Feasibility of installation in the LHC and SPS

A. Rossi, V. Previtali, B. Salvachua

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Integration issues

- Space available in SPS and LHC
- Cryogenics
- Vacuum
- Impedance
- Overlapping with other devices
- Summary
E-Lens TEL2

Operating temperature
Solenoid 4K
Vacuum RT

Vacuum $\sim 10^{-8}$ mbar
LHC IR4 RB46 or RB44

Intrabeam space 420 mm
RB46 preferred because rounder beam and
LHC IR4 RB44 integration

Rotation of the TEL2 e-gun and collector for integration in IR4
⇒ Need of new support

Y. Muttoni
SPS BA4 (~ Coldex location)
If is series to crab cavities no room for a second Y chamber? TBC

Collimation scheme to be checked. Existing collimators in SPS:
- 51899-BRCV (vertical)
- 51902-BRCH (horizontal)
- 52102-BRCZV (vertical)
Integration issues

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Typical flow scheme of a LHC sector for cryogenics

- The solenoid for the e-lens could be seen as a stand-alone magnet at 4.5K
- As such, it would require dedicated supply/return helium cryogenics interfaces
- So far for LHC, done via a dedicated service module of the distribution line (QRL)
- To be studied if present RF interface could fit, provided a new dedicated RF refrigerator is confirmed for LS2, (some 30-50m distance to RB zones)

Courtesy of S. Claudet
Interfaces to be considered

- **Mechanical:**
  - Operating pressure, stability required, maximum allowed pressure (safety device), test pressure: 17 bar
  - Number and type of interfaces for supply/return piping

- **Thermal:**
  - Heat loads at different temperatures: 4K, 12W He vessel, 25W N₂ shield
  - Particular constraints for cool-down & warm-up

- **Electrical (power):**
  - How to power and protect the leads and magnet (QPS?)

- **Instrumentation/Controls:**
  - Input signals (pressure, temperature, level)
  - Output signals (Cryo start/maintain for powering)
Sequence to be considered

**Preliminary integration study for final layout**

**Formal validation required after each step**

- Gathering of information, clarification of interfaces
- Qualification of HW at surface (SM18 or equivalent) to check technological aspects
  
  (Possible qualification with SPS beam if appropriate, as done for crab cavities as LHC was not considered as a test bench). Does this apply for e-lens? **Could be installed in BA4 but not working at the same time as Crab Cavities.**

- Final installation in LHC

Courtesy of S. Claudet
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**Tevatron specifications**

Devices to be installed must meet the following criteria:

1. The device must be able to be baked to a temperature of at least 100 degrees Centigrade.
2. The device must reach $1 \times 10^{-8}$ Torr in a 3 day period, using the same ion pumps as it would use in the Tevatron, and blanked off in a manner which represents conditions in the Tevatron.

**G. Stancari:** @ Tevatron the beam-pipe vacuum is provided by 4 ion pumps (255 l/s nominal, total) and includes valves upstream and downstream; since installation in 2006, pressure has been in the $1E^{-9}$ to $1E^{-8}$ torr also during warm-ups of the Tevatron or during scraping experiments.
Electrodes are basically unbaked

If pressure measured at ion pump location central pressure higher
Vacuum requirements for LHC

- E-lens enclosed between valves provided with NEG cartridge, pump and gauge. TO BE INTEGRATED

- Possible instabilities (pressure and e–cloud) TO BE VERIFIED (e–cloud should be suppressed by solenoid field when e–lens working)

- Possibility of baking at higher temperature TO BE INVESTIGATED

- Surface tests required
Integration issues

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Impedance

- Impedance issues at Tevatron very different from CERN since Tevatron bunches much longer (1–2 m)

- Preliminary studies with a layout similar to the Tevatron setup show:
  - Very large longitudinal impedance (both low frequency contribution and resonant modes)
  - Smaller transverse impedance contribution
  - The current model is quite unfavourable as it assumes that all inserts are floating

❖ Some modifications are likely be required in this region, to be confirmed.
Integration issues

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- Summary
Overlapping with other devices

**SPS – BA4**

- Interference with COLDEX up to end of 2015 (TBC)
- Competing with Crab Cavities (same or different Y chambers?)

**LHC – IR4**

- Space for both Crab Cavities and E–lens if installed at opposite sides of IP4.
Integration issues summary

- Space available and overlapping with other devices:
  - Does TEL2 physically fit in SPS if Crab Cavities installed at the same time (Y chamber?) If in parallel to be operated separately because cryo cannot supply both devices at the same time.
  - LHC: turning of gun and collector solenoid necessary. Consequences?
  - Space for cables? Water cooling for collector?
  - Can we use the same power supply? Where to install them? Will they work at 50 Hz?

- Cryogenics
  - Interfaces
  - Quench protection system?
Integration issues summary

- **Vacuum**
  - E-cloud and pressure instabilities to be checked
  - Can we bake the beam pipe at higher temperature?

- **Impedance**
  - Longitudinal both low and high frequencies too high. Modification likely to be required.

- **LS2 or earlier shut down periods?**

- **What can be prepared before final installation?**

- **What else?**