Energy Measurement and Calibration for the DESY Testbeam

Torben Lange (ATLAS)

Summer student report

torben.lange@desy.de

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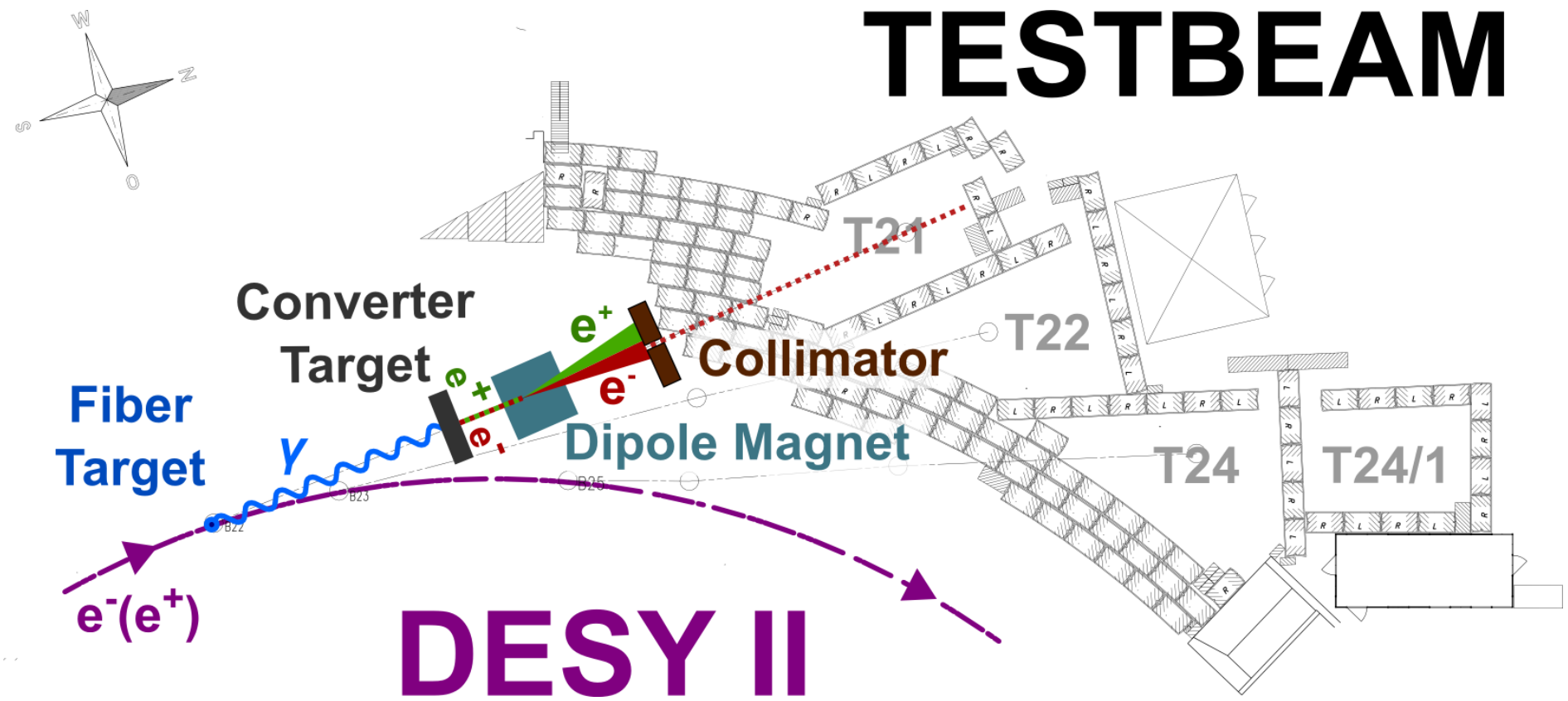
Content

Introduction

The DESY testbeam areas

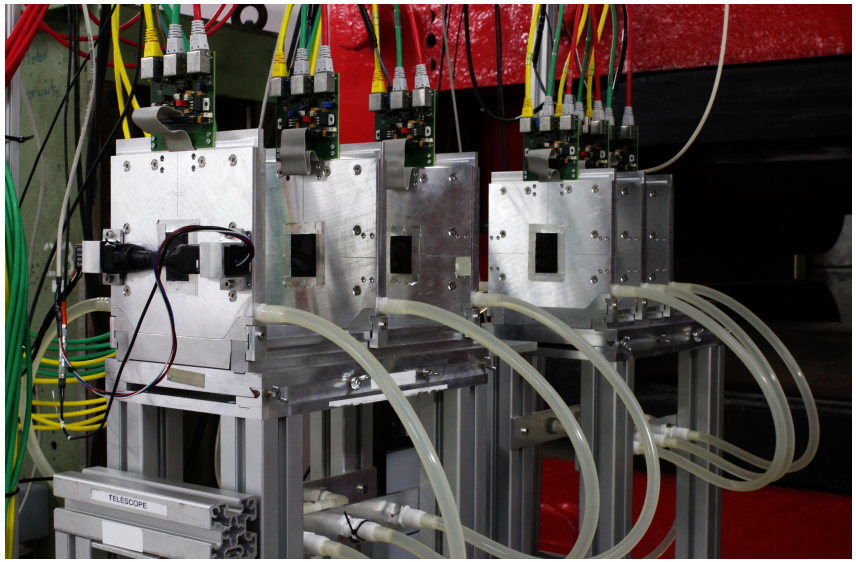


Introduction

The DATURA telescope

The DATURA telescope consists of:

- 6 Planes with MIMOSA 26 pixel sensors for tracking
- 4 Scintillator tubes for triggering



Goal:

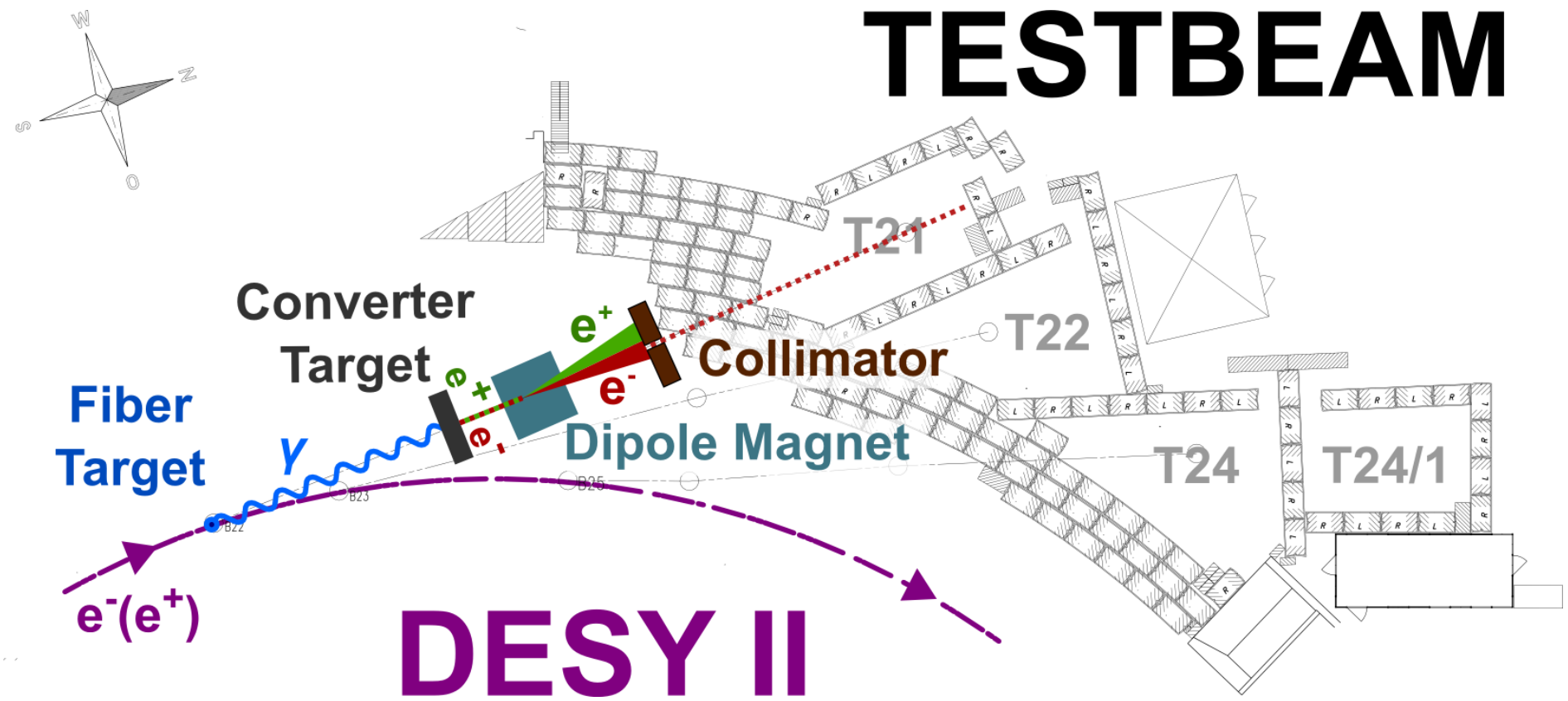
- reconstruction of particle path up to a $\sim \mu m$ resolution

  $\rightarrow$ testing and calibrating of new detector components

Problem: No information about beam energy $\rightarrow$ user has to rely on good energy calibration

Introduction

The DESY test beam areas



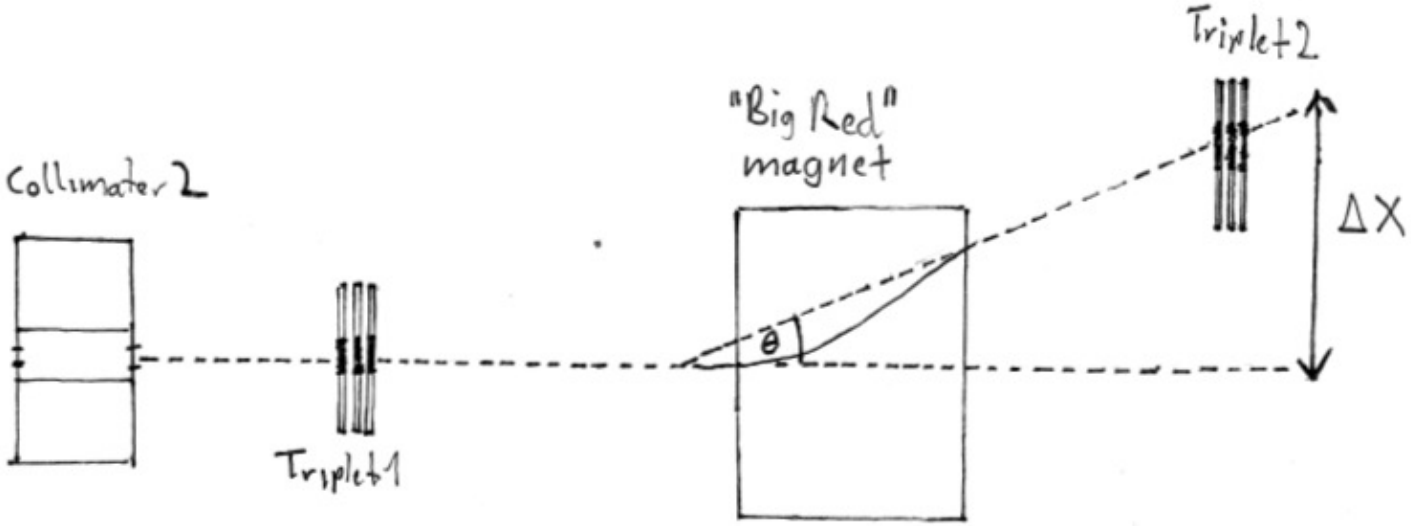
Experimental Setup

The Big Red Magnet

Experimental Setup

Basic Idea

- Idea: Deflect electrons/positrons in magnetic field
- Angular measurement $\rightarrow$ energy measurement



- Measurement of initial angle allows to measure the energy for every single particle!

Energy Calibration

Energy determination with Boris Method

How do we calculate the energy out of the deflection angle?

In a simpler case we could use: $\theta \approx \frac{eBL}{p}$

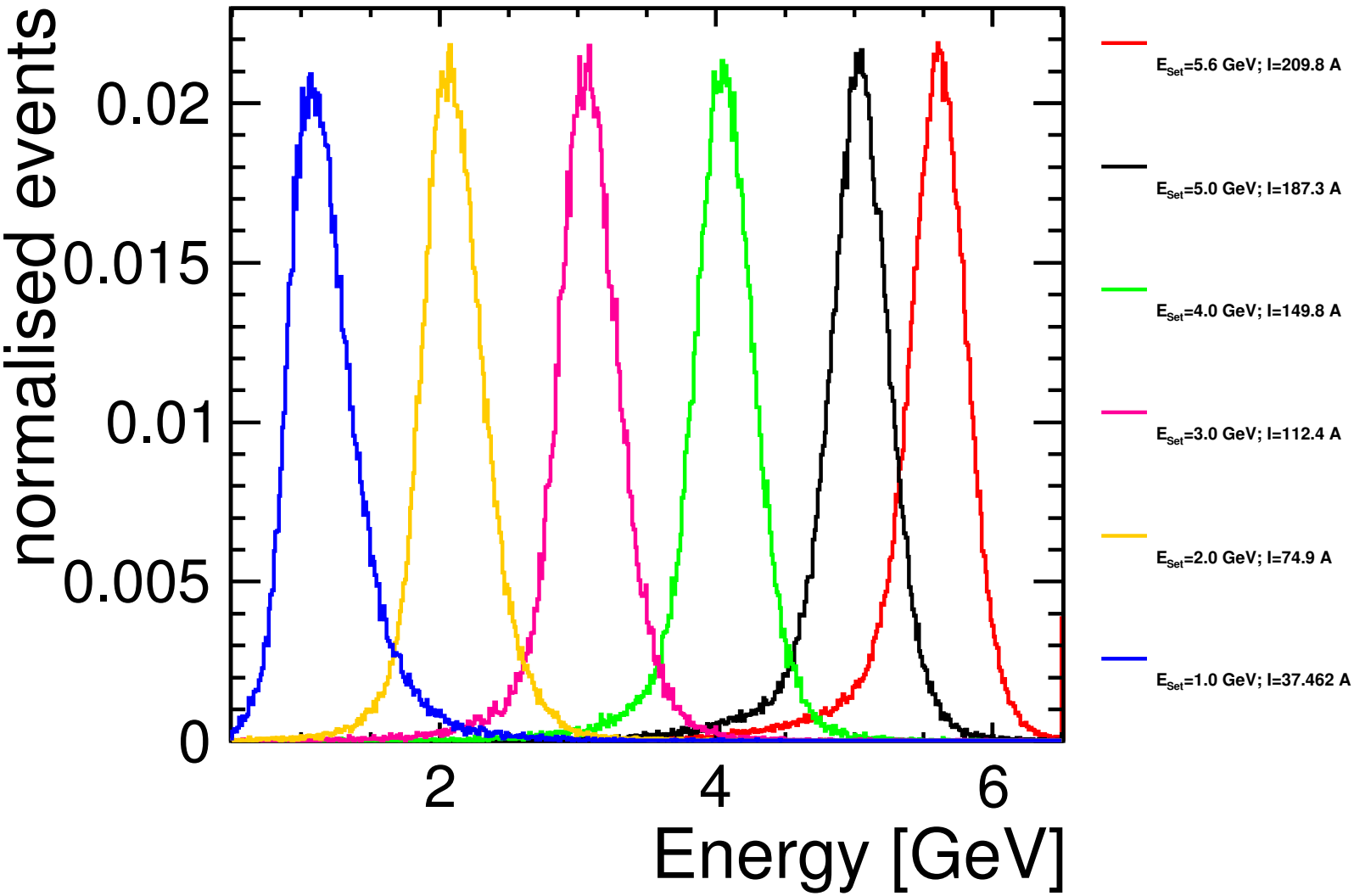
But: magnetic field is not homogeneous $\rightarrow$ use Boris method to simulate deflection angle for given energy

$$\begin{pmatrix} \theta_{in} \\ \theta_{out} \\ I_B \end{pmatrix} \Rightarrow \boxed{\text{Simulation}} \Rightarrow E$$

Energy Calibration

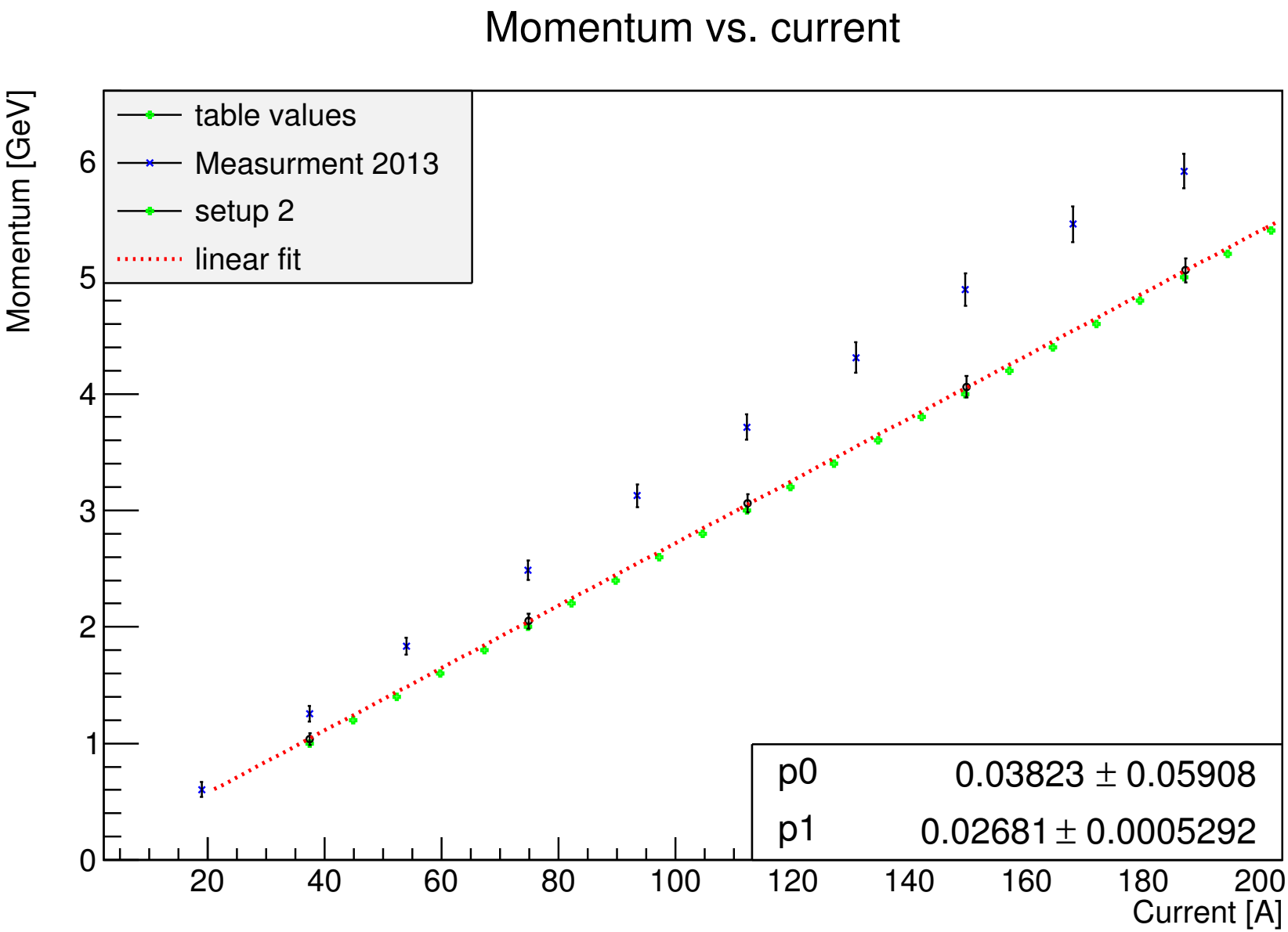
Results

Setup 1



Energy Calibration

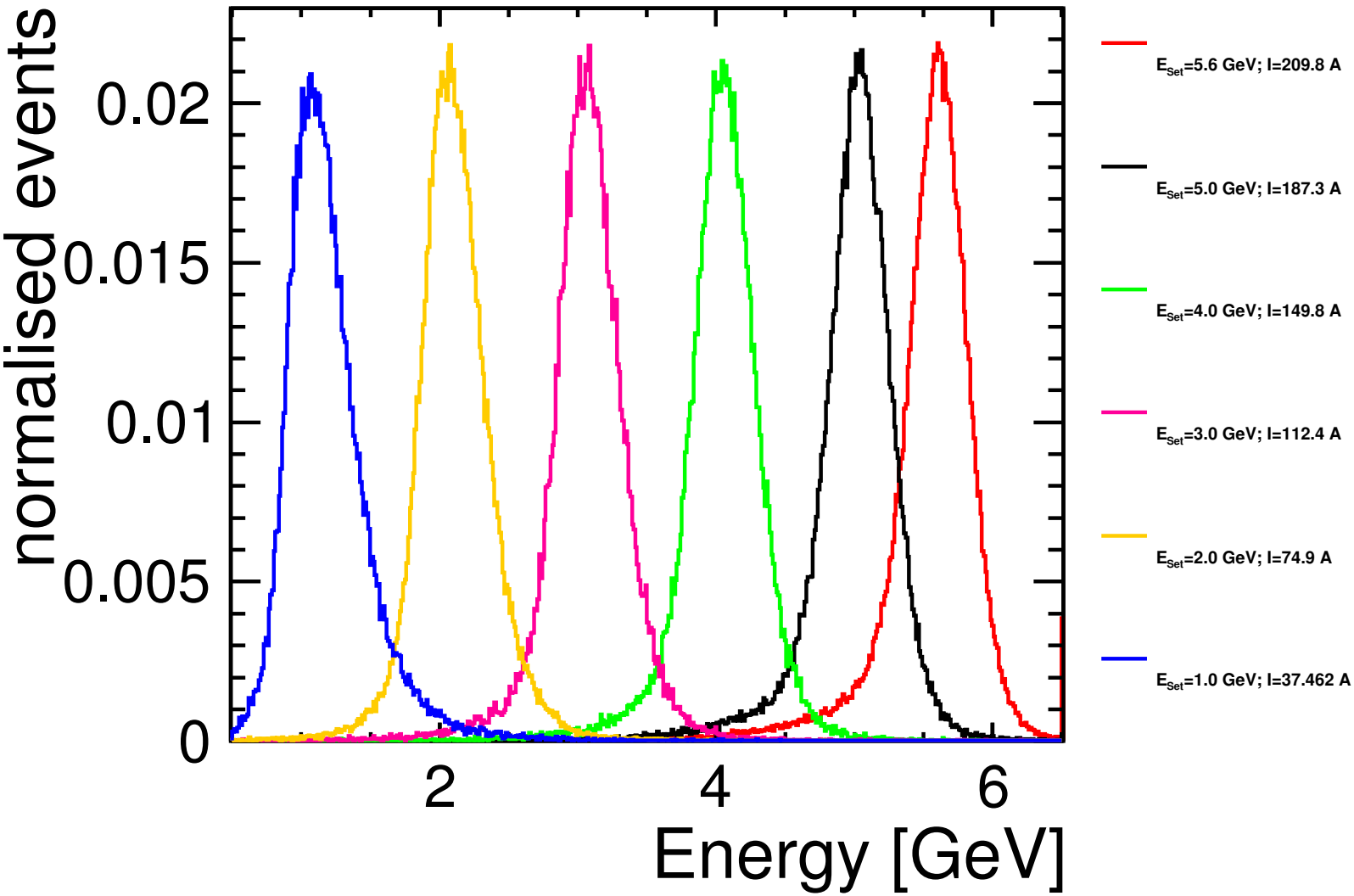
Comparison to previous results



Energy Spread

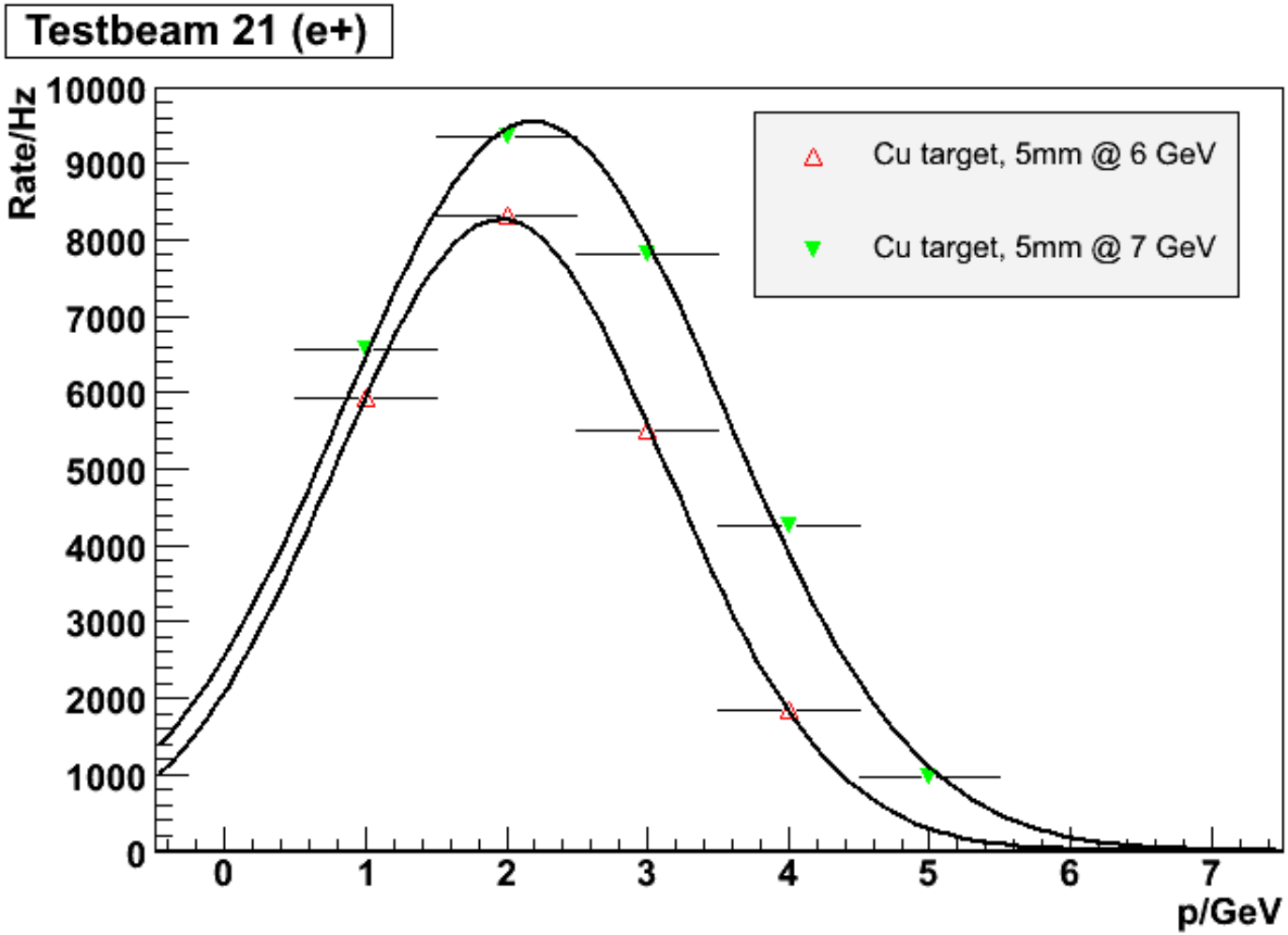
The next Step

Setup 1



Energy Spread

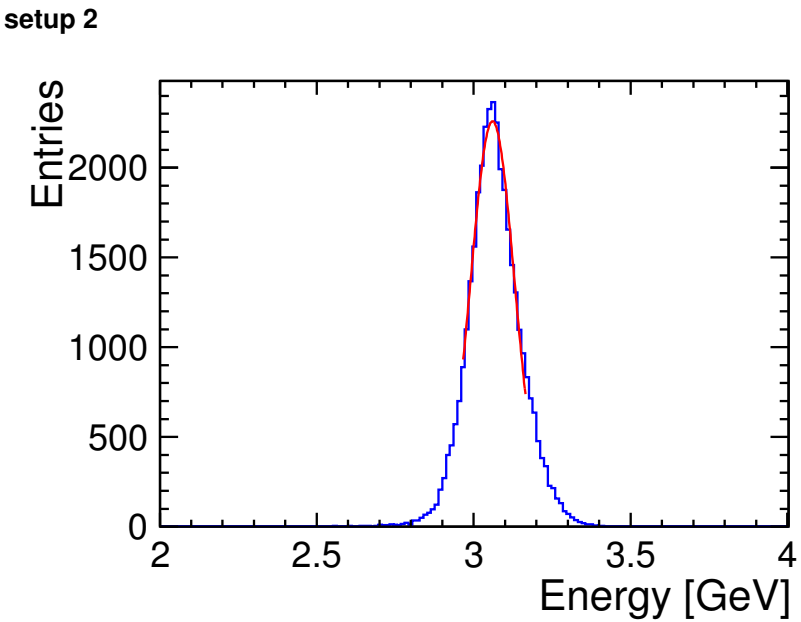
Energy distribution

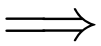


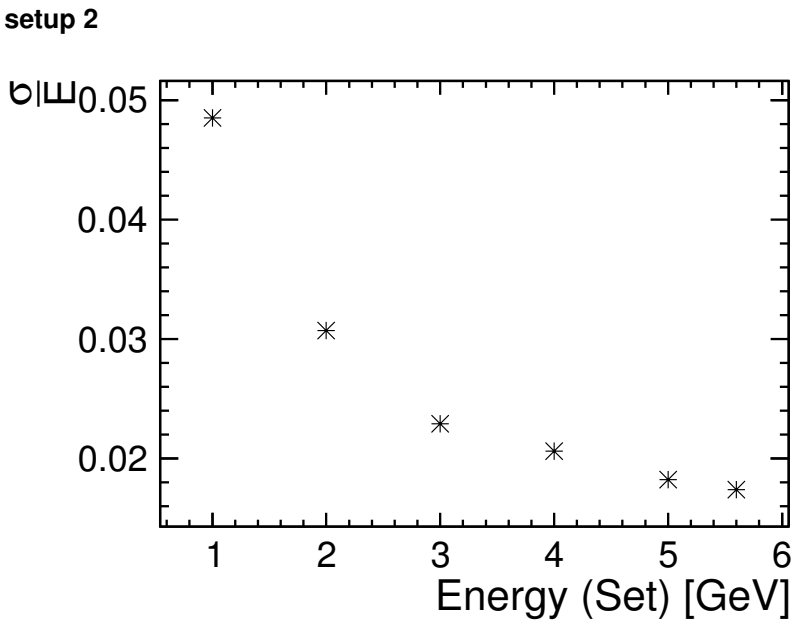
Collimator $\triangleq$ Energy window

Energy Spread

Dertermining the energy width



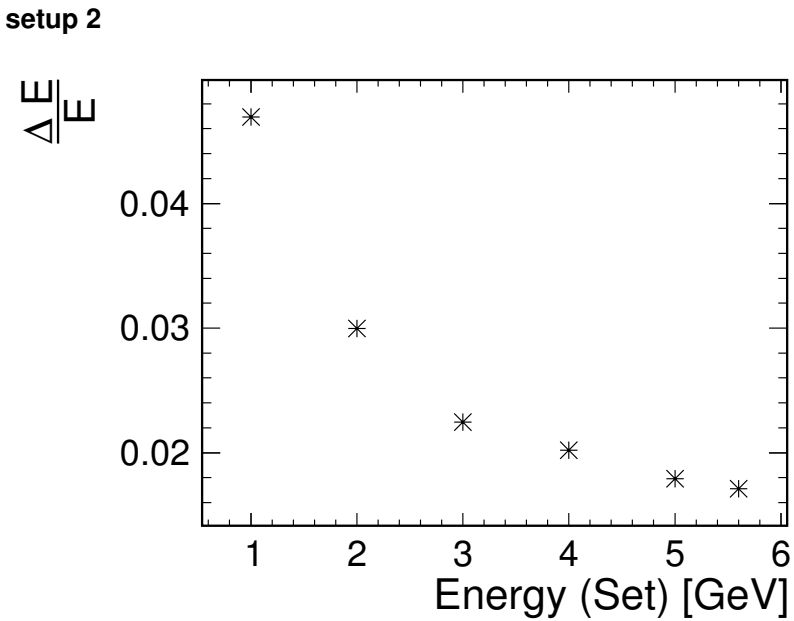




Energy width result of two effects:

- Limited resolution of the measurement (multiple scattering, fluctuations in B field, ...)
- Beam contains more than one energy (energy spread)

Determining the experimental resolution out of the angular resolution and assuming: $\sigma \approx \sqrt{(\Delta E)^2 + \sigma^2_{E(\theta)}}$ we get:



an energy spread of $\approx 2 - 5\%$

Conclusion, Outlook and literature

Outlook

Conclusion:

- the energy of the test beam was measured using the deflection in a magnetic field
- the measured and expected energies coincide within 1 σ
- the energy spread of the beam is about $2 - 5\%$

Possible work for the future:

- derive energy spread properly using a simulation
- analyze remaining data for collimator dependent energy spread

Conclusion, Outlook and literature

Literature

- https://telescopes.desy.de/
- http://arxiv.org/pdf/1603.09669v2.pdf
- http://particle-physics.desy.de/e252106/e252106/e252211
- https://www.particleincell.com/2011/vxb-rotation/