UK Activity in the b-τ Group

❖ Introduction

- UK responsibilities
- The Data-Handling / Test-Beam Analysis Group.

❖ What UK people are doing …

❖ The future.

Introduction

- The UK leads the b-τ Data-Handling & Test-Beam Analysis group.

- We are responsible for ensuring that ORCA can process real data:
  1. From Test-Beams.
  2. From the final CMS Tracker.

- We are responsible for providing information from the ORCA simulation, where the design of the Tracker Readout requires it.

- Most of the man-power is actually from Italy and CERN, especially for test-beam analysis ...

What UK people are doing …

Ian

- Leads Data-Handling & Test-Beam Analysis Group.
- Selected zero suppression algorithm for FED.
- Estimated data rate from CMS Tracker.

Ivan

- Proved that FED dynamic range doesn't affect hit resolution.
- Modifying ORCA so that it can read Tracker FED data format.

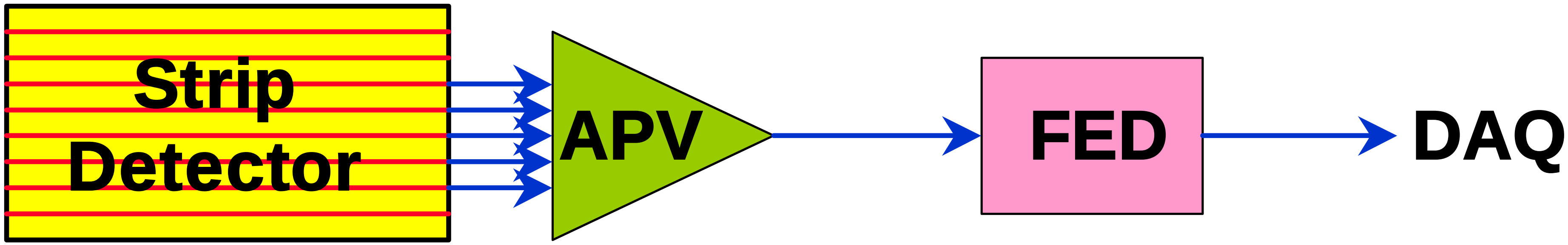
Nancy

- Identifying best algorithm to calibrate Tracker pedestals & noise.

Rob

- Studying the `HIP effect' with test-beam data.

FED Zero Suppression Algorithm



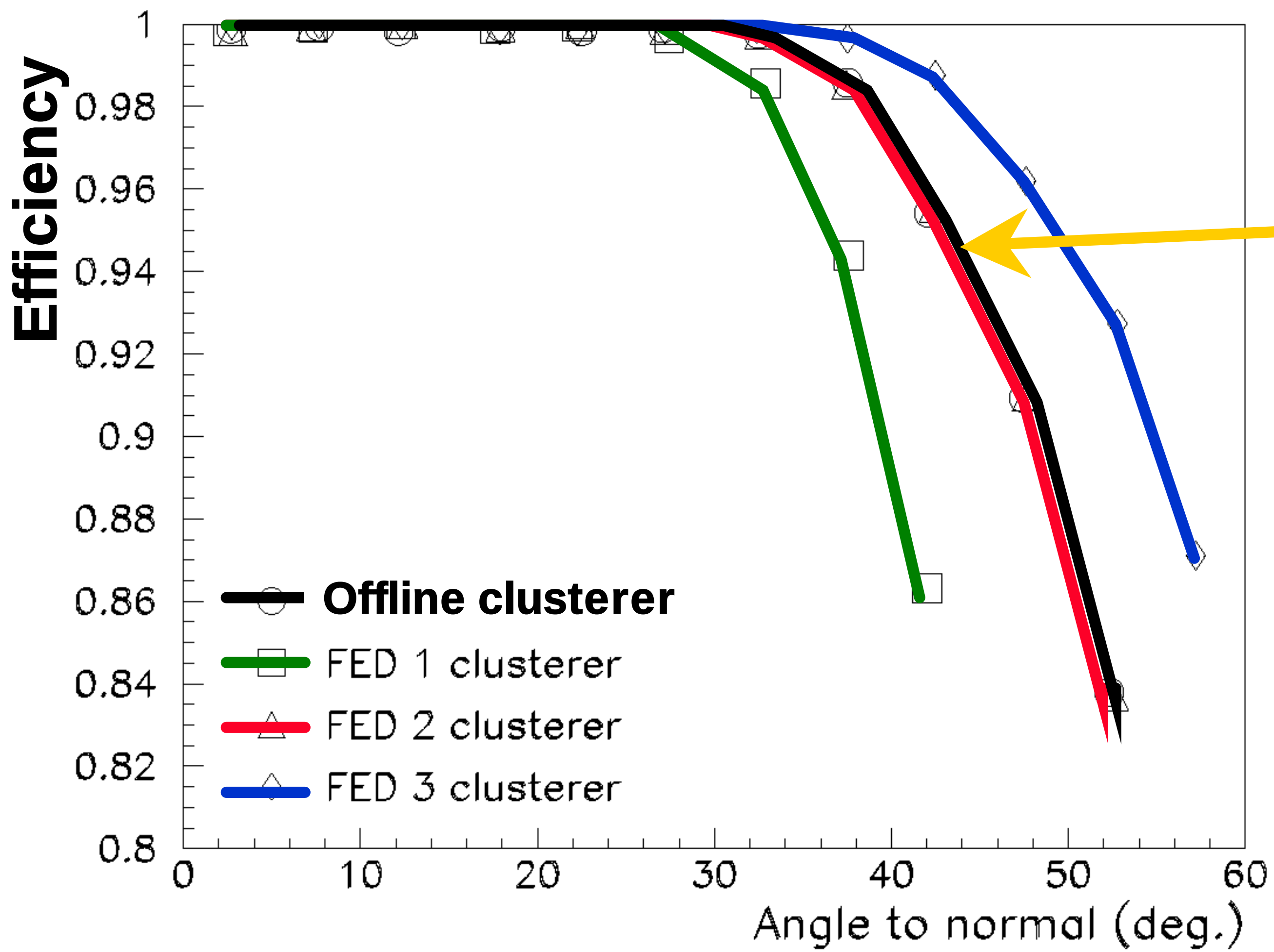
- Tracker FEDs only output to DAQ, the pulse height on strips they associate to clusters.

- Which clustering algorithm should it use ? Require:
  - Very simple (runs in FPGA).
  - High efficiency
  - Fake cluster rate much smaller than genuine cluster rate.

- Before clustering, must subtract common-mode noise for each APV:
  - Which algorithm ?

FED Zero Suppression Algorithm

Zero suppression algorithms implemented in ORCA to allow study:

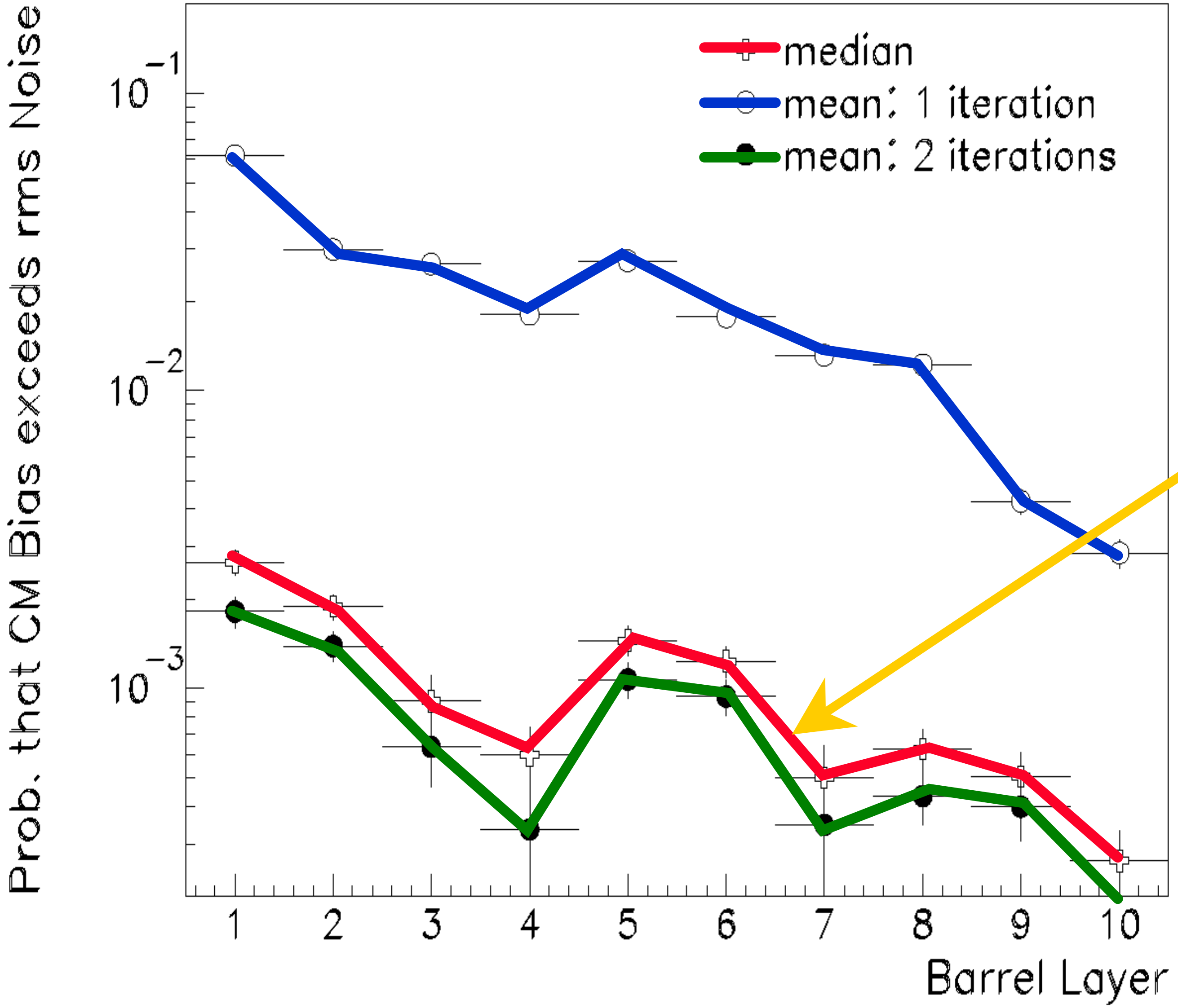


Chose `FED2' clustering algorithm:

Isolated strips $> 5\sigma$
Non-isolated $> 2\sigma$

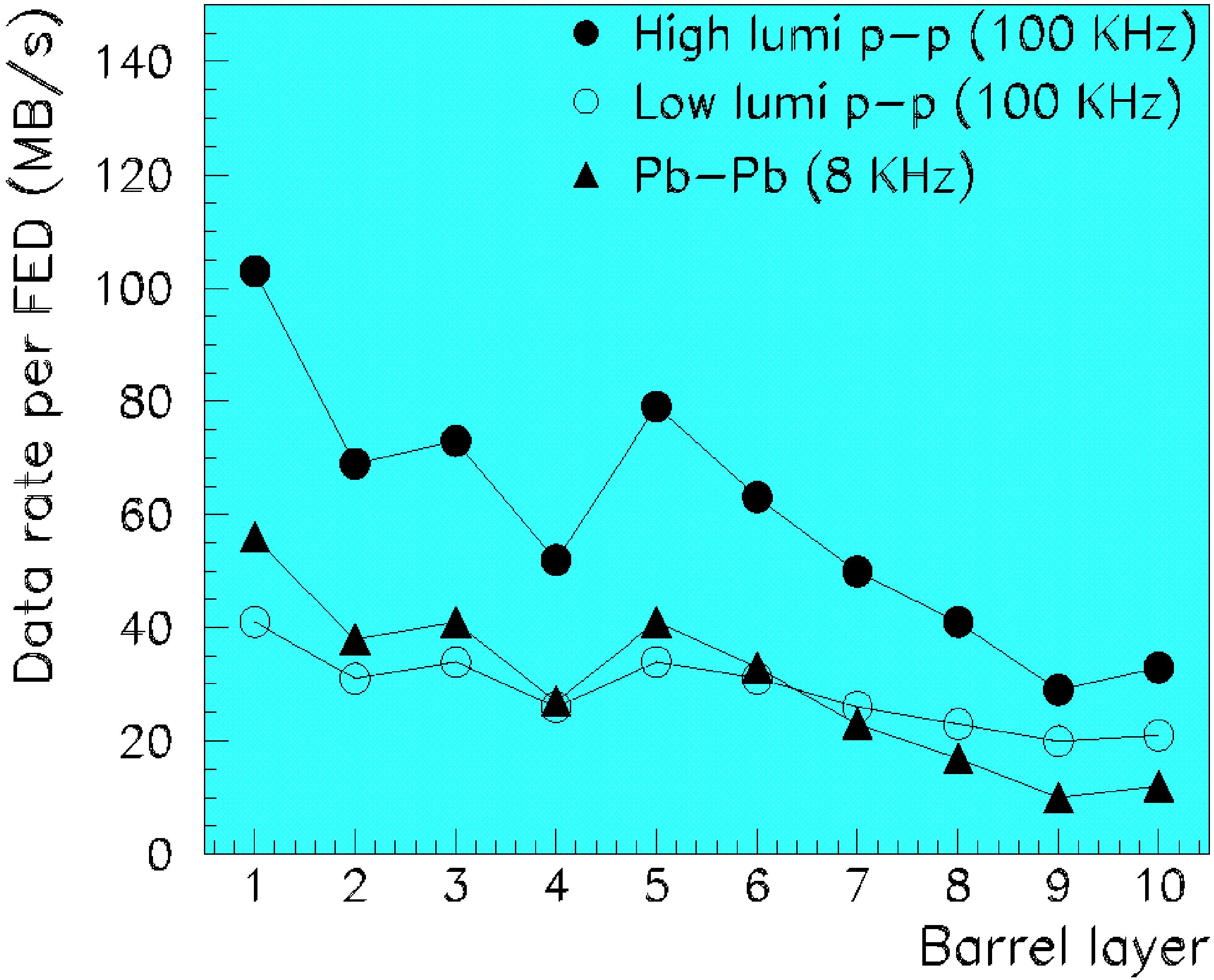
(Better efficiency than `FED1' and smaller fake rate than `FED3').

FED Zero Suppression Algorithm



Common-mode noise offset estimated from median pulse height on APV's channels

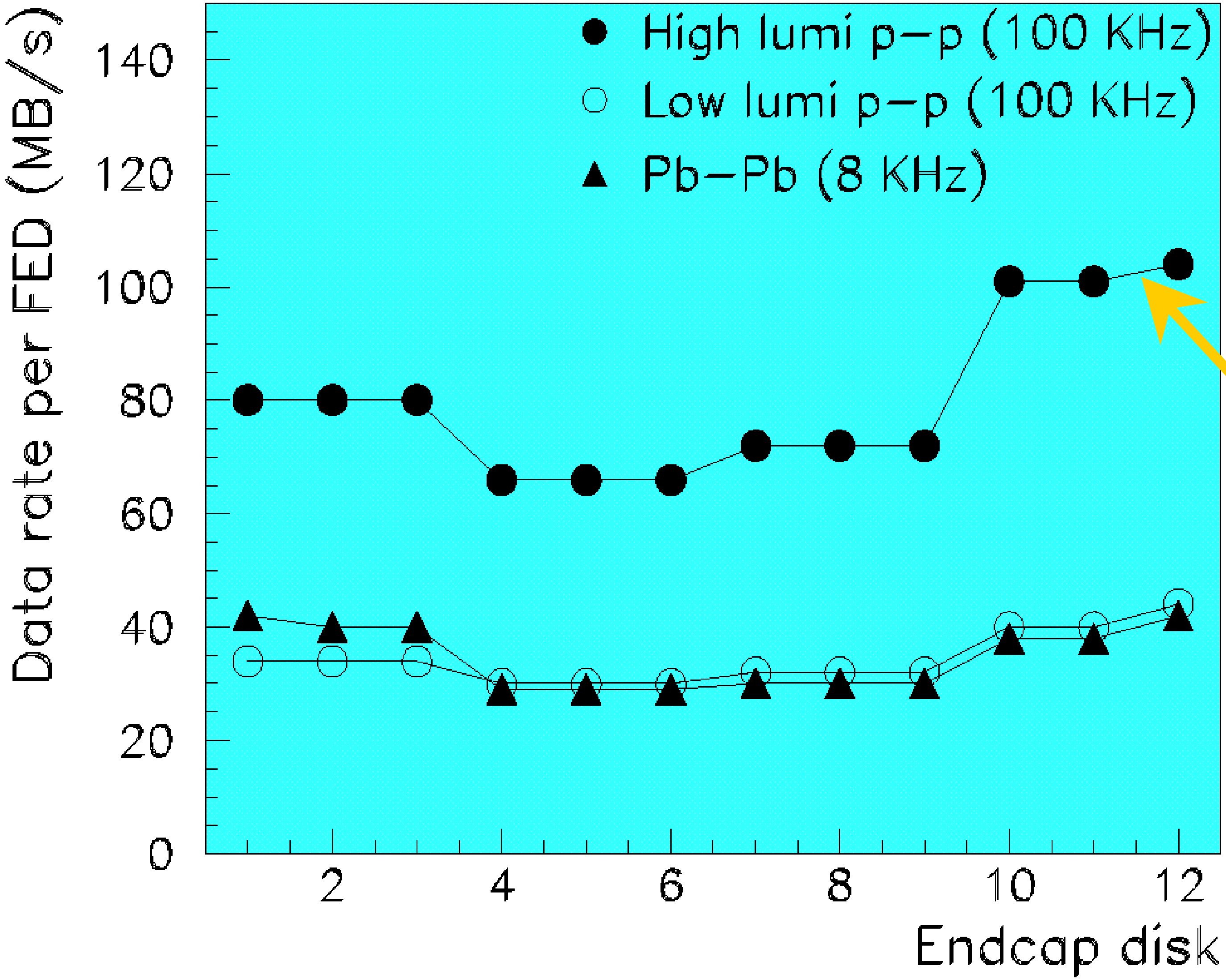
Tracker Data Rate



Data rate per FED estimated from tracker occupancy and APV→FED cabling map.

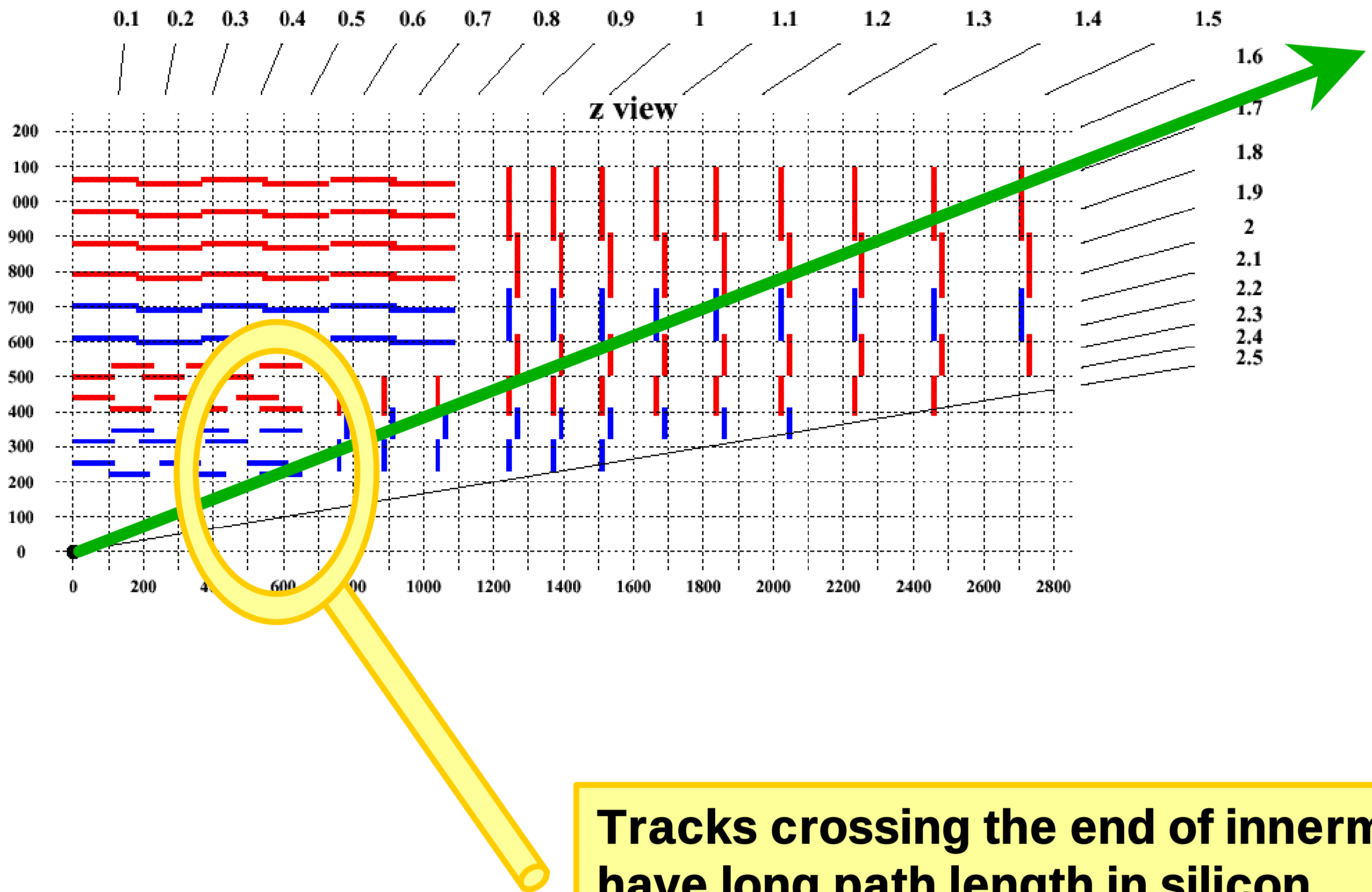
Everywhere < 200 MB/s limit of DAQ !

Tracker Data Rate



ECAL end-cap produces neutron background in tracker !!!

FED Dynamic Range

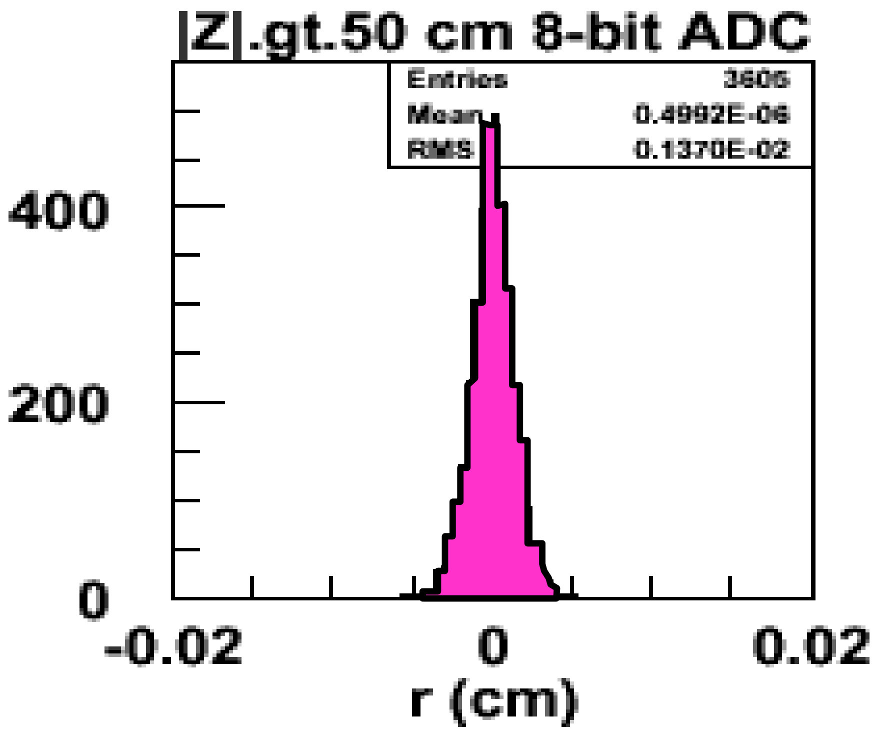


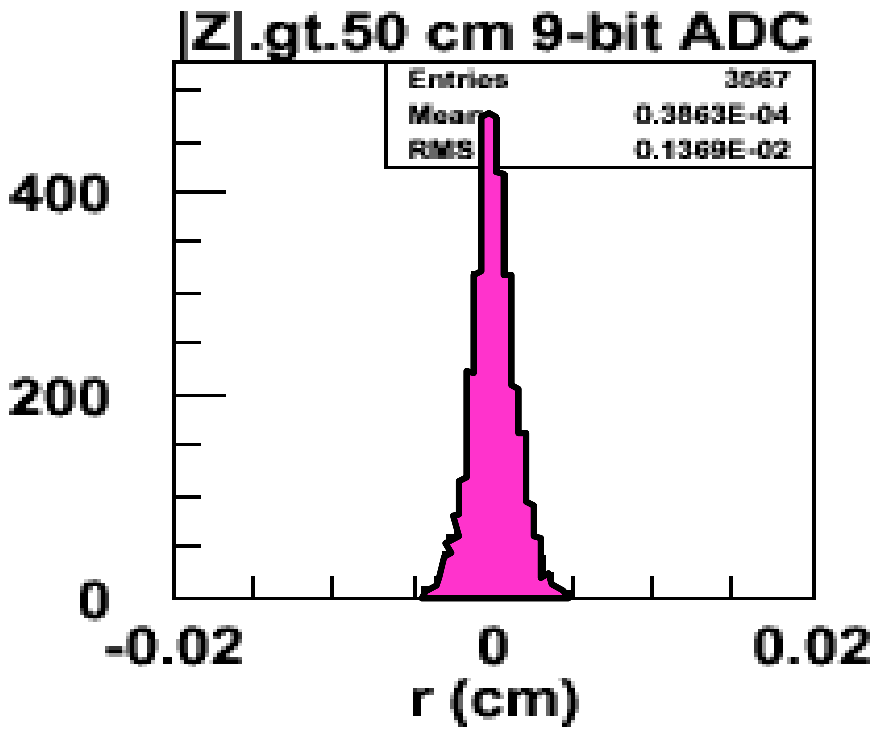
Tracks crossing the end of innermost barrel layer have long path length in silicon, so give big signal.

FED Dynamic Range

- The standard 8-bit FED badly truncates these MIP signals.
- Would doubling FED dynamic range to 9 bits improve hit resolution ?

…. No !





Tracker Data Format

- Each FED produces a block of data, which must be unpacked in ORCA.
  - Code to pack/unpack zero-suppressed data being written.
  - Code for raw-data to be produced.
  - Probably need additional code to actually write datasets in these formats.

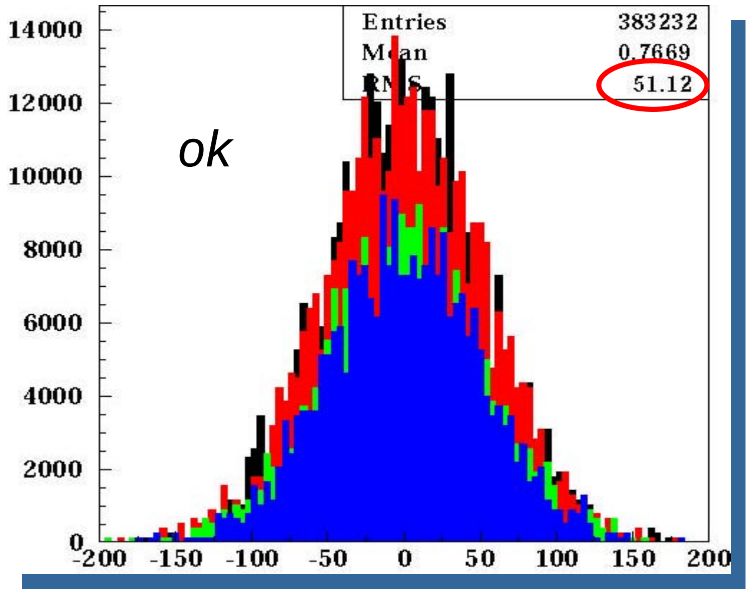
- Also considering compressing data (Huffman encoding etc.) on filter farm, to reduce data volume on tape.

- Progress in implementing Silicon module → FED cable mapping in ORCA.

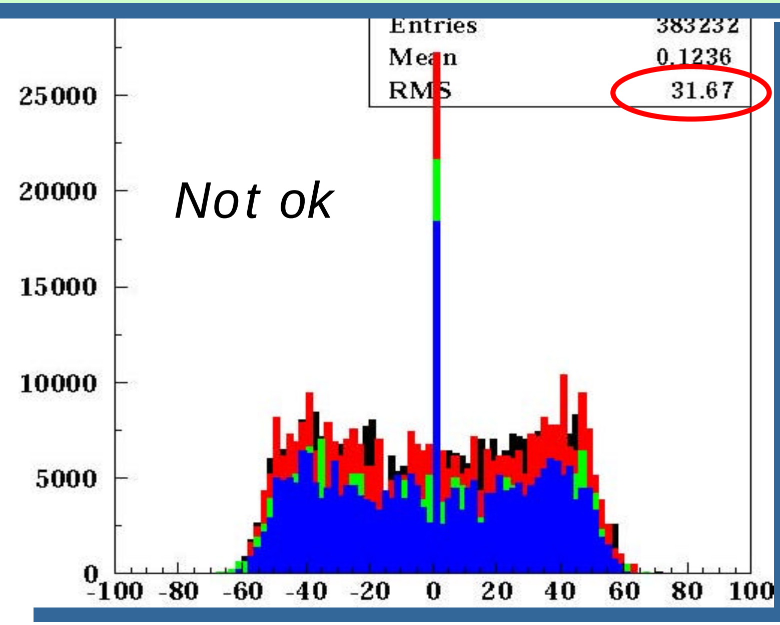
Pedestal & Noise Calibration

- **New ORCA software lets one run a variety of calibration algorithms on test-beam and Monte Carlo data.**
- **The Monte Carlo analysis can examine algorithm robustness in difficult conditions (high occupancy, high common-mode noise ...)**

Median based algorithm



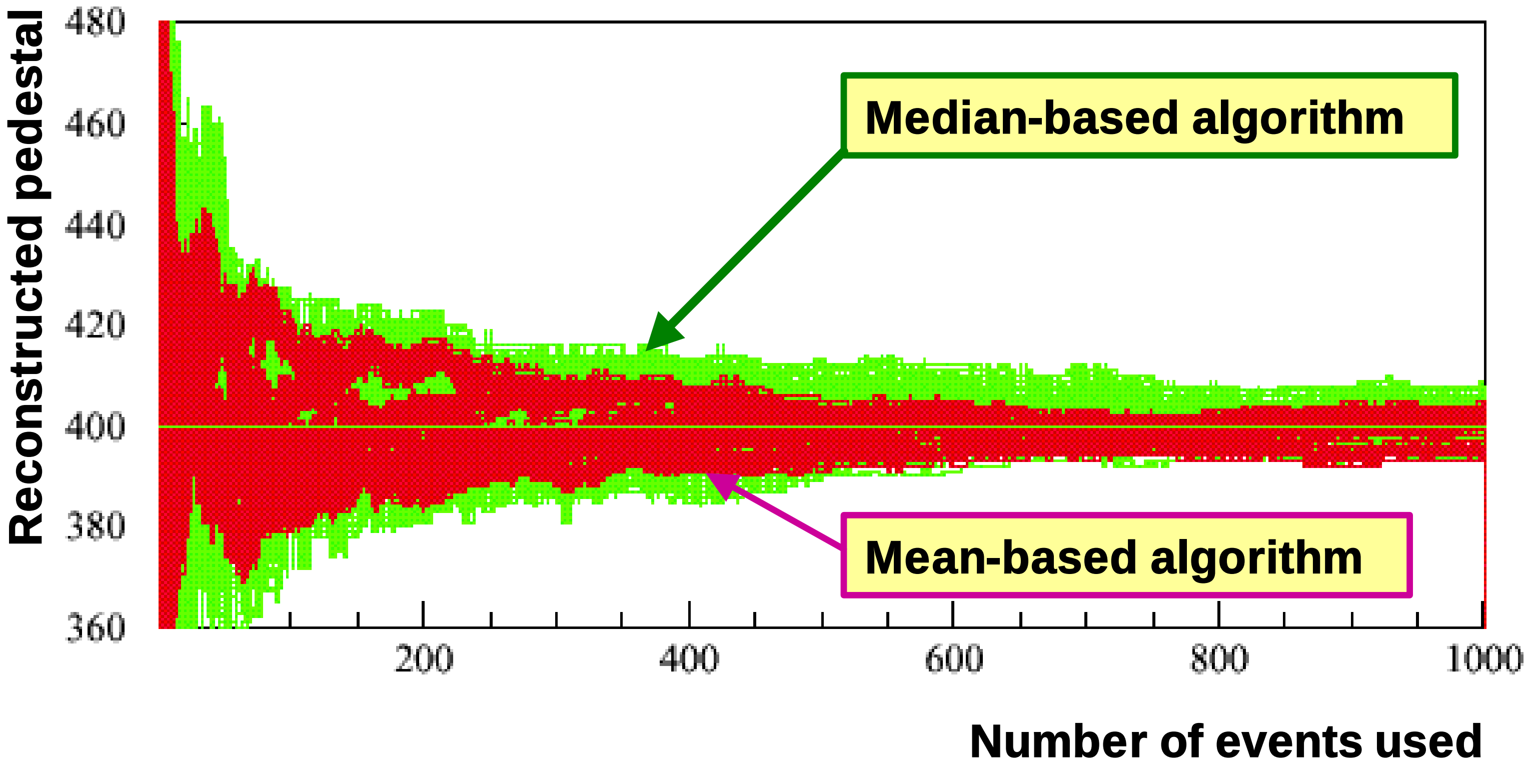
Mean based algorithm



Reconstructed common-mode, when input common-mode noise = 50 ADC counts.

Pedestal & Noise Calibration

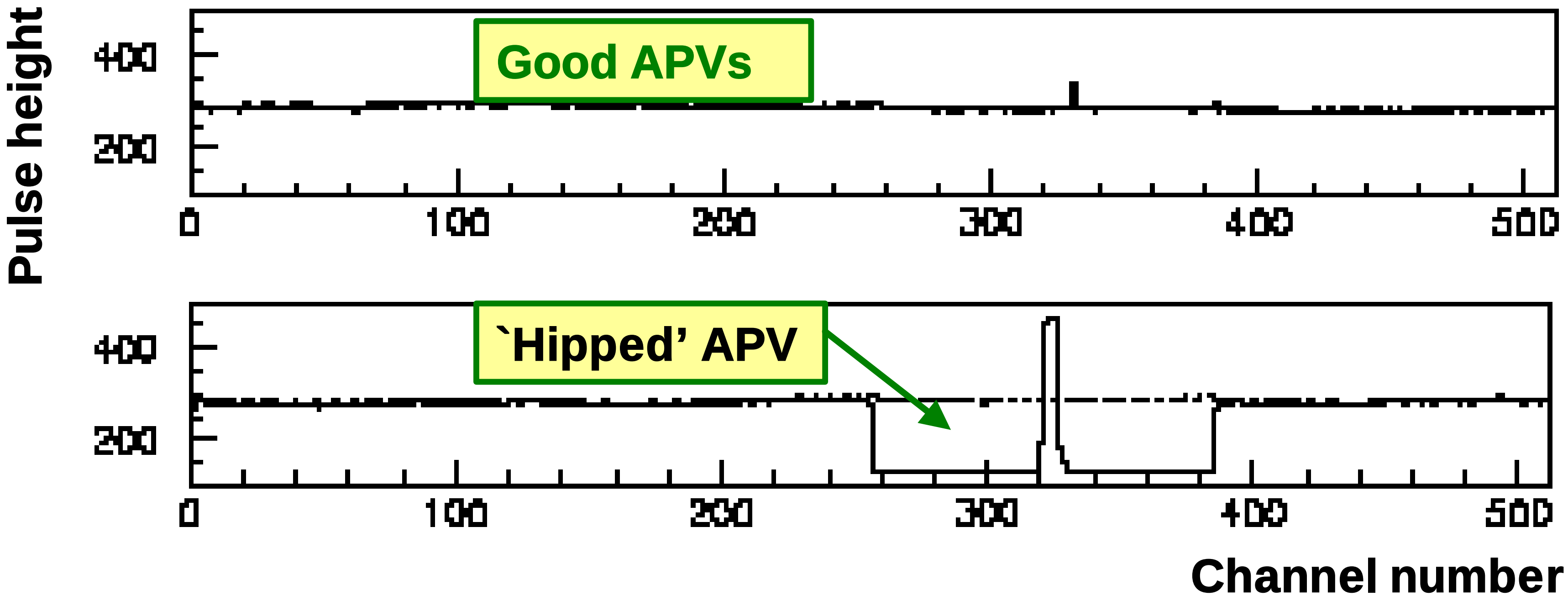
Study of number of events needed for pedestal calibration.
(Input: pedestal = 400, noise = 18, common-mode noise = 100)



Test-Beam Analysis of the HIP Effect

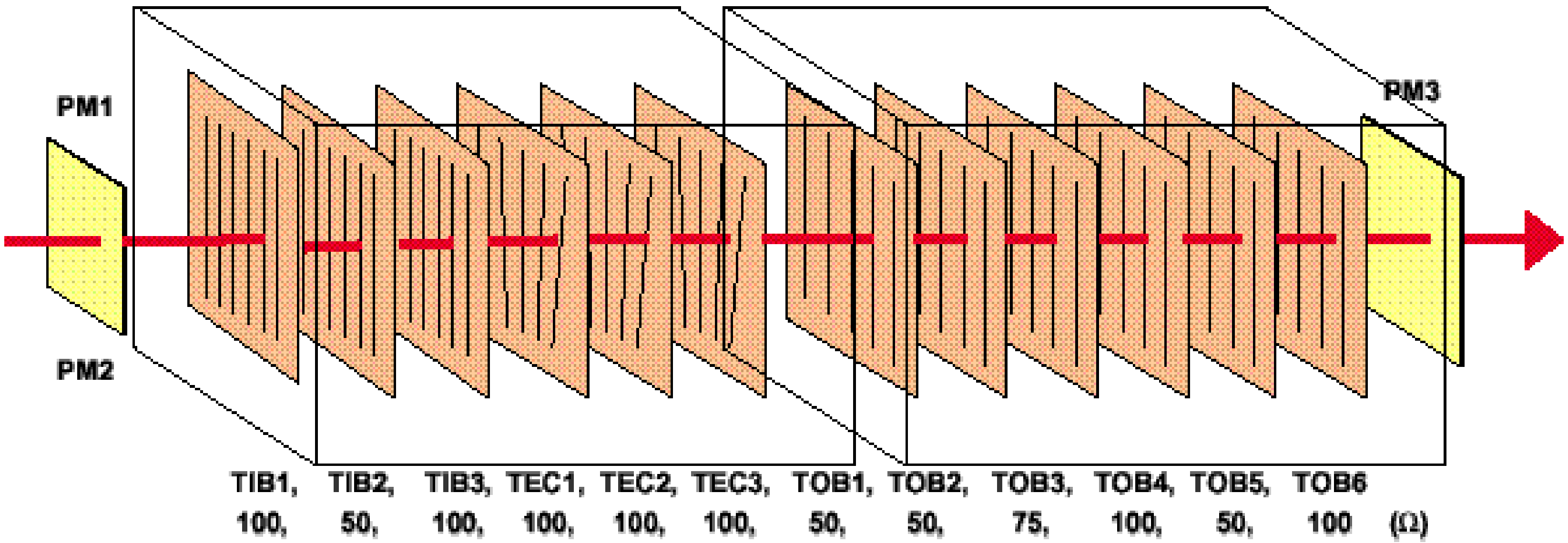
Highly Ionizing Particles from nuclear interactions give very large signals. These saturate a few channels of the APV chip, and via common-mode effects drive all the other channels in the APV chip low.

First seen in Oct. 2001 test-beam data …



Test-Beam Analysis of the HIP Effect

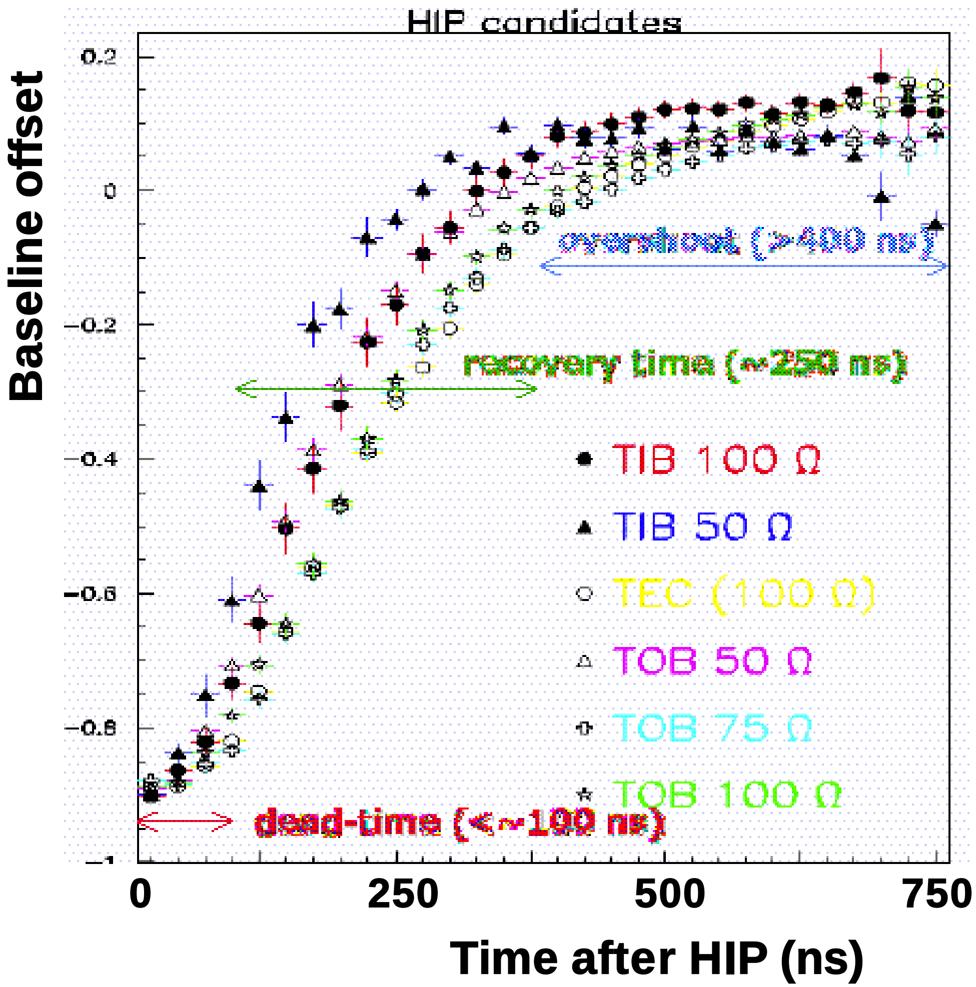
Detailed HIP study made using 2002 PSI 200 MeV/c test-beam data



Fraction of pions producing HIP effect in APVs measured:

(1 – 7) X 10^{-4} depending on module type.

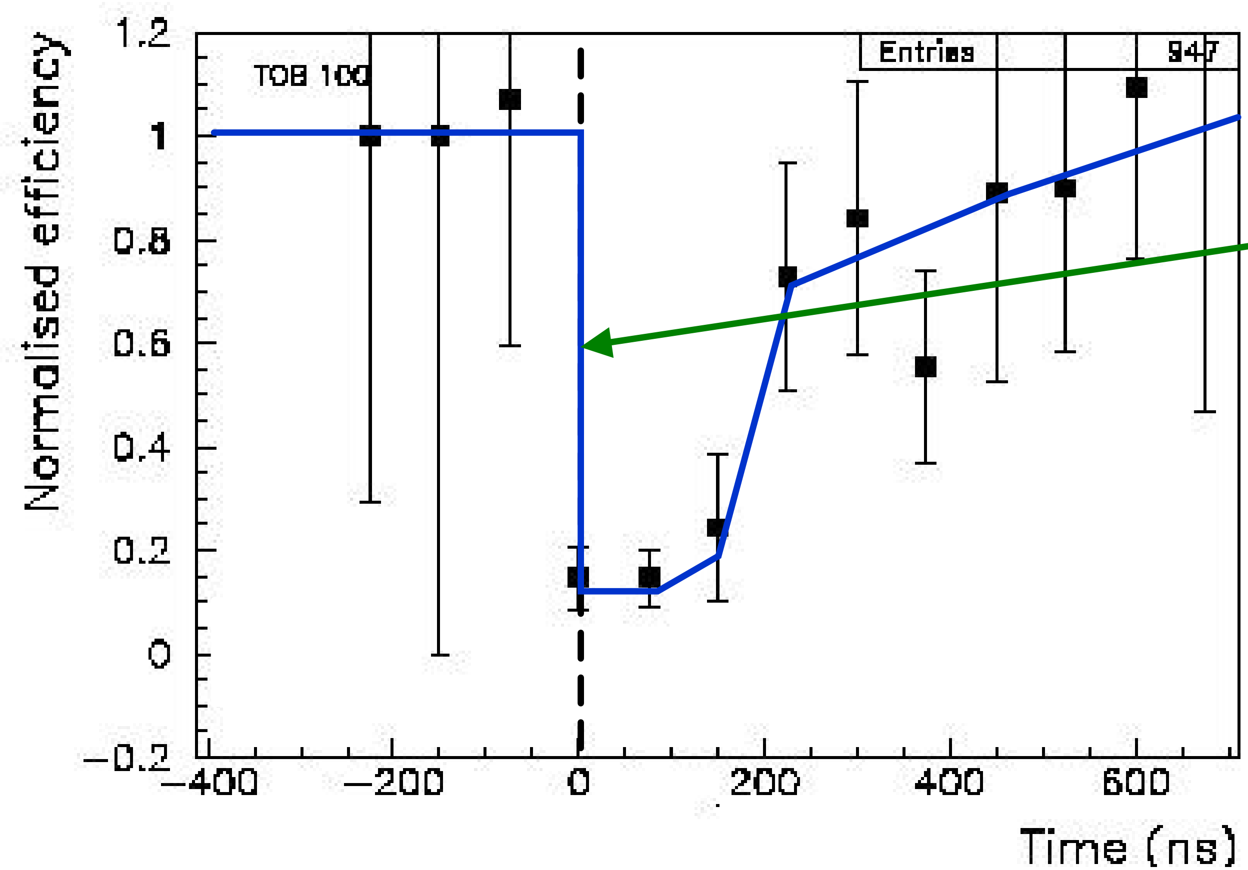
Time evolution of HIP recovery using trains of 30 events following each HIP.



Baseline takes a few hundred nanoseconds to recover.

Test-Beam Analysis of the HIP Effect

Efficiency vs. time measured by looking for hits on reconstructed tracks.



HIP occurs at time 0.

Inefficiency of CMS Tracker due to HIPs ~1%

The Future

- Now preparing for 25 ns test-beam in May:
  - Online monitoring histograms with XDAQ and/or ORCA.
  - Read new data format (ROOT).
  - Kalman filter tracking & alignment.
  - Module geometry from Detector Description Database.

- Ongoing work to prepare us for 2007:
  - Data format.
  - Cabling map.
  - ORCA on filter farm.

- b-τ group to study in detail 2 (3 ?) channels for physics TDR:

  A/H $\rightarrow$ $\tau\tau$ and ttH $\rightarrow$ bb.

  We will probably be responsible for calibration etc.

Conclusions

- UK is responsible for ORCA Test-Beam Analysis / Data-Handling software.
- 4 physicists from Brunel, IC and RAL involved.
- Many activities:
  - Management of group.
  - FED zero suppression algorithm.
  - Tracker data rate.
  - Hit resolution vs. FED dynamic range.
  - FED data format in ORCA.
  - Pedestal/noise calibration algorithms.
  - Test-Beam Analysis
- Now preparing for May 25 ns test-beam.