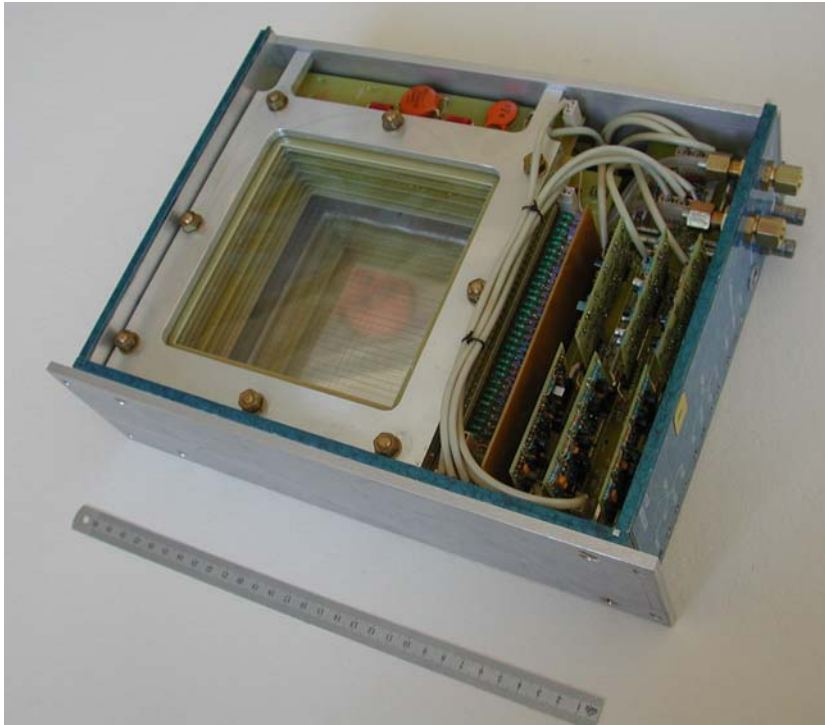


ITEP Beam Chambers

P. Gorbunov (U. of Toronto and ITEP, Moscow)



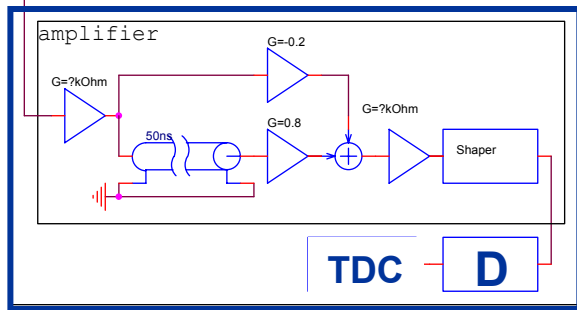
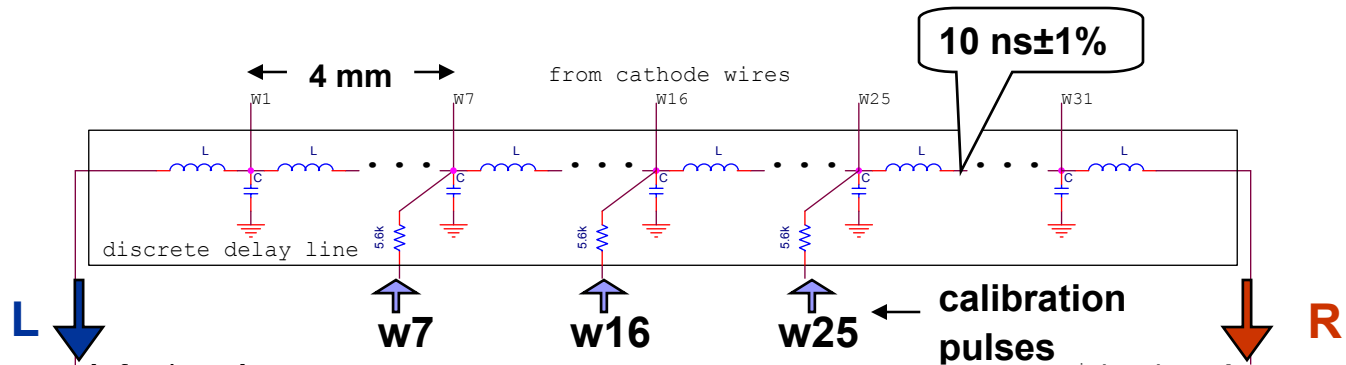
Features:

- X-Y MWPCs with cathode DL r/o
 - working area: $120 \times 120 \text{ mm}^2$
 - gas: Ar-CO₂ (80:20); HV: 2.25 kV
 - detection efficiency $\approx 100\%$
 - accuracy: 120 – 200 μ
 - readout channels: 6 (analog)
 - availability: 4 (currently in H6)
 - built in 2002
-
- Successfully used in Fcal TB2003 and OPERA'2002 (nuclear emulsion)

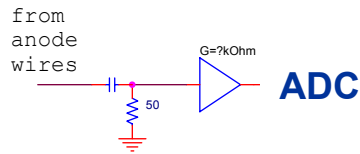
Technical features

- Two identical chambers (X- and Y-) in common housing
- Anode planes: 25 wires, 20 μ , 6 mm spacing
- Cathode planes: 31 wires, 100 μ , 4 mm spacing, \perp to anodes
- Anode-to-anode: 26 mm
- Calibration pulser signals can be injected to cathode wires 7,16 or 25 (3000 pulser events at start of each run)
- Lumped delay line with 10 ns cells
- More on the design and comparison with MC simulation:
 - cern.ch/atlas-fcaltb/Memos/Hardware/BPB/BPC_Note1-2003.pdf
 - cern.ch/atlas-fcaltb/Memos/Hardware/BPC/ITEP_BPC_design_Rus.doc (in Russian)
- Real rate limit: ~30 kHz
- No multitrack measurement (rejection only)

Readout electronics



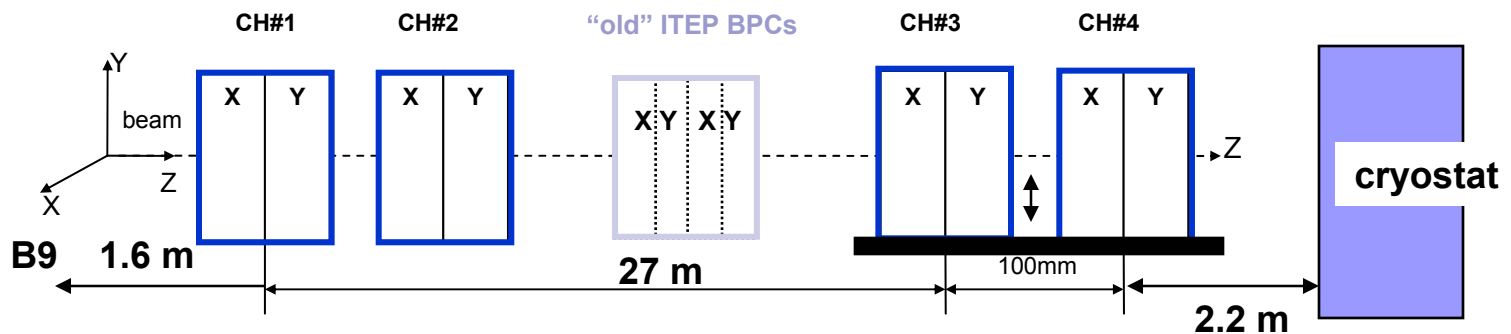
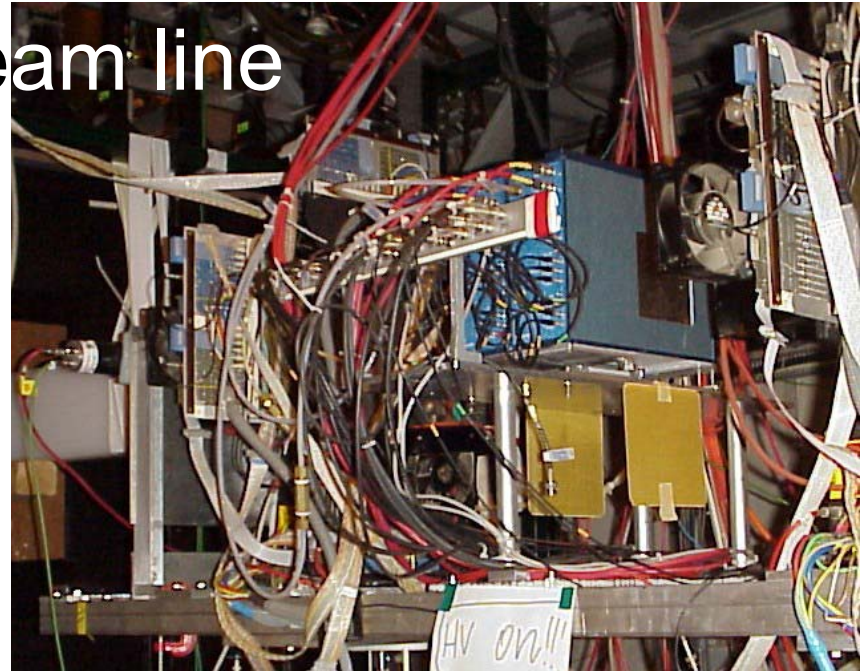
- Analog constant-fraction shaping (to reduce time-walk) : front-end
- TDC LeCroy 2228A (11 bit, 250 ps)
- ADC LeCroy 2249A
- External NIM discriminators LeCroy 623
- Custom calibration pulser



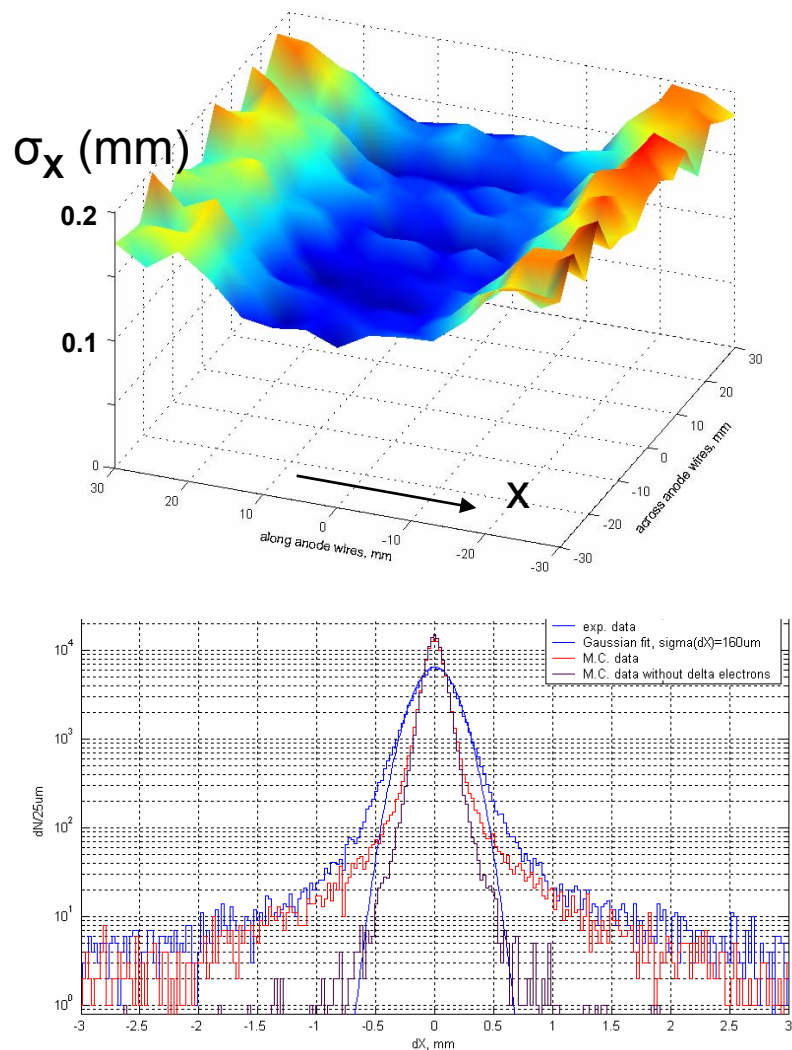
$$X \approx G_X (t_L - G_{RL} t_R - t_0)$$

ITEP BPCs in H6 beam line

- two “stations” of 2 BPCs: near & far
- an auxiliary mid-station with 4 “old” BPCs (300 μ resolution)
- advantages of arranging BPCs in pairs:
 - better space resolution (<100 μ , important for the near station!)
 - δ -electron rejection (see below)
 - easier cabling



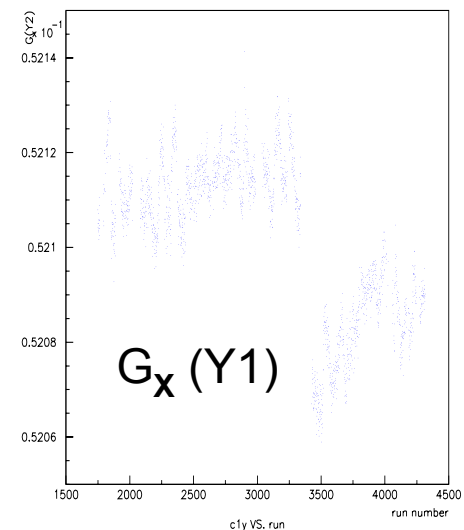
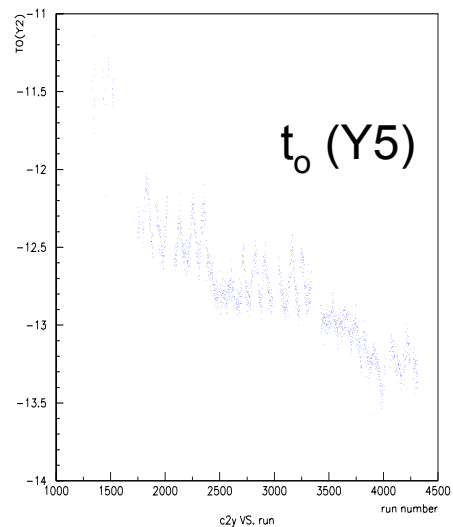
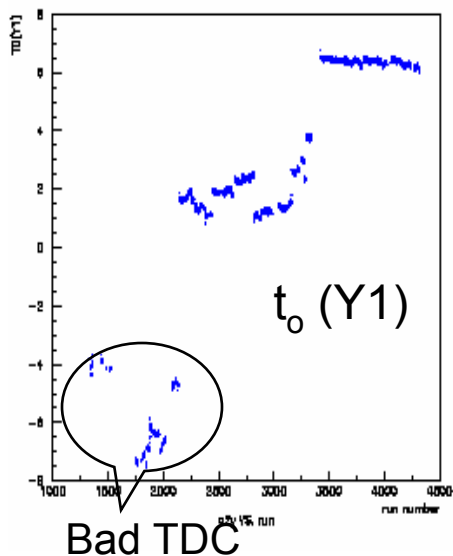
Space resolution



- has been studied in dedicated test beam measurements, confirmed in H6: $\sigma = 110\text{-}200 \mu$, depending on the hit position.
- σ is \sim constant across the measurement direction (across anodes) and deteriorates towards the edge cathode wires
- MC shows that the tails of $dX > 1$ mm are due to δ -electrons
- The cut $|dX| < 1$ mm has $\epsilon=97\%$ ($|dX| < 0.5$ mm: $\epsilon=95\%$) and largely eliminates δ -electrons

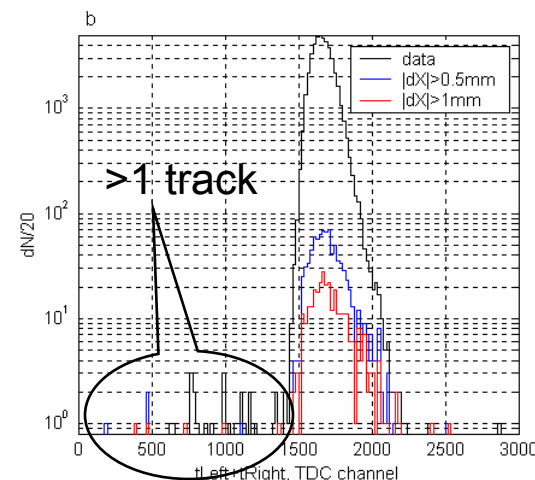
BPC calibration

- Internal calibration (G_x , t_0) – with an external pulser, at start of run
- G_{RL} and G adjustment, mutual alignment of all chambers: with beam tracks
- For most of the BPCs, the calibration drift during FCal TB runs was negligible. Exeptions: ch. 1 and one case of a faulty TDC



Multi-track rejection

- Can rely on external counters... *trust but verify!*
- $t_R + t_L$ for *single* tracks has a lower limit = Σ line delay
- Anode signal amplitude



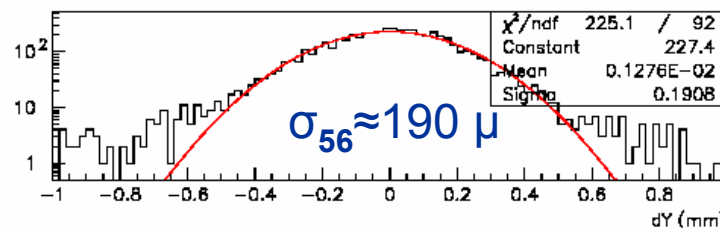
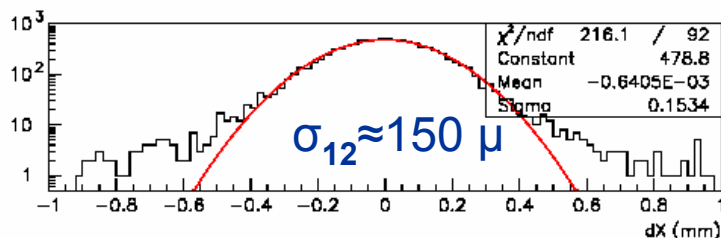
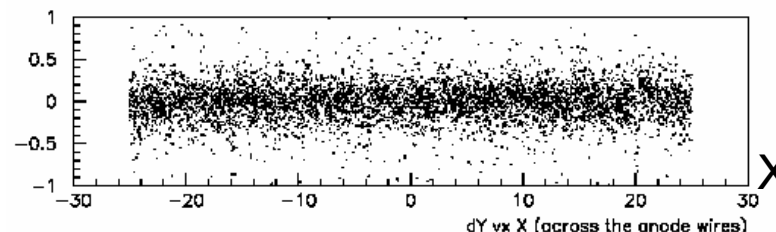
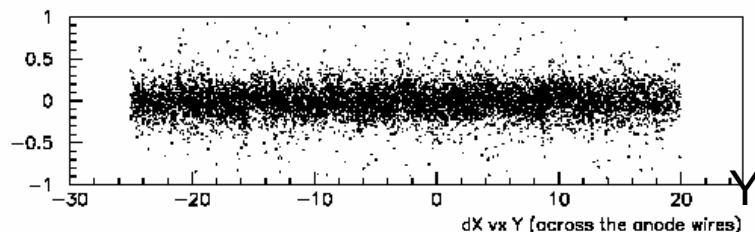
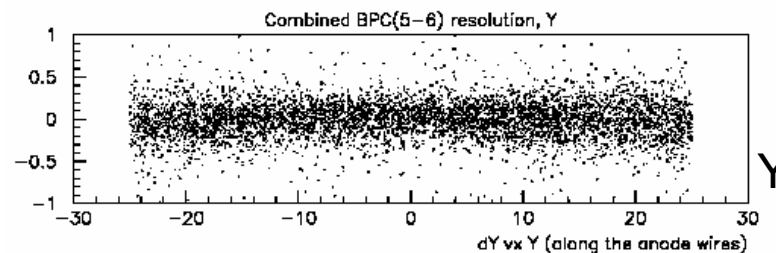
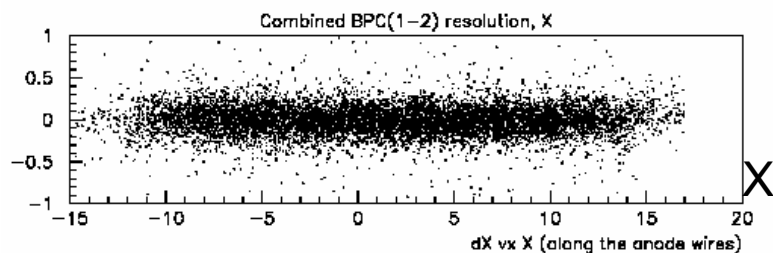
Summary

- ITEP BPCs: new beam chambers, designed for high-accuracy measurements
- No visible ageing effects
- robust, easy to maintain and read-out

BPC resolution: H6 data

$dX=X(1)-X(2)$, 30x40 mm²

$dY=X(5)-X(6)$, 60x60 mm²



Impact point prediction

