

# Multipacting at LPSC

Meeting FCC vacuum and IN2P3

16 /11/ 2021

# Summarized

- Internal R&D IN2P3 Project 'Multipac'
- Multipacting test bench

# Internal R&D IN2P3 Project: Multipac

- Project on going
- IN2P3 laboratories involved: LPSC, IJC Lab, SIMaP
- Goal :
  - Improve the test bench dedicated to multipactor studies.
  - Master the phenomenon and apply this knowledge to particle accelerators
  - Explore Anti-Multipacting Surface Engineering Processes for Accelerators
- Support:
  - IN2P3 (with project funding )
  - CNRS (via the inter-institute call for projects 80Primes: EPISAMA project)
  - Carnot Energies Institute of the Future (NITALD project).

# Multipacting test bench

The accelerator group at LPSC has developed an experimental set-up dedicated to multipactor phenomenon study. The test bench is composed of :

- **RF devices** : Network analyzer, amplifier 80 MHz – 1GHz @ 400 W guaranteed...
- **Coaxial measurement vessel** : Coaxial line ( $\phi_{\text{ext}}$  : **38.8 mm** /  $\phi_{\text{int}}$  : **16.87 mm**) which allowed us to observe multipactor up to 180 MHz.
- **Diagnostics** : Power and pressure measurements, electron pick-up with a polarized antenna + 45V thermocouples, RGA.
- **Data acquisition and setup automation**: Handled by a LabVIEW software running on a standard PC
- **Clean room**: ISO 7 with ultrasonic bath, vacuum oven, demineralized water, ...

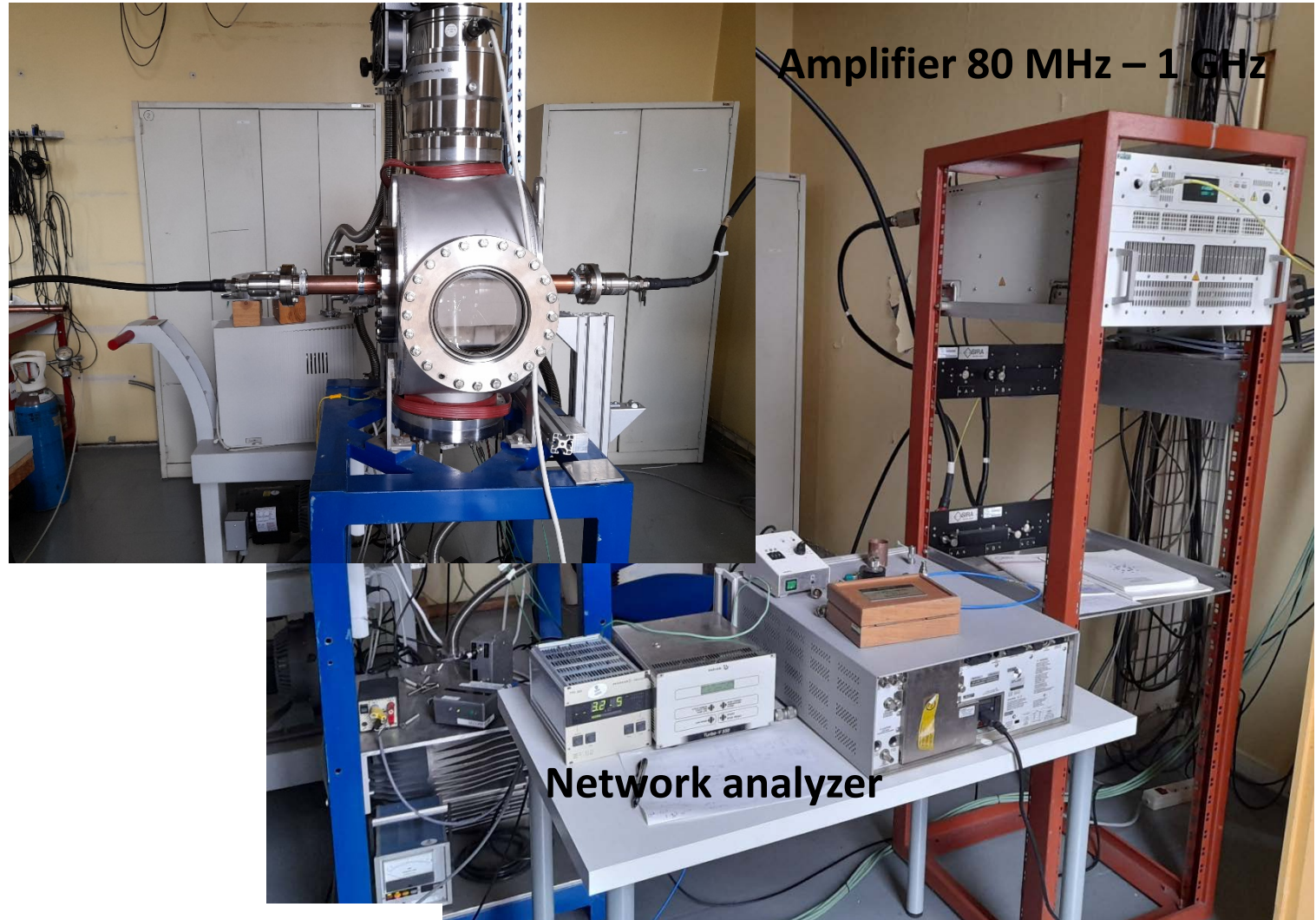
It can be used also to measurement of the multipactor on samples ( TiN, NEG..) coated at the coaxial lines

# Multipacting test bench

Coaxial measurement vessel



Amplifier 80 MHz – 1 GHz

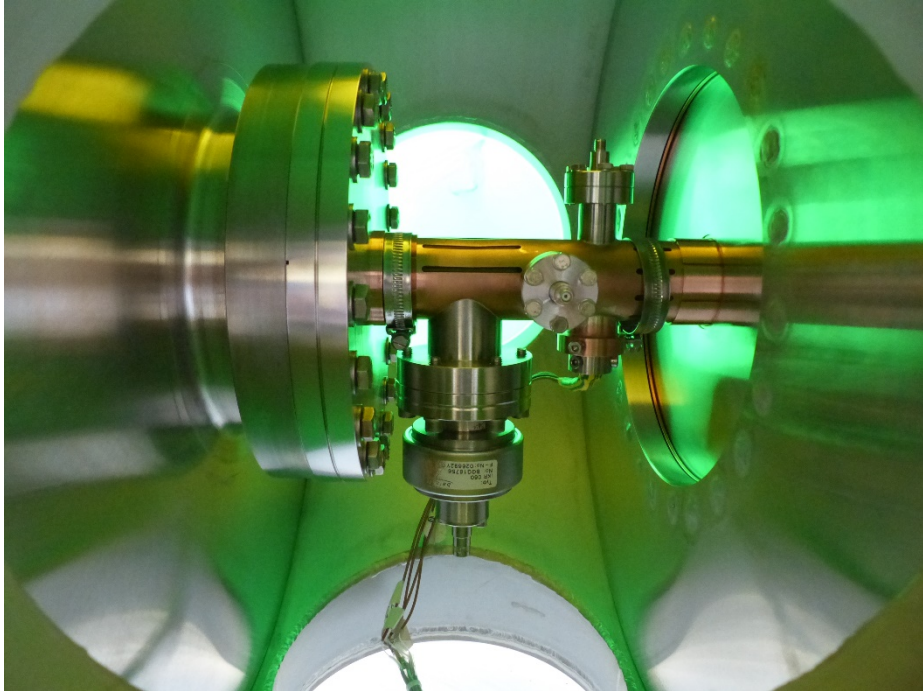


Network analyzer

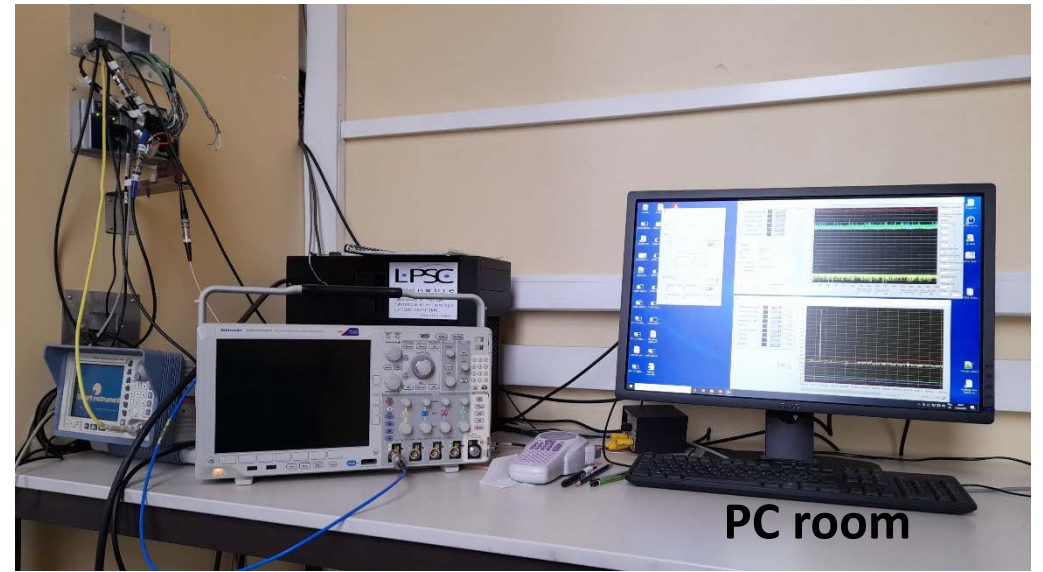
Test bench dedicated to multipactor studies



# Multipacting test bench



**Inside the coaxial measurements vessel**



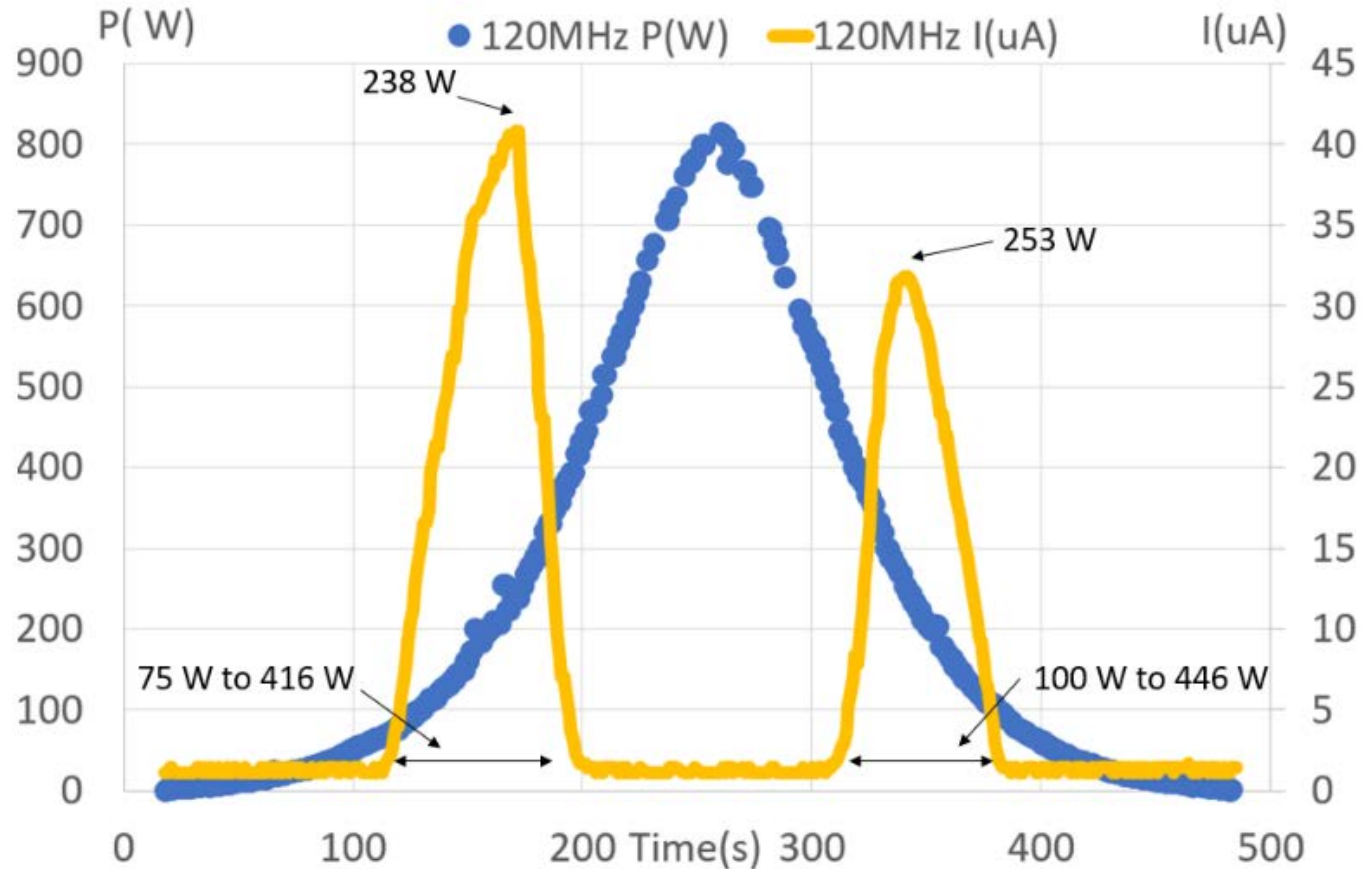
**PC room**



**Clean room ISO 7**

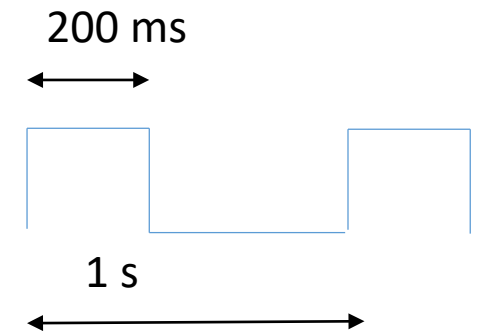
# Multipacting test bench

Monitoring measurements (One measurement per second, maximum values recorded)



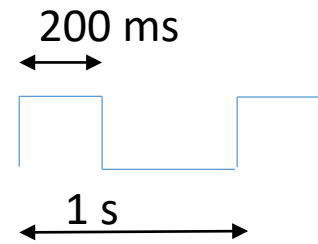
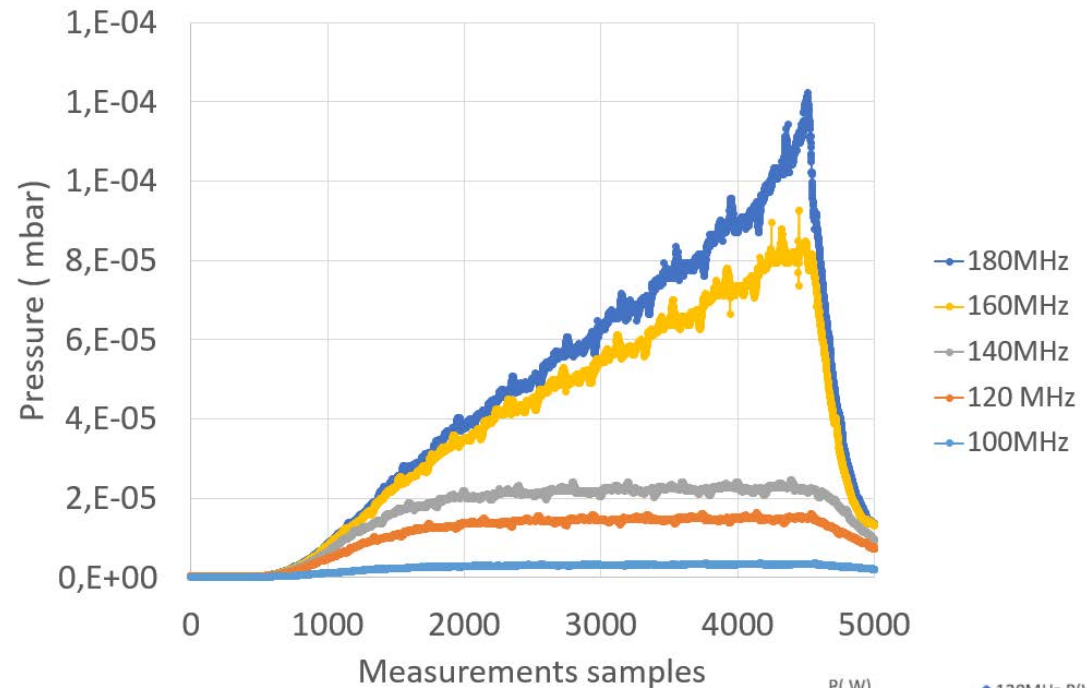
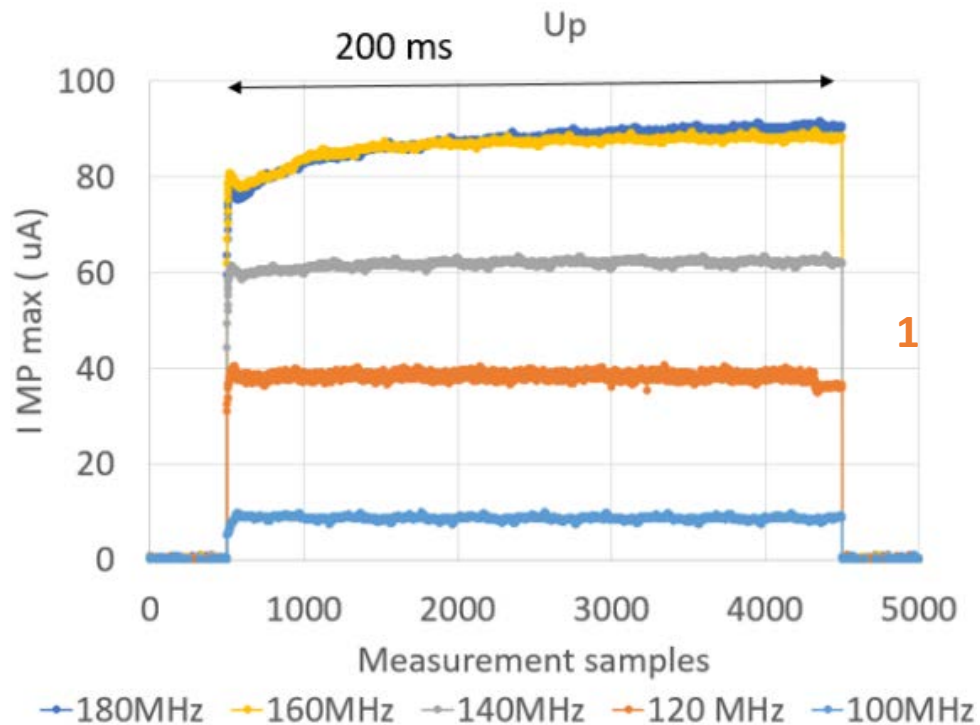
Power and multipacting measurement in pulse mode at 120 MHz

Consecutive rise and fall power ramp in pulse mode:

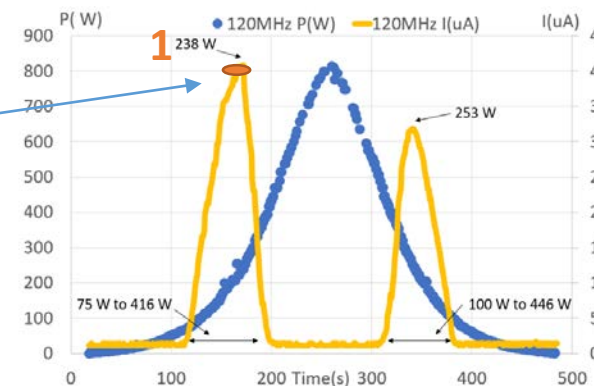


# Multipacting test bench

Snapshot (20 kS/s – 4000 samples @ 200 ms)

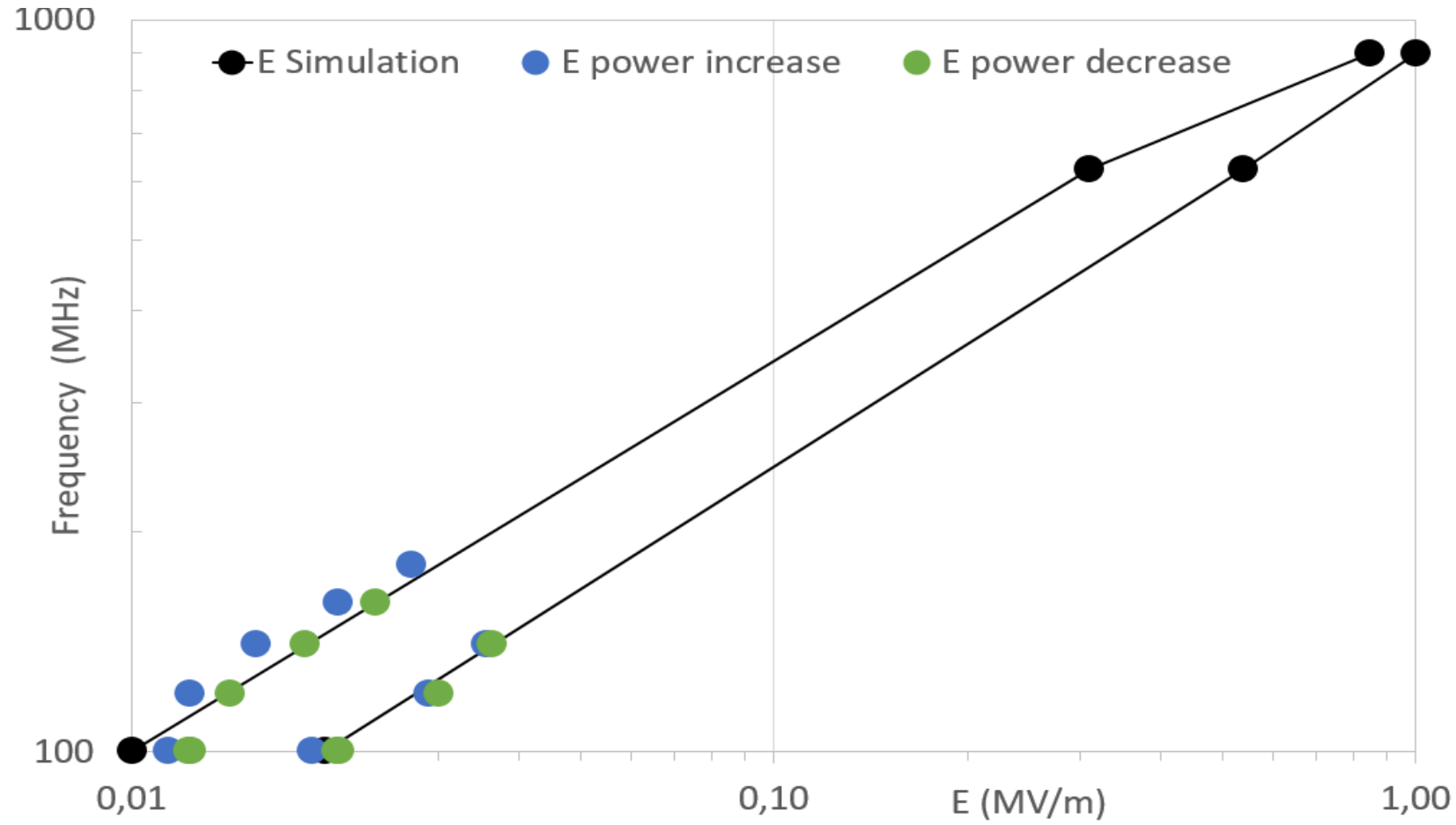


*A snapshot of waveforms at maximum multipactor current at point 1 when the power is increased at 100, 120, 140, 160 and 180 MHz.*





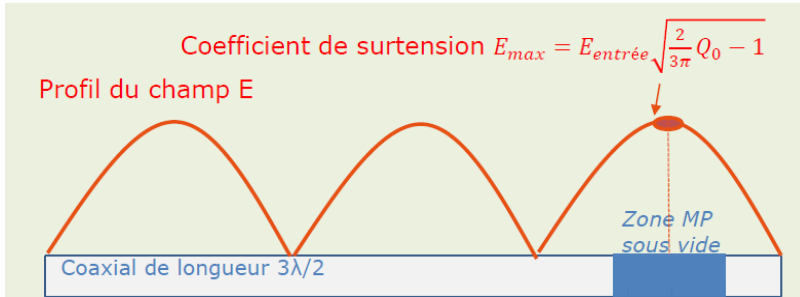
# Test bench measurement and simulation correlated



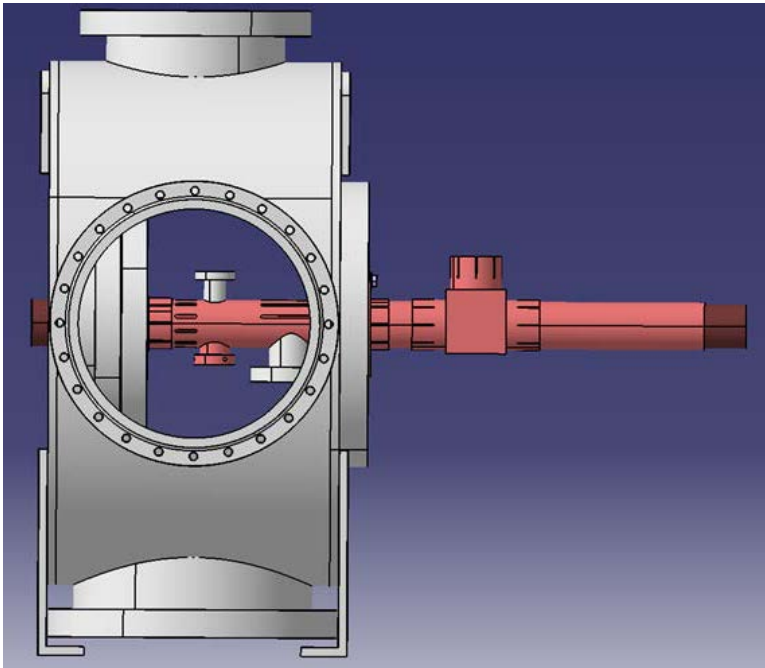
*Comparison of the electrical field range where multipacting has been measured and the simulation results (HFSS /MUSICC3D@IJC Lab).*

# Improving multipacting test bench

- Validation up to 1 GHz with resonant configuration



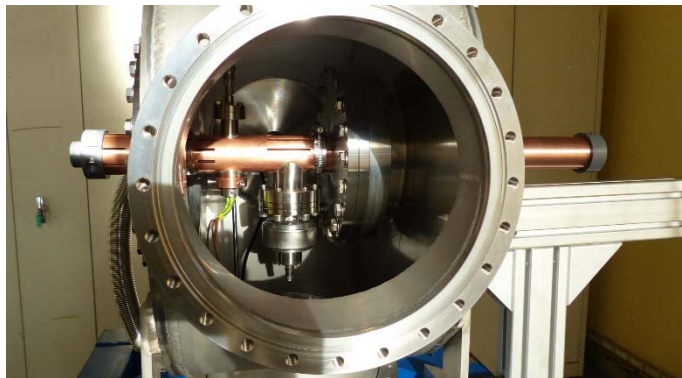
Frequency ( MHz)	$Q_{0\text{measurement}}$	K measurement	K theorie without dielectrics
911	1300	17	30
88	-	-	17



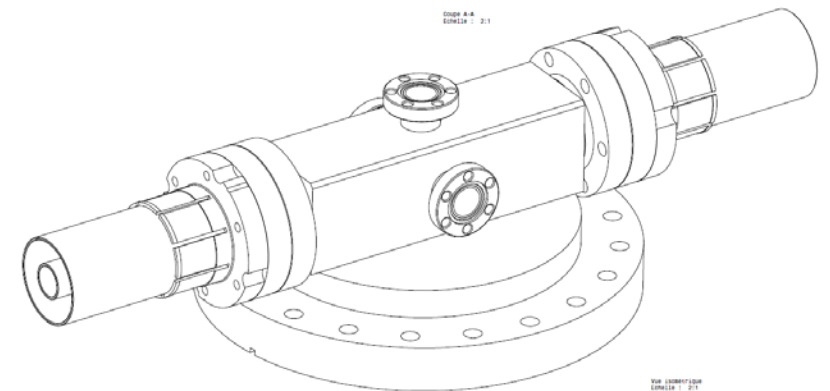
Test bench in resonant configuration

# Improving the multipacting test bench

- To study antimultipactor coated ( TiN, NEG ) on dielectric ( Al<sub>2</sub>O<sub>3</sub>) disk supports (  $\phi_{\text{ext}}$  : **38.8 mm** /  $\phi_{\text{int}}$  : **16.87 mm** )
- New diagnostics: Under study for implementation measurement of electron energy, arc detector, voltage probe.
- Placing the test bench in the clean room
- Adaptation to allow easy assembly and disassembly of samples
- Improving backing in situ
- Improving the vacuum level (  $10^{-8}$  mbar rather than  $5 \cdot 10^{-8}$  mbar today )



**Multipacting test bench**



**Improved multipacting test bench**