Charge measurement with the ATLAS SCT detector, using the Time-over-Threshold method

GRADUIERTEN KOLLEG Masse-Spektrum-Symmetrie
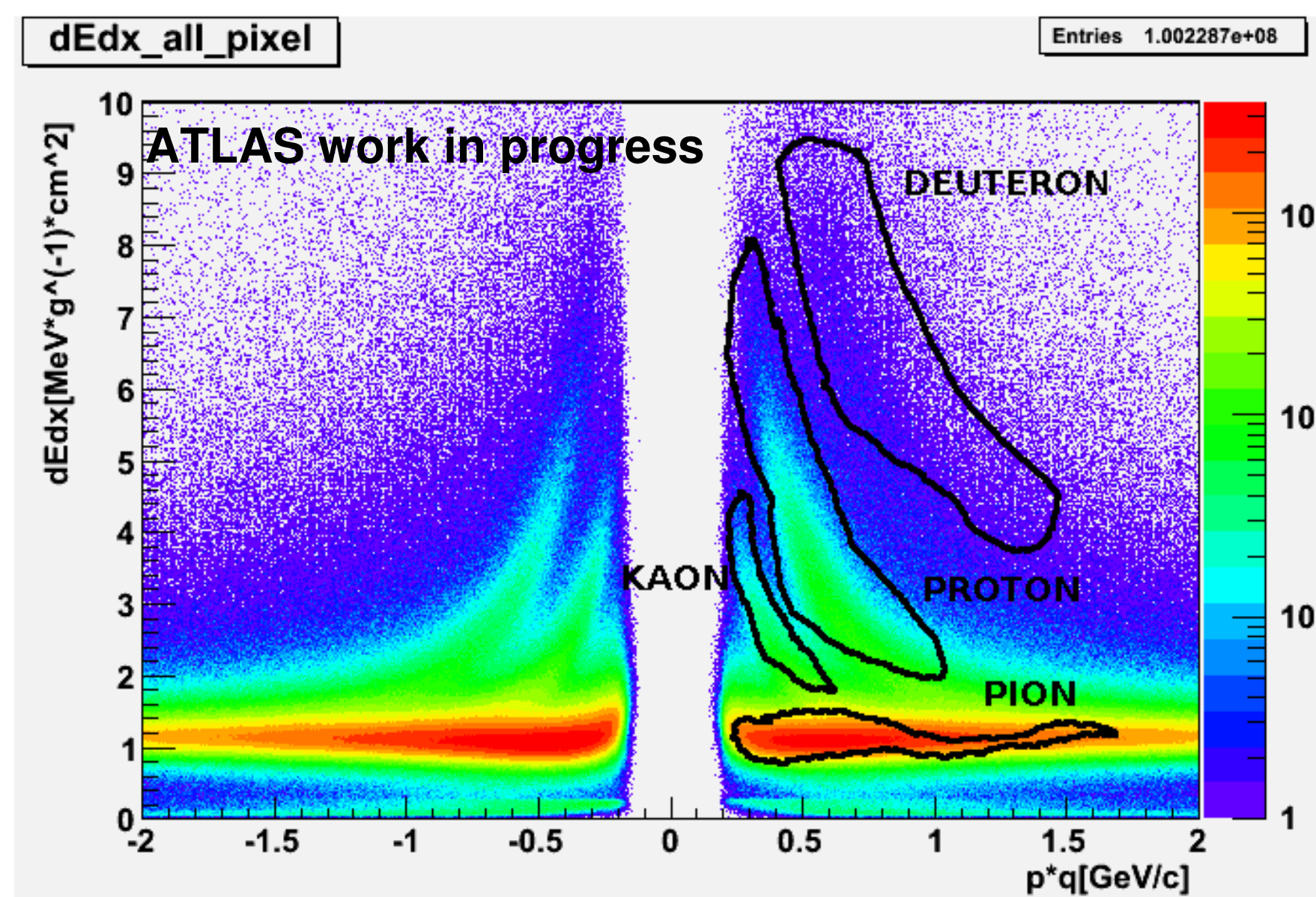
DESY

Motivation

- The SemiConductor Tracker does *not* provide dE/dx, but **Time-over-Threshold bins. Try to:**
  - **Reconstruct dE/dx in SCT**
  - **Compare it with the better resolution dE/dx reconstructed in the Pixel subsystem**
  - **From the SCT dE/dx, discriminate particles and monitor radiation.**

- **Pixel dE/dx vs Momentum * Charge** . The bands are low resolution Bethe Bloch curves. The charge in Pixel and SCT events is usually +1 or 1: p, D, π, K, e

Methods

- **For each track: clusters (=hits)** on both sides of each **module**
- **For each hit: strips** fired with charge

- **Read out 3 consecutive bunch-crossings for each strip:**
  - Bin 1 if bunch-crossing pulse > 1fC
  - Bin 0 if bunch-crossing pulse < 1fC
- **The more consecutive 1-bins, the higher the signal.**
  - 101 (illegal), 000: weight=0
  - 001,010,100: weight=1
  - 011,110: weight=2
  - 111: weight=3

- Correction for tracks passing at an angle: cos(α)=cos(θ)*cos(φ)
  - θ, φ are the polar and azimuthal angles in the module coordinates
 - For modules overlapping: division by #Track_hits
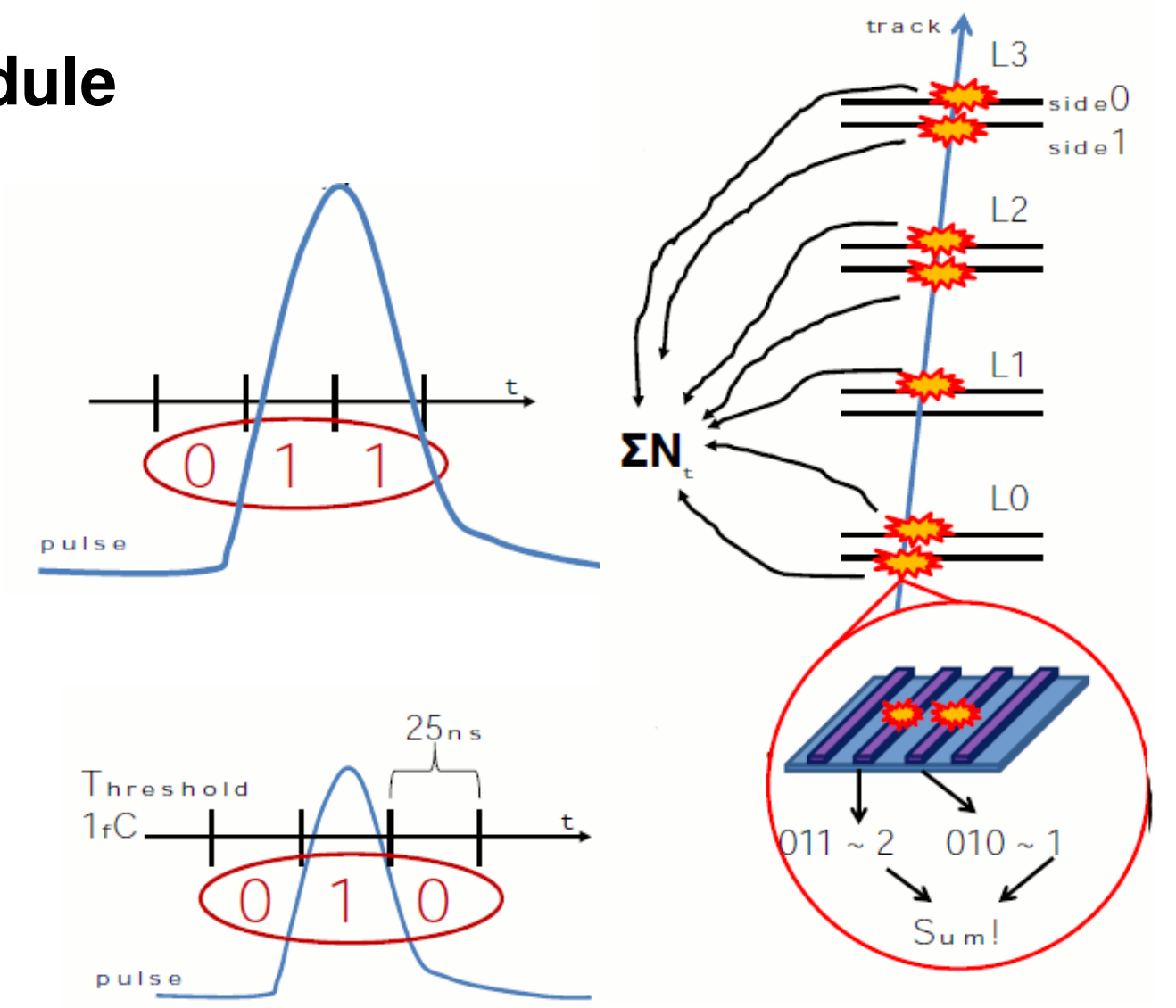
$$dE/dx(SCT)_{Track} = \frac{\sum_{\#SCT\_track\_hits} \sum_{\#Hit\_strips}(weight_{strip} \cdot \cos(\alpha))}{\#Track\_hits}$$
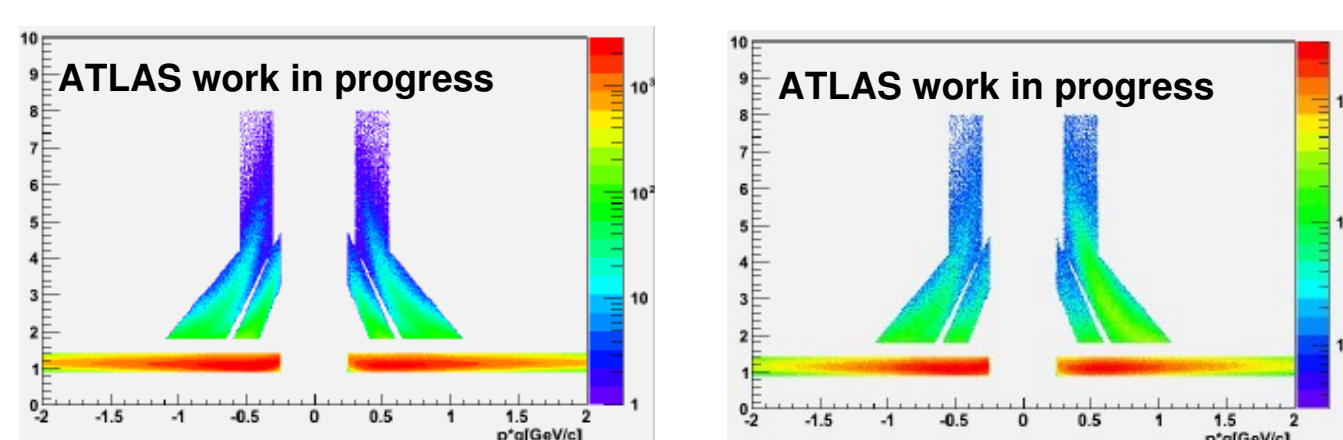
- **Used 4 million pp collision events, sqrt(s)=7TeV, from 2010-2011**

- **Sources of tracks:**
  - Noise
  - Gas interactions downstream in the beampipe
  - **Primary vertex PV:** in the beampipe, very close to the IP
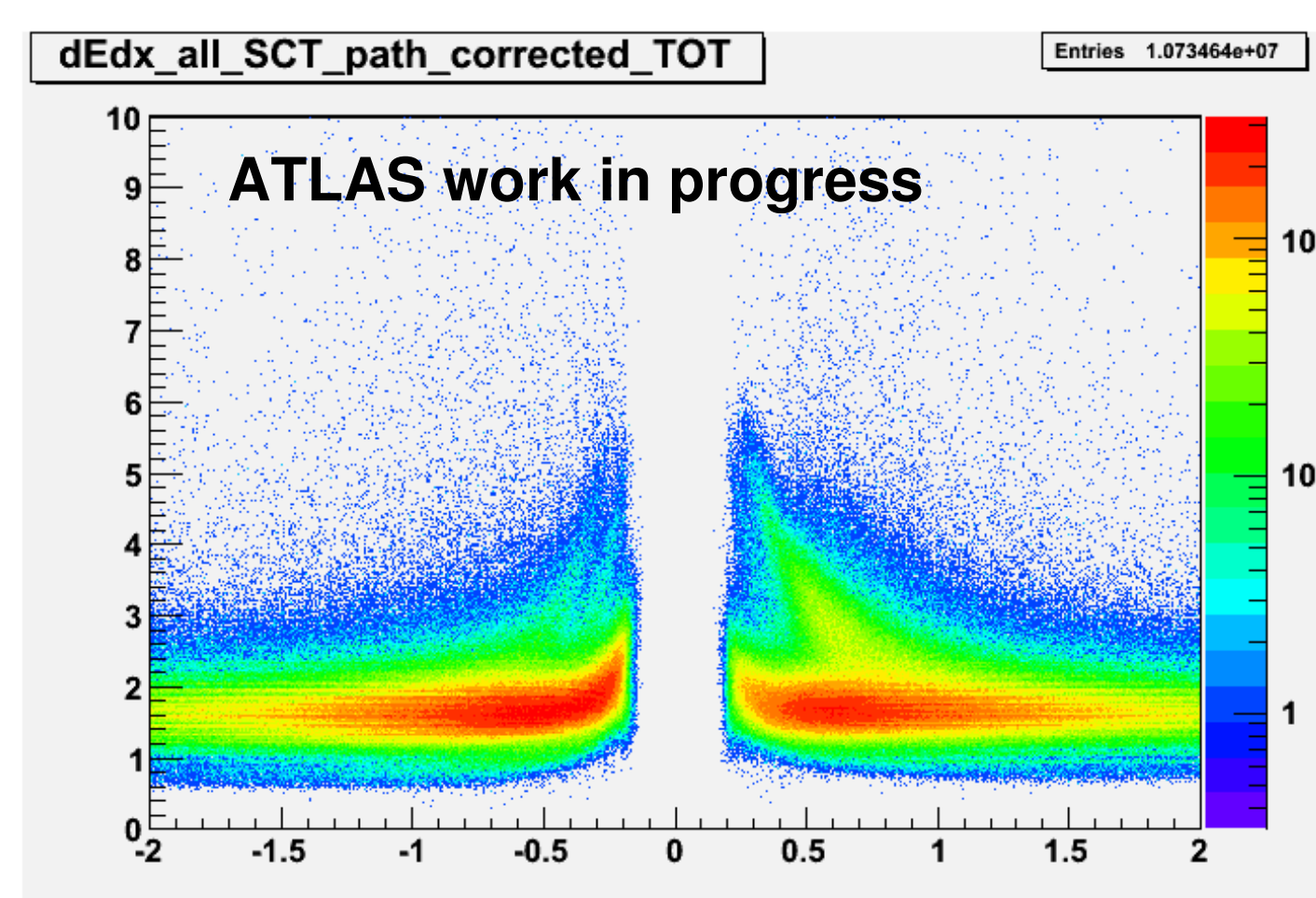   - **Small d0:** d0<2mm
  - **Secondary vertex SV:** in the beampipe wall
    - **High d0:** d0>2mm
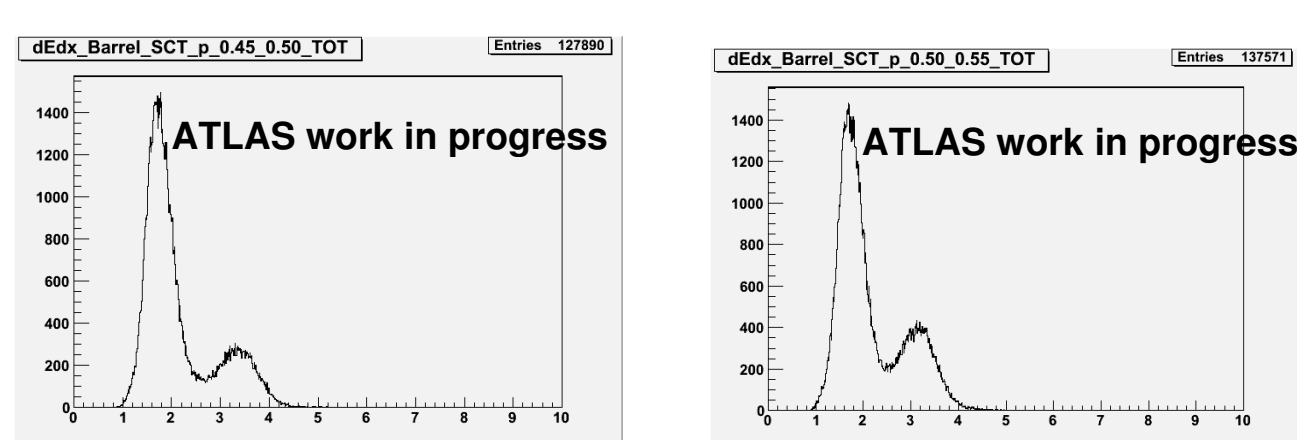 - *(Where d0 = perpendicular distance of the track to the beam line)*
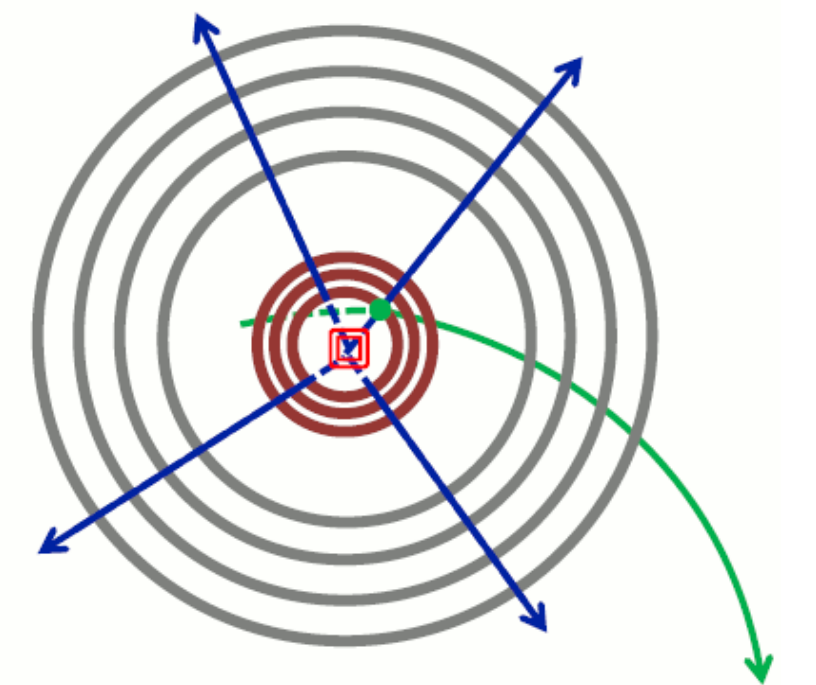
Recent Results

- **Comparison dE/dx with geometrical cut on bands:**
  - **PV (left):** K+, K-, p, p-bar bands
 - **SV (right):** more pronounced p bands, because of the material interactions

SCT dE/dx for SV tracks

- **SCT dE/dx of the above plot, for momentum slices (GeV)** 0.45-0.50 (left) and 0.50-0.55 (right). **The small bumps (p-band) are well separated** from the background: **sign of good reconstruction**

Important findings: Protons and Aging Effect:

- **AGING EFFECTS:** identify protons and monitor their peak SCT dE/dx for several months 2010, momentum slice 0.50-0.55 GeV
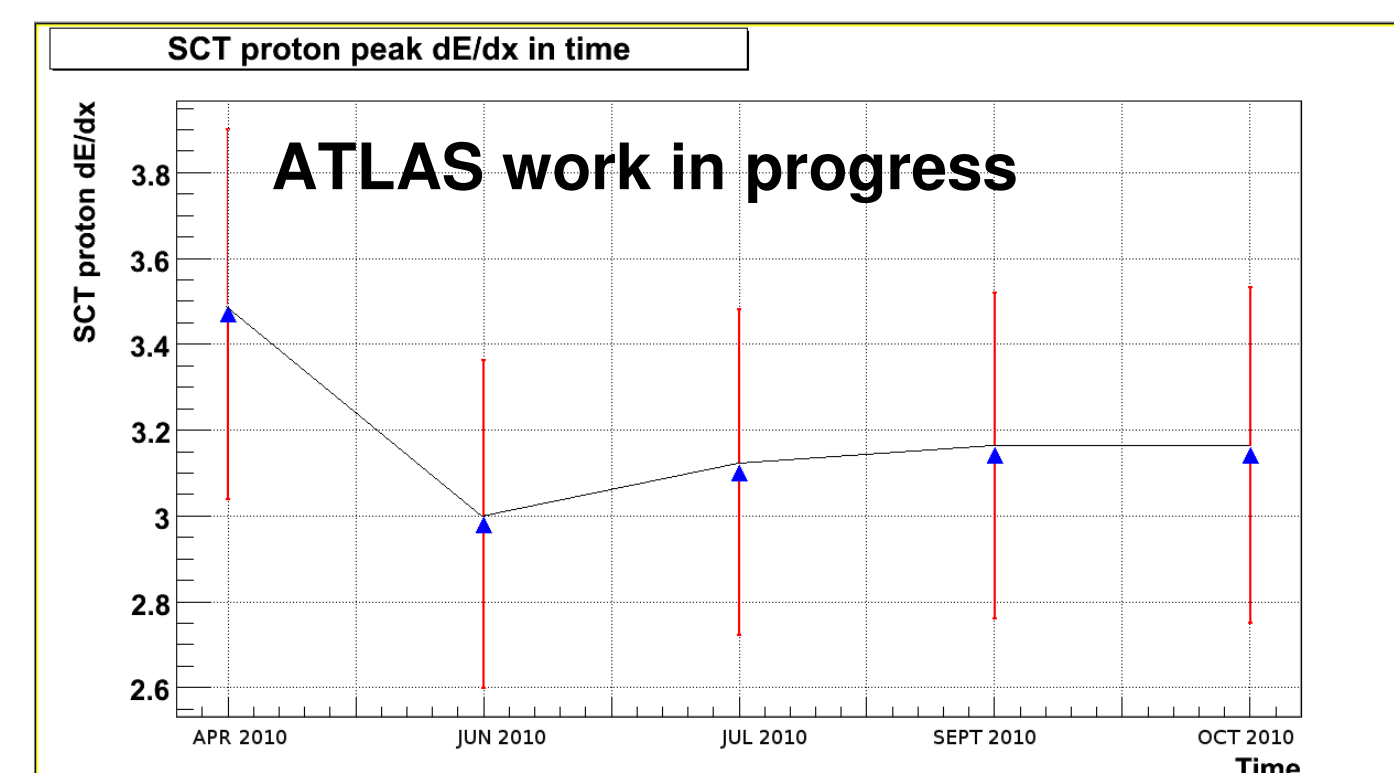
- The error bars represent the Sigma from Gaussian fit

- In April the timing scan changed, which might have caused the jump 3.4 → 3.1 (3.0)

- **The peak shouldn't have changed in such short months (little radiation damage), and it didn't !**

- **We'll monitor further for next years.**

Outlook:

- The first results on dE/dx reconstruction for SCT are very encouraging, **BUT**

  - **Measuring dE/dx in SCT is still challenging, because of the less precise readout than for the Pixel detector**

  - **Useful for long-term charge and radiation monitoring**

- More investigations:

  - Cosmics, Heavy Ions

  - Find the highest discriminator for dE/dx (#strips, weights)

  - Pick up pions and protons from resonance states (K0S→π π, Λ→p π-)

Selected Talks

- *"Can we measure charge at the SCT, ATLAS detector?"*, Deutsche Phykalische Gesellschaft Tagungen, Göttingen, Feb 2012

- *"Proposal for Higgs follow-up"*, BND school, Sept 2011

- *"Can we measure charge at the SCT, ATLAS detector ?"*, GK Blockcourse, DESY Zeuthen, Oct 2011

Collaborations

- ATLAS group, DESY Zeuthen
- SCT group, CERN

Profit from the GK

- Financial support for the Belgian Netherlands Dutch international school in Particle Physics
- GK lectures covering the combined Particle Physics, Astrophysics and Theoretical Physics fields, with input from the Humboldt-Universität zu Berlin, DESY Zeuthen and TU Dresden
- "Grant Application" soft skill course at the HU graduate school

Contact Details and further Information

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