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Beam profile reconstruction via a scintillator scraper

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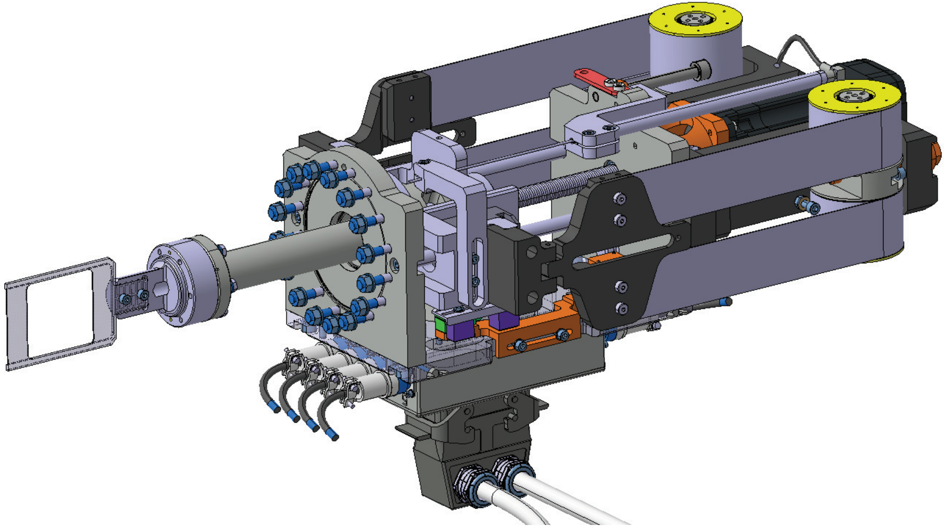
In the AD and ELENA accelerators at CERN, the beam profile is reconstructed using a pair of horizontal and vertical scrapers.

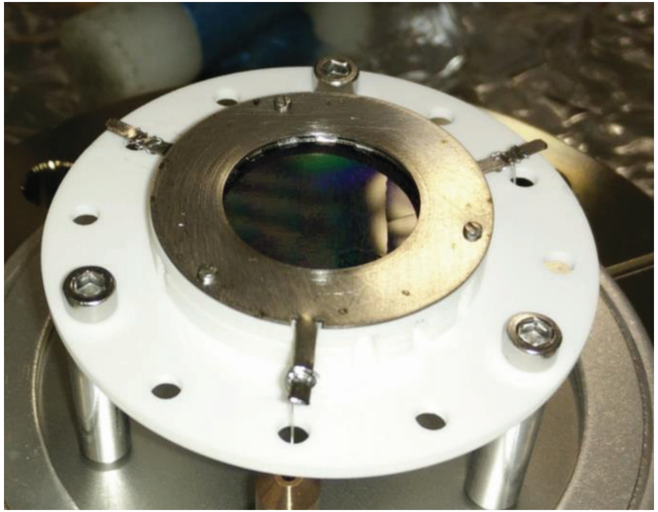


Horizontal beam scraper with stepping motor

- 1mm tungsten blades moved into the beam with stepping motors
- Antiprotons annihilate in the blade creating secondary particles
- These particles are detected by downstream scintillators placed outside the vacuum
- The flux of secondary particles detected is proportional to the particles in the beam

Despite being destructive, this method is used due to its simplicity of usage with low intensity antiproton beams.

Test proton beams are used during machine set-up, but these particles instead of annihilating, create secondary electrons that can be detected using MCP, like in ELENA.



Micro-channel plate (MCP)

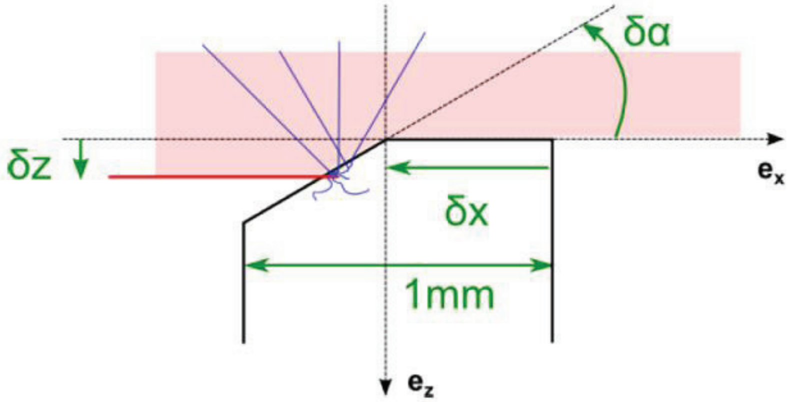


Figure 3: Schematics of the scraper blade with the different scanned parameters.

Secondary electron emission

We would like to investigate the possibility of replacing the tungsten blade with an active material, like a scintillator. Specifically we are studying inorganic scintillating fibres:

- The beam interacts with the scintillating fibre
- A fraction of the light created is trapped inside it and travels to its end
- A suitable photodetector reads-out the light coming from the fibre

YAG:Ce 1mmx1mmx140mm fibres

The new techniques of production of fibres from inorganic scintillators allow using different materials (LYSO, LuAG:Ce…), each one having different properties: light yield, emission spectra, emission time...

Fibre sizes can go down to 200 microns x 200 microns and lengths as big as 30 cm.

Photodetector candidates:
- Hybrid photodiodes (HPD)
- Silicon photomultipliers (SiPM)
- Silicon PIN diodes
- Photomultiplier tubes (PMT)
- Multi-anode photomultipliers (MAPMT)
- MCP

Ideally, we would like:
- A photodetector looking directly to the light coming from the fibre
- A position-sensitive photodector
- Fast and with good spatial resolution
- Vacuum compatible or installed in a vacuum flange

Some of the research paths that we are considering:
* Could a small 1.3mmx1.3mm SiPM be glued to the fibre and still be suitable for vacuum?
* The CMS experiment used HPD installed in vacuum flanges
* Transparent window feedthrough plus a PMT outside
* An UV emitting scintillator and a MCP installed in a vaccuum flange

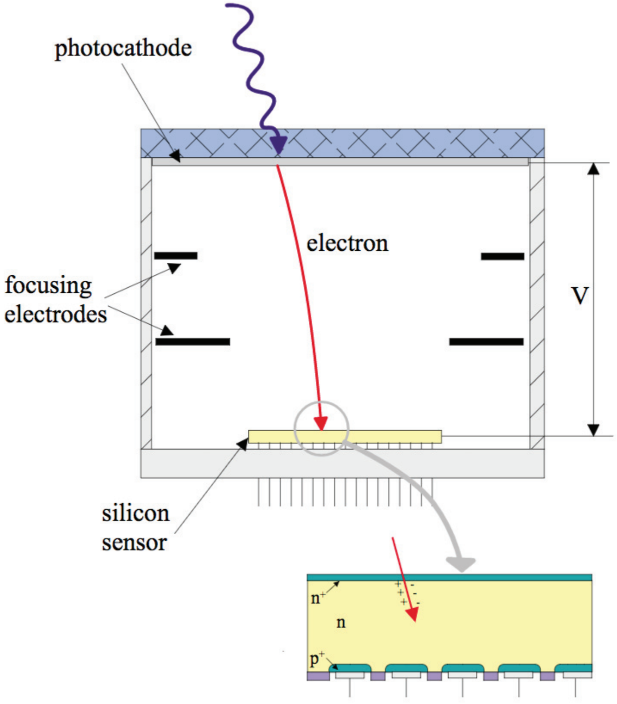


Figure 1. Main components and principle of operation of a HPD.

Theoretical advantages of this new scraper:

- Works in the same manner for anti protons and protons -> simplicity
- Direct detection -> more sensitive to low intensity beams
- More accurate profiles?
- Depending on the photodetection method used it could be possible to retrieve spatial information

But is not so easy…

First problem: are the materials suitable for ultra-high vacuum (10E-13 mbar)? -> Inorganic scintillators apparently are!

Second problem: which photodetector use? What kind of vacuum feedthrough?

There are probably many ideas already tested in particle physics literature -> Talk to experts! Research!

Thank you very much for listening

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