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Beam Diagnostics for Future Low Energy Storage Rings

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Challenges

- Energy MeV ... keV ... eV
- Intensity
 μA ... nA ... pA ... fA
- Particles antiprotons, exotic/radioactive ions, ...

An example:



Facility for <u>Antiproton and Ion Research</u>



<u>U</u>ltra-low Energy <u>S</u>torage <u>R</u>ing

- Electrostatic ring
- Antiprotons & protons/ions
- Deceleration from
 300 keV to 20 keV
- Space charge limit: ~10⁷ particles
- Beam intensity:
 ~1 µA to ~100 fA



The Task

66 Development of Novel Beam Instrumentation for Future Low Energy Storage Rings

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66 Development of Novel Beam Instrumentation for Future Low Energy Storage Rings





Reconnaissance

- Intensity: Cryogenic Current Comparator Faraday Cup Current Transformer Capacitive Pick-Up
- Position: Capacitive Pick-Up
- Transverse Profile: Scintillating Screens Microchannel Plate Secondary Emission Monitor Wire Scanner / Harp



Legend: "strikethrough" = too much / too many for a PhD student!

Faraday Cup

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Simulations









Design Work







Measurements (Preliminary)



Done with electrons @ CI

Next: protons @ INFN-LNS

Antiprotons = annihilation = charge escape

Capacitive Pick-Up

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Signal Estimation / Simulations



Design Work







Measurements





Done with a stretched wire @ CI

Measurements vs. Simulations



Scintillating Screens



CsI:Tl

 \odot

Measurements



(d)

(c)



Measurements



Done with protons @ INFN-LNS

Secondary Emission Monitor

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The Andrew Construct

2-in-1: Foil-based SEM & MCP



2-in-1: Foil-based SEM & MCP



Simulations



Design Work

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ο MCP1_Mid

0 PV4-

ο PV4+

+

PV3+

PV3-

MCP2_Mid









1st Result: the Cookie Crumbles



Results (Preliminary)



Partially defocused beam

Defocused beam

Done with electrons @ CI

Next: protons @ INFN-LNS, antiprotons @ CERN

Summary: Faraday Cup

- fA currents measured with e-, soon with protons
- not suitable for <u>absolute</u> measurements with antiprotons

Summary: Capacitive Pick-Up

- linearity demonstrated, no sensitivity tests (?)
- could be calibrated against the Fcup, but no USR-like beams available
- simulations for low velocity beams

Summary: Scintillators

- fA currents observed
- sensitive enough for protons = too sensitive for antiprotons
- idea: an aperture in the screen for approx. machine tuning based on halo measurements

Summary: MCP & SEM

- preliminary images with e- (MCP), soon with protons (SEM & MCP)
- challenges at CERN: contaminated antiproton beam with a broad energy spectrum

References

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