TORCH

A Cherenkov based Time of Flight detector

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On behalf of the TORCH collaboration

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TORCH - motivation

• The Timing Of internally Reflected Cherenkov light (TORCH) is an ERC funded R&D project ultimately aiming to deliver a prototype

• Particle identification is crucial for LHCb physics

• Proposed location of TORCH: in front of RICH2

• Particularly useful for tagging
• Basic principle: Measure time of flight, momentum is known – so mass can be derived

• Time of Flight measured using Cherenkov photons

• Goal is to provide 3σ K-π separation for momentum range 2-10 GeV/c (up to kaon threshold of RICH-1)

• Requires timing single photons to a precision of 70ps
Detectors for TORCH

- Micro Channel Plate PMT
- Leading detector for time-resolved photon counting
- Anode pad structure of 8x128 pixels chosen to achieve required resolution on photon angle
- Tube under development at industrial partner (Photek Ltd, UK)
Mini-TORCH

• Progress well underway for testing small-scale prototype in testbeam

• Small version of radiator and focusing block have been acquired and assembled

• Detector and electronics for setup nearly finished

• Currently testing optics with laser injected from bottom
Selecting testbeam parameters

- Light can take many paths to detector (direct path shown)
- Simulation set up to help select optimal testbeam parameters
- Reflections off the side of the radiator plate dominate since Cherenkov cone is isotropic in one angle
- Tilting the beam “filters out” downward light from Cherenkov cone – TIR condition is not met
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Patterns

• Simulation run in Geant 4 (just direct photons shown)

• Repeated for 1000x 10 GeV kaons

• Many effects accounted for in simulation
  • Quantum efficiency of detector
  • Scattering from surface roughness effects
  • Rayleigh scattering
  • Absorption by glue
  • Imperfect reflection of mirror surface in focusing block
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Timing precision

• Relevant information from Geant is timing

• Performance of testbeam setup dependent on reconstruction

• Chromatic dispersion correction applied

• Algorithm performing well

• Single photon resolution ~90ps sigma

• Dominated by performance of detector
Detector testing setup

• Newest series of MCP detectors is being tested in the lab

• Laser is attenuated to single photon level using variable attenuator

• Microfocus for precision

• Laser is scanned over surface using motion stages
Detector testing

- Currently testing effect of deliberate charge sharing
- Improve resolution by getting measurement from several pixels instead of one
Conclusions

• TORCH is a Cherenkov based Time-Of-Flight detector proposed to further improve PID performance of LHCb

• Testbeam scheduled for May 2015

• Preparation is under way
  • Small prototype has been constructed
  • Good performance on timing reconstruction algorithm

• MCP-PMT detectors proposed to be used are performing well
  • Suitable for meeting timing requirements of TORCH

• Lab testing ongoing

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