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A Laser-Based Beam Density Distribution Diagnostic for the RAL Front End Test Stand

David Lee

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Outline

The RAL Front End Test Stand

The Need for Non-Destructive, Non-Interceptive Diagnostics

Laser-Based H^- Beam Diagnostics:

- Basic Principle
- The Approach Taken

Progress Made:

- Particle Transport Simulations
- Laser Characterisation

Conclusions and Outlook

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The Front End Test Stand

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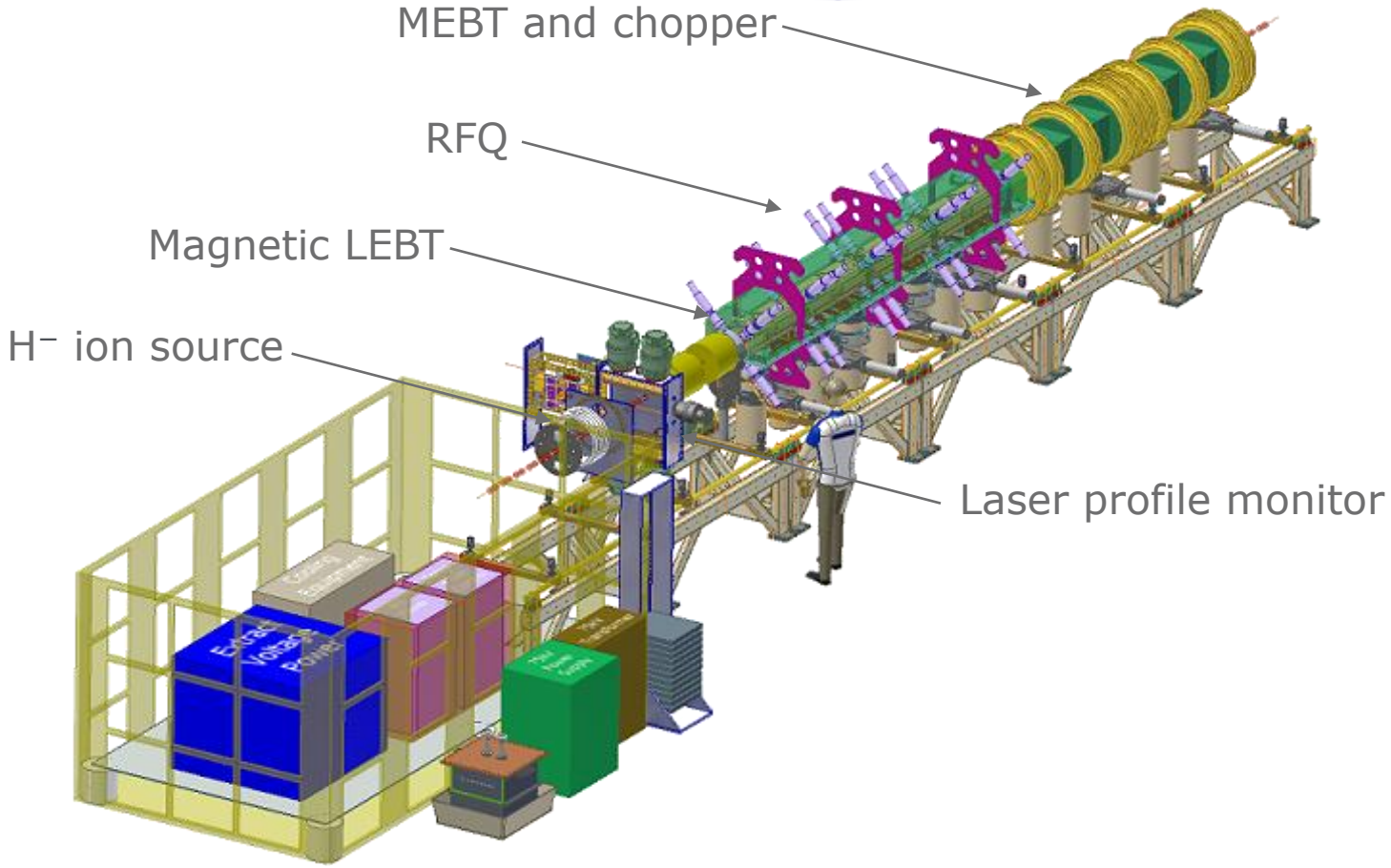

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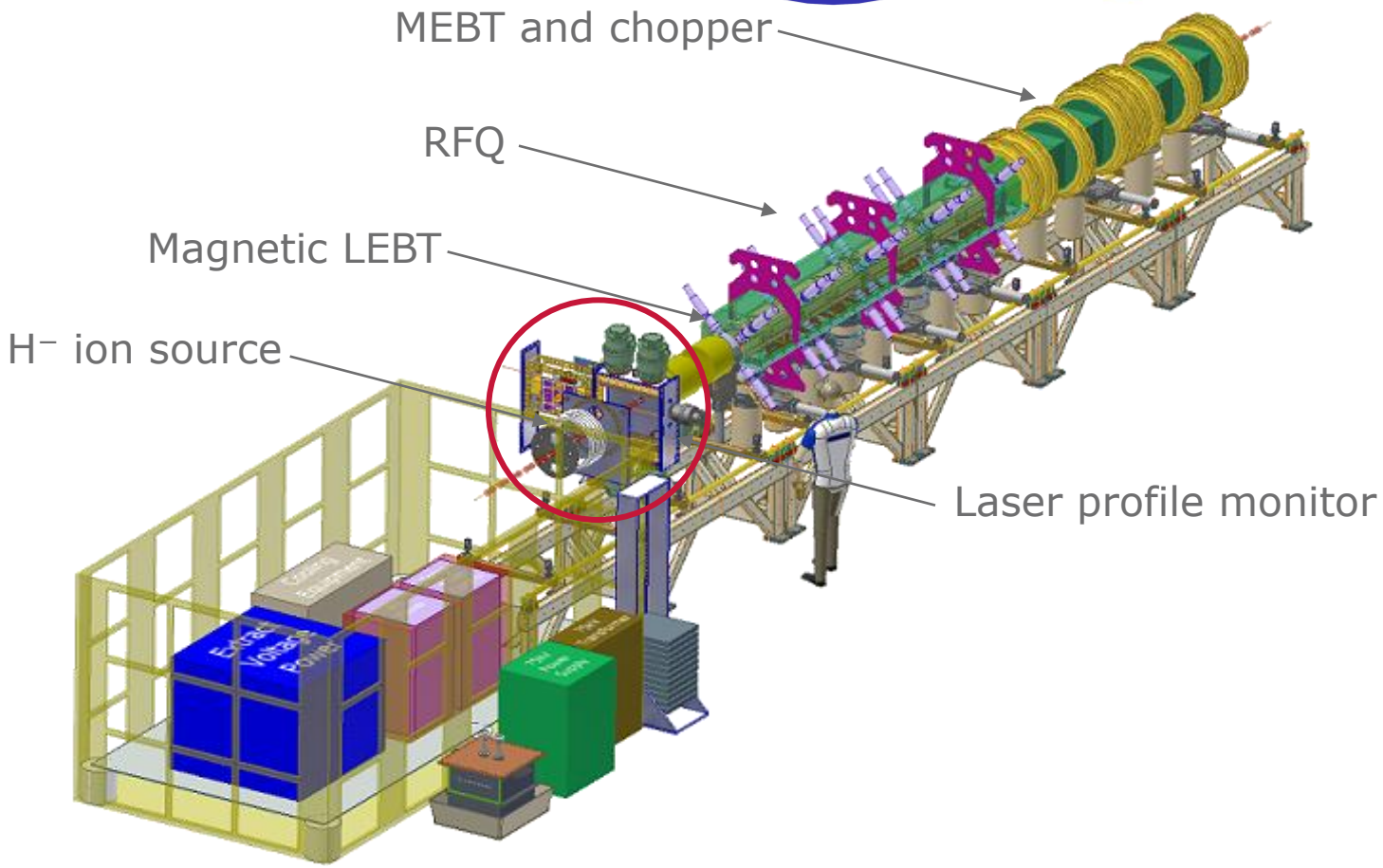

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The Need for Non-Destructive, Non-Interceptive Diagnostics

Allows for online monitoring of the beam

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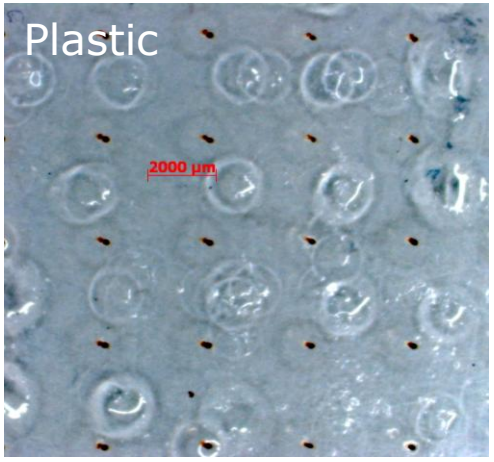
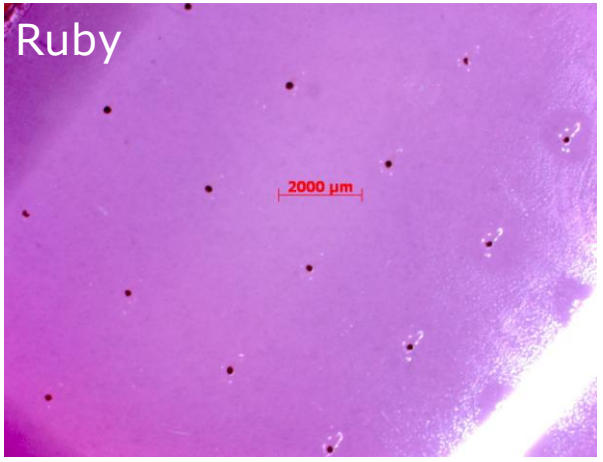
The Need for Non-Destructive, Non-Interceptive Diagnostics

Allows for online monitoring of the beam

Prevents the beam damaging the instrument





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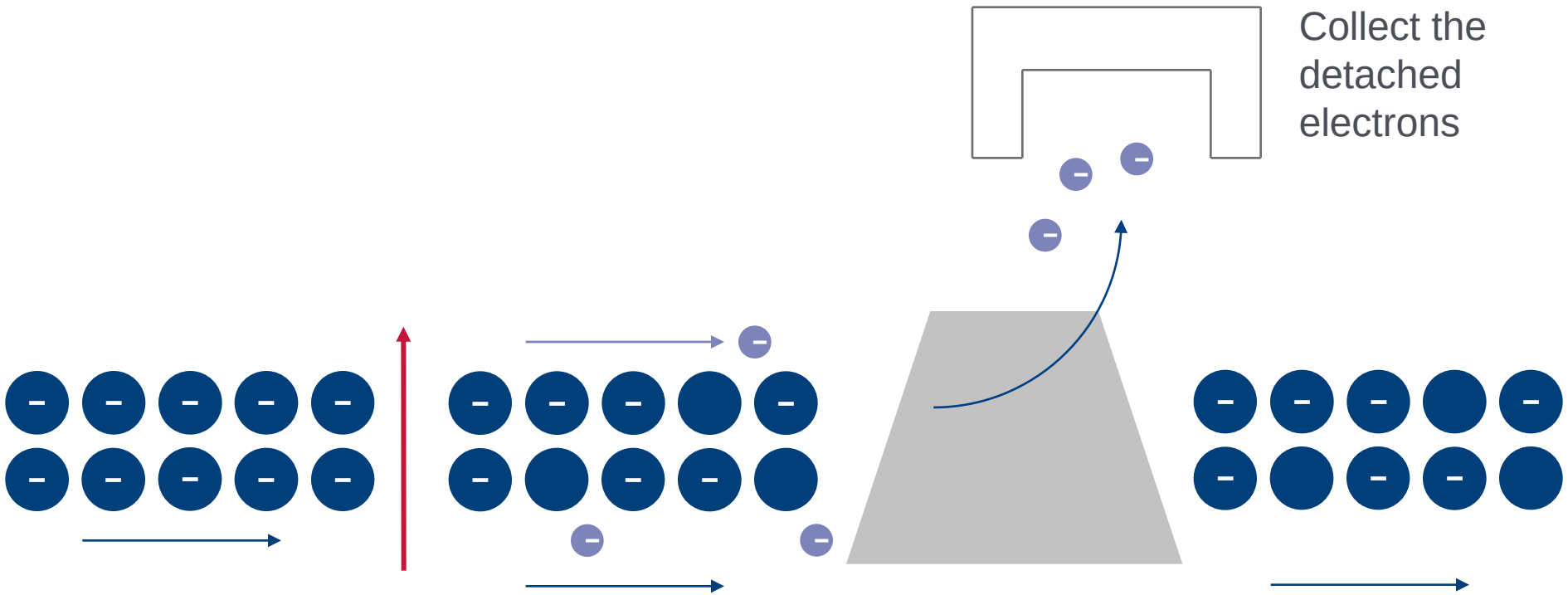
Laser-based Beam Diagnostics: Principle for H^-



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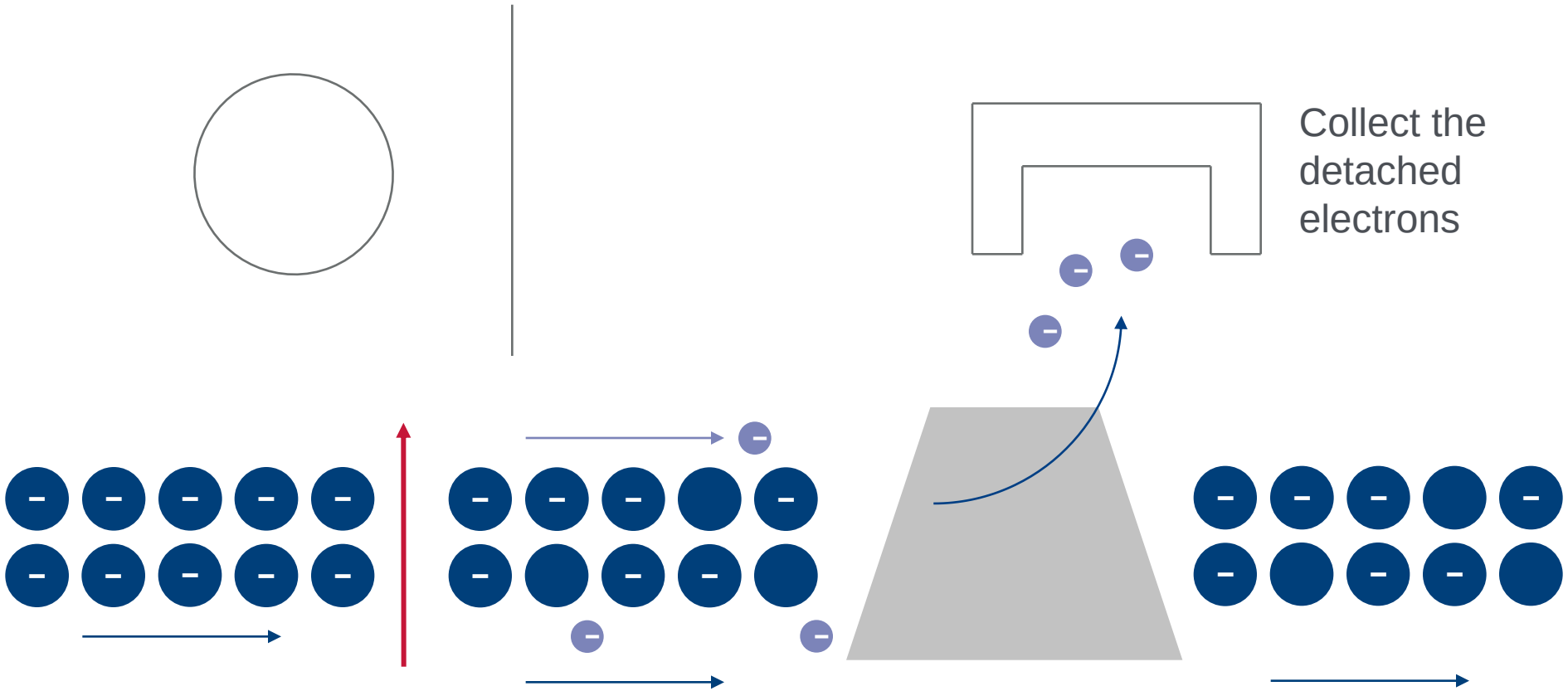

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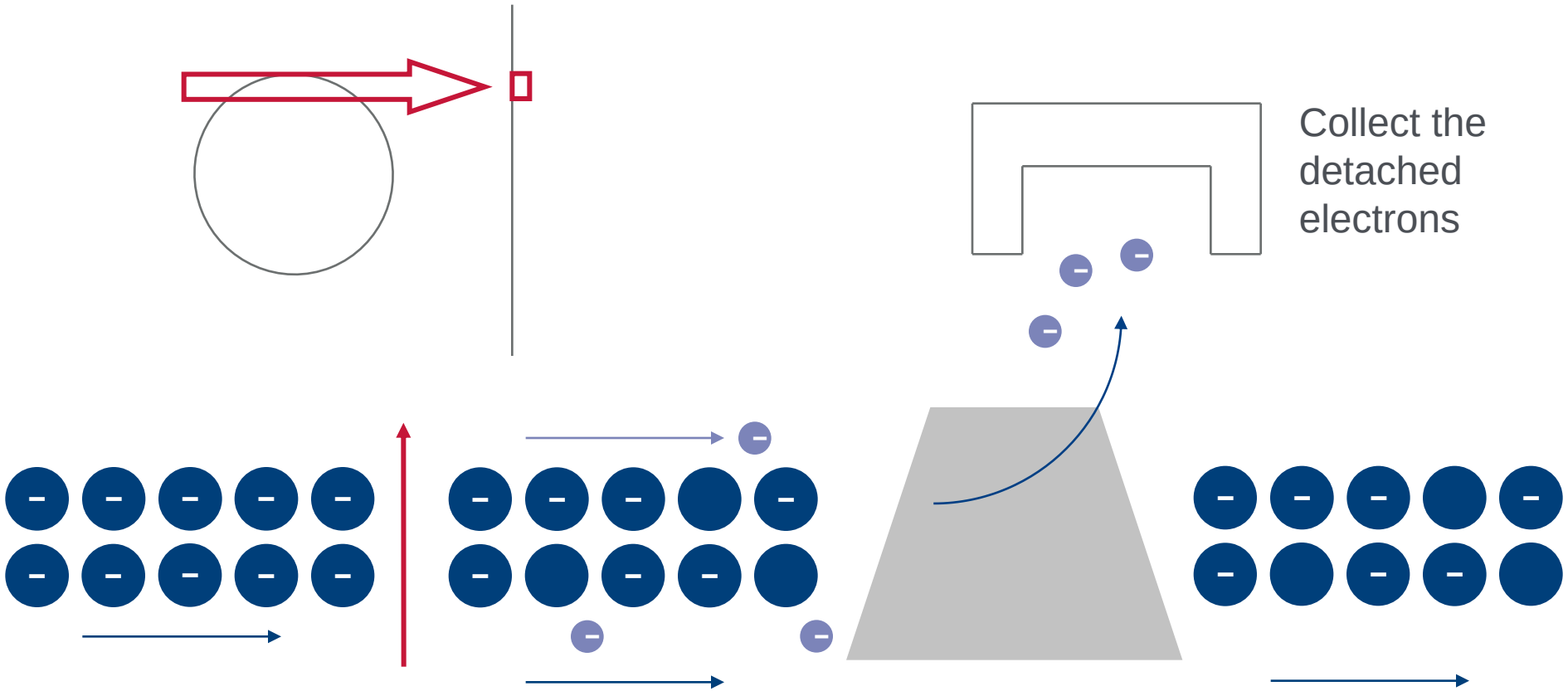

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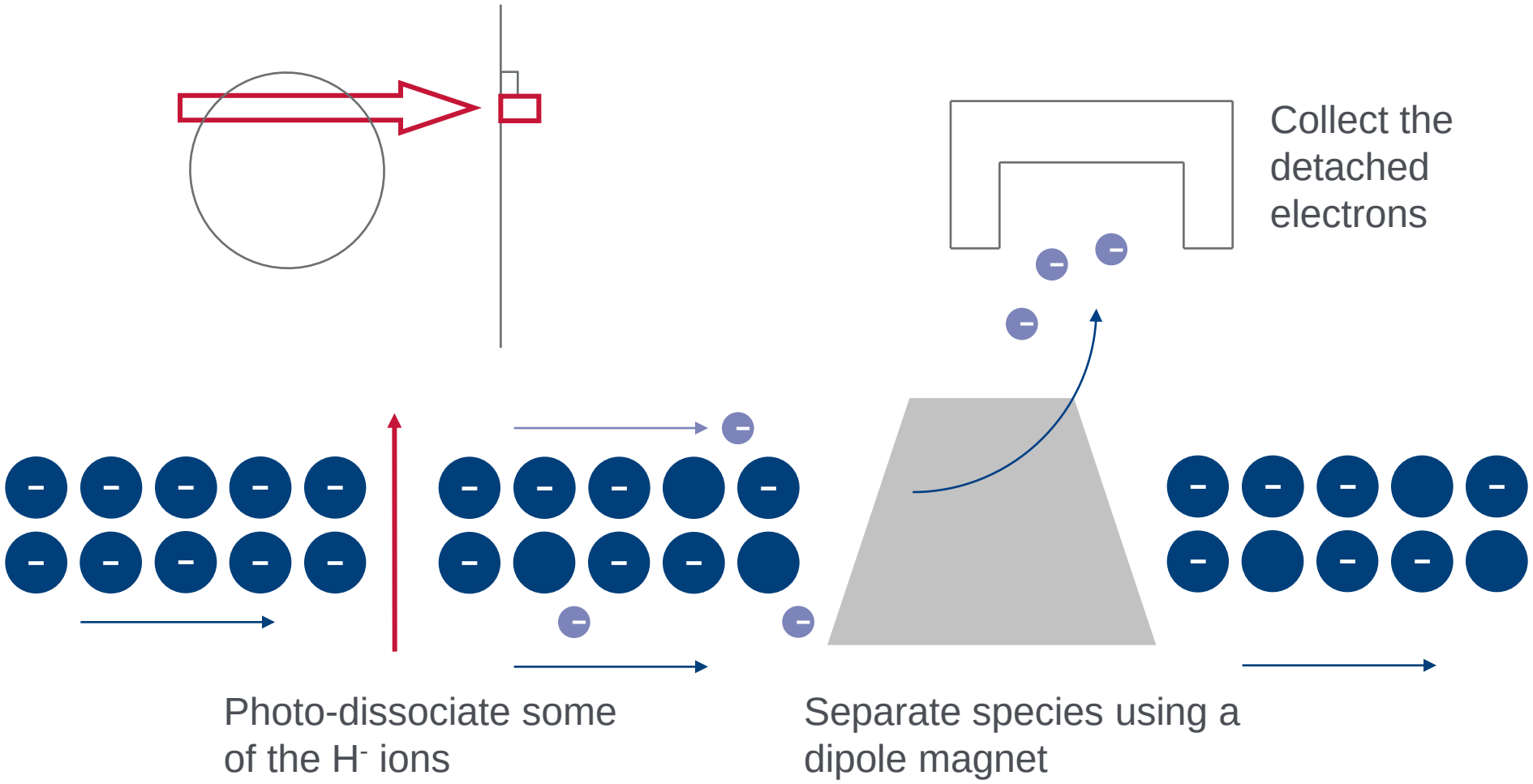

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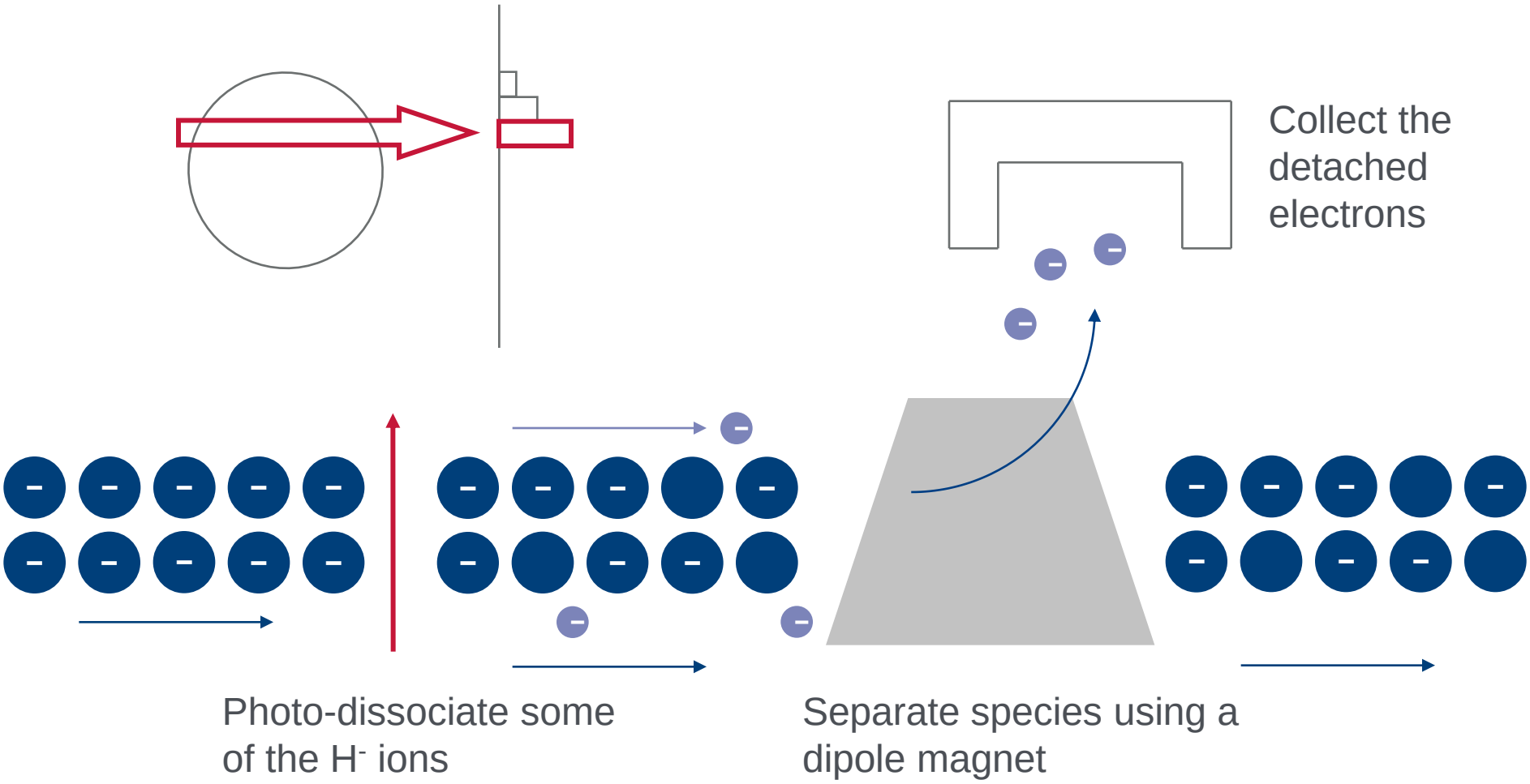

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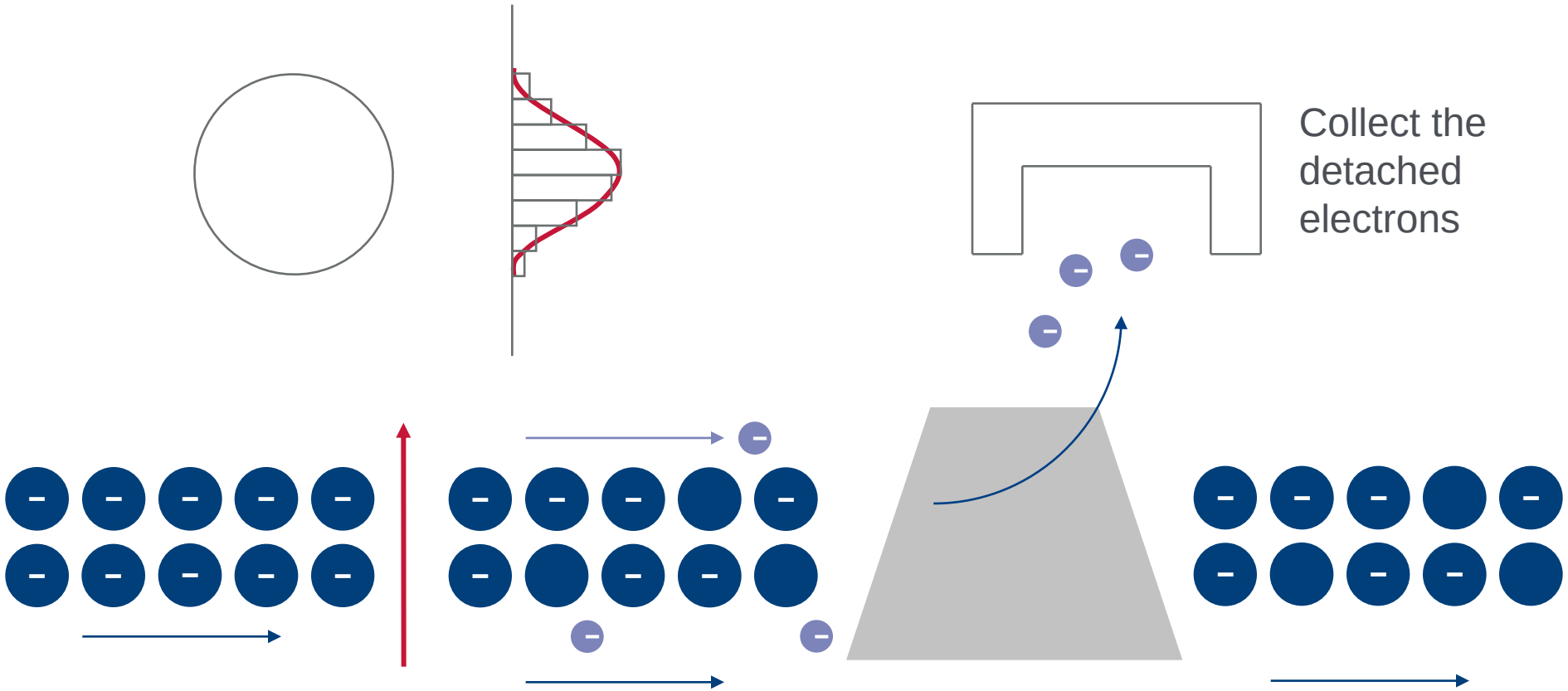
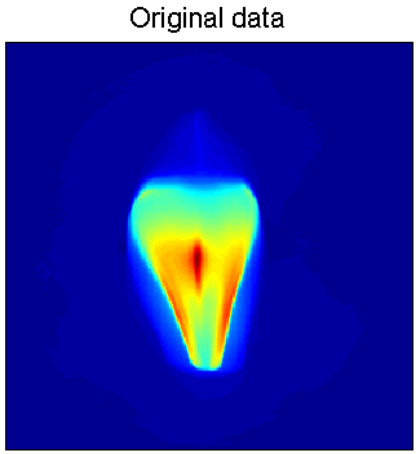


The Need for Multiple (>2) Projections



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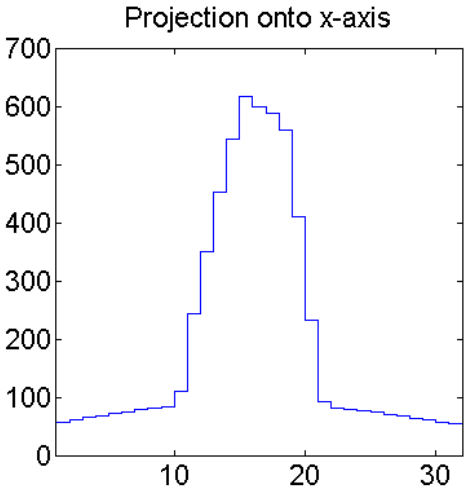

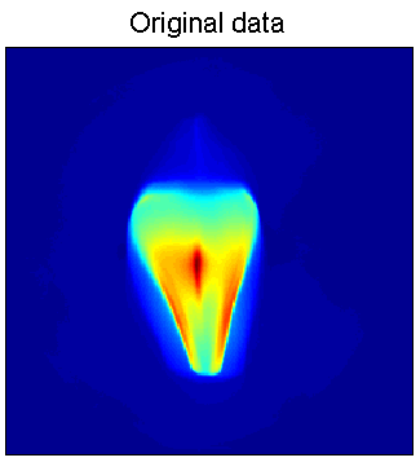

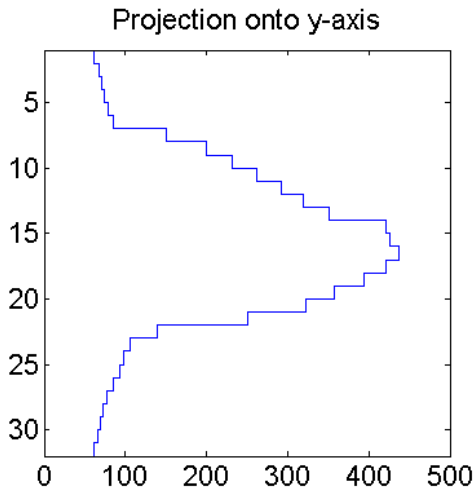

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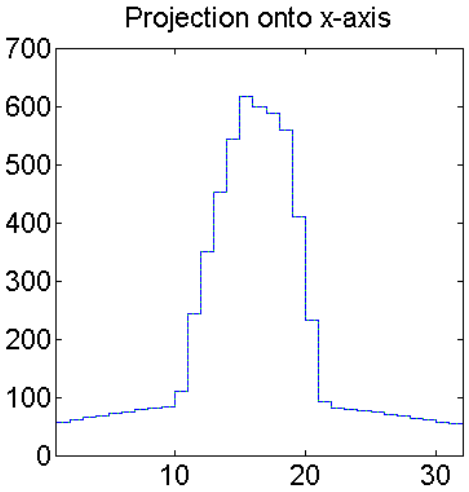

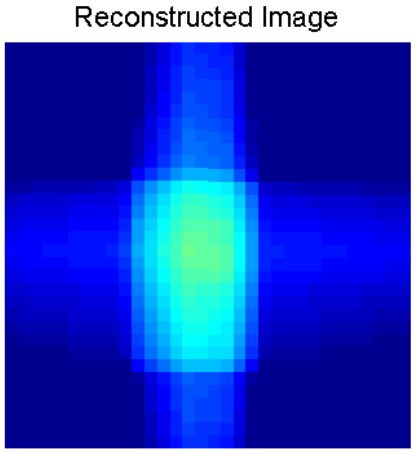

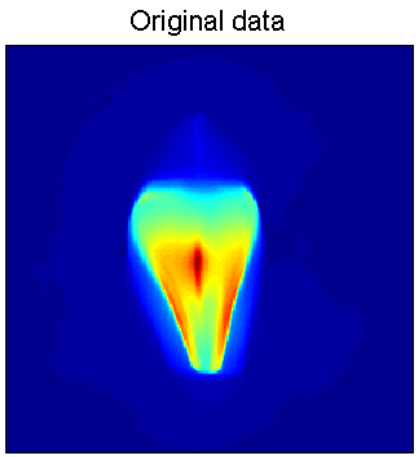

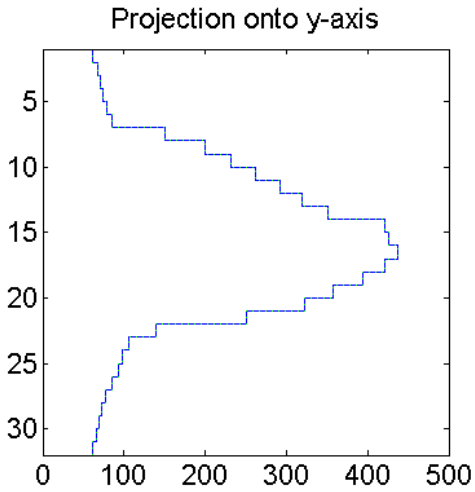

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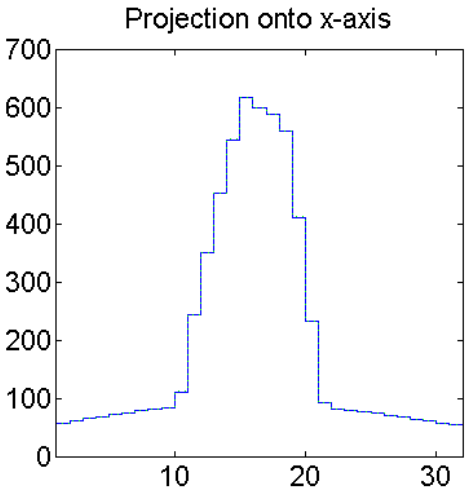

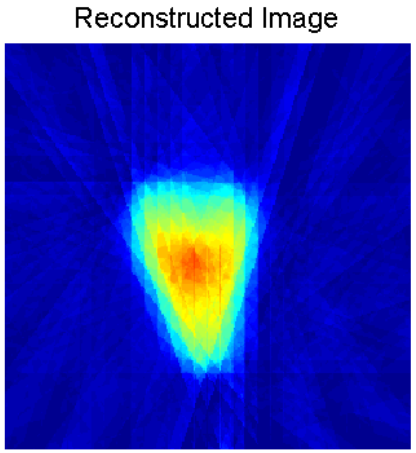

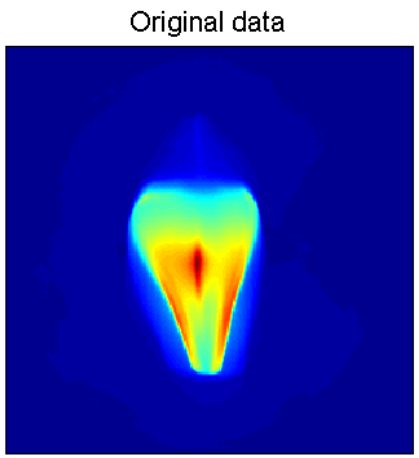

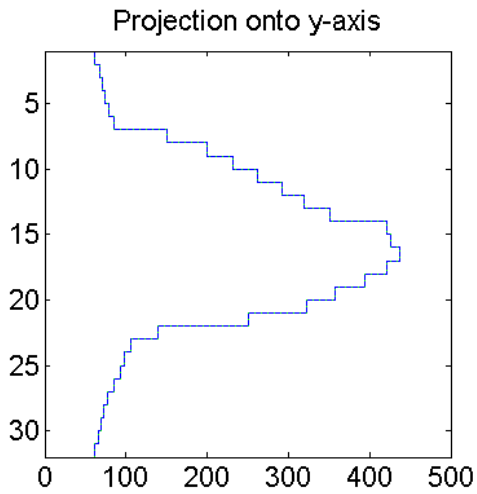

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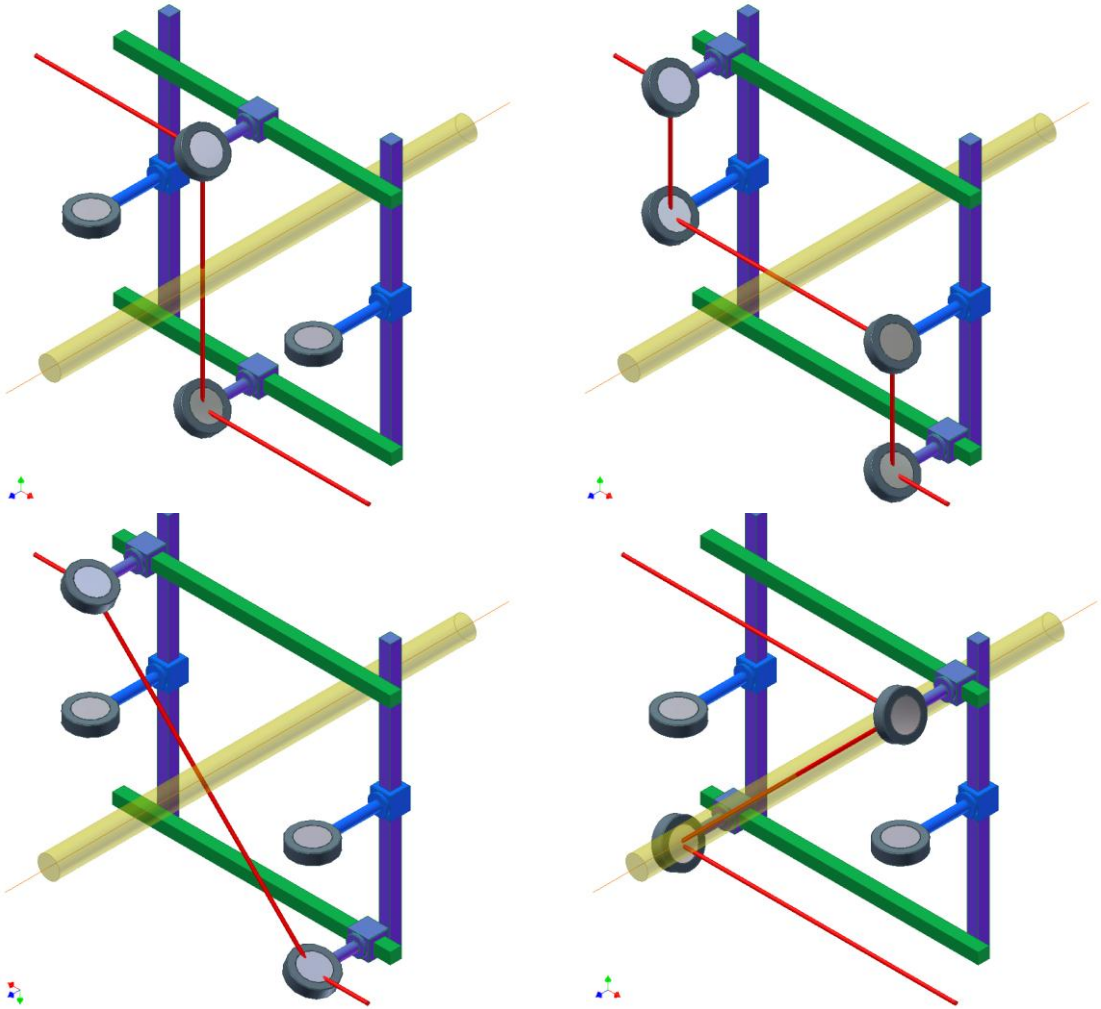

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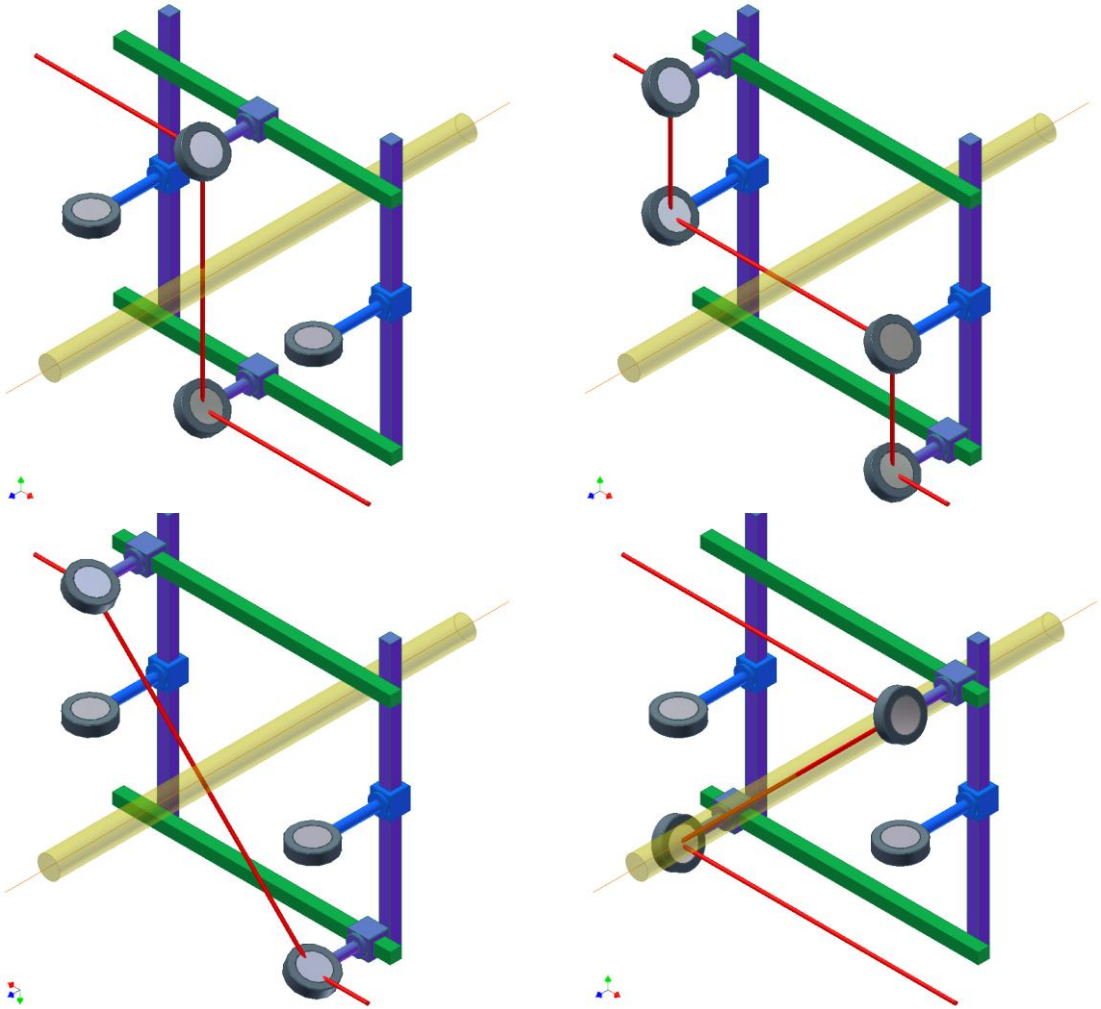

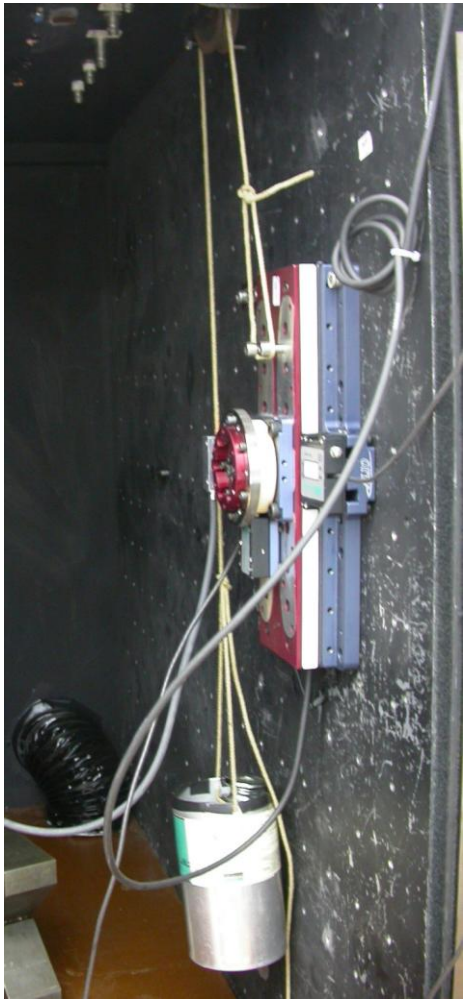

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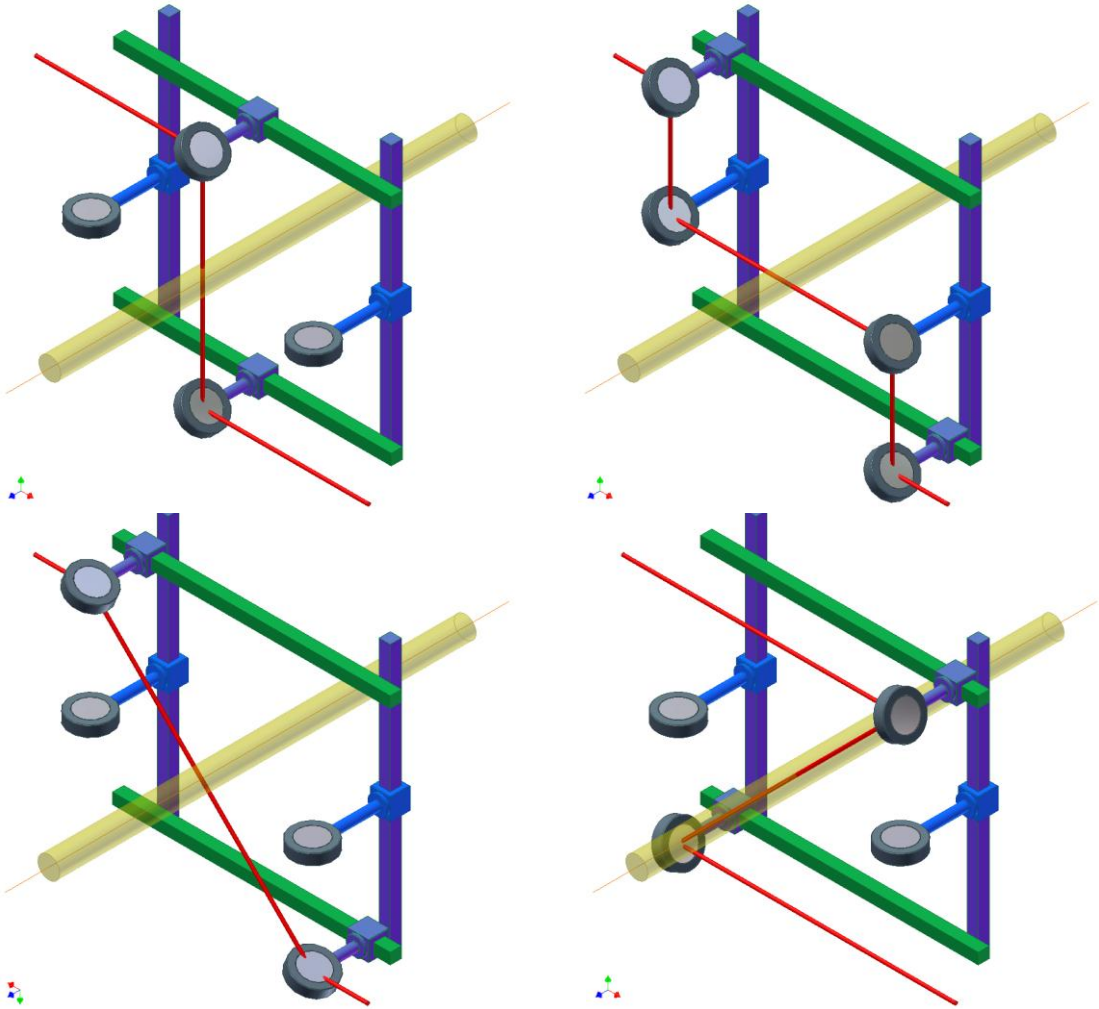
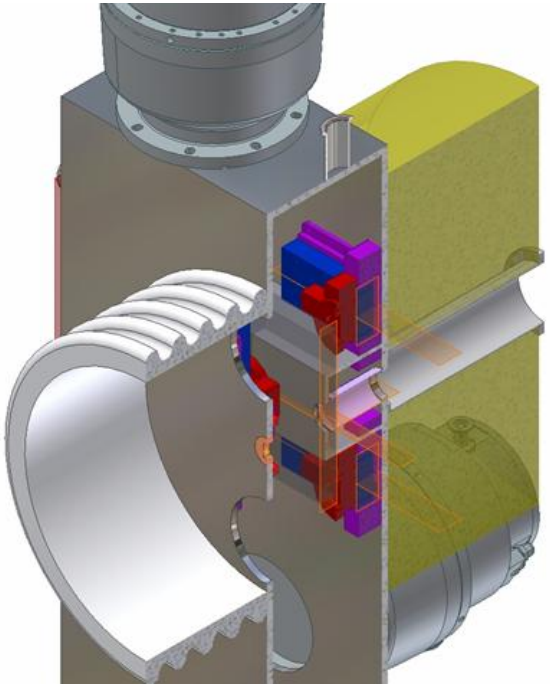
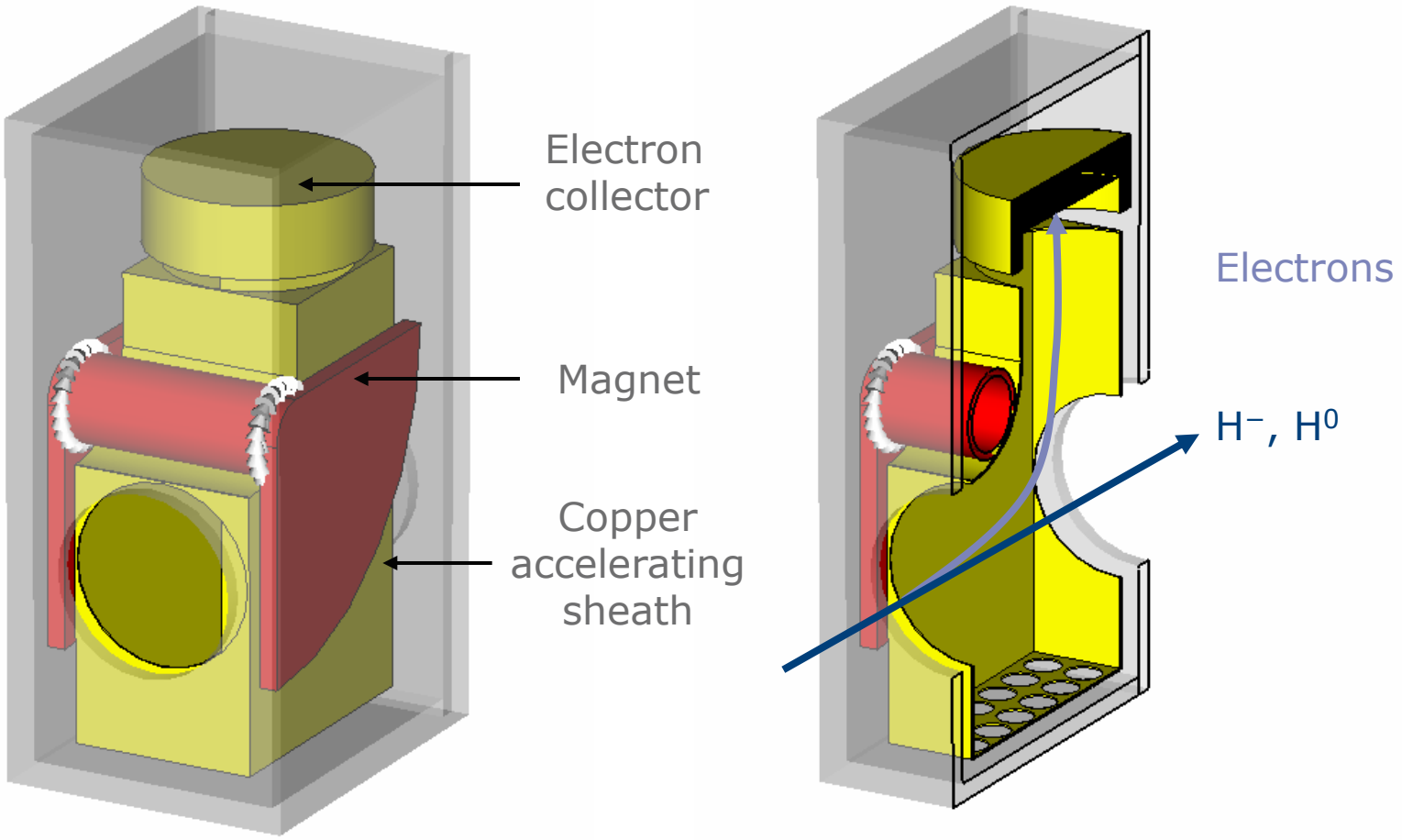




Simulated Detector Performance



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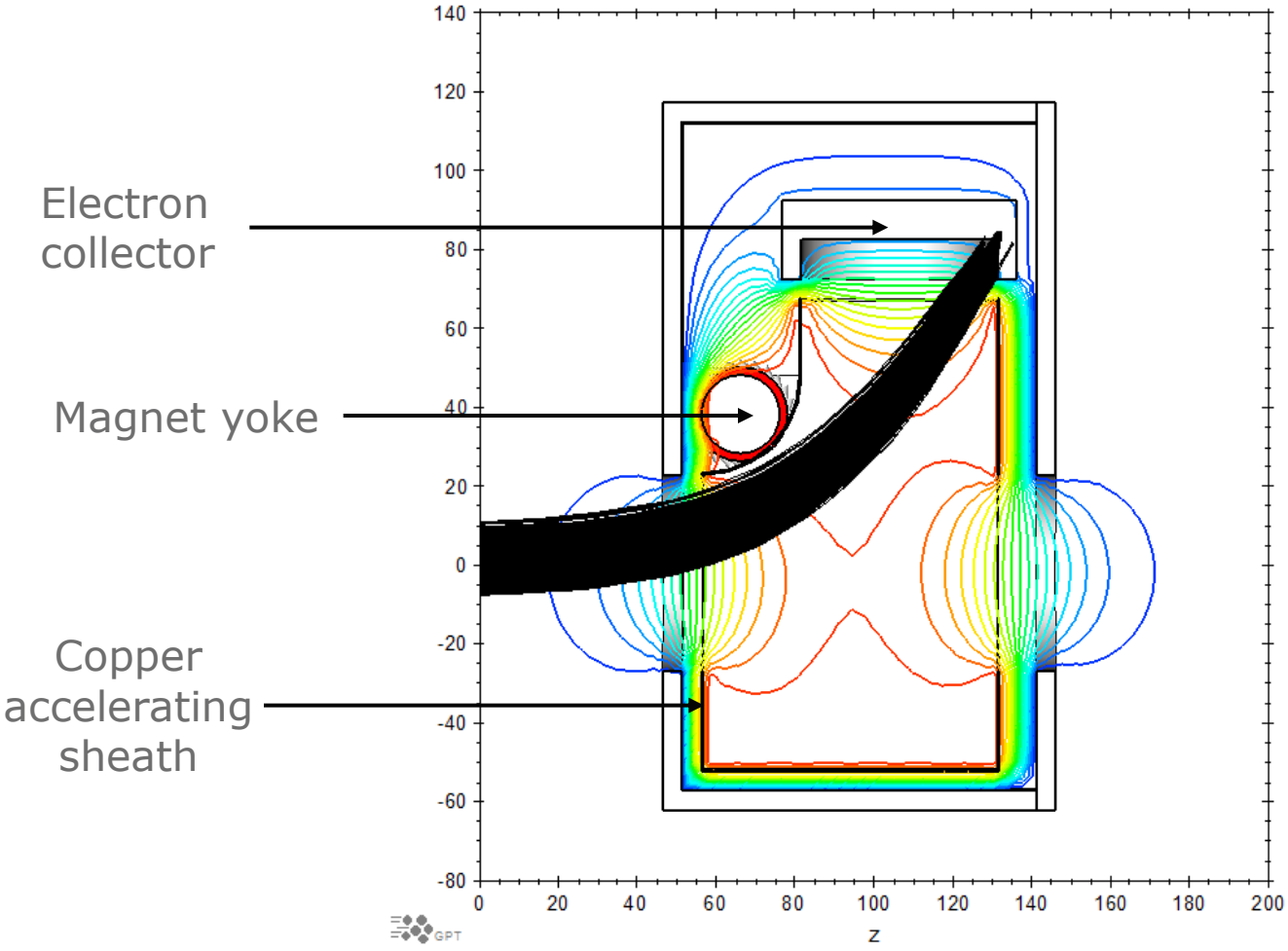
Simulated Detector Performance



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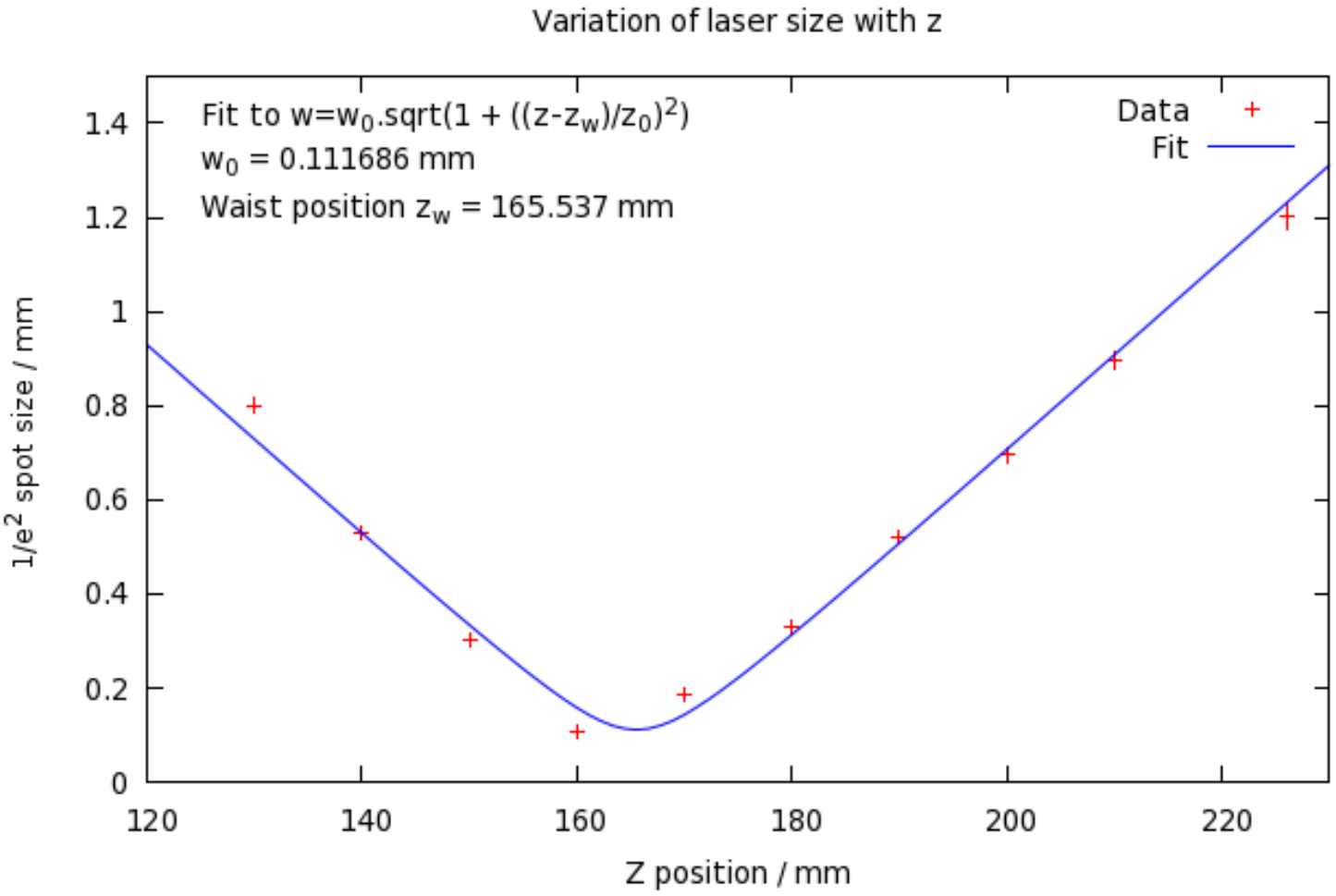
Laser Characterisation



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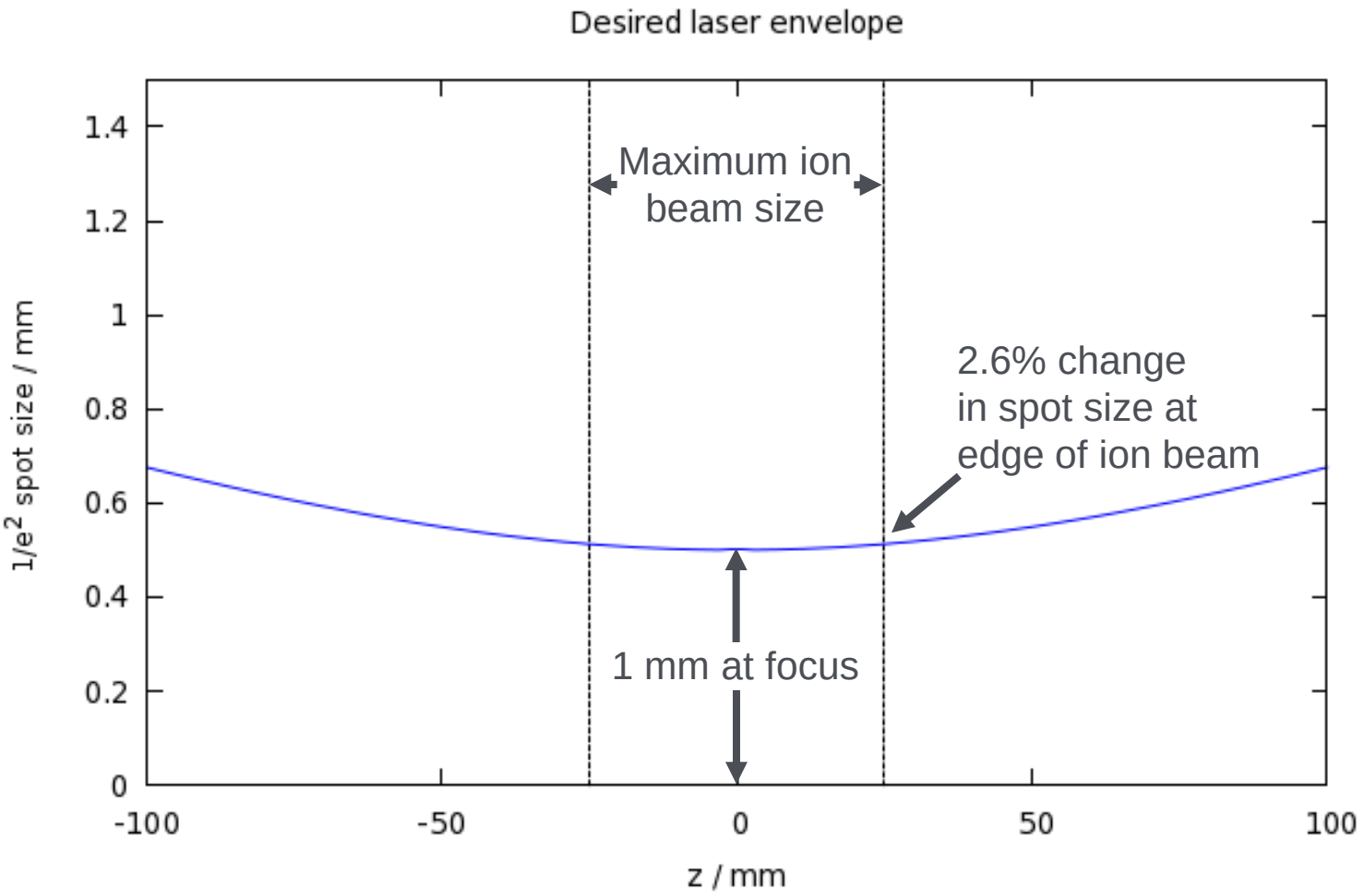

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Conclusions and Outlook

Non-destructive diagnostics are essential for high-power ion beams

- Laser-based diagnostics are a solution

Progress towards installation and operation of a laser-based beam density distribution diagnostic for the RAL Front End Test Stand is going well

- Electromagnetic simulations show efficient electron collection
- Laser characterisation shows that a good resolution can be reached
- Installation and first measurements are on schedule for the summer

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Spare slides

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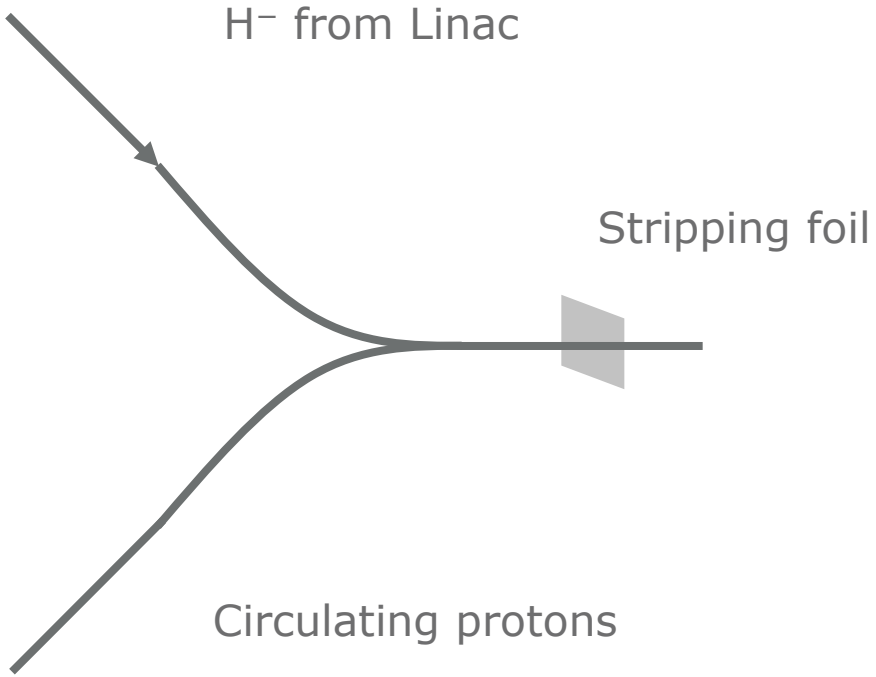
Abstract

The RAL Front End Test Stand is being constructed to demonstrate the production of a 60 mA, 3 MeV, 50 pps, chopped H- beam suitable for future high-power proton accelerators.

Due to the high beam brightness and a desire to have online instrumentation while the accelerator is operational, a series of non-intrusive, non-destructive diagnostics, based on the photo-detachment of the outer electrons of the H- ions, are being developed. This talk describes a device that will measure the 2D ion beam density distribution, due to be installed in the summer.

H^- Injection



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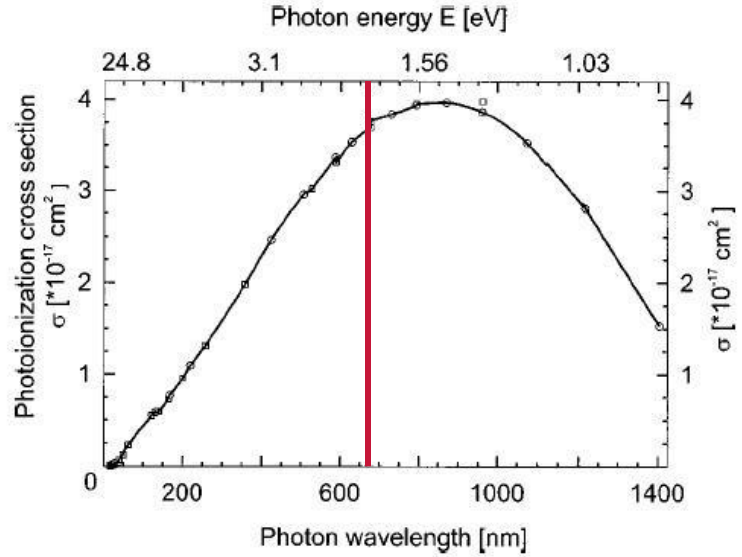
Laser-based beam diagnostics principle for H^-



Rev. Sci. Instrum. **73**, 998 (2002)

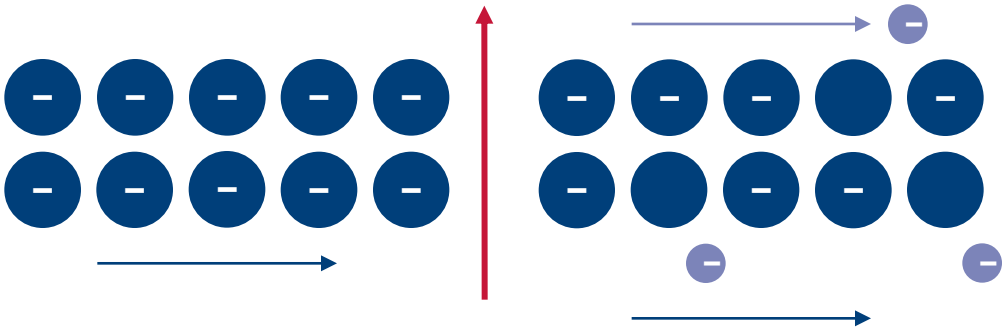
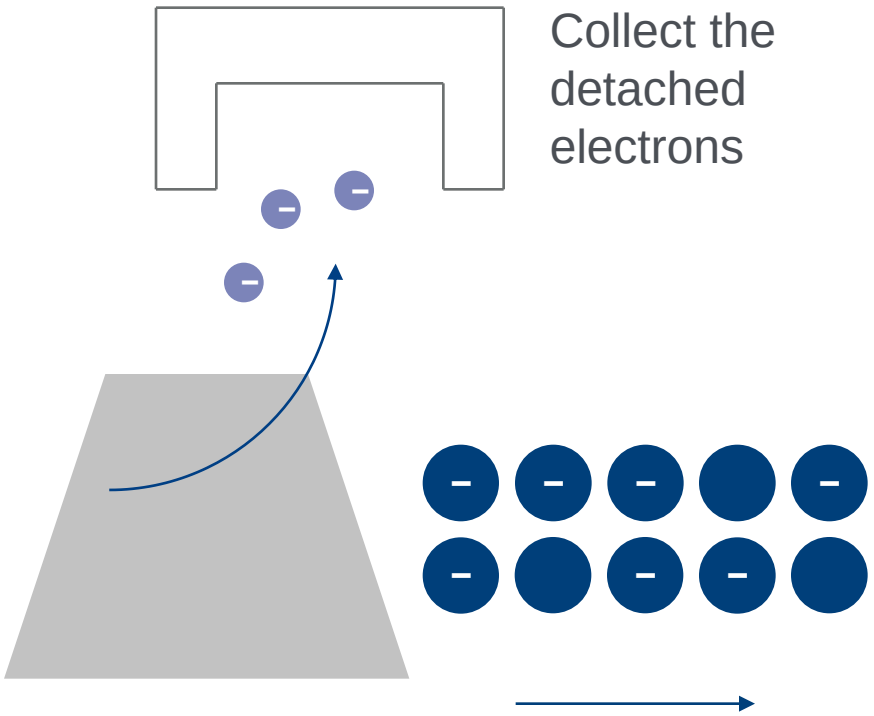


Photo-dissociate some of the H^- ions



Collect the detached electrons

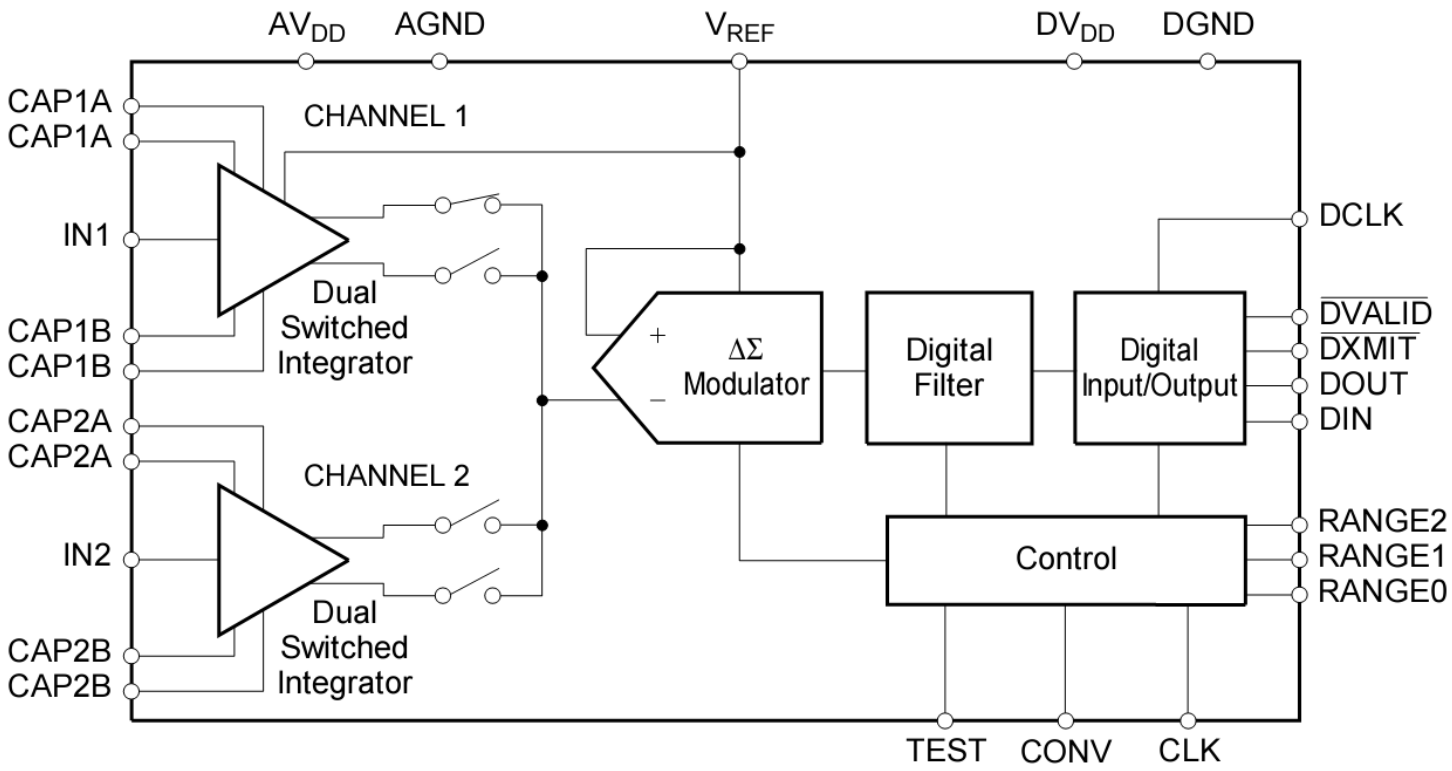
Separate species using a dipole magnet

ADC

Two channel, integrate and hold, 20-bit ADC

Minimum sensitivity: −0.2–50 pC

Expected signal size ~1 pC so in effect we have a ~ 14-bit ADC



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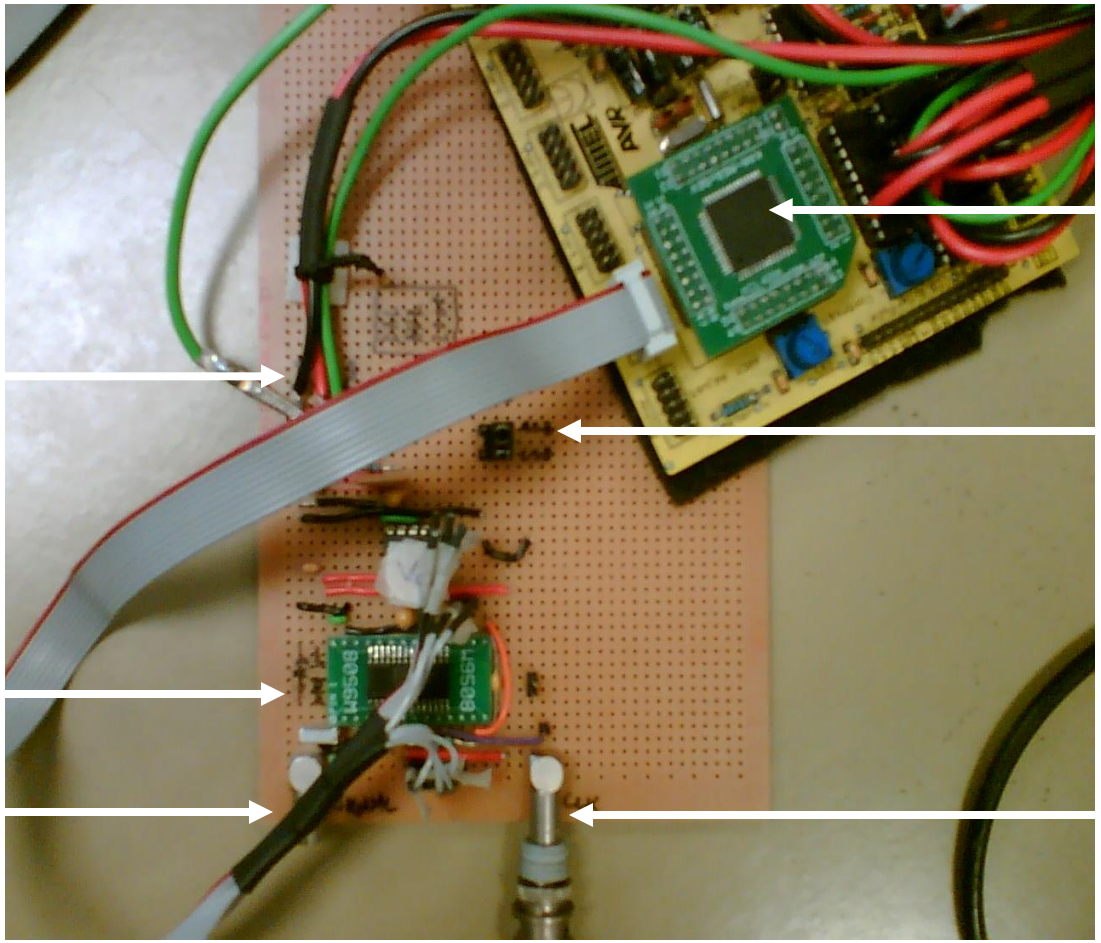
ADC Protoboard



ADC Test Charge Resolution