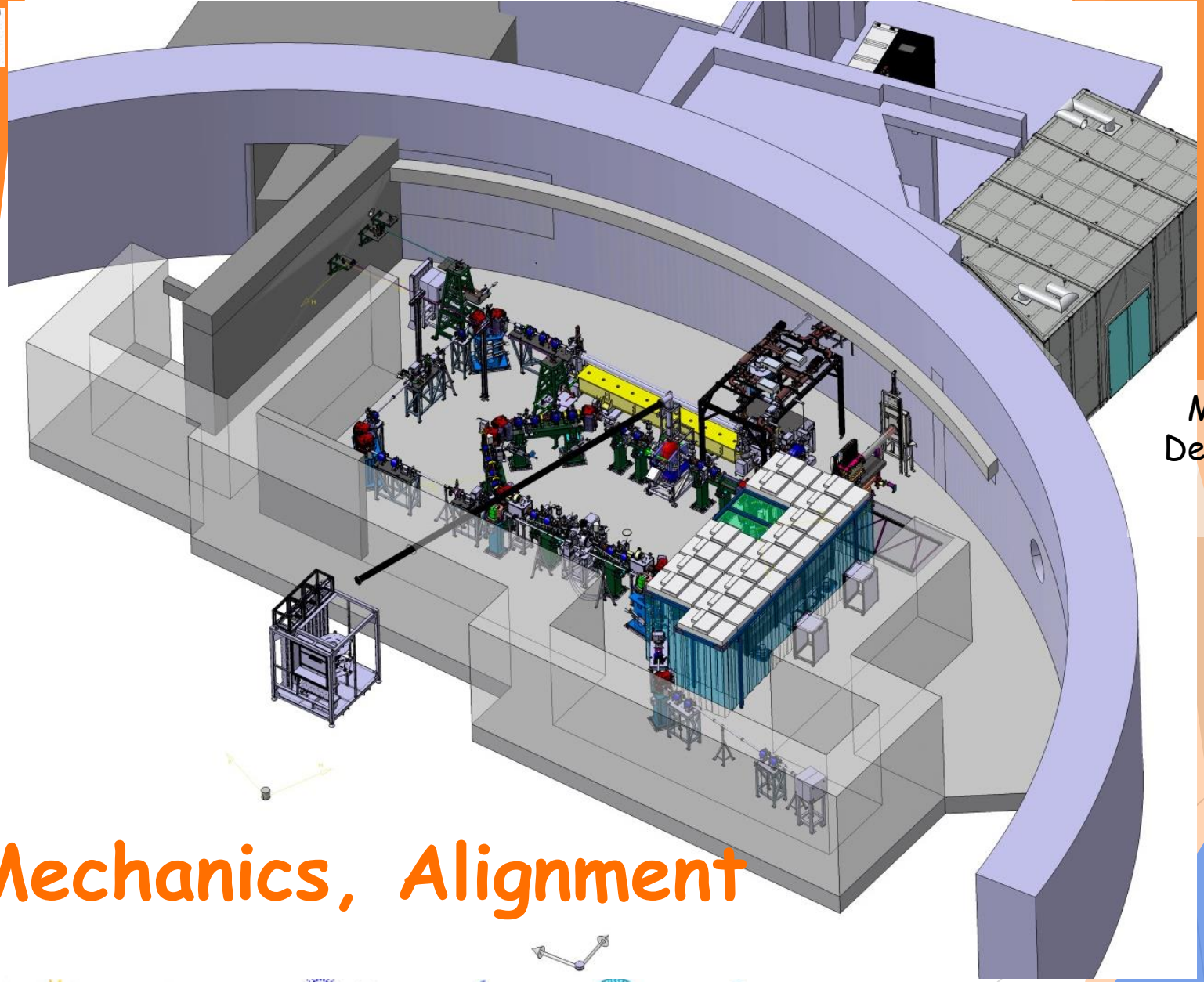


Mechanical
Design Office

@LAL

Mechanics, Alignment

•Programme Investissements d'avenir de l'Etat ANR-10-EQPX-51. Financé également par la Région Ile-de-France. *Program « Investing in the future » ANR-10-EQOX-51. Work also supported by grants from Région Ile-de-France.*

Design Office @LAL

Storage RING :

Magnets, Vacuum items, Assembly of the Ring by Rodolphe Marie

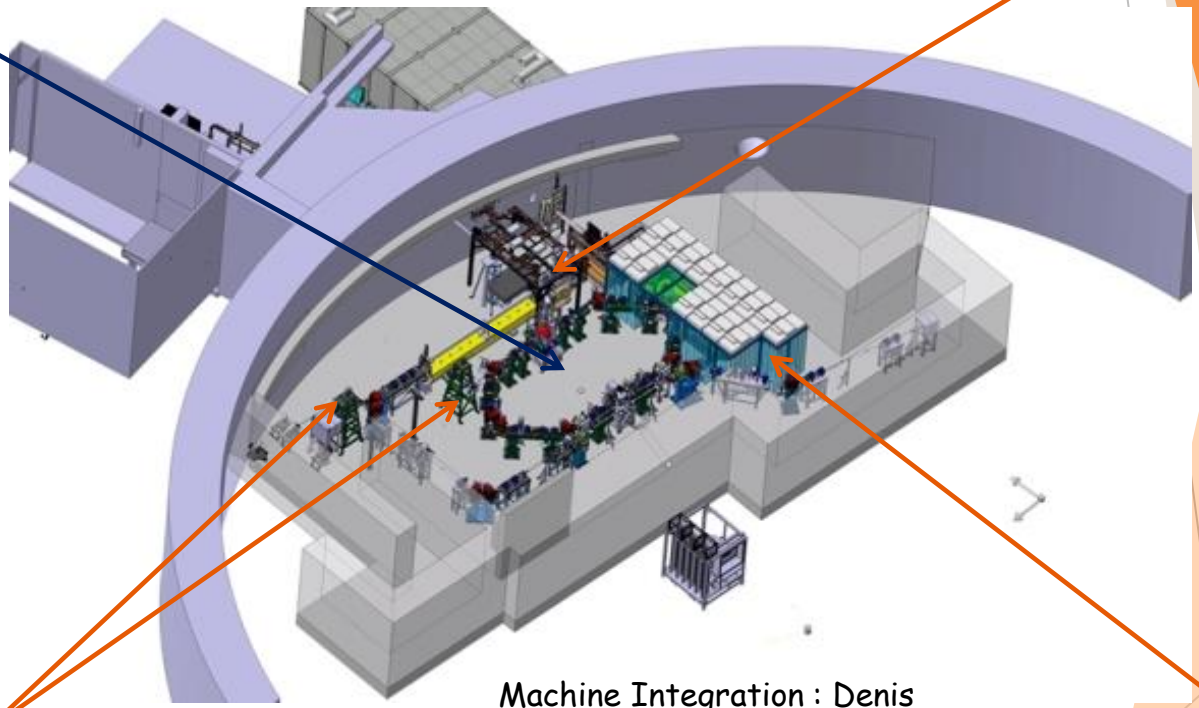
Chambers by Alexandre Blin (-> INSU 4/2016) + Rodolphe

Girders by Saïd (-> CDD IRFU 12/2016) + Gregory Iaquaniello (10/2016)

Bellow RF + FBT by Damien Le Guidec

LINAC & TL & ET :

Alexandre Gonnin & Didier Auguste



Machine Integration : Denis

X Beam Line (SERAS, Néel)

Optical Cavity : Yann Peinaud

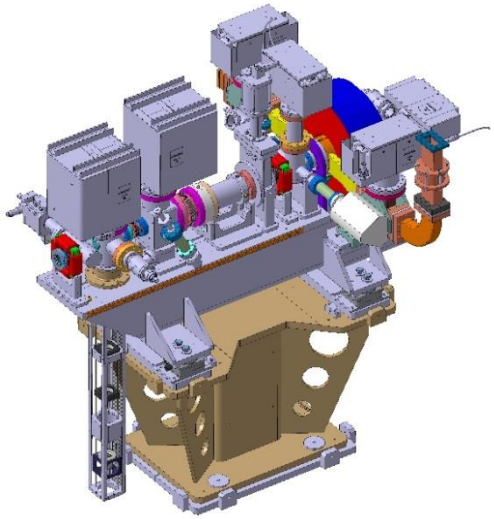
Beam Transport Lines :

Cerenkov-Synchrotron-Laser : Saïd Bouaziz & Didier & Denis + Gregory

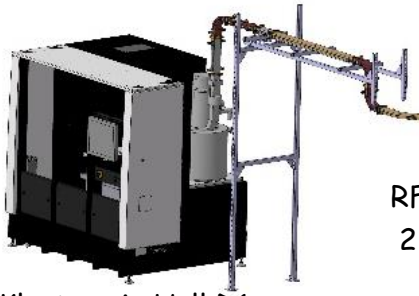
From The Workshop : Michel, Jean, Remy, Jean-Philippe, Frederick, Patrick, Emmanuel, Olivier, Guillaume, Bruno et Eric

All FE structural analysis (strength, thermal, vibration, topology optimization) by Julien Bonis (ANSYS)

LINAC

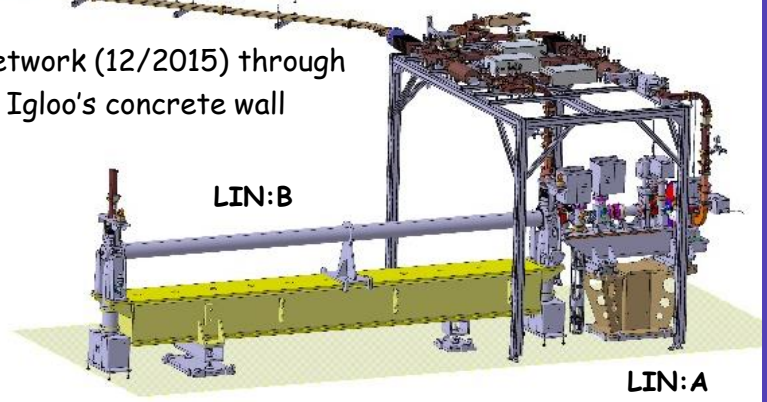


RF Gun (03/2017)

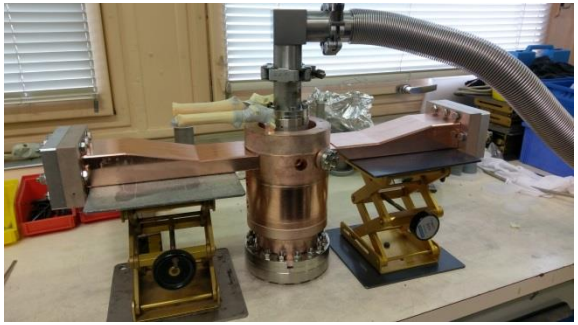


Klystron in Hall D1

RF Network (12/2015) through 2,5m Igloo's concrete wall



LINAC girder (02/2015)



LIL section (10/01/2017)
From LINAC Roof at SOLEIL to LAL

LINAC foot installation (02/2017)

Section LIL (10/01/2017@LAL)
Vacuum conditioning (03/2017)

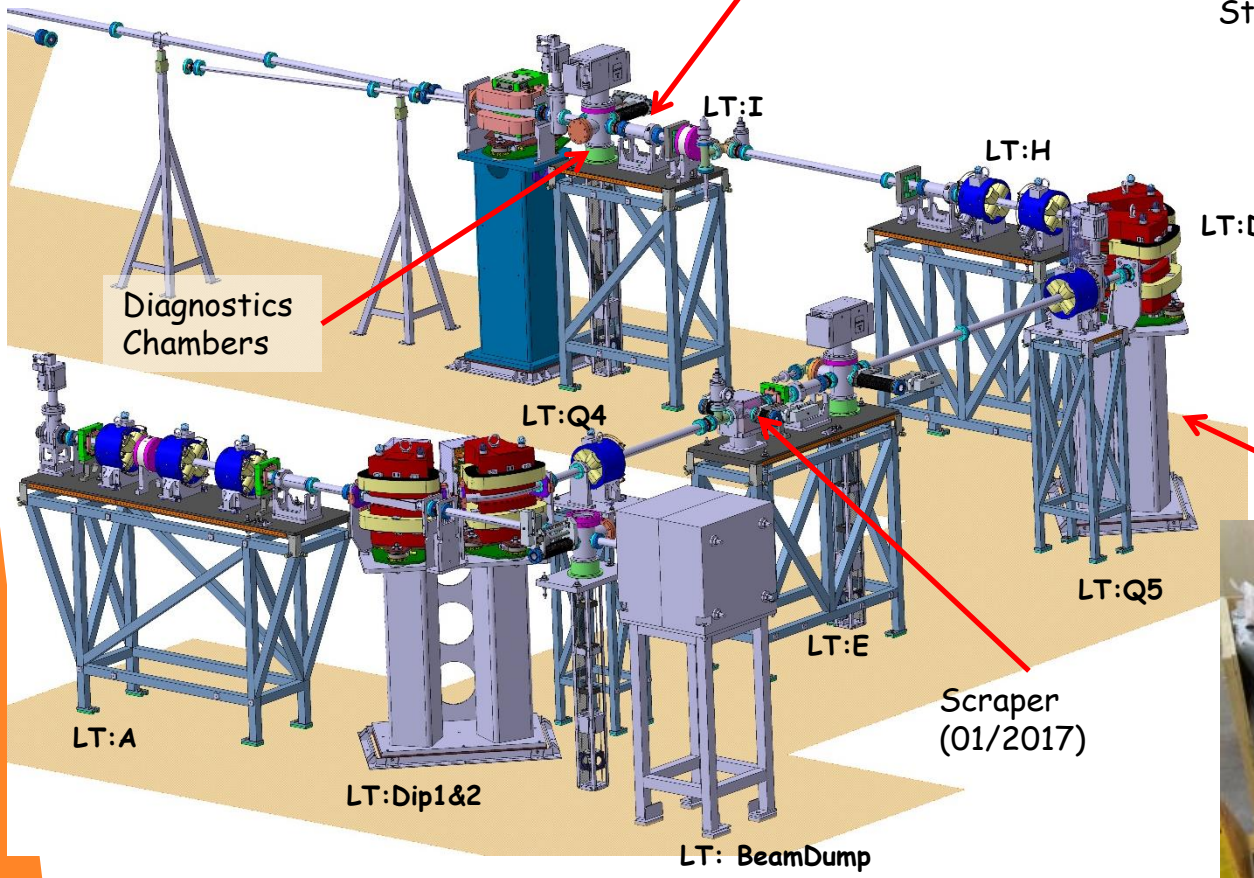
Transfer Line

Made in LAL-Workshop

•5 BPM Stripline (12/2016)

frames (07/2015)

Straight chambers



Scraper (01/2017)

Dipole's supports 10/2016

Storage RING

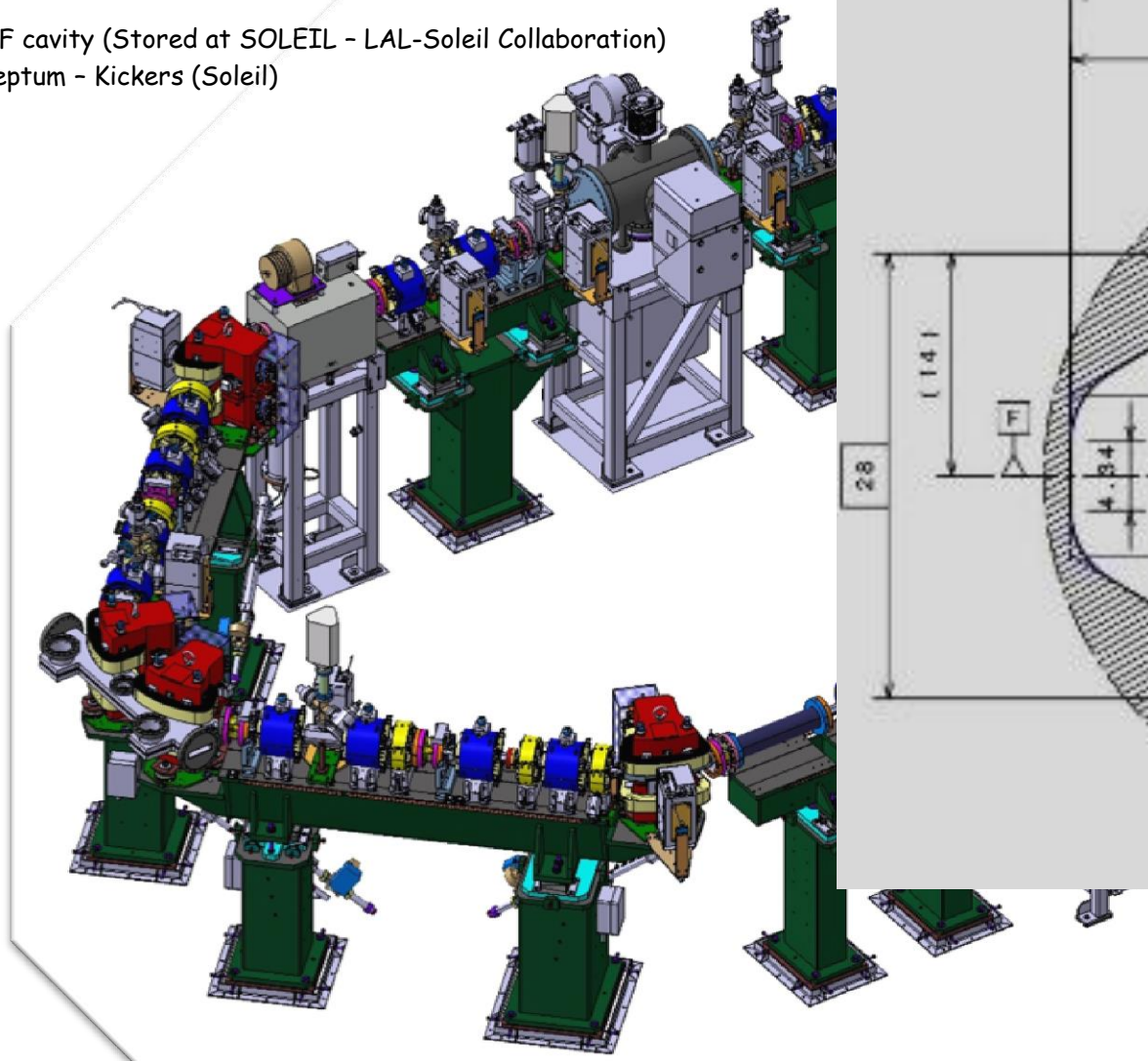
•Assembly of straight or curved chambers in a ~18m perimeter ring under 10^{-10}mbar pressure, baked-out, including BPM and connected by 18 RF bellows (thermic dilatation)

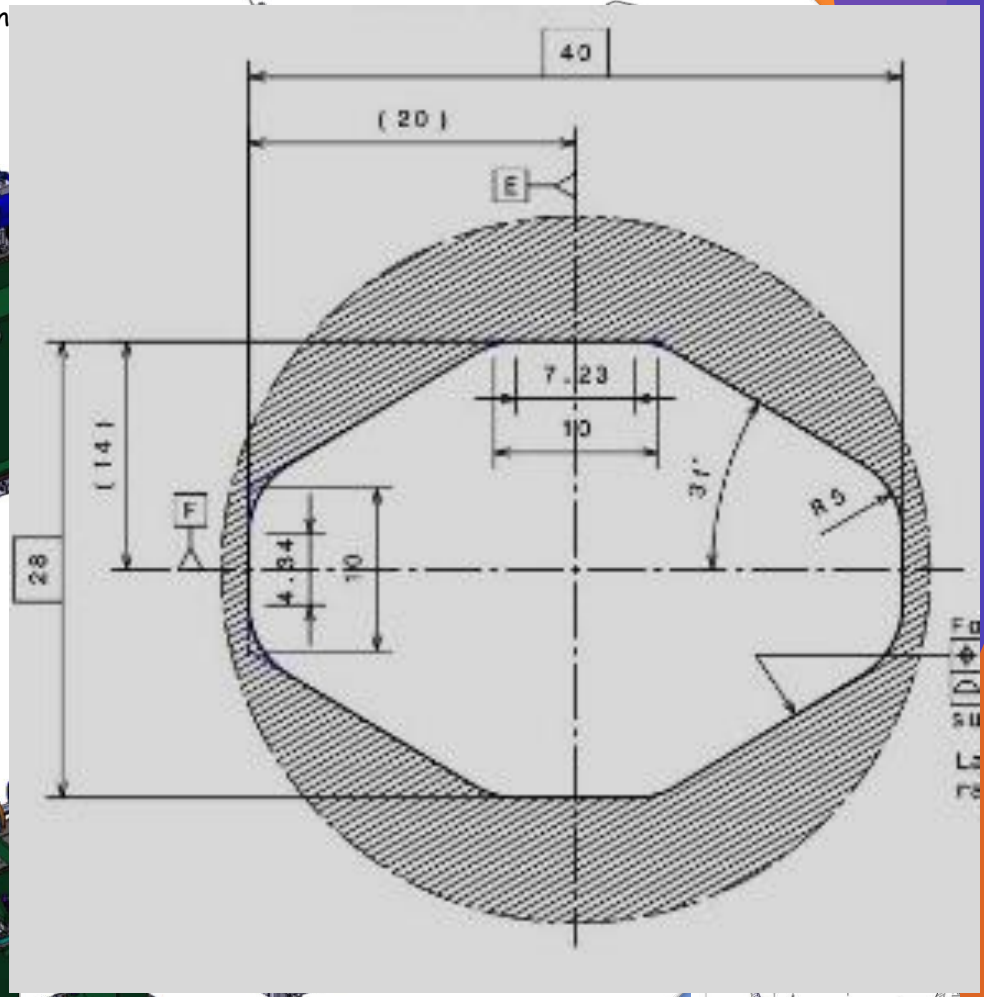
•Copper RF gasket for the vacuum tightness and the geometrical contin

•34 Quadrupoles, 13 Sextupoles, 15 Dipoles

• RF cavity (Stored at SOLEIL – LAL-Soleil Collaboration)

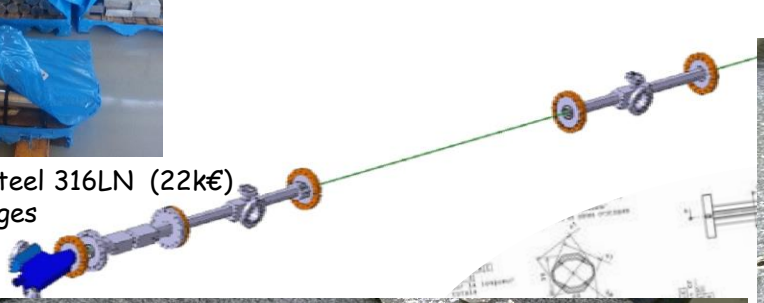
•Septum – Kickers (Soleil)





RING : The Chambers

1,2t Stainless Steel 316LN (22k€)
+ 500kg CF Flanges



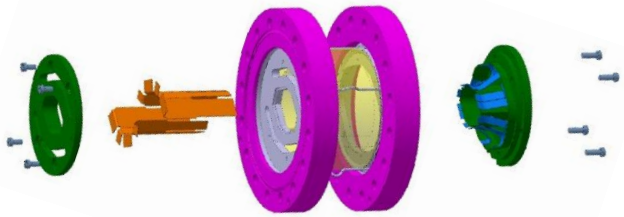
Inside the magnet => magnetic permeability <1,010
Very close to the magnet ~1mm , without contact, fine positioning => mechanical machining with high precision
Including UHV design, pumping ports, BPM
Thermic dilatation (bakeout 200° , vacuum) => Brackets designed for supporting chambers without stress (~3mm)
Internal octagon machined by EDM copper wire cutting (EDM=Electrical Discharge Machining)
TIG or EBM welding

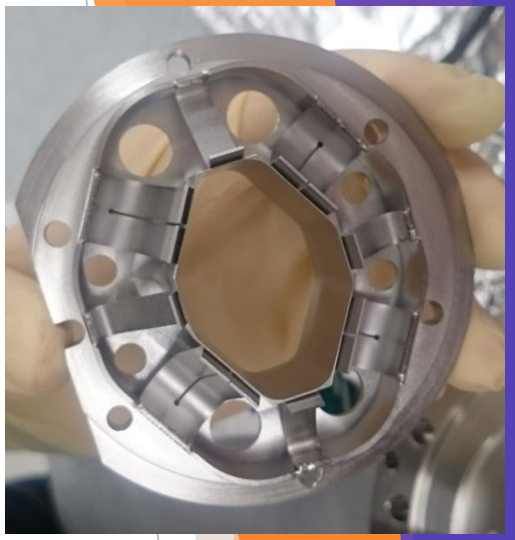
Tender (PUMA) published the 3/3/2016
Notified le 31/5/2016 to Rial Vacuum in Parma (Italy)

198 628 €HT

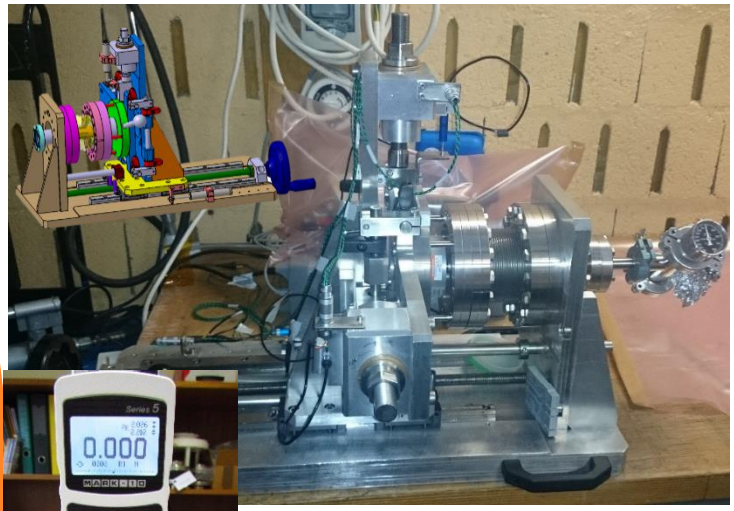
Step 1 : 3 chambers Kicker Type A link, bent chamber Type B & C, FBT-like, received 9/3/2017

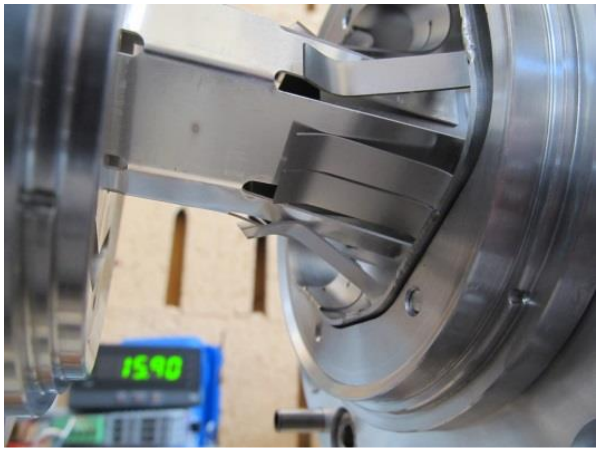
RING : RF Bellows

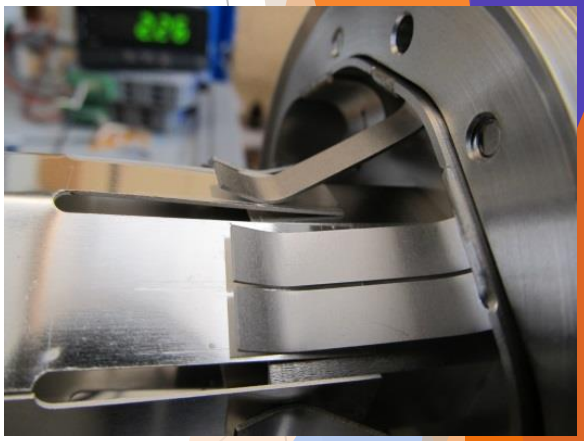




- ✓ Extension 4.5mm, compression 11.5mm, transverse ±3mm
- ✓ Realization (09/2015) of a test bench to measure the extension/compression of the bellow and strain of the RF spring blades : design of the geometry for a strain on the fingers between 150g to 180g all along the displacement.







- ➢ Tender (PUMA) published 4/4/2016
- ➢ t0=15/6/2016 pour 73 720 €HT to Rial Vacuum (Parma, Italy)

- ➢ 2 steps : Realization of 18 Bellows + 2 spares
- ➢ Step 1 : 1st bellow with CF100 flange, 02/2017
- ➢ Step 2 : 7 bellows with CF100 turning flange + 13 bellows with CF100 flange - 04/2017

RING : Girders

Manufactured in 12/2015 by Nortemecánica (~Gijon, Spain)

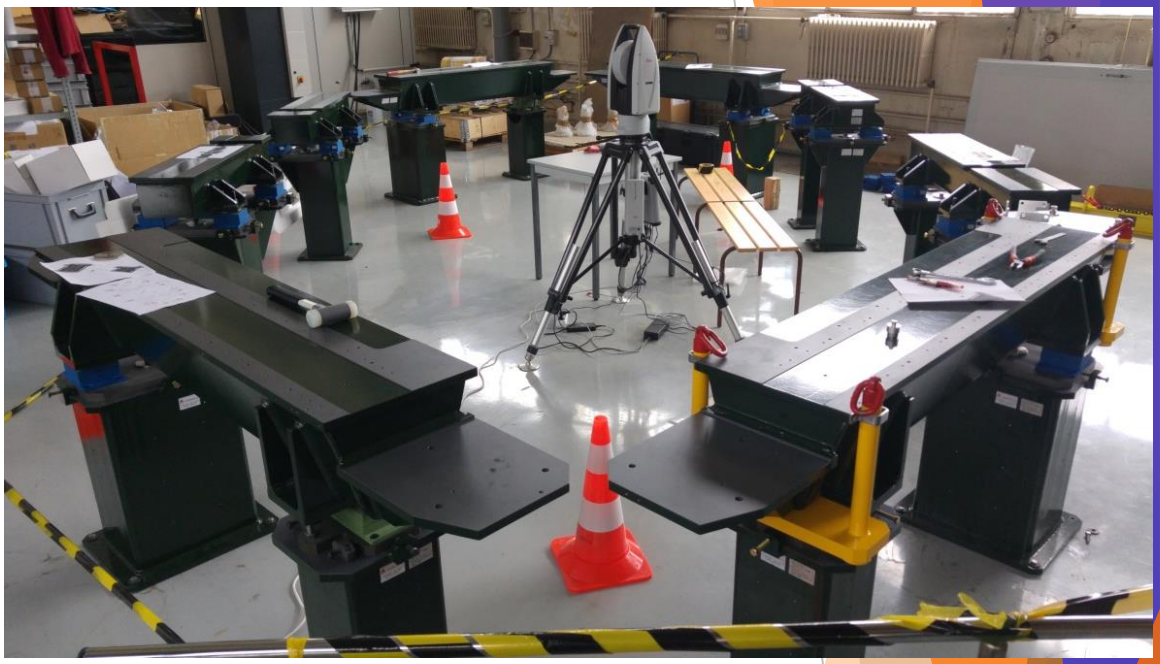
- ✓ Flatness of 0,03mm on 1,6m to allow fine adjustment between chambers of 50µm and 100µm between girders
- ✓ Very fine machining and holes localization to place the magnets (Ø8H7 40µm)

Linear adjustment :

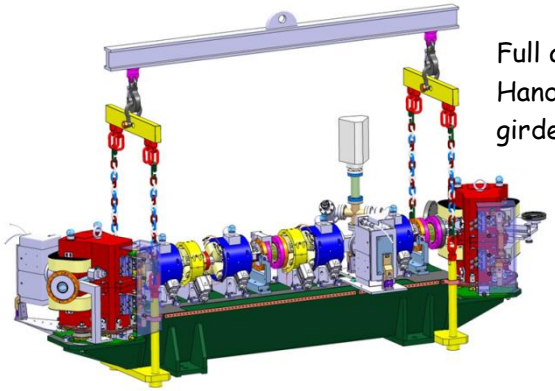
- •X= ±20mm
- •Y= ±20mm
- •Z= ±20mm

Rotations:

- •X= ±3°
- •Y= ±0,38°
- •Z= ±1,9°
- •Resonant frequency >40Hz



•Assembly of the storage ring with Laser Tracker at LAL-208 – 01/2017

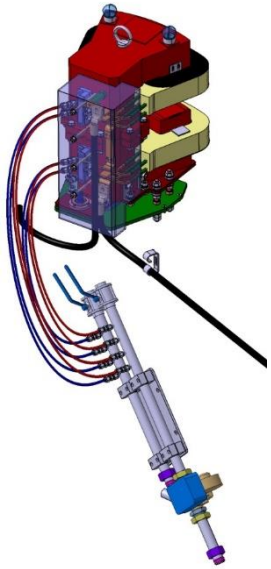


Full assembly Girders weight :1,5 tons.
Handling tool has been designed in order to safely bring the fully equipped girders from the 208 building to the ThomX bunker

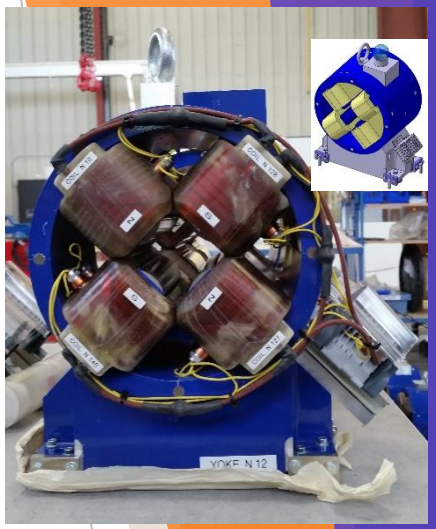
RING : The Magnets

Full mechanical design at Design Office : poles, coil winding design, interface with girders

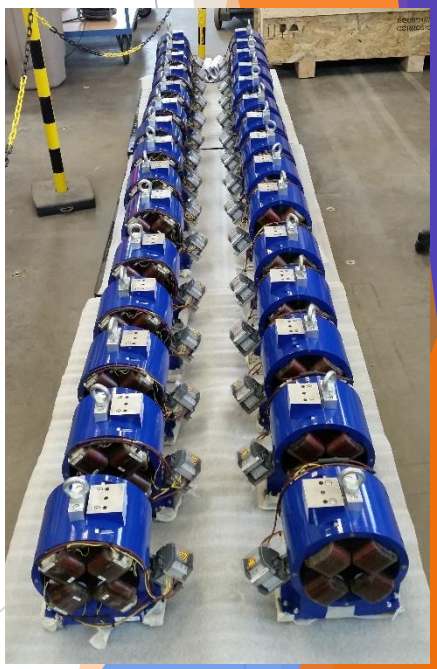
15 Dipoles



13 Sextupoles



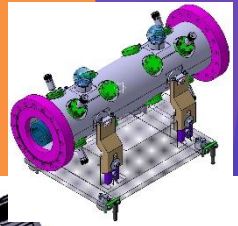
34 Quadrupoles



LAL (C.Vallerand) & SOLEIL (F.Marteau) collaboration.

See C.Vallerand presentation

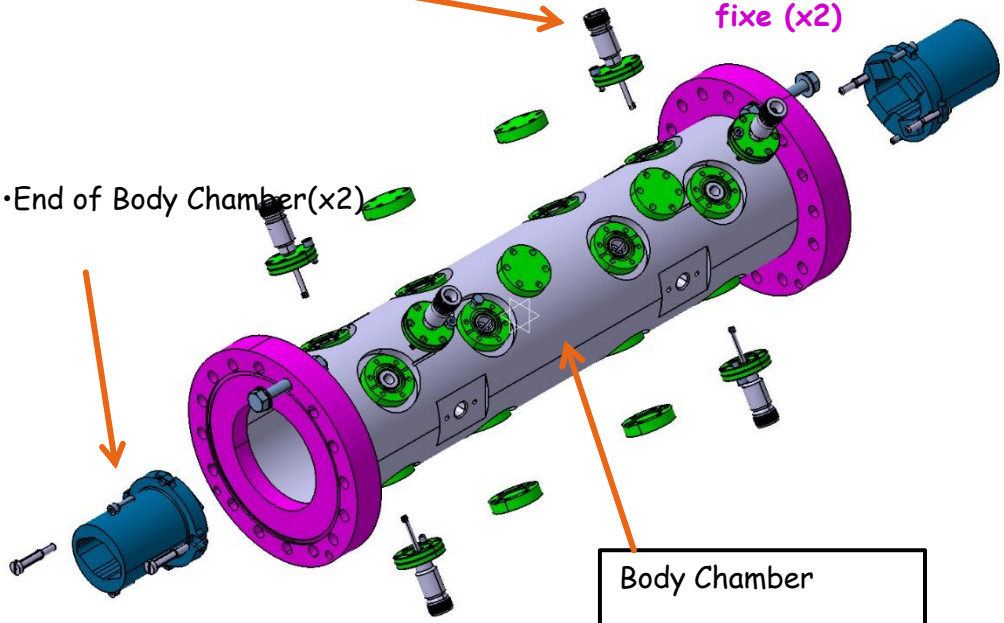
RING : FBT



•Electrical Feedthrough(x8)

DN100CF Flange fixe (x2)

•End of Body Chamber(x2)

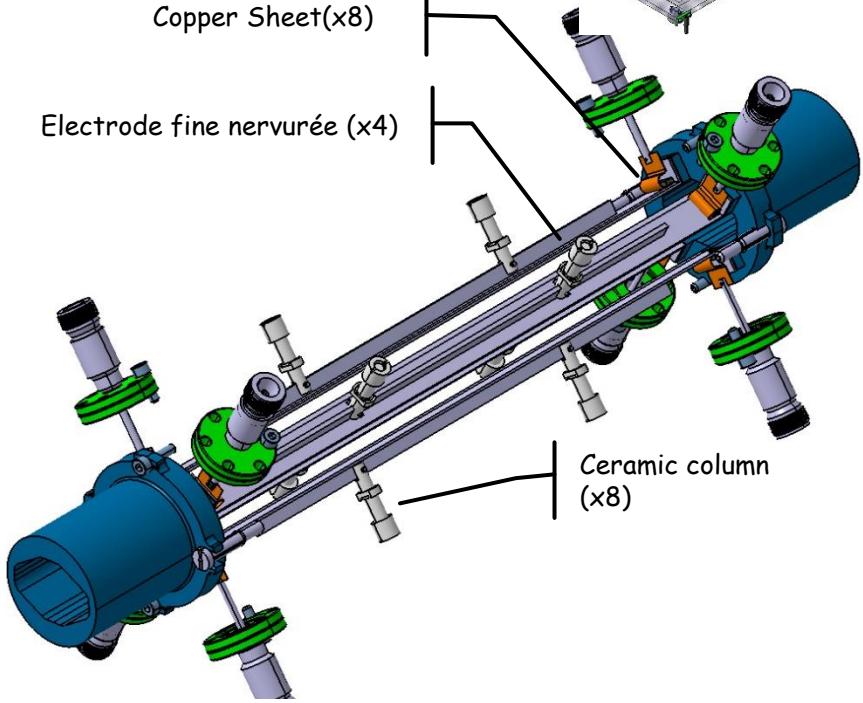


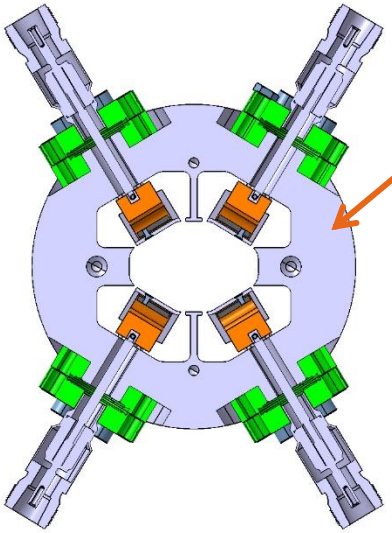
Body Chamber

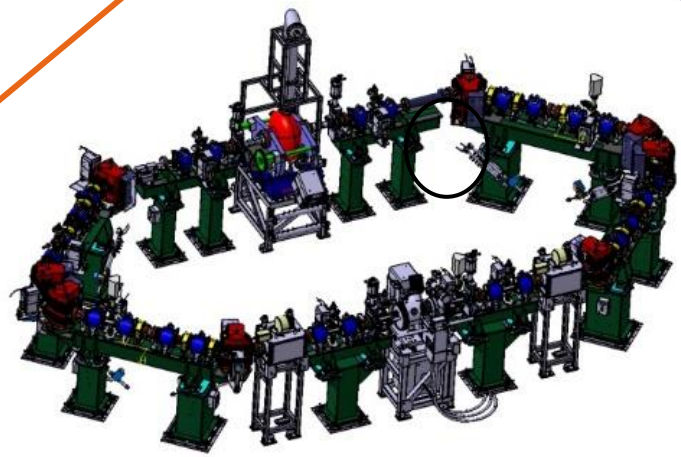
Copper Sheet(x8)

Electrode fine nervurée (x4)

Ceramic column (x8)

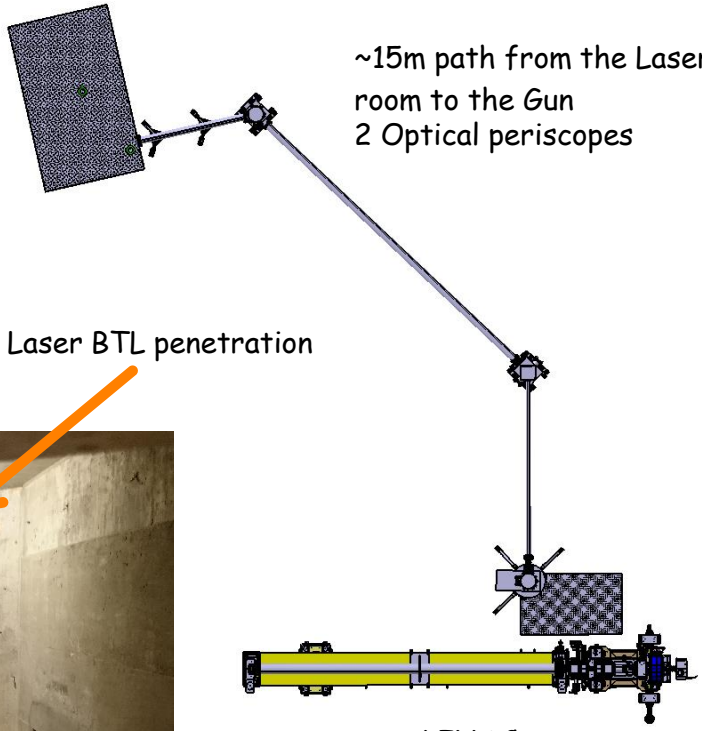






Lentgh « Flange to flange » = 444,4 mm
Matière : AISI 316 LN (d=7,9)
Weight : 20,8 kg (hors support)
UHV Surface : 2900,6 cm²

BTL : Photocathode Laser

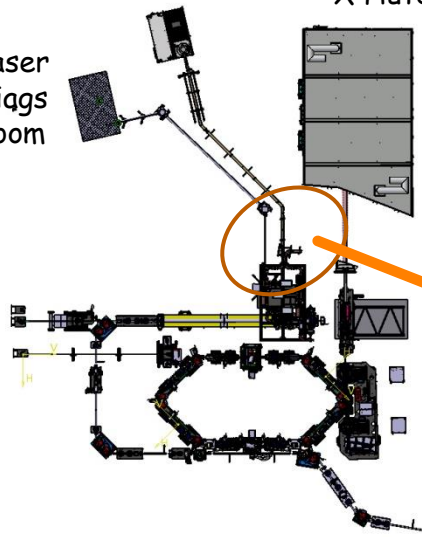


~15m path from the Laser-Diag room to the Gun
2 Optical periscopes

RF Klystron

X Hutch

Laser Diggs Room

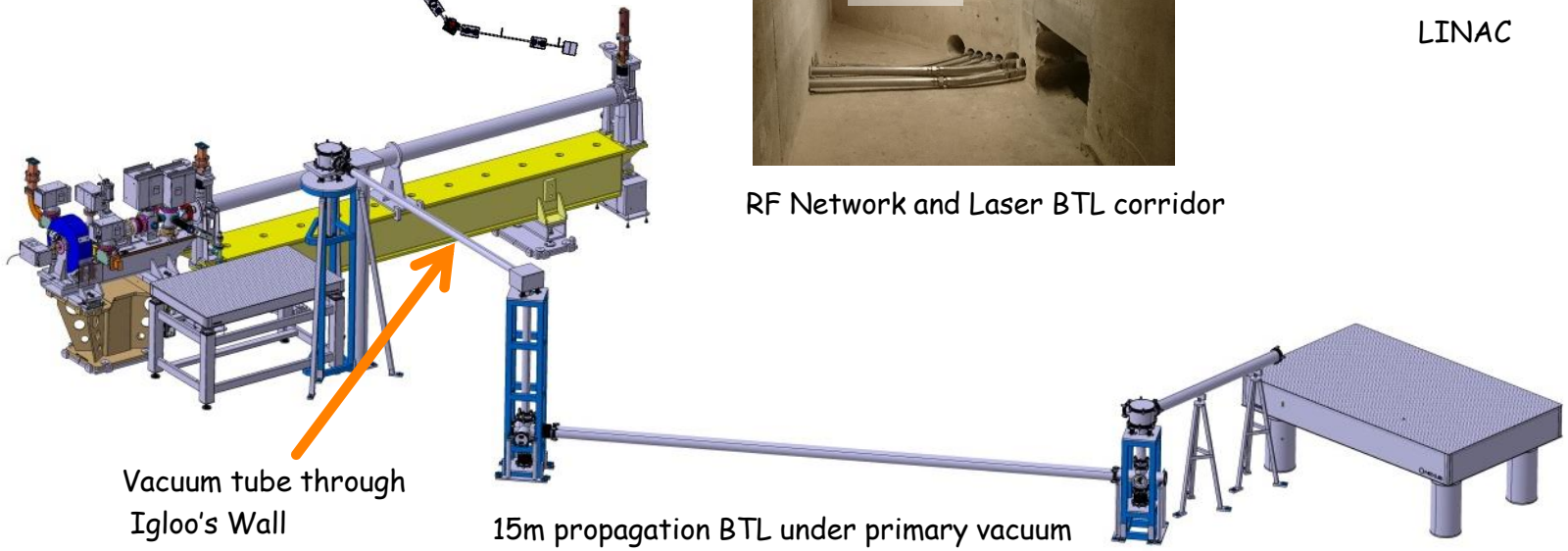


RF Network penetration

Laser BTL penetration

RF Network and Laser BTL corridor

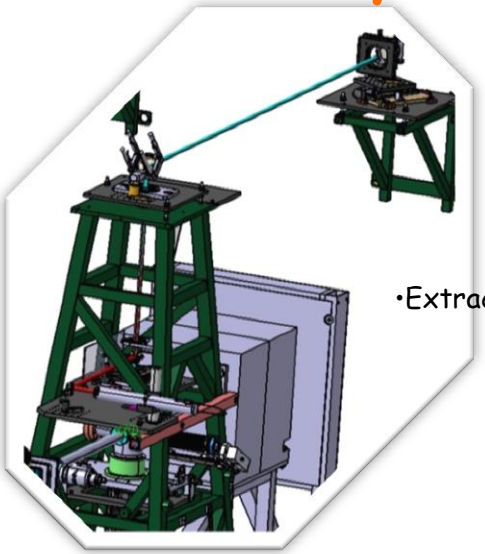
LINAC



Vacuum tube through Igloo's Wall

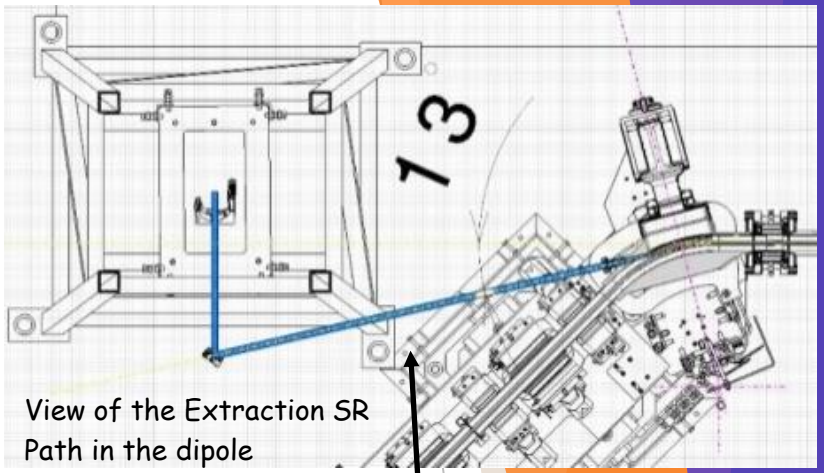
15m propagation BTL under primary vacuum

BTL: Synchrotron, Cerenkov



•Extraction CR

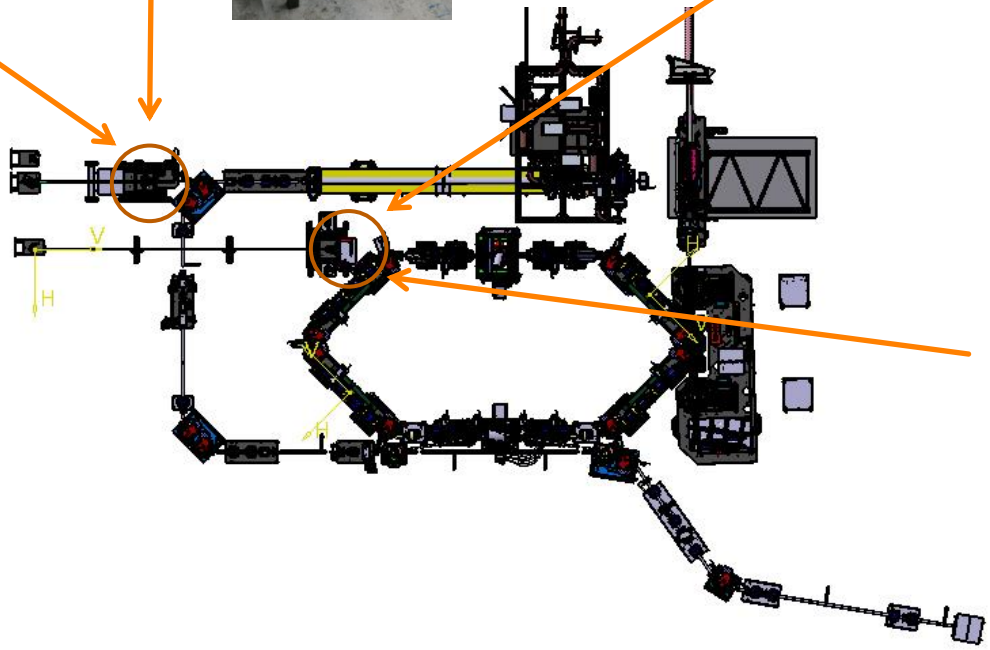
2 "Eiffel Towers" machined and welded at LAL-workshop

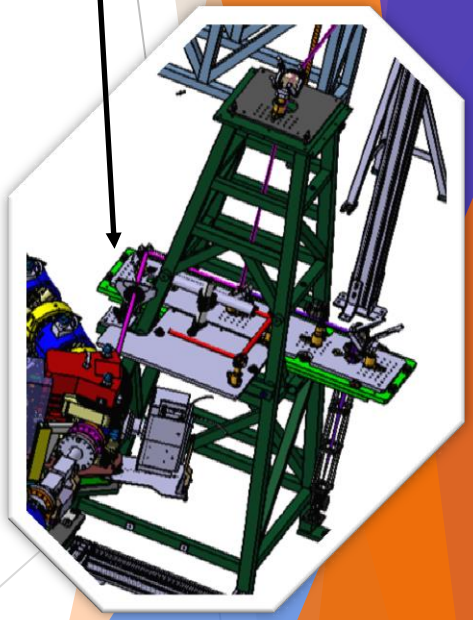


View of the Extraction SR Path in the dipole

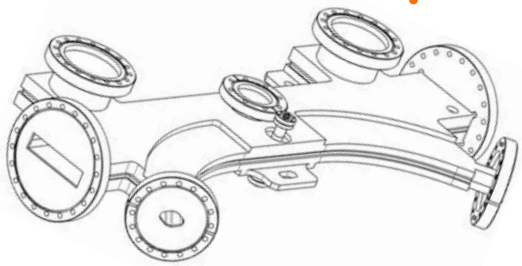
•Extraction SR

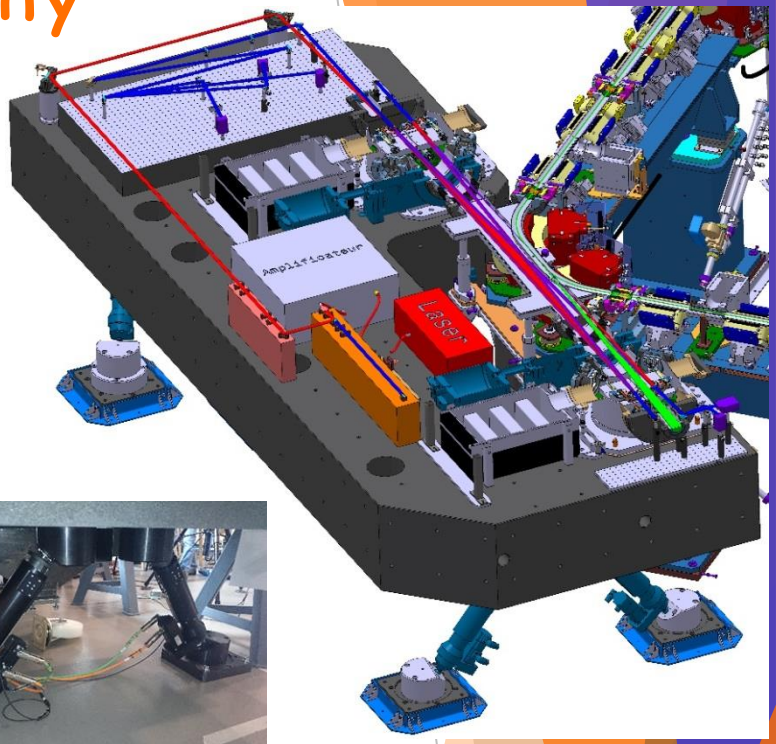
•CR Screen





Interaction Point : Optical Cavity

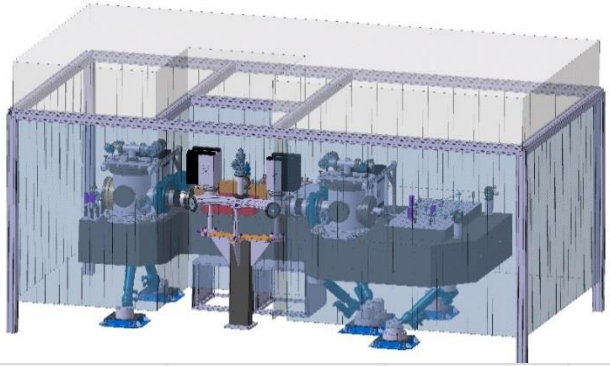


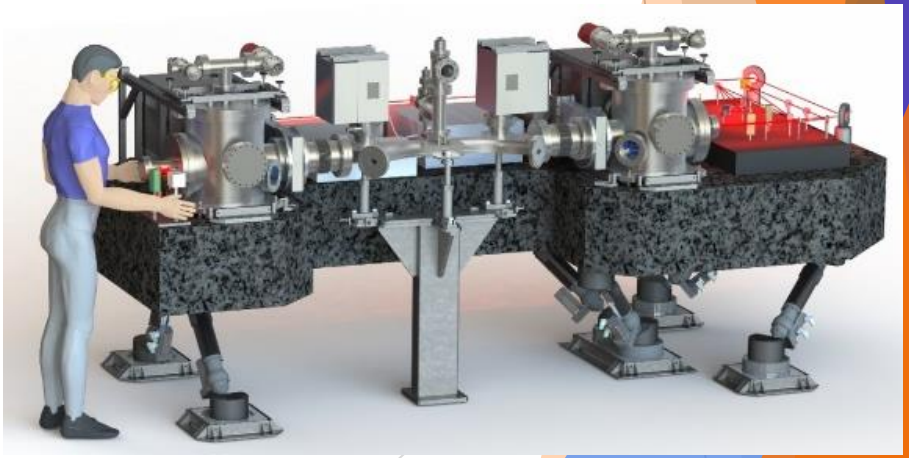


A Fabry Perot cavity inside two UHV chambers (delivered January 2015) connected by an Stainless Steel 316LN IP Chamber et 2 Bellows.

•Whole assembly in a clean room class ISO-5 with laminar flow

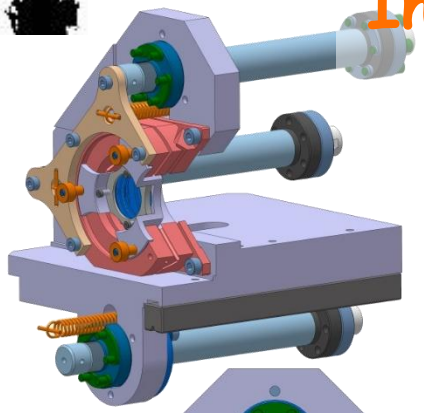
•Assembled on a 5t hexapod - granite table for a fine spatial matching of the cavity on the electron beam – Symétrie (Nîmes, France) - FAT June 2015

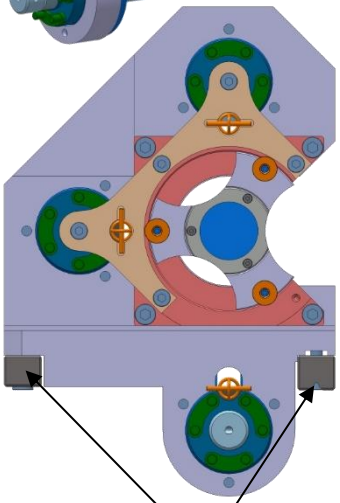




Degré de liberté hexapode	Déplacement axe par axe	Résolution	Répétabilité
Tx (e)	/	/	/
Ty (t)	± 2 mm	1 µm	0.8 µm*
Tz (v)	± 5 mm	1 µm	0.8 µm*
Rx / Pitch	± 1 mrad	2 µrad	0.8 µrad**
Ry / Yaw	± 1 mrad	2 µrad	0.8 µrad**
Rz / Roll	± 3.5 mrad	2 µrad	0.8 µrad**

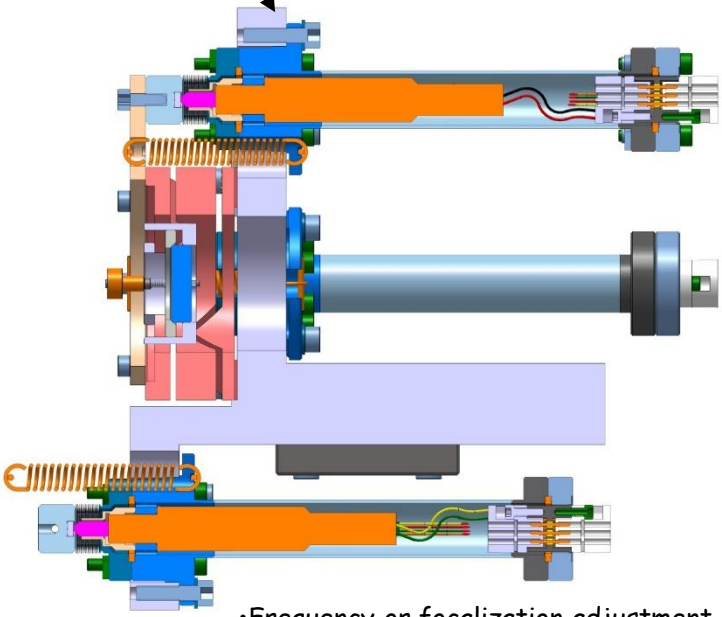
Interaction Point : Inside the Optical Cavity



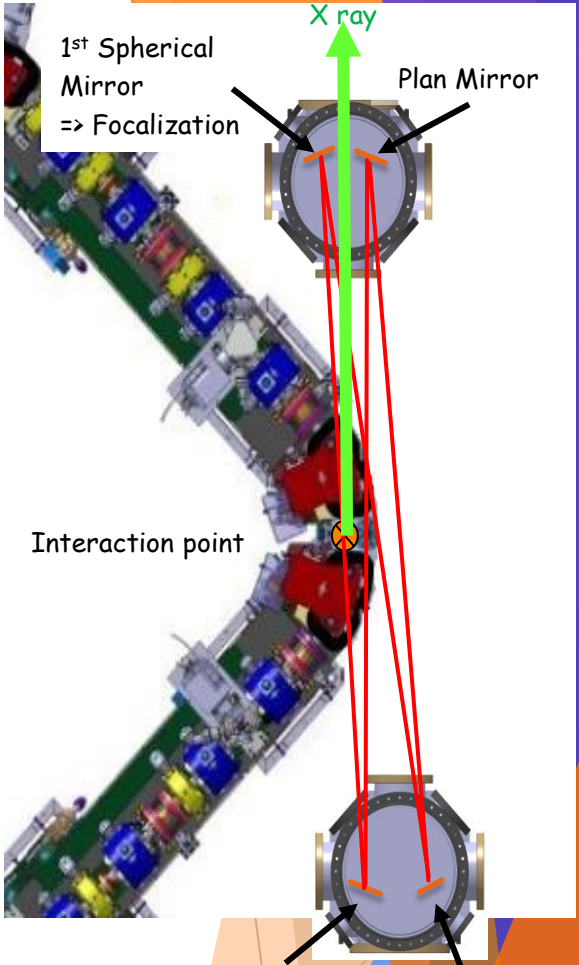


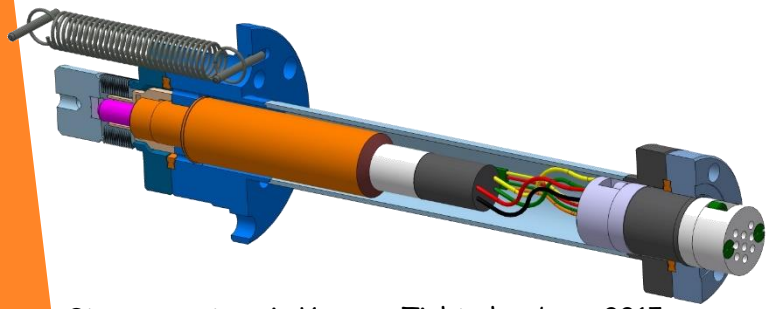
•Longitudinal adjustment with 2 balls on a V and one on a plane

•Angular adjustment on flex mount with stepper motor

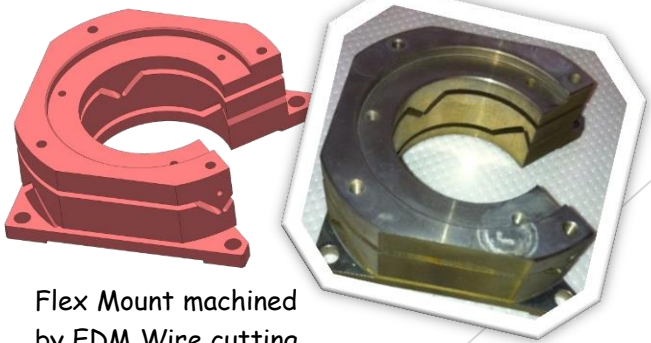


•Frequency or focalization adjustment



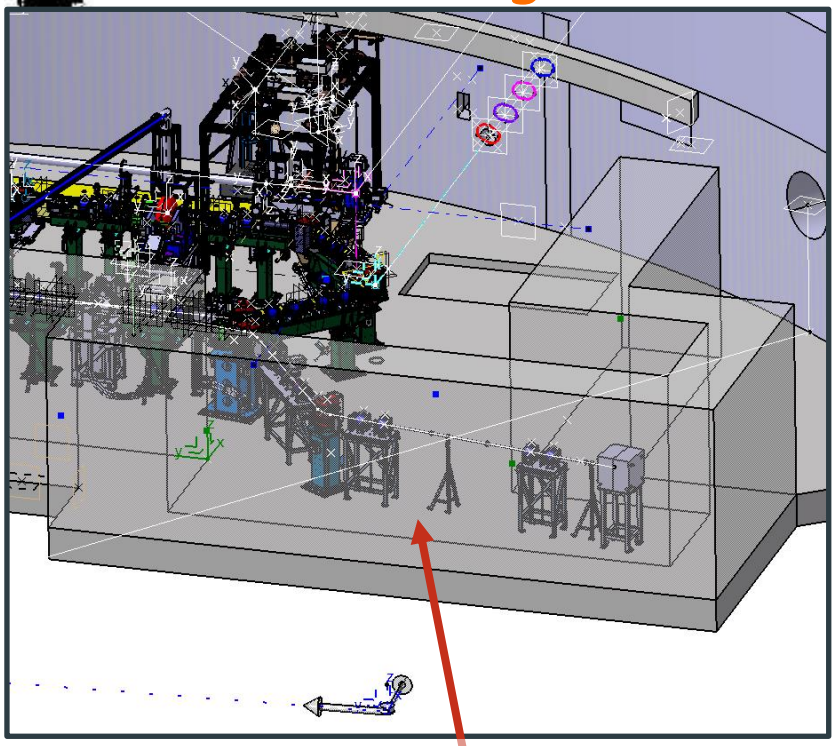


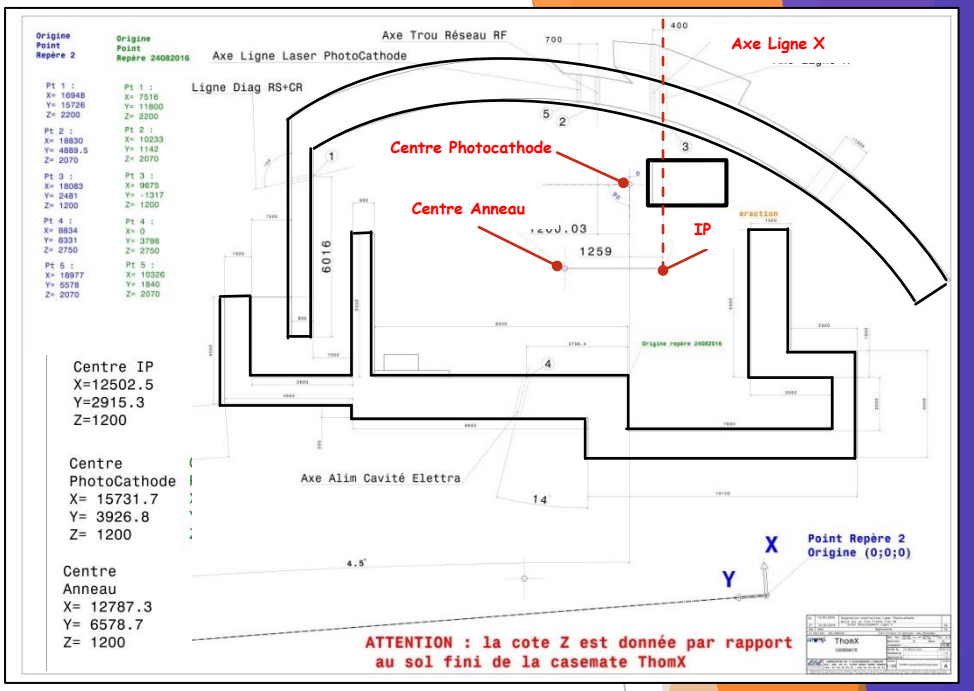
Stepper motors in Vacuum Tight chambers 2015



Flex Mount machined by EDM Wire cutting

IGLOO Integration





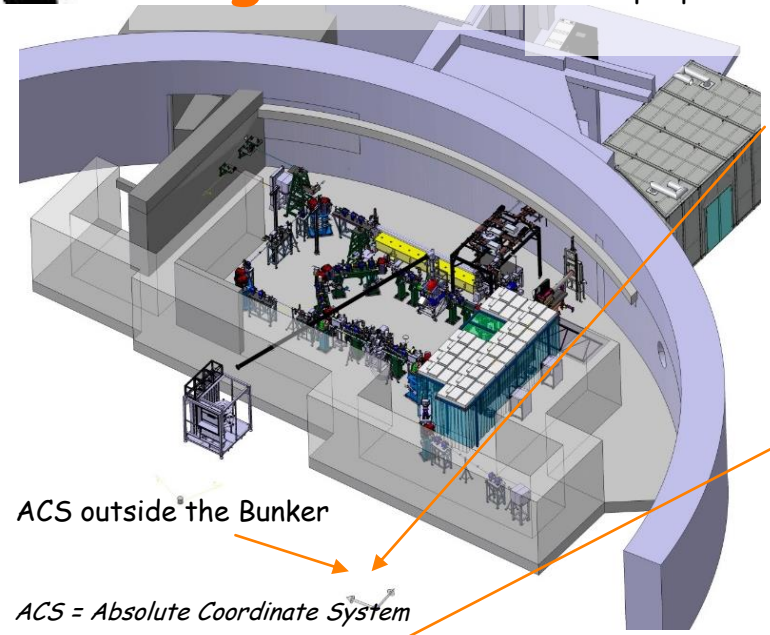
- ✓ Full 3D CATIA model (Machine + Igloo) => before 2014 to 2015
- ✓ 1st Localization of the machine (Axes & VIP of the machine) =>02/2016
- ✓ Construction Site Survey => from March to December 2016
- ✓ Permanent Cross-checking => from March to end 2016
- ✓ Final Choice of the X Line axis through the real hole (non perfect) to the X hutch through the 2,5m wall => decision by the end of 2016

View of the X line Table 1 location and X Line hole

Drilling of the X Line penetration

Alignment

Very 1st step : 11/2016, purchase of the AT930 Laser Tracker from HEXAGON METROLOGY
6 LAL people from DO & Workshop trained by HM and SOLEIL Alignment Group
(Thanks to A.Lestrades and M.Ros)



ACS outside the Bunker

ACS = Absolute Coordinate System
Perfectly known by surveyors

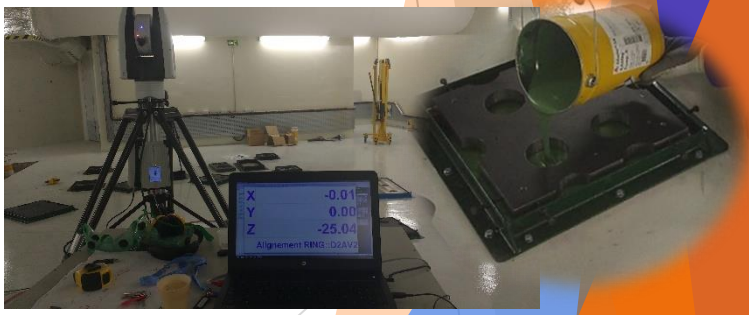
•Step 1 : before construction of the walls, several targets sealed to the ground in the area of the machine, targets fully described in the ACS

•Step 2 : Once the bunker built, 8 targets glued on the bunker walls to establish a network. These 8 targets are connected to the 1st ground targets and to the ACS (not visible anymore)
=> The 8 final targets are fully described X,Y,Z in the ACS

•Step 3 : survey of the 8 targets in the bunker and localization of the tracker in the ACS.
4 targets were bonded in the X hutch

•Step 4 : permanent marks on the principals axis of the machine and adjustment frames in order to adjust plates (bonded) with the tracker for components of the storage ring, transfer and extraction line and Optical cavity

SOLEIL's targets
(gift from Ros & Lestrades)



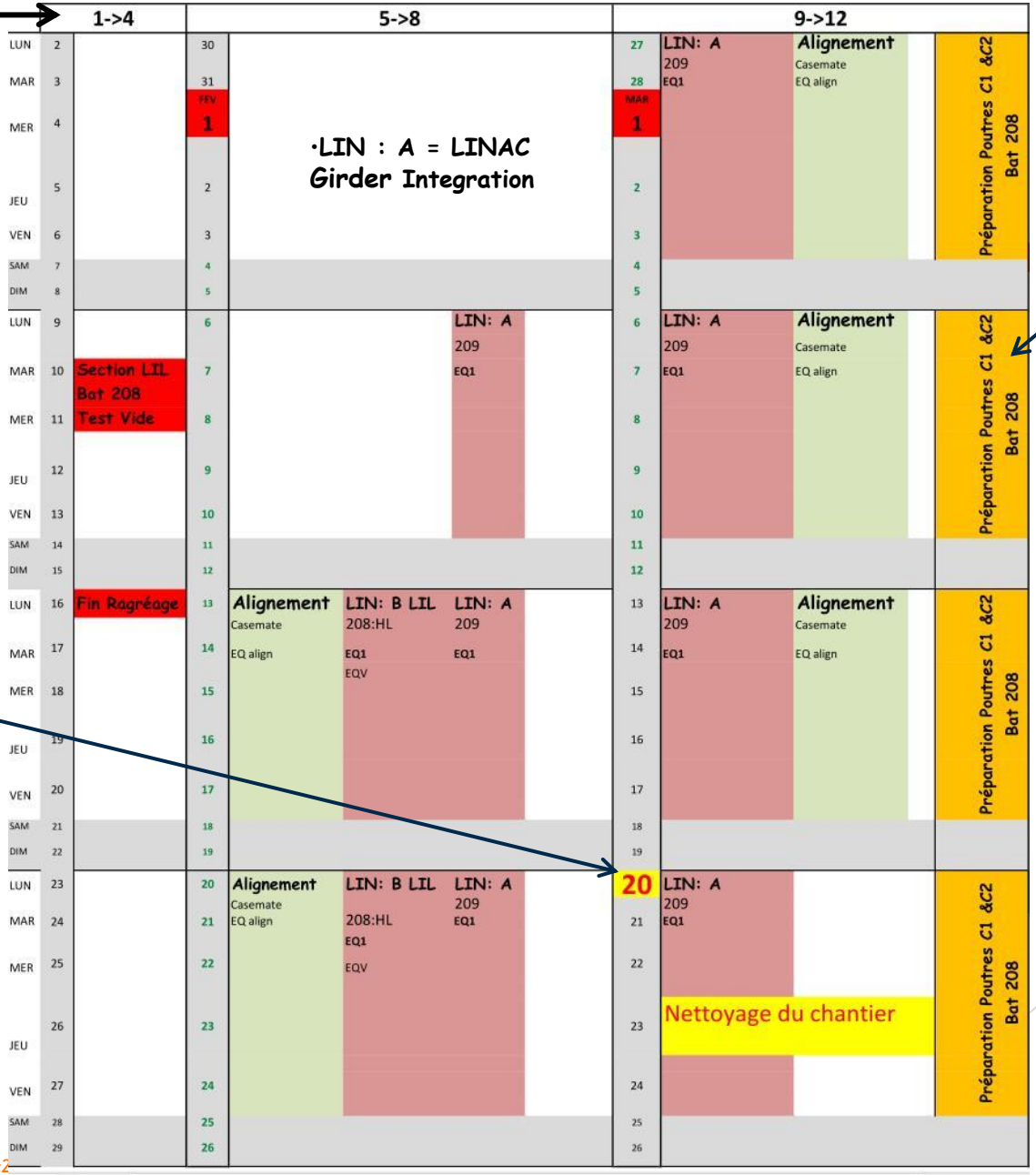
Bonding of the Steel plates on the bunker ground

LAL Alignment Group :A.Thiebault, A.Gallas, R.Marie, B.Leluan, O.Vitez,D.Douillet

Today in the Bunker

2017 Integration Schedule : January to March

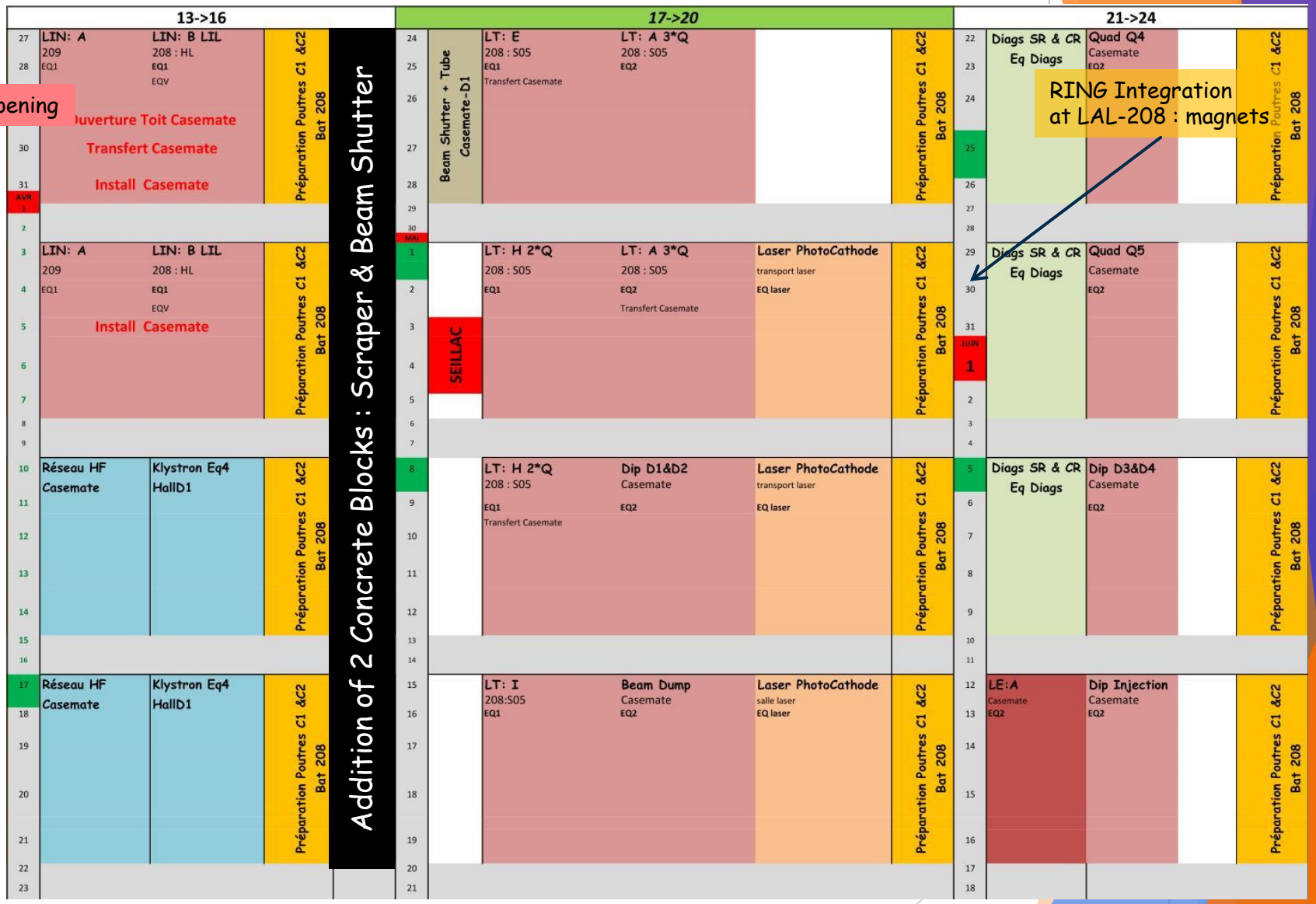
Weeks number



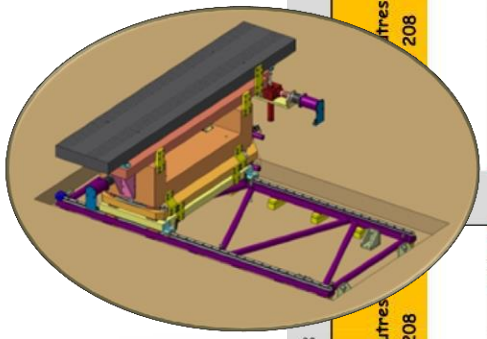
RING Integration at LAL-208

MAC

2017 Integration Schedule : April to June



2017 Integration Schedule : July to September



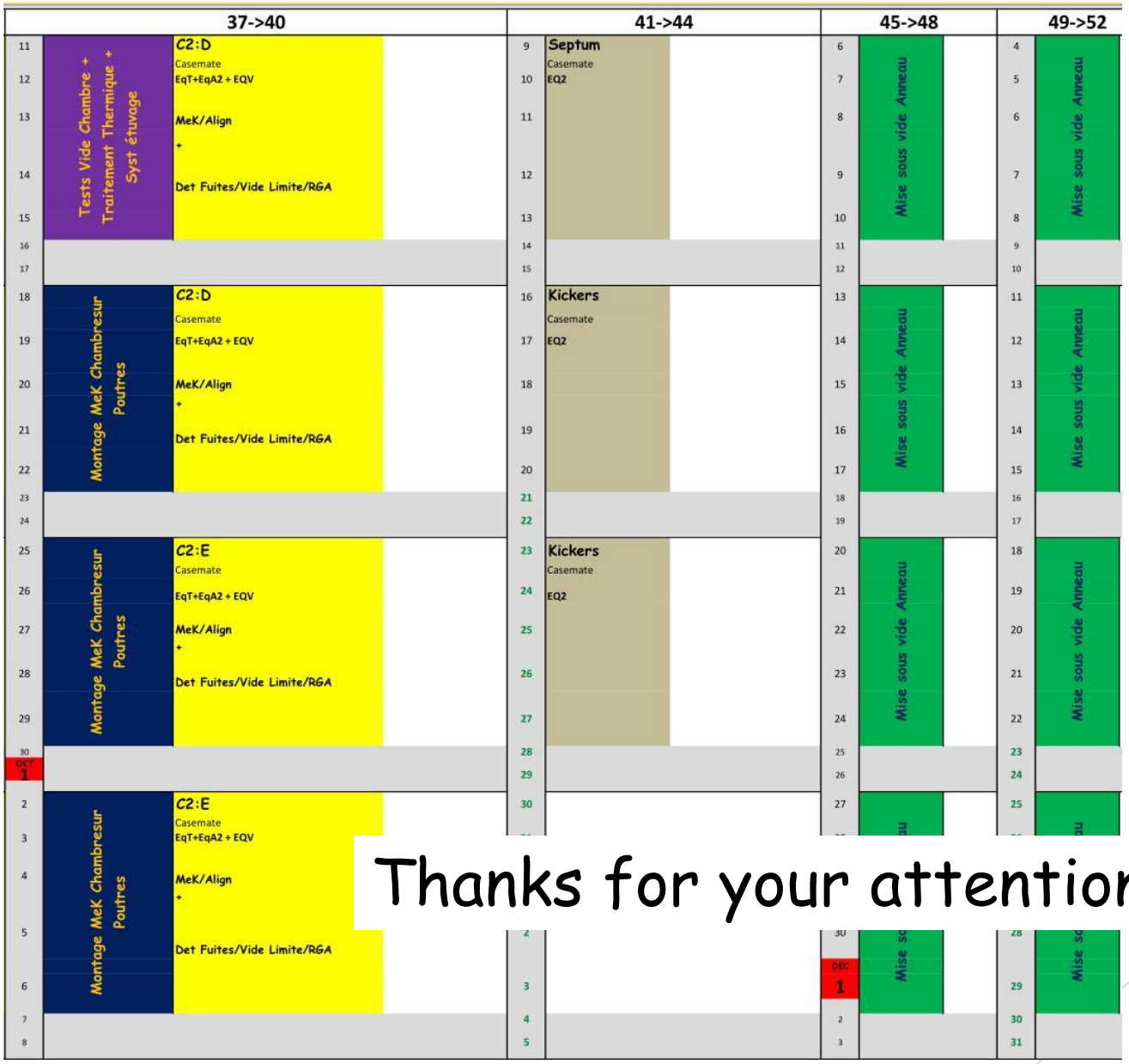
Positioning and Sealing of X Line Table 1

RING Integration at LAL-208 : magnets and chambers

Delivery (?) of Ring chambers

	25->28	29->32	33->36
JULY	Préparation Poutres C1 &C2 Bat 208	LE:B Casemate EQ2	Fin Reception Chambres
	Préparation Poutres C1 &C2 Bat 208	LE:C Casemate EQ2	Tests Vide Chambre + Traitement Thermique + Syst étuvage
	Préparation Poutres C1 &C2 Bat 208	Table Aligne X	Tests Vide Chambre + Traitement Thermique + Syst étuvage
	Cavité RF Casemate EQ2	Table Aligne X	Tests Vide Chambre + Traitement Thermique + Syst étuvage
		C1:A (Septum-) Casemate EqT+EqA1 + EQV MeK/Align + Det Fuites/Vide Limite/RGA	Tests Vide Chambre + Traitement Thermique + Syst étuvage
		C1:A (Septum-) Casemate EqT+EqA1 + EQV MeK/Align + Det Fuites/Vide Limite/RGA	Tests Vide Chambre + Traitement Thermique + Syst étuvage
		C1:C (Septum+) Casemate EqT+EqA1 + EQV MeK/Align + Det Fuites/Vide Limite/RGA	Tests Vide Chambre + Traitement Thermique + Syst étuvage
		C1:C (Septum+) Casemate EqT+EqA1 + EQV MeK/Align + Det Fuites/Vide Limite/RGA	Tests Vide Chambre + Traitement Thermique + Syst étuvage
		C1:D (IP-) Casemate EqT+EqA1 + EQV MeK/Align + Det Fuites/Vide Limite/RGA	C2:A Casemate EqT+EqA2 + EQV MeK/Align + Det Fuites/Vide Limite/RGA
		C1:D (IP-) Av Cav FP Casemate EqT+EqA1 + EQV MeK/Align + Det Fuites/Vide Limite/RGA	C2:A Casemate EqT+EqA2 + EQV MeK/Align + Det Fuites/Vide Limite/RGA
		C1:E (Ip+) Casemate EqT+EqA1 + EQV MeK/Align + Det Fuites/Vide Limite/RGA	C2:C Casemate EqT+EqA2 + EQV MeK/Align + Det Fuites/Vide Limite/RGA
		C1:E (IP+) Casemate EqT+EqA1 + EQV MeK/Align + Det Fuites/Vide Limite/RGA	C2:C Casemate EqT+EqA2 + EQV MeK/Align + Det Fuites/Vide Limite/RGA

2017 Integration Schedule (October to 2018 …)



2018 …. Optical Cavity, FBT Septum, Kickers and more …. but "You Never Can Tell"

Thanks for your attention