Measurements and Simulations of the DESY II Electron test beam

DESY Summer Student Program 2007

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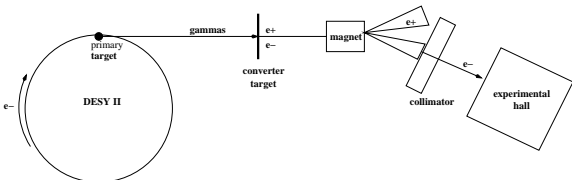
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Outline

Test Beam Lines at DESY II

Test beams at DESY are used in "'parasitic"' mode → *DESY II beam is not affected*

- DESY II operated with electrons or positrons
- Bremsstrahlung is produced in a 7 μm thick carbon fiber
- Pair production in different secondary targets
- Momentum selection with a dipole magnet
- Beam formation with collimators
- Four test beam lines 21, 22, 24 and 24/1 available at DESY II.
- Electrons up to 7 GeV.

Why Test Beam Lines?

- Increasing demand for research and development of detector components:
  - proof-of-principle
  - testing prototypes
  - final calibration
  - ...

- *Easy acces to a well known High energetic beam.*

⇒ Old facilities. Retuning and Precise characterisation needed.

Project

- Building a detector to measure rates and energies.
- Programming software to analyse the data of this detector.
- Complete scan of propierties of the beam line 22 for different parameters.
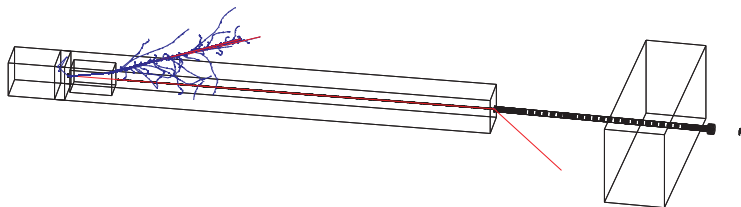- Implementing a Monte Carlo simulation to support the measurements.

Hector de la Torre & Philipp Rahe

Detector overview

The BACCHUS detector
(BeAm Characterizing Calorimeter pincHed from argUS)
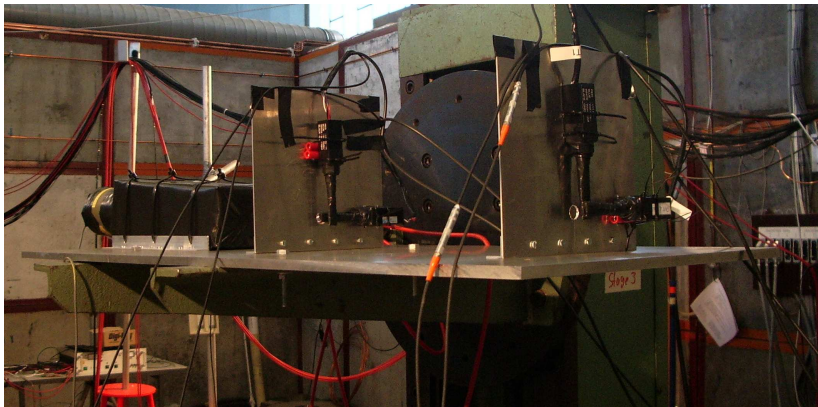
Monte Carlo Simulation Study with GEANT4

- The toolkit GEANT4 is widely used in HEP, astrophysics and in medicine applications
- Simulates passage of particles through matter
- ⇒ **Complete implementation of beam line 22 geometry**
- ⇒ **We are able to monitor the beam in different places along the beam line → Momentum, position & type of particle.**
- *Problem!: We generated only 10^6 particles, one bunch $\approx$ 10^{10} → We do not have enough data in the experimental hall*

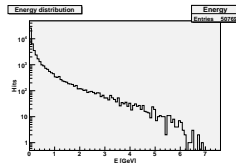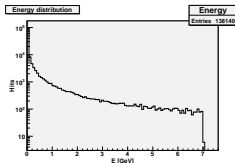## Which studies did we make?

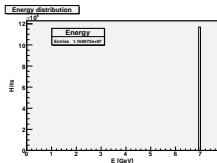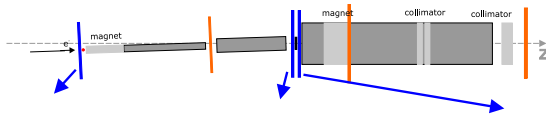# Complete scan of:

- Converter Target $\rightarrow$ 7 different.
- Momentum selection in the magnet. from 1 GeV to the momentum of DESY II beam.
- Primary target.

Both in the simulation and using the BACCHUS detector.

Energy distribution results from the Simulation

- $1250 \times 10000 \ e^-$ at $7\,\mathrm{GeV}$.
- Single fiber with a diameter of $7\,\mu\mathrm{m}$
- Cu $10\,\mathrm{mm}$

Energy distribution results from the Experiment

We measure it comparing the rates for different momentum selection.

Targets

- *Not linear with the thickness!!*
- *Not higher rates for low energies!! → Angular distribution is different in the magnet!! rates suppresed by the collimators.*

- The rates for different momentum selection
  - Grow with the thickness of the target.
  - Low rates for energies close to desy II as seen in the simulation.

Fiber bundle

- DESY II will be used for continuous PETRA III injection with positrons at lower current
- Test beams require high rates
- Possible solution: Using a bundle of fibers, each 7 μm thick, but actual layout is difficult to study.
- First shot in the simulation: 5 fibers along the beamaxis

- Simulation reveals a gain in rates of factor 1.2.

- Experiment reveals a gain in rates of factor 3.

- Needs improvement -> Single bunch VS Broader Beam.

- May be possible that PETRA III concurrent running will be affected by this target. First data shows some effect in DESY II beam. More studies needed.

Conclusion

- Basic information about the beam line such as the profiles and energy distributions are available.
- Qualitative verifications of the measured data are achieved.
- Geometry for further application is available.
- Lots of data collected for future Test Beam users.
- Detector and software for analysis available for upcoming studies.
- To understand better the experimental data : More data from the simulation needed.

Test Beam Line
○○

Project
○

The detector

Simulation

Study and results
○○○○

Conclusion
○●

Thank you for your attention!!