LHC Injectors Upgrade
PSB RF
Renovation and upgrade plans
Summary

Existing RF systems.
Foreseen consolidation / upgrade.
New technology for C02 and C04.
Advantages / Risks.
5-cells Finemet® 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 and 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.

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® cavity prototype

5-cells open cavity.

Solid-State amp.

Full assembly.

Installation layout in PSB 6L1.

Vacuum chamber.

Finemet® 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® system will then be used for acceleration using it either in parallel with the existing one or alone.
**Planning**

**Finemet®**
- **2011** Design, produce and install in 6L1 a test cavity (5 cells, 3 kV).
- **2012** Beam test on dedicated users and MDs.
- **2013 - 2014** 13 cells, 8 kV installed in 6L1.
- **2015** Beam test on dedicated users and MDs.

**C02 and C04 standard**
- **2011** Design an upgraded C04 final amplifier and renovate test place.
- **2012 – 2014** C04 tests in the test place. C02 and C04 tuning and filament supplies studies.
- **2015** Specification of items for C02 and C04 consolidation.

**C16**
- **2012 - 2014** C16 Tuning and filament supplies studies.
- **2015** Specification of items for consolidation.

**Parallel activities**
- **2015** Beam test on dedicated users and MDs.
- **2015** Specification of items for C02 and C04 consolidation.

**Depending on test results**
- **2016 - ?** Production of cells to fully equip the PSB with wideband cavities instead of C02 and C04! Procurement of power supplies, ITL, new cables installation, etc.
- **2016 - ?** Production of C04 upgraded amplifiers. Procurement of power supplies, ITL, new cables installation, etc. for C02 and C04 consolidation
- **2016 - ?** Procurement of power supplies, ITL, new cables installation, etc. for C16 consolidation

**LS 2** Wideband cavities installation or C02 and C04 consolidation + C16 consolidation
LHC Injectors Upgrade

THANK YOU FOR YOUR ATTENTION!