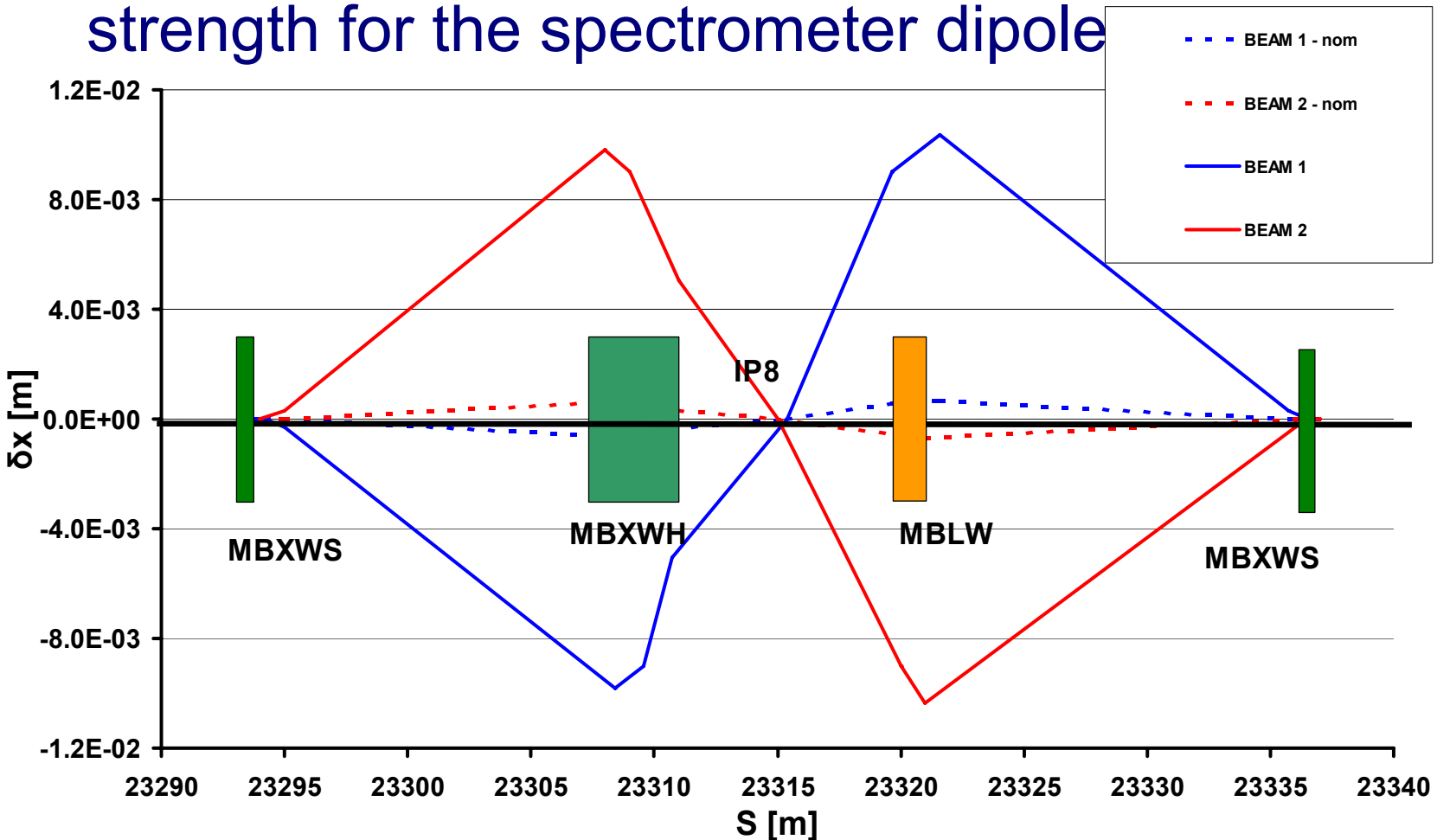# VELO detector and available aperture in IR8

Y. Papaphilippou

Thanks to M. Giovannozzi, W. Herr and B. Jeanneret

October 23rd, 2006

# Internal crossing bump of IR8 with collision strength for the spectrometer dipole

- Internal crossing angle of ±2100μrad in the horizontal plane!
- Deflection of ±0.010m at MBXWH, corresponding to 29σ, as compared to 0.0006m (2σ) of the nominal bump

Aperture in IR8 with full spectrometer dipole strength

- When crossing angle is added beam excursion of 0.011m (33σ) at MBXWH, as compared to 0.0004m (6σ) for the nominal scheme

- When polarity and external crossing angle sign are mismatched, two additional crossings occur ~15m left and right of the IP (in total 4 crossings)

BEAM 1

MBLW

IP8

MBXWS   **MBXWH**   **MBXWS**
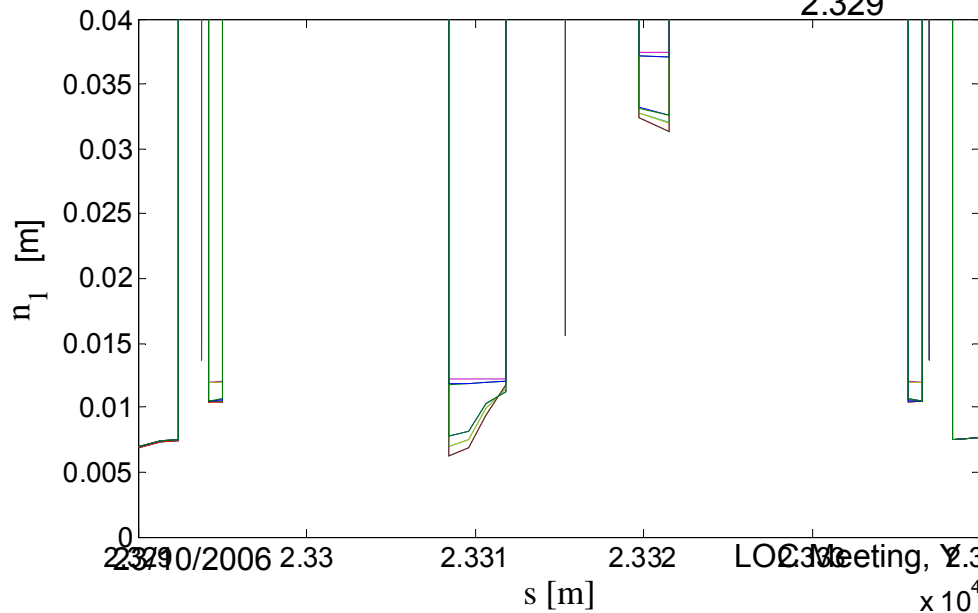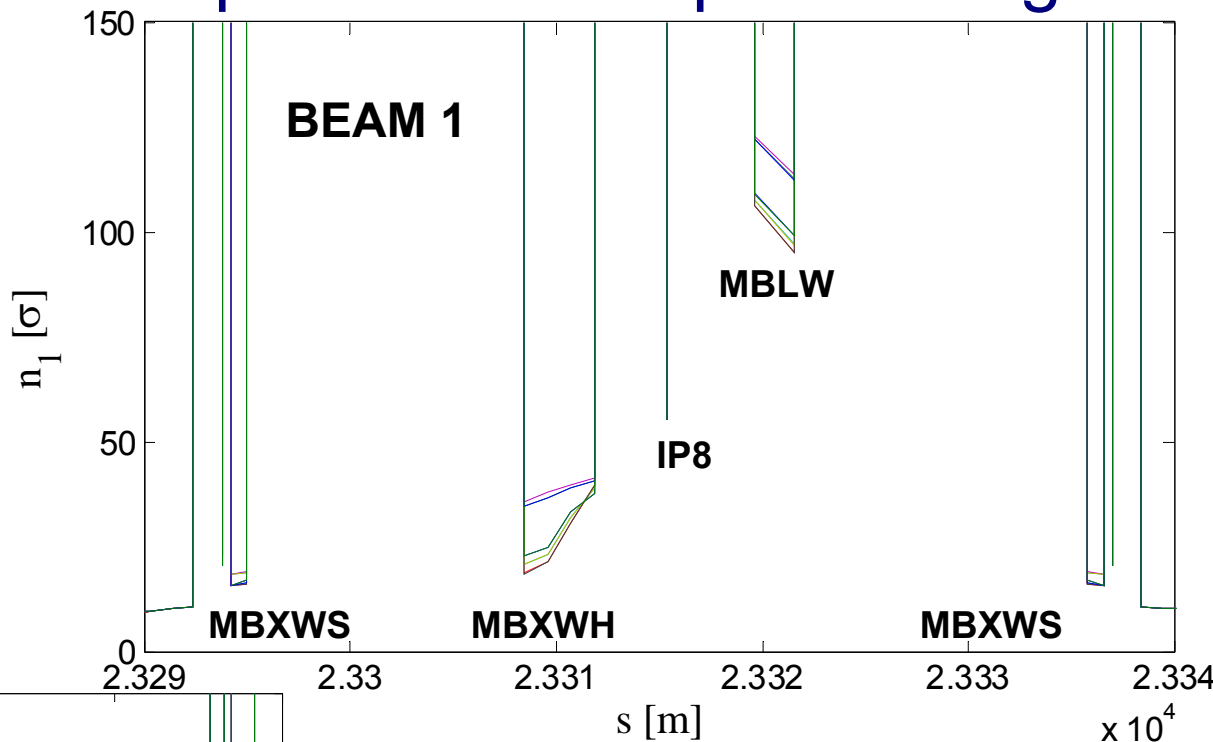
- Biggest loss in aperture around MBXWH

- n_1 correspond to even smaller values than MBWXS in mm

Aperture loss in IR8 by element

Equipment	n_1 nominal [σ]	n_1 full [σ]	n_1 nominal [m]	n_1 full [m]	n_1 nominal [%]	n_1 full [%]
BPMSW.1L8	20	20	0.014	0.014	45	45
MBXWS.1L8	16	16	0.010	0.010	40	40
MBXWH.1L8	34	19	0.012	0.006	45	24
IP8	56	56	0.016	0.015	52	52
MBLW.1R8	111	95	0.037	0.031	58	50
MBXWS.1R8	16	16	0.010	0.010	40	40
BPMSW.1R8	20	20	0.014	0.014	45	45

■ Not important impact in any element apart MBXWH

  ☐ Available aperture of 6mm (with respect to 12mm), corresponding to 15σ of aperture loss

  ☐ Remaining aperture corresponds 24% of the available

VErtex Locator in LHCb

M. Ferro-Luzzi, PH/LBD
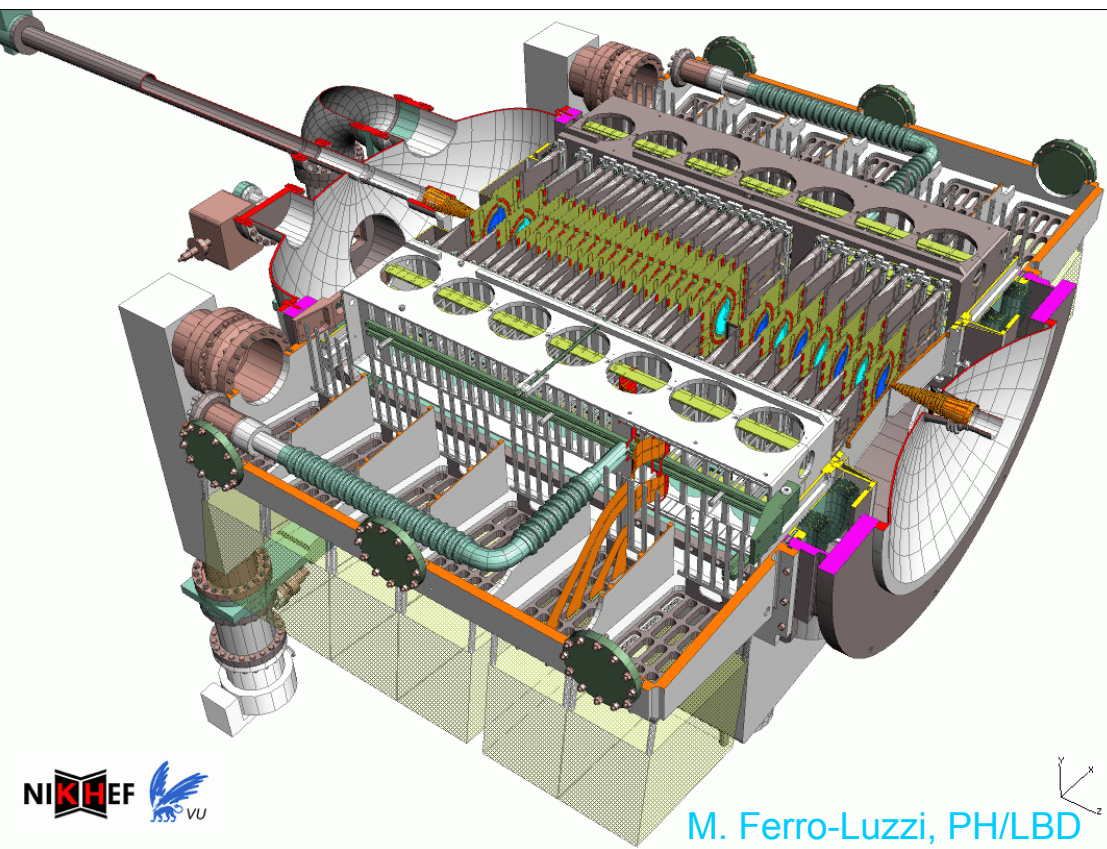
- Used for precise localization of track coordinates close to the interaction region in order to reconstruct production and decay vertices of b-hadrons
- Surrounding IP8 (from ~0.35m left to 0.75m right)
- Series of retractable silicon sensors closing down to an aperture of 5mm radius
- Sensor boxes can be centered around the beam by moving laterally (by 30mm) and up or down (by 5mm)
- Ability to locate precisely the beam position from beam gas events
- The experiment is interested in closing the VELO to its minimum during the 450 GeV collisions' run, for calibration purposes

Simple considerations regarding aperture

J. Van den Brand, PH/ULB
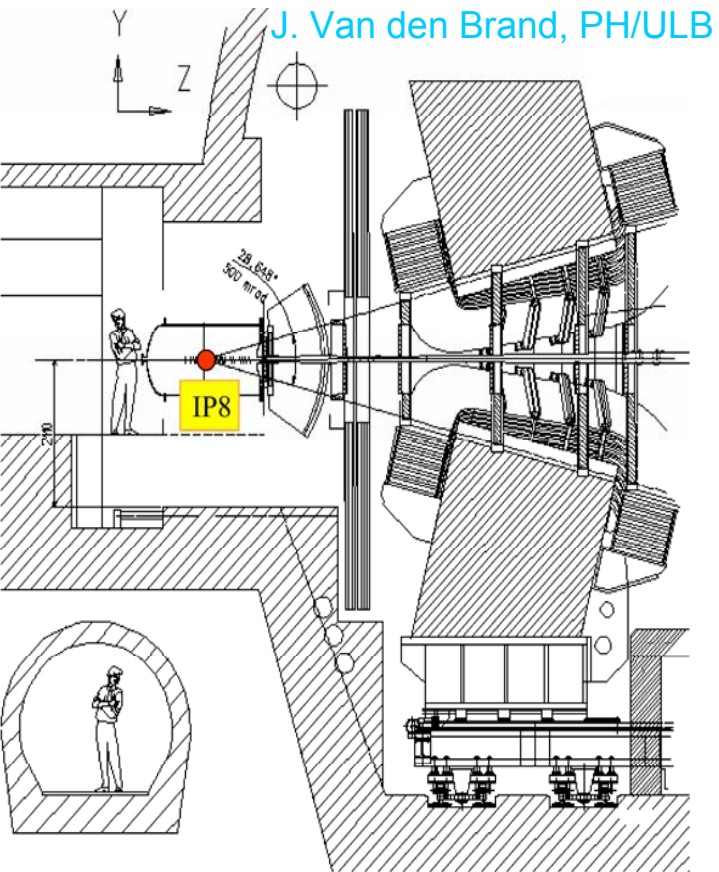
- β-function at the right side of the VELO is 10.07m at injection
- Beam size in this location is 0.28mm
  - VELO minimum aperture of **5mm** corresponds to 17.8σ
  - 7σ corresponds to **2mm**
  - For nominal crossing angle of ±135μrad, the horizontal displacement at the right edge of the VELO is **0.1mm** (0.4σ)
  - For extreme crossing angle of ±2.1mrad, the horizontal displacement becomes **1.6mm** (5.6σ)
  - Peak orbit tolerance of **4mm** corresponds to 14.3σ
  - Mechanical tolerance of **2.2mm** corresponds to 7.7σ
- For no crossing and separation, the VELO aperture has to be bigger than **9mm**

- Including above tolerances and an extra 20% for the beta beating and spurious dispersion, the VELO radius has to be higher than **12mm** for the extreme crossing angle and **10.5mm** for the nominal one
- Centring the VELO around the beam, allows a further 4mm of closure (**8mm** and **6.6mm**)

Closure of the VELO for different scenarios

Internal crossing angle [mrad]	Vertical Separation	External crossing angle	VELO aperture [mm]	
			With CO of 4mm	Without CO
2.1	+	+	12.2	7.2
0.135	+	+	11.4	7.4
2.1	0	+	11.1	7.1
0.135	0	+	9.6	5.6
2.1	+	0	12.3	8.3
0.135	+	0	11.5	7.5
2.1	0	0	11.3	7.3
0.135	0	0	9.7	5.7
-2.1	+	+	12.4	8.4
-0.135	+	+	11.5	7.5
-2.1	0	0	11.2	7.2
-0.135	0	0	9.7	5.7
0	0	0	9.6	5.6

- The VELO apertures quoted allow $n_1 = 7\sigma$
- For the nominal scheme the VELO cannot be closed to less than **11.4mm** (nominal internal crossing angle)
- Different spectrometer polarity has a minor influence in the available aperture
- Influence of the external crossing angle is also minimal
- Influence of the separation important mostly for small internal crossing angles
- After centring VELO around the CO, aperture can be closed down to **5.6mm** (for no internal crossing angle) or to **7.1-7.2mm** for the maximum crossing angle
- In all the simulations, a mechanical tolerance of **2.2mm** was used and has to be refined
- It is important to know the precision with which the detector can be centred around the beam
- Any failure maybe catastrophic for the detector and its manipulation has to be included in machine protection loop