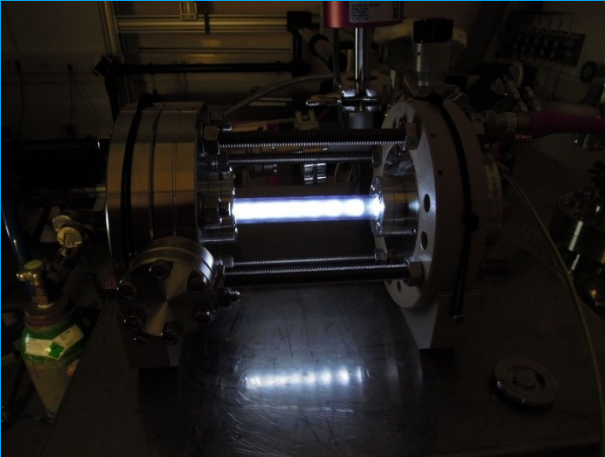


Gas discharge plasma cell performance.



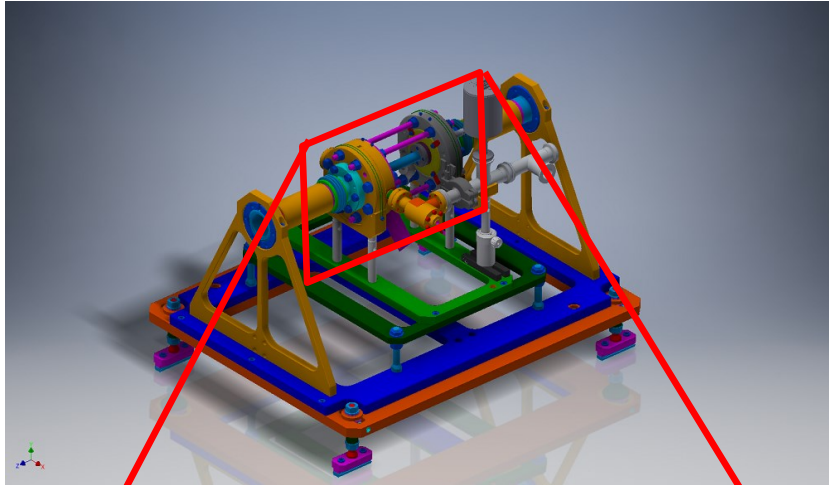
Gregor Loisch

PPS

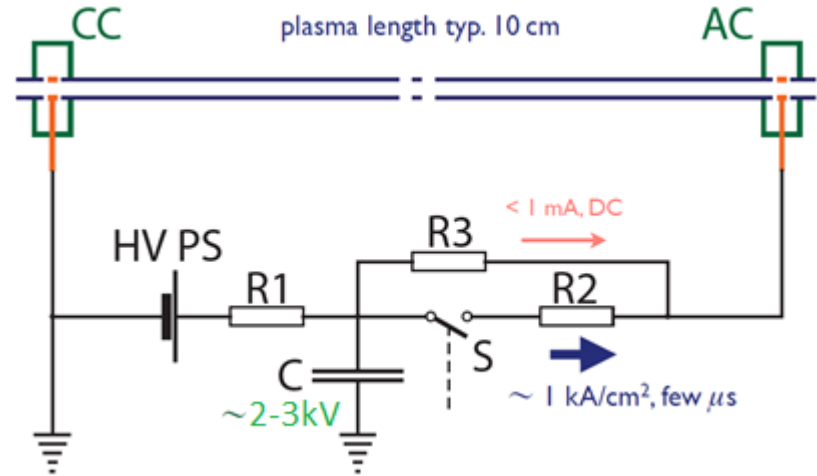
Zeuthen, 07.07.2016

1. Gas discharge plasma cell
2. Previous measurements
3. Electron density measurements
 - I. Procedure
 - II. Results
4. Gas discharge cell for beam experiments

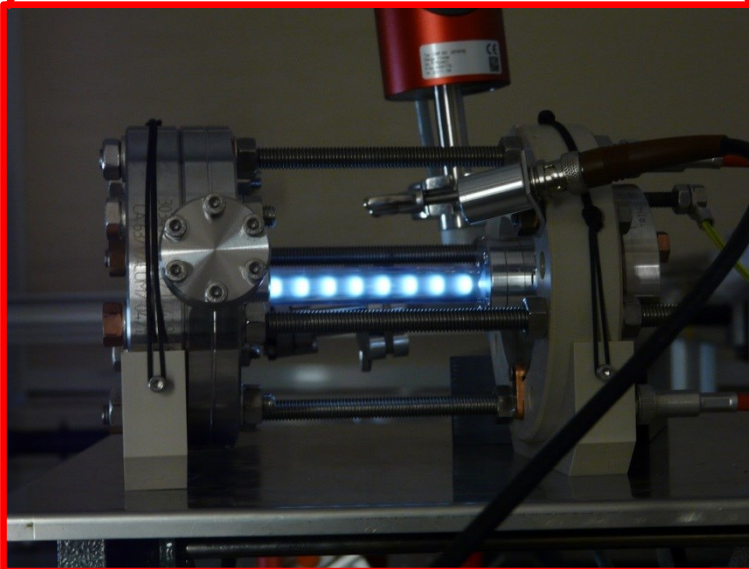
Reminder: Gas discharge plasma cell



Design of the discharge plasma cell



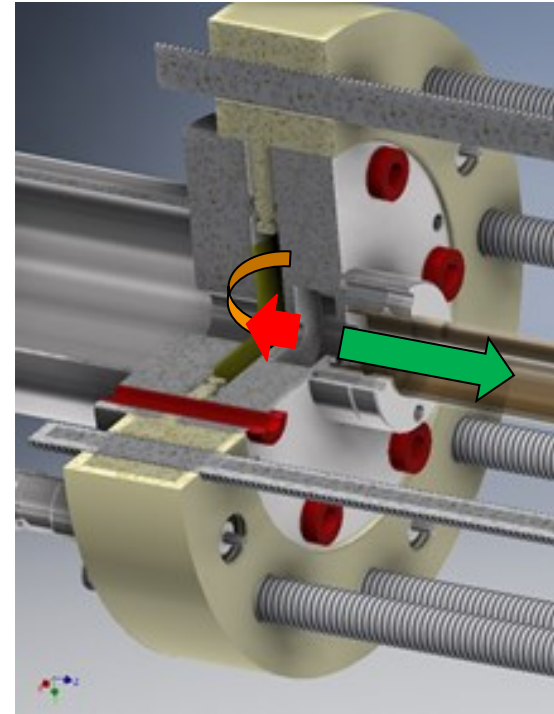
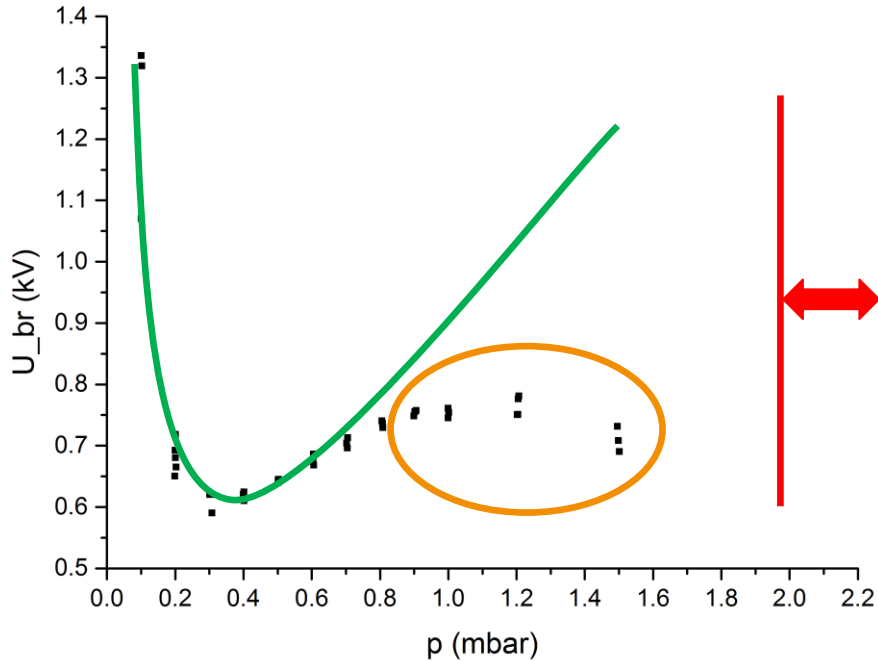
Layout of the discharge circuit



- > Cell for (any) plasma wakefield acceleration experiments
- > Gas (Ar, ~0.5-8 mbar) is pre-ionised with a (1-2 mA) glow discharge
- > Main arc discharge (100-550 A, ~6 μ s) when switch closes

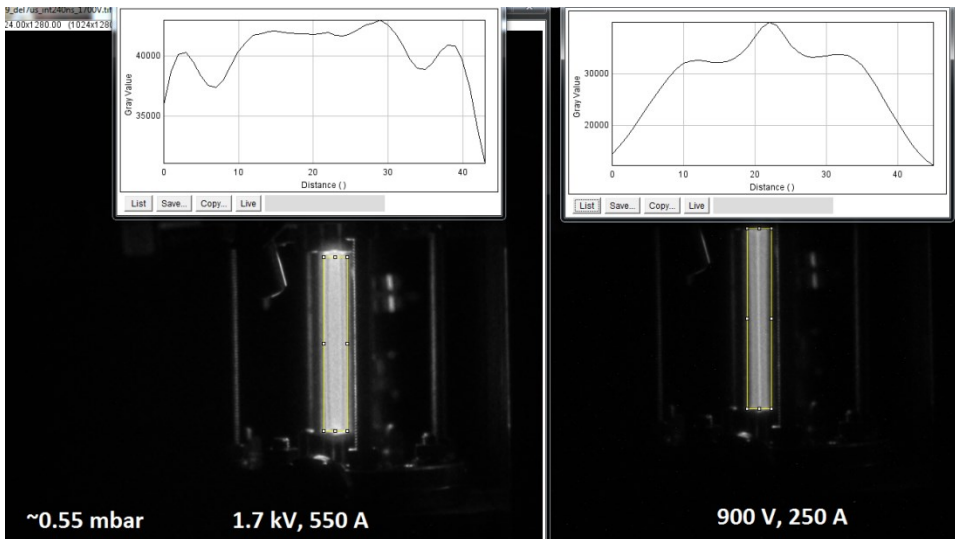
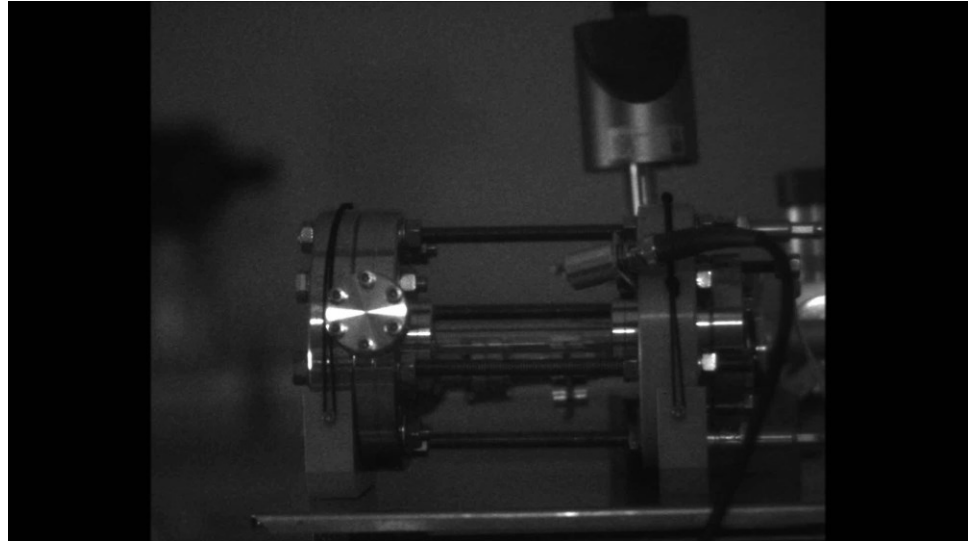
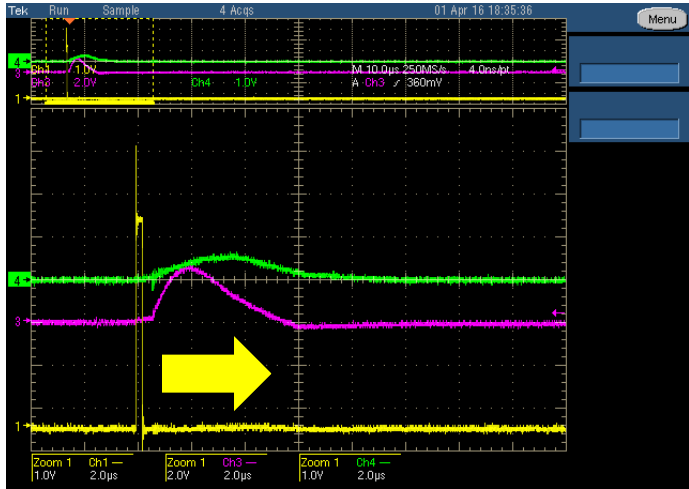
So far: First measurements

Measuring the breakdown voltage



- > Behaviour understood
- > Solutions if higher pressures than ~ 2 mbar needed:
 - ❖ Floating window flange
 - ❖ Window directly on cathode

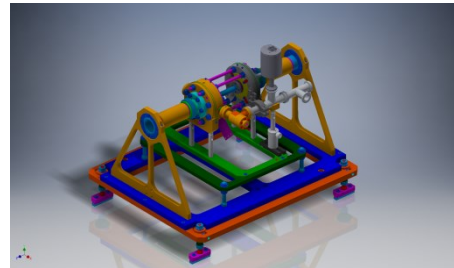
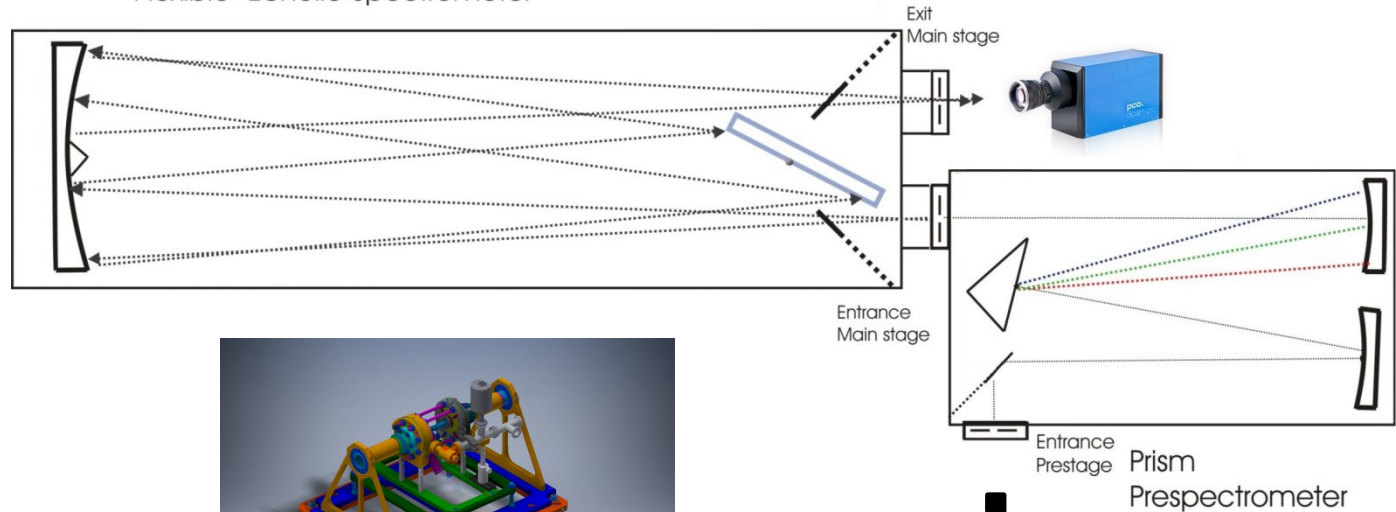
So far: First measurements



- First measurements done
- Transverse structures found
 - To be studied
- Plasma behaves as expected
- Density measurement ongoing

Electron density measurements

Flexible Echelle Spectrometer

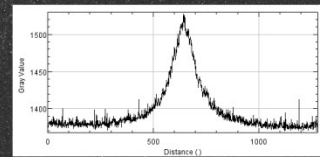
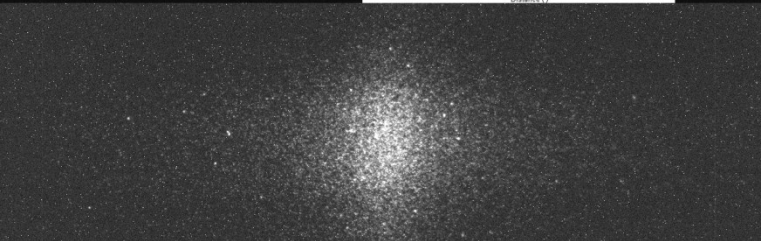
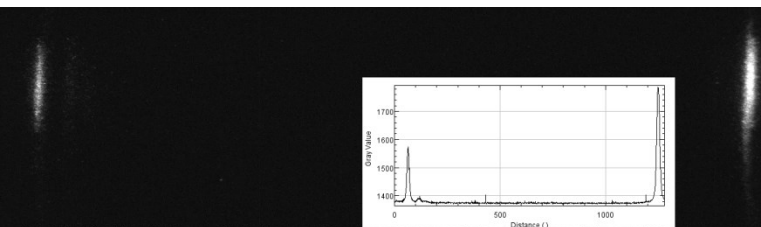


- Well established method
- Fast
- Intrinsic error (~20 %)

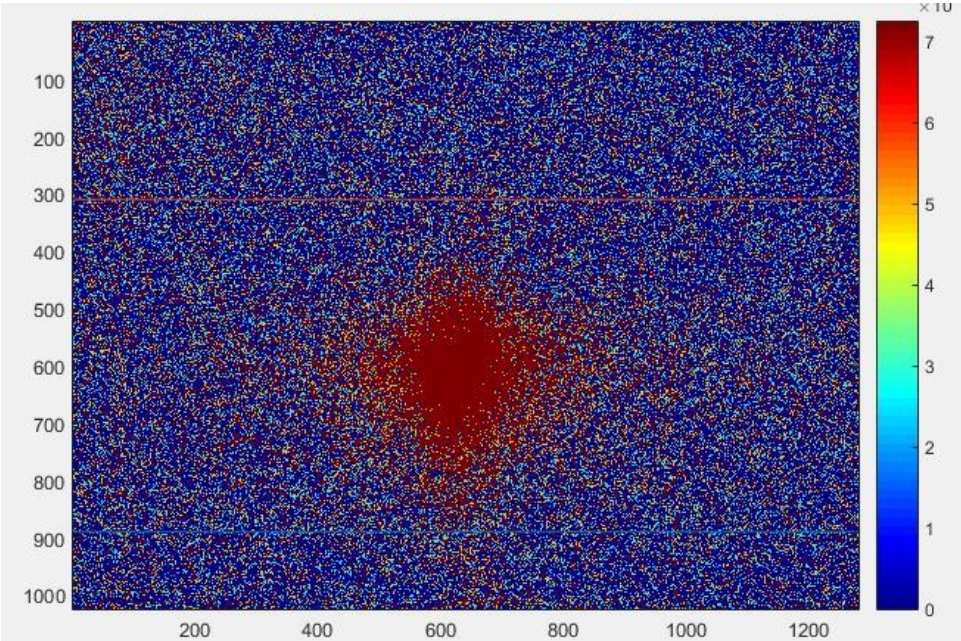
Reminder:
Stark broadening of spectral lines measurement

$$N_e = C(N_e, T) \Delta \lambda_S^{3/2}$$

(Griem 1964)



Electron density measurements



U:\gloisch\measurements\GDPPlasmaDensity\DiCam\160705
_experiments at 5mbar\reihe iii\22 1800V 5014mbar.tif

Maximum 890
Minimum 310

Load line

22.8508 $\times 10^{15} \text{ cm}^{-3}$

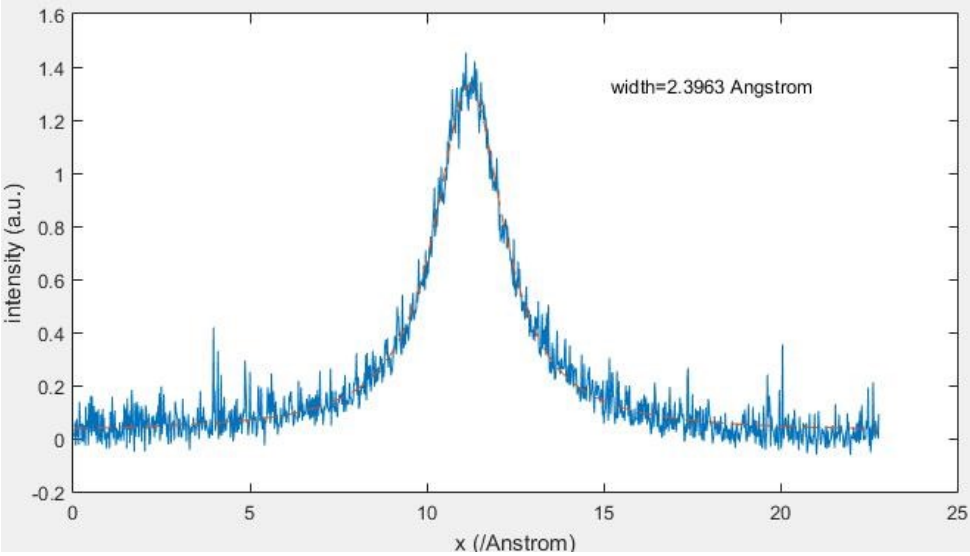
Give calibration

0.017814 Angstr/pixel

print GUI to jpg

Load Bkgrnd

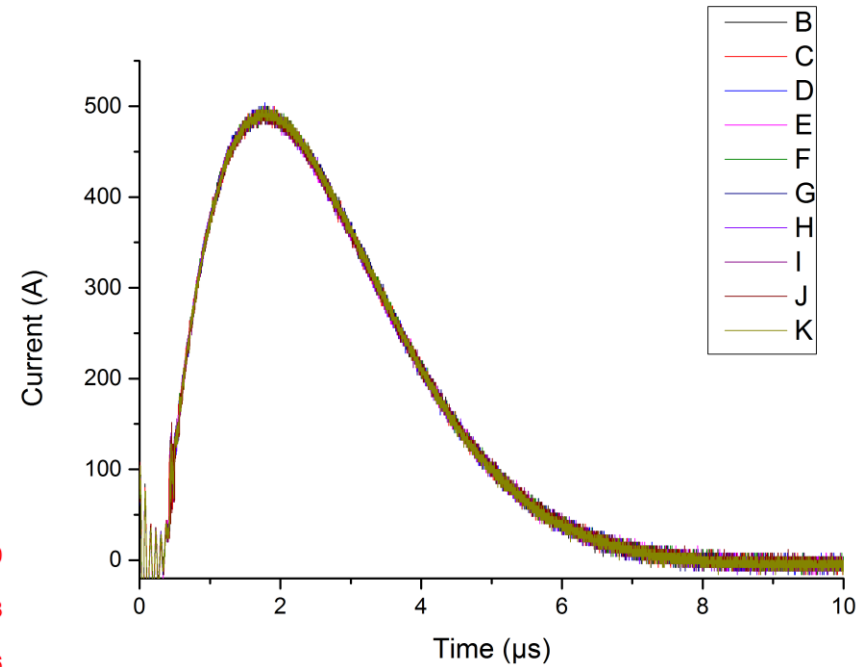
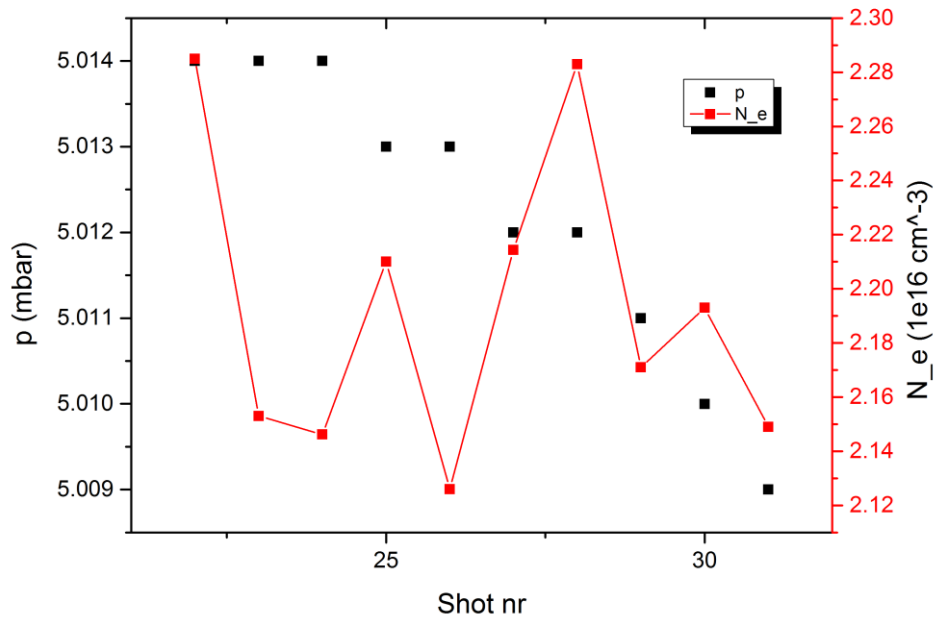
Bkgrd
file:U:\gloisch\measurements\GDPP
lasmaDensity\DiCam\160705 experiments at



Electron density measurements

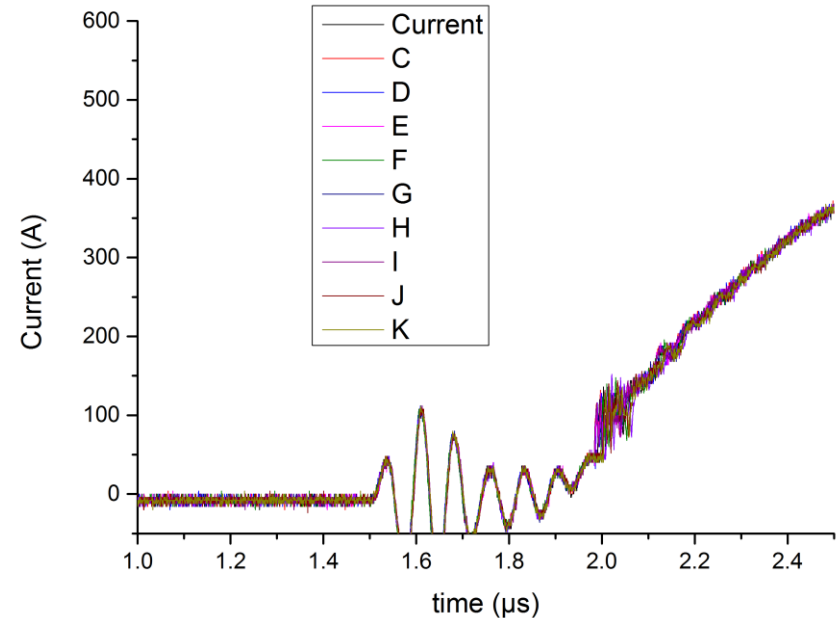
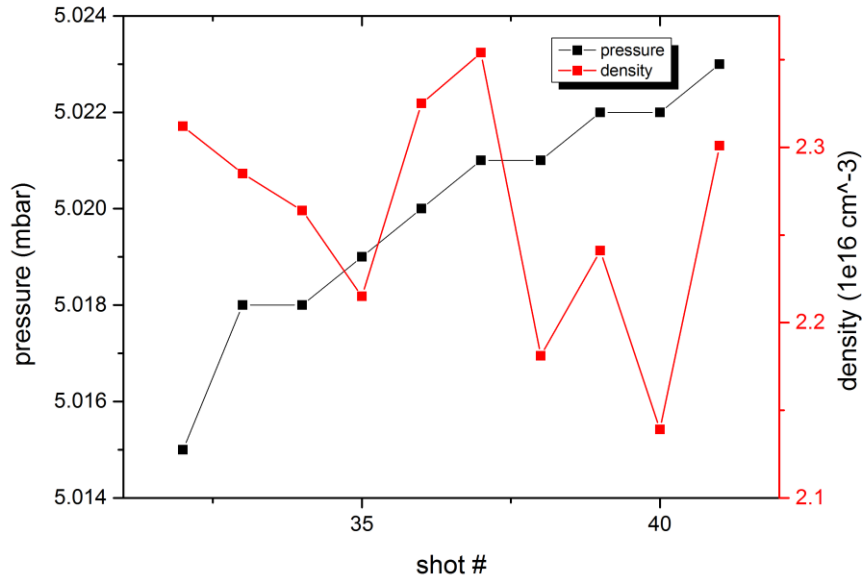
1.8 kV, 5 mbar: 10 shots in a row

- > Electronics run stable
- > Electron density stable in measurement error
- > Error caused mainly by low signal



Electron density measurements

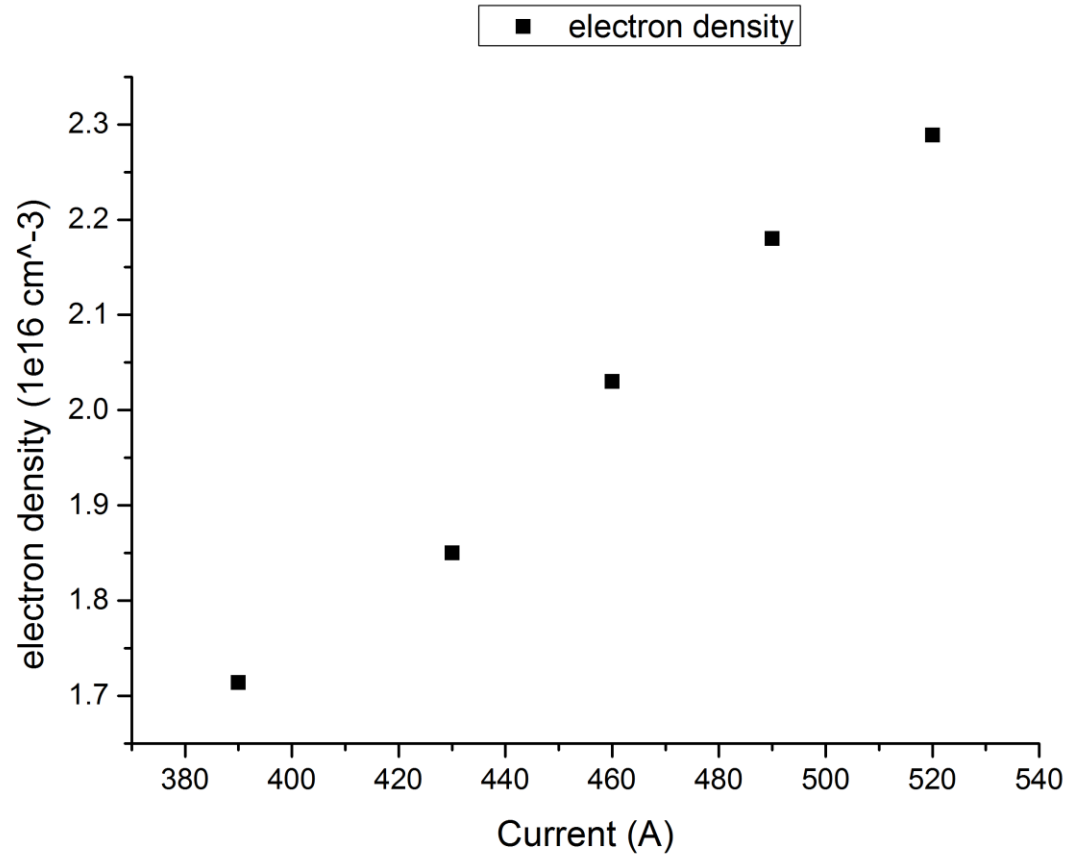
1.85 kV, 5 mbar: 10 shots in a row



- Oscilloscope triggered on camera gate
→ measure current jitter
- No jitter observable

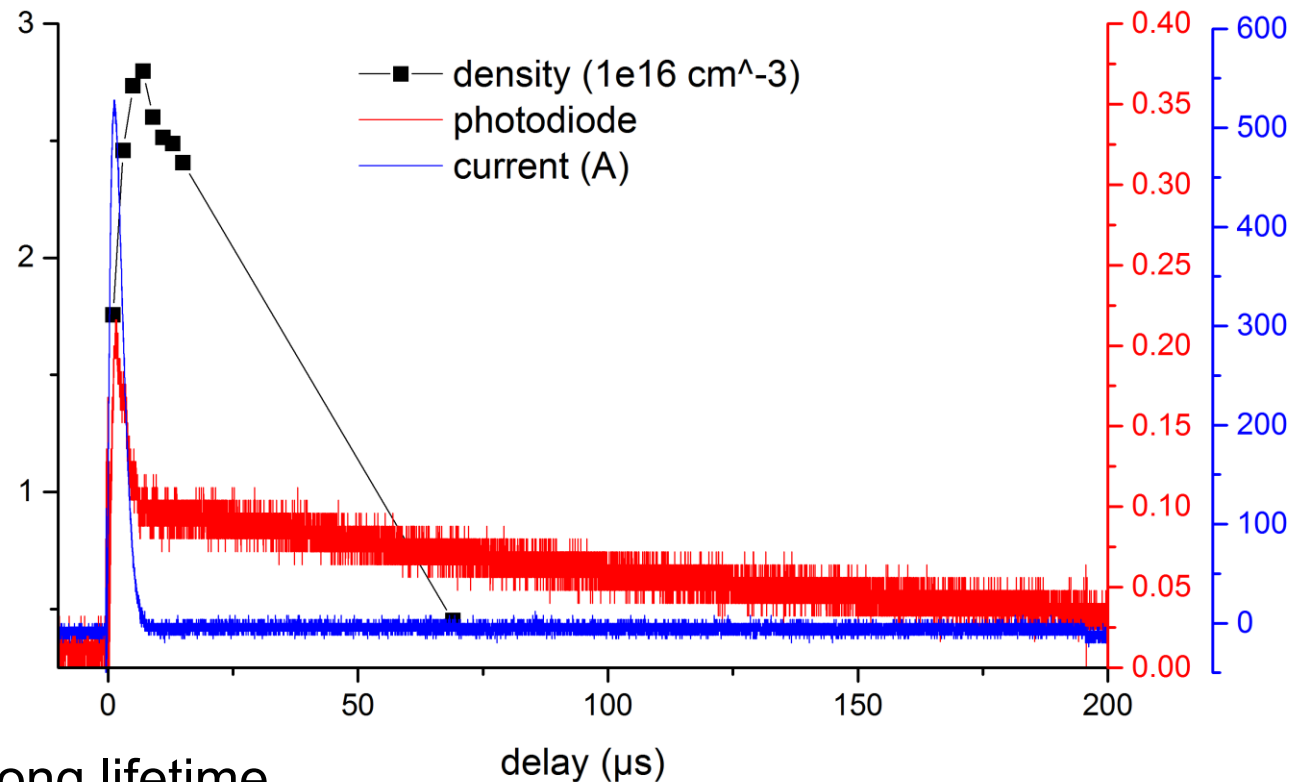
Electron density measurements

Density in first 10 μs of discharge for varying voltage / current (10 pics averaged)



Electron density measurements

Time resolved density (10 pics averaged)

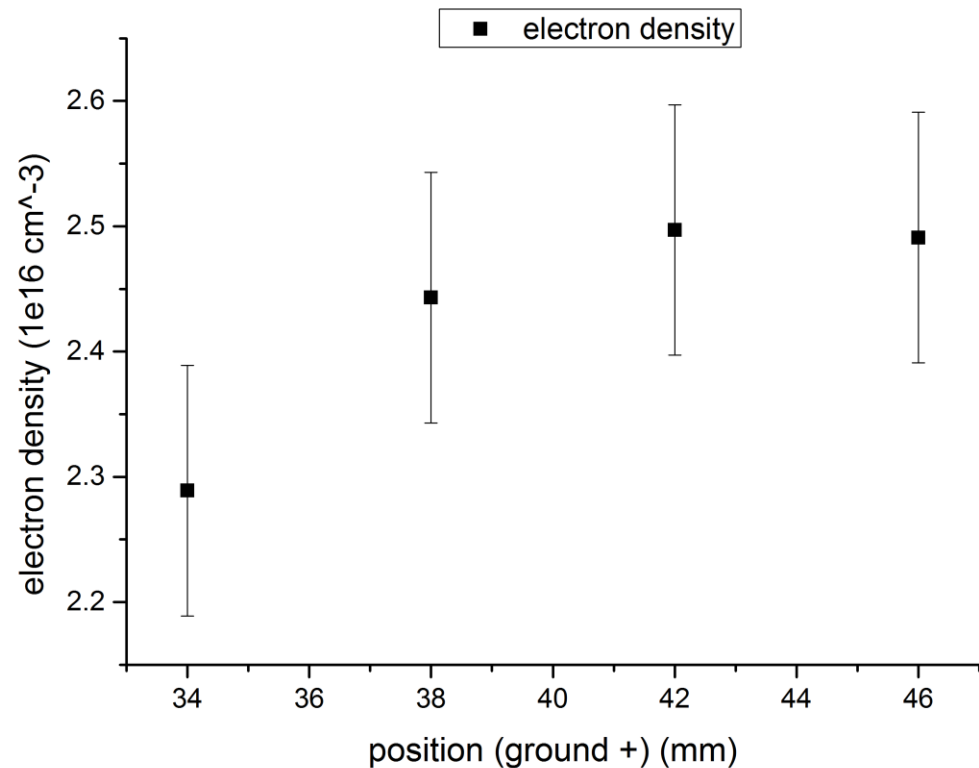


- > Discharge has a long lifetime
→ where does it end?

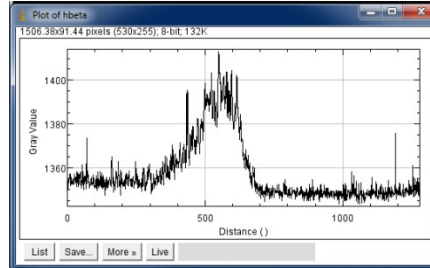
Electron density measurements

Spacially resolved density (10 pics averaged) - preliminary

- > Space resolved measurement very rough
- > Densities are in the range of relative error
- > To be studied more thoroughly



Electron density measurements - outlook

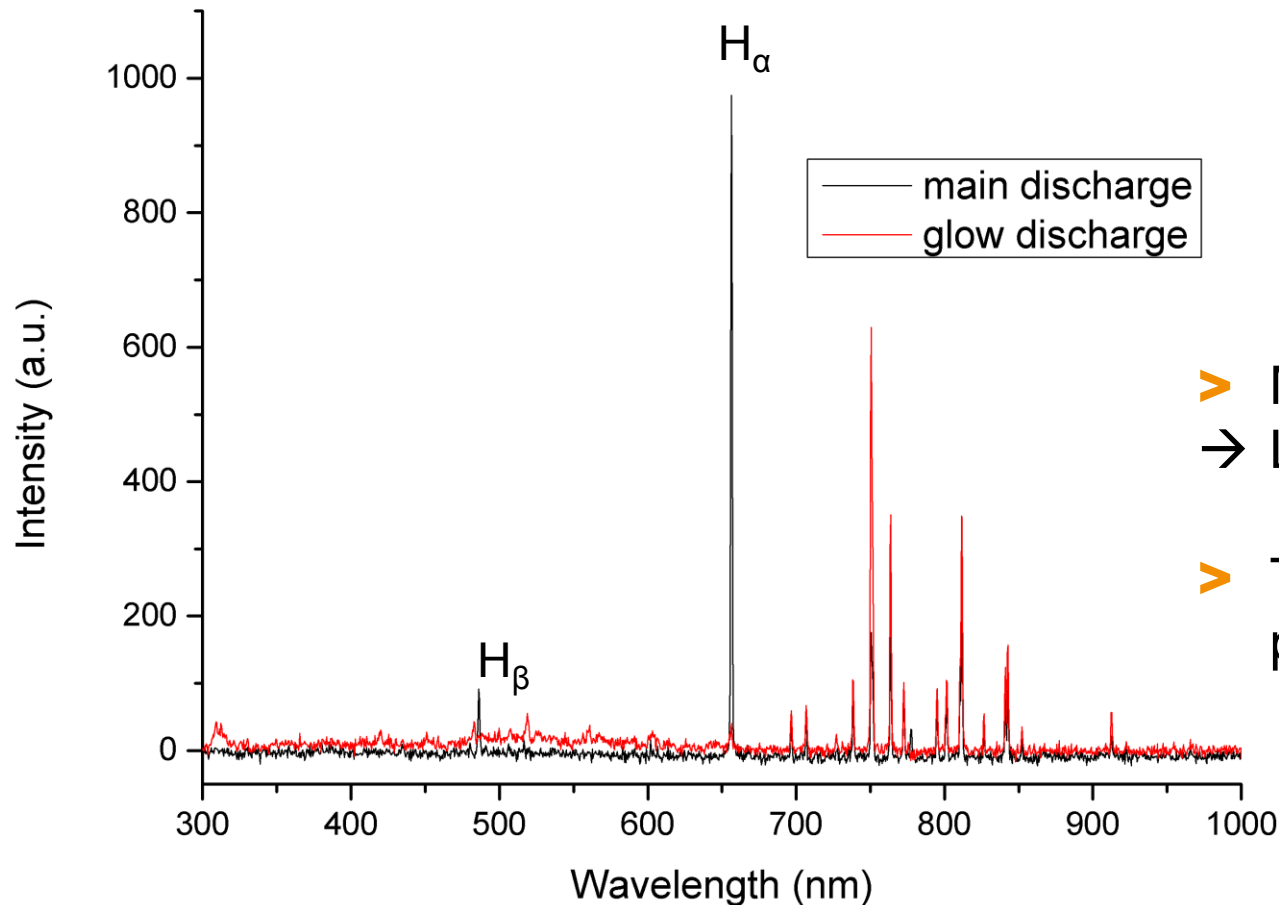


Before publication:

- > Measure electron temperature
- > Other pressures
- > If possible define experimental error:
 - > Measure other lines (see image of H_{beta})
 - > Measure line shift
 - > Modulation of electron beam (!)

Density measurements

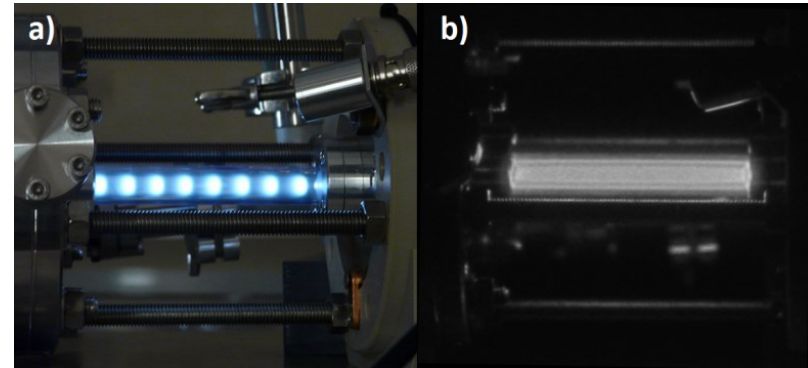
Broadband spectrum (OO pocket spectrometer)



- > Mainly red lines
- Low temperature..?
- > To be verified with correct parameters

Advantages of the gas discharge cell

- Cell has proven necessary electron density
- Simple setup
 - *No laser*
 - *No heating* (→ fast)
 - *Electron windows directly at plasma* (~5 mm)
 - Thicker windows usable
 - *No Lithium*
 - No severe damage to accelerator possible
 - Easy handling
- Cell is compact → additional screen directly before/after cell, magnets, etc. possible
- Online density measurement possible

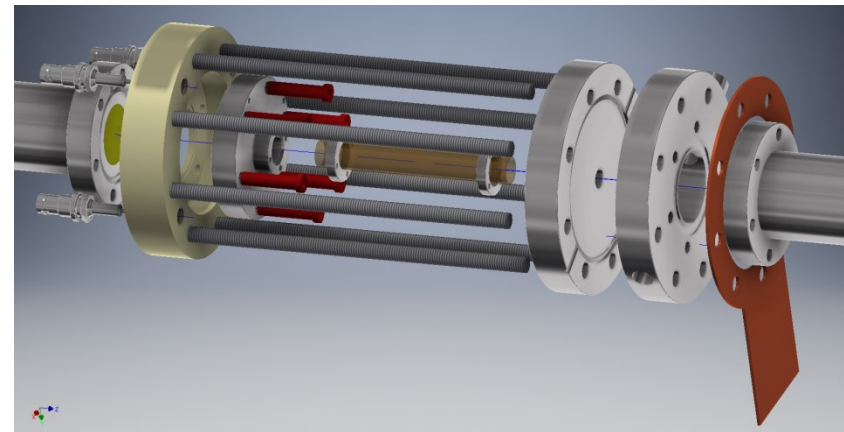
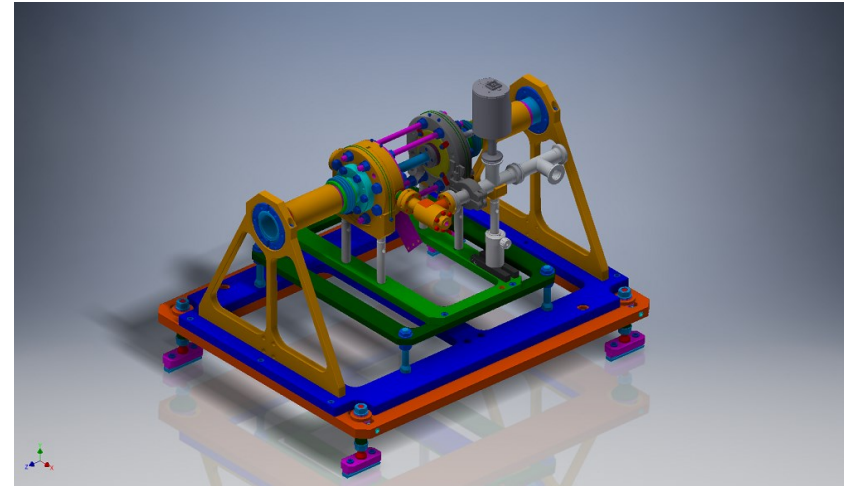


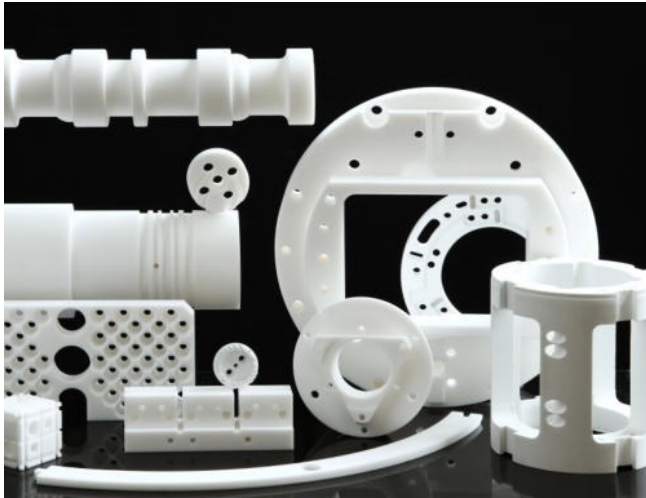
Necessary effort before installation

- Produce new cell with minor changes (→ experiments with present cell can go on)
 - *One side flange welded shut (?)*
 - *Backside of HV-electrode welded*
 - *Insulator-flange made of Macor (HH)*
 - *Insulating bellow-flanges (HH)*
 - *11 parts in total (mostly modified standard flanges)*

- Continue with measurements
- Make electronics ready for 10Hz operation
 - *Exchange charging resistor with inductor*
 - *Stress test*
 - *(ventilation inside?)*
 - *(backup system?)*

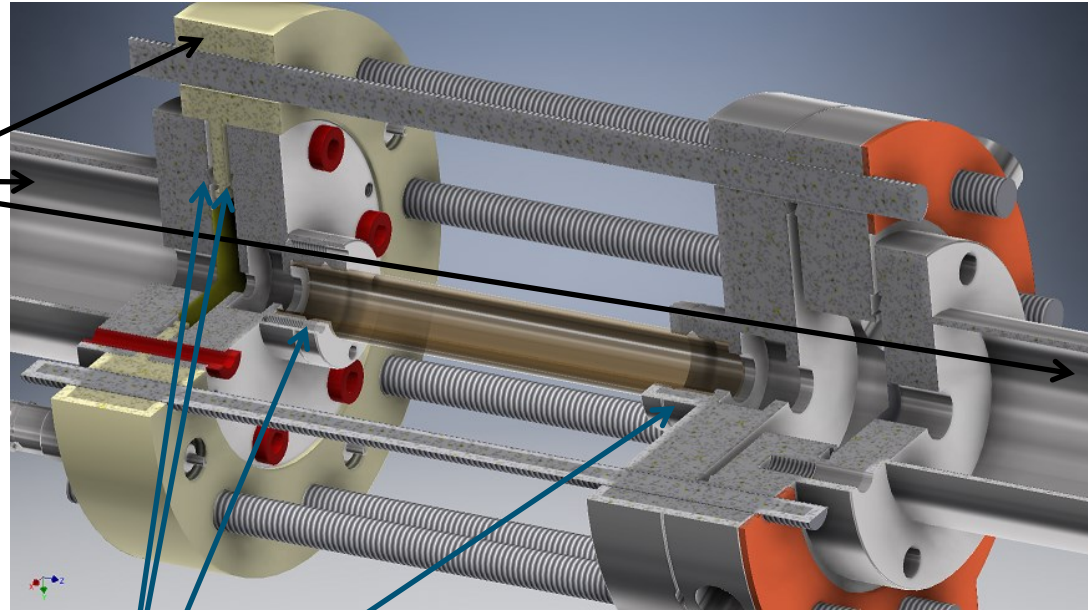
- Assembly and vacuum tests
- Need 1 trigger and 1 SHV cable in the tunnel (+ 1x 230V, 50Hz); 2 BNC optional





Macor

- Suitable for UHV
- Machinable ceramic
- Conform with DESY vacuum specs



Indium

- Suitable for UHV
- Sealing between metal and insulators
- Conform with DESY vacuum specs

*G. Loisch, A. Oppelt, D. Richter, G. Koss, J. Engel, S. Philipp,
M. Hochberg, M. Sack*

Thank you very much
for your attention!

