A NEW SYSTEM FOR MONITORING TRANSVERSE BEAM PROFILES

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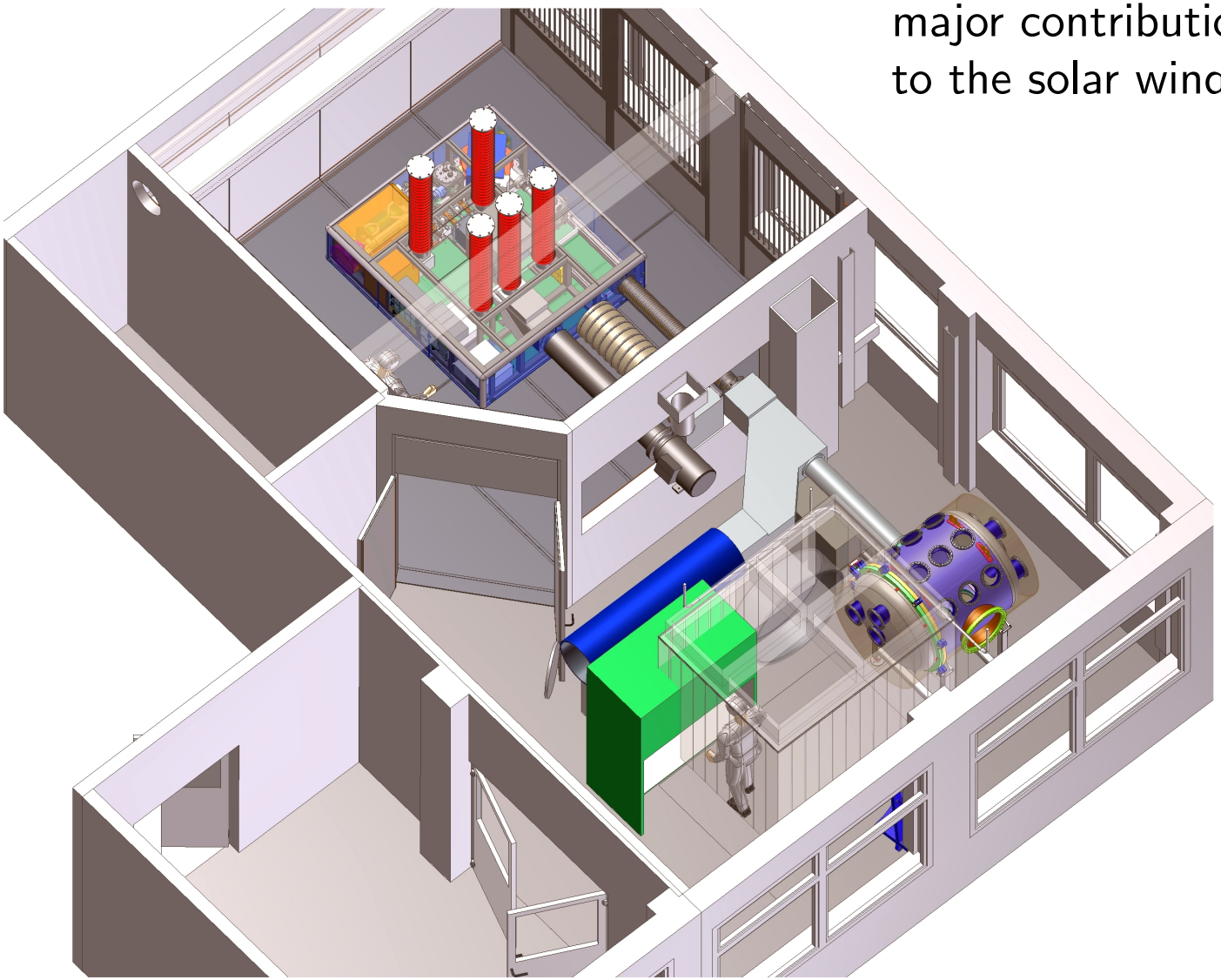
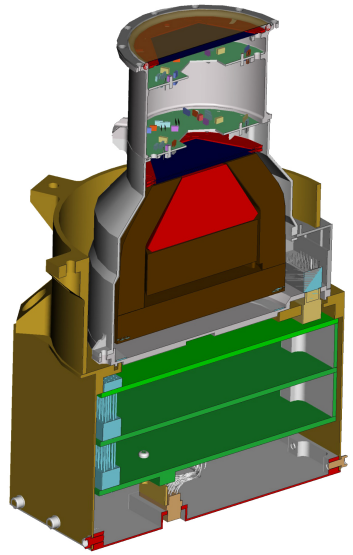
Solar Wind Calibration Laboratory

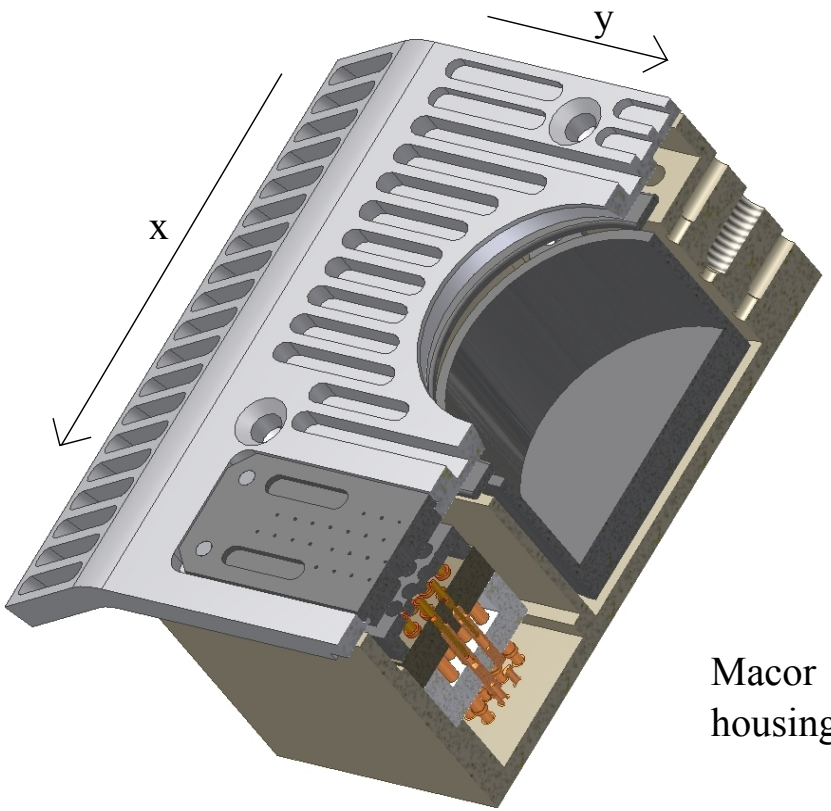


major contributions of ion species to the solar wind:

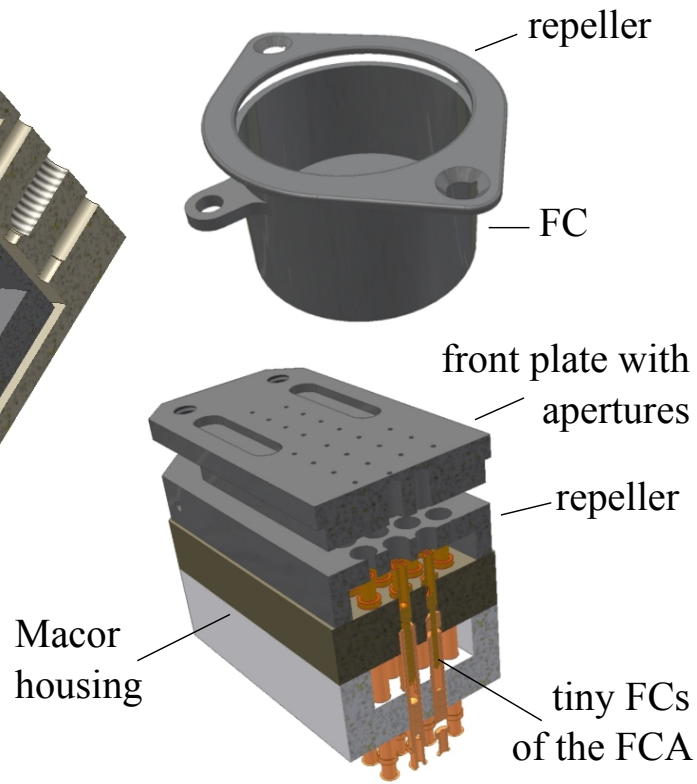
- H^+
- He^+ - He^{2+}
- C^{4+} - C^{6+}
- O^{6+} - O^{8+}
- Ne^{8+}
- Mg^{10+}
- Si^{8+} - Si^{9+}
- Fe^{6+} - Fe^{16+}



Mechanical Design



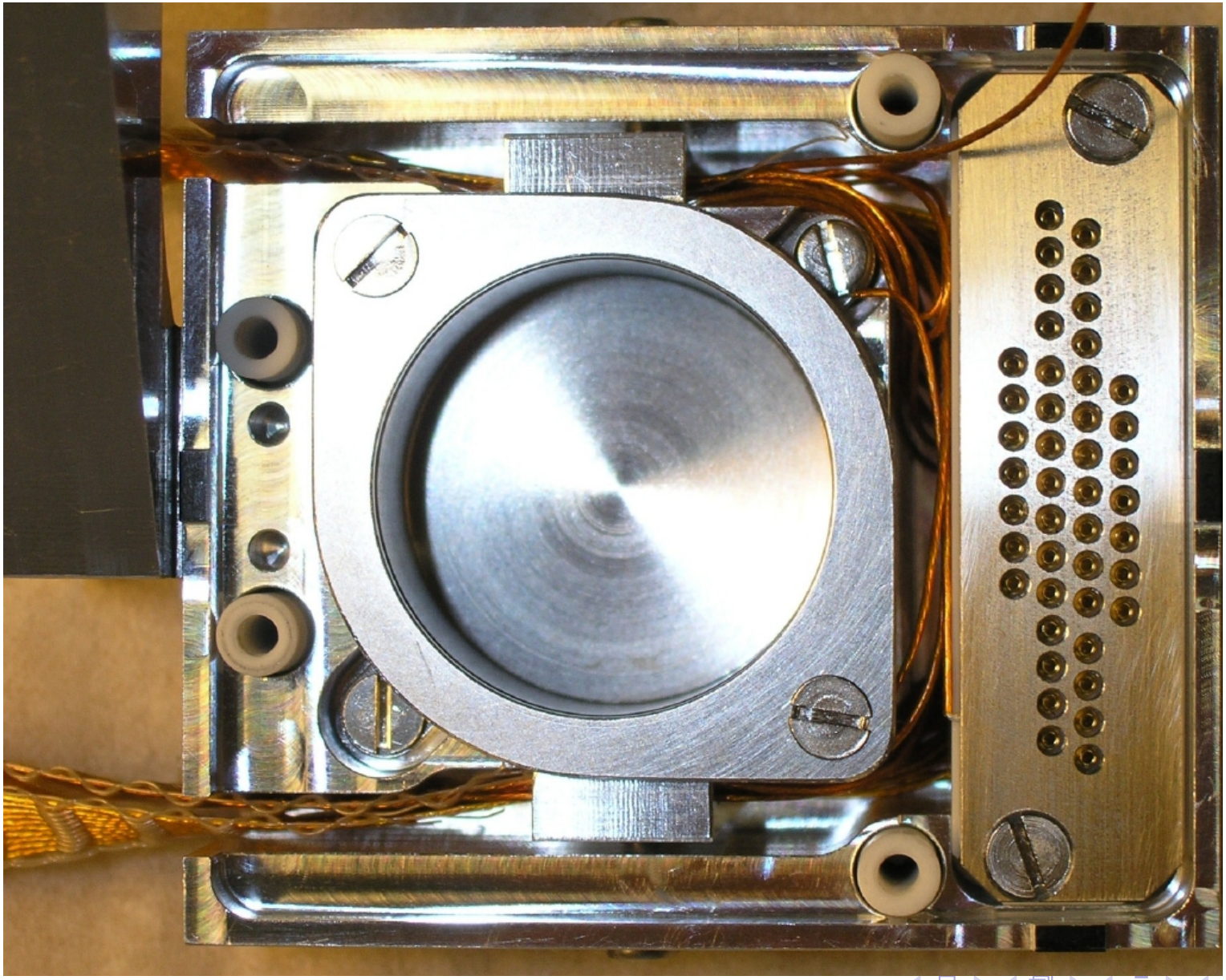
cut view of the detector
with mounted front cover



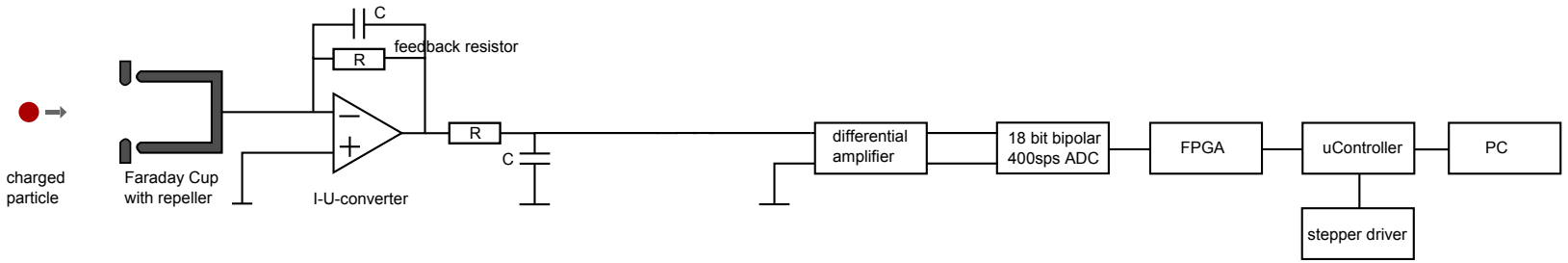
detection hardware in detail

[Panitzsch et al., 2009, Rev.Sci.Instrum.]
doi:10.1063/1.3246787

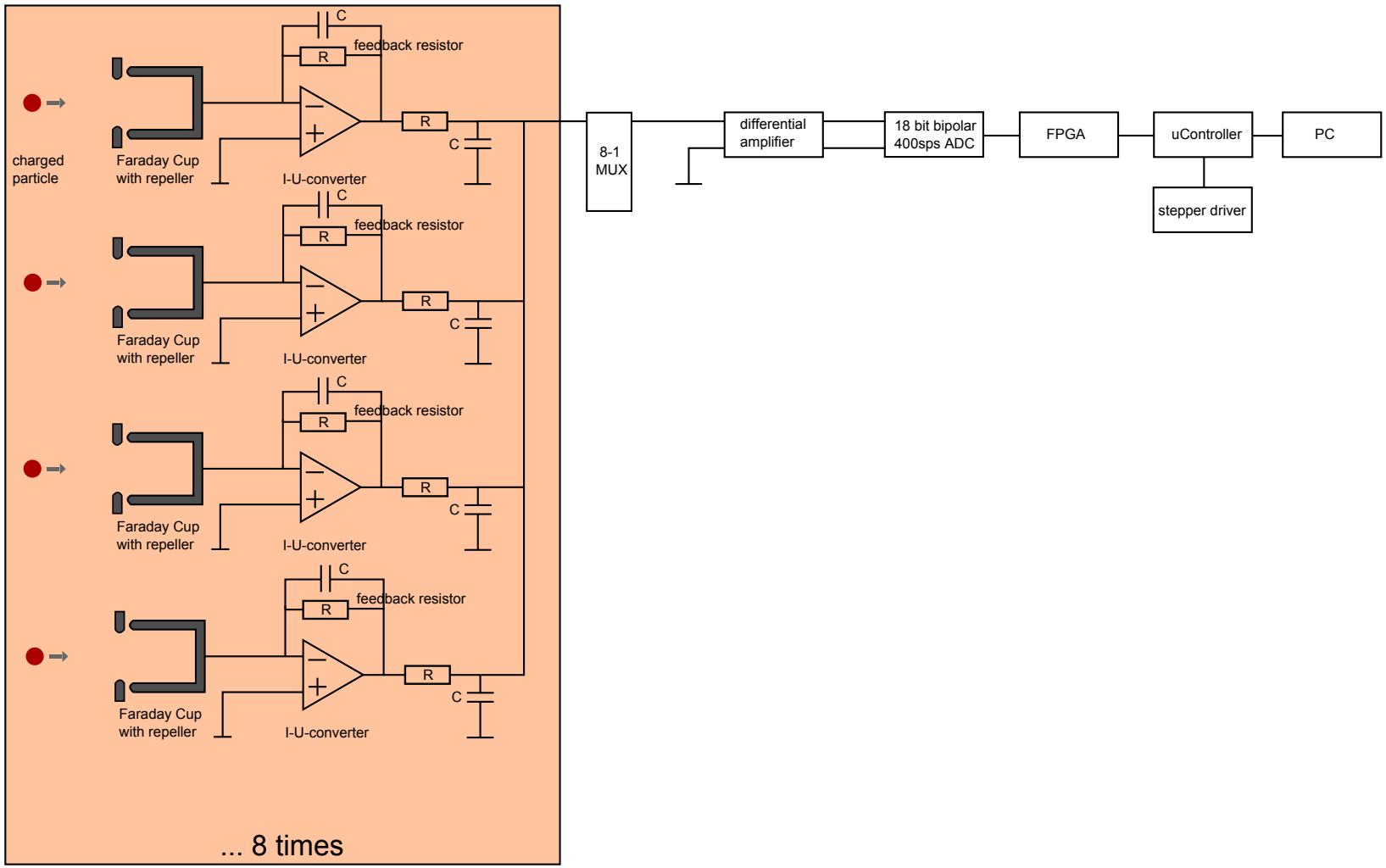
Assembled Detector without Front-Plate



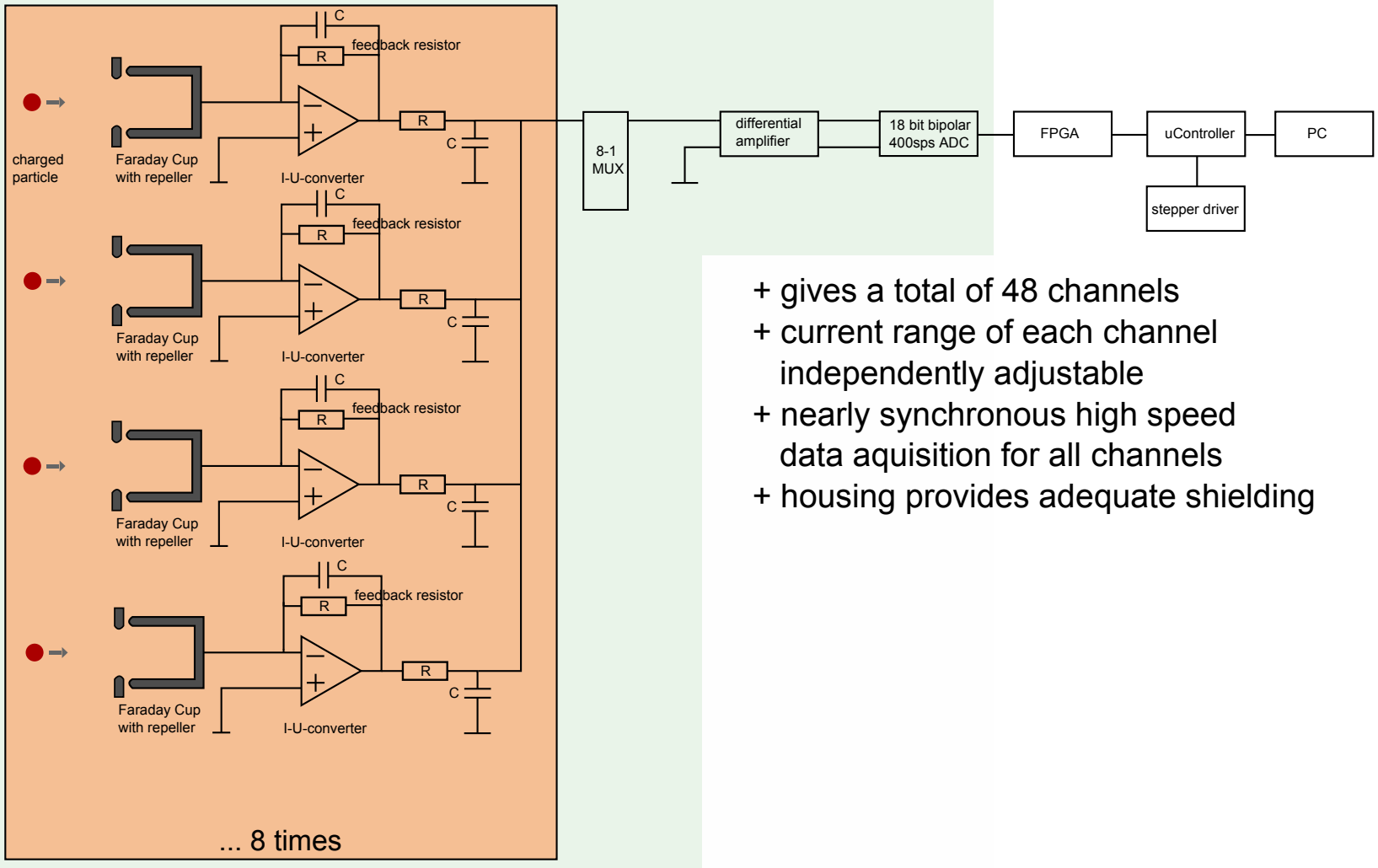
Basic Circuit



1^{st} Iteration

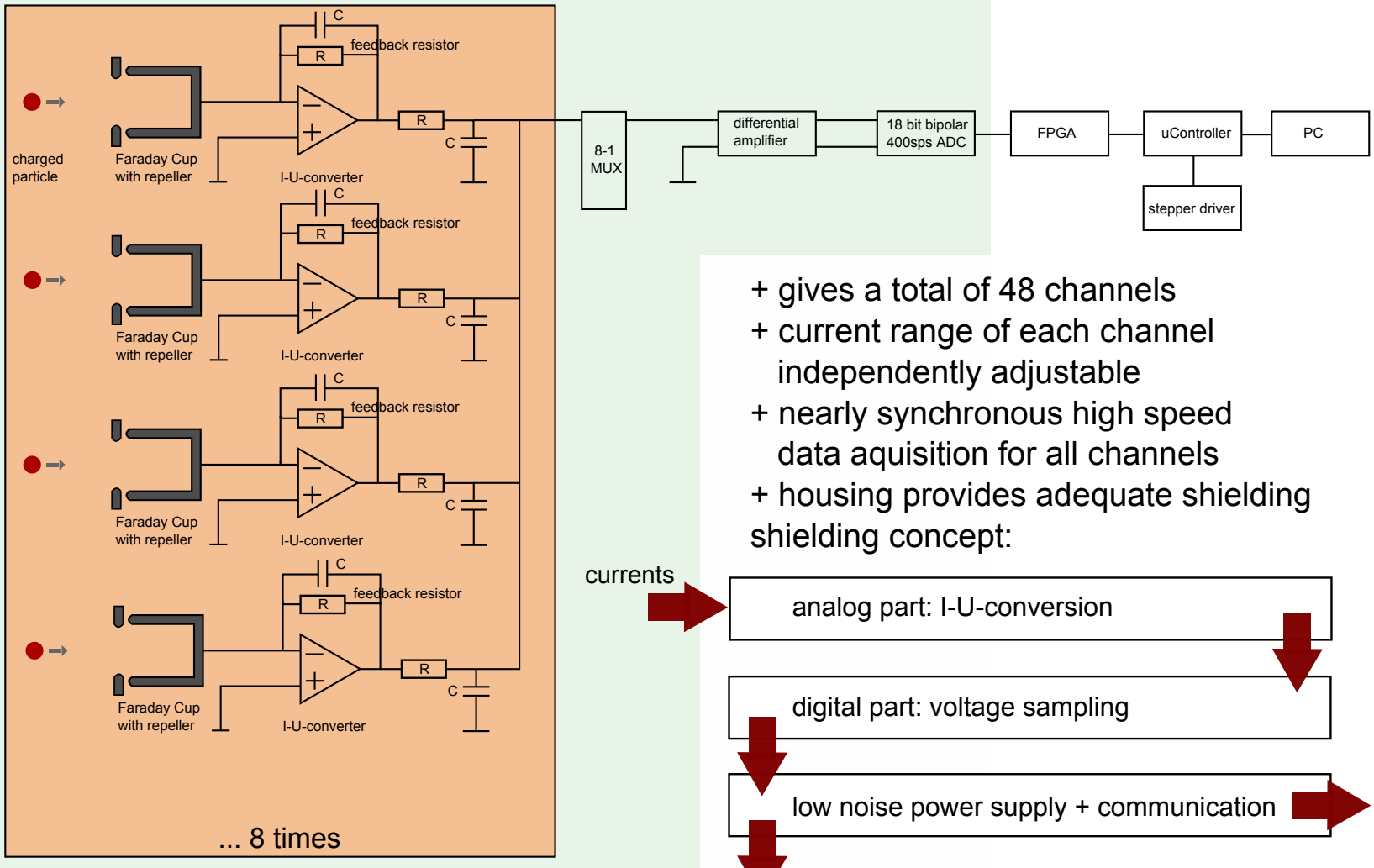


2^{nd} Iteration



+ gives a total of 48 channels
+ current range of each channel independently adjustable
+ nearly synchronous high speed data aquisition for all channels
+ housing provides adequate shielding

Electronic Design Summary



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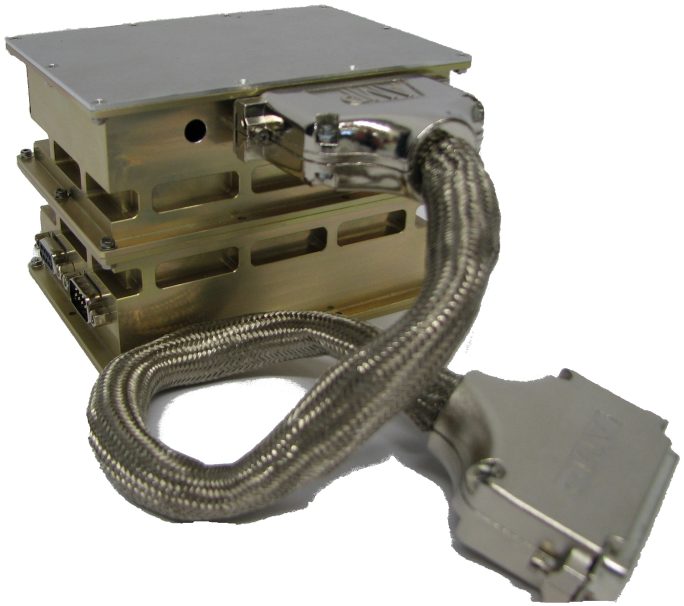
shielding concept:

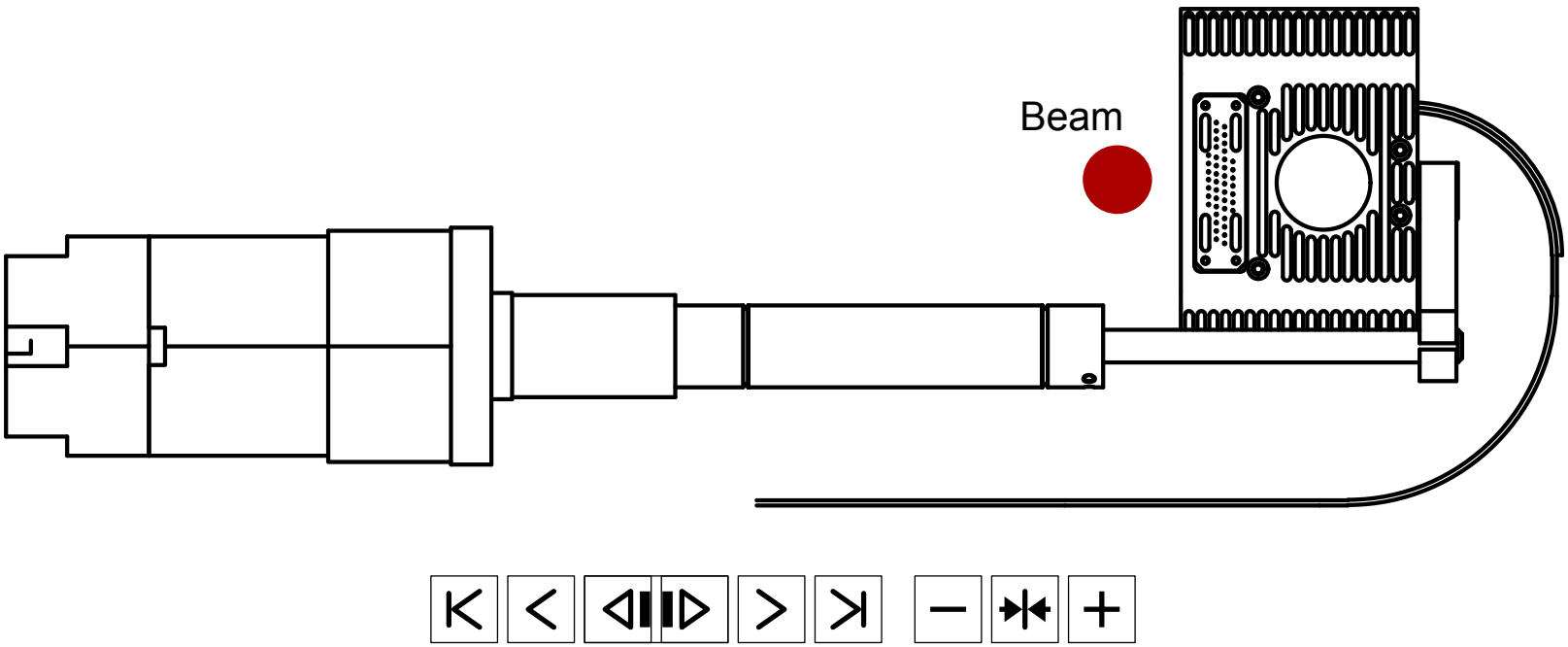
currents

Detector Hardware



Above: Aluminum housing containing the complete electronics (analog, digital, supply, communication, stepper driver);
Right: Vacuum-sided hardware (detector with blinds)

Realtime Animation of Profile Scans



Faraday Cup Array (FCA)

Characteristics:

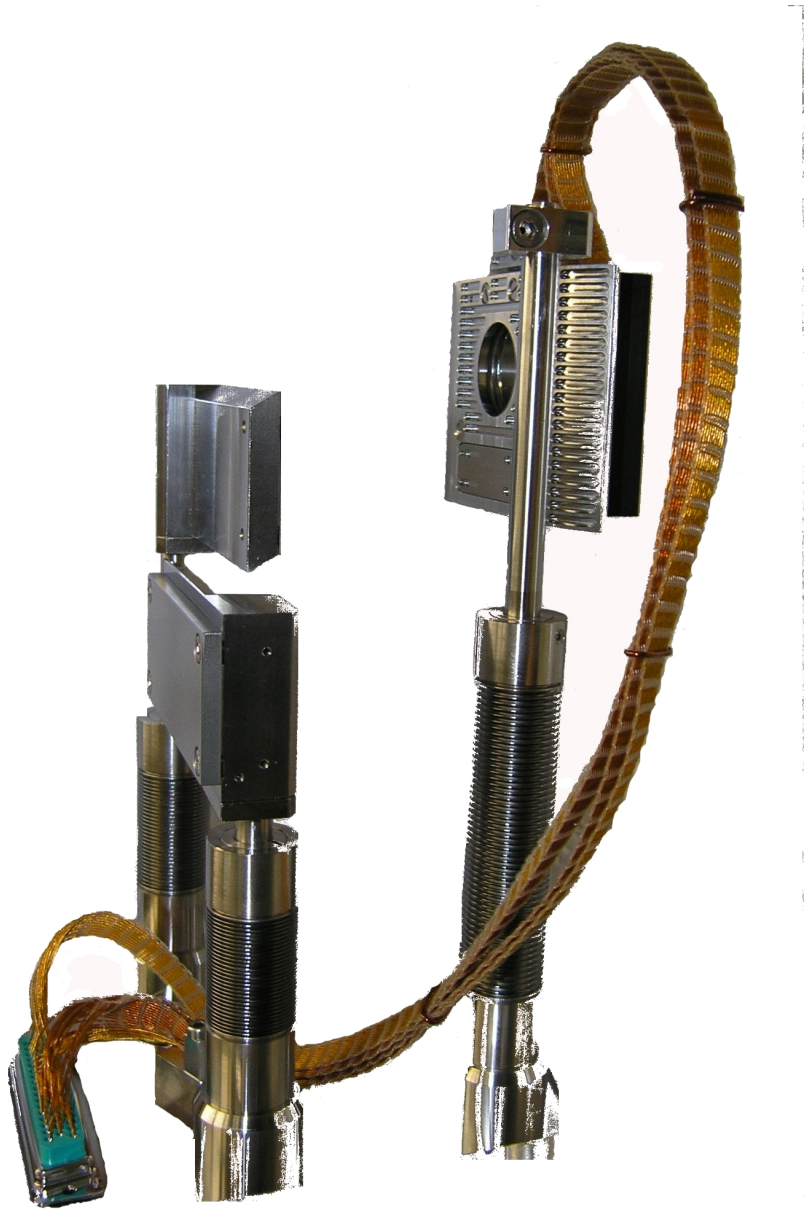
- FC & FCA in one detector
  $\rightarrow$ profile & total current measurable
- direct measurement with suppression of secondary electron escape
- high durability: up to 40 W of beam power
- fast system: 5 s per profile scan (stepper-limited)

Detector hardware:

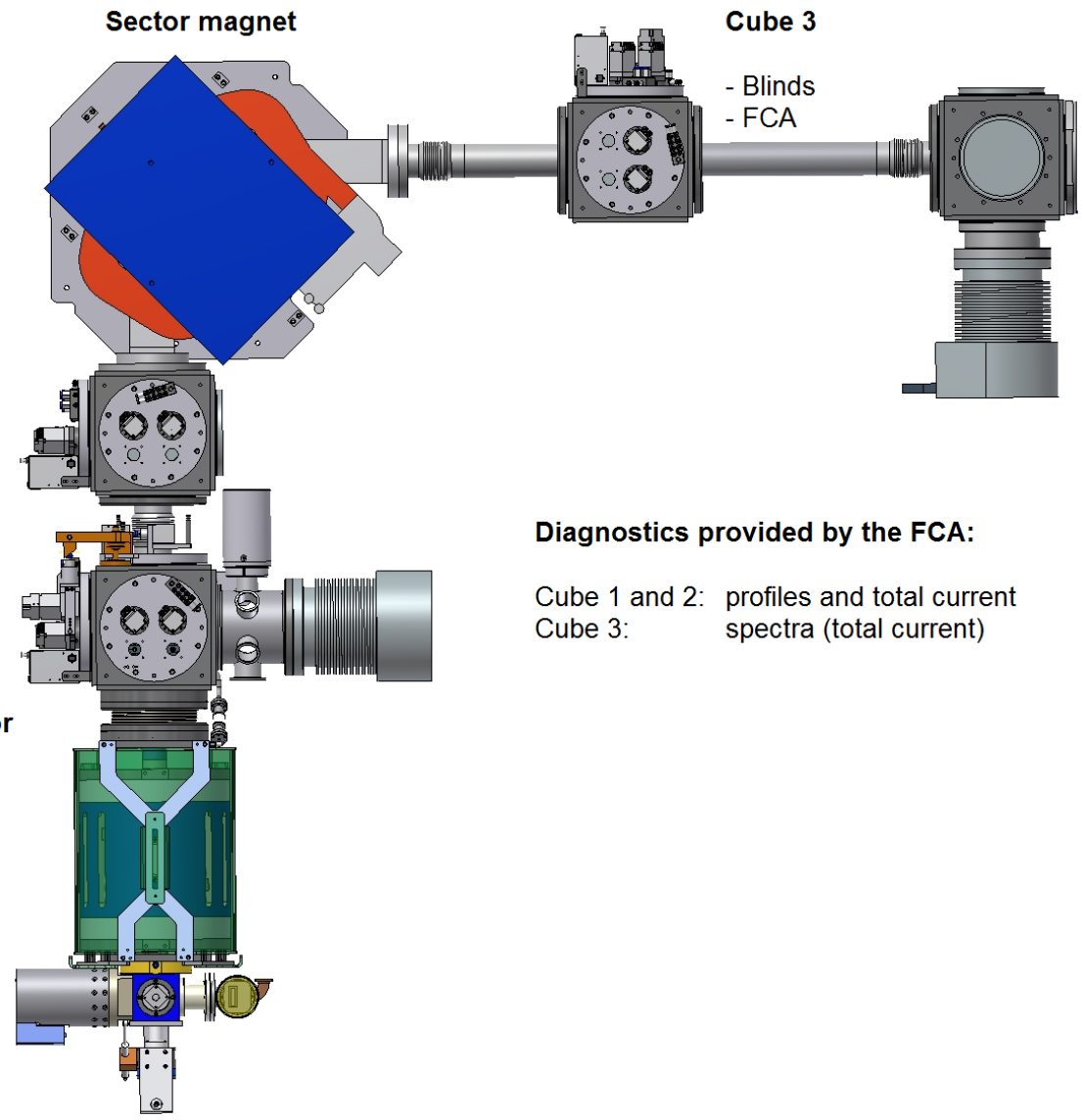
- spatial resolution:
  22 x 20 measurements/cm^2
- scanned area: 45 x 30 mm^2 (30 mm fix)
- detection of structures on mm-scale

Detector electronics (present configuration):

- large dynamic range: 50 pA $\rightarrow$ 5 μA
  $\rightarrow$ high sensivity at absolute current values
- ranges from 200 nA/cm^2 to 20 mA/cm^2 (if $P_{beam} < 40$ W)



Placements of the FCAs (and Beam Line)

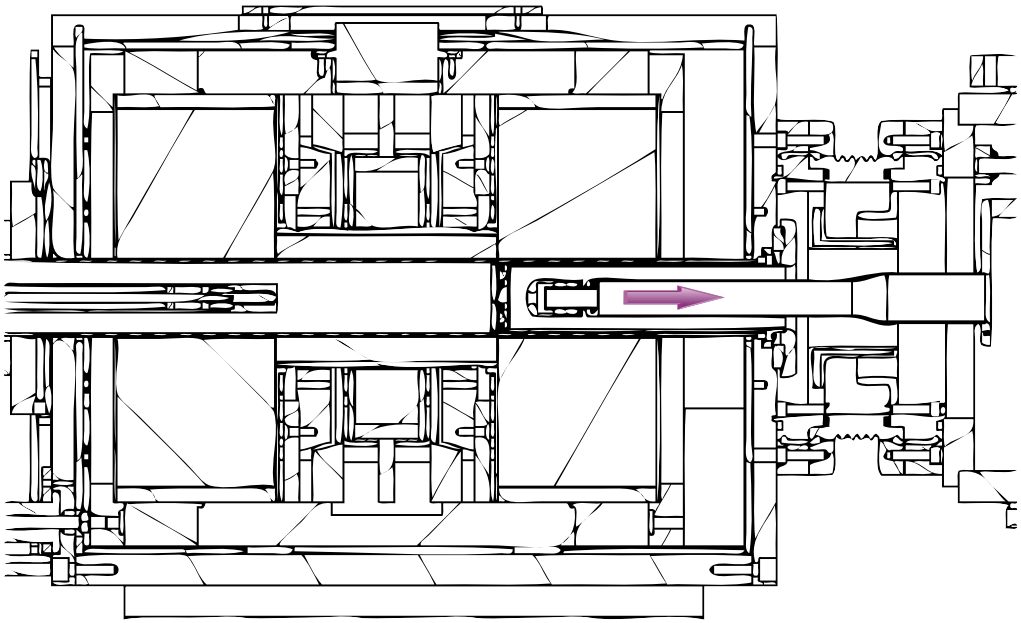


Diagnostics provided by the FCA:

Cube 1 and 2: profiles and total current
Cube 3: spectra (total current)

Ion Beam Focussing

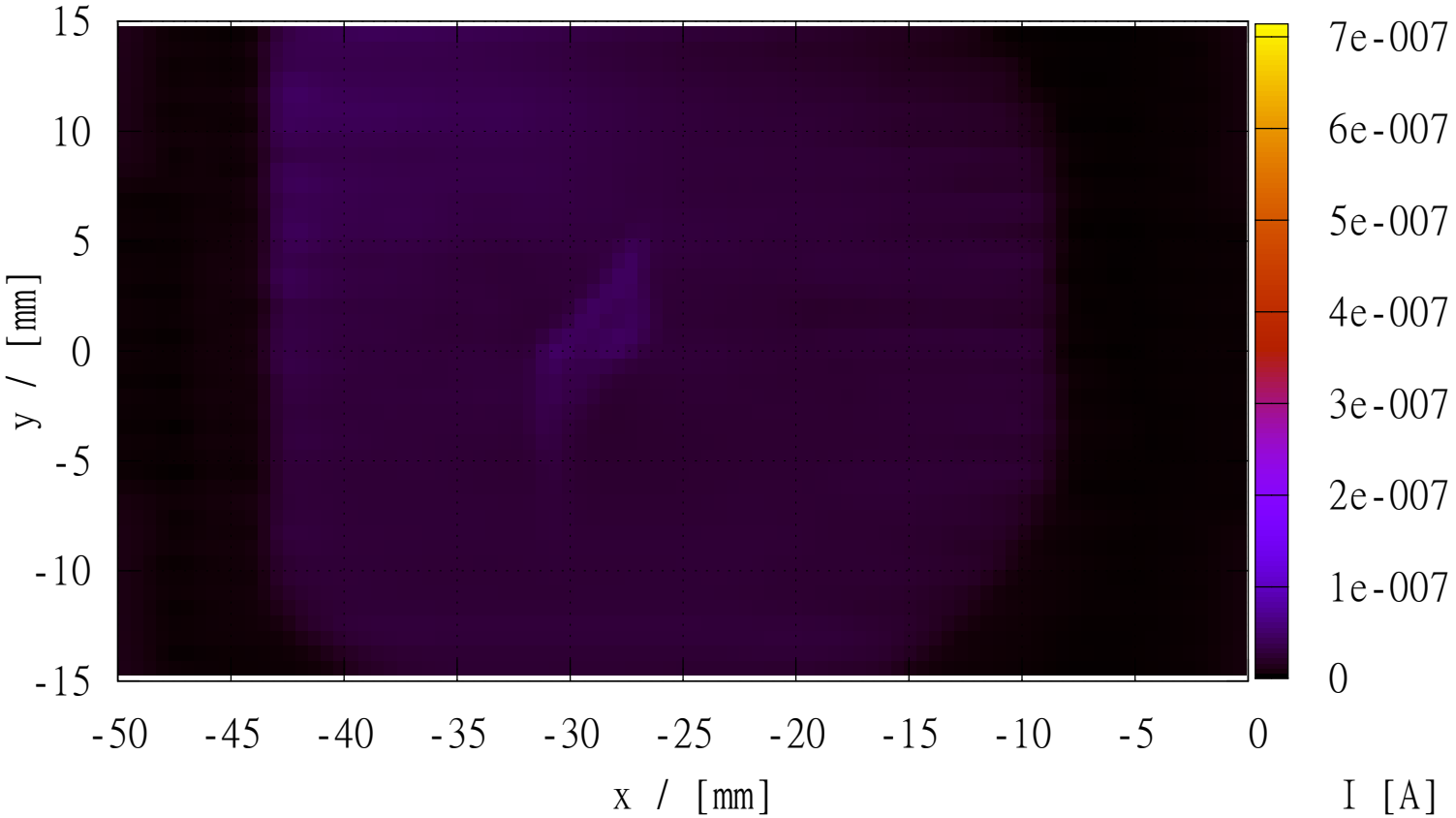
Procedure



Source Settings

pressure inside plasma chamber	p_{ECR}	1.0×10^{-5} mbar
microwave power	$P_{\mu w}$	50 W
microwave frequency	$f_{\mu w}$	11 GHz
extraction voltage	U_E	15 kV (test 1) from 13 to 2 kV (test 2)
extraction position perpend. to beam line	d_{Ep}	central
extraction position along beam line	d_{Ea}	from 5 to 25 mm (test 1) 25 mm (test 2)

Ion Beam Focussing by Moving the Extraction (Coaxial)



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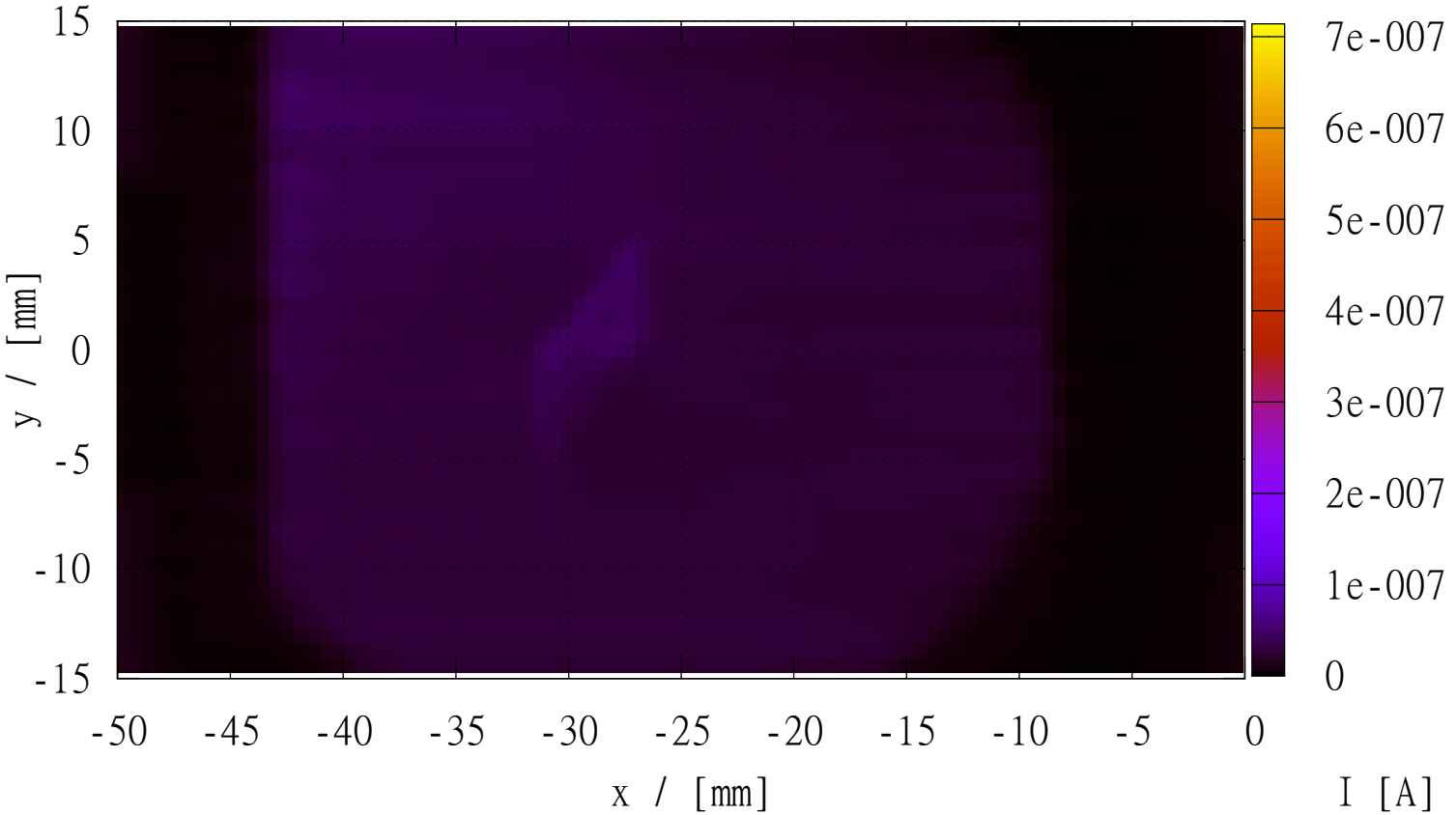
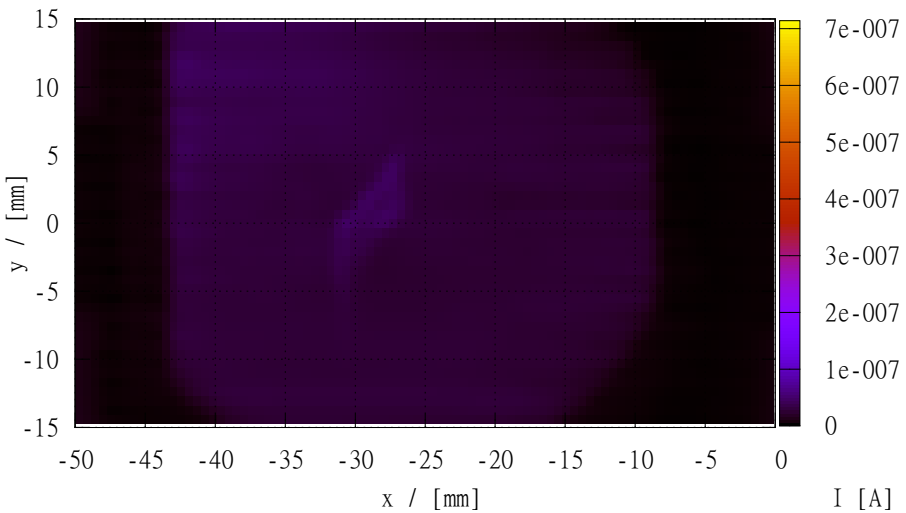


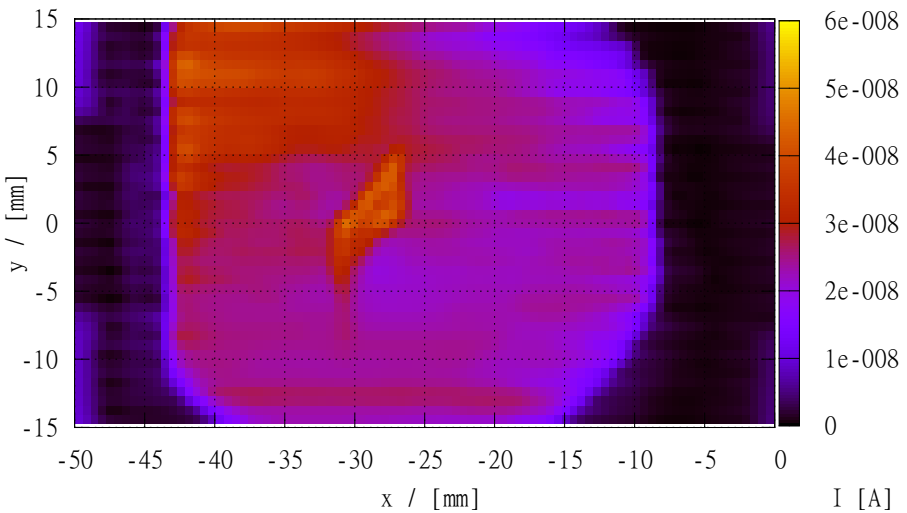
Ion Beam Focussing by Moving the Extraction (Coaxial)

The extraction is moved im mm-steps starting at a distance of 5 mm to the plasma electrode ending at a distance of 25 mm.

same scale:



full scale:



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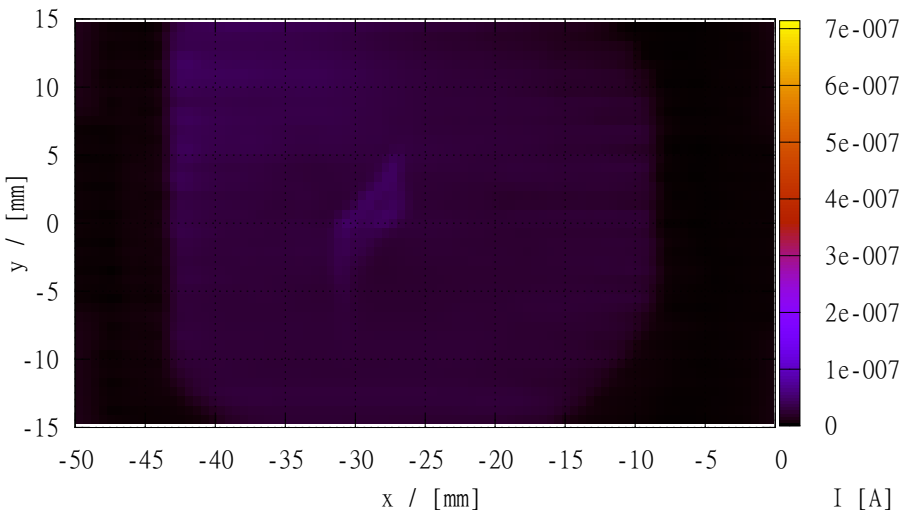

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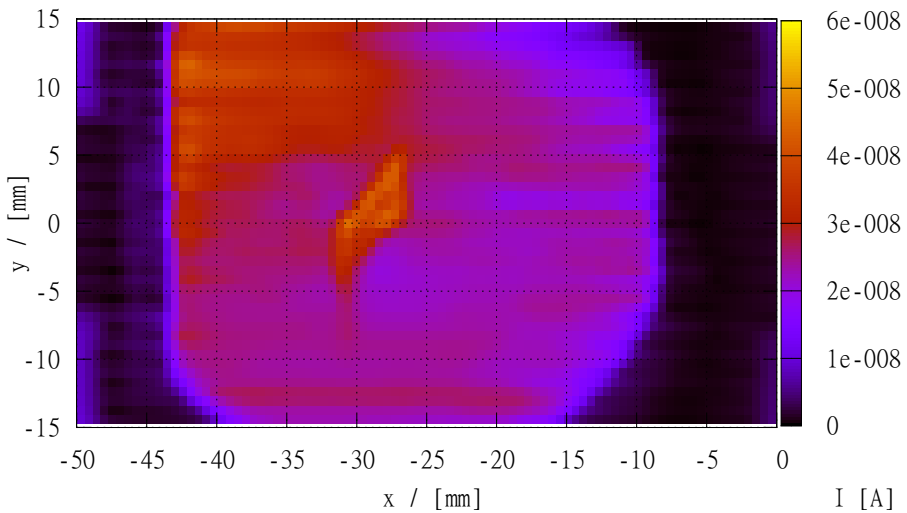
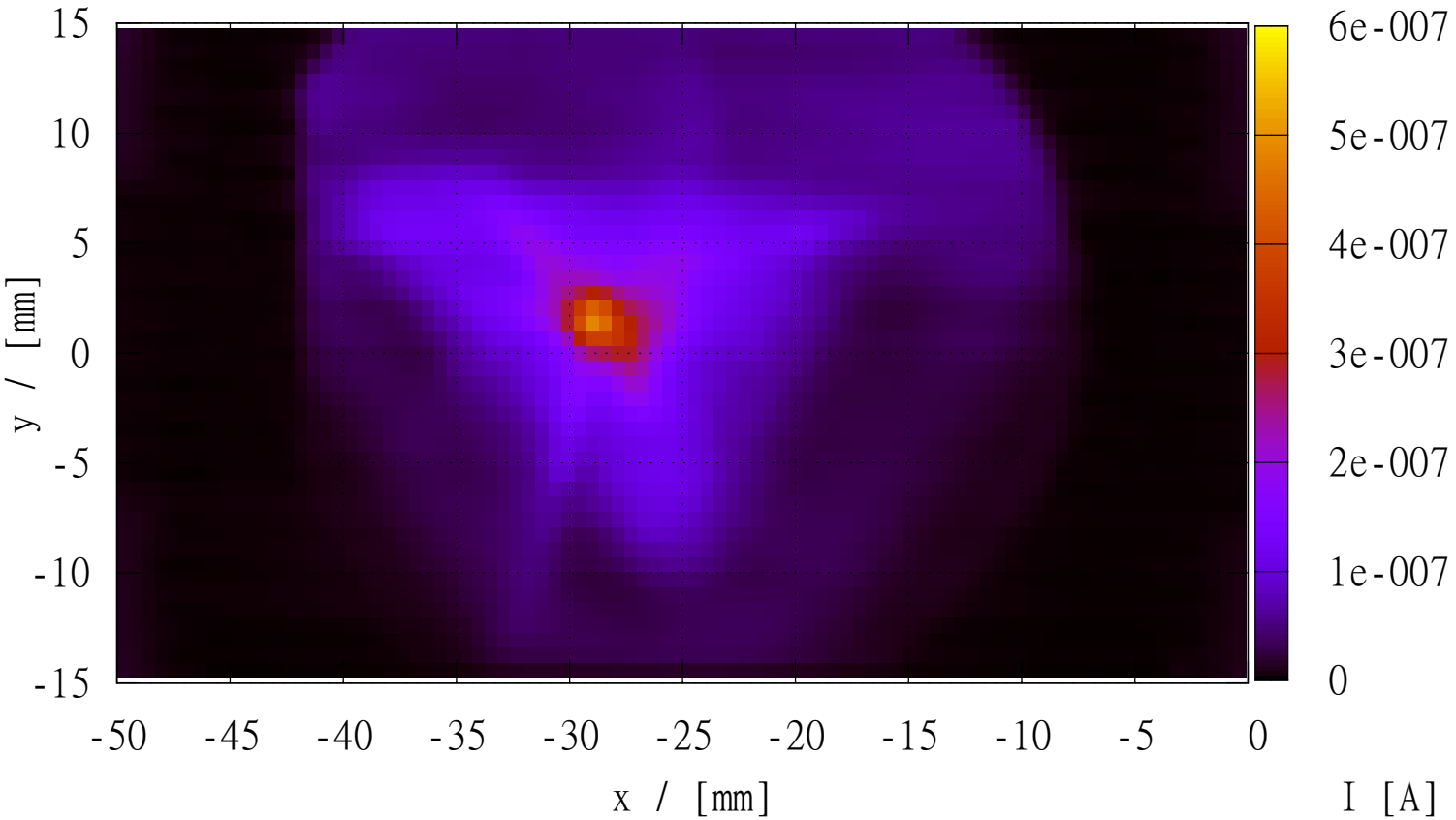


Ion Beam Focussing by Varying the Extraction Voltage



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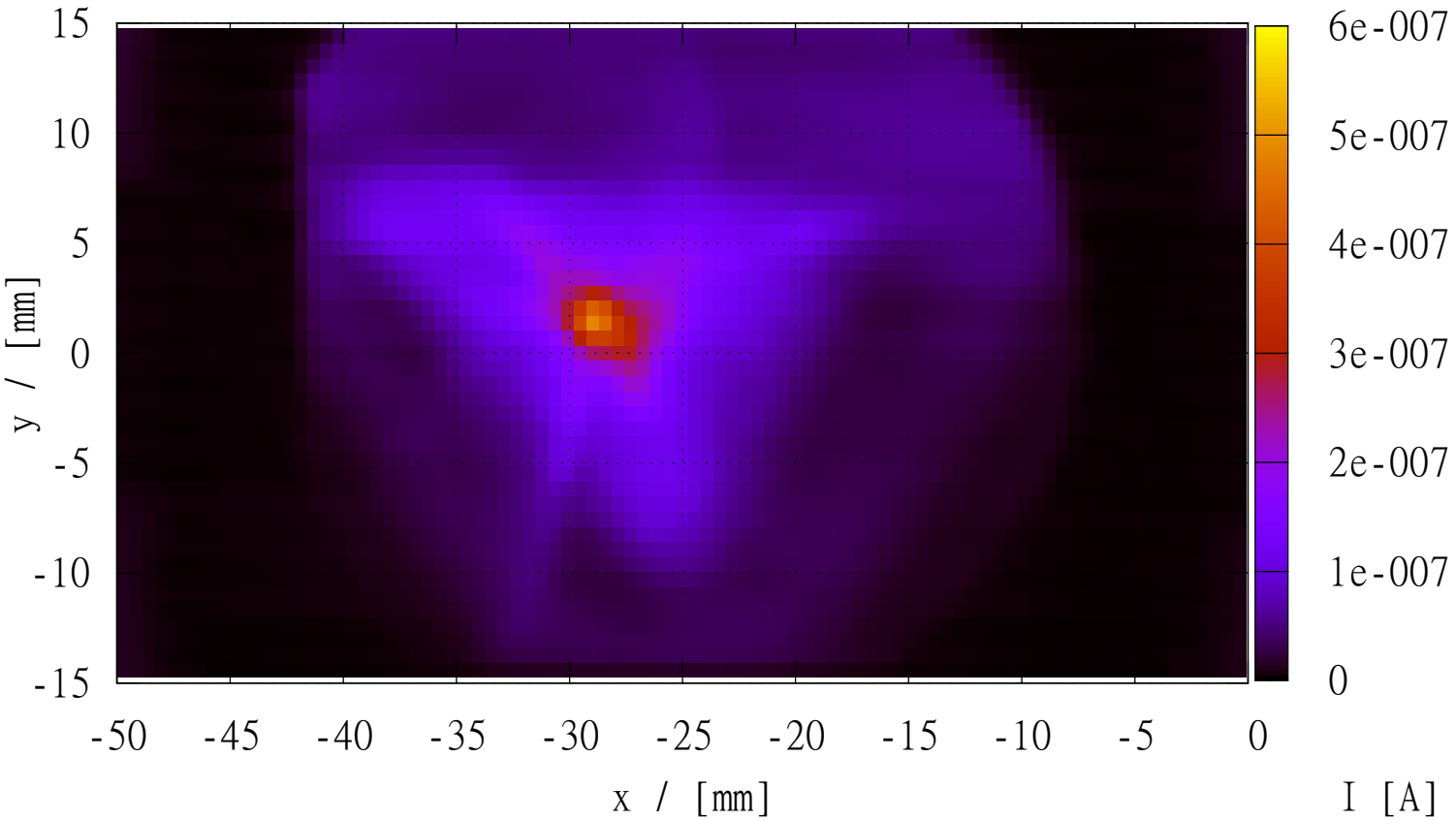
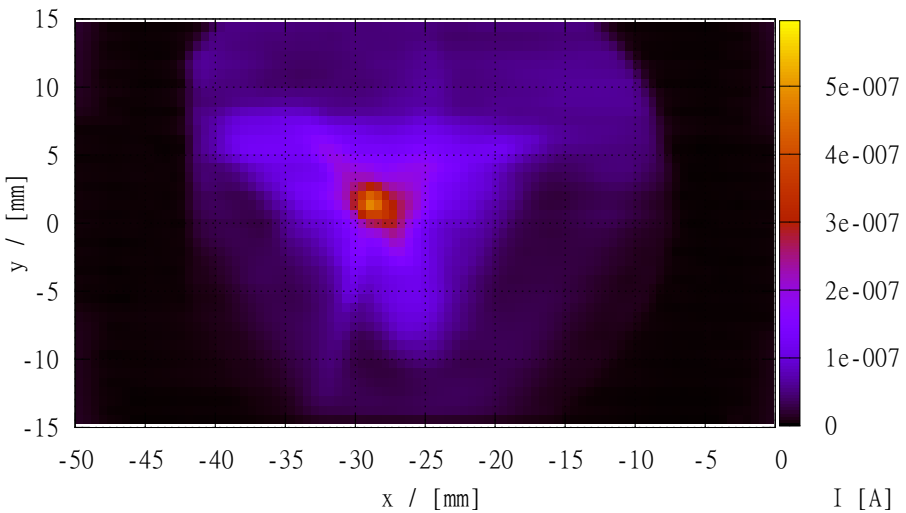


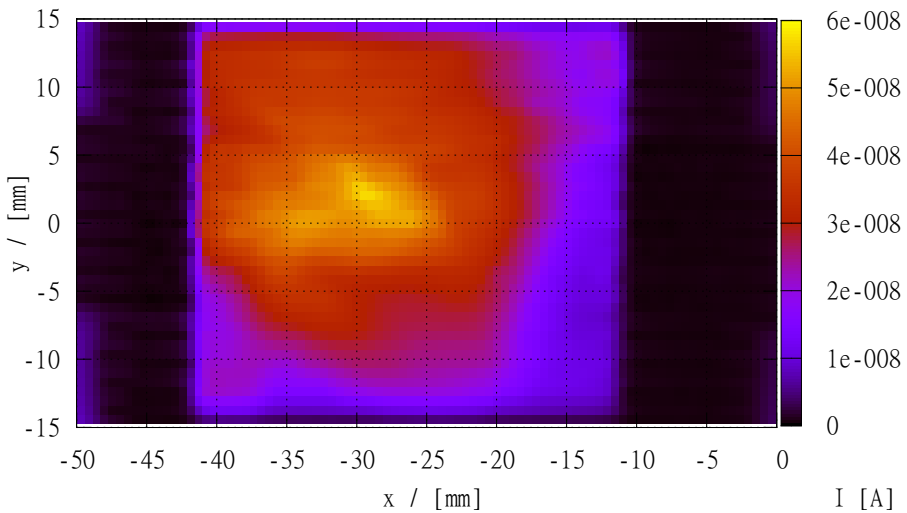
Ion Beam Focussing by Varying the Extraction Voltage

The extraction voltage is lowered in 1 kV-steps starting at a voltage of 13 kV, ending at 2 kV.

cube 1:



cube 2:



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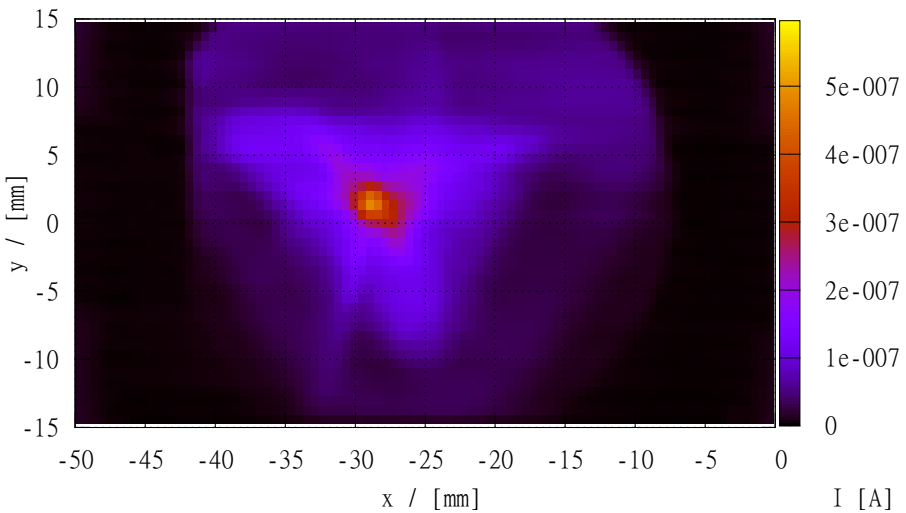

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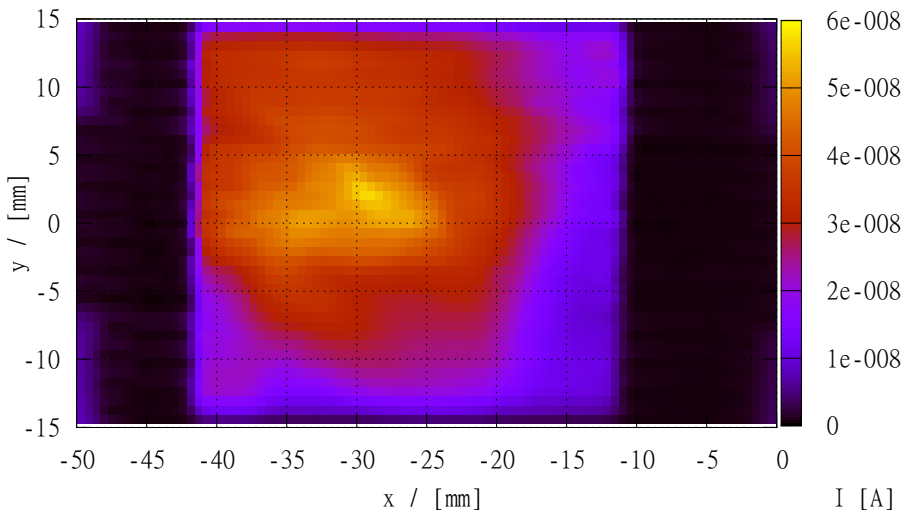
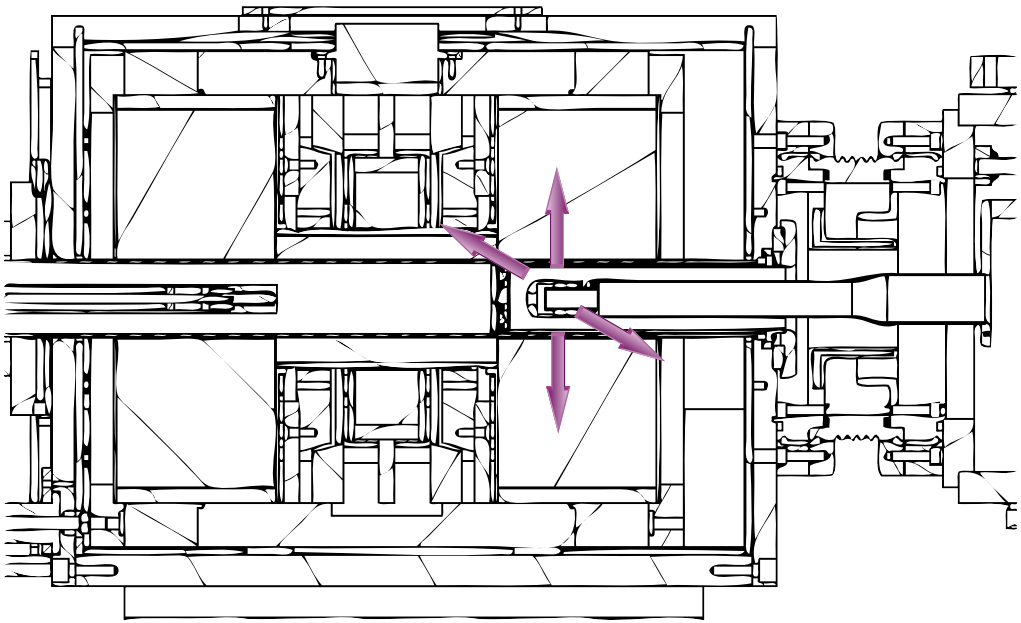


Ion Beam Steering

Procedure



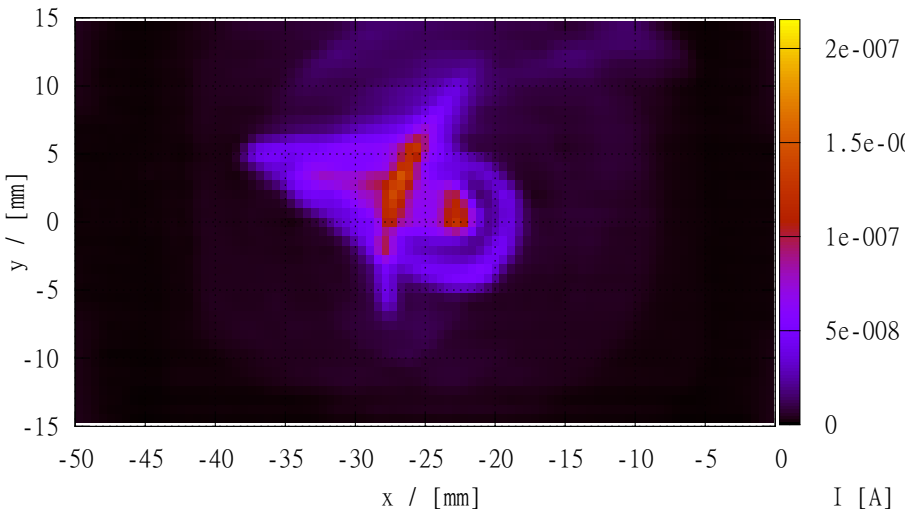
Source Settings

pressure inside plasma chamber	p_{ECR}	1.0×10^{-5} mbar
microwave power	$P_{\mu w}$	50 W
microwave frequency	$f_{\mu w}$	11 GHz
extraction voltage	U_E	6 kV
extraction position perpend. to beam line	d_{Ep}	variable
extraction position along beam line	d_{Ea}	25 mm

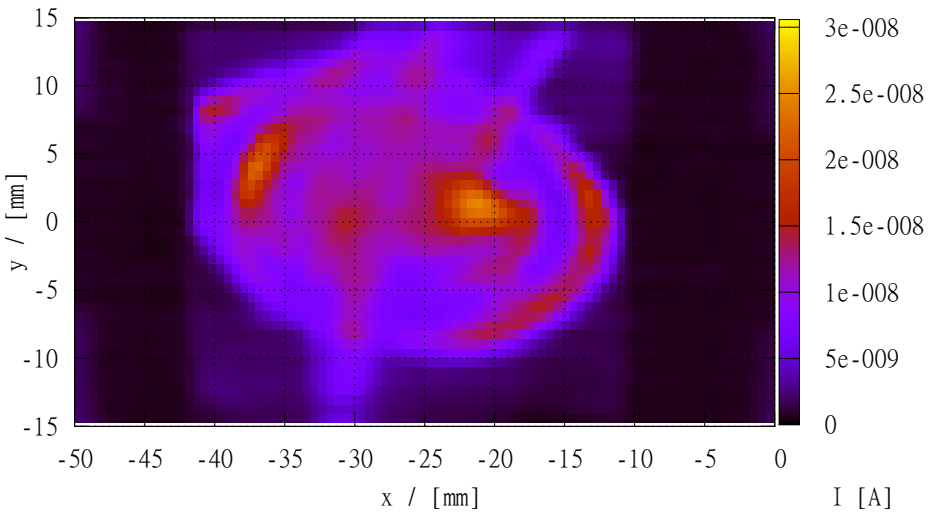
Ion Beam Steering

extraction moving horizontally
0.5 mm per step

cube 1:



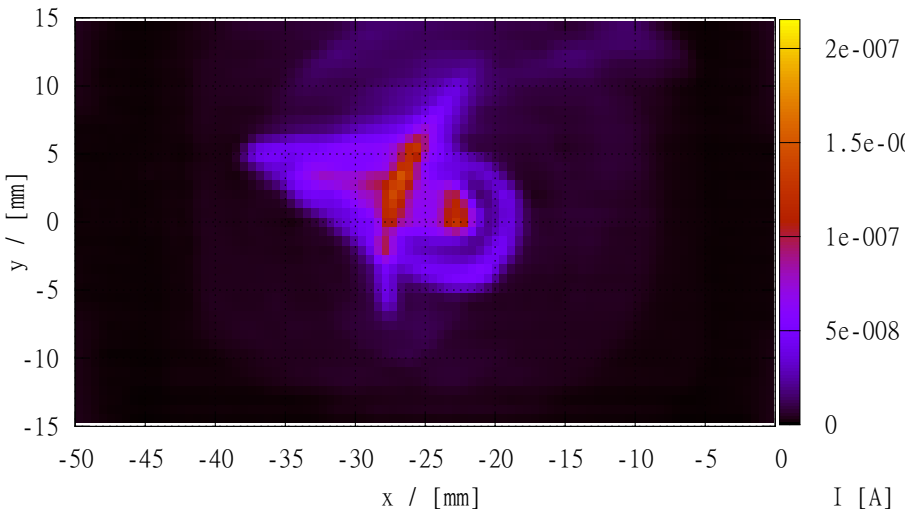
cube 2:



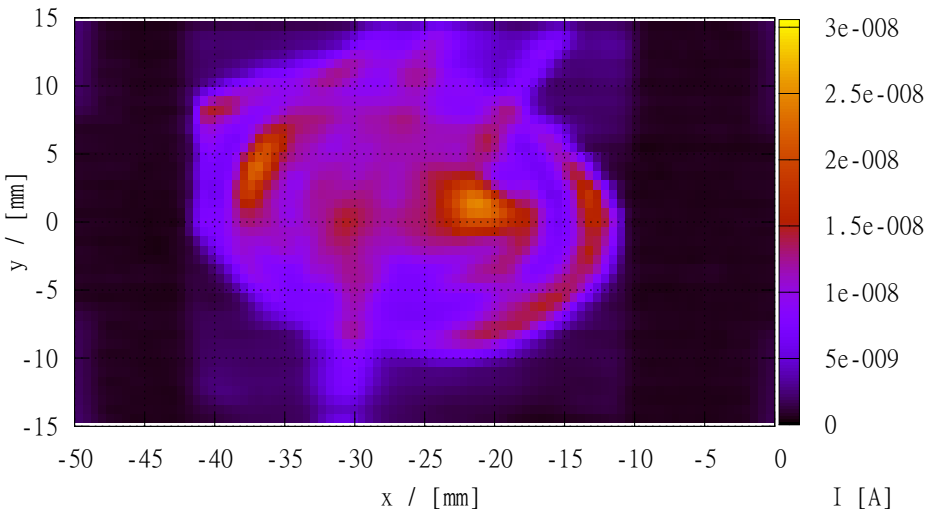
Ion Beam Steering

extraction moving horizontally
0.5 mm per step

cube 1:



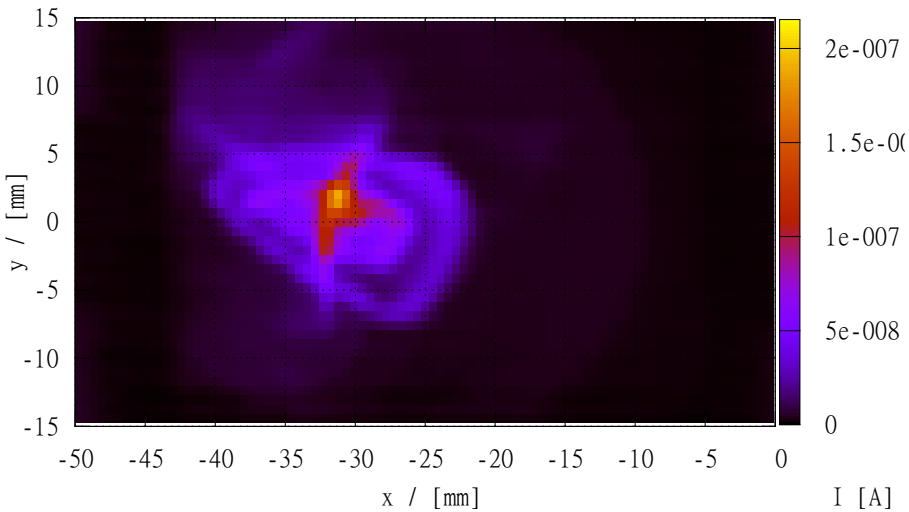
cube 2:



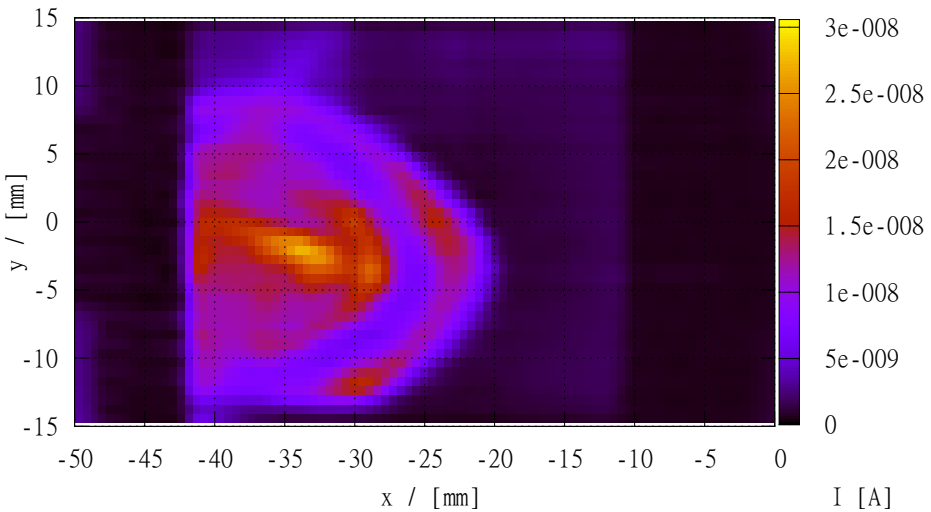
Ion Beam Steering

extraction moving vertically
0.5 mm per step

cube 1:



cube 2:



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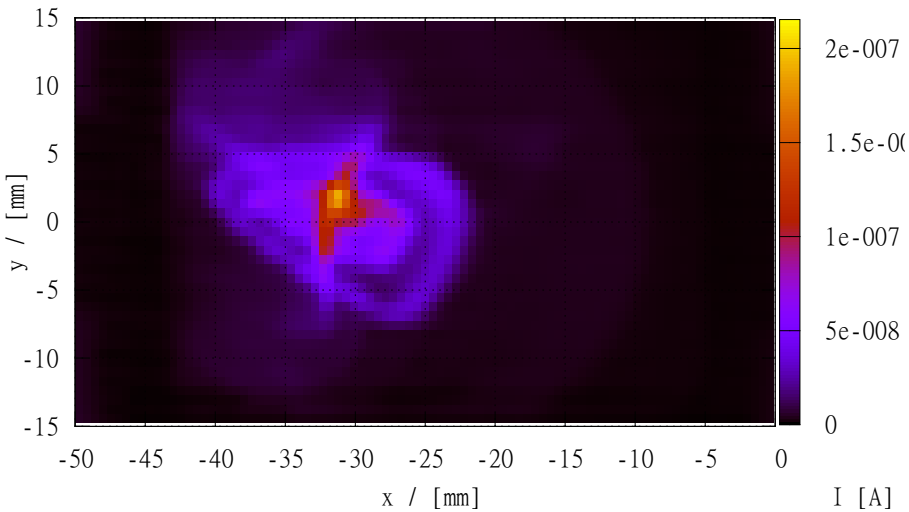

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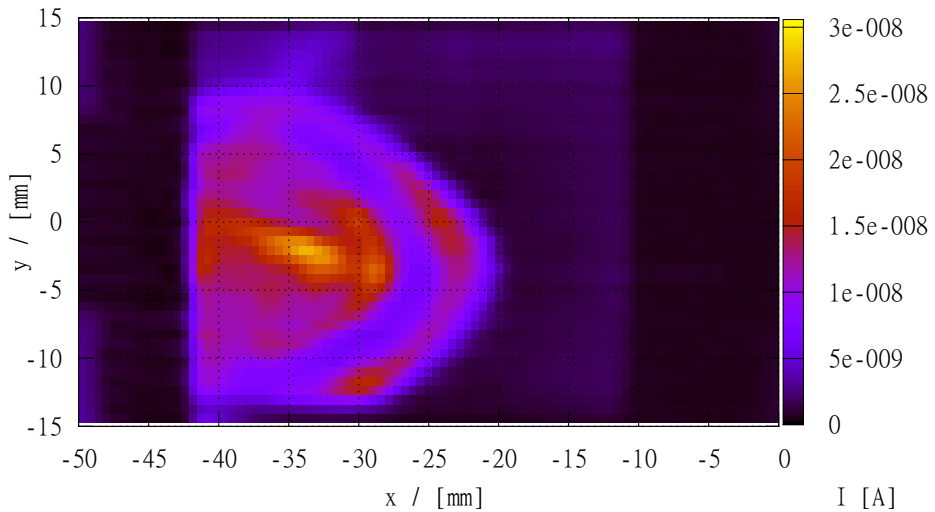
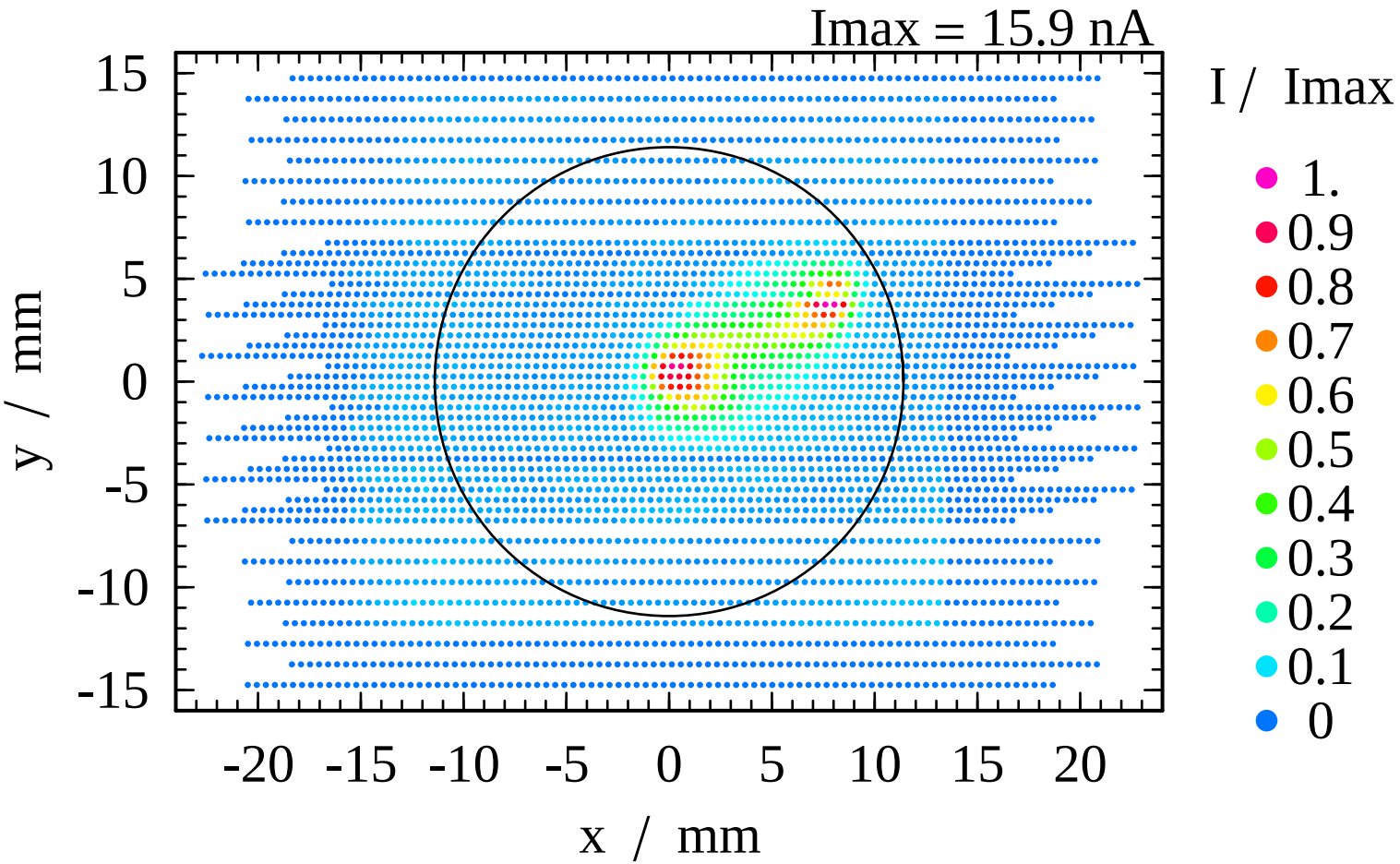
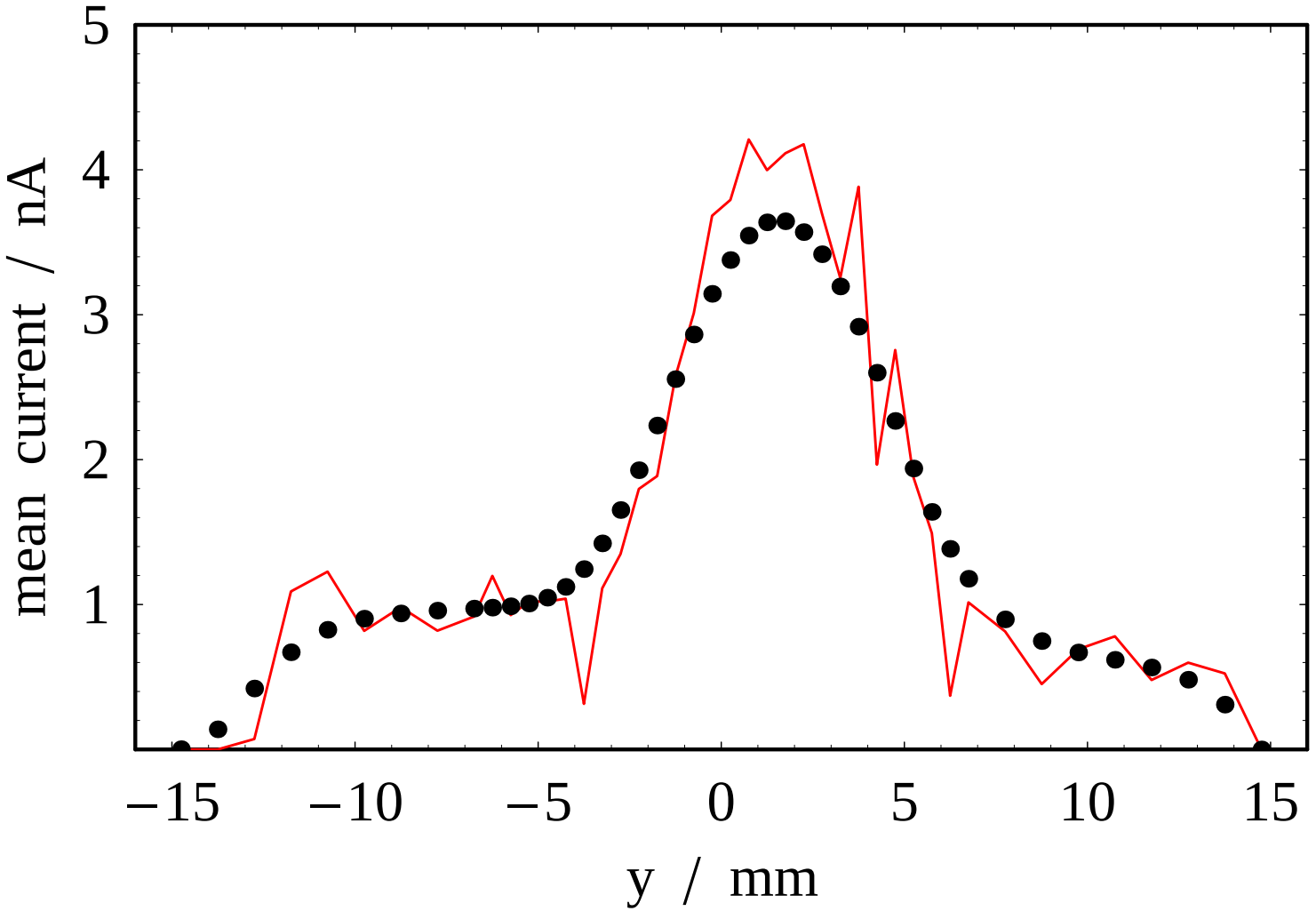


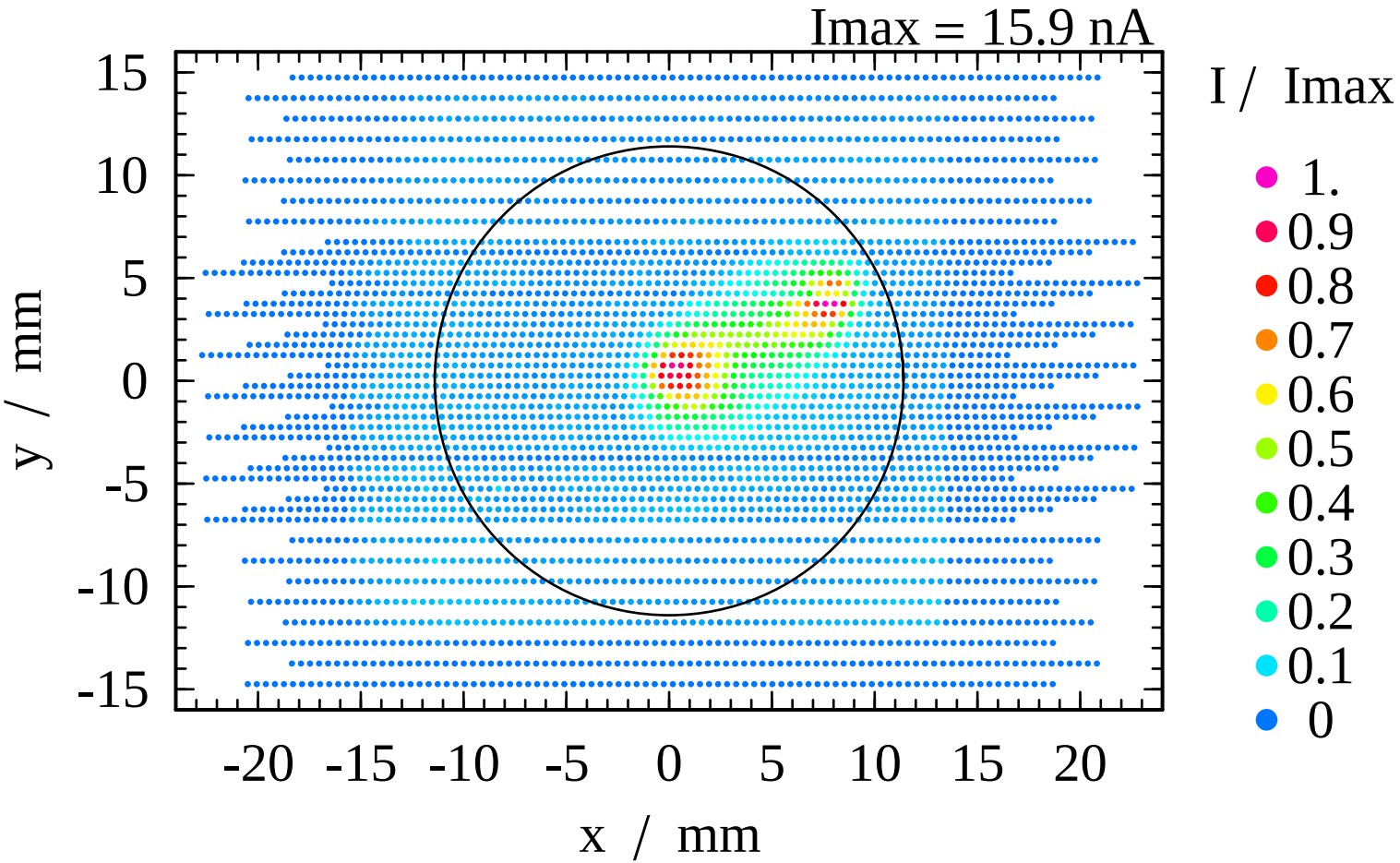
Original Profile in Discrete Representation



Cross Direction Profile (1D)



Comparison Between Corrected and Original Profile



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- high spatial resolution

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- applicable for positive and negative currents
(electron and ion beams)

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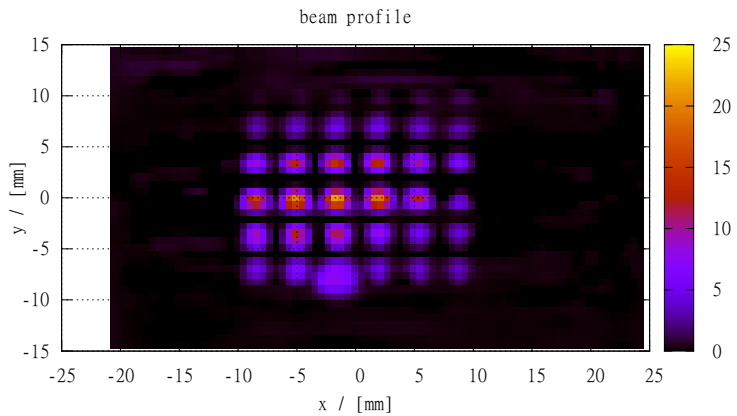

Beam profile with inserted pepper plate