

Reminder of VELO WF studies and WF suppression design

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LHC Impedance WG
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NB: informal presentation on Elias' request (exposes only myself, not LHCb)

VELO detectors (silicon strips) are in the vacuum

- ▶ separated from beam vacuum by a thin Al foil
- ▶ a 'WF suppressor' ensures continuity to beam pipe

Among the many challenges we had to face was the RF challenge

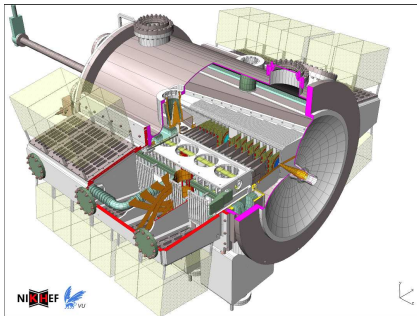
- ▶ VELO must not deteriorate the LHC beams (impedance)
- ▶ VELO must not deteriorate *because of* LHC beams (RF heating or RF pick-up noise)

Performed WF simulation studies (MAFIA, ABCI)

Performed 1:1 scale mock-up measurements (NIKHEF)

Performed RF pick-up sensitivity tests with prototype detectors

Discussed with LHC Impedance experts (D. Brandt, L. Vos, O. Brüning) within LEMIC (K. Potter) and LEB (R. Veness, now M. Gallilee)



LHCb Public Notes

1. '*A first study of wake fields in the LHCb vertex detector*' N. van Bakel, J.F.J van den Brand and M. Ferro-Luzzi, CDS LHCb-99-041
2. '*Wake fields in the LHCb vertex detector: strip shielding*' N. van Bakel, J.F.J van den Brand and M. Ferro-Luzzi, CDS LHCb-99-043
3. '*Wake fields in the LHCb vertex detector : alternative designs for the wake field suppressor*' N. van Bakel, J.F.J van den Brand and M. Ferro-Luzzi, CDS LHCb-99-044

LHCb Internal Notes:

1. '*Shielding of the VELO detectors from the LHC beam high-frequency fiels : preliminary considerations*' N. van Bakel and M. Ferro-Luzzi, LHCb-2001-081
2. '*Numerical calculation of the VELO coupling impedance*' N. van Bakel, J.F.J van den Brand and M. Ferro-Luzzi, LHCb-2001-082

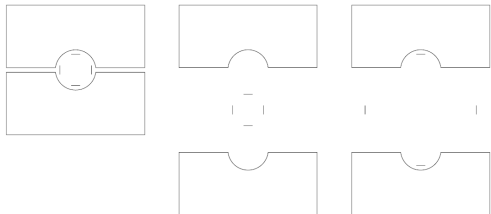
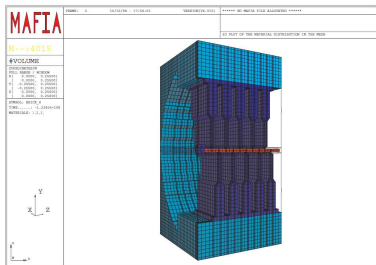
Temporarily here:

<http://massi.web.cern.ch/massi/tmp/lhcb-wakefield-notes/>

'Wake fields in the LHCb vertex detector: strip shielding'

N. van Bakel, J.F.J van den Brand and M. Ferro-Luzzi, CDS LHCb-99-043

Started with a box with deep corrugations 'hidden from the beams' by long thin metallic strips



Features:

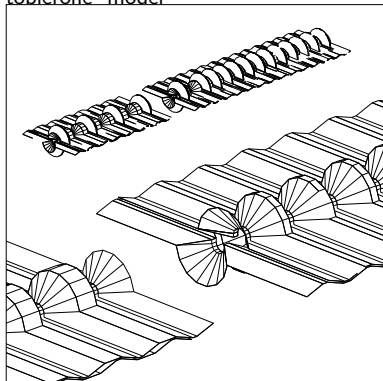
- ▶ Strips are really needed with this kind of deep corrugations
- ▶ Strips are not nice in terms of material transparency (for forward particles)
- ▶ Not so nice results when opening the detectors
- ▶ Mechanically difficult

'... alternative designs for the wake field suppressor' (1)

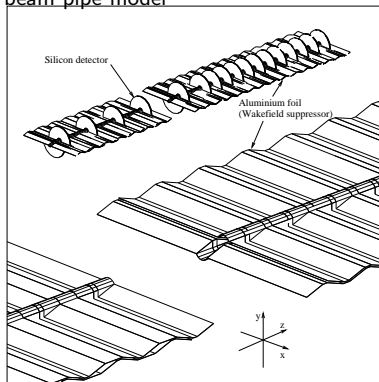
N. van Bakel, J.F.J van den Brand and M. Ferro-Luzzi, CDS LHCb-99-044

Explored design without strips, but reduced corrugation depth

'toblerone' model



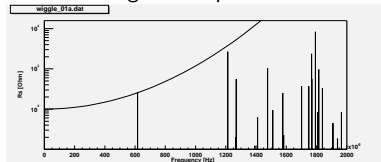
'beam pipe model'



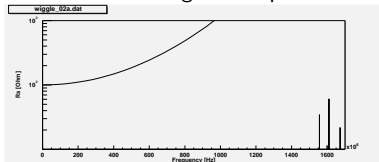
'... alternative designs for the wake field suppressor' (2)

'Wake field suppression is needed for the proposed vertex detector structure [...] The effect of shielding with an RF-screen depends on the corrugation depth of the RF-screen; simulations show that losses due to resonant modes become acceptable for a corrugation depth smaller than 20 mm. The Beampipe and Toblerone designs provide sufficient shielding (frequency domain) when the detector halves are closed. If the detector halves are retracted from the beam axis lower frequency eigenmodes arise and the heat loss rises to several Watts for both geometries. This is still acceptable but has to be studied in more detail, preferably in an experimental setup. [...]

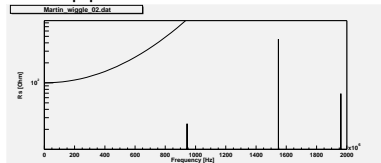
20 mm corrugation depth



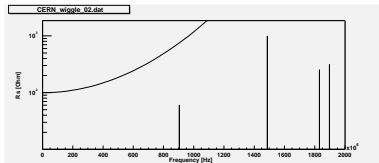
5 mm corrugation depth



'beam pipe model' OPEN

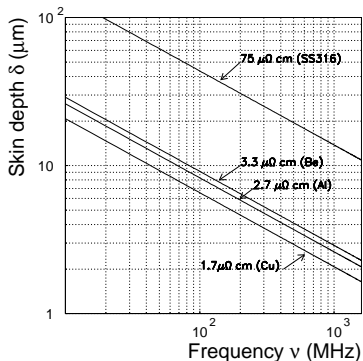
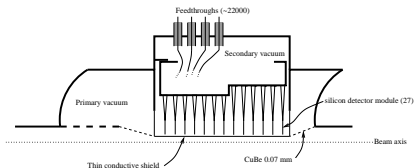


'toblerone' model OPEN

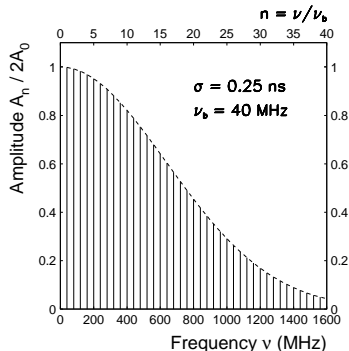


'Shielding of the VELO detectors from the LHC beam high-frequency...'

N. van Bakel and M. Ferro-Luzzi, LHCb-2001-081

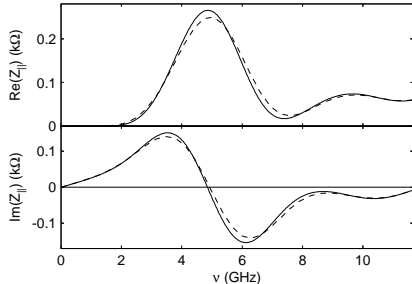
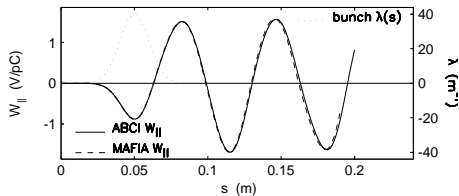


'We presented an estimate of absorptive attenuation of the LHC high-frequency fields through the thin-walled encapsulation of the LHCb VELO. We argued that the (aluminium) wall thickness of 100 μm proposed in the Technical Proposal is sufficient to shield the detectors against high-frequency components of the LHC bunch spectrum when only considering RF attenuation in the shield. However, other ways of picking up RF noise (through gaps, feedthroughs, or low frequencies) should be considered and tested in a realistic environment.'

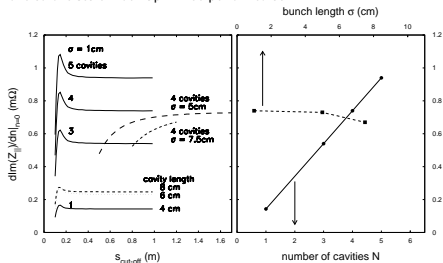


'Numerical calculation of the VELO coupling impedance'

N. van Bakel, J.F.J van den Brand and M. Ferro-Luzzi, LHCb-2001-082



'We performed a set of computer simulations (using the MAFIA package) to estimate the low-frequency slope of the longitudinal impedance of the LHCb VELO baseline design with the detectors in the closed position. From these studies we expect $[d\text{Im}(Z_{||})/d\nu]_{\nu=0} \approx 5.5 \text{ m}\Omega$. Further studies will be carried out for the detectors in the open position and measurements on a one-to-one scale mock-up will be performed at NIKHEF.'



Production Detector Vacuum Box (RF)

(November 9, 2006)

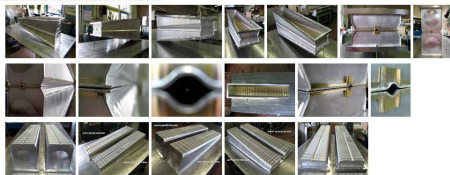
The Second Right en Left box are ready for transport to CERN.
Two PT100's are glued in each box and a Torlon coating (for electric isolation) is brushed on the inside.



RIGHT BOX:



LEFT AND RIGHT DETECTOR BOX:



“Mechanical design Vertex Locator” (at NIKHEF)

<http://www.nikhef.nl/pub/departments/mt/projects/lhcb-vertex/>

“Detector Vacuum Foil (RF box)”

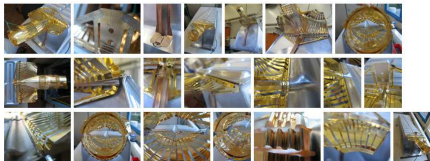
<http://www.nikhef.nl/pub/departments/mt/projects/lhcb-vertex/prototypes/secondary-foil>

Production of Wake Field Suppressors

Prototype work Wake Field Suppressor

(July 19, 2006)

The new extended downstream weak field suppressor is ready.



“Mechanical design Vertex Locator” (at NIKHEF)

<http://www.nikhef.nl/pub/departments/mt/projects/lhcb-vertex/>

“wake field suppressor”

<http://www.nikhef.nl/pub/departments/mt/projects/lhcb-vertex/prototypes/wakefieldsuppressor/>

“production-steps wake field suppressor”

<http://www.nikhef.nl/pub/departments/mt/projects/lhcb-vertex/production/wakefieldsuppressor/>

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Future

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Future

- ▶ LHCb Upgrade (in LS2): we intend to reduce the inner radius of the foil (5.5 \rightarrow 3 – 4 mm)
- ▶ We would be glad to obtain your expert feedback on impedance aspects (via LEB)