



University  
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Experimental  
Particle Physics

**For the VELO Group**

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## **FEST'09: proposal for a production for VELO alignment studies**

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**Special thanks to Silvia Borghi for preparing most of the material !**

# VELO alignment studies

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- ❑ The VELO alignment needs not only “standard tracks” but also long tracks that cross many modules (particles with a trajectory parallel to the beam)
- ❑ For a test of the VELO alignment procedure (including the Alley implemented in HLT) it would be most useful to include in FEST’09 the production of LSS arc beam gas events (see next slides)

# Rate: LSS and arc beam gas

- ❑ Interaction of beam with gas in the arc ( $\pm 250$  m from LHCb)
- ❑ High energy particles close to beam line
- ❑ Estimates are unshielded. Real flux will be further reduced

But this year:

- Less current ↓
- Less bunches ↓

In this condition, the residual gas density was evaluated in ATLAS and CMS, as first approximation we can consider the same scale factor for LHCb

Rates of particles in the VELO with nominal LHC beam			2008	2009 & 2010
	Tracks used in Alignment	Overlap tracks used in Alignment	Tracks/ Overlaps used in Align.	Tracks/ Overlaps used in Align.
All Halo $\mu+h$	830 kHz	4.5 kHz	2.5 kHz / 14 Hz	280 kHz/ 1.5 kHz
L0 selected Halo $\mu+h$	4.5 kHz Only about 0.5% of events pass L0 trigger	22 Hz Only about 0.5% of events pass L0 trigger	14 Hz/ 0.07Hz	1.5 kHz / 7 Hz

# Rate: VELO beam gas

Inelastic beam-gas rate per bunch

$$R_{pA} = \sigma_{pH} \times A^{0.7} \times N \times f \times n \times d \quad \text{p}$$

- $d = 50 \text{ cm}$  ,  $N = 9 \times 10^{10}$  p per bunch
- $n = (p / \text{mbar}) \times (2.5 \times 10^{16} \text{ molecules/cm}^3) \times (\text{so-many-nuclei/molecule})$
- $k_b = 156$  bunches per beam
- Inelastic cross section  $\sigma_{pH} = 40 \text{ mb}$

Gas type	$A^{0.7}$	$p$ mbar	$R_{pA}$ Hz	$k_b R_{pA}$ Hz
H <sub>2</sub>	1	$5 \times 10^{-10}$	0.05	7.8

M. Ferro Luzzi

# HLT alley: an alignment-friendly PR (1/3)

- ❑ The need for tracks parallel to the beam axis has been emphasised many times
- ❑ No suitable pattern recognition exists to easily do this and to be used at HLT level
- ❑ A new, fast, efficient, and pure pattern recognition was developed

Marco Gersabeck

# HLT alley: an alignment-friendly PR (2/3)

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## □ The idea:

- Look for a certain number (small range) of space-points in  $r$ - $\phi$  projection of all modules (both halves)
- Check that this number is not produced by combinatorics on a single module
- Ensure that the number of space-points is a local maximum
- Optional: Check whether track candidate has a minimum number of space-points in both halves to detect overlap tracks
- Don't fit the track candidate as this is thought to be a filter only, to select useful events for alignment

Marco Gersabeck

# HLT alley: an alignment-friendly PR (3/3)

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- The status:
  - Filter implemented as PatVeloAlignTrackFilter in Tf/PatVelo
  - Thanks to Gerhard for implementing it in HLT1:
    - Two ‘alleys’ for generic parallel tracks and for overlap tracks specifically
    - Can pre-scale differently and hence enhance overlap sample
  - Outputs of these ‘alleys’ should end up in calibration stream
- Future plan
  - Tune the parameters on Monte Carlo minimum bias events and ‘halo’ events

Marco Gersabeck

# Data samples for VELO alignment

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□ We would request the following to be added to the FEST'09 production:

Description	Event type	field	energy	# events
BeamGassLSSArc	60040000	On	5 TeV	2M that corresponds to 100k tracks in the VELO
Beamgas H 5 TeV	60001001	On	5 TeV	500k
Beamgas O 5 TeV	60001008	On	5 TeV	500k



## A step further ... impact on physics

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- The proposal should provide us all the necessary to run the alignment as if on real data
- What about the physics?
- One could straightforwardly investigate the effect of residual misalignments on the analysis of a benchmark B channel ...
- If accepted as a feasible idea, we would request 50k  $B \rightarrow \pi\pi$  events with same conditions (particular interest within the CP WG)