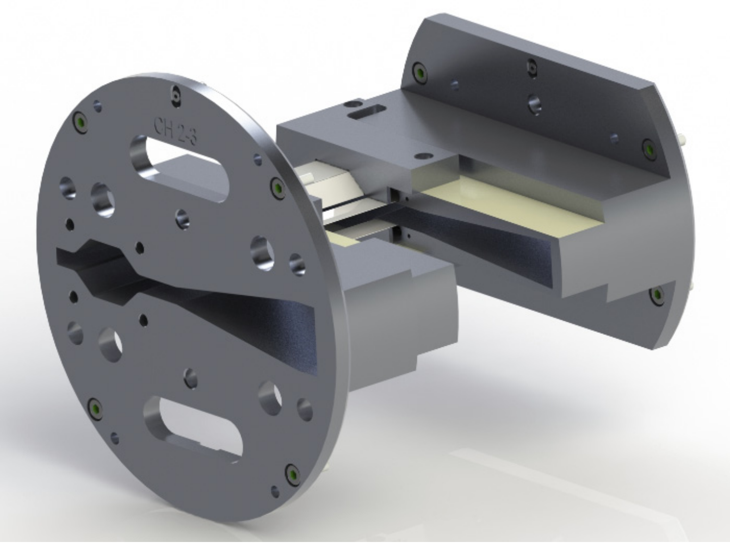

# RF Fingers for the new ESRF-EBS storage ring

*Th. Brochard**, *L. Goirand, P. Brumund, J. Pasquaud, S. White*

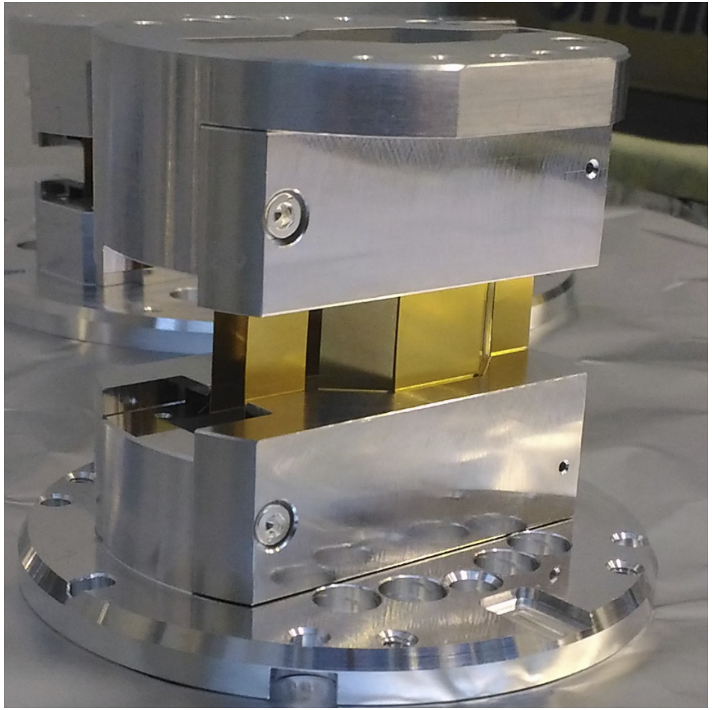


ESRF | The European Synchrotron

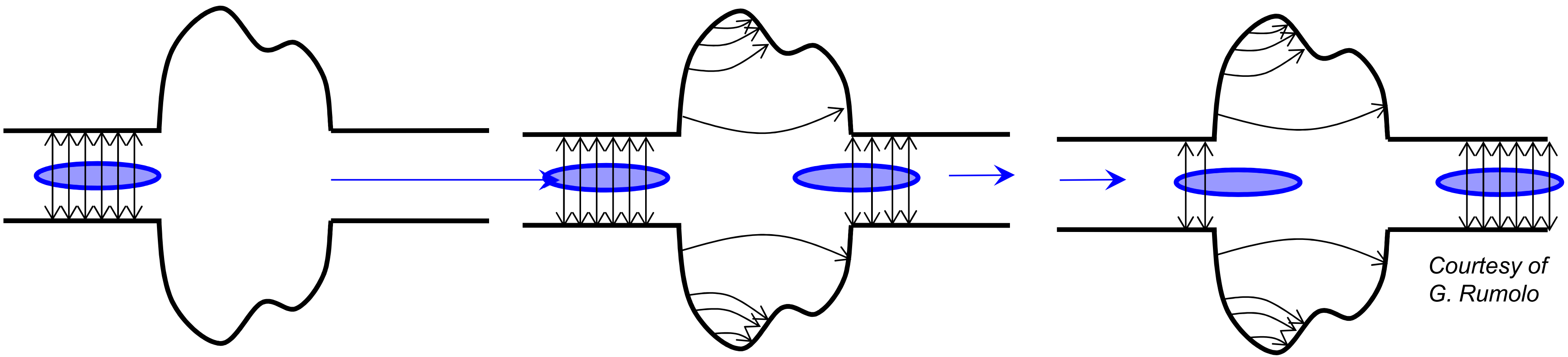
* brochard@esrf.fr

# OUTLINE

- ❖ Wake fields
- ❖ RF Finger conceptual design
- ❖ FEA calculations
- ❖ RF Finger final design
- ❖ Validation tests
  - Computed tomography images
  - With electron beam on ESRF machine
- ❖ Conclusion



# WAKE FIELDS

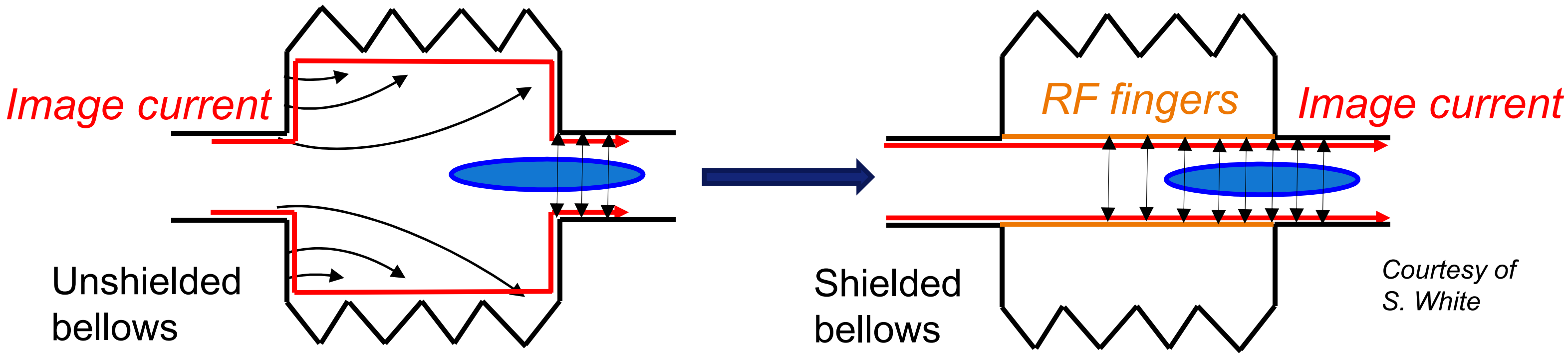



When the beam goes through a discontinuity it introduces an electro-magnetic field which keeps ringing after the beam has passed:

- The field generated from the head of the bunch can affect its tail: **single bunch instabilities**
- The field from one bunch can affect all trailing bunches: **multi-bunch instability**

**Beam instabilities can be very severe and prevent the machine from reaching its nominal performance: it is important to minimize their sources of as much as possible in the design phase of an accelerator**

# WAKE FIELD FROM A BELLOWS

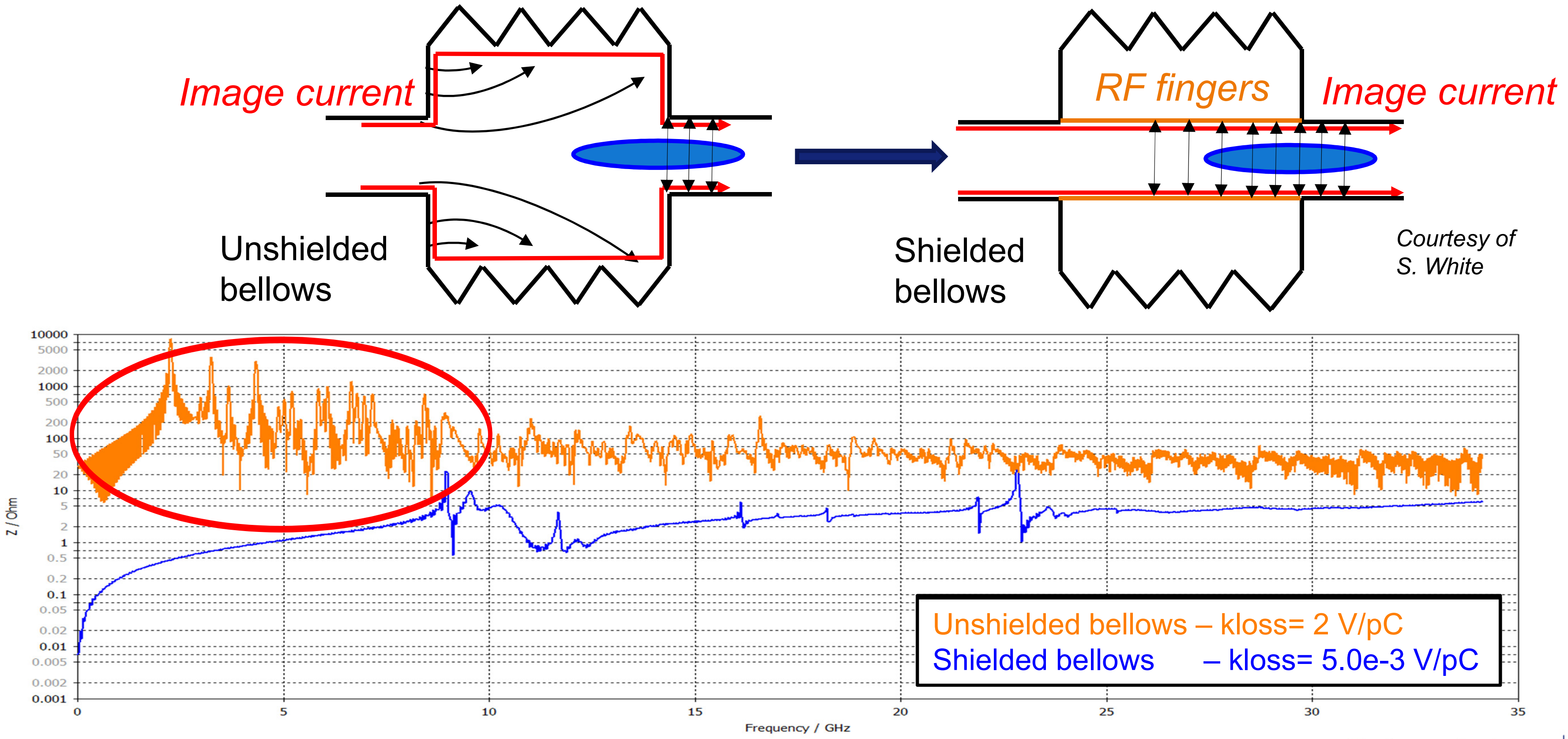



Bellows introduce a cavity type discontinuity which can be the source of strong resonant fields:

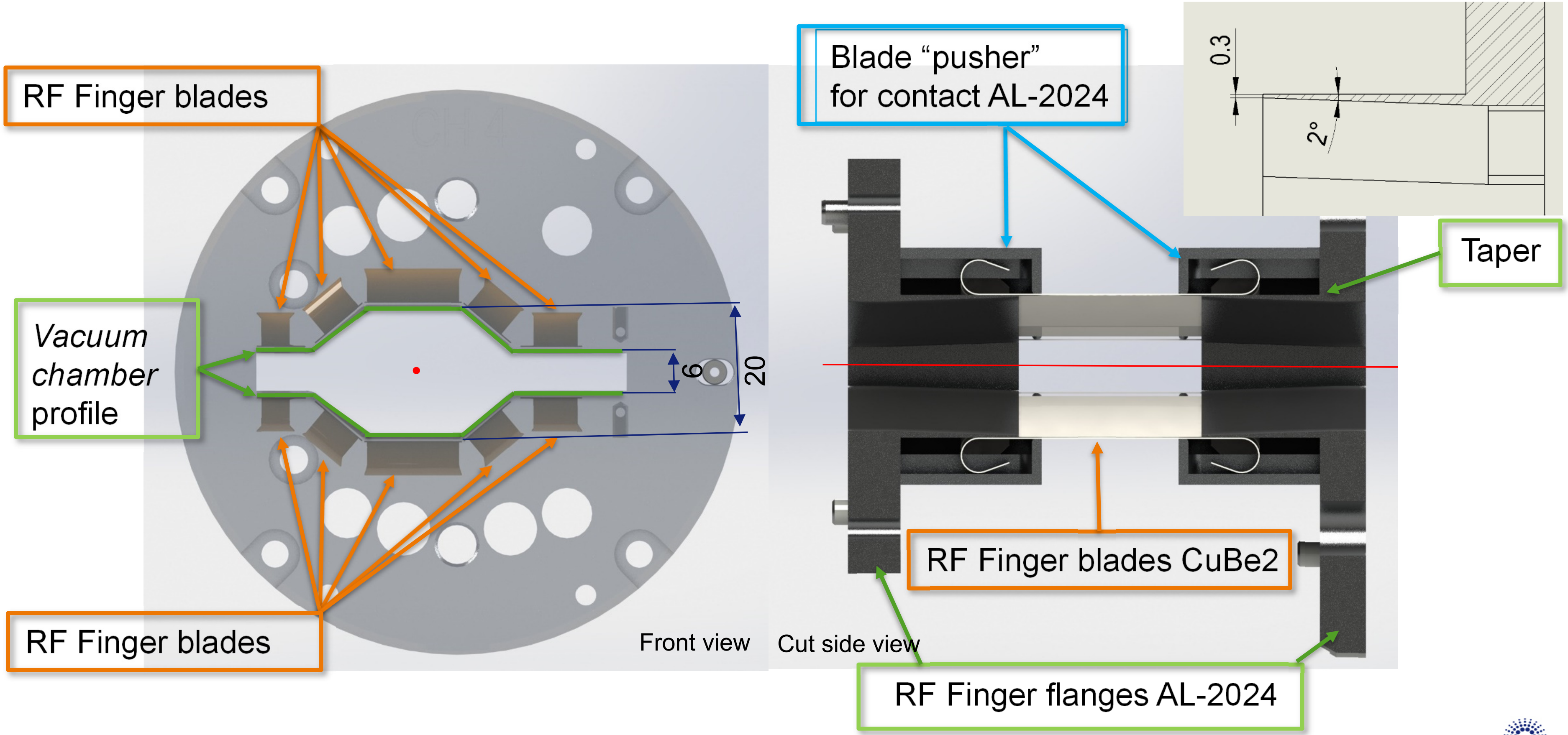
- These resonant fields can be the source of instabilities
- It possible to “shield” the cavity from the beam using plates made of high conductivity material
- These are generally called RF fingers due to their shape

- Efficiency and principle is then verified with realistic EM simulation on the 3D model

# WAKE FIELD FROM A BELLOWS



# RF FINGER CONCEPT DESIGN



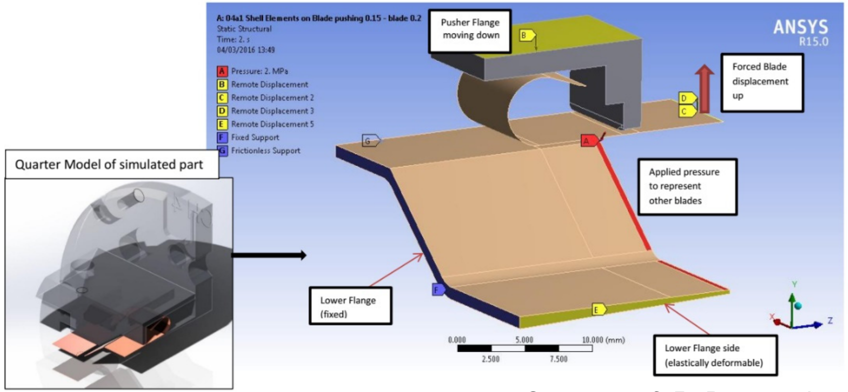
# FEA ON 3D / 2D MODELS

## 3D Model for contact and stresses created

- One blade considered
- Contact Pressure created by “pusher” displacement

## Checked Results:

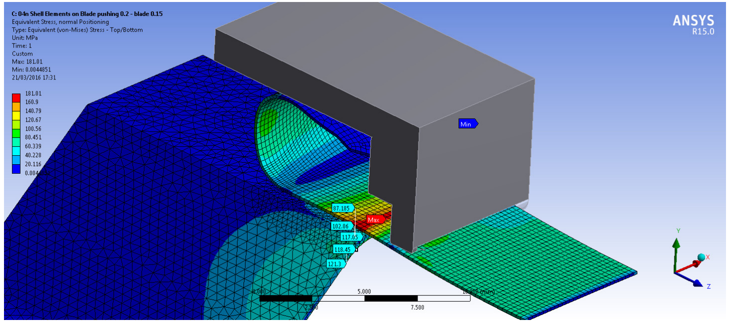
- Components Stress (blade/flange) In 2 load cases:
    - Normal contact
    - Extreme load case (blade bending)
- Contact pressure (electrical contact)

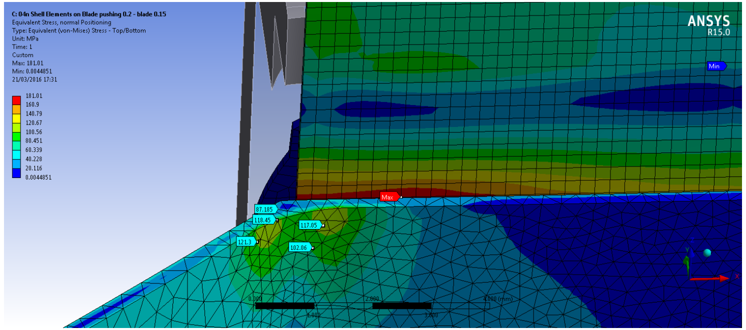



*Courtesy of P. Brumund*

## Stressed checked in:

- ✓ Blade
- ✓ Flange



# FEA ON 3D / 2D MODELS

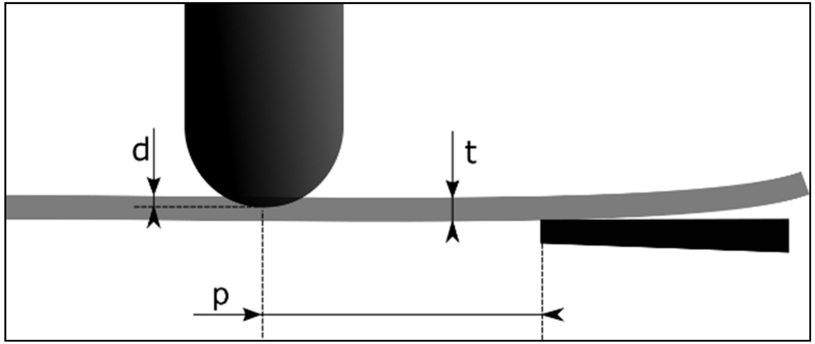
Calculations performed for models with varied parameters:

- d : pushing depth
- t : blade thickness
- p : pusher distance

Parameters varied in reasonable ranges

Evaluated results:

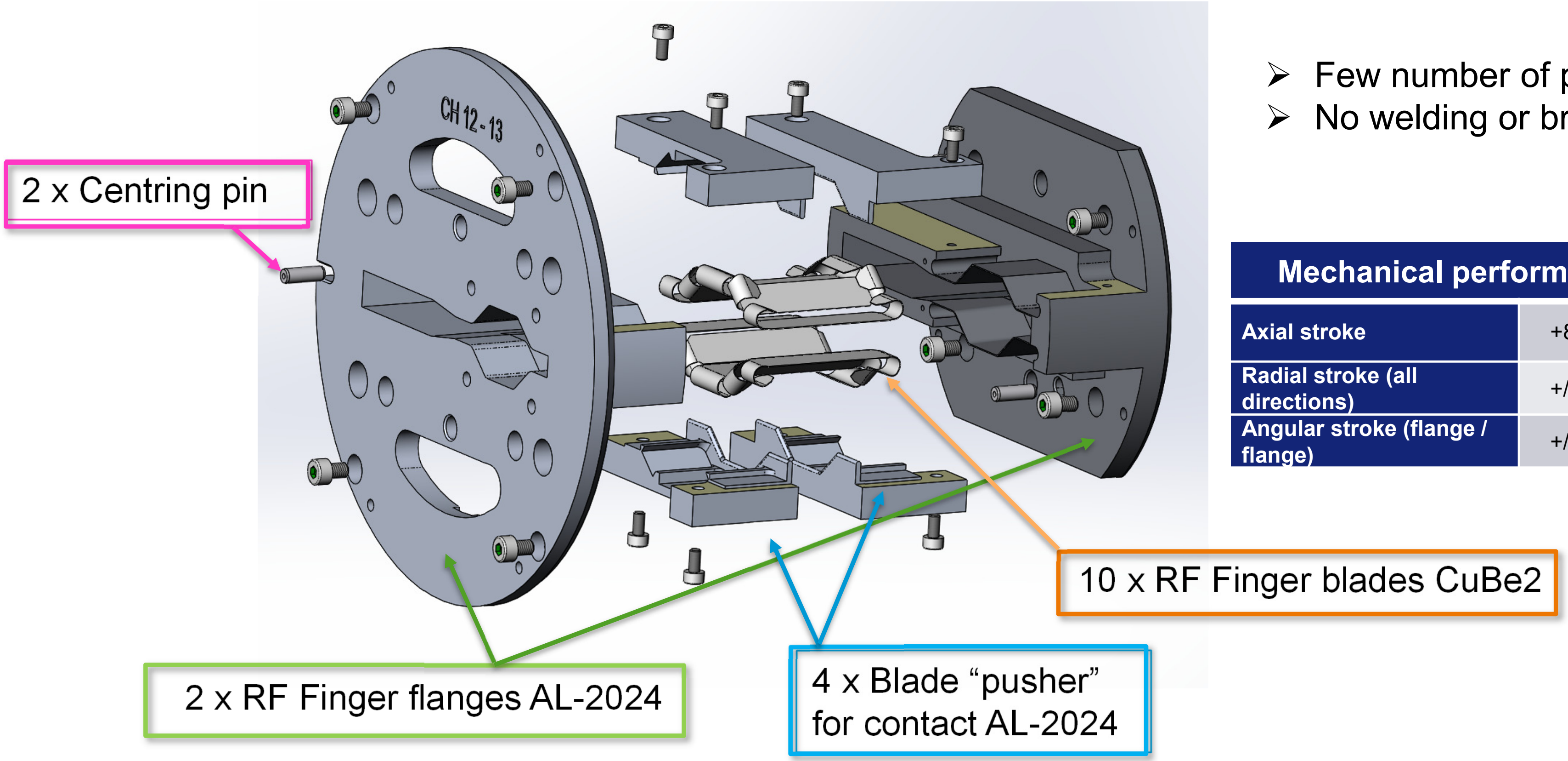
- ✓ Max. Stress in Blade/Flange
- ✓ Contact pressure




| Blade thickness t [mm] | Pushing depths d [mm] | Distance p [mm] |
|---|---|---|
| | 0.20 | 2.75 |
| 0.125 | 0.30 | |
| | 0.40 | |
| | 0.15 | 2.75 |
| 0.15 | 0.20 | |
| | 0.25 | |
| | 0.30 | |
| | 0.10 | **2.75** |
| | **0.15** | |
| **0.2** | 0.20 | |
| | 0.40 | |
| | 0.30 | 3.25 |

*Courtesy of P. Brumund*

# RF FINGER FINAL DESIGN

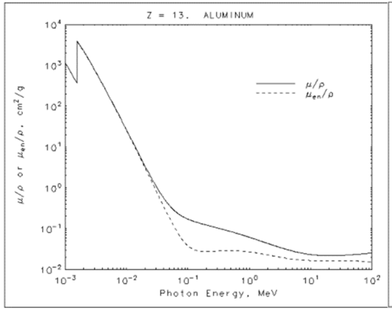


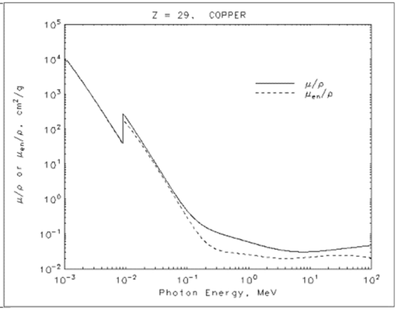

- Few number of pieces
- No welding or brazing

| Mechanical performances | |
|---|---|
| Axial stroke | +8 / -19 mm |
| Radial stroke (all directions) | +/- 1 mm |
| Angular stroke (flange / flange) | +/- 5 degrees |

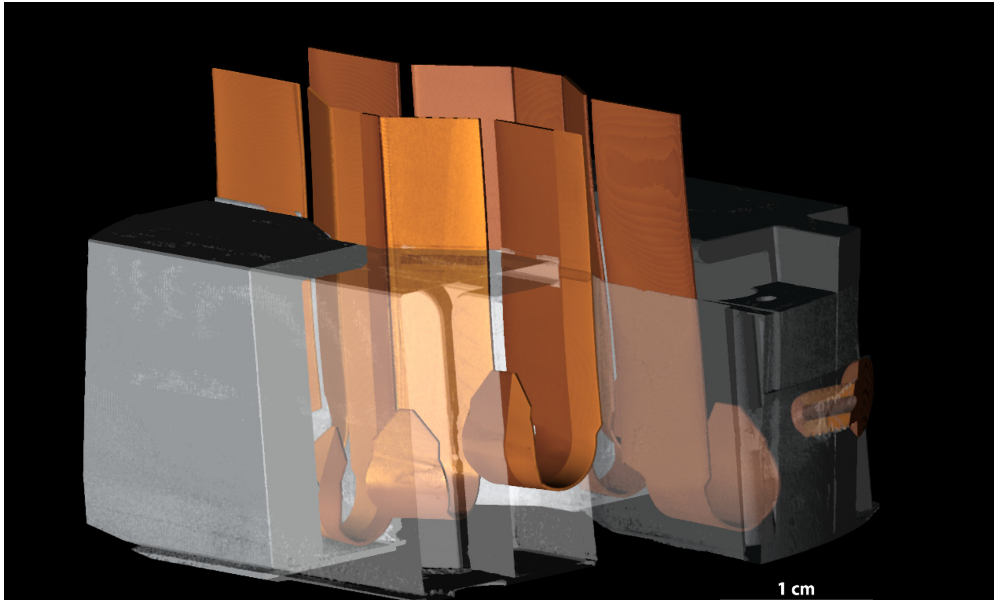
# TESTS – CT IMAGES

- Filters ……….….….….….…..: Aluminium 45 mm + Copper 2 mm
- Energy peak……………..….: 105 keV
- Pixel size …………….….…...: 13.4 µm
- Filed of view ……….…........: 58 mm in half acquisition mode
- Nb scans …………………..: 20
- Nb projections …………….: 6000 / scan
- Exposure time …………….: 60 ms
- Total acquisition time…….. : 2 hours
- Distance sample / detector : 2 m




$$I = Io\ \exp(-\mu x)$$

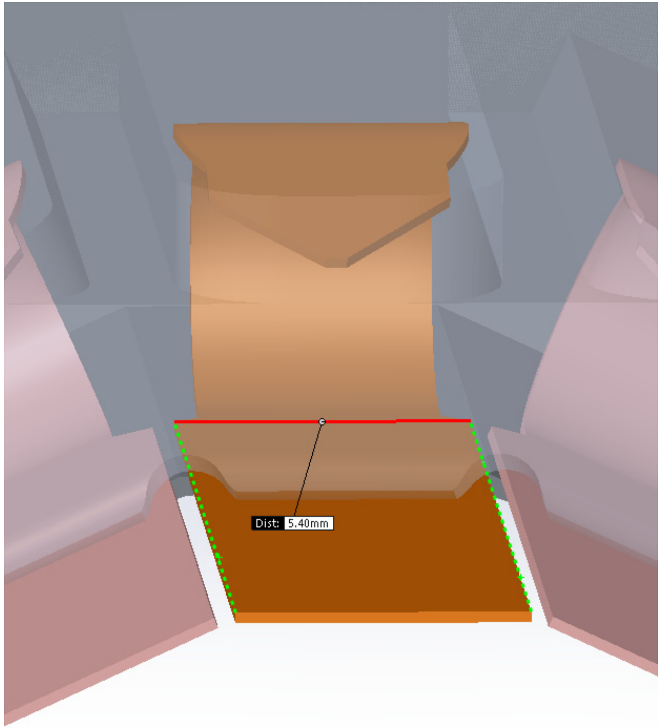



*Courtesy of V. Fernandez*

# TESTS – CT IMAGES

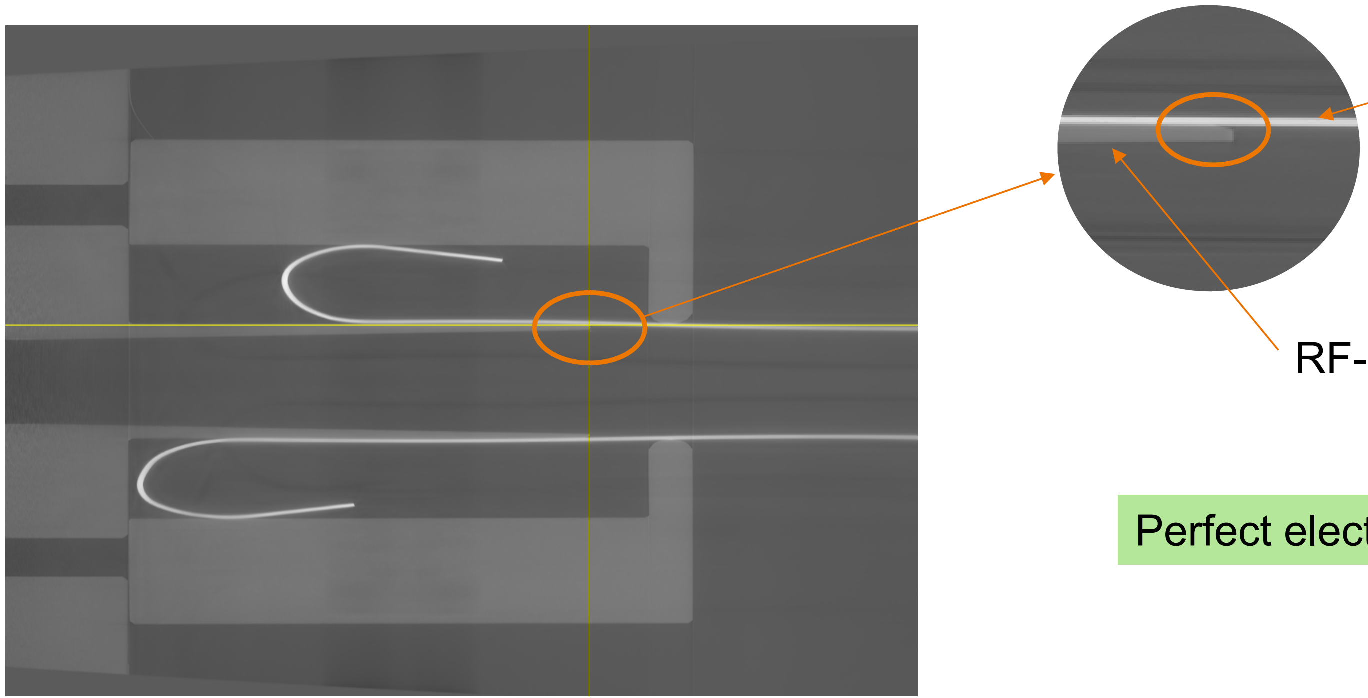
CT image


CAO image



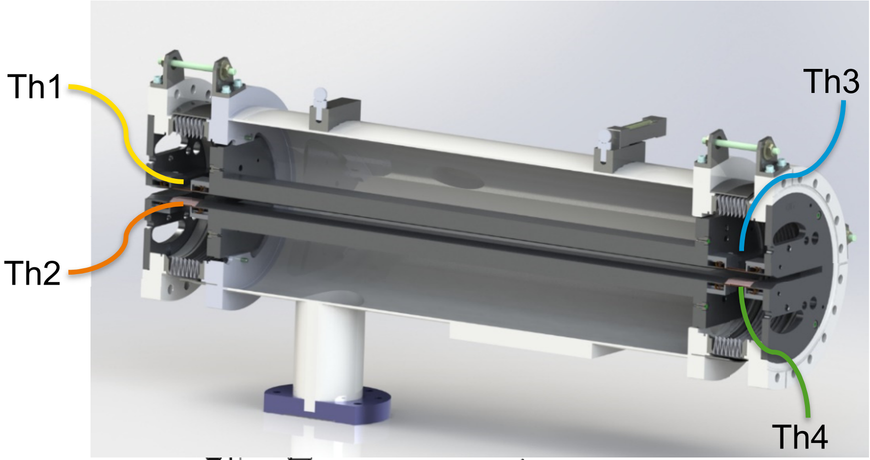
# TESTS – CT IMAGES

## Electrical contact CuBe2 blades / Al flange




Perfect electrical contact

# TEST ON EXISTING MACHINE

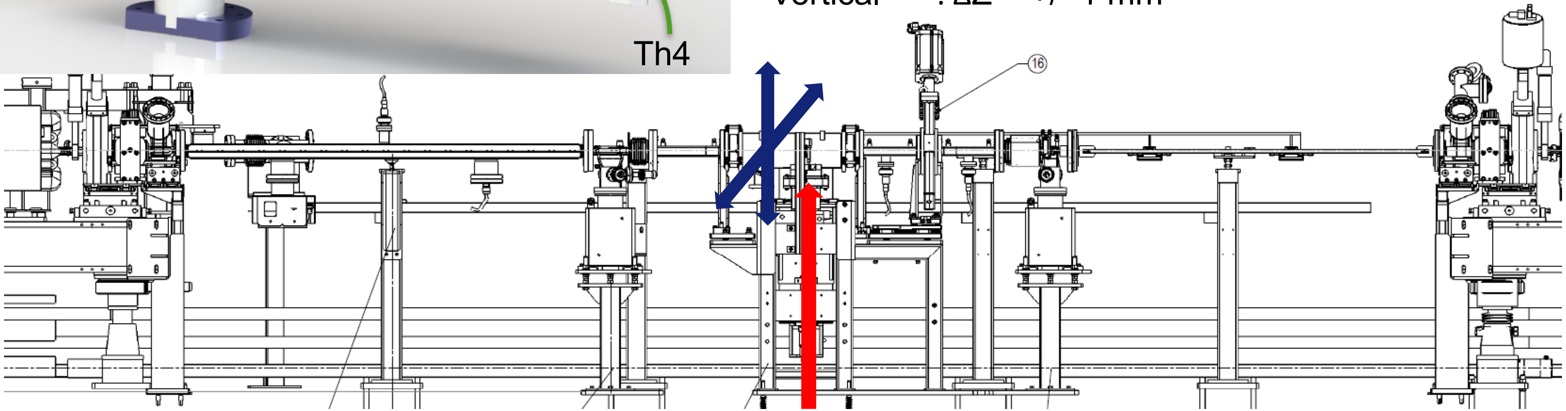



Study of ΔZ and ΔX misalignment of RF finger proto chamber with different beam parameters.

**Checked Results:**

- Vacuum pressure
- RF-Finger temperature
- orbit stability

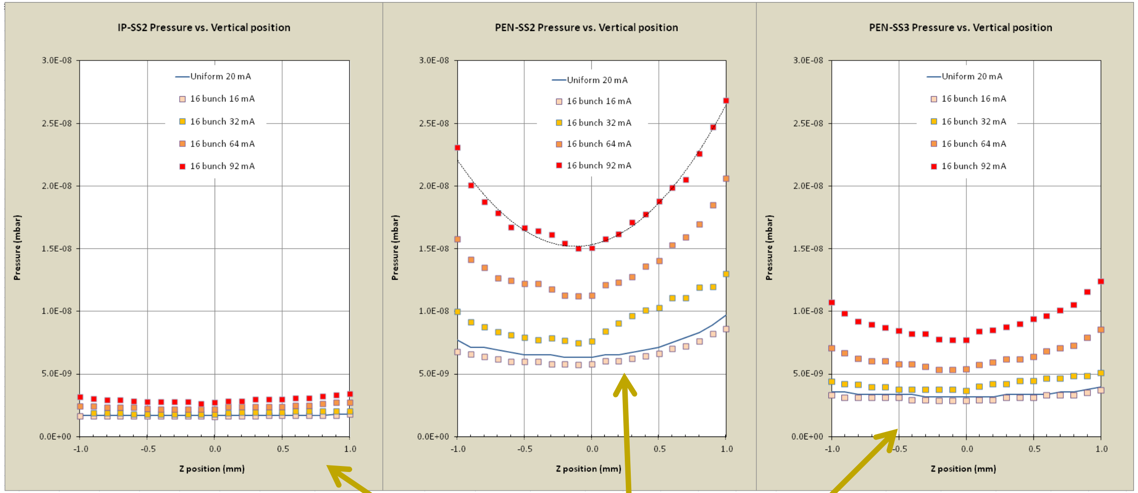
Horizontal : ΔY = +/- 1 mm
Vertical : ΔZ = +/- 1 mm



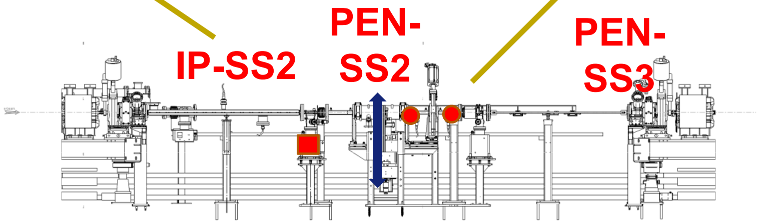

RF Fingers chamber

# TEST ON EXISTING MACHINE

## Pressure vs. Vertical position of RF finger Chamber




- ✓ No vacuum problem signature
- ✓ Good alignment

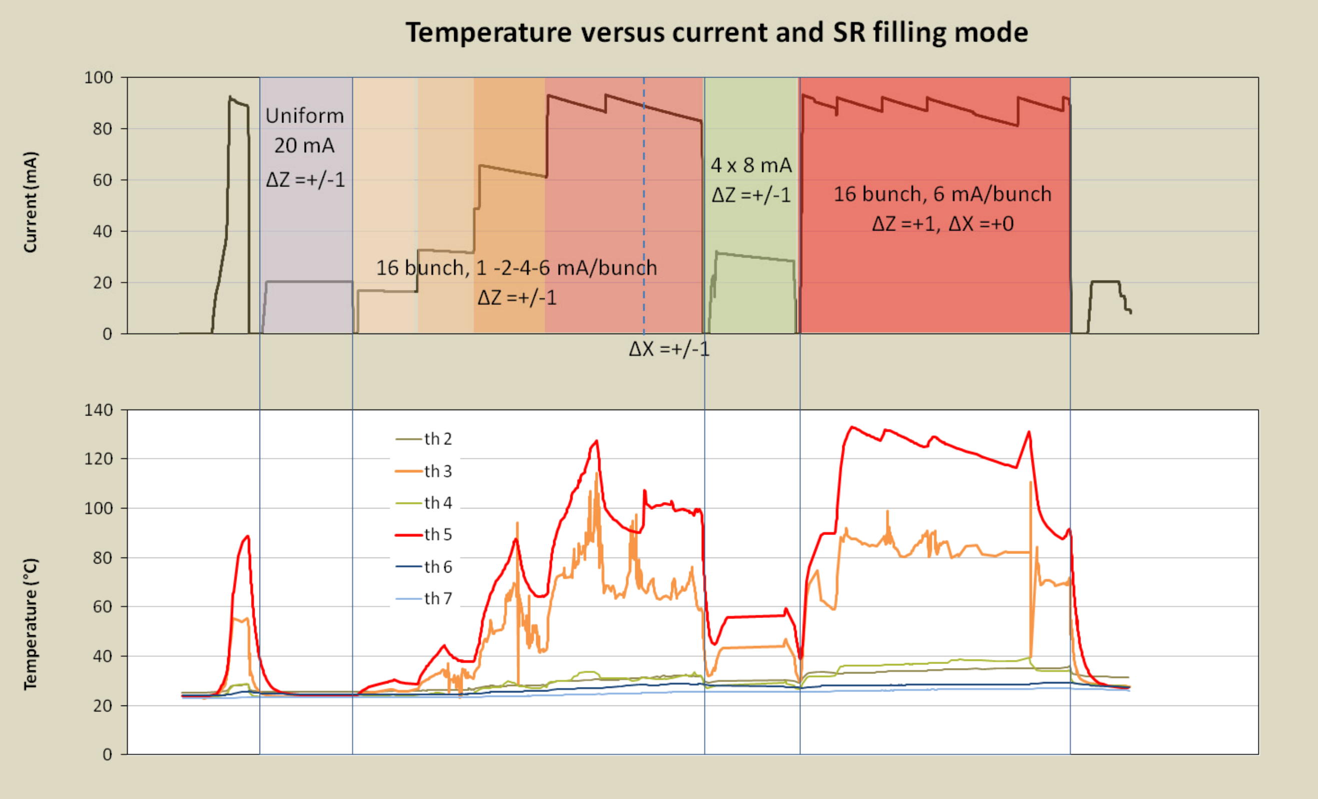



ΔZ = +/- 1 mm

*Courtesy of A. Meunier*

# TEST ON EXISTING MACHINE

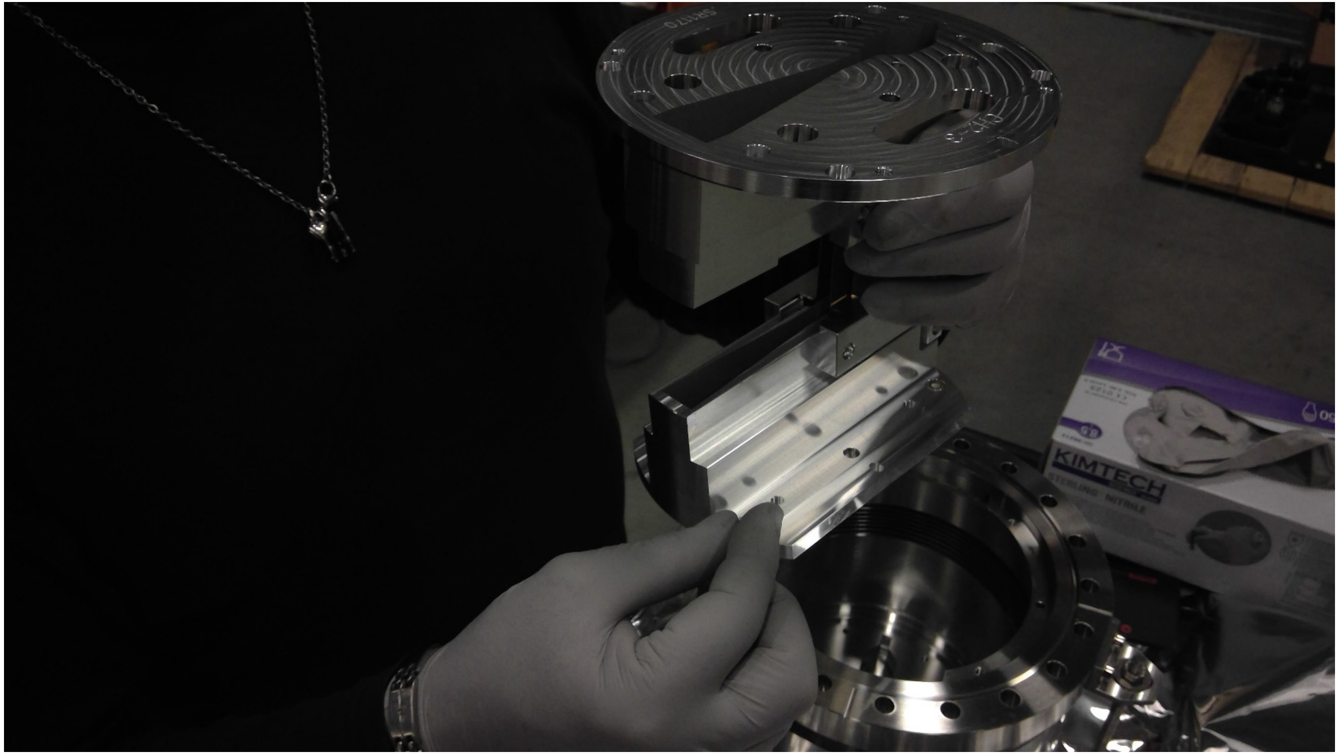
## Temperature vs. Vertical position of RF finger Chamber




- ✓ No abnormal heating and max T = 100 °C
- ✓ No beam orbit instability

*Courtesy of A. Meunier*

# MOUNTING IN BELLOWS




- Vacuum screws preparation

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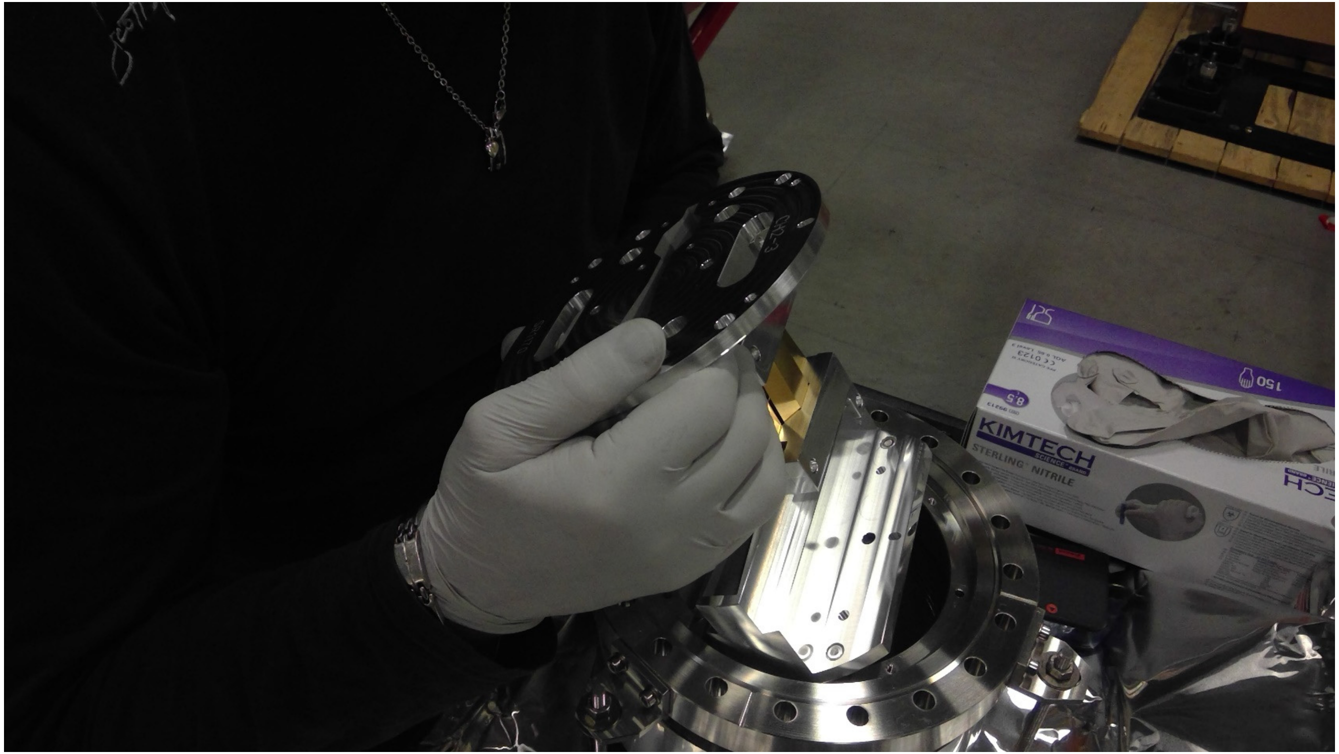


- Vacuum screws preparation
- Insert RF-Finger in bellows

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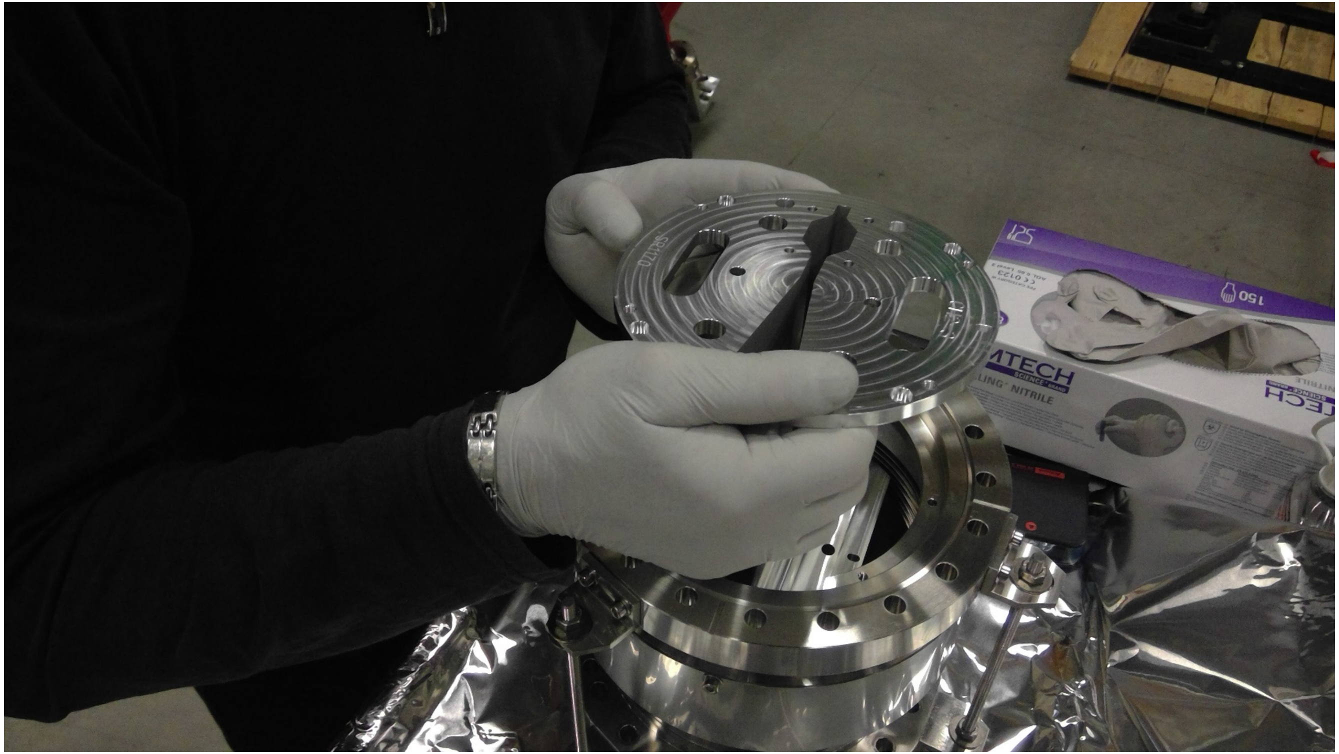

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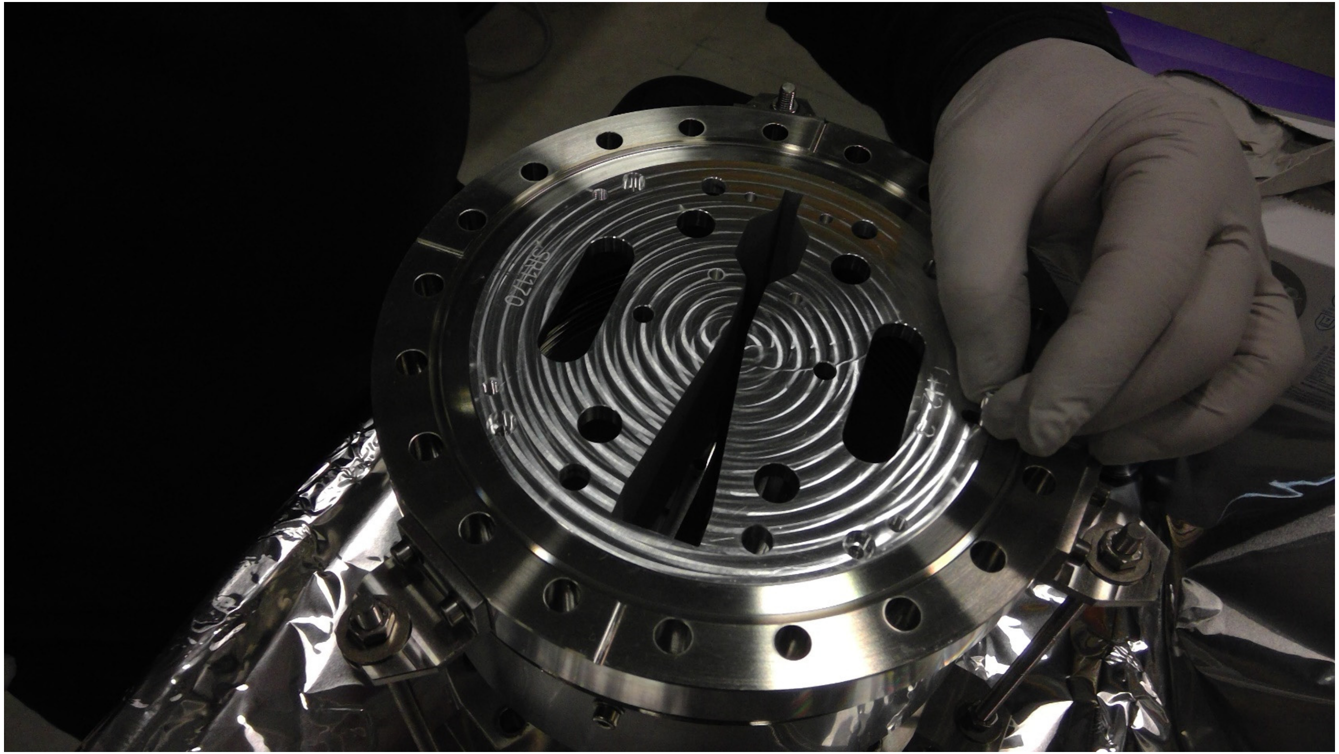
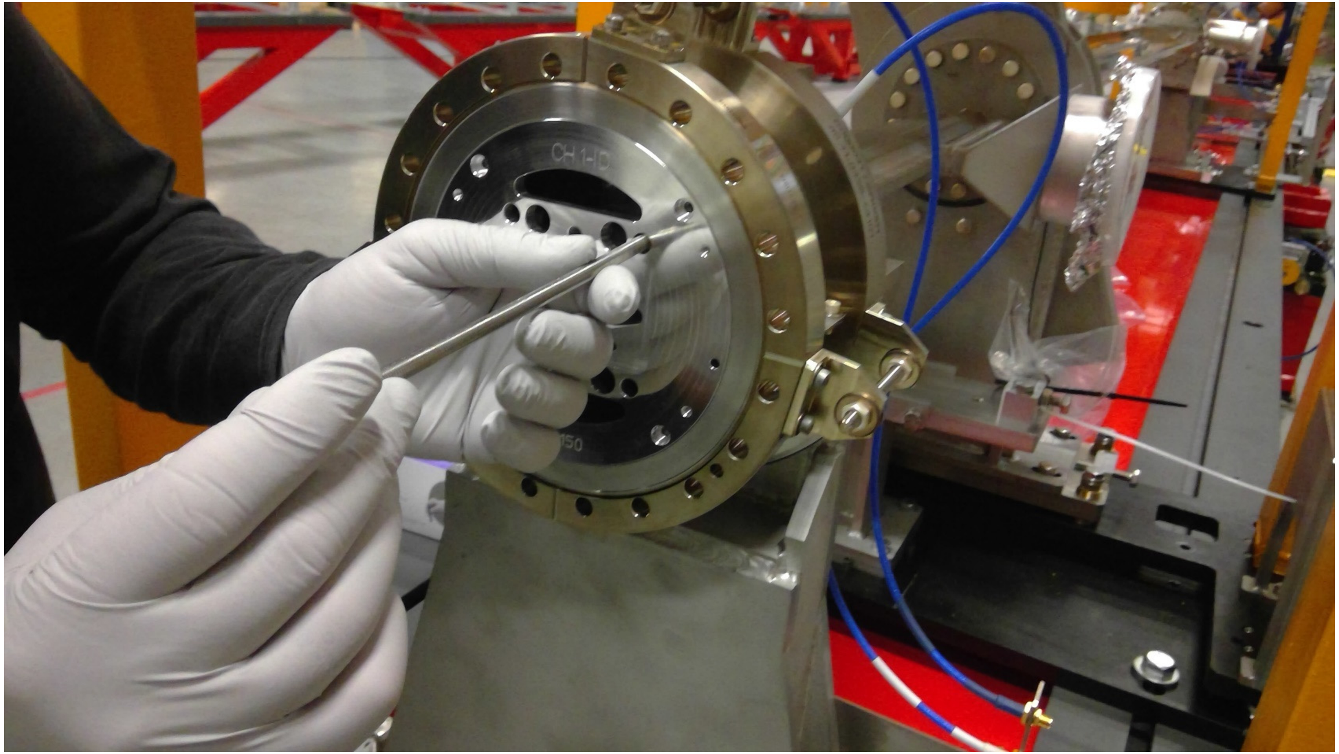


- ➢ Vacuum screws preparation
- ➢ Insert RF-Finger in bellows
- ➢ Centring pin in place

# MOUNTING IN BELLOWS

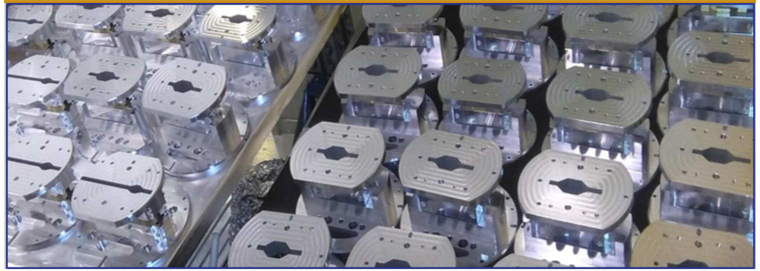



- ➢ Vacuum screws preparation
- ➢ Insert RF-Finger in bellows
- ➢ Centring pin in place
- ➢ Final fixation

# CONCLUSION

The ESRF's patented RF fingers are highly compact, robust and reliable components designed for the new ESRF-EBS machine.

**If you are interested in this technology, please CONTACT US** at industry@esrf.fr



## Features

- ❖ Excellent electrical contact on the edge of the sleeves in any position
- ❖ Flexible compact design adaptable to any shape
- ❖ Compact and light (less than 1 kg)
- ❖ No welding or brazing
- ❖ Easy to assemble and mount (few pieces)
- ❖ Parts replaceable
- ❖ No risk if finger falling into the beam area
- ❖ Large axial and radial stroke
- ❖ Long life (many cycles)

*Courtesy of M. Rivadeneira*

# THANK YOU FOR YOUR ATTENTION