Probe disturbance in a neon glow discharge

Institut of Physics, University Greifswald, Germany

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Motivation

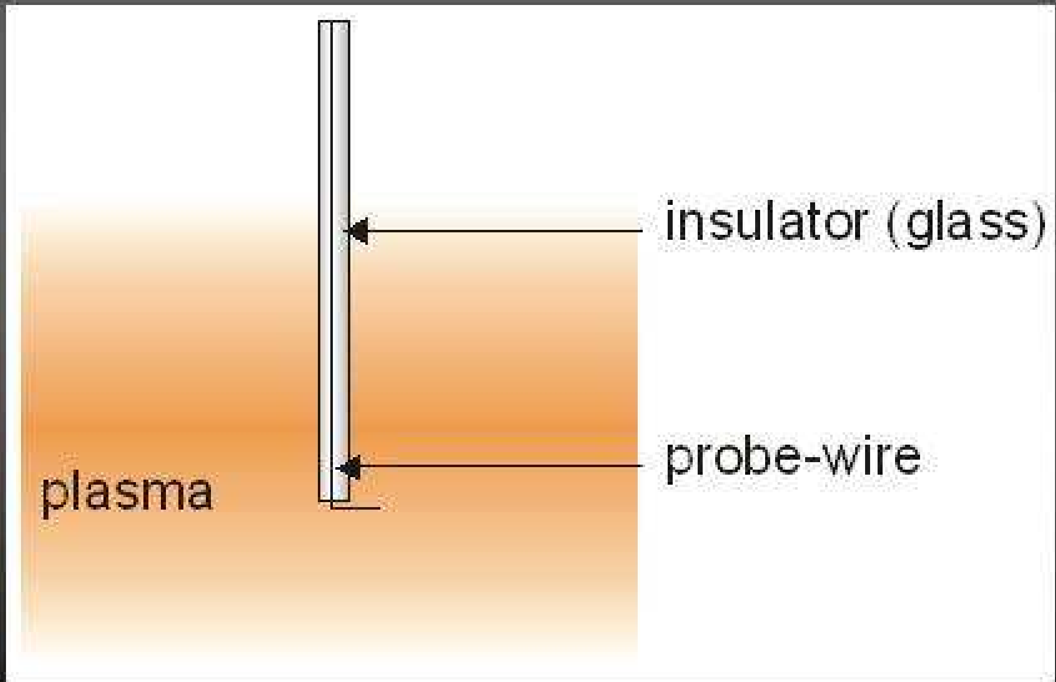
- probe measurement to determine important plasma parameters like n_e, T_e or the EEDF (electron energy distribution function)
- the parameters you can get with a relatively simple setup
- disadvantage: probes are always in contact with the plasma

→ local disturbance of the plasma parameters which we want to get

→ errors in the probe measurement caused by the probe

Motivation

angled probe



Visible Effects

disturbance through a probe:

no probe inside

probe in plasma

Motivation

main questions:

- How big is the error in comparison to the undisturbed plasma?
- What does the error depend on?

- estimation of error by measurements of the particle density $n(1s_i)$ ($i=2,3,4,5$) of excited atoms in the vicinity of the probe by LAS (laser absorption spectroscopy)

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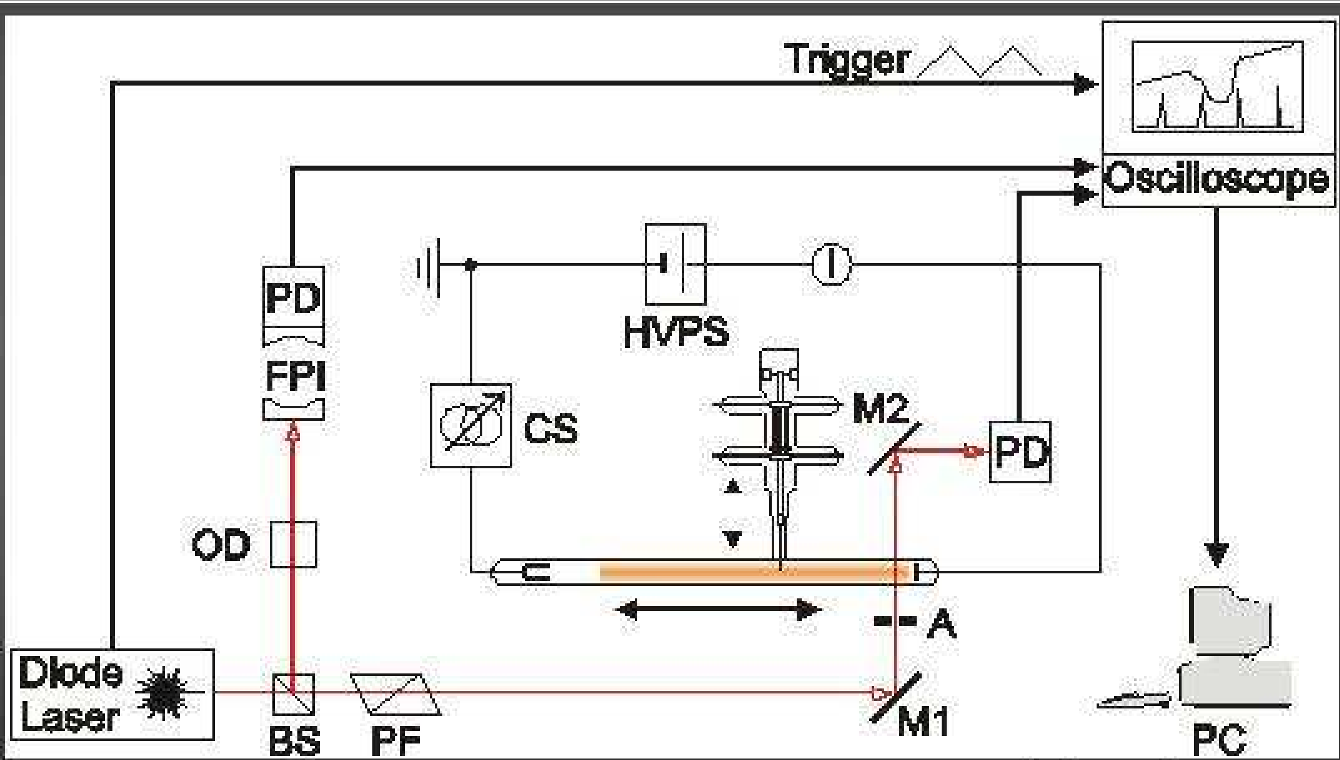
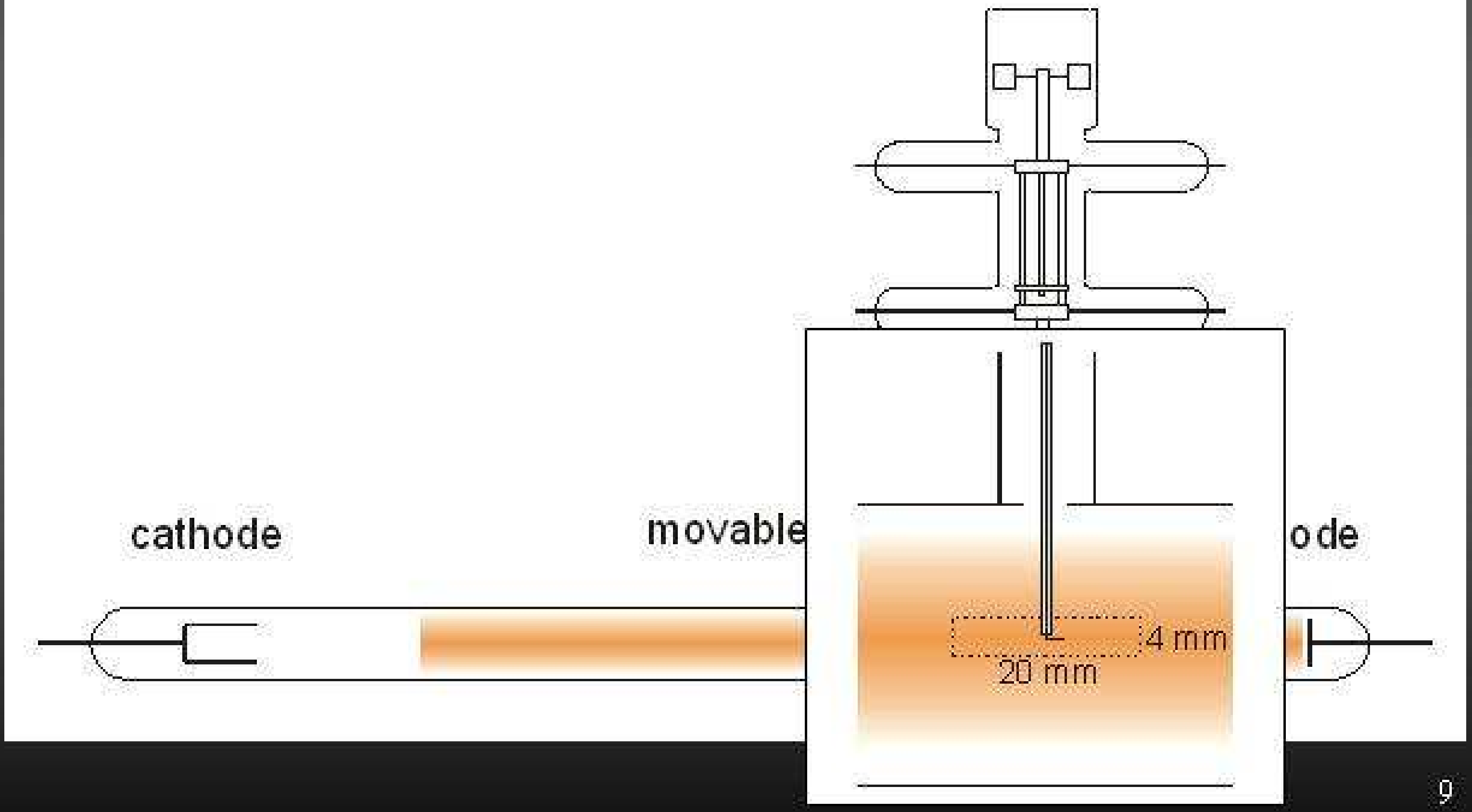
LAS Setup



BS Beam Splitter, CS Current Source, HVPS High Voltage Power Supply, PD Photodiode, PF Polarizationfilter, M Mirror

Measuring Range



Measuring Conditions

- measurements are made at the discharge currents
  3 mA, 5 mA, 10 mA, 15 mA, 20 mA

- undisturbed case – probe out of plasma

- with probe: different probe potentials:
  - floating potential
  - plasma potential

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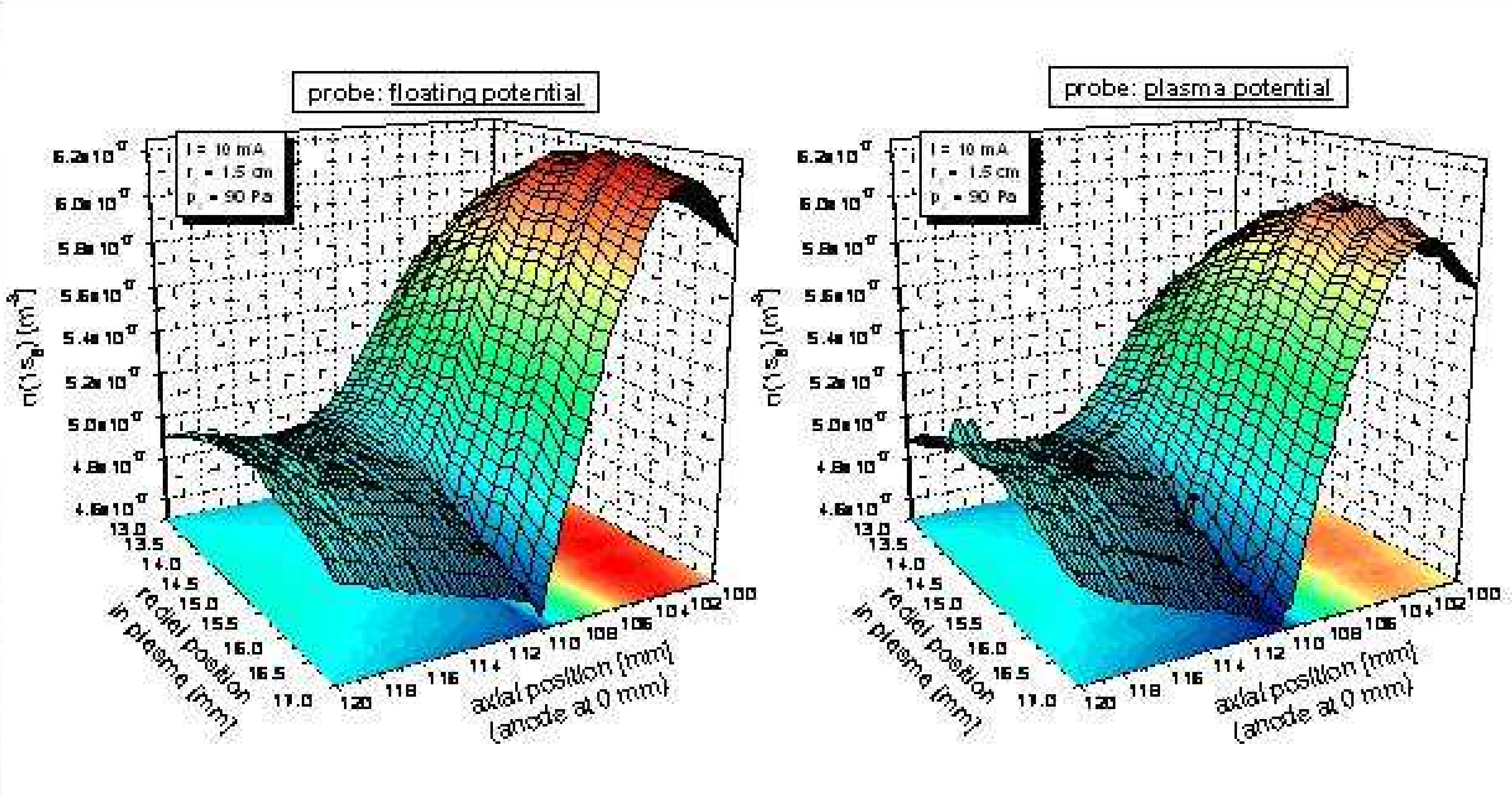
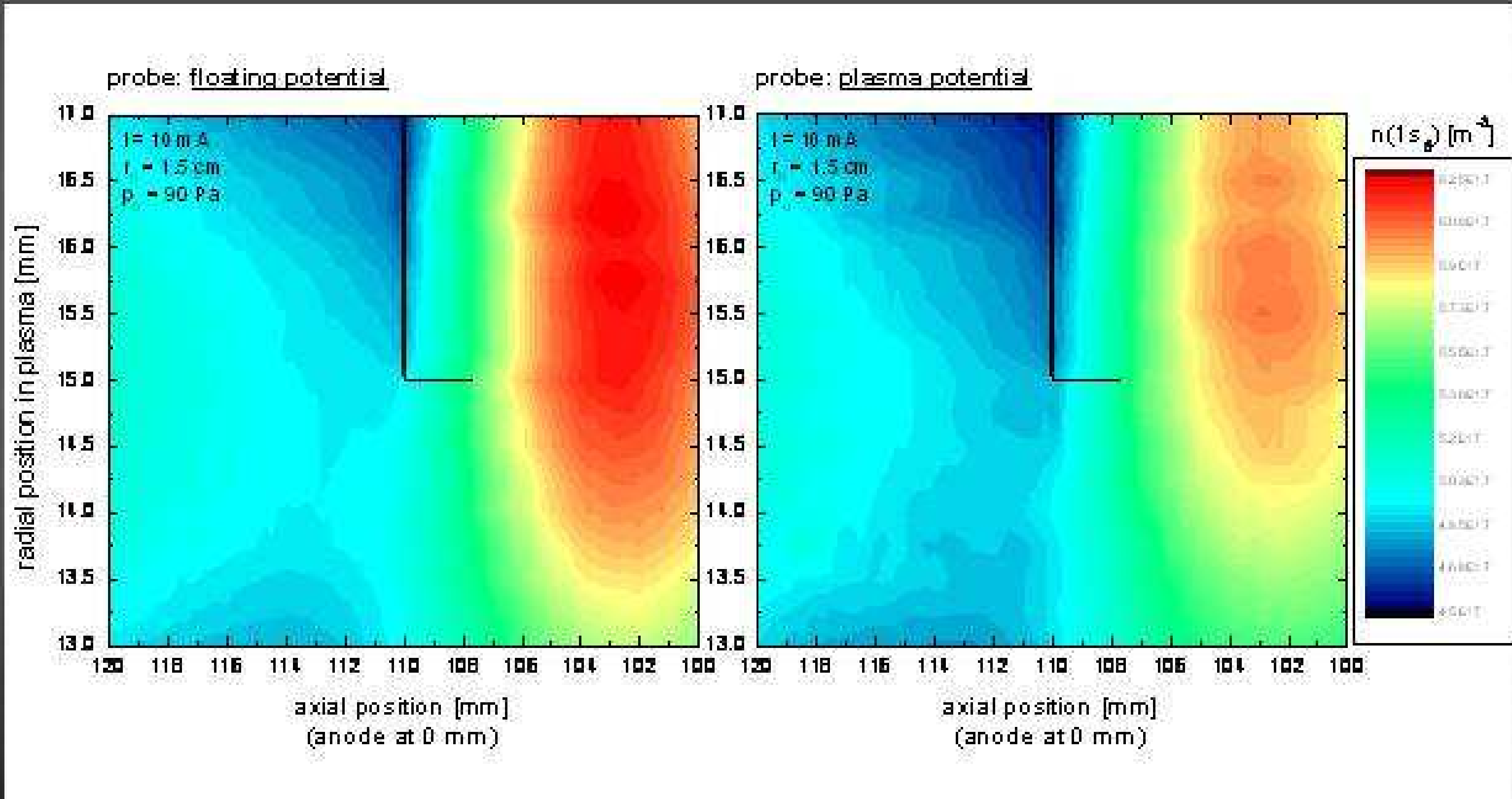
Results


probe: floating potential
probe: plasma potential
I = 10 mA
p = 90 Pa
radial position in plasma [mm]
axial position [mm] (anode at 0 mm)

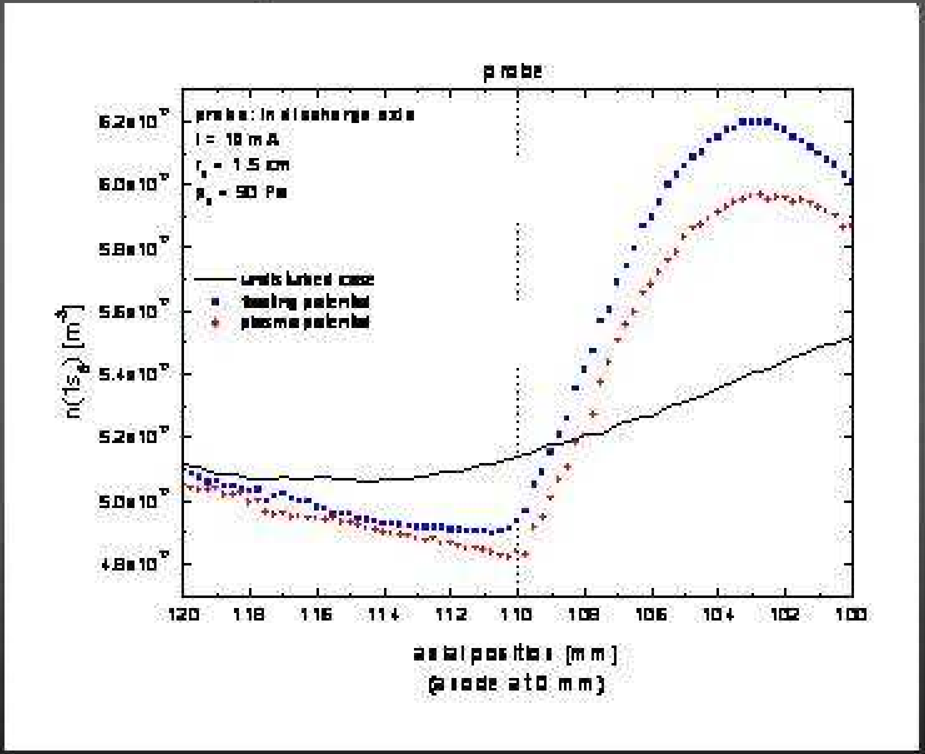
Results


probe: floating potential
probe: plasma potential
I = 10 mA
r = 1.5 cm
p = 90 Pa
radial position in plasma [mm]
17.0
16.5
16.0
15.5
15.0
14.5
14.0
13.5
13.0
120 118 116 114 112 110 108 106 104 102 100
axial position [mm]
(anode at 0 mm)

Results

<u>comparison to the undisturbed case:</u>

- particle densities in discharge axis



Results

simple estimation of the error made by probe measurements:

$I_{discharge}$	floating potential error [%]	plasma potential error [%]
3mA	-8	-8
5mA	-1	-6
10mA	1	-2
15mA	1	-1
20mA	0	0

Results

<u>changing the orientation of the probe tip:</u>

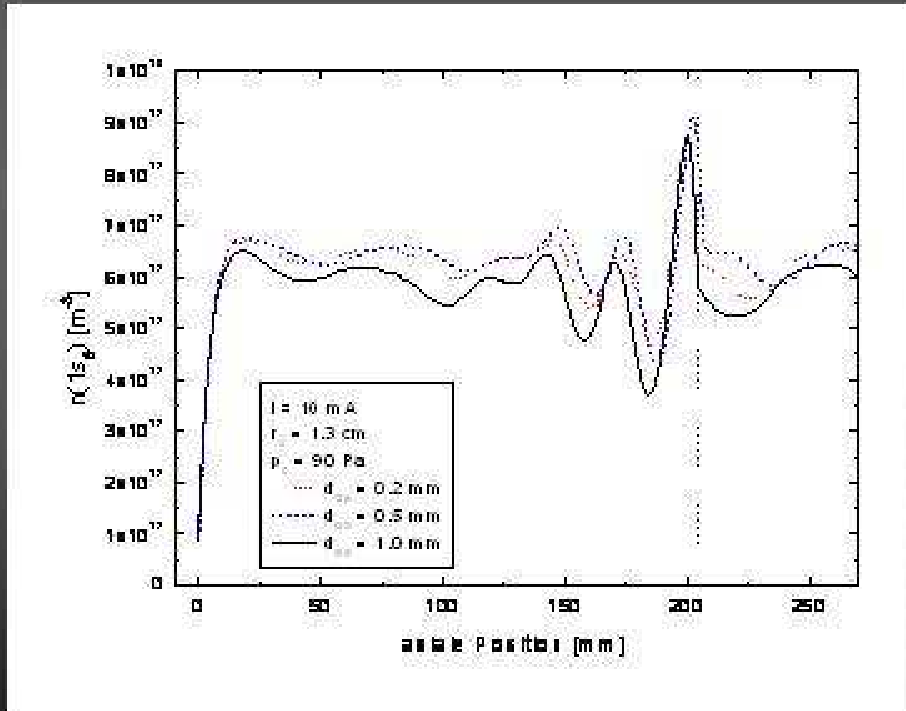
- error of an linear probe at floating potential in comparison to the angled probe:

	error in comparison to the undisturbed case [%]	
I_{dis}	angled probe	linear probe
3 mA	-8	-13
5 mA	-1	-7
10 mA	1	-7
15 mA	1	-4
20 mA	0	-9

(assumption: the main disturbance is caused by the insulator, the error was calculated from the diagram of the angled probe at floating potential)

Results

<u>dependance of the diameter of the insulator:</u>



<u>Theory</u> :

the disturbance is proportional to the surface of the insulator ←→ disagree with measurement

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Outlook

- exact calculation of the error by using the plasma balance equations
- check the found results by LIF (laser induced fluorescence)
- measurement of the 3-dimensional structure of the disturbance by LIF

Summery

- existence of a systematical error caused by the probe!

Error depends on:

- the discharge current
- the probe potential
- the orientation of the probe in the plasma!
- length of the probe wire
- depth of the probe in the plasma