Status Report of the RAL Photo—Detachment Beam Profile Monitor

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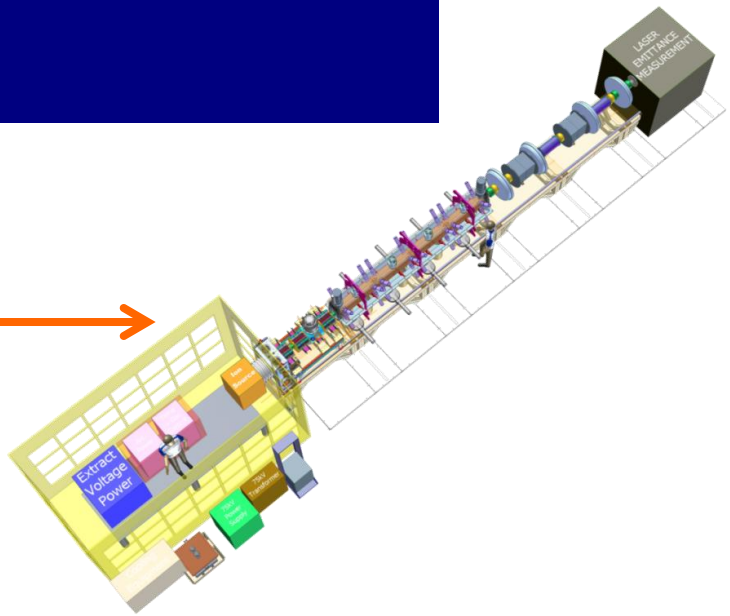
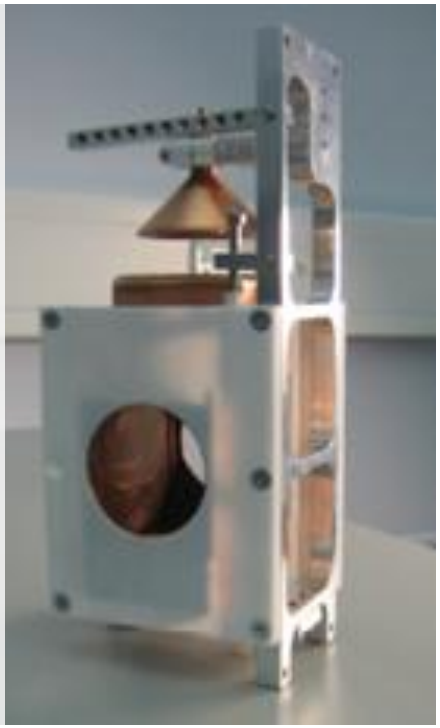
Outline of the talk

Front End Test Stand FETS at RAL
H- ion beams and its Photo Detachment diagnostics

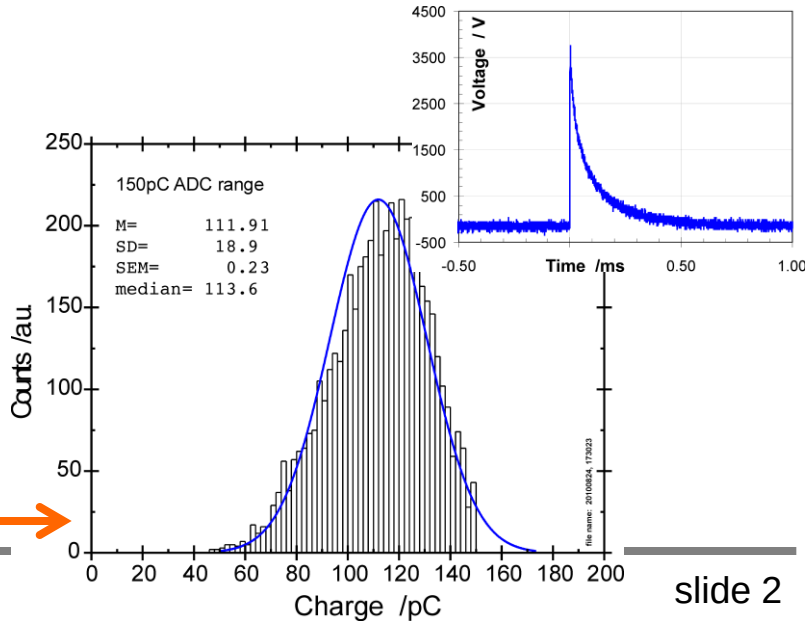


detector of photo detached elect.

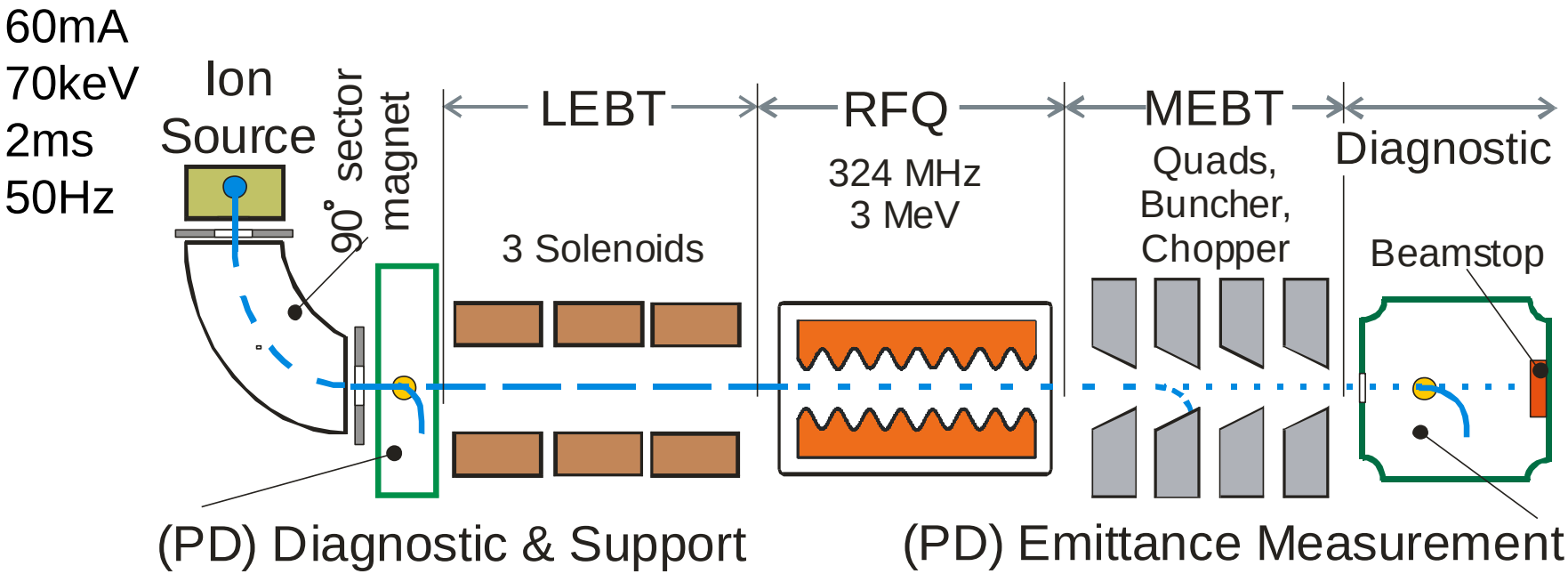


Technical design of the electron detector

Experimental results and discussion of achieved measurements



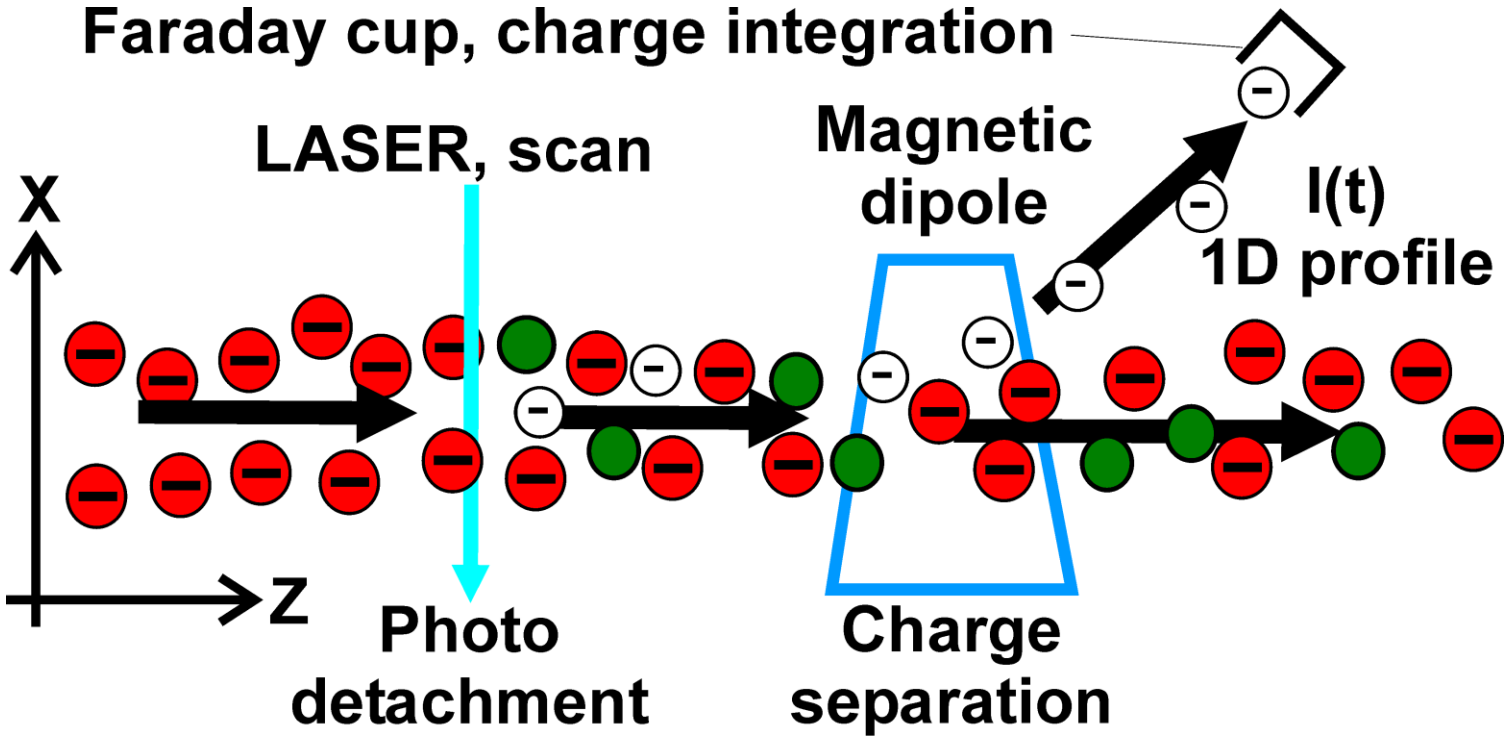
The Front End Test Stand is an R&D project suitable for many HPPA like Isis upgrade.



The beam profile monitor is placed in the first vessel downstream of the ion source and post acceleration system.

The beam profile monitor started as a Ph.D. project at Imperial College (David Lee).

Photo detachment can be used to diagnose the H- ion beam non destructive.

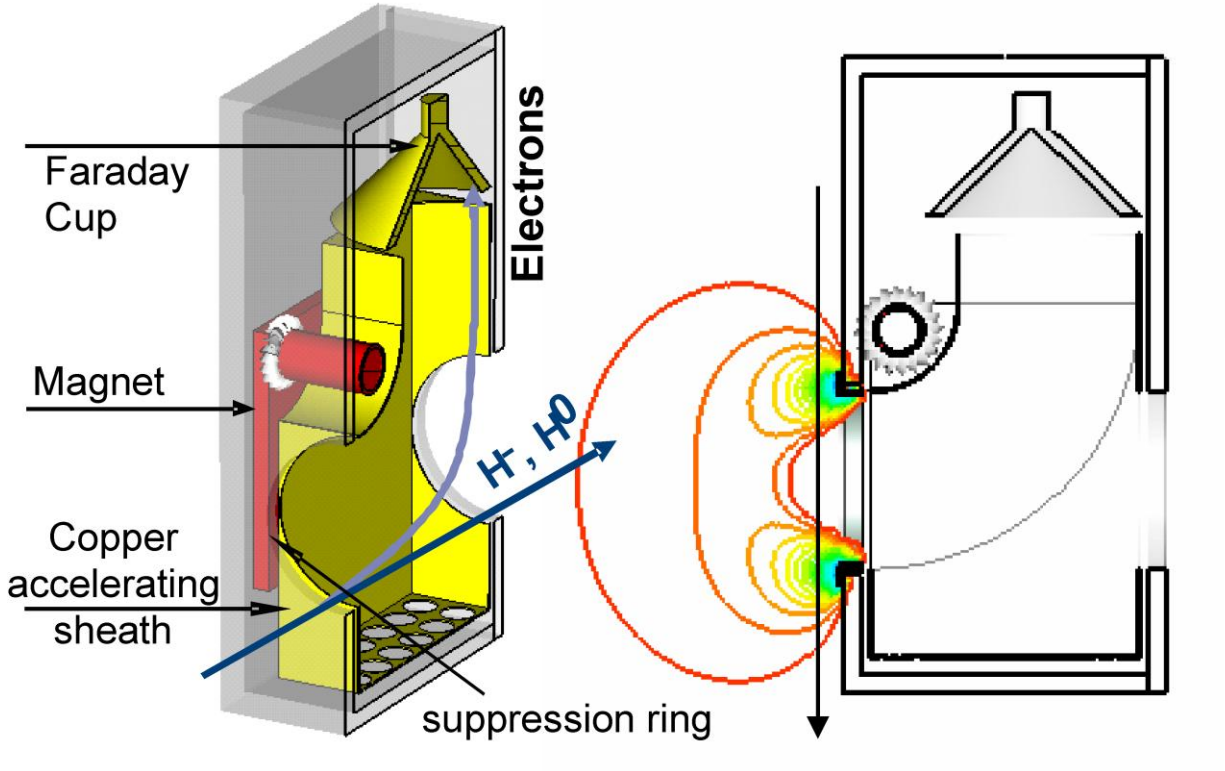


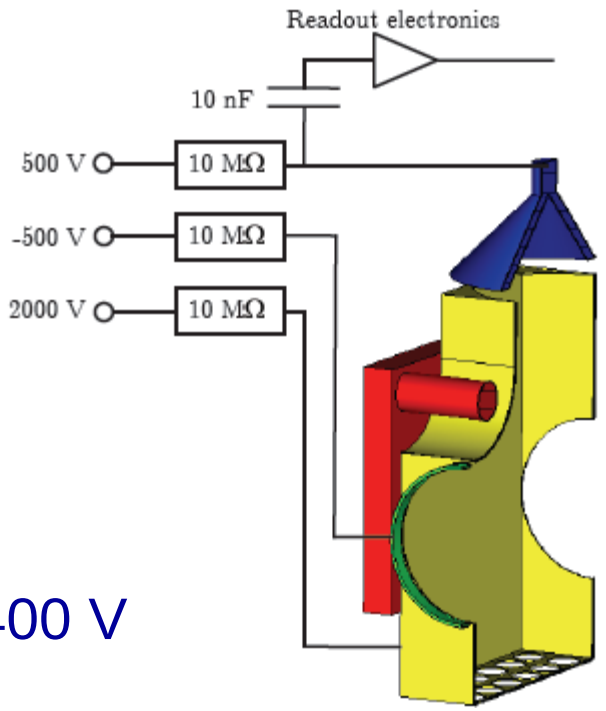
$$\hbar\omega + H^- \longrightarrow H^o + e^-$$

~75% of cross section
with Nd:YAG or 2nd harmonics

- non destructive
- online measurements
- final aim: tomography (2D)
- other variants also possible

The detector set up to collect the electrons.

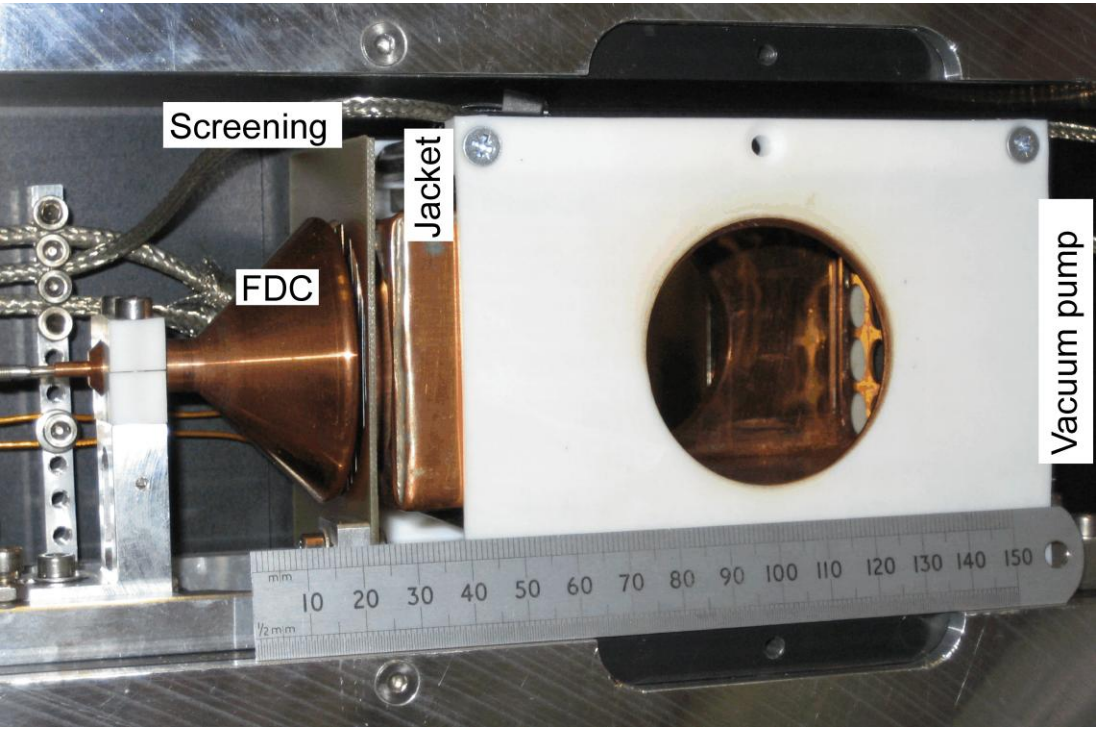




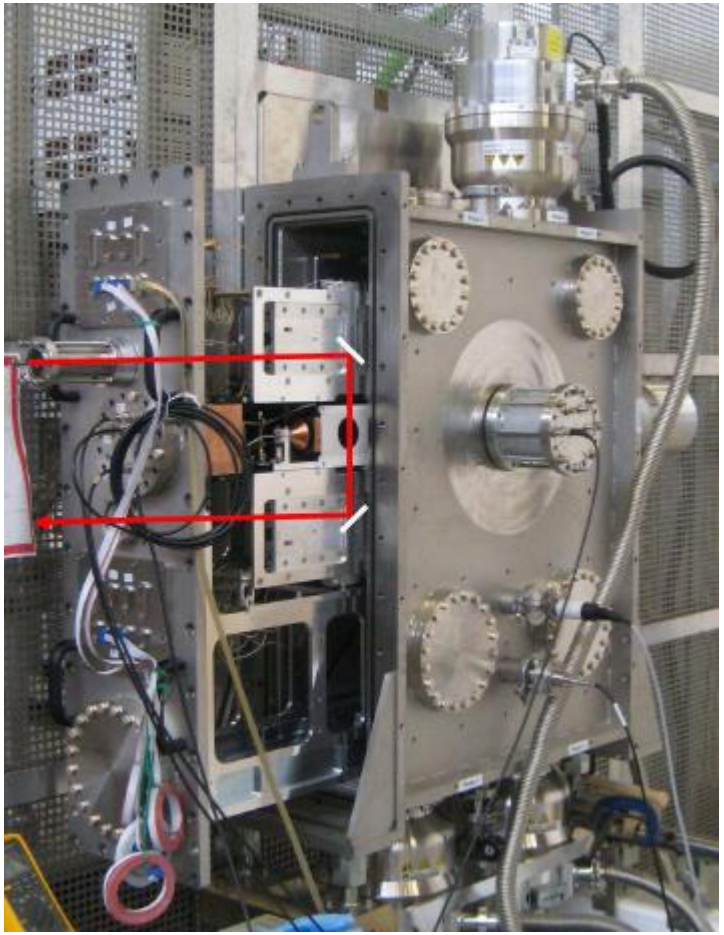
- ~ suppression ring: S = - 500 V
- ~ acceleration sheath: J = + 2 kV
- ~ grid: G = +200....+400 V
- ~ Faraday cup bias: B = + 500 V
- ~ magnet current: I = + 1A

work done by David Lee

Detector & optical beam path. The diagnostics is integrated in the 1st (differential) pumping vessel



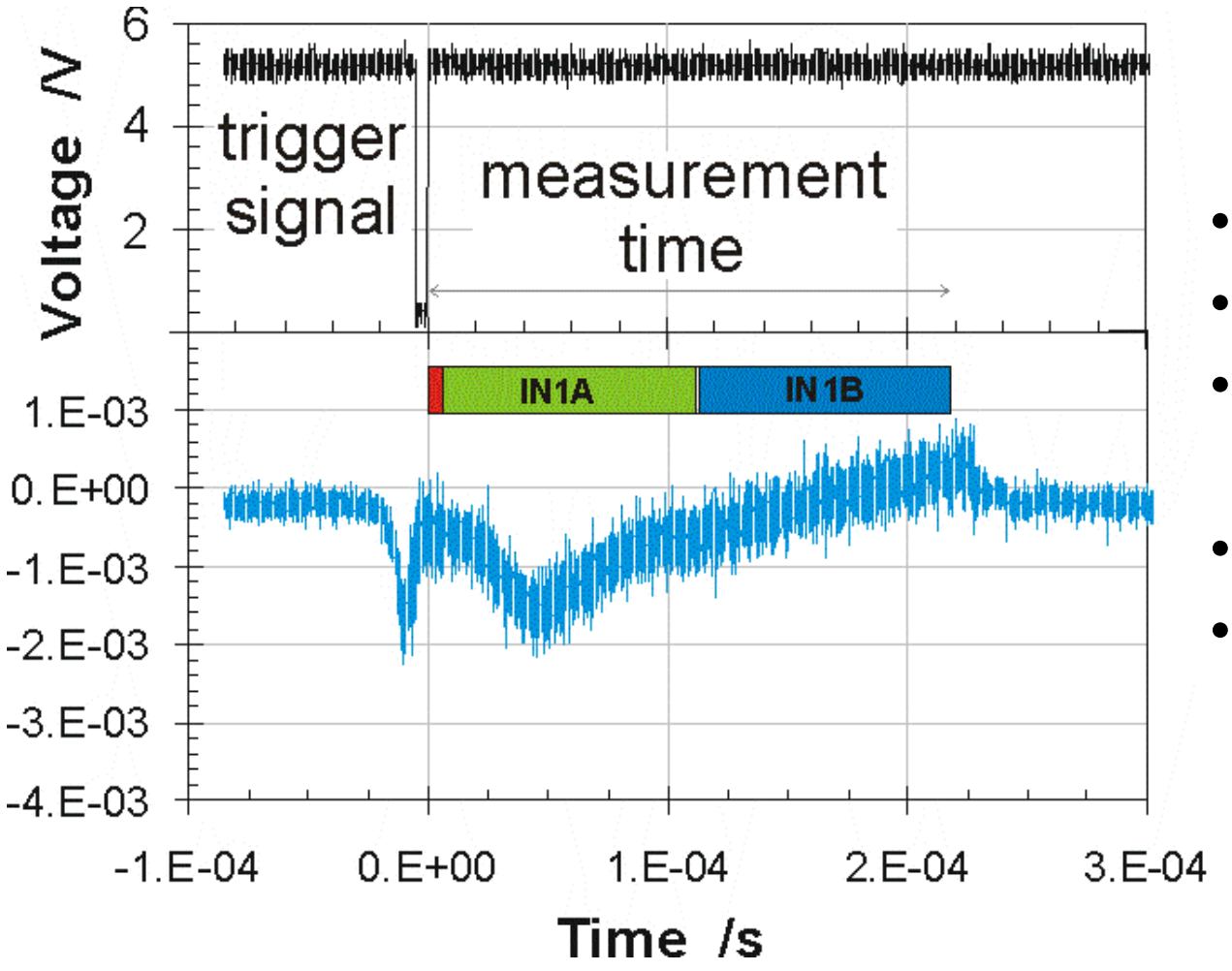
Blow up of the electron detector. Opening hole is 50mm in diameter.



Optical beam path of the laser.

The signal will be sampled and digitized with a current amplifier.

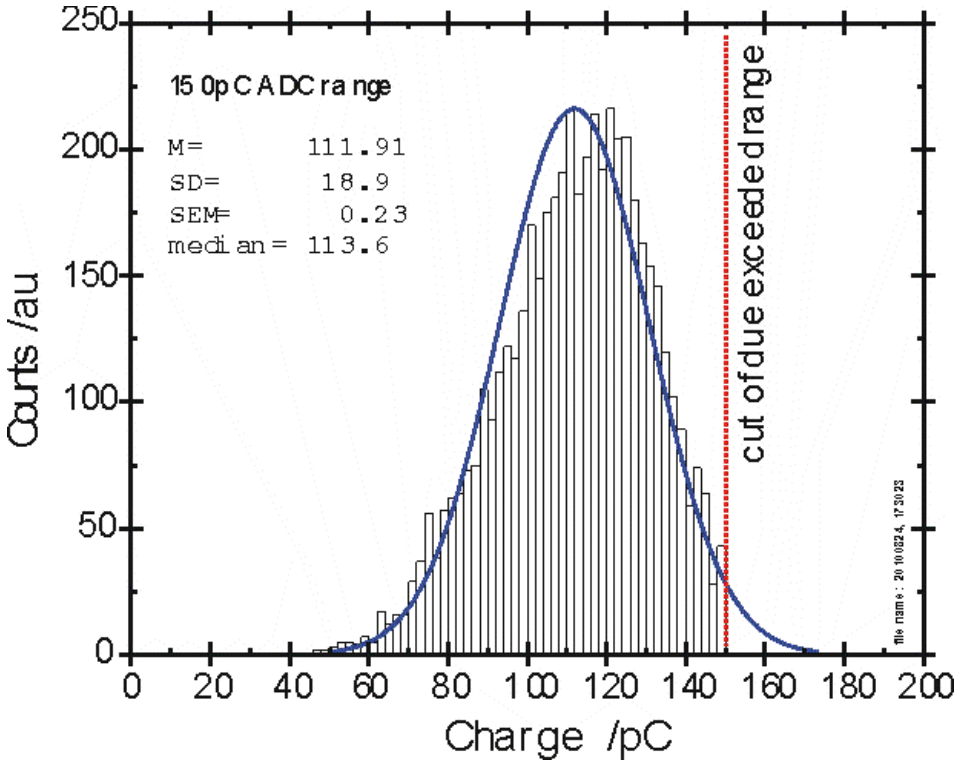
Electronics: rise time μs & resolution pC



- 50.....350pC range
- 20 bit resolution
- 2 integration cycles at 103μs
- 25Hz rep. rate
- "IN1B" delivers more stable results

The background is large compared to the photo detachment effect & needs carefull substraction.

High beam losses cause a large background signal.



Two different types of sources affect the background:

- slow variations → **mean** (stability of the ion source
- fast variations → **SD** (secondary effects, ion beam noise)

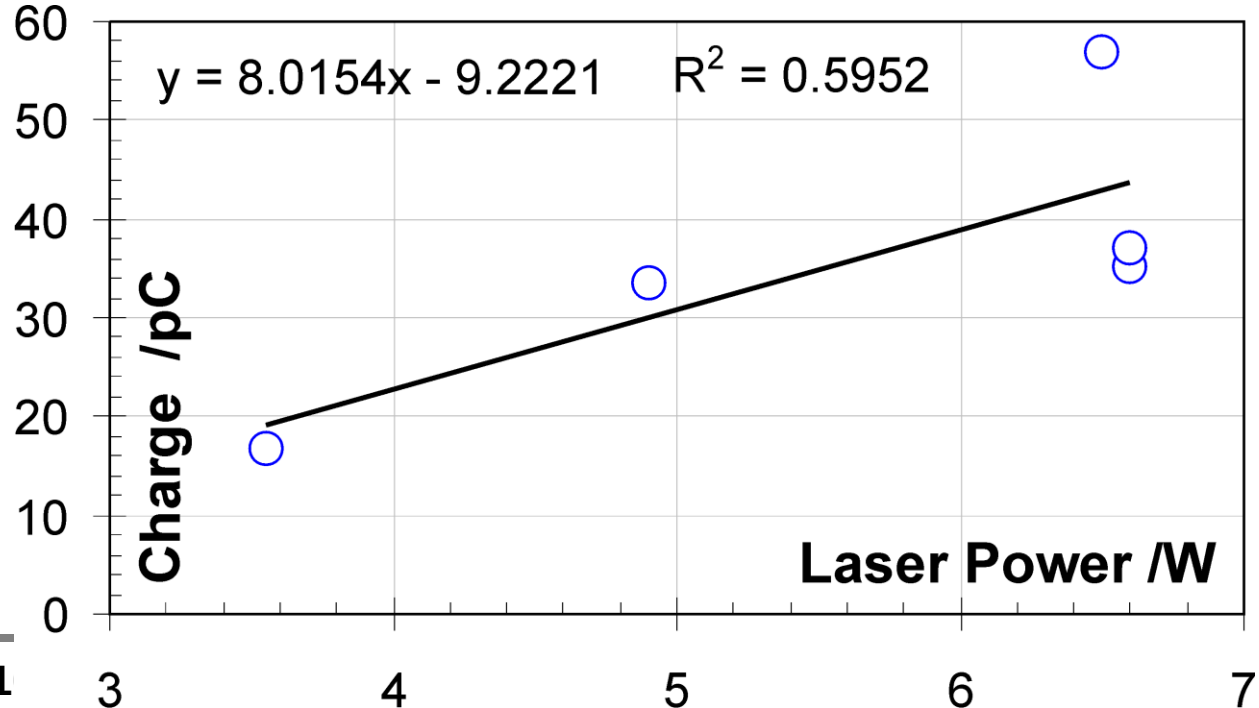
It is NOT possible to run the detector as it is supposed to do.
Needs to find empirical settings to min. background + max. PD electrons.

Comparison of some measurements from different days/ different detector settings.

	No. 1	No. 2	No. 3	No. 4	No. 5
Range /pC	150	100	350	350	150
P_{laser} /W	6.62	6.62	6.4	6.4	6.5
Δ_{mean}	1.84	2.17	46.0	34.0	56.9
Dipole I /A	0.62	0.62	0.41	0.41	0.34
Grid G /V	109	109	159	159	155
Bias B /V	0	0	89	89	94

- Grid and Bias have strong impact
- variation of the means
- secondary effects

Linear Regression suffers from instabilities caused by the ion source.



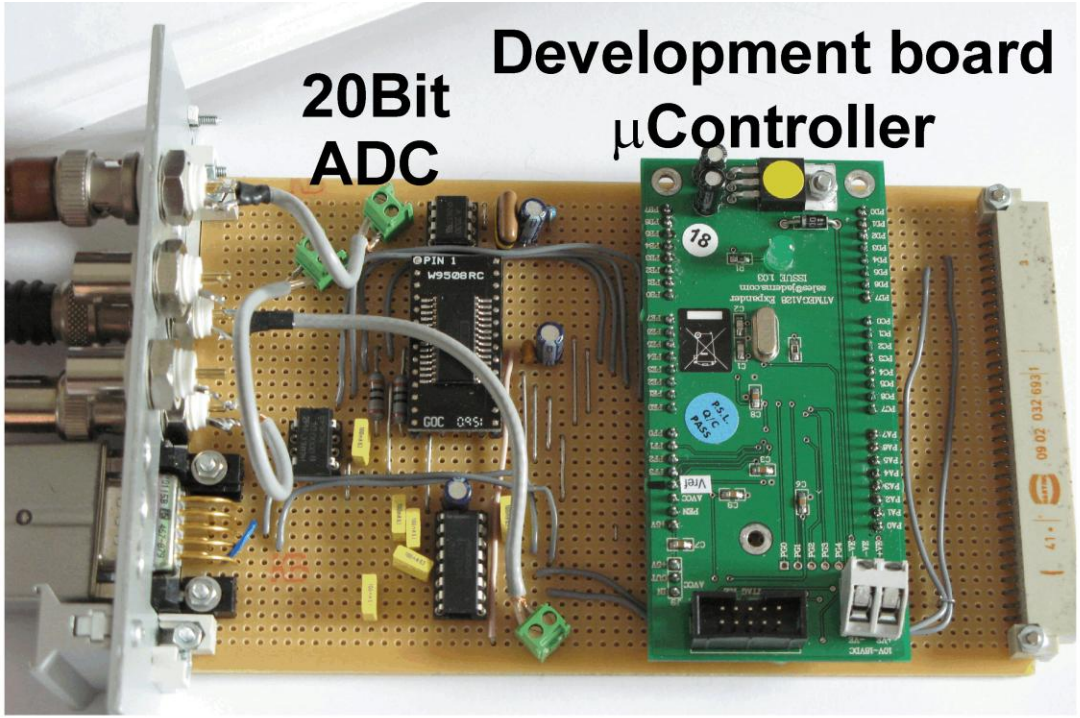
Summary and Outlook.

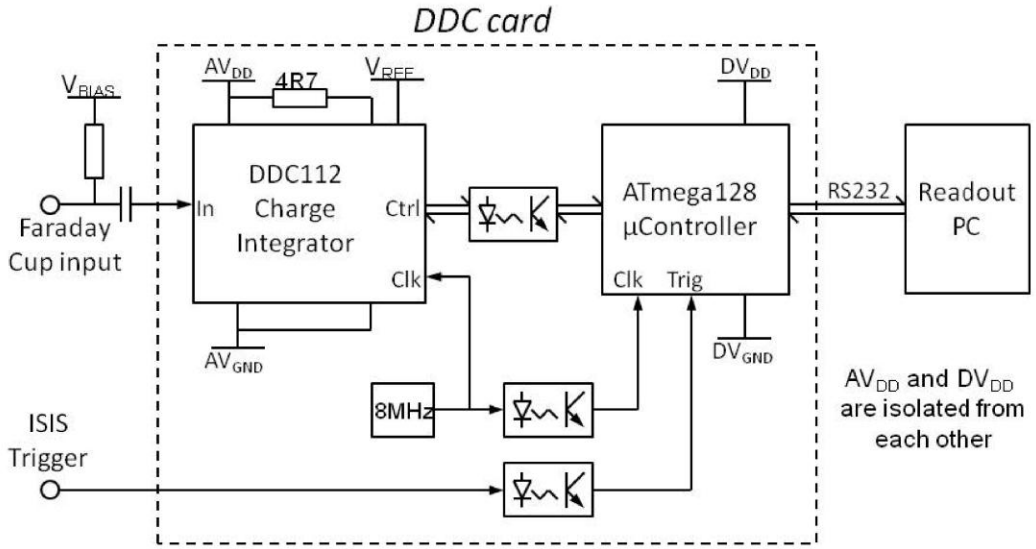
- Photodetachment diagnostics at RALs front end test stand
- First experimental tests show small signal
- Beam loss causes problem, i.e. background

- Until end of laser loan more measurements are planned
- Move BPM to another place
- Redesign detector to minimize interference with beam

- nothing said about:
  final aim of tomography, reconstruction, emittance
  photo detachment (2D and 4D phase space)

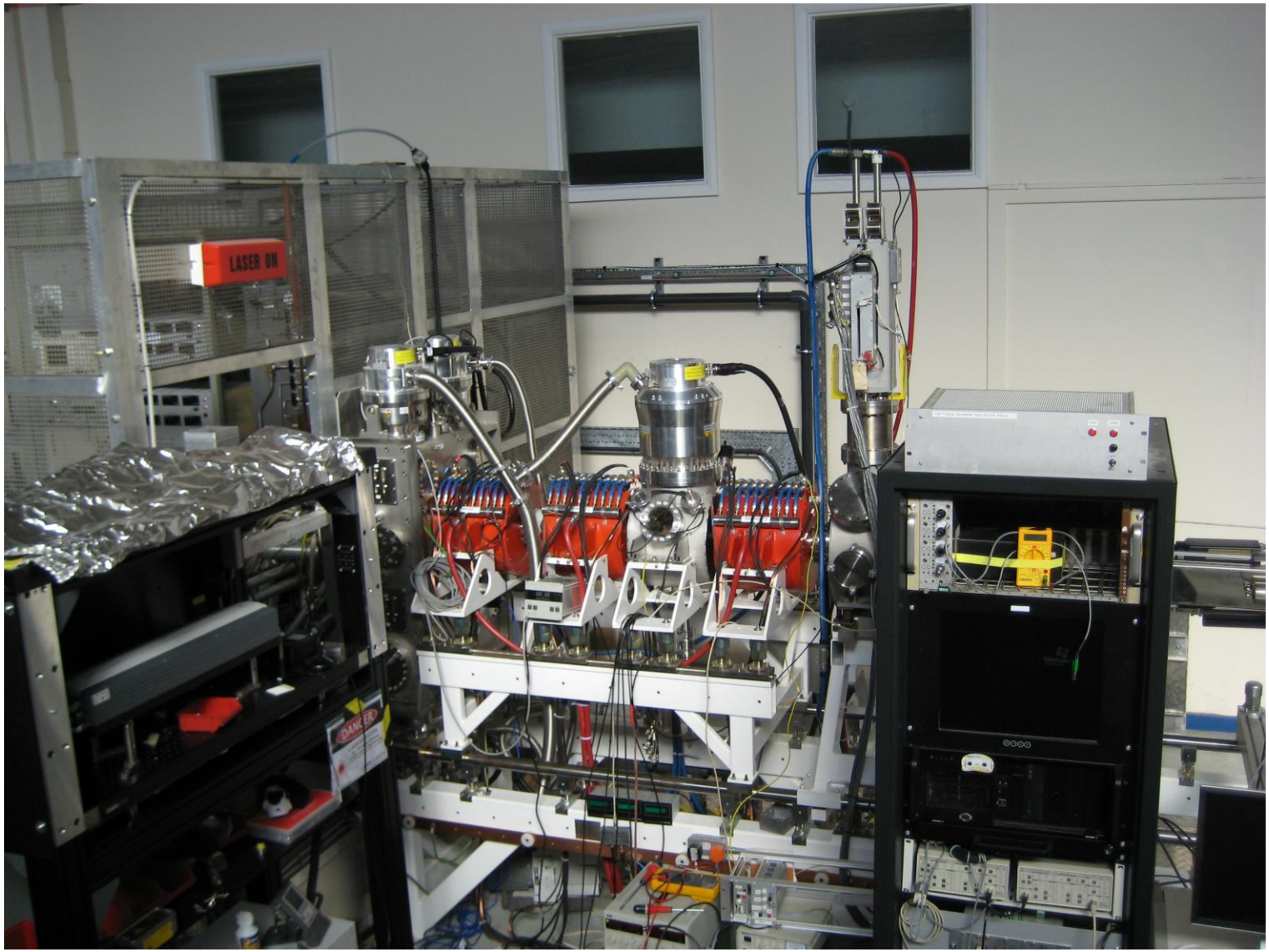
Some extra slides



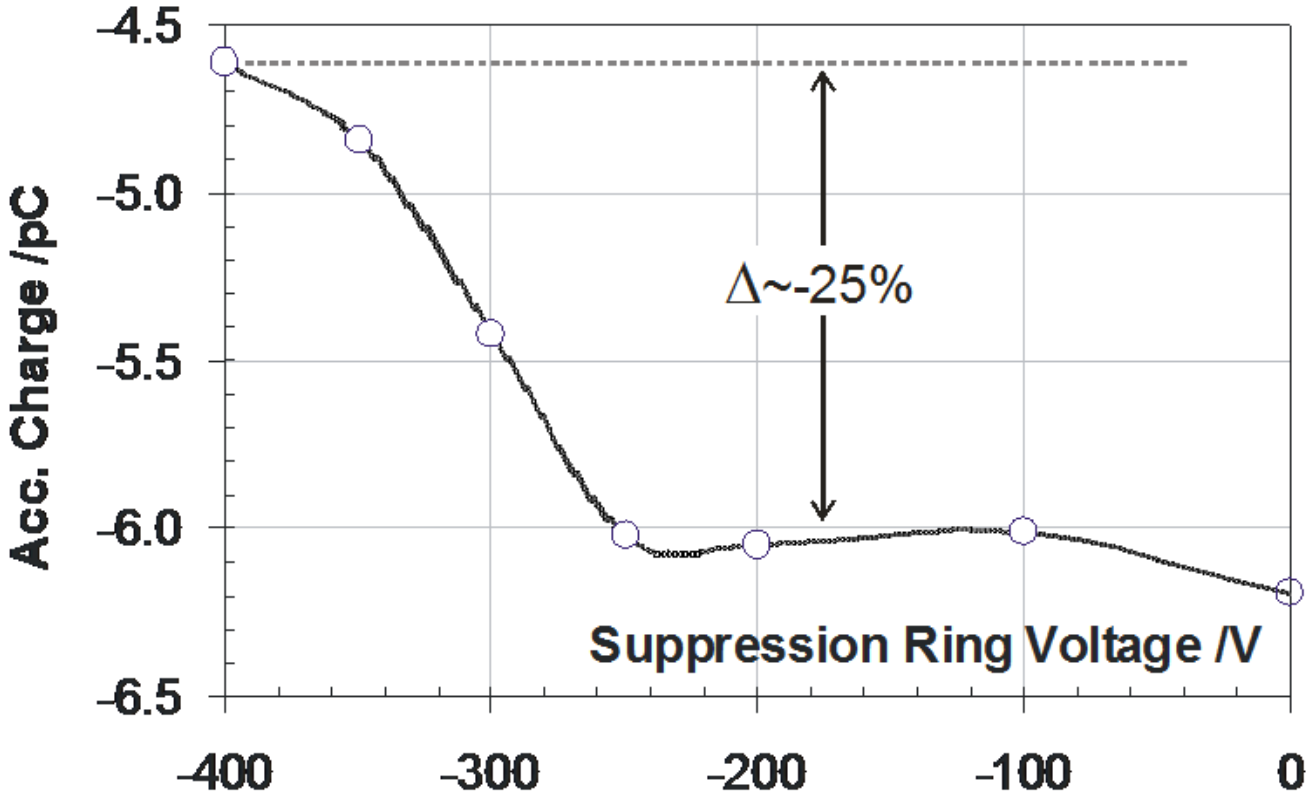


@ Gary Boorman

Faraday Cage and Low Energy Beam Transport Section of the Beam Line.

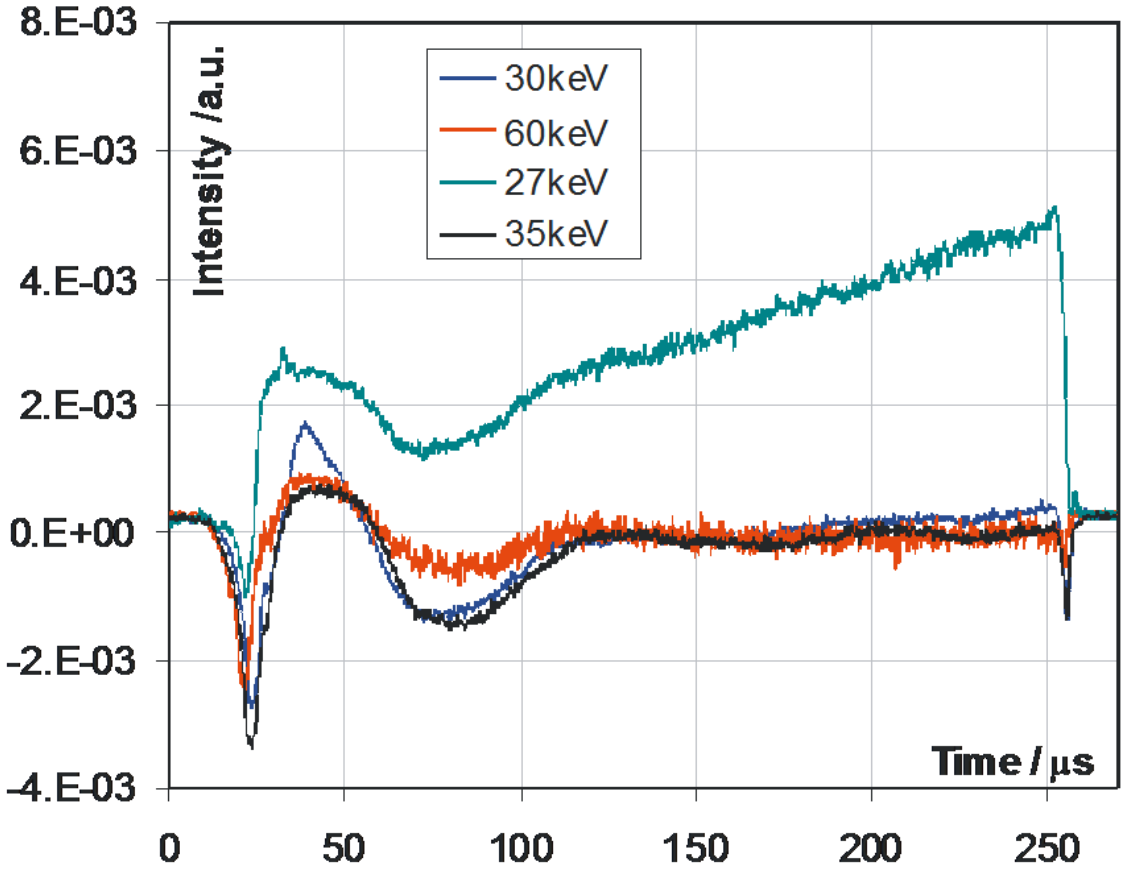


Similar to the jacket sheeth the suppression ring also influences the FDC signal.



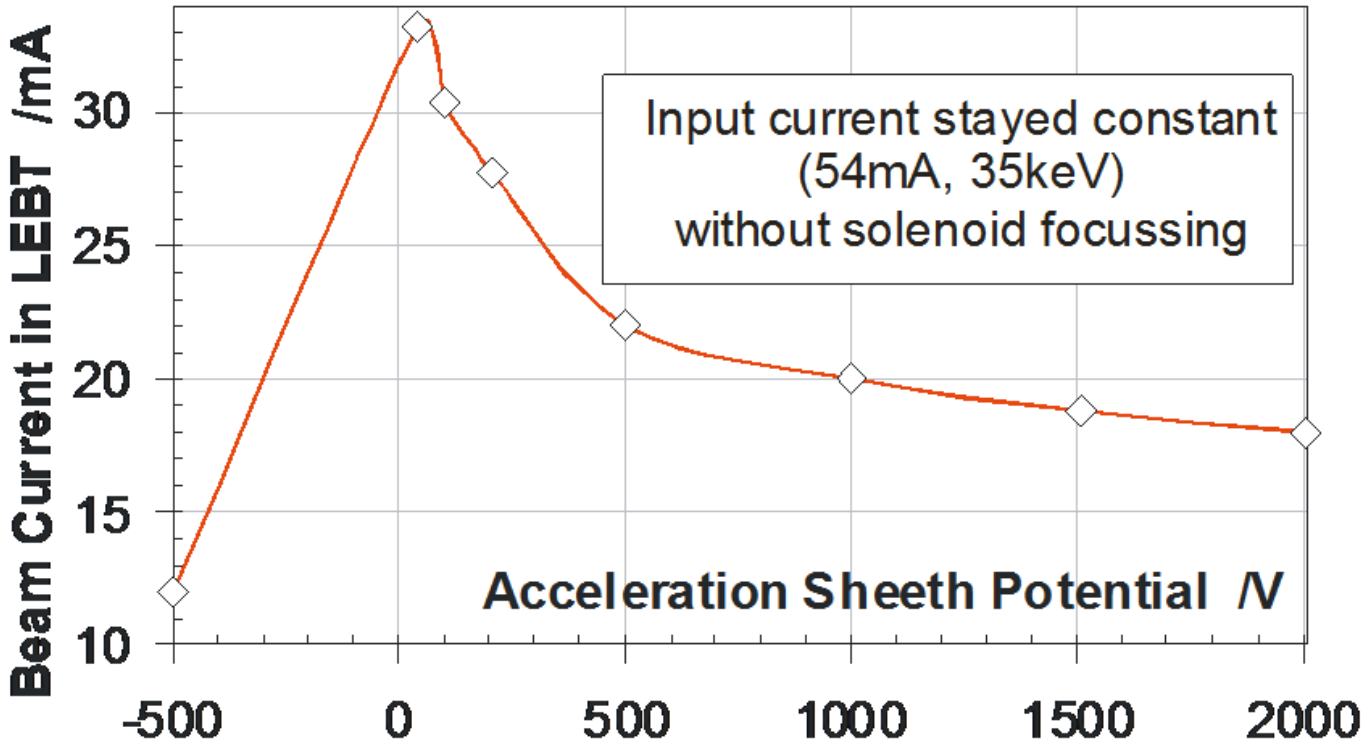
Variation of the suppression ring voltage to avoid penetrating others than photo detached electrons into FDC.

Different background signals vs. beam energy



Detector chosen to negate signal at 35keV beam energy.

Influence of the detector ("jacket", acceleration sheath) on the transmission of the beam.



Influence of the detector to the transported beam current.