ALFA and AFP

ATLAS Detectors for Forward Physics

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on behalf of the ATLAS Collaboration

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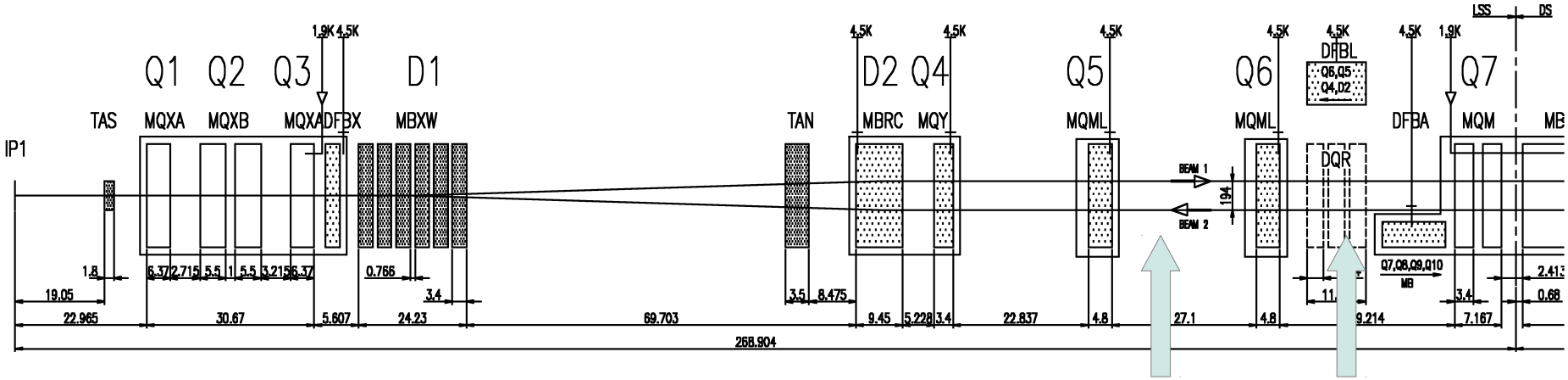
Introduction

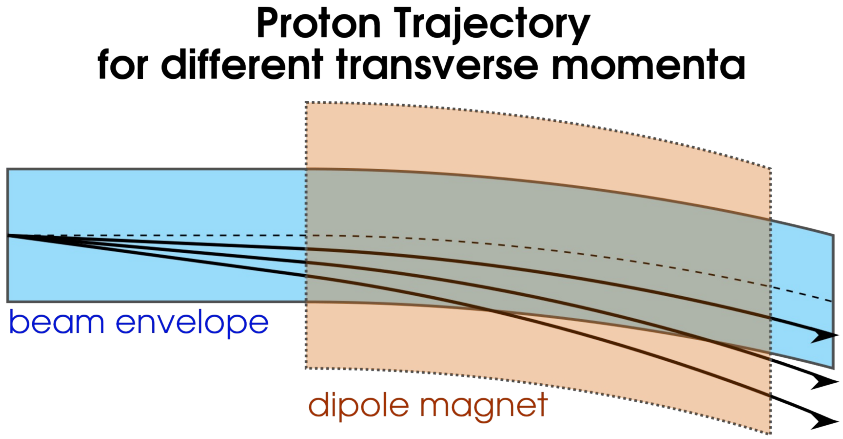
- **Aim:** detect intact protons scattered at very small angles measure elastic/diffractive processes
- Detectors must be located close to the beam
- Protons must leave the beam envelope
- Two detectors in ATLAS: ALFA and AFP
  - Different running conditions
  - Different physics goals



Introduction

ALFA

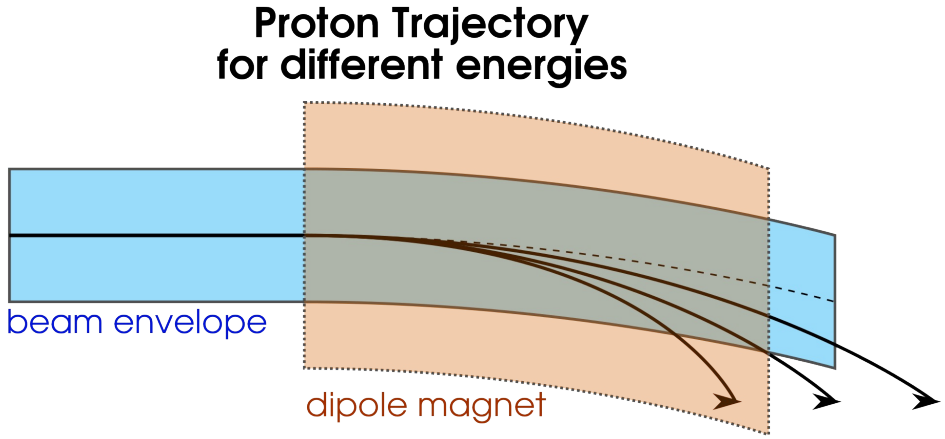
- Absolute Luminosity For ATLAS
- already installed
- mainly elastic scattering (→ absolute luminosity, total cross section)
- proton leaves the beam envelope due to its p_T



- special machine settings

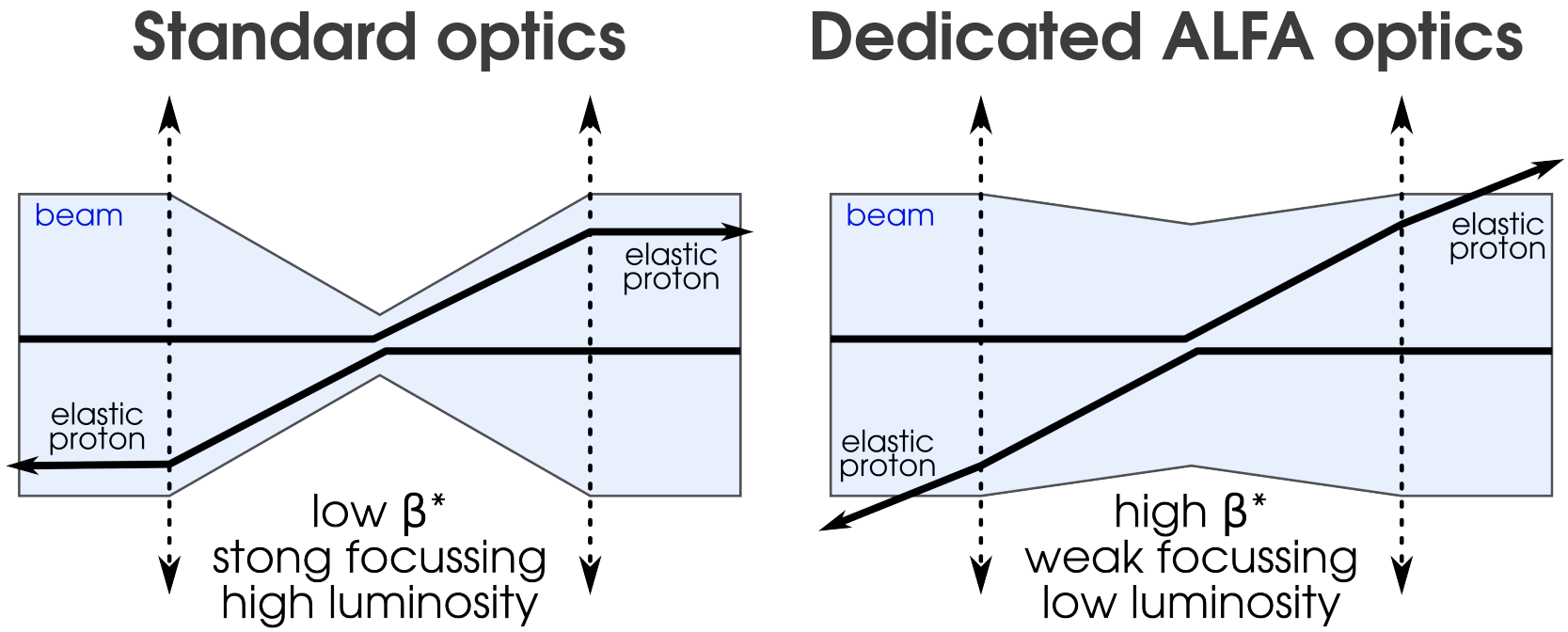
AFP

- ATLAS Forward Proton
- under approval (installation possible in 2013/14)
- high mass diffraction, γγ
- proton has lost energy
- LHC machine as a magnetic spectrometer



- standard LHC runs

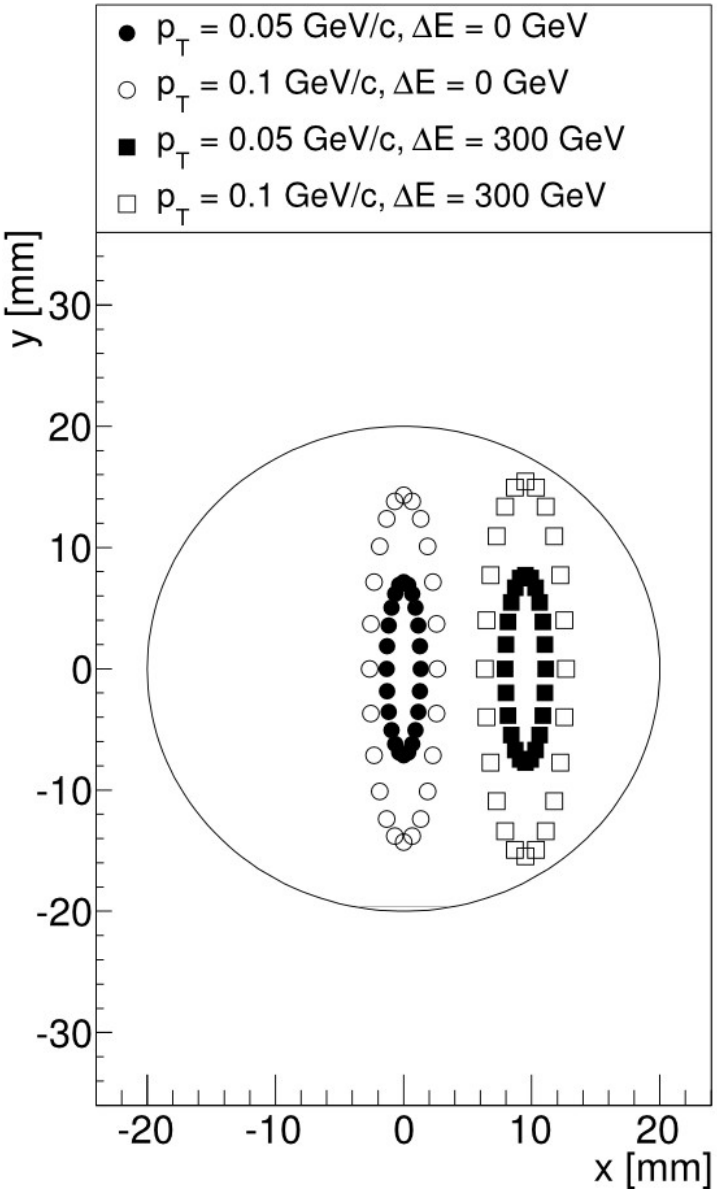
Special runs for ALFA



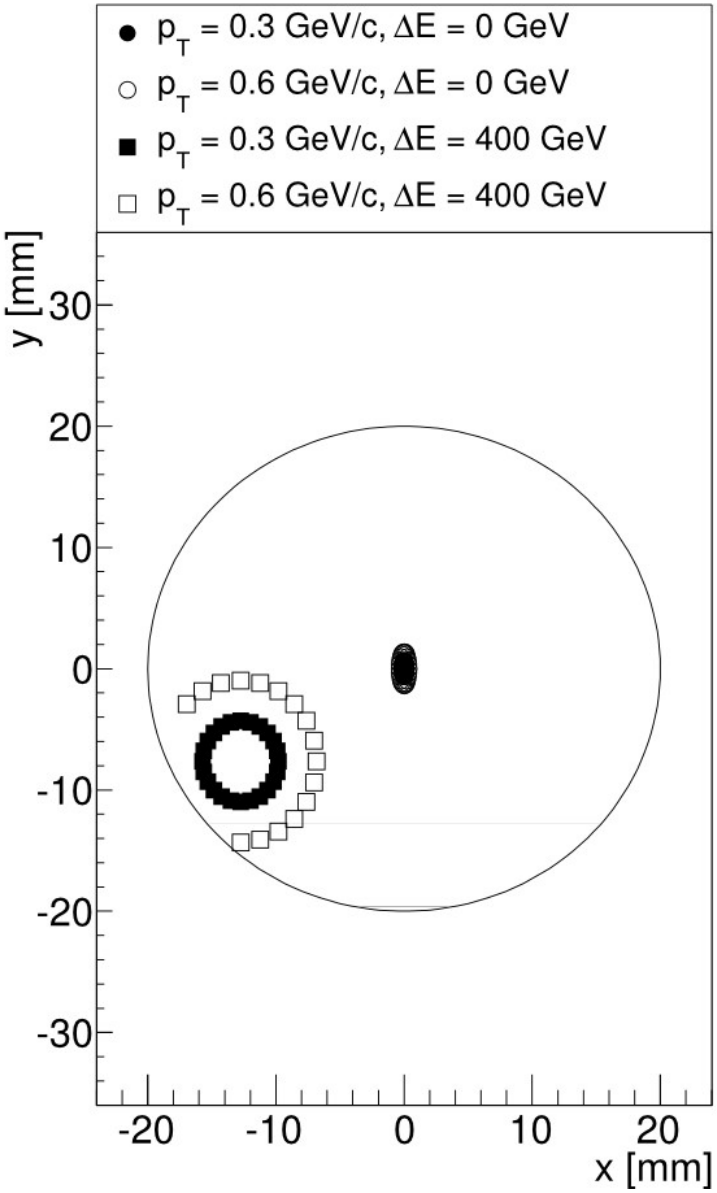
- β* – betatron function at the IP (~ focal length of the quadrupole system)
- Large cross section of el. scatt. – measurements possible with low lumi
- Low luminosity → low pile-up → small background

Proton positions in ALFA and AFP

Dedicated optics (ALFA)



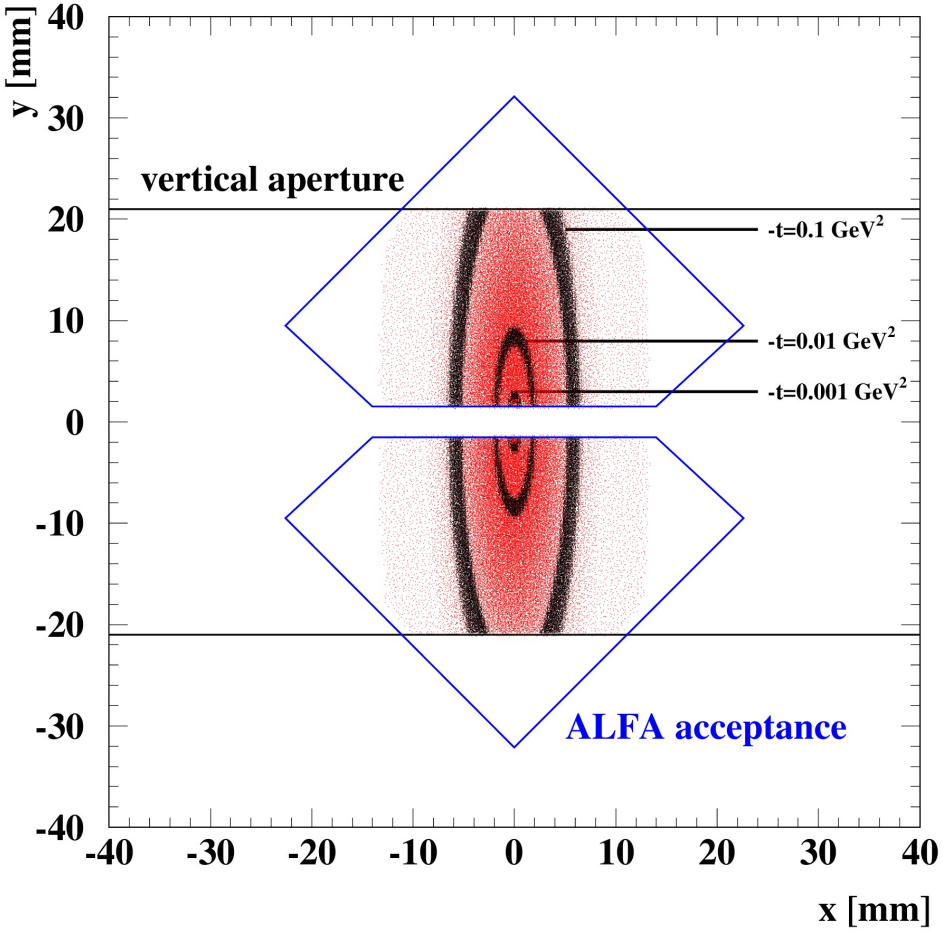
Standard optics (AFP)



Proton positions in ALFA and AFP

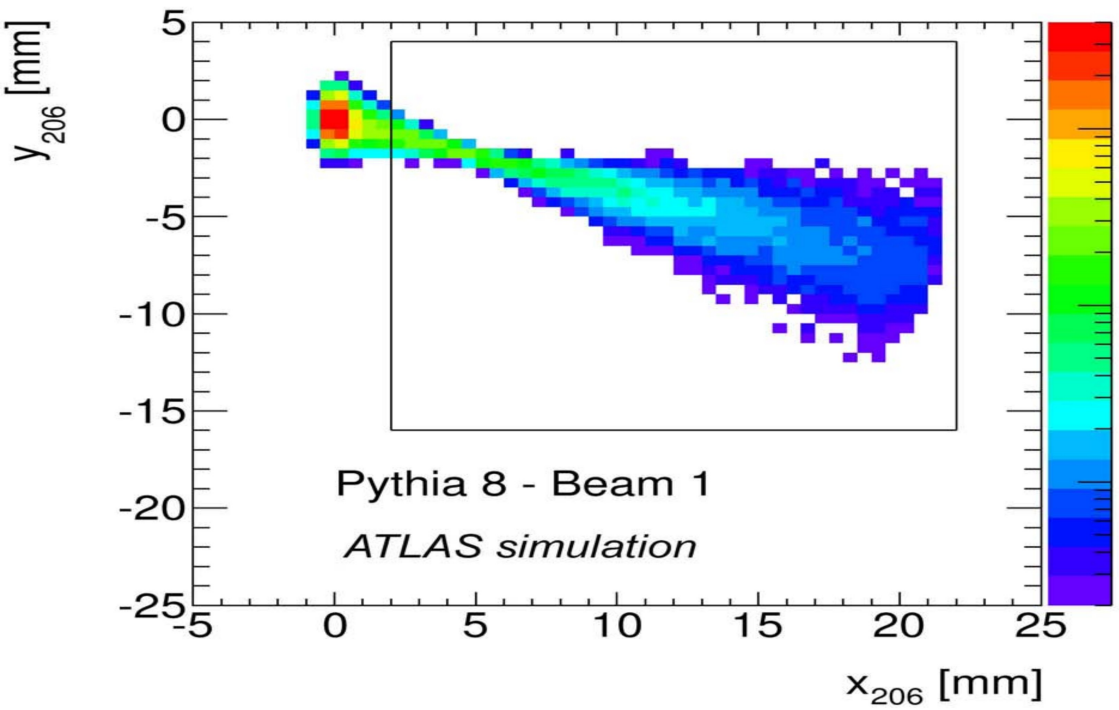
ALFA

- Elastic protons
- Vertical approach



AFP

- Diffractive protons
- Horizontal approach



The Detectors – comparison

ALFA

- 240 m from the IP
- Roman Pots
- Vertical movement
- Scintillating fibres

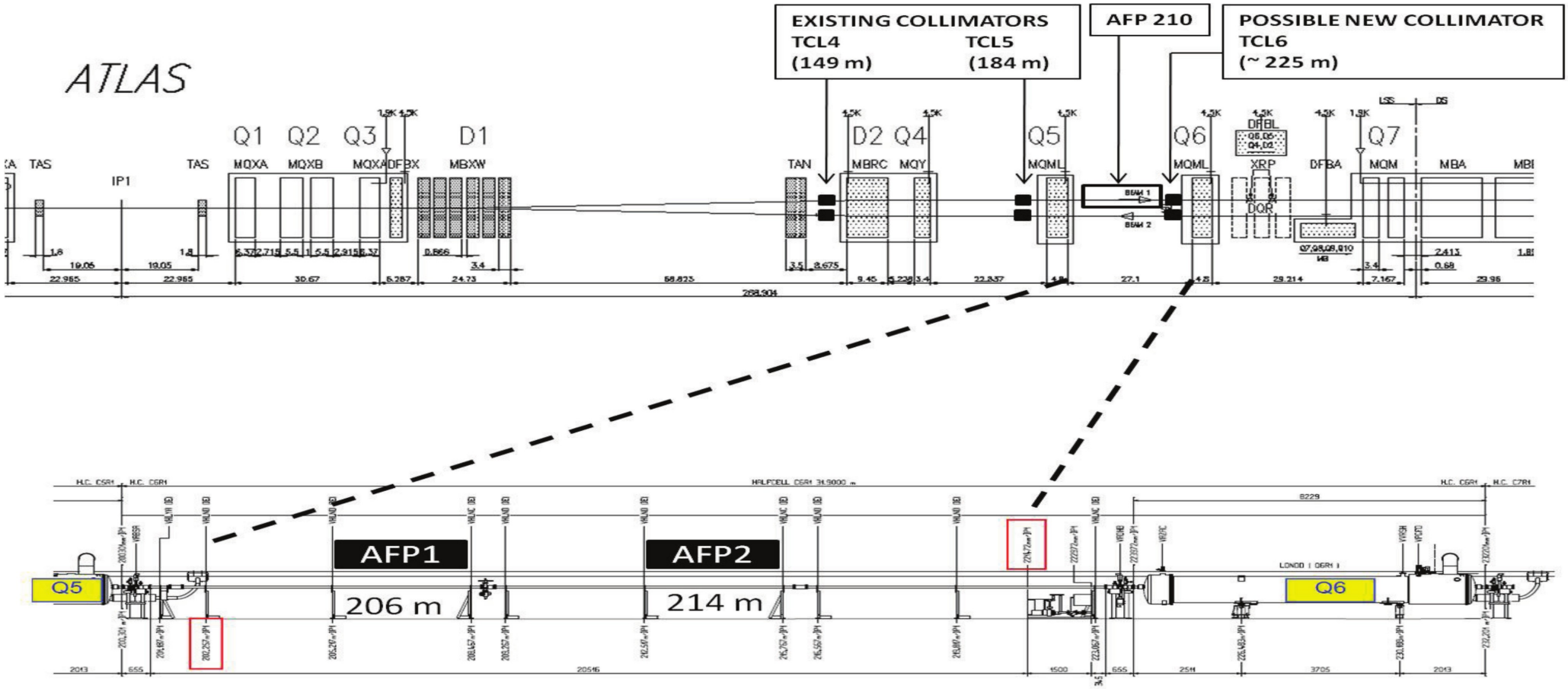
AFP

- 210 m from the IP
- Movable Beam Pipe
- Horizontal movement
- 3D Pixel detectors
- QUARTIC timing detector

See talk by Sune Jakobsen on ALFA detectors

See talk by Maciej Trzebiński on AFP physics

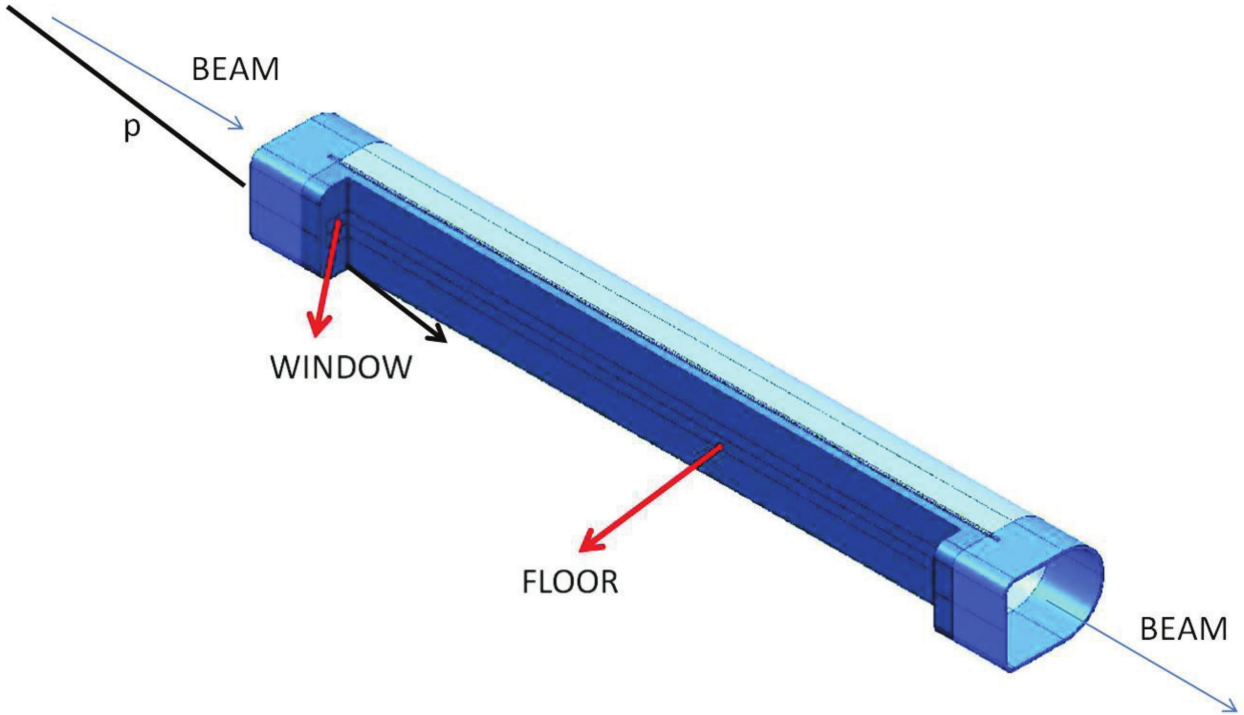
AFP – Overall Setup

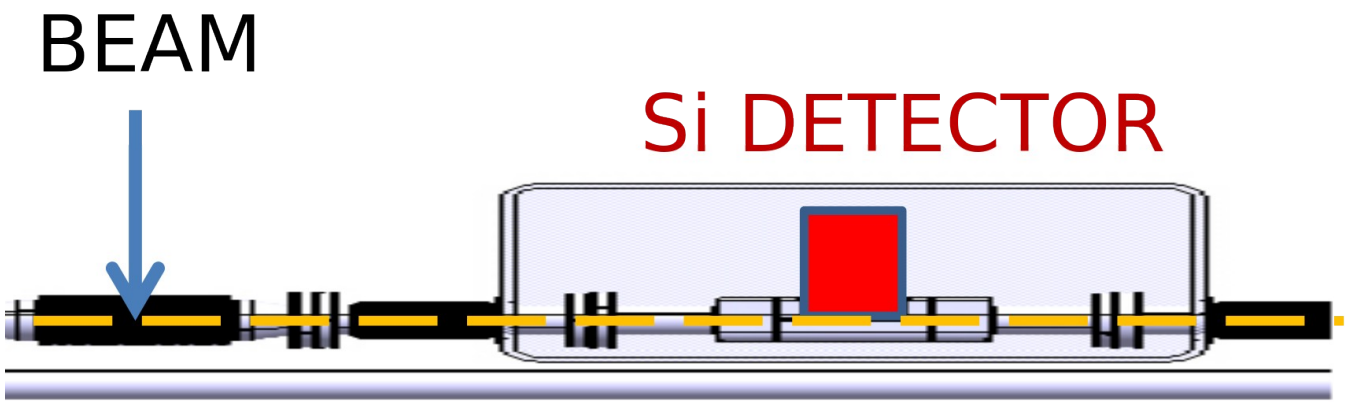


- 206 – Si detectors
- 214 – Si + QUARTIC
- Trajectory position & direction
- Time-of-flight

AFP – Movable Beam Pipe

Whole beam pipe section moves w.r.t. the beam together with the detectors





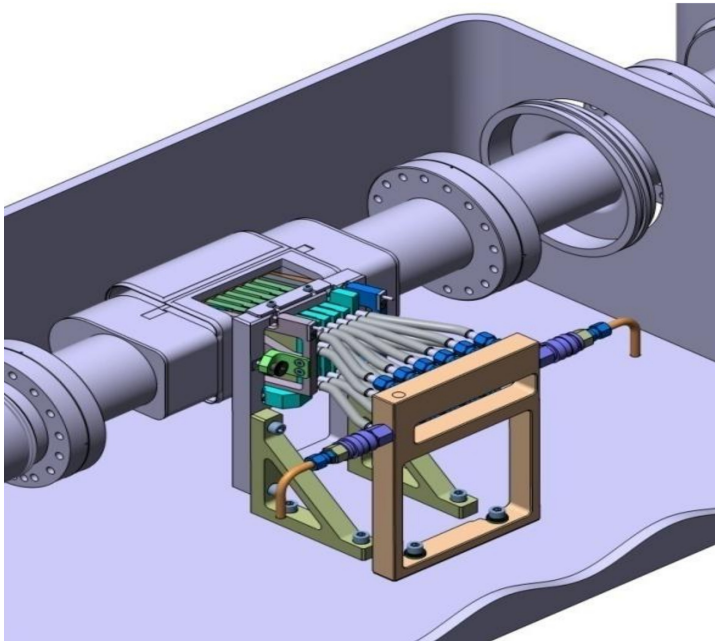
AFP – Position Measurement

Requirements

- Resolution – 10 μm (horizontal), 30 μm (vertical)
- Thin dead zone at the edge (below 100μm)
- Radiation hard electronics

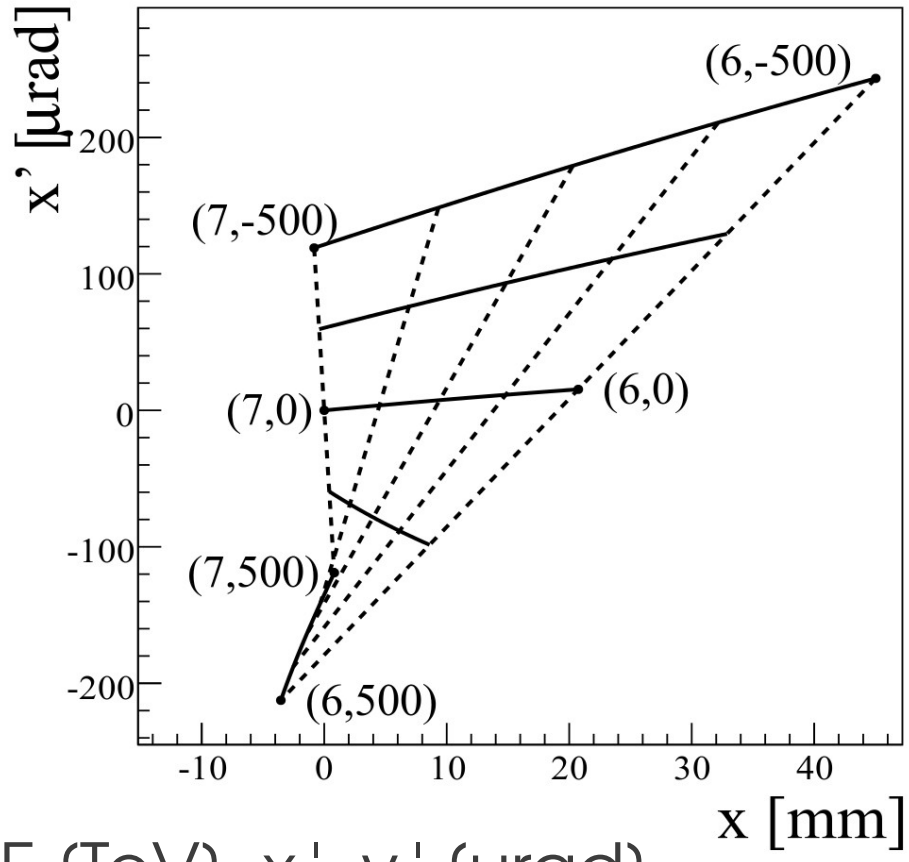
Solution

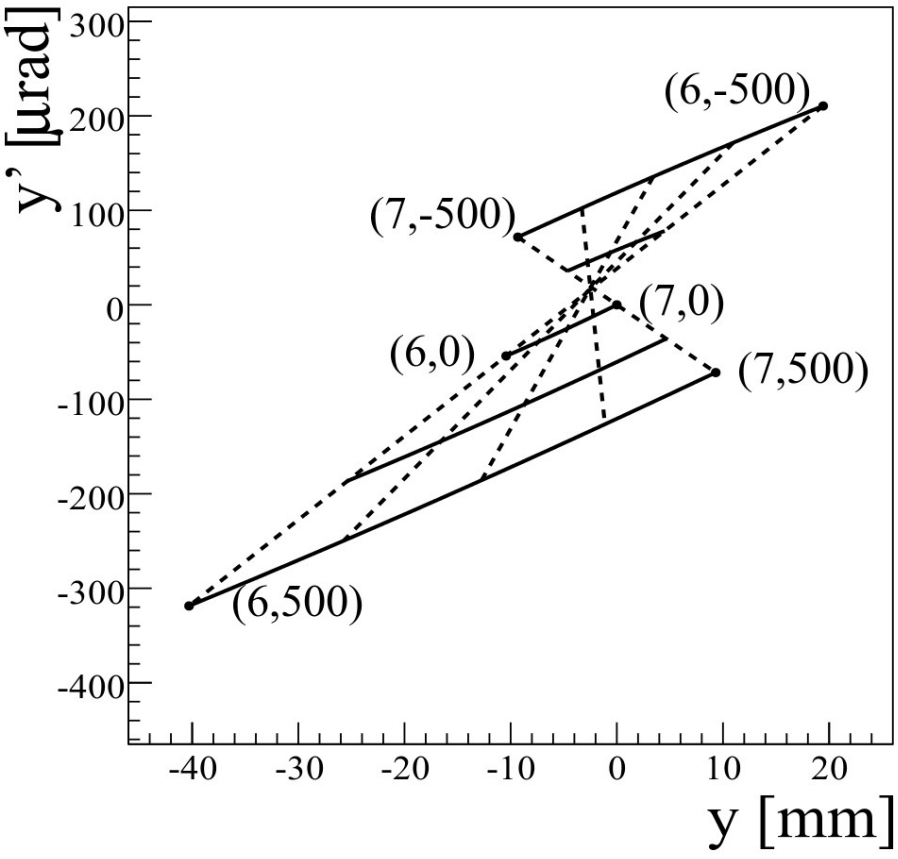
- 3D silicon sensor + FEI4 chip, following ATLAS IBL (Insertable B Layer)
- Design of the mechanics being finalised



AFP – Energy Reconstruction

- Proton transport: $(E,x_0',y_0') \rightarrow (x,y,x',y')$
- No coordinate mixing: $(E,x_0') \rightarrow (x,x')$, $(E,y_0') \rightarrow (y,y')$

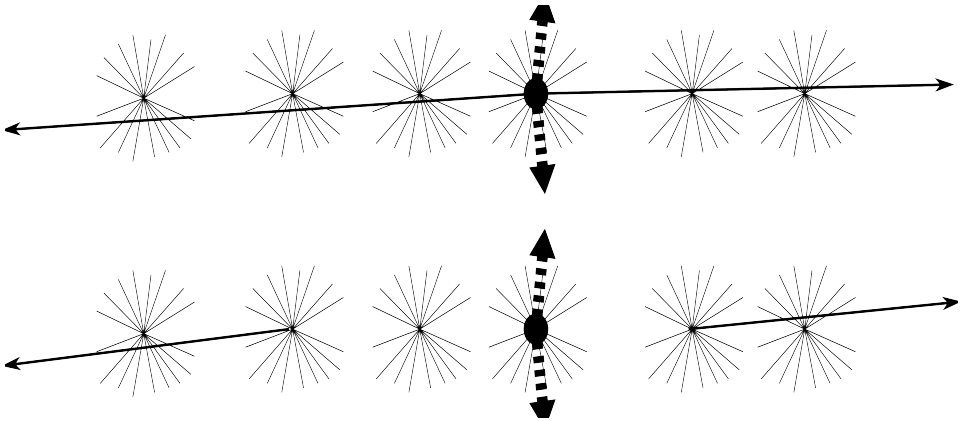


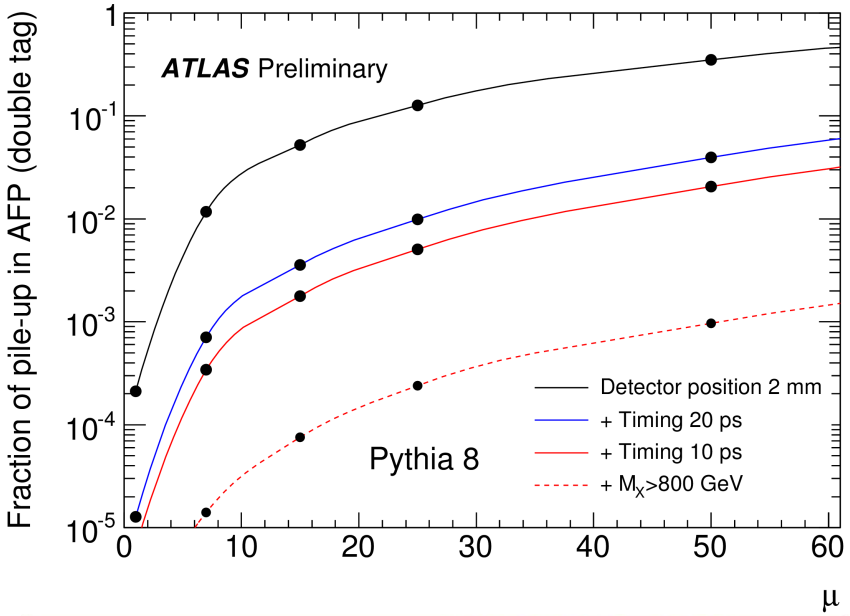


E (TeV) x_0', y_0' (μrad)

AFP – Timing Detectors

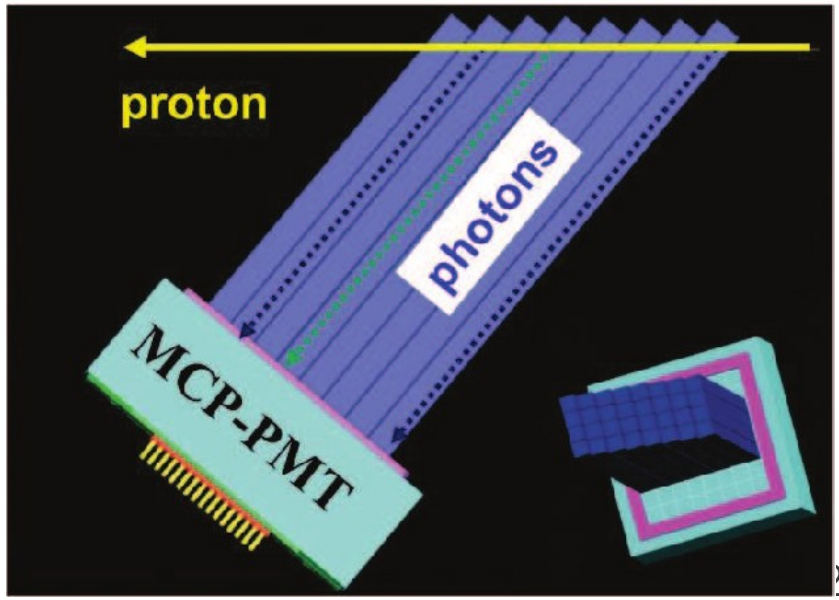
- Pile-up background rejection





QUARTIC detectors

- Resolution of 10 – 20 ps
- Reject 90% of background
- 8x4 quartz bars (position measurement)



How to achieve 10–20 ps resolution?

Component	Timing resolution [ps]
Quartz bar	22 (15)
MCP-PMT	20 (16)
CFD	5
Total	**30**
Cable dispersion	15%
Total	**24.5**
HPTDC	20 (12)
Reference clock	5
Total per bar	**40 (30)**
Total for 8 bars	**14**
Total for 2 QUARTIC	**10 (7)**

- Possibility to reach 10 ps time resolution by next year
- Improvement to 7 ps possible with minor developpments
- Possible improvements in spatial resolution (fibres instead of bars)

Summary

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- mainly elastic scattering
- Roman Pots
- vertical movement
- scintillating fibres

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Backup

Quadrupoles vs diffractive protons