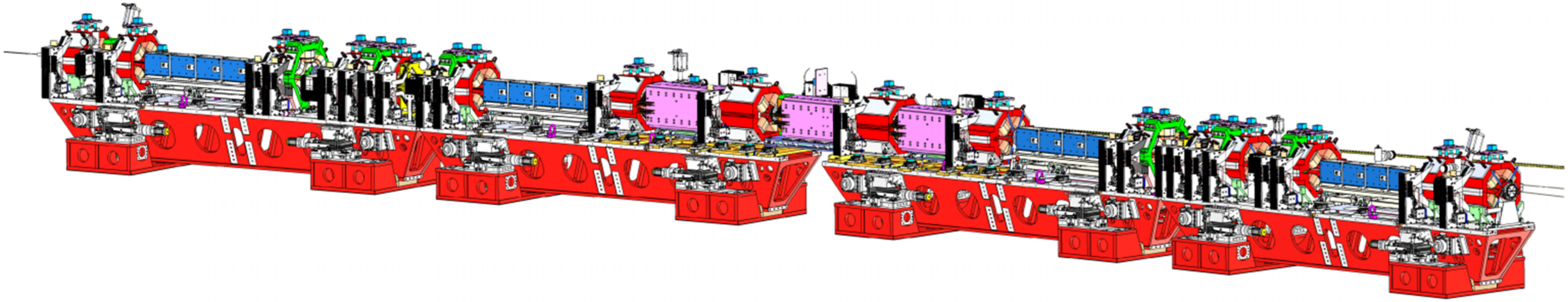

THE ESRF ACCELERATOR UPGRADE:

THE EXTREMELY BRILLIANT SOURCE (EBS) PROJECT

VACUUM CHAMBERS – RF FINGERS

Loys Goirand, Philippe Marion, Jean-Claude Biasci, Pierre Van Vaerenbergh, Filippo Cianciosi, Joel Pasquaud, Thierry Brochard, Jacques Borrel, Philipp Brumund.
goirand@esrf.fr

EBS VACUUM CHAMBERS

- **Principles & Constraints:**
  - Mechanical
  - Beam
  - Vacuum
  - RF
- **Vacuum Chambers Families:**
  - Aluminium Chambers
  - Stainless Steel Chambers
  - Diagnostic Chambers
- **RF Fingers:**
  - RF Fingers
  - RF GasKets
- **Conclusion**

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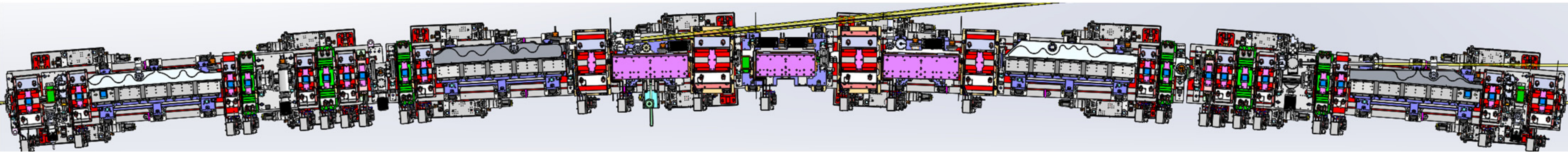
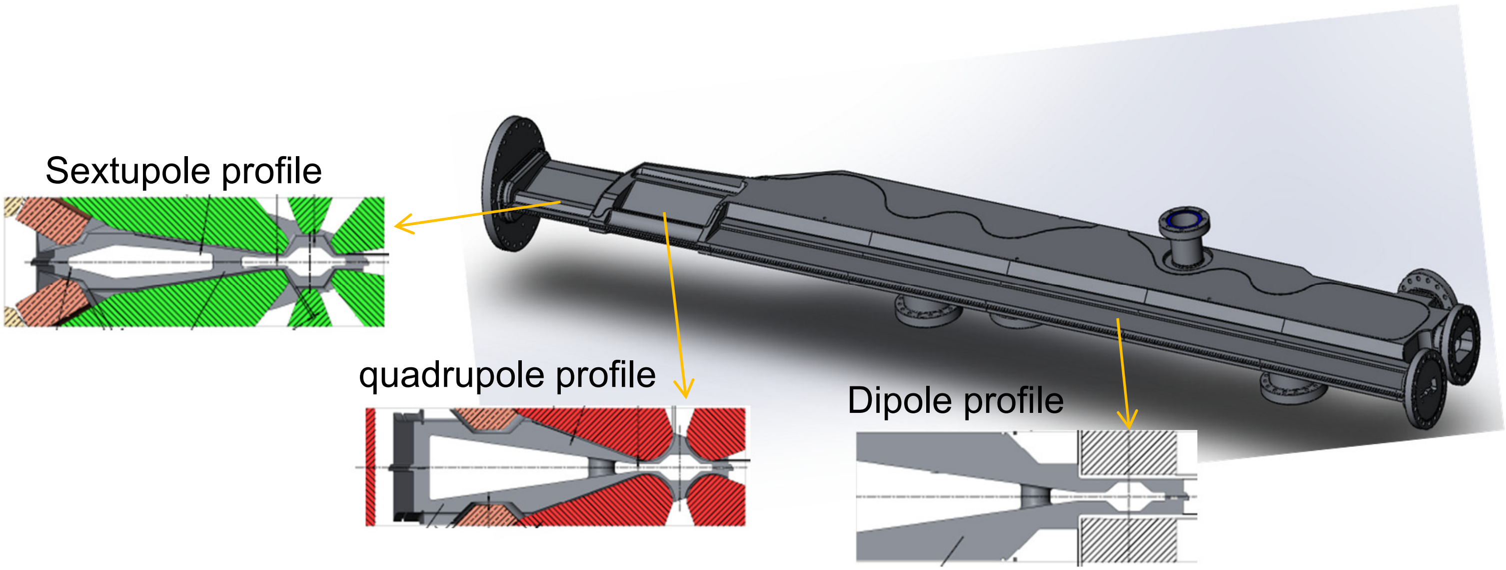


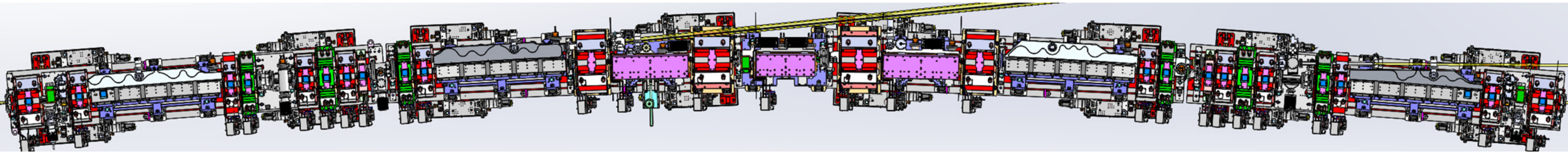
Free space between magnets (total for one cell): **3.4m** instead of **8m** today
31 magnets per cell instead of 17 currently

✓ Very limited space available between magnets for flanges, valves, bellows, BPMs

Several chambers have different successive external cross sections to pass through several different magnets.



EBS VACUUM CHAMBERS – GENERAL PRINCIPLES & CONSTRAINTS



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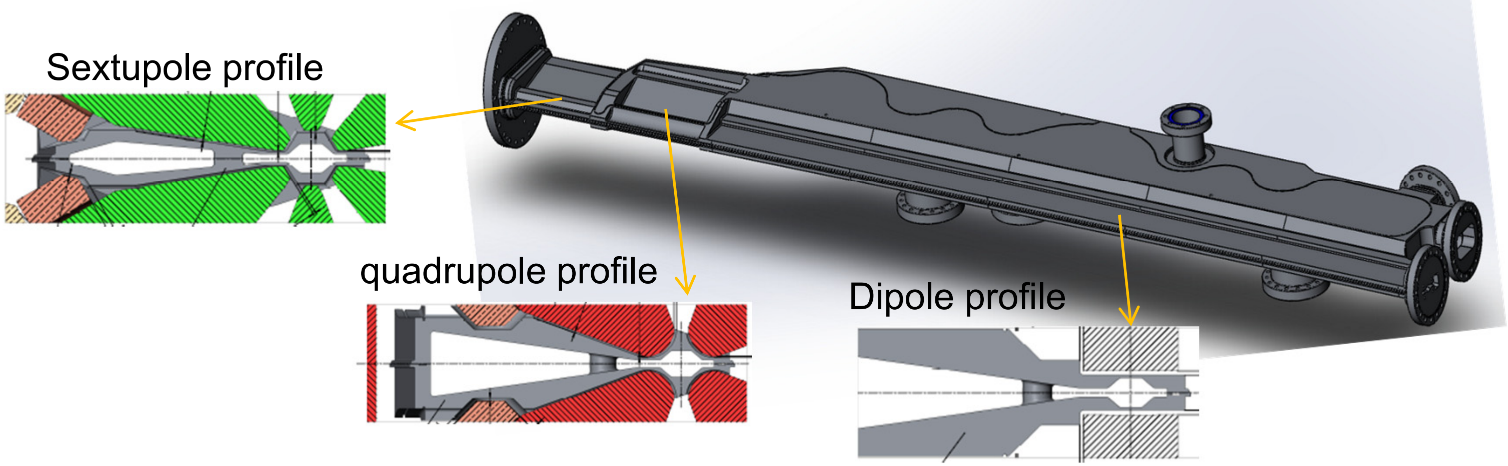
Several chambers have different successive external cross sections to pass through several different magnets.

Such chambers are difficult to manufacture by extrusion or by folding
=> several chambers made of welded assemblies of machined parts

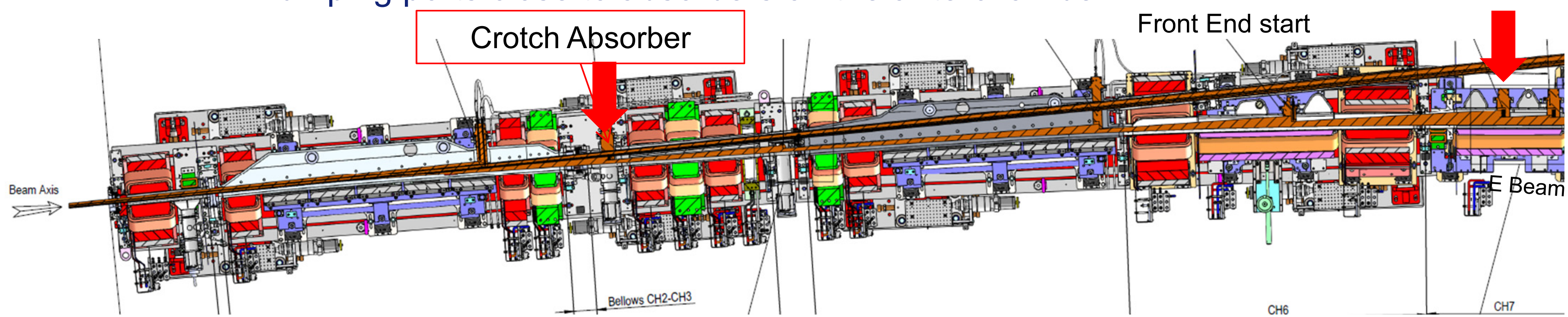


The Electrons and Photons beams need a long distance before being in separate chambers

Chambers with ante-chamber where the photon beam can circulate

=> Lumped absorbers

=> Pumping ports close to absorbers on the ante-chamber

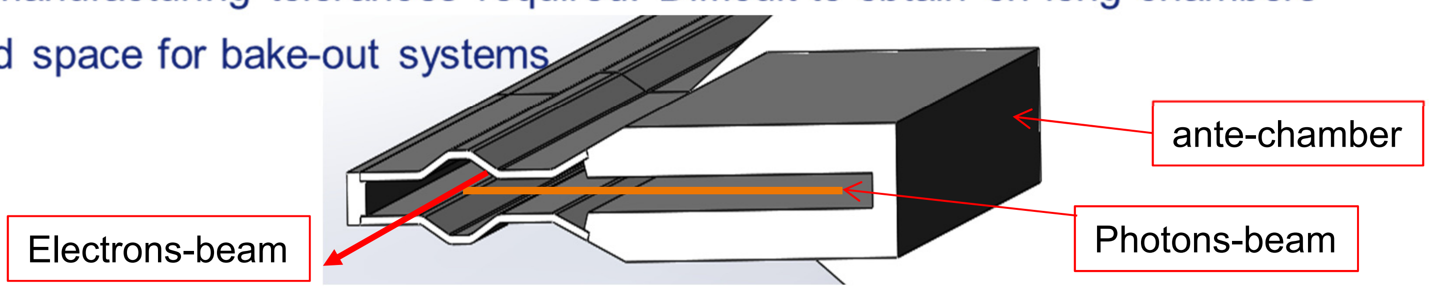


Very little space available between poles and e- beam stay clear zone for chamber and bake out systems

⇒ Small chamber thickness around e- beam. A thick ante-chamber acts as a stiffener. Several design iterations to obtain acceptable stress and strain

⇒ Tight manufacturing tolerances required. Difficult to obtain on long chambers

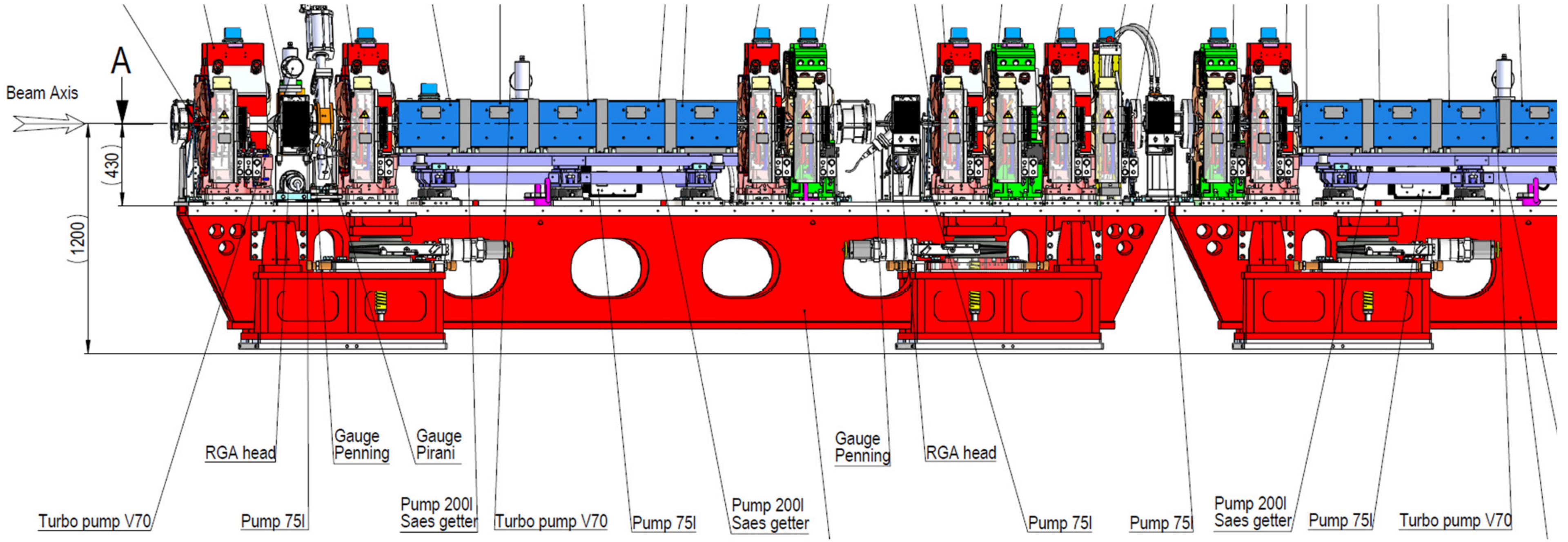
⇒ Limited space for bake-out systems



EBS VACUUM CHAMBERS – GENERAL PRINCIPLES & CONSTRAINTS

✓ <u>Pumping mainly by lumped pumps (Ion pumps or NEG pumps fitted on pumping ports)</u>

Only 2 chambers (CH1 and CH14) from 14 will be NEG coated.

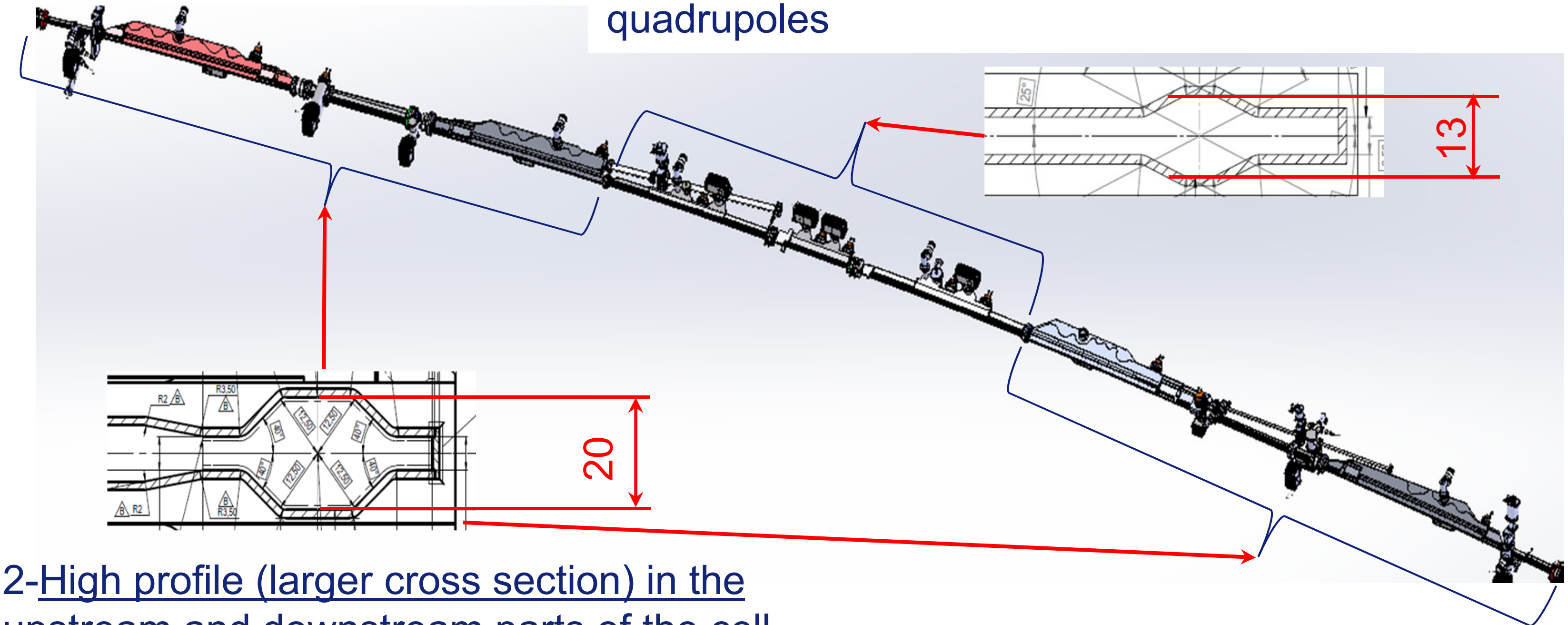


IP & NEG Pumps		CH 1	CH 2	CH 3	CH 4	CH 5	CH 6	CH 7	CH 8	CH 9	CH 11	CH 12	CH 13	CH 14
IP	55 L/s-1							2				1		
	75 L/s-1	1	1	1	1	1	1		1	2		1	1	1
NEG	GP100						1							
	GP200		2			2			1	2			2	

Pumping and pressure calculations done by Hugo Pedroso-Marques.

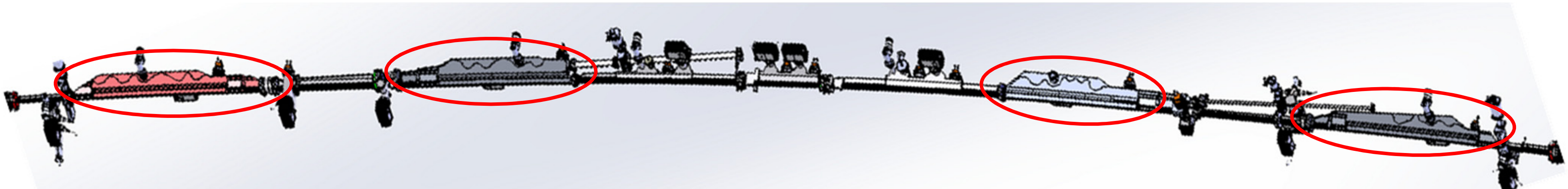
2 different sizes for inside profile around the e-beam

1-Low profile (small cross section) in central part of the cell Inside dipole-quadrupoles and HF quadrupoles

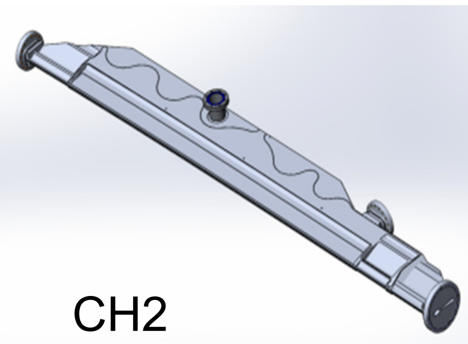


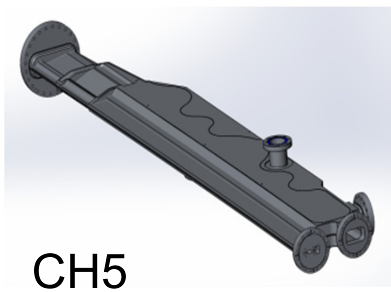
2-High profile (larger cross section) in the upstream and downstream parts of the cell

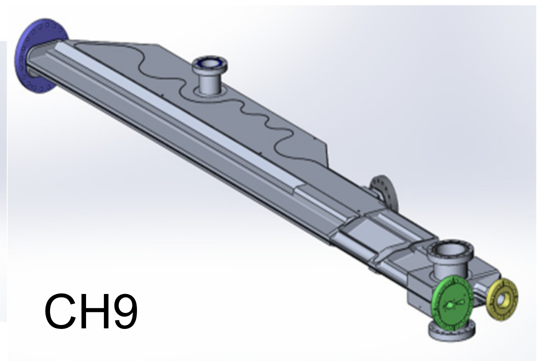
FAMILY 1: ALUMINIUM DIPOLE CHAMBERS

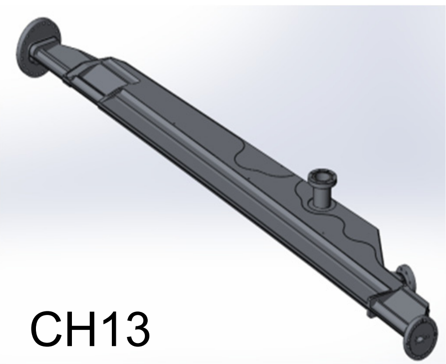


4 dipole chambers per cell made of Aluminum alloy









Dipole chambers are in Aluminum alloy 2219 T87
- easy to machine
- lightweight
- weld-able
- good mechanical properties

Designed in collaboration with INFN Frascati

ESRF engineer: Filippo Cianciosi

5

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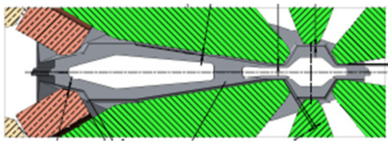
Aluminium cheaper and easier to machine than stainless steel
=> well adapted for complex shapes.

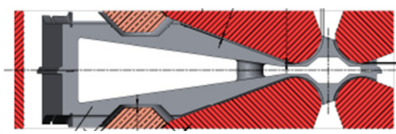
Flanges:
- Bi-metallic CF flanges

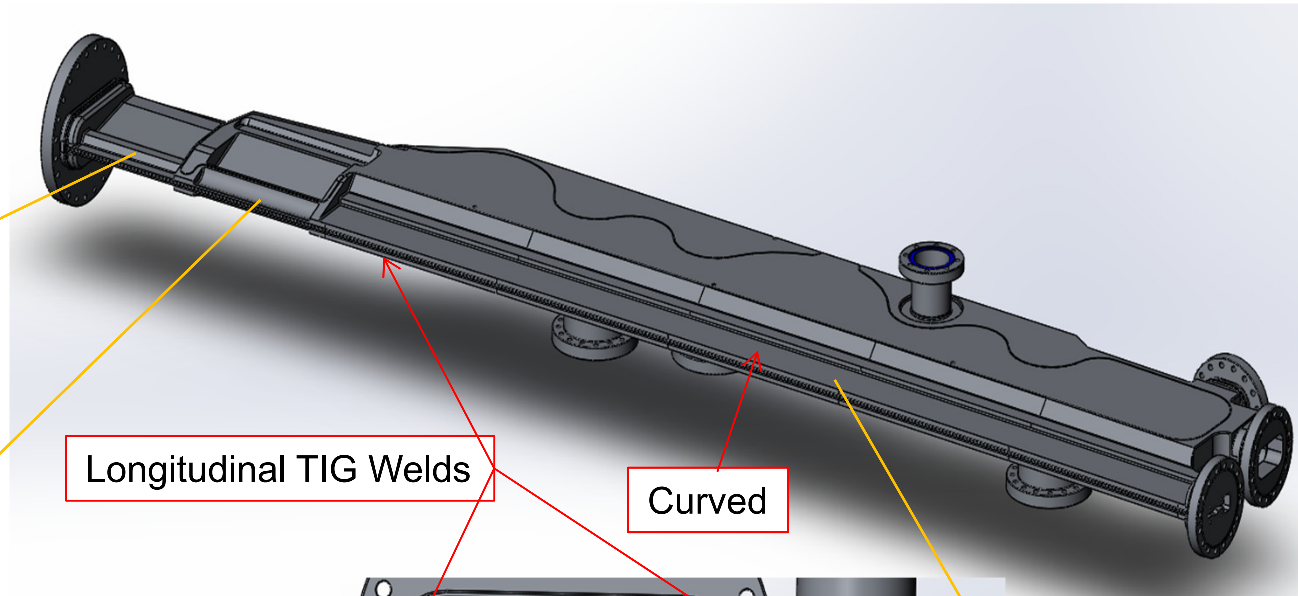
Outside profiles

Sextupole profile



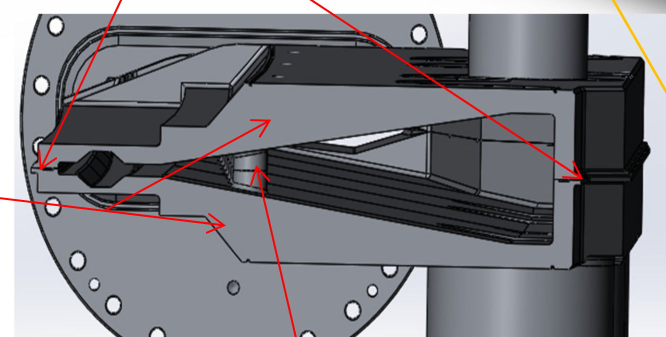
Quadrupole profile





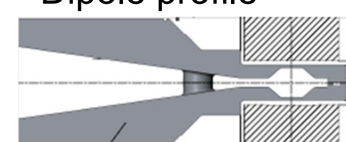
Longitudinal TIG Welds

Curved



Upper / lower half part shaped by machining

Dipole profile



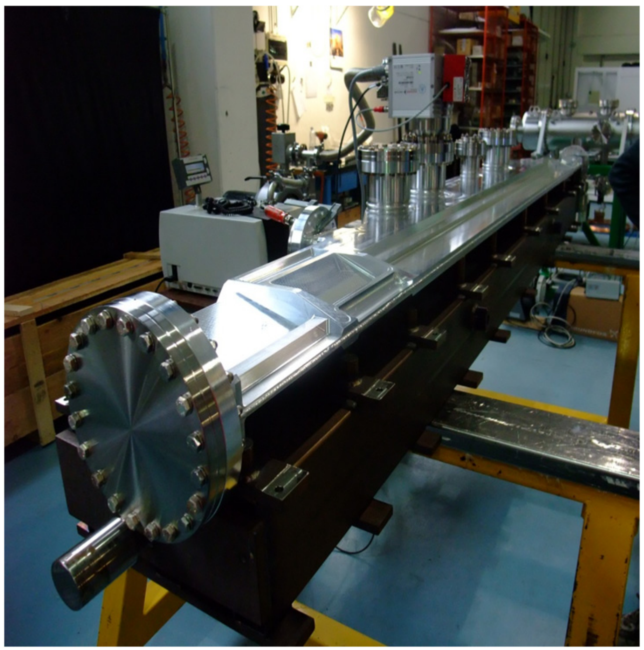
Integrated spacers to reduce stress and strain

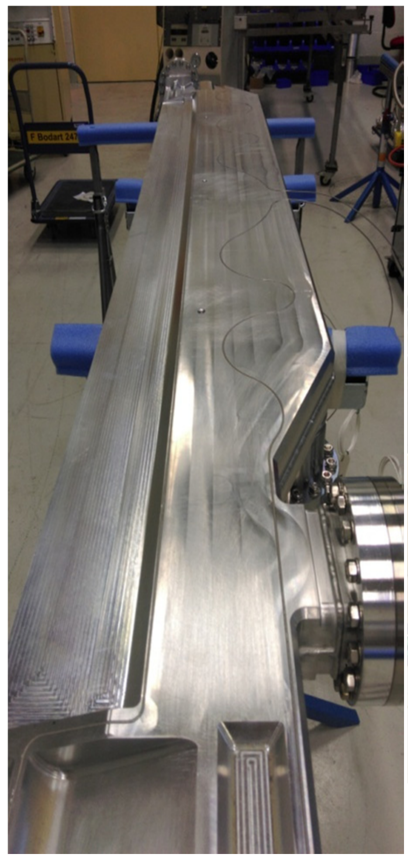
Designed in collaboration with INFN Frascati

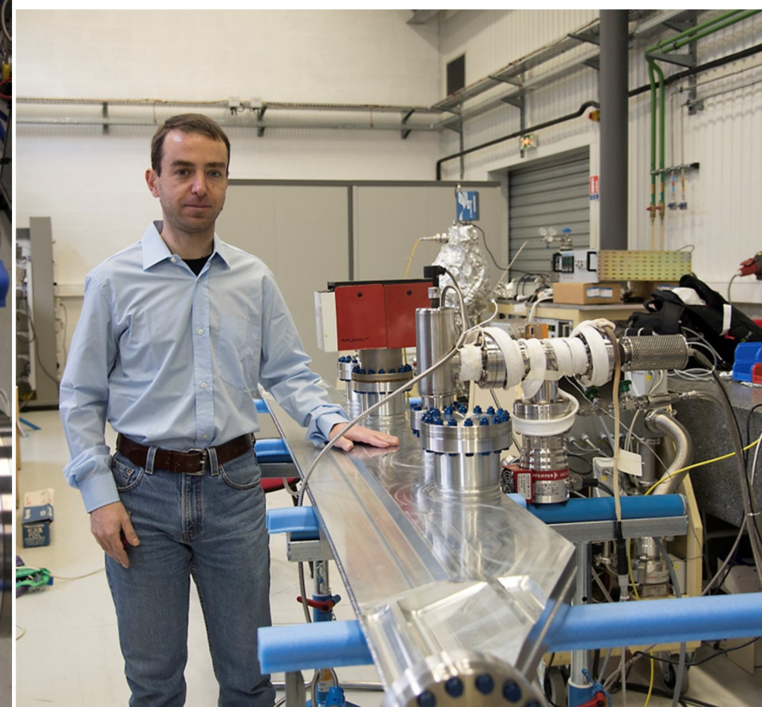
ESRF engineer: Filippo Cianciosi

A prototype aluminum chamber was produced to validate the manufacturability
Call for tender for the series production in progress

Precision achieved : on the profile / on straightness: 0.1mm

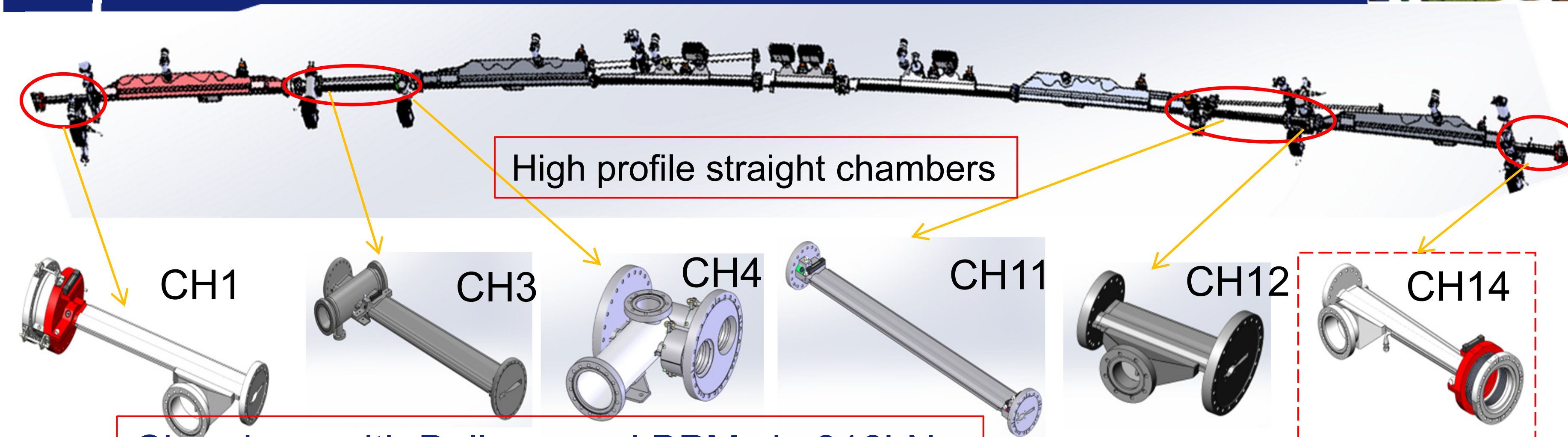






ESRF engineer: Filippo Cianciosi

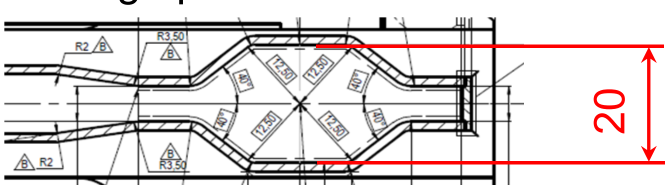
FAMILY 2: HIGH PROFILE STAINLESS STEEL CHAMBERS



Chambers with Bellows and BPMs in 316LN and 316L stainless steel.
- easy to weld
- non-magnetic
- good mechanical properties

Copper integrated in the chamber body (explosion bonding), water-cooling through the chamber wall

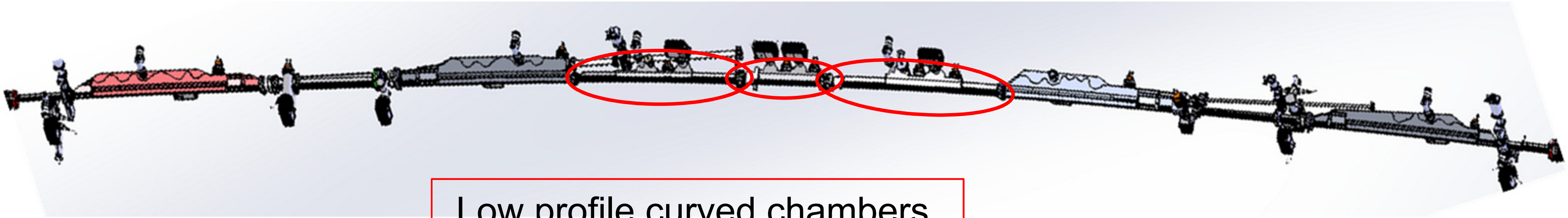
High profile cross section



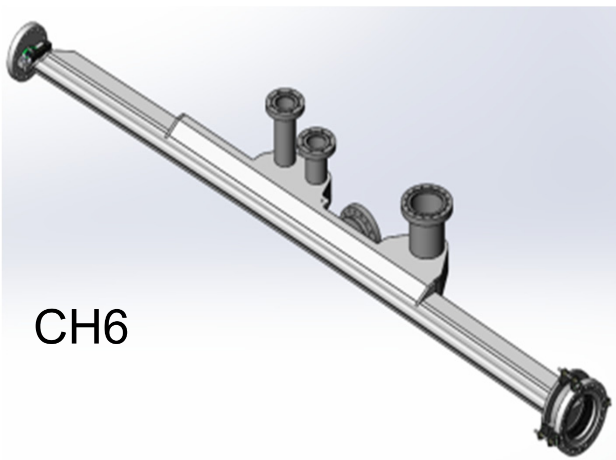
Pierre Van Vaerenbergh

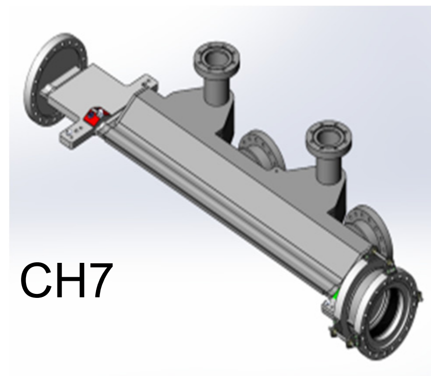
Joachim Leonardon, Thibault Ducoing

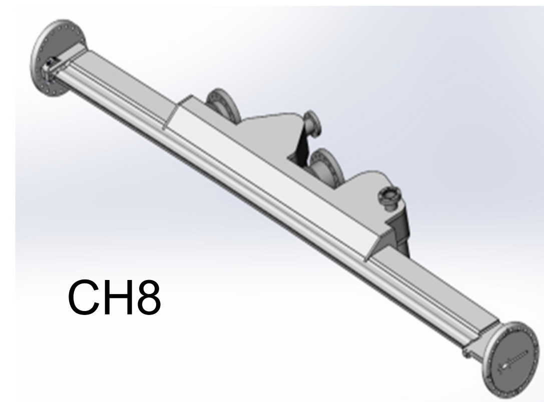
FAMILY 3: LOW PROFILE STAINLESS STEEL CHAMBERS



Low profile curved chambers

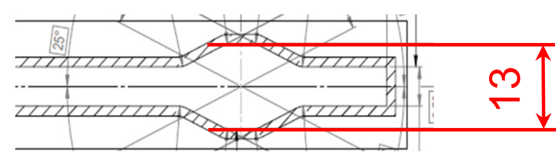






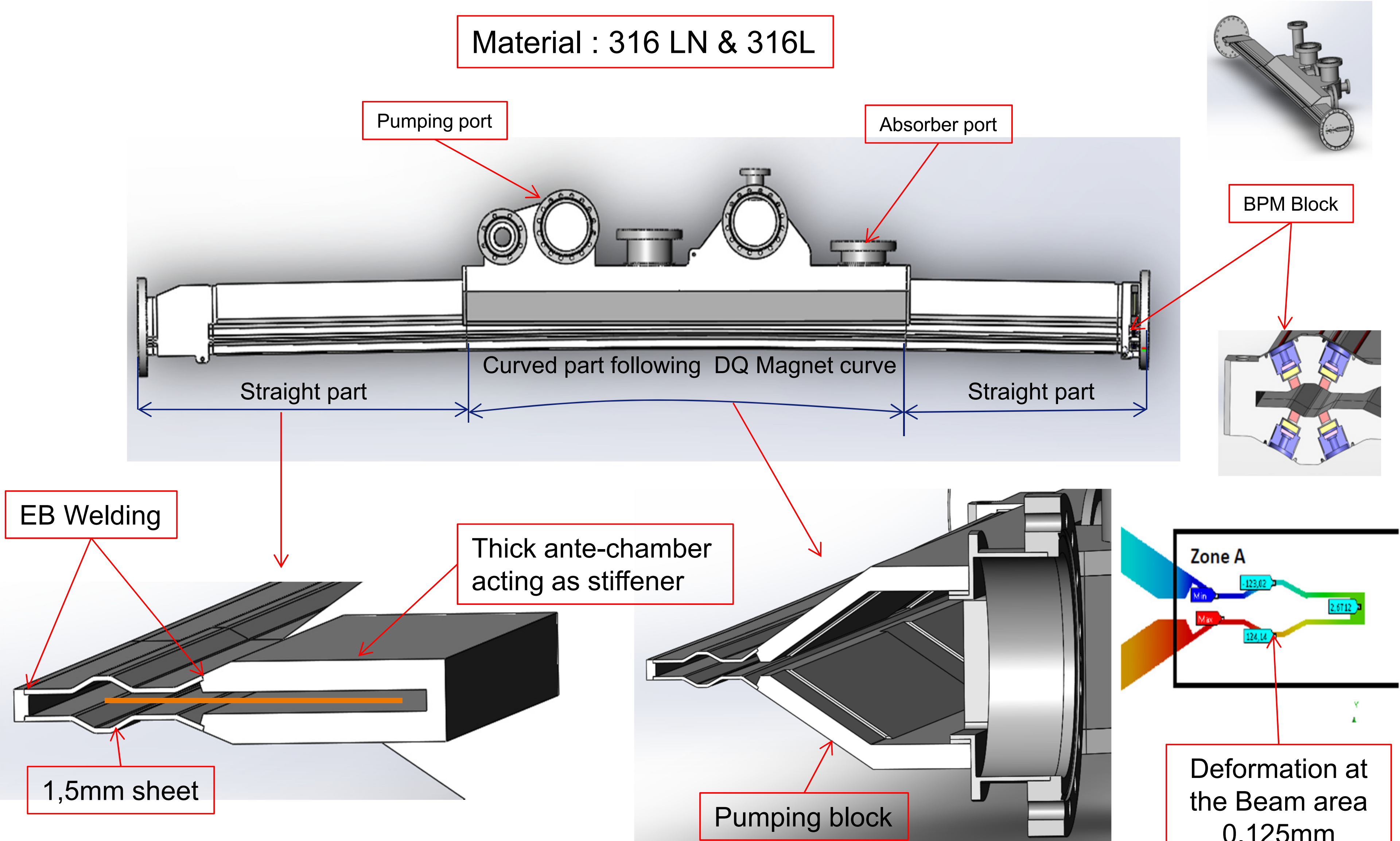
Chambers with Bellows and BPMs in 316LN and 316L stainless steel
- easy to weld
- non-magnetic
- good mechanical properties

Low profile cross section (inside dipole-quadrupoles and HF quadrupoles)



Courtesy of Joel Pasquaud

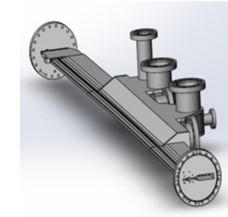
FAMILY 3: LOW PROFILE STAINLESS STEEL CHAMBERS



Courtesy of Joel Pasquaud

FAMILY 3: LOW PROFILE STAINLESS STEEL CHAMBERS

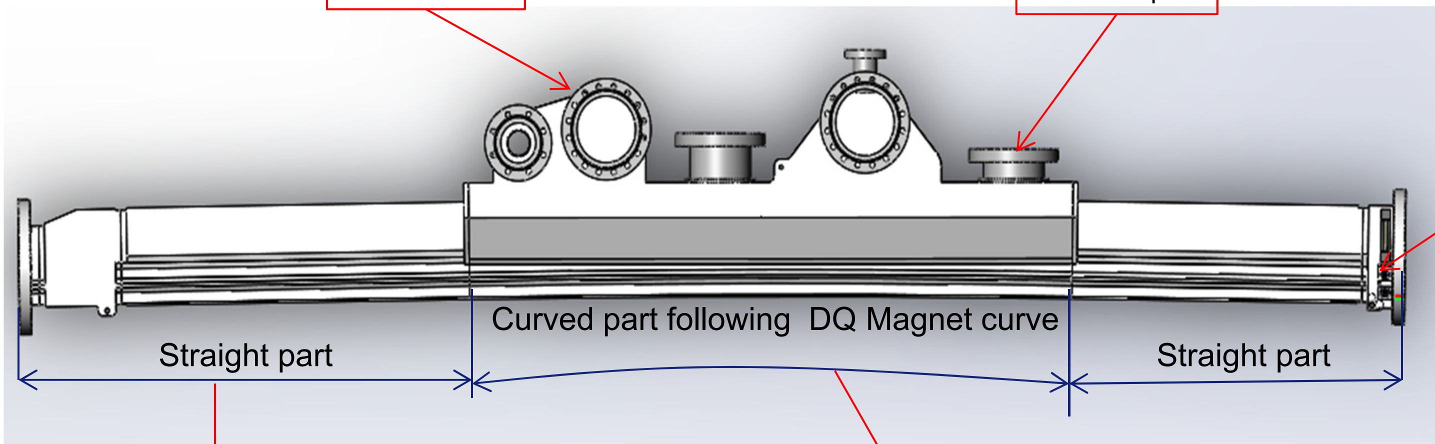
Material : 316 LN & 316L

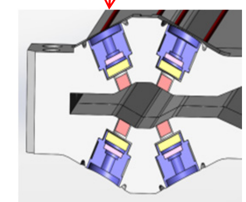


Pumping port

Absorber port

BPM Block

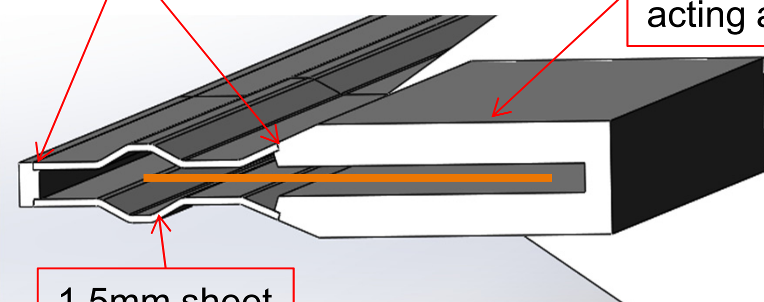




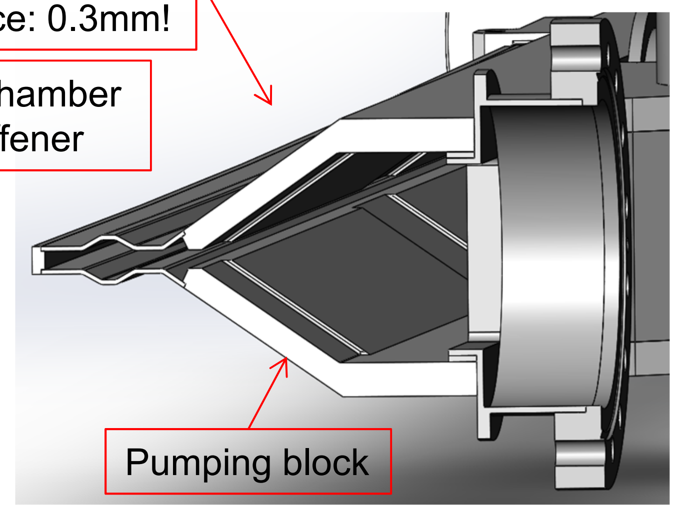
Requested shape tolerance: 0.3mm!

EB Welding

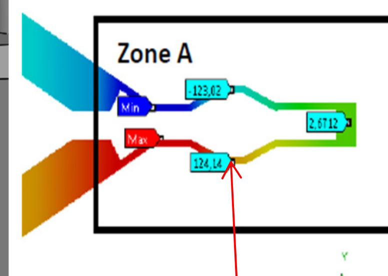
Thick ante-chamber acting as stiffener



1,5mm sheet



Pumping block



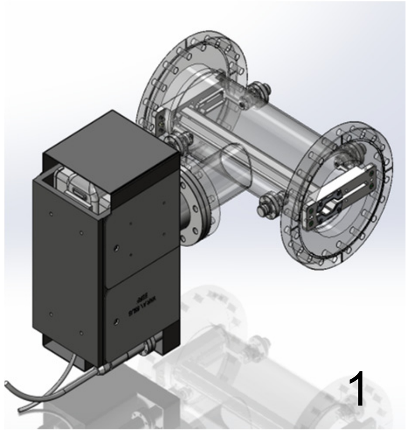
Deformation at the Beam area 0.125mm

Courtesy of Joel Pasquaud

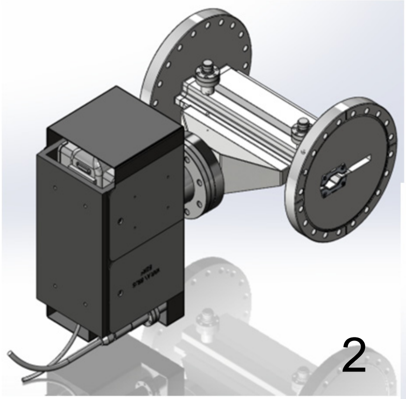
CH12 DIAGNOSTICS

1. H Stripline
2. V Stripline
3. Shaker
4. Current transformer
5. Beam Killer
6. Beam losses collimator

   New device associated with a iron shielding



1



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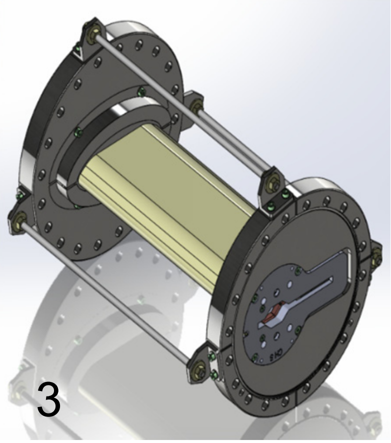

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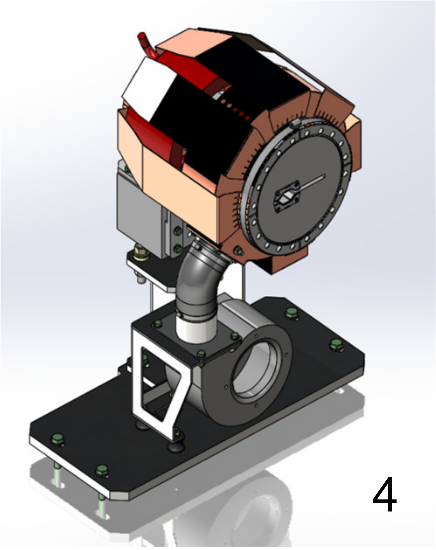

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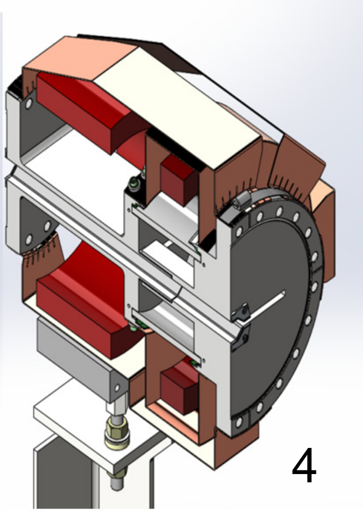

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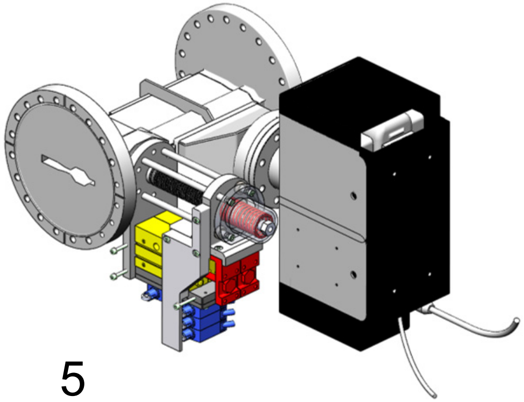

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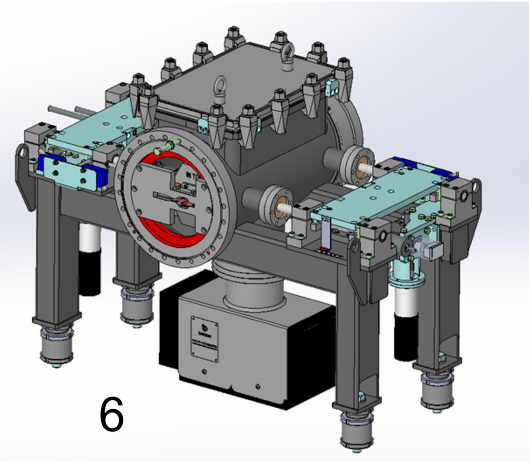


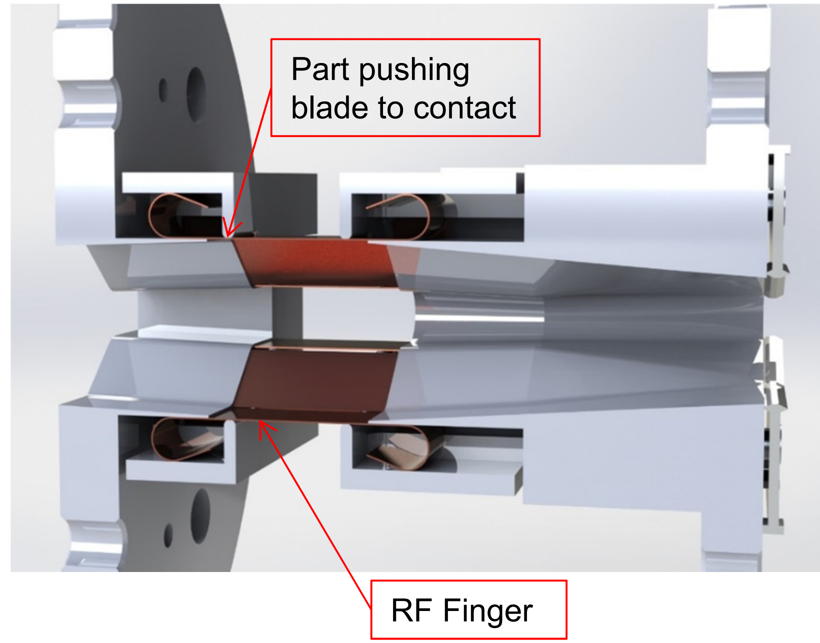
6

J Borrel

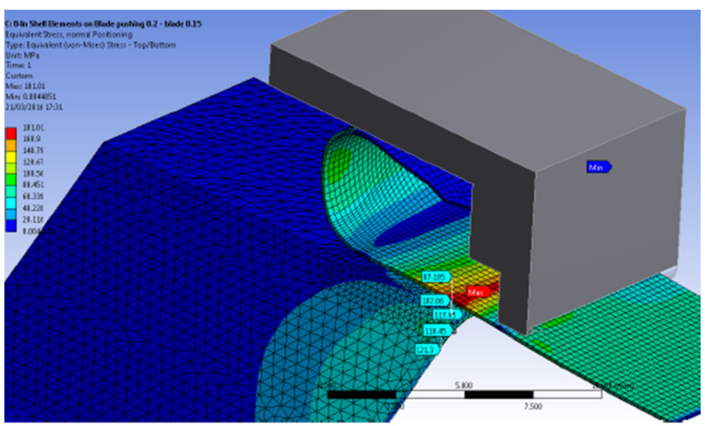
RF impedance has a direct effect on the beam quality (brillance & stability).

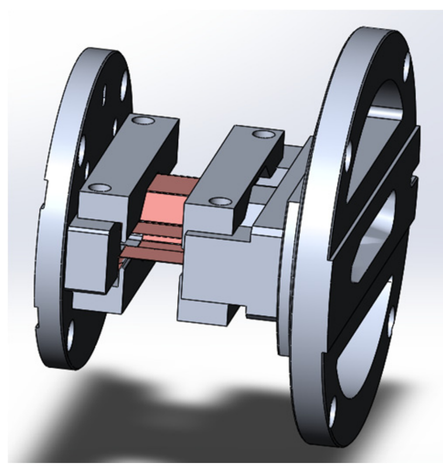
To minize it:

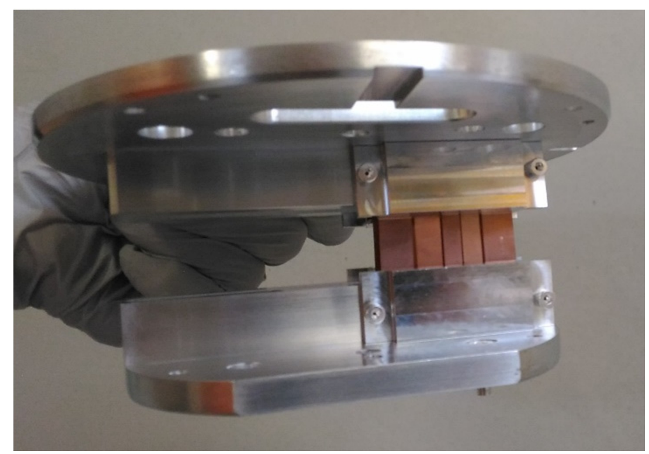
- Smooth transitions between profiles
- No change of the profile inside the RF fingers
- RF gasket between flanges



- ❑ 2 different profiles = 2 different sizes of RF Fingers.
- ❑ FEA model for mechanical and RF
- ❑ Prototype tested,
- ❑ Patent Pending



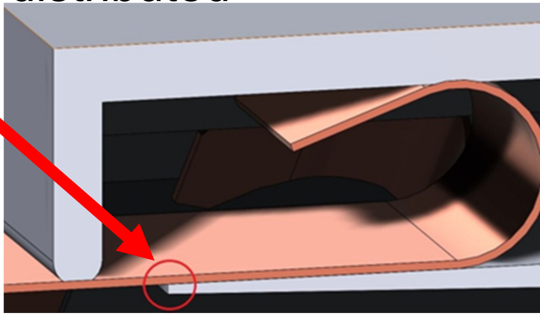


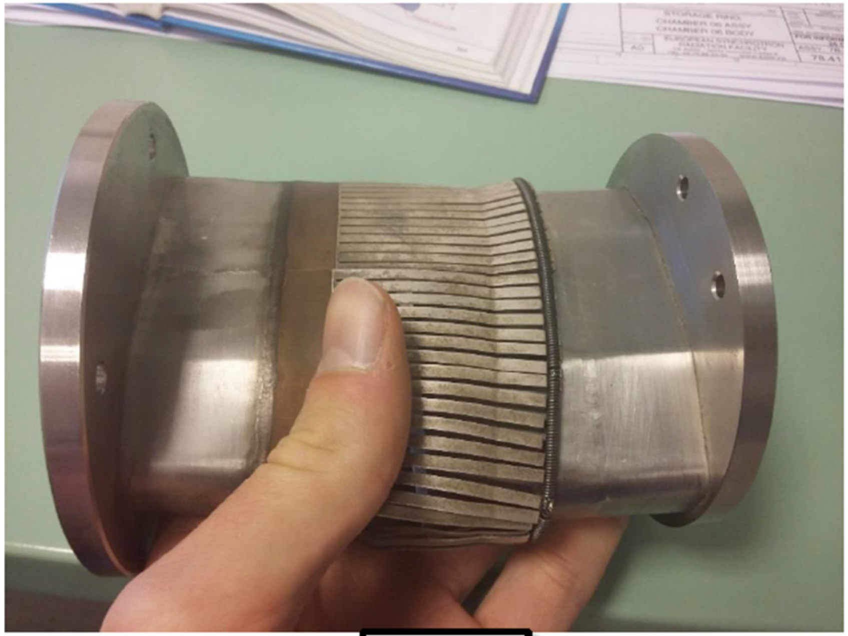


P Brumund, T Brochard, L Goirand, J Pasquaud, Simon White

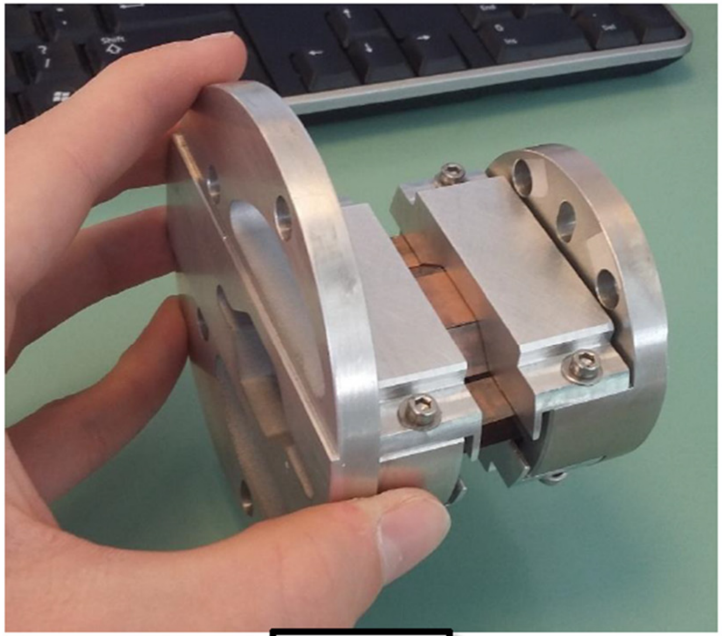
Comparison to old design

- Old design simpler but improper for new profile
- In new design the electrical contact pressure is better distributed
- The electrical contact is on the edge of the sleeves
- No welding or brazing
- Parts replaceable
- Compact but allowing high lateral and vertical offsets
- No risk of finger falling into the beam area

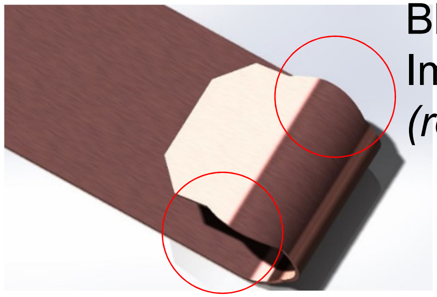




Old design



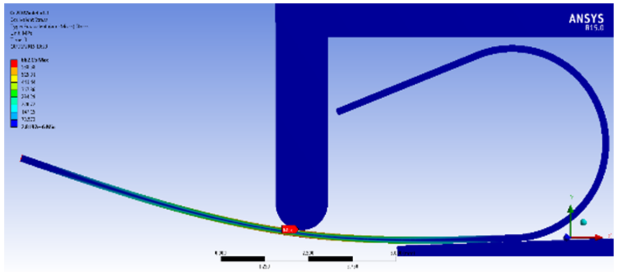
New design



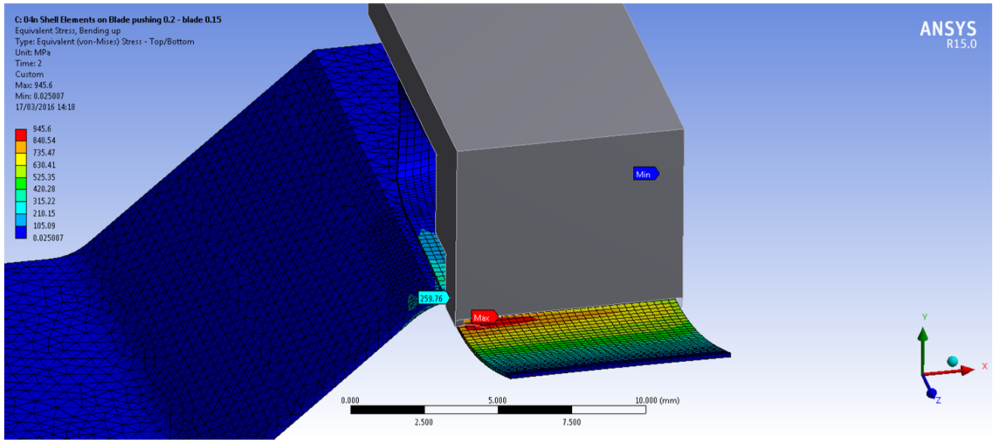
Blade Geometry Improvement *(rounded edges)*

- **Improvement of Rf impedance, lateral blades added**
- **Improvement of blade geometry for more flexibility**
- **Calculations (2D/3D) performed with goals:**
  - Validation of concept
  - Optimization of design to obtain good flexibility and contact behavior
- **Test Bench to verify new prototypes mechanically**

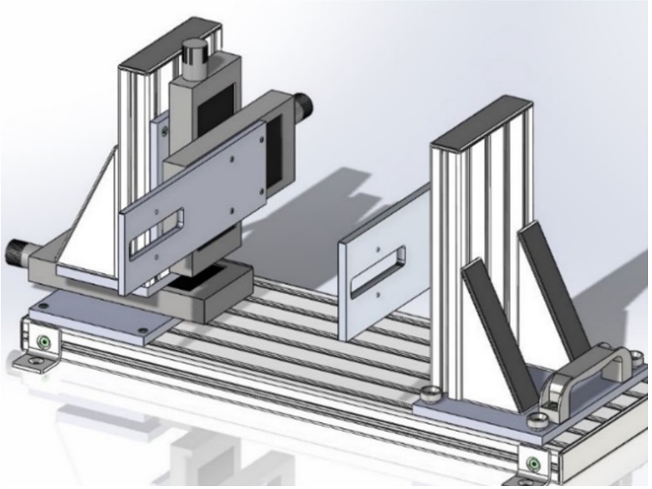
2D FE Model

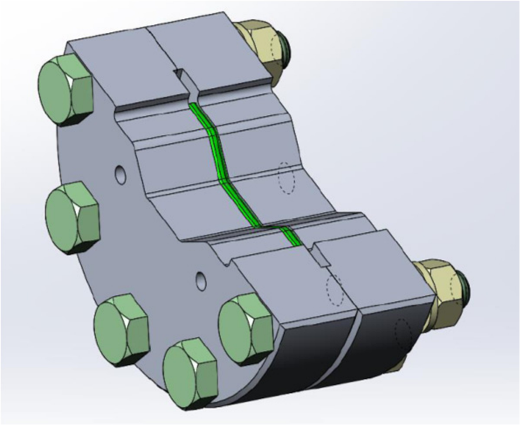


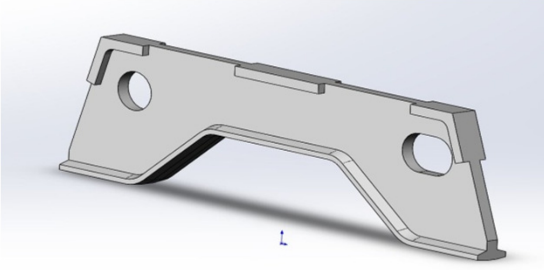
3D FE Model



Test Bench

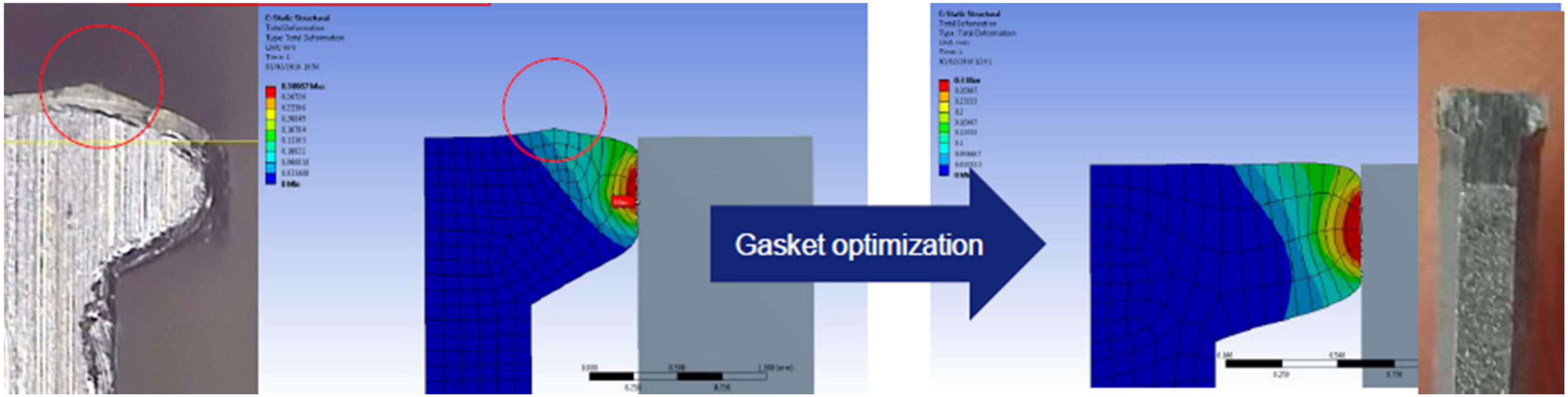






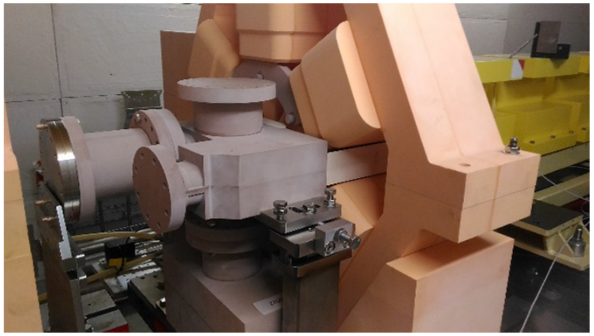
RF Gasket design

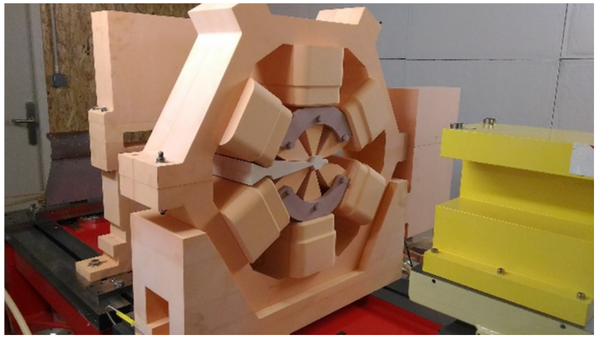
- First prototypes showing bump
- FE Model simulation
- Dimensions were optimized using the FE model
- New prototype test showed good results



P Brumund, T Brochard

Test assembly with mock-up to scale



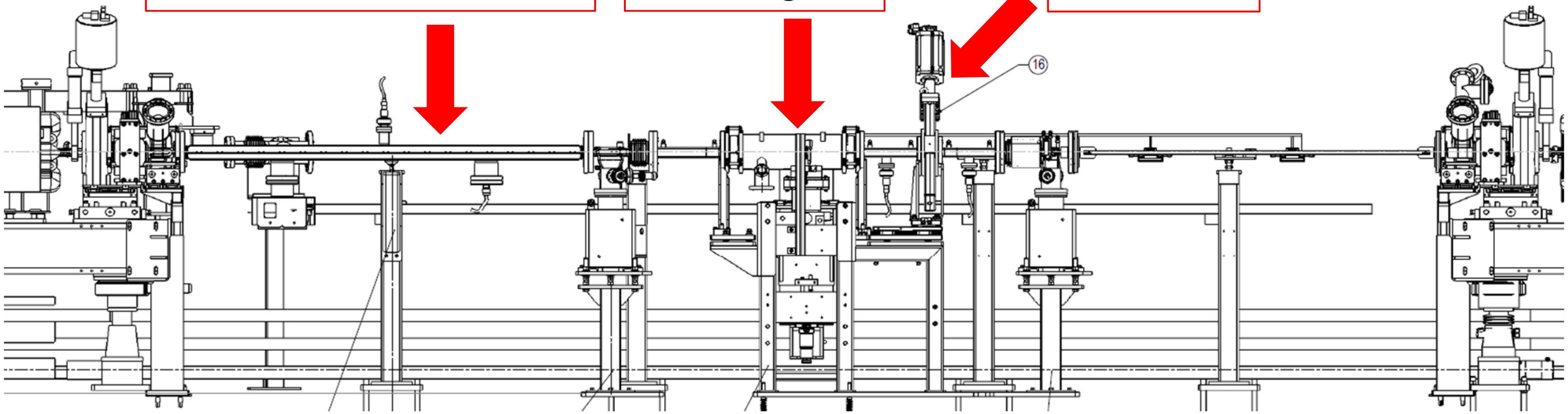


Vacuum and RF test of different devices on the existing machine

Aluminium Chamber

RF Fingers

RF Valve



CONCLUSIONS

The EBS lattice is technically demanding

We combined different technical solutions:

Material :

- Aluminium
- Stainles-steel

Manufacturing:

- Machined from block
- Welded assembly
- Folding (thin1.5mm and thick 12mm)
- Stamping.

Vacuum:

- Ion pump
- Neg pump
- Neg coating

Absorber:

- Lumped absorber
- Distributed absorber

RF:

- New RF finger device
- RF gasket

MEDSI 2016

Design: Mechanical, Vacuum, RF, Thermal, Cost constraints

- Many iterations to finalize dimensions & drawings
- Material choice
- FEA modelling
- Photon absorbers integration
- Magnets interferences
- Supports interface
- Ante-chamber internal profile adjustement

Contracts phase 1: Design review

- Manufacturers requirement
- Many iterations to finalize dimensions & drawings
- FEA modelling when thickness
- Magnets and correctors interferences verification
- Raw material dimensions modification

Contracts phase 2: Pre serie:

- End 2016

Now


THANK YOU FOR YOUR ATTENTION