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Differential cross section measurements for pp elastic scattering at ANKE

December 17, 2013 | David Chiladze (HEPI, Tbilisi State University)

FFE Contract: COSY 080

Outline

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- Experimental Setup
- Measurement Technique
- Target Density Determination
- Luminosity
- Preliminary Results
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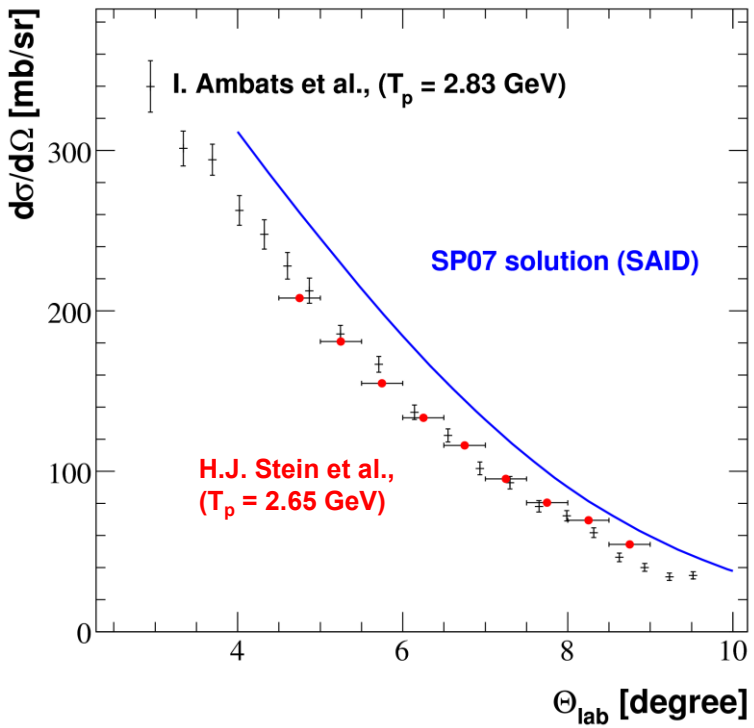
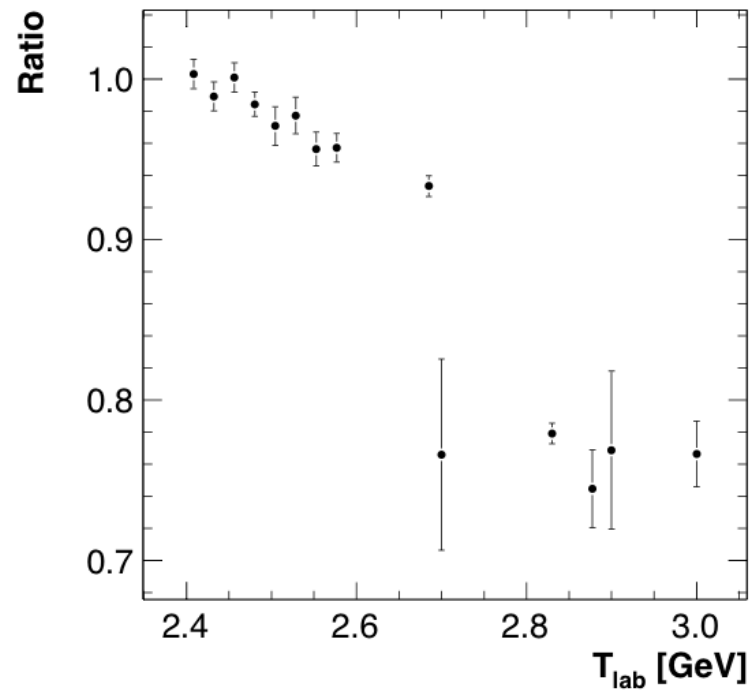
Motivation

- NN description requires precise data for Phase Shift Analysis.
- There are severe problems with the small angle predictions from SAID above 2.5 GeV.

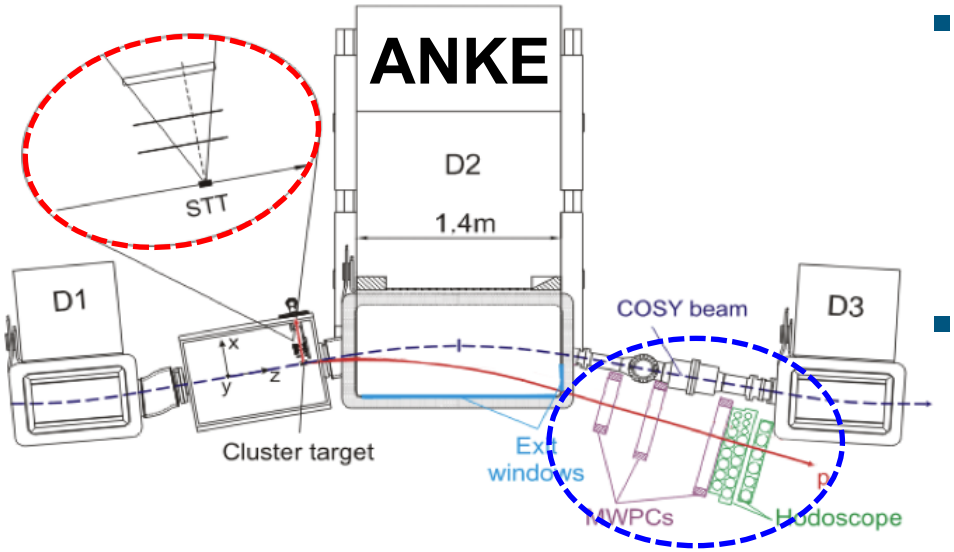


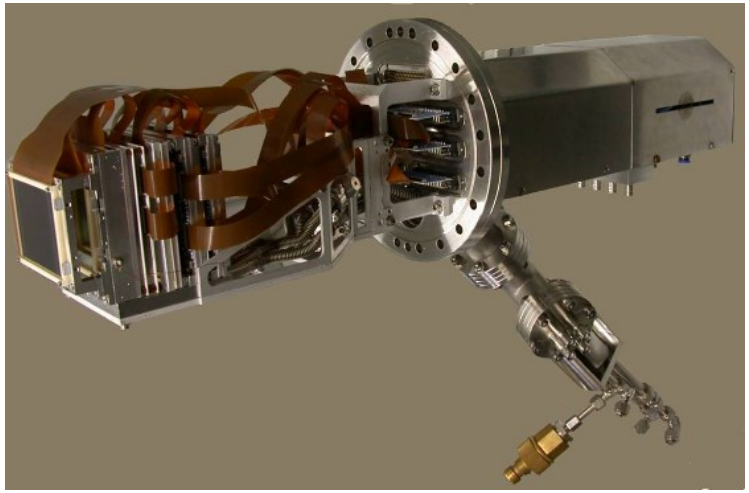
Ratio of the experimental data to the SAID predictions averaged over angular range: $10^\circ < \theta_{cm} < 30^\circ$



In order to deduce information on np system it is necessary to have equally <u>robust pp data</u> in the <u>same</u> angular range.

Experimental Setup





- $d\sigma/d\Omega$ measurement in the angular range: $5° < \theta_{cm} < 30°$ for the energies: T_p = 1.0, 1.6, 1.8, 2.0, 2.2, 2.4, 2.6, 2.8 GeV.
- Proton detection either with **FD**, or with **STT**, or with both in coincidence.
  - Three Multi-wire Chambers with two layers of Scintillation hodoscopes. ($10° < \theta_{cm} < 30°$)
  - Three layers of double-sided silicon strip detectors. ($5° < \theta_{cm} < 15°$)

Measurement Technique

- Absolute measurement of pp elastic scattering (dσ/dΩ) using the Schottky technique. **COSY proposal #200 (PAC-37)**
- Cross section σ of given physical process is related to its event R rate by luminosity:

$$\sigma = \frac{R}{L}$$

Accuracy 2-3%

Where: $L = n_B \cdot n_T$

  - Accurate measurement of beam intensity n_B is possible via the high precision Beam Current Transformer (BCT) device.
  - Effective target thickness n_T can be obtained via the measurement of the frequency shift of coasting beam using the Schottky device.

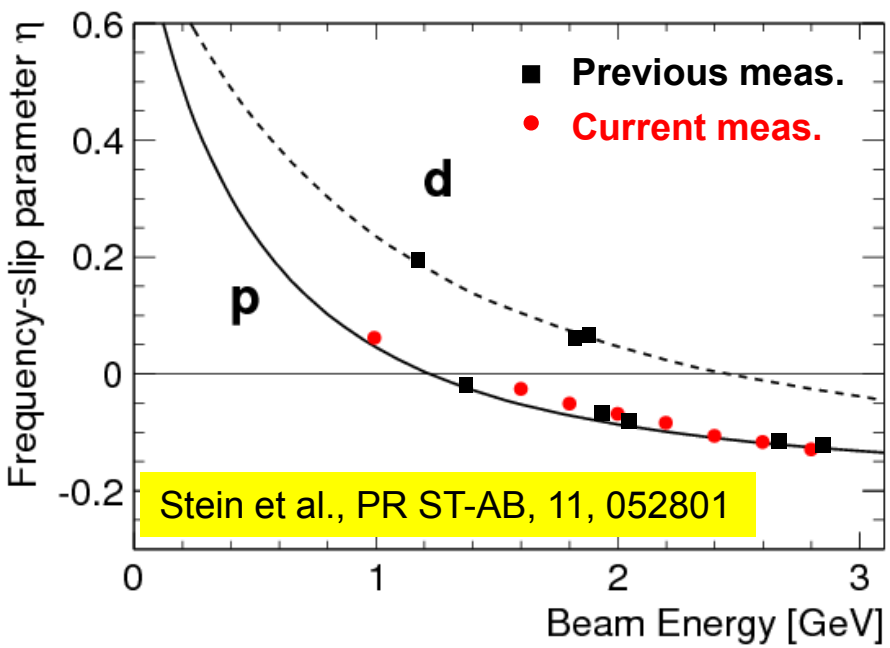
$$n_T = \left(\frac{1+\gamma}{\gamma}\right) \frac{1}{(dE/dx)m} \frac{T_0}{f_0^2} \frac{1}{\eta} \frac{df}{dt}$$

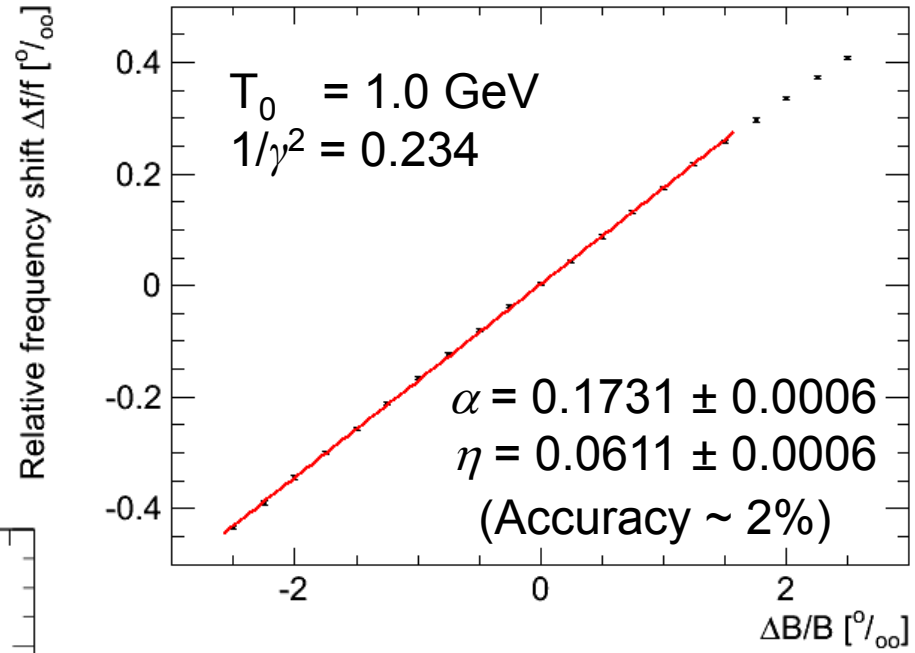
Details in: Stein et al., PR ST-AB, 11, 052801

Target Density

η parameter is connected to the momentum compaction factor α:

$$\eta = \frac{1}{\gamma^2} - \alpha$$





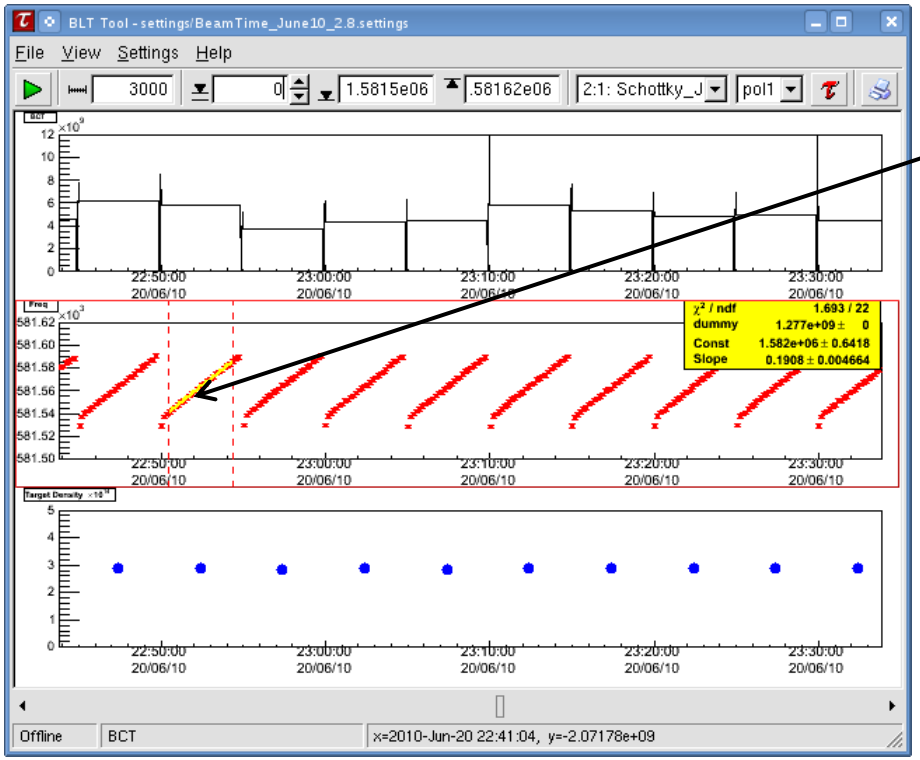
Mean revolution frequency shift is connected to ΔB/B change in the bending magnets via momentum compaction factor α:

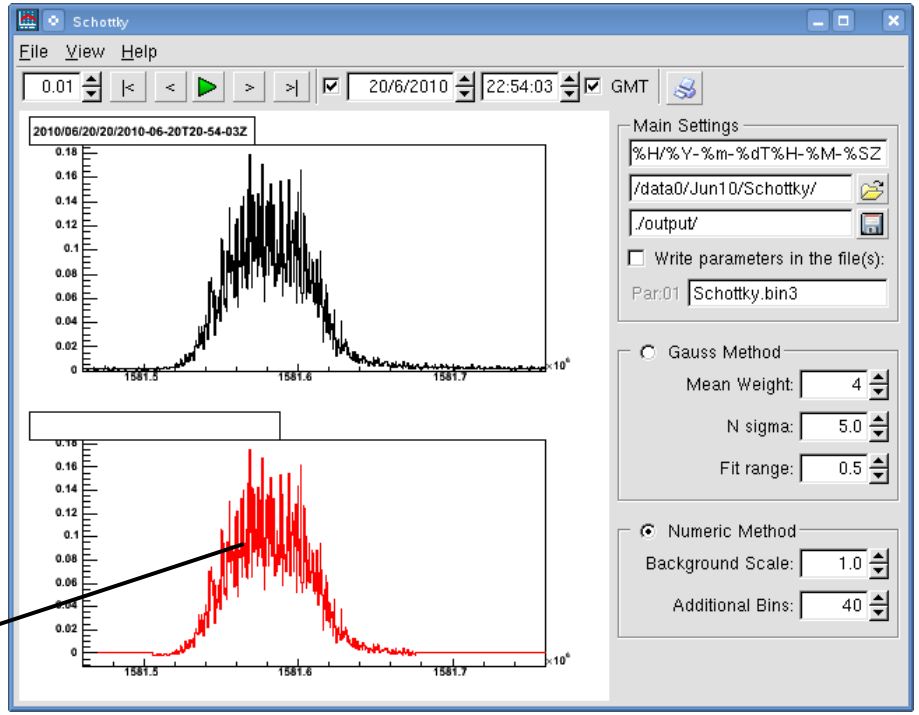
$$\frac{\Delta f}{f_0} = \alpha \frac{\Delta B}{B}$$

Luminosity

Dedicated software package determines:

- Revolution frequency
- Frequency shift
- Target density



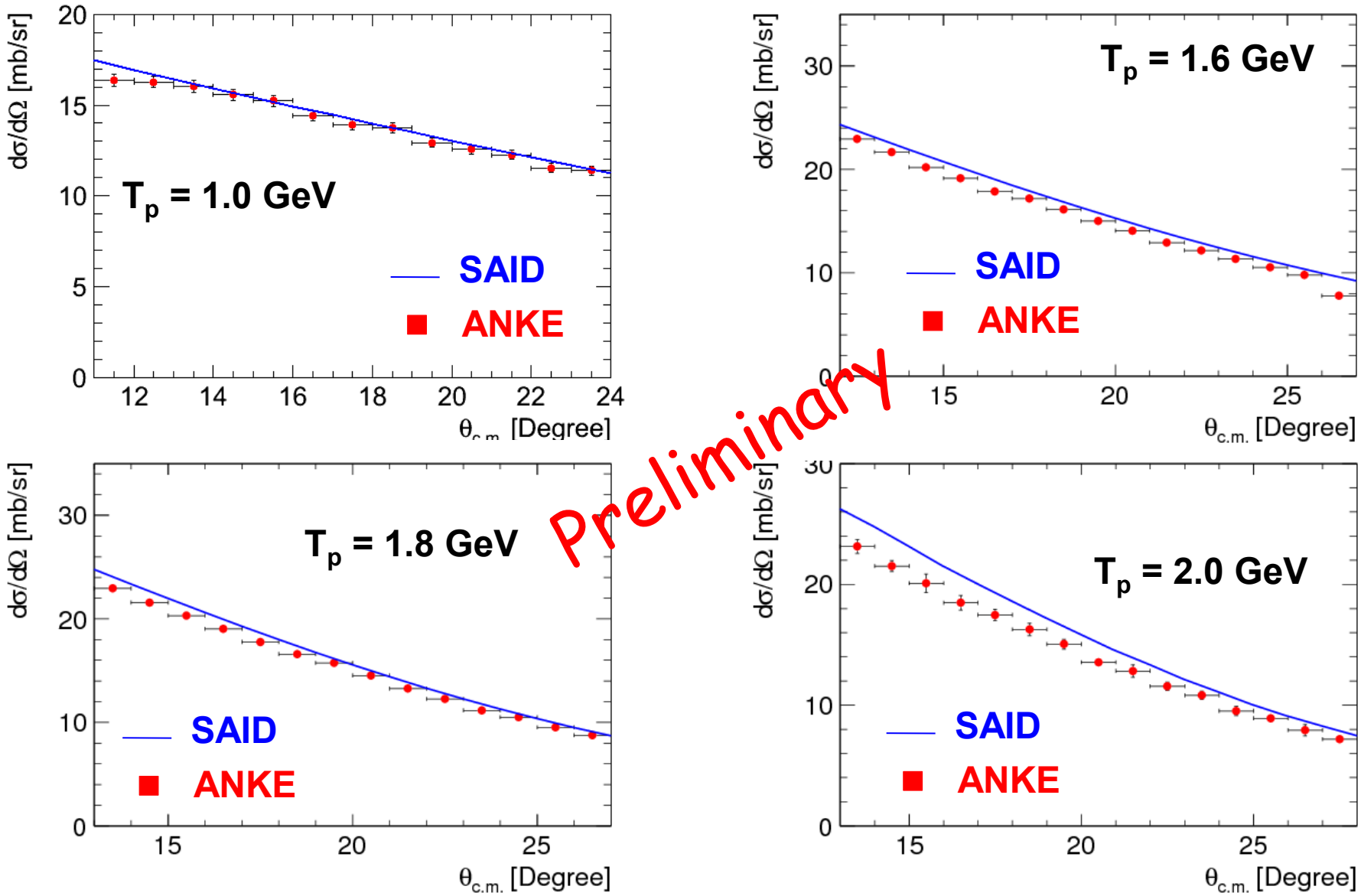


$$n_T = \left(\frac{1+\gamma}{\gamma}\right)\frac{1}{\eta}\frac{1}{(dE/dx)m}\frac{T_0}{f_0^2}\frac{df}{dt}$$

$$L = n_B \cdot n_T$$

With 2-3 % accuracy

Preliminary Results: Forward Detector



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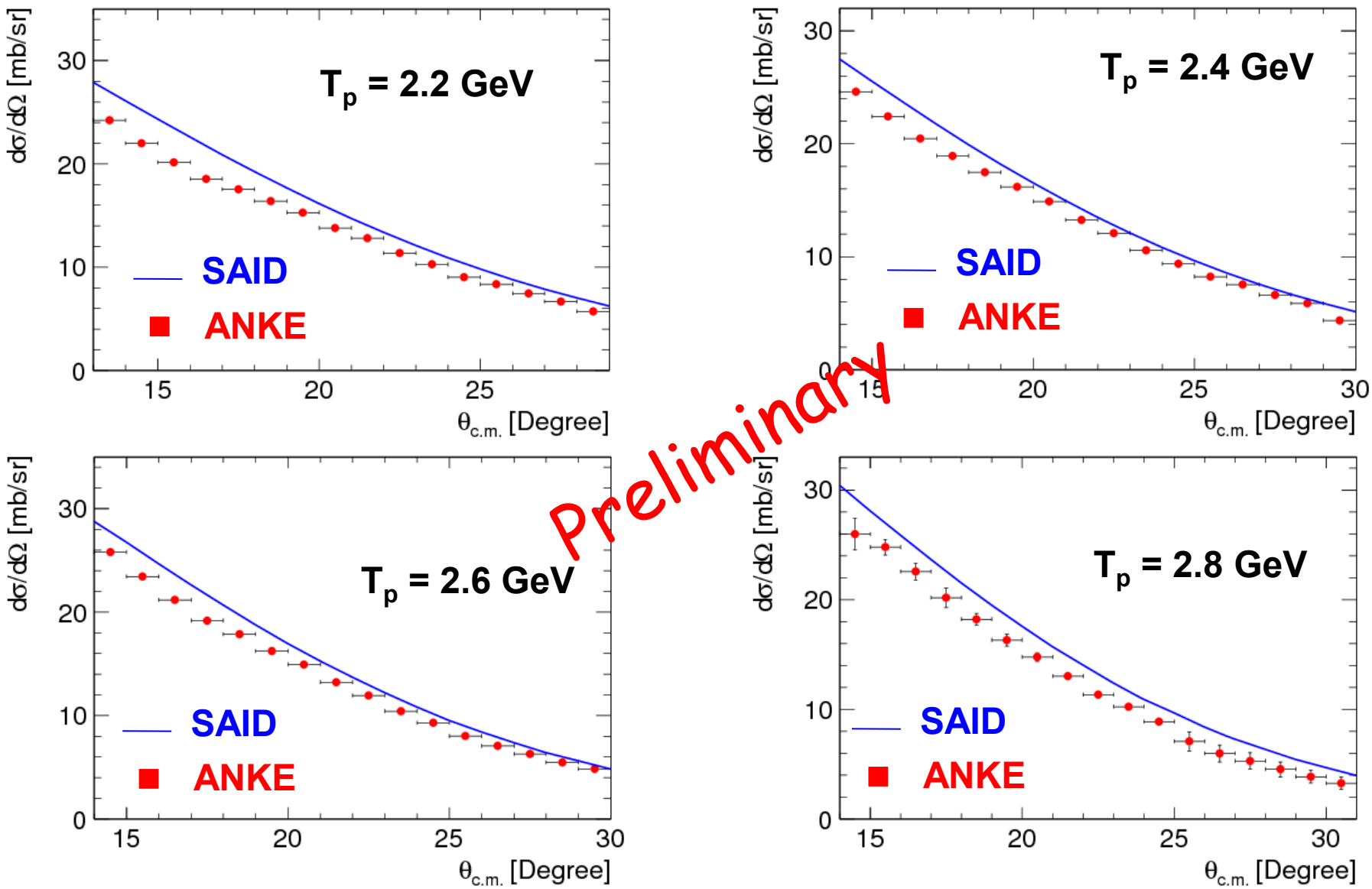
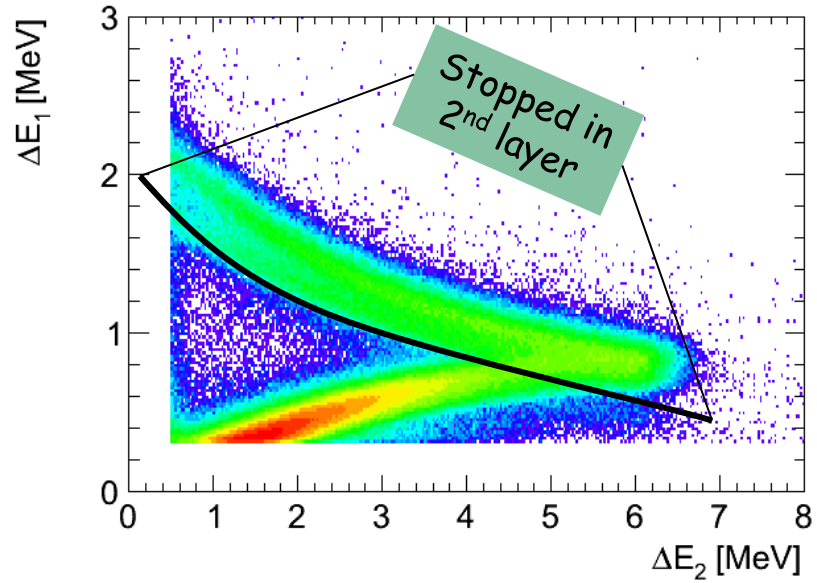
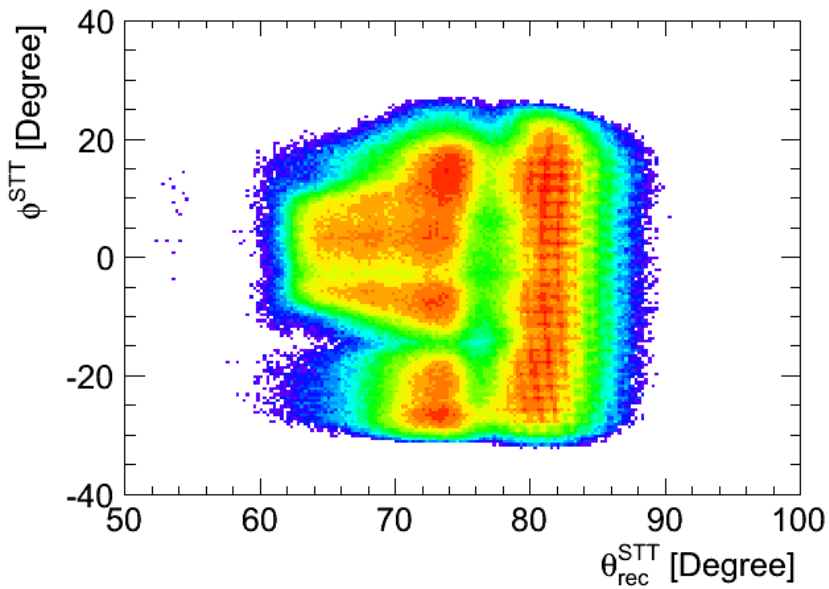
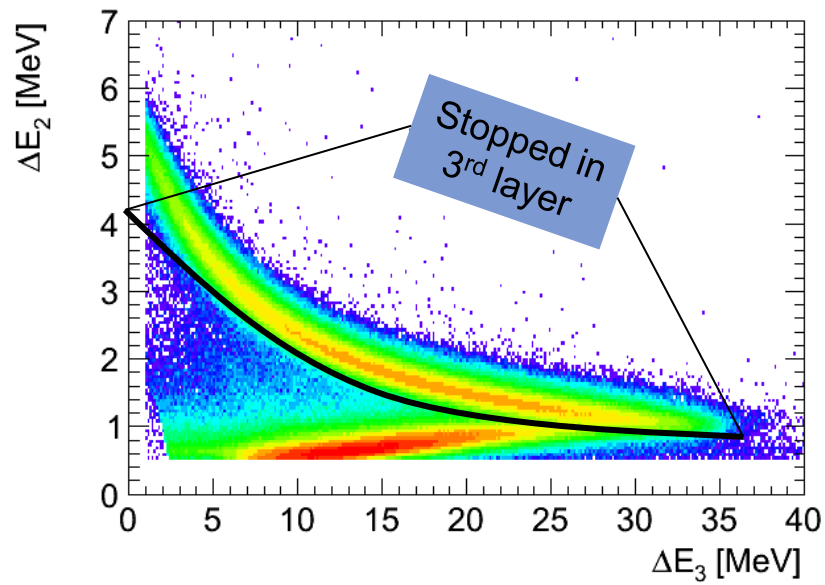


STT Analysis

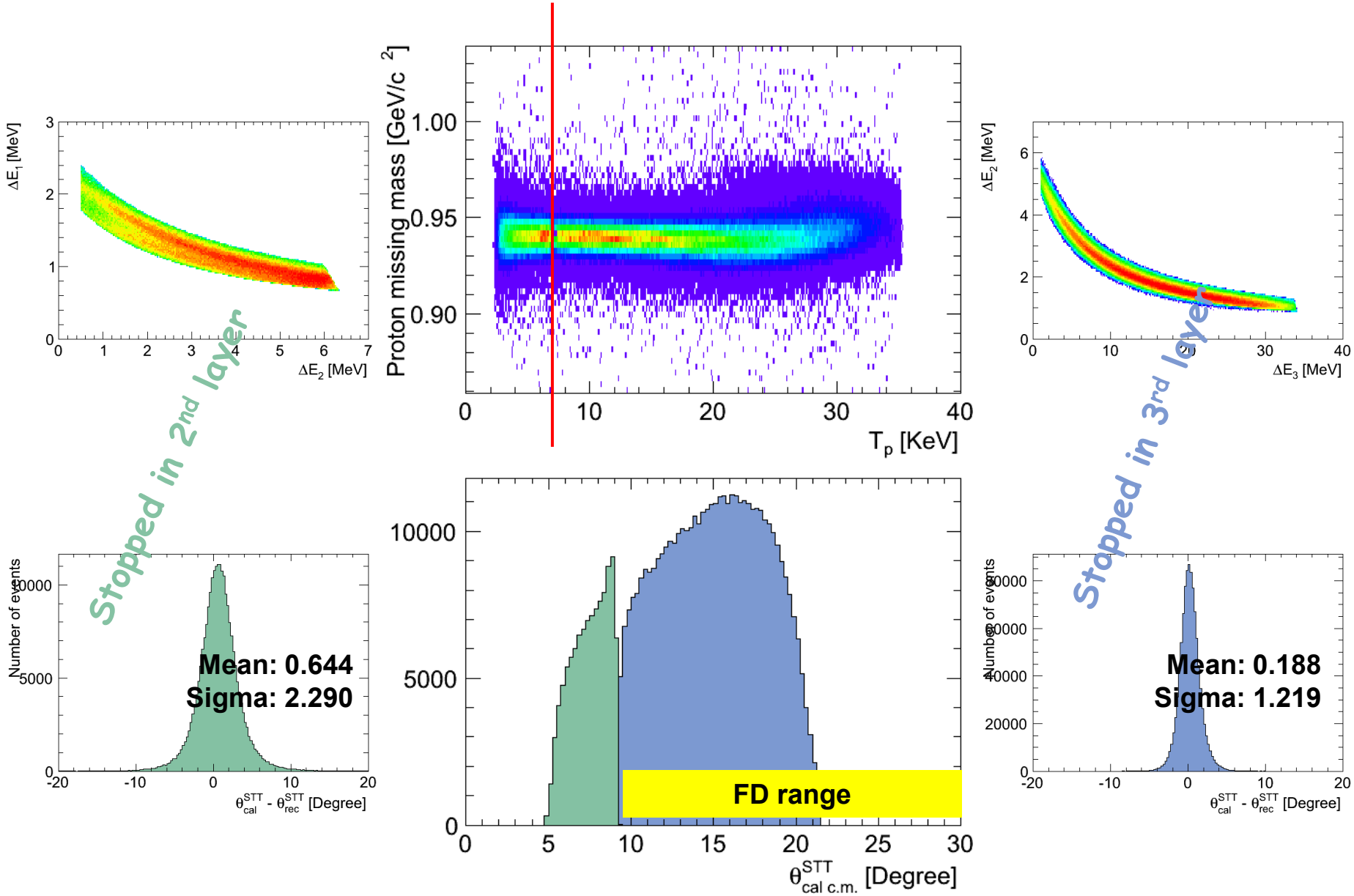
- Three layers with different thickness 70 µm, 300 µm, and 5 mm allow very good particle identification
- Track and consequent vertex reconstruction
- Very accurate energy measurement for stopped particles





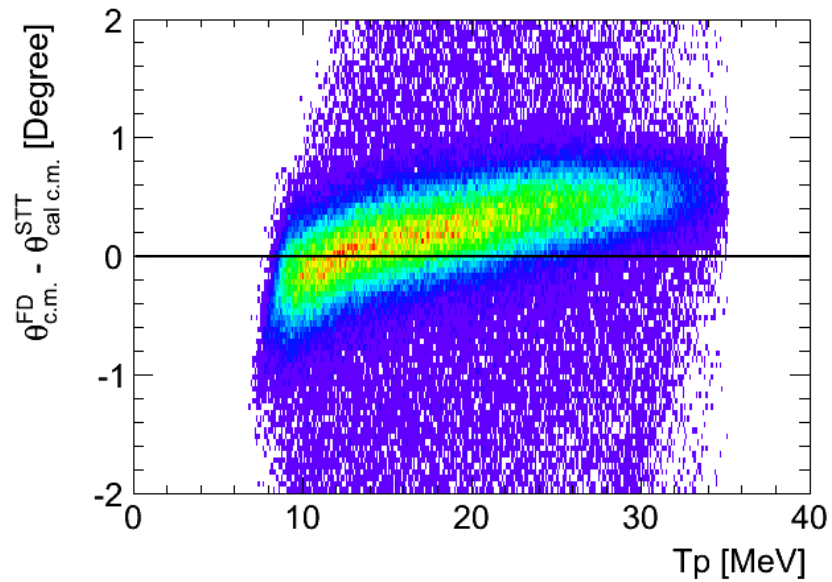


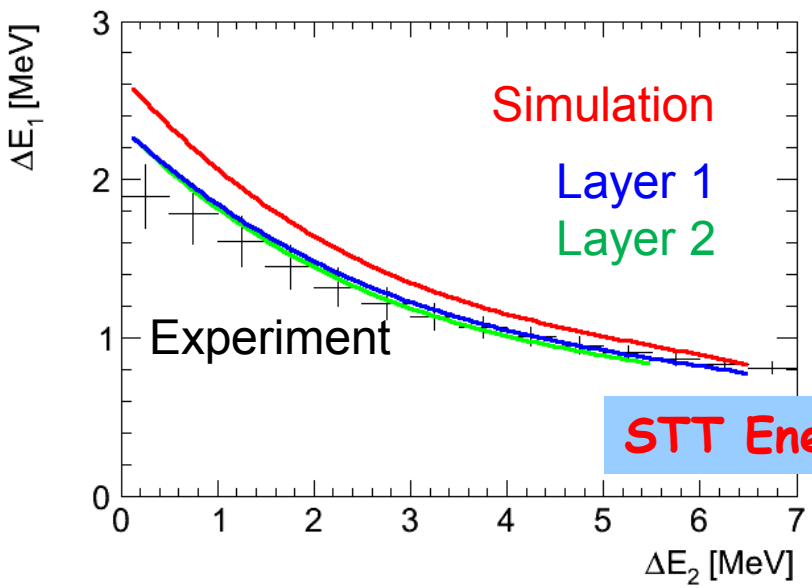
STT Analysis: Stopped particles

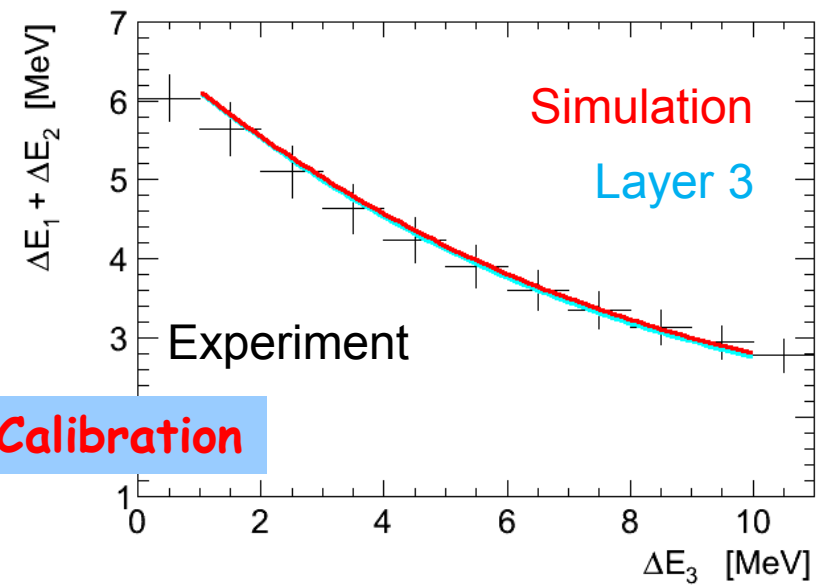


STT Analysis: Coincidence with FD

- There is a difference between FD and STT angle
- Energy calibration depends on energy itself
- It is necessary to consider energy dependence in the calibration procedure.



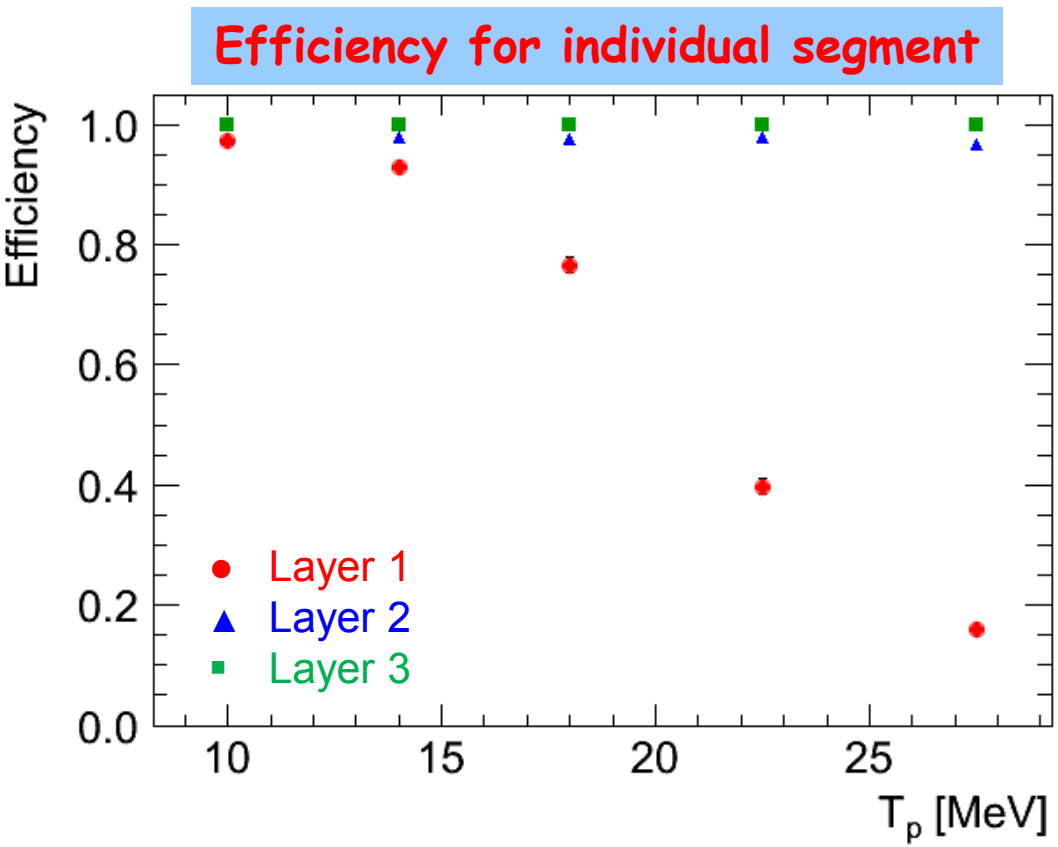


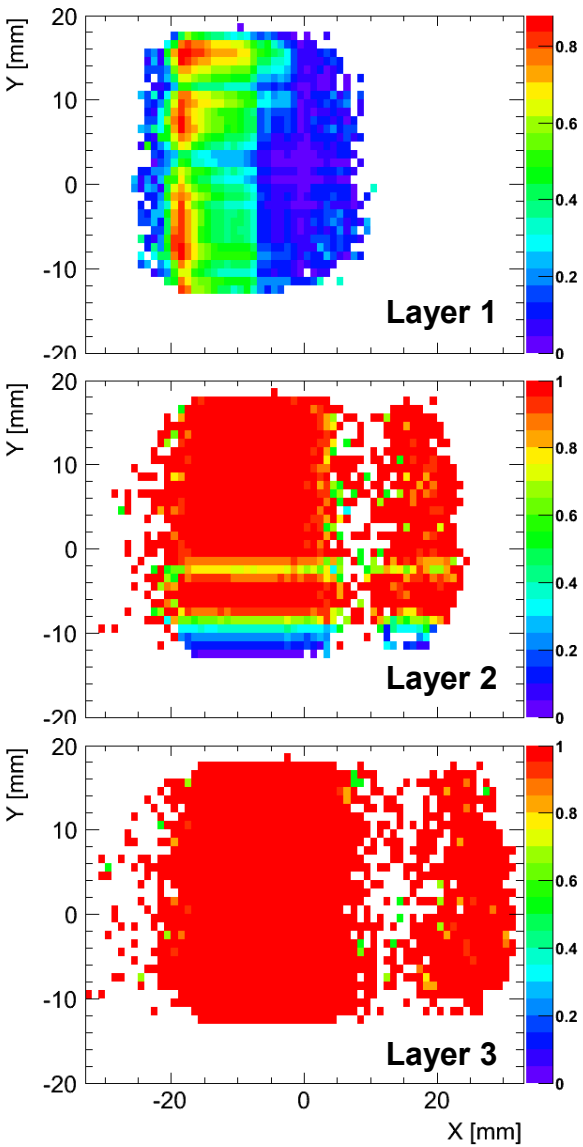


STT Energy Calibration

STT Analysis: Efficiency

- Trigger from Forward Detector
- Efficiency of 1st layer decreases for high energy particles as energy loss is very close to threshold





Summary & Outlook

- High precision luminosity determination with schottky technique has been achieved (accuracy ~ 2 – 3%)
- ANKE can provide robust pp data in energy region Tp = 1.0 – 2.8 GeV for c.m. angular range 10 – 30° (uncharted territory)
- STT can provide valuable check of systematics and possible increase in angular range.
- Expected precision of differential cross section around 5% (analysis in progress).