

Characteristics and Monte Carlo Simulation Studies of Test Beam Line 22

Summerstudent Program 2007

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14. September 2007

Outline

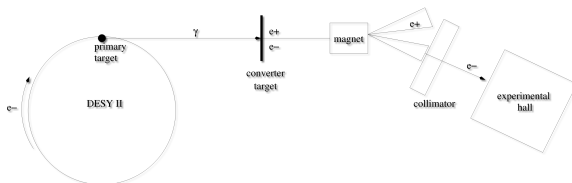
- 1 Test Beam Line
- 2 Our Project
- 3 Simulation
 - Introduction
 - Geometry
 - DESY II beam profile
 - Results
- 4 Conclusion
- 5 Experimental results
 - Next talk by Héctor de la Torre Pérez

Why Test Beam Lines?

- Increasing demand for research and development of detector components:
 - proof-of-principle
 - testing prototypes
 - final calibration
 - ...
- Four test beam lines 21, 22, 24 and 24/1 available at DESY II
- Electrons up to 7 GeV
- Concurrent operations with other DESY facilities (PETRA III)



Test Beam Lines at DESY II



Test beams at DESY are used in "parasitic" mode:

- DESY II operated with electrons or positrons
- Bremsstrahlung is produced in a $7\ \mu\text{m}$ thick carbon fiber
- Pair production in different secondary targets
- Momentum selection with a dipole magnet
- Beam formation with collimators

Our Project

- Building a detector to measure rates and energies
- Programming software to analyse the data of this detector
- Measuring rates and energies at test beam line 22
- Implementing a Monte Carlo simulation to support the measurements

Our Project

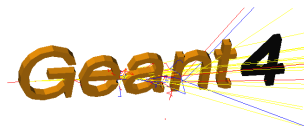
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Monte Carlo Simulation Study with GEANT4

- The toolkit GEANT4 is widely used in HEP, astrophysics and in medicine applications
- Simulates passage of particles through matter

Steps we have implemented:

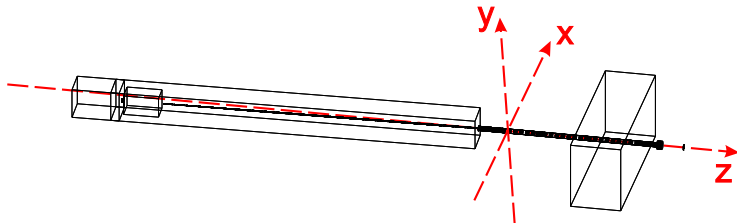
- Geometry of the beamline
- Physical processes and involved particles
- Sensitive detectors for data acquisition



<http://cern.ch/geant4/>

⇒ **Complete simulation of beam line 22**

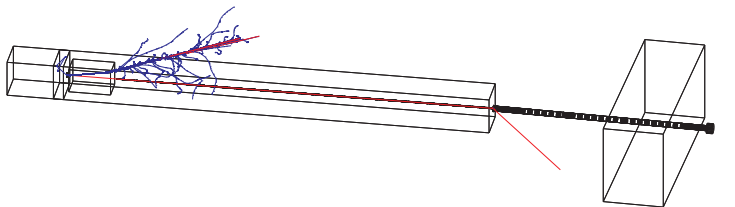
Geometry



Some parameters:

- Primary particles: Momentum and position
- Primary and secondary targets: Material and geometry
- Magnetic field: Strength
- Collimators: Inner sizes

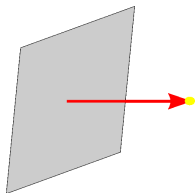
Geometry



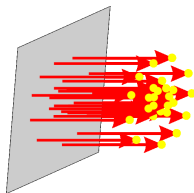
Some parameters:

- **Primary particles: Momentum and position**
- Primary and secondary targets: Material and geometry
- Magnetic field: Strength
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Modelled Beam Profiles of DESY II

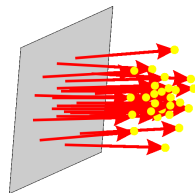


No distribution



Spatial distribution
according to the
emittances

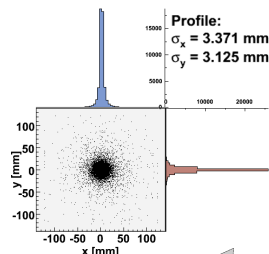
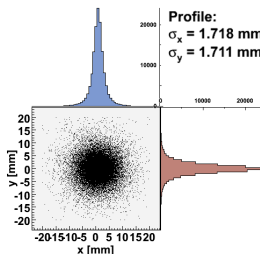
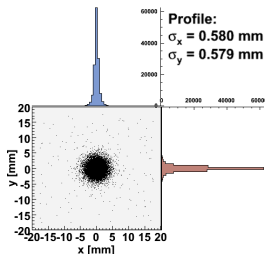
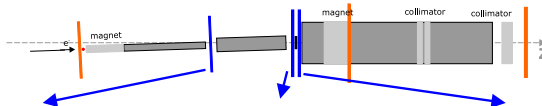
$$\sigma_x = 350 \text{ nm},$$
$$\sigma_y = 35 \text{ nm}$$



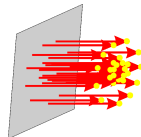
Momentum
distribution

$$\sigma_\phi = 0.5 \text{ mrad}$$

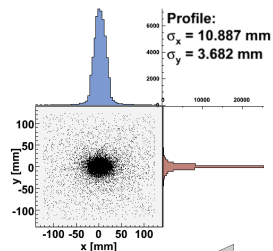
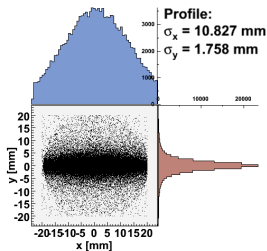
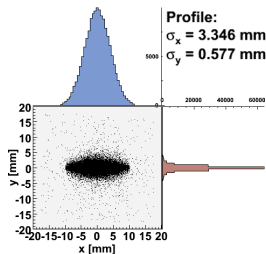
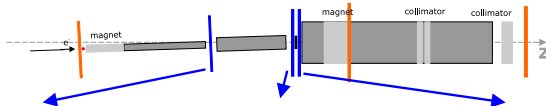
Beam Profiles in a Standard Run



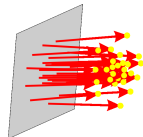
- 1250×10000 e^- at 7 GeV, lateral distributed
- Single fiber with a diameter of $7 \mu\text{m}$
- Cu 10 mm



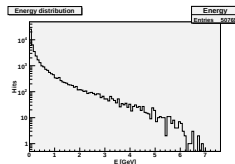
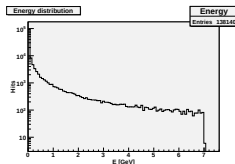
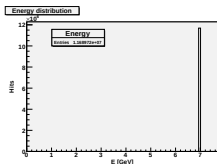
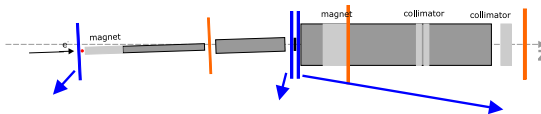
Beam Profiles using Momentum Distribution



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



Energy distribution



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

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 $7\text{ }\mu\text{m}$ thick, but actual layout is not known
- First shot in the simulation: 5 fibers along the beamaxis
- Simulation reveals an factor of 1.2.
- Needs improvement
- The simulation cannot give any information about the beam in DESY II

Conclusion

- Basic information about the beam line such as the profiles and energy distributions are available.
- Qualitative verifications of the measured data are achieved.
- To compare rates with the experimental results a high number of primary events has to be used, this was not possible on our machines.
- Geometry for further application is available

