



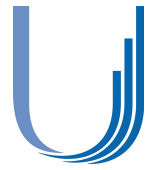
# LHC Injectors Upgrade





## LHC Injectors Upgrade





# Summary

***Existing RF systems.***

***Foreseen consolidation / upgrade.***

***New technology for C02 and C04.***

***Advantages / Risks.***

***5-cells Finemet<sup>®</sup> cavity prototype.***

***Foreseen tests.***

***Planning.***



# Existing RF systems

Three systems are presently installed in the machine:

## C02

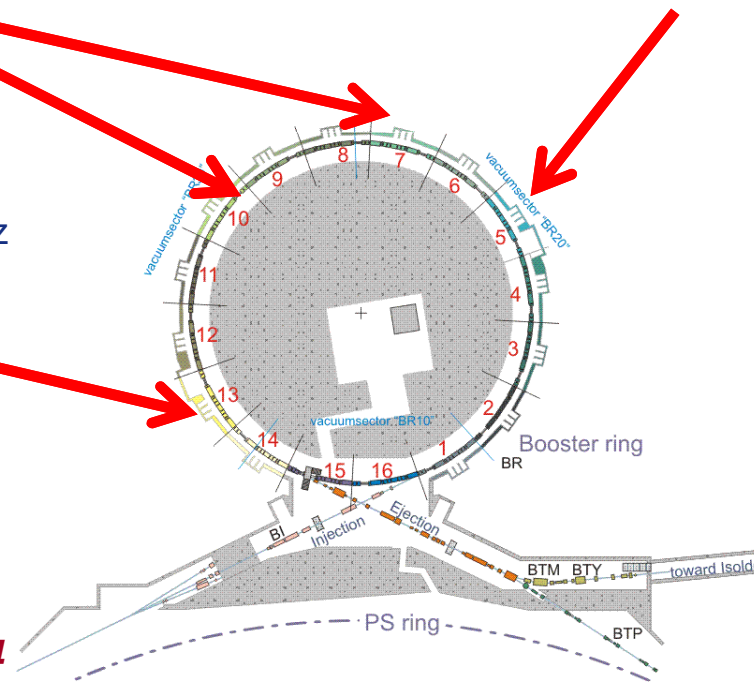
- Frequency range 0.6 (\*1.0) – 1.8 MHz
- Gap Voltage 8 kV
- Installed in sections 7L1 and 10L1

## C16

- Frequency range 6.0 – 16 MHz
- Gap Voltage 6 kV
- Installed in section 5L1

## C04

- Frequency range 1.2 (\*2.0) – 3.8 MHz
- Gap Voltage 8 kV
- Installed in section 13L1



\* Frequency with injection from LINAC4



# Foreseen consolidation/upgrade

## *In the ring:*

- Keep the cavities
- Keep the C02 and C16 final amplifiers
- Redesign the C04 final amplifier to:
  - Increase the mean available RF power
  - Increase the available RF current for beam loading compensation.
  - Deal with the foreseen 2 GeV energy upgrade.
- Replace all the irradiated cables.

## *On the surface:*

- Replace the interlock system with modern PLC.
- Replace the interfaces with the control system (G64!!!).
- Move the AVC and Tuning loops to the new digital beam control electronics.
- Implement new protections.
- Replace the 6 kV - 8 kV Anode HV power supplies and grid bias supplies.
- Install new stabilized tubes filament heaters.
- Replace tuning supplies.





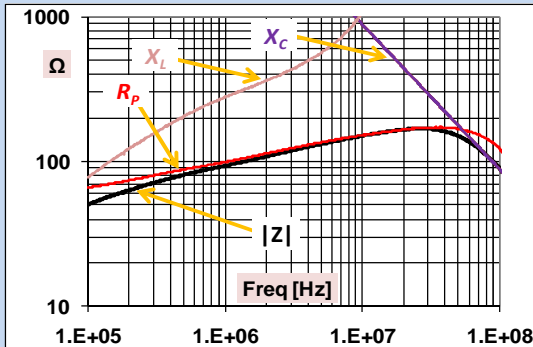
# New technology for C02 and C04.

*A substantial improvement could be achieved using wideband (0.6MHz to 4MHz), Finemet® loaded cavities.*

## Finemet exhibits wideband response

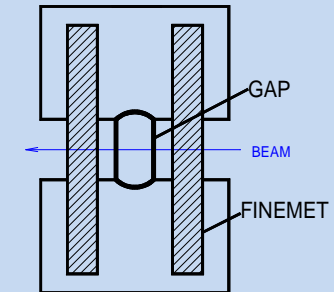
$C_p$  mostly depends on geometry and drives the high frequency response. The capacitive effect is enhanced by the final stage output capacitance.

$R_p$  and  $L_p$  drive the low frequency response. They are mostly dependent on Finemet® Characteristics.



*A basic cell configuration composed of one gap and two cores gives many advantages:*

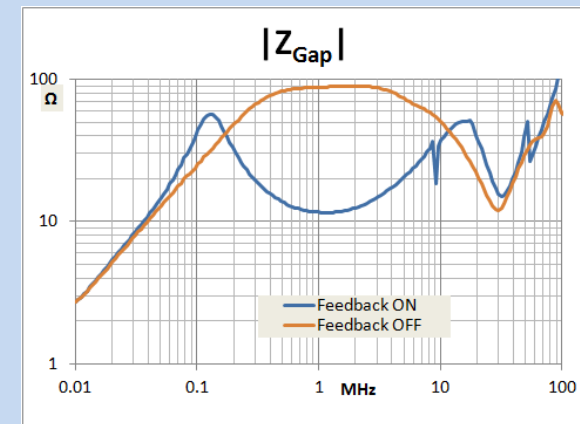
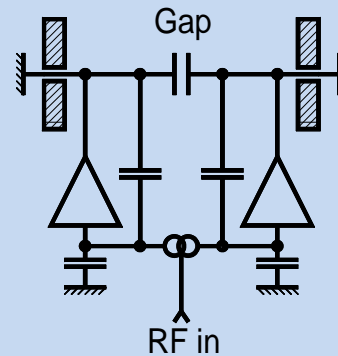
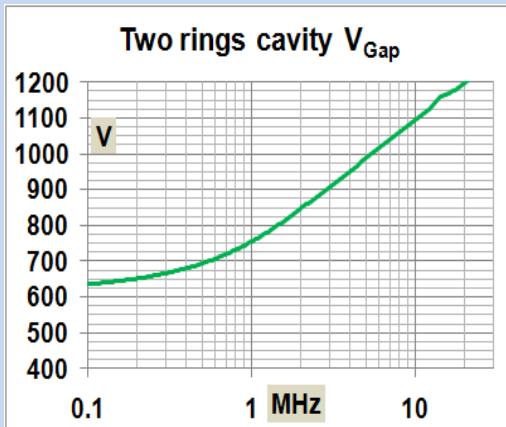
- Full exploitation of the Finemet® wideband response.
- Power requirements in the range of compact solid-state amplifiers.
- Fast RF feedback feasible to reduce the gap impedance and compensate the beam induced voltage.
- Gap voltage compatible with solid-state gap shorting devices.



## 2-Rings cavity

Size compatible with PSB.

$V_{Gap} > 700 V_{Peak}$   
 Freq > 600 KHz  
 P = 2 x 670 W  
 Length = 13 cm



*In the available space a substantial voltage increase can be achieved or hot spares can be installed.*





# Advantages / Risks

## *Advantages*

- Single system to cover C02 and C04 frequency range.
- Modular system.
- Solid-state amplifier.
- Multi harmonic operation.
- No tuning.
- Substantial increase of installed RF voltage (up to 300%).
- Increased system reliability (hot back-up by on line spare cells).

## *Risks:*

- New technology.
- New configuration
- Completely new design.
- Different beam compensation scheme.
- ...?

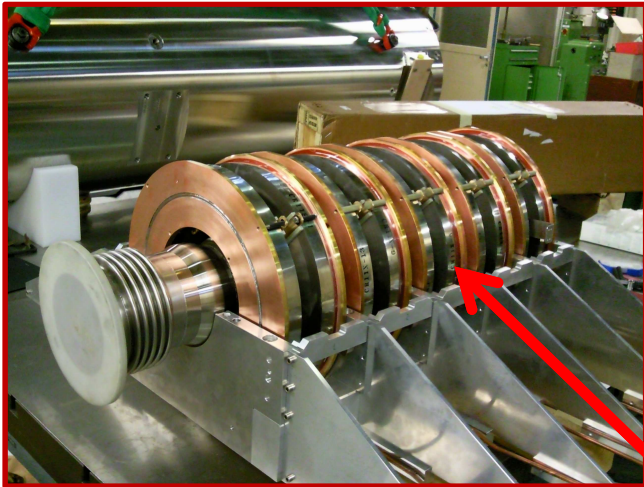
***Tests with beam absolutely needed.***





# 5-cells Finemet<sup>®</sup> cavity prototype

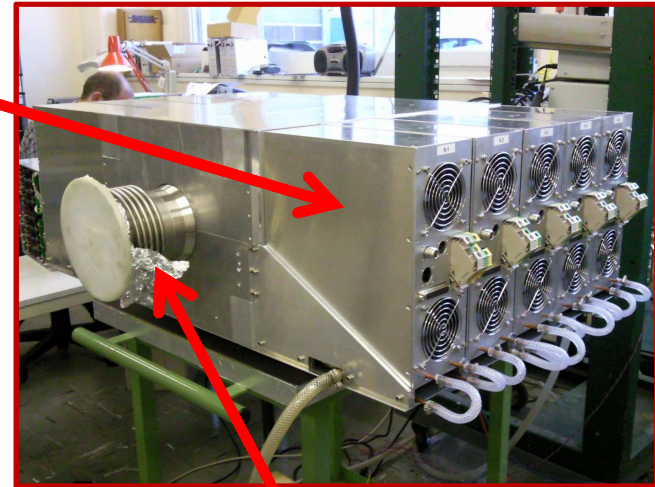
5-cells open cavity.



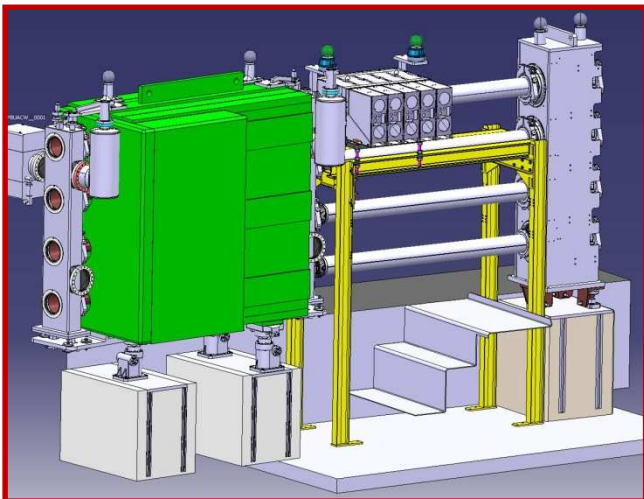
Solid-State amp.



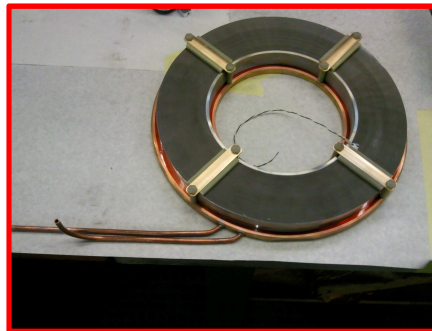
Full assembly.



Installation layout in PSB 6L1.



Vacuum chamber.



Finemet<sup>®</sup> on a cooling ring.







# Foreseen tests

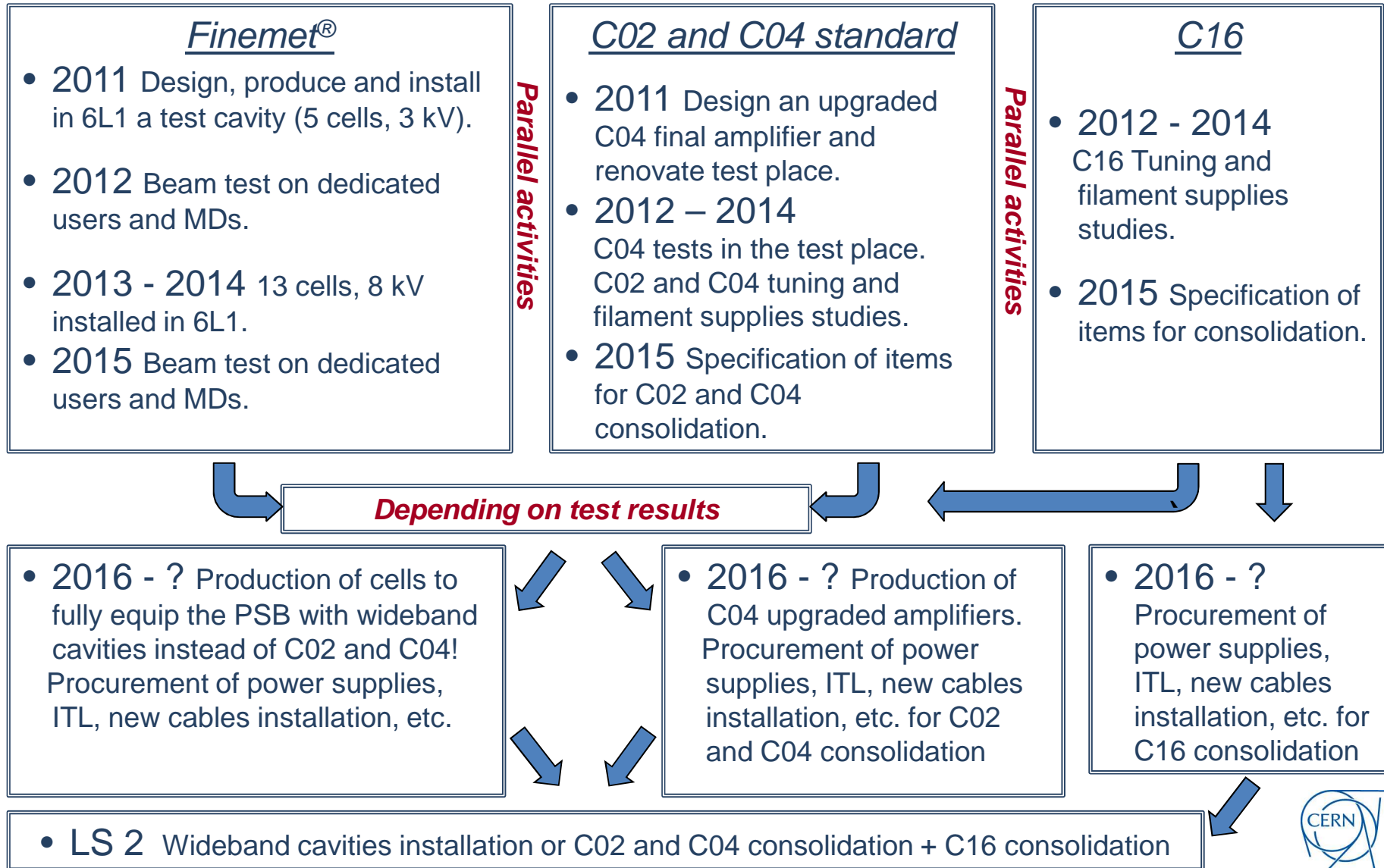
- PPM operation.
- Each gap equipped with shorting relays.
- Dedicated beam control low level electronics available.

## Beam test required to study:

- Operation with wideband cavities.
  - Beam loading compensation.
  - Beam instabilities build-up.
  - Amplifier reliability.
  - ... and much more!
- 
- Beam will be initially accelerated with the existing system to study the beam induced voltage and compensation effectiveness (RF feedback).
  - The new Finemet<sup>®</sup> system will then be used for acceleration using it either in parallel with the existing one or alone.



# Planning





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**THANK YOU FOR YOUR ATTENTION!**

