Follow up of LHCb RF box studies

N. Biancacci for the impedance team

Acknowledgements:
Introduction

LHCb – Ve(rtex)lo(cator)

LHCb detector

Picture from P. Collins, 2nd RF foil checkpoint Meeting, March 2017
Introduction

- One of the main limitation in the detector resolution is represented by the amount of multiple scattering the particle have in the Al RF box.
- One solution currently explored (< LS4) is to reduce the Al thickness from 350um to 150um in the RF box sensitive areas by chemical etching.
- Other alternatives being explored for phase-II upgrade (> LS4)
# Timeline

**LHC roadmap: according to MTP 2016-2020**

<table>
<thead>
<tr>
<th>Year</th>
<th>LS2 Starting in</th>
<th>LS3 LHC: Starting in</th>
<th>Injectors: in</th>
<th>Duration BC</th>
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<td>2020</td>
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<td>2021</td>
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- Physics
- Shutdown
- Beam commissioning
- Technical stop

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**LHC Performance Workshop 2016 – Chamonix’16**

Conclusions
F. Bordry
3rd March 2016
Phase I RF box upgrade

Al RF foil thinning by etching
- Baseline option for phase-I upgrade being followed up with NIKHEF.
- Promising results of chemical etching down-to 250um, being tested to get 150um.
- Extensive description of etching tests in *P.Maurin, 2nd RF foil checkpoint Meeting*
Phase-II RF box upgrade

1) Al RF foil thinning by “polishing”
   • Discussed with CERN experts G.Favre and S.Atieh.
   • Novel technique for surface polishing down to order of 10nm.
   • Uses water polishing with diamond particles.
   • Polishing for longer time scales would provoke surface erosion similarly to etching.
   • An Al RF box window could be provided for testing.

Actions needed

   • Provide a test-bench to perform a mechanical etching.
   • Verify thinning achieved as well as uniformity and vacuum leak tightness.
Phase-II RF box upgrade

2) Metal coating on polymers.
   - An option could be using PEEK polymers (high temp. melting point ~380 C).
   - Expertise with polymers already present at CERN and currently being investigated (S.Tavares).
   - Transparent to particles.
   - Possibility to mill halves to approach more the detectors.
   - Need to be coated to screen RF fields (50-100um Cu).
   - Could reconsider the presence of foil corrugations.
   - Already done at CERN in the past for a crab cavity mokup.
   - Tests being carried out also by Vacuum (G.Bregliozi).

Actions needed
   - To produce a PEEK block to be coated with metal (Cu).
   - To measure outgassing rate before/after backeout.
   - To assess the gain in detection resolution and impedance/RF shielding.
Phase-II RF box upgrade

3) No RF foil

- Would be the best option to improve resolution
- Need to make detectors and electronics/cables compatible with LHC primary vacuum (discussion on going with vacuum experts)
- Cannot imagine absence of path for beam image currents - huge resonant modes in the whole geometry (large pillbox), fields at the detectors, edge effects, heating, ...
- RF field coupling inside could be removed by ad-hoc All Mode Couplers.

Actions needed

- To simulate the Velo without RF box and with detectors - STP file needed.
- To assess the impact on impedance and instability.
Phase-II RF box upgrade

4) Wire mesh RF box

• A Beryllium wire mesh can give effective RF shielding (F.Caspers)
• Material density can be made same as thin Al foil (or better?)
• UHV compatible
• Need to consider only one vacuum.
• Engineering questions: wire path, spacing, orientation, radius? Industries available (see for example here)

Actions needed

• To produce a Beryllium wire mesh and assess screening efficiency.
• To assess shielding efficiency
• To assess gain in resolution as a function of material density.
• To assess the RF box shape and rigidity.
Conclusions and outlook

- **Alternative scenarios for the phase II LHCb Velo upgrade are available.**
- **Long timeline (2025!)** - Not an excuse to relax 😊
- **BE-EN-EP-TE groups involved** - great opportunity for pushing knowledge in material engineering for physics targets!
- A series of **common actions have been envisaged** in order to follow up and improve/select the alternatives: **coordination needed!**
- It is a **full-time task and resources should be allocated** (shared Doct/Fell between ABP/LHCb?)