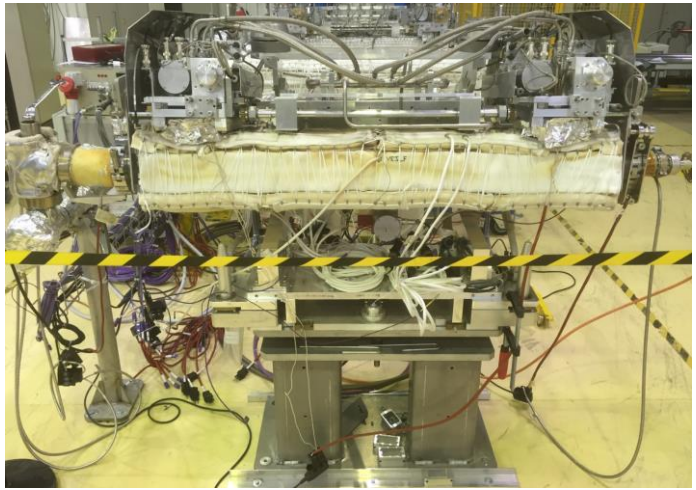
- **Which tools do we have to include in the design to do the alignment with your equipment?**

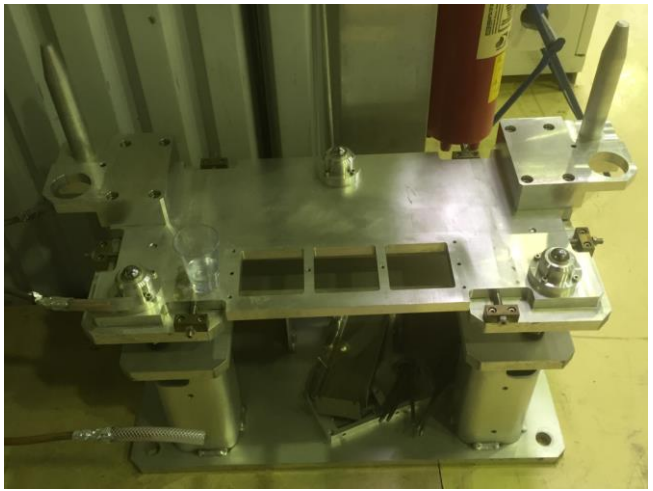
¿  ?



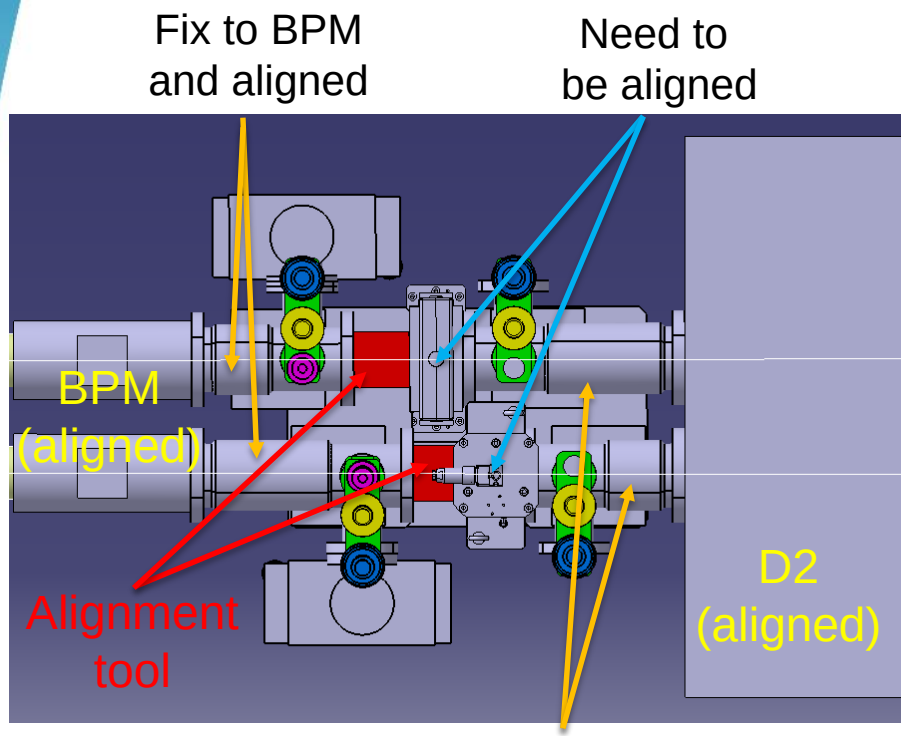
Alignment equipment

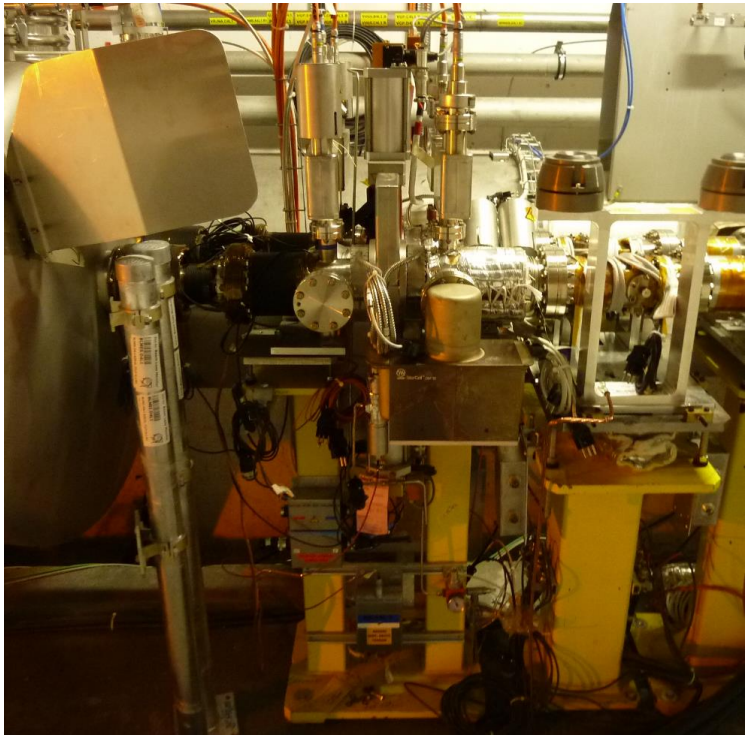
- **Idea: to have a support aligned only once and its ancillaries easily exchangeable, without re-alignement, in order to follow ALARA recommendations.**
  - **What is the alignment accuracy for this kind of support?**
  - **What are the alignment tools do we need for this kind of support?**





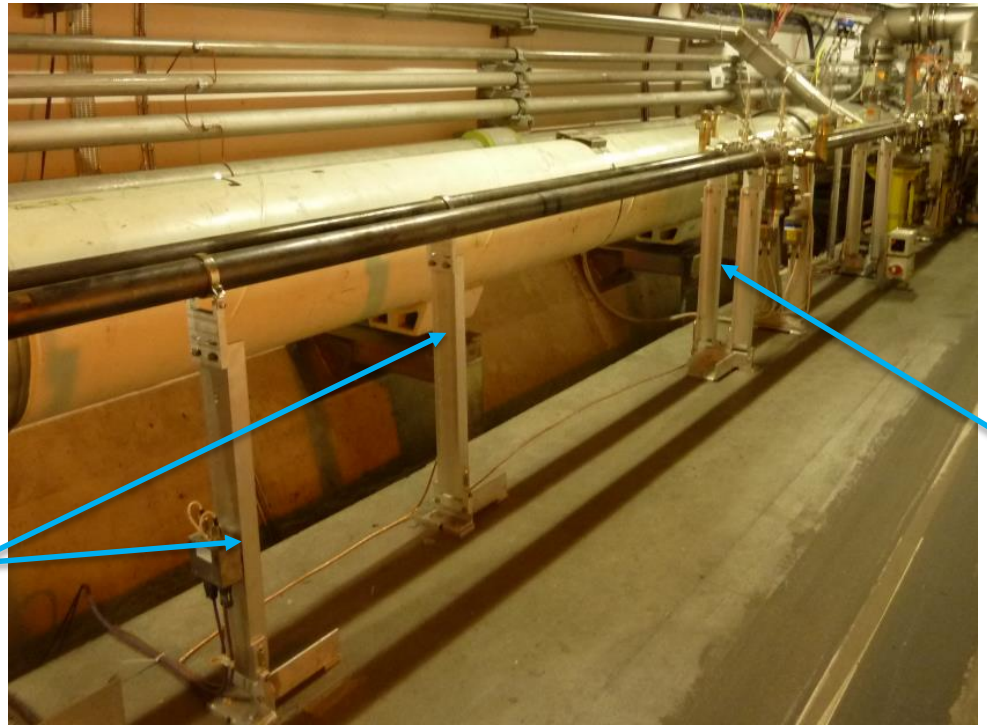
Alignment equipment: VA





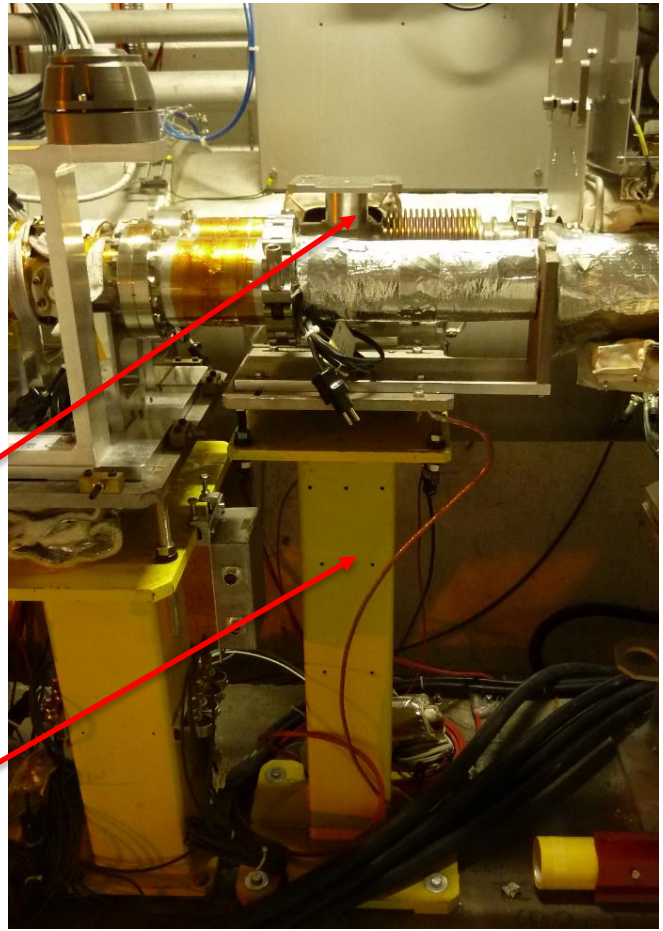
Alignment equipment: VC

- Vacuum chamber supports have to be aligned
- Movable & fixed supports



Alignment equipment: VMT

- Some Vacuum modules with double bellows have to be aligned



Questions

Questions

- What is the achievable alignment accuracy of an upgraded alignment system for the VA, VC, VMT?
- Concerning the alignment equipment, what are the tools that you need to align an equipment?
- If we design a new support, which tools do we have to include in the design to do the alignment with your equipment?
- How do you do the alignment? Which tools or which methodology do you use?

THANK YOU FOR YOUR ATTENTION!!!