Turbulence measurements with the double rake probe

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Group 3
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Introduction

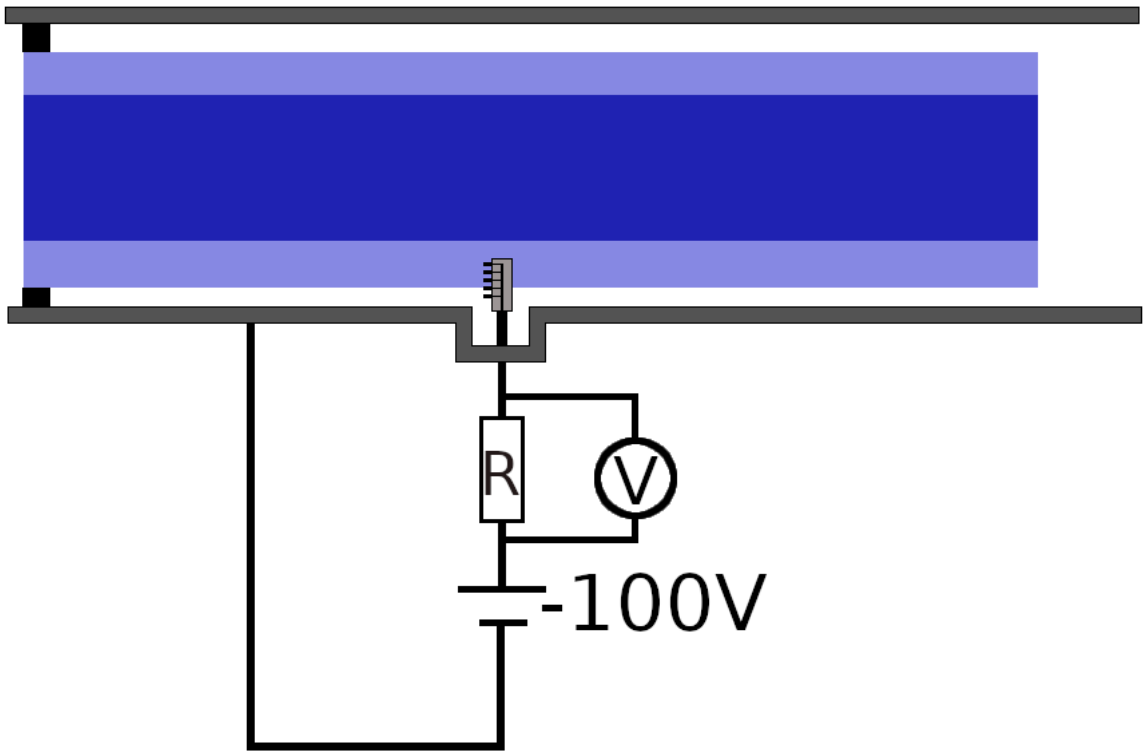
- Motivation
- Probes
- Statistical analysis
- Results

Why and how we measure turbolences

- More turbolence $\rightarrow$ more unstable plasma
- To determine where they origin
- To determinate their velocity

- With probes (abrupt changes in saturation current)

Measuring setup



- Probe voltage
- I_{sat} current

Figure: *Schematics of the measuring setup*

Positioning of the probe

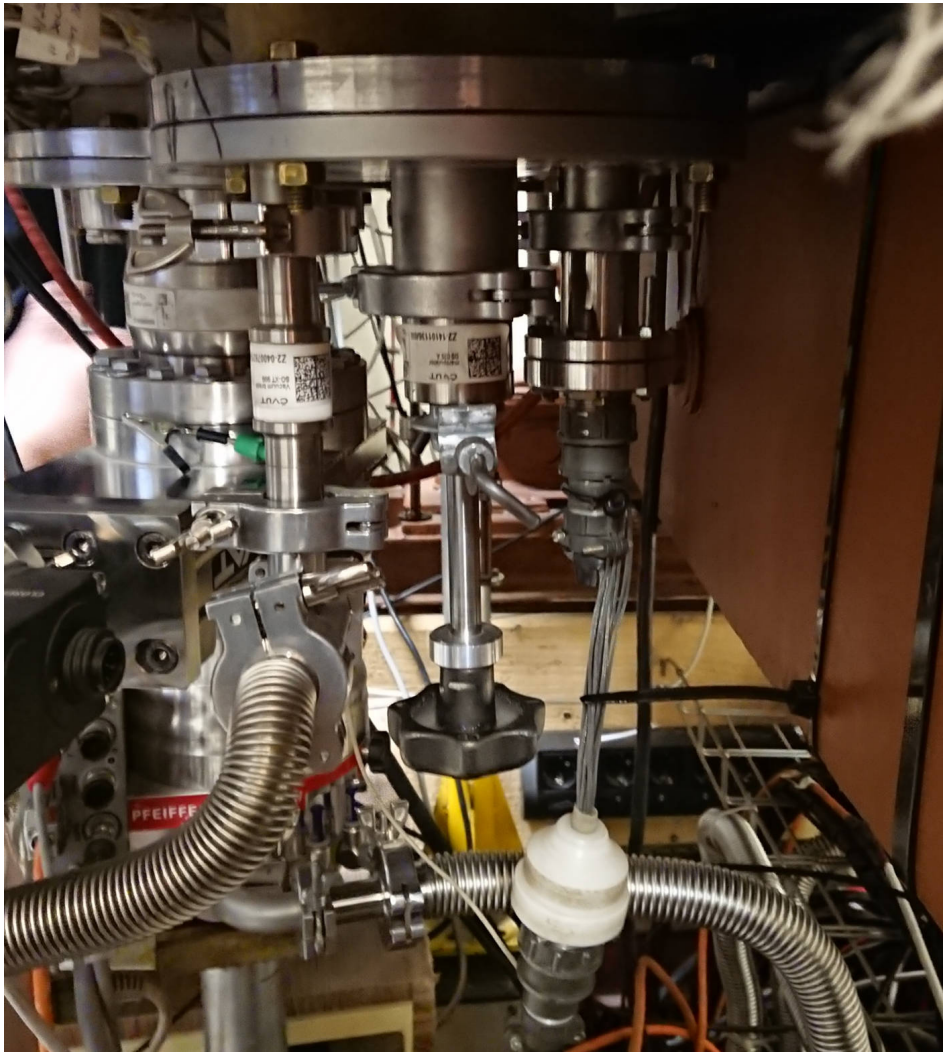


Figure: *Probe moving arm and manipulator*

- In and out
- Rotation

Double rake probe

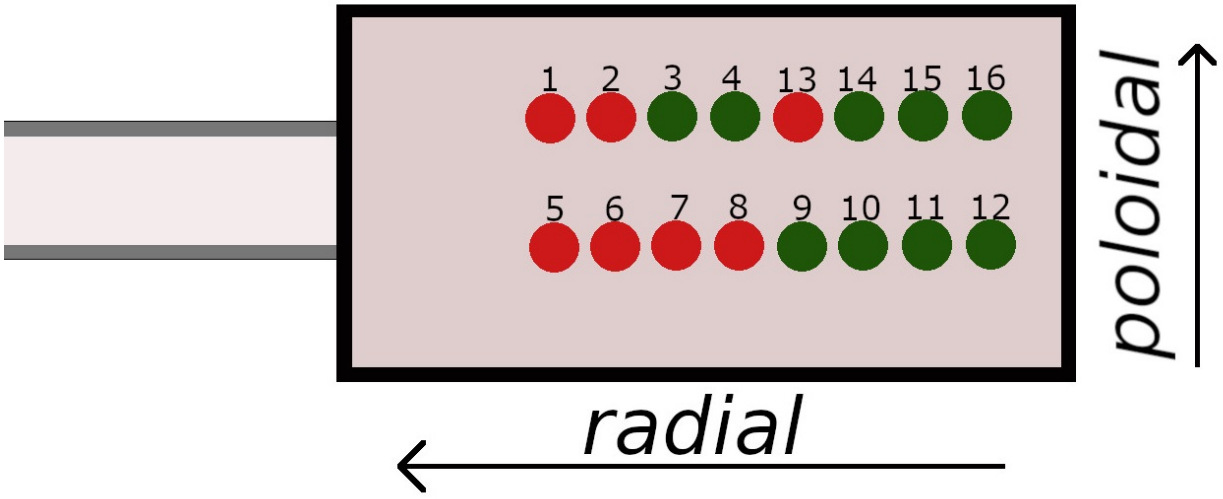


Figure: *Schematics of the double rake probe*

Figure: *Double rake probe*

- Red - not operational
- Green - operatinal

I(U) Charasteristics

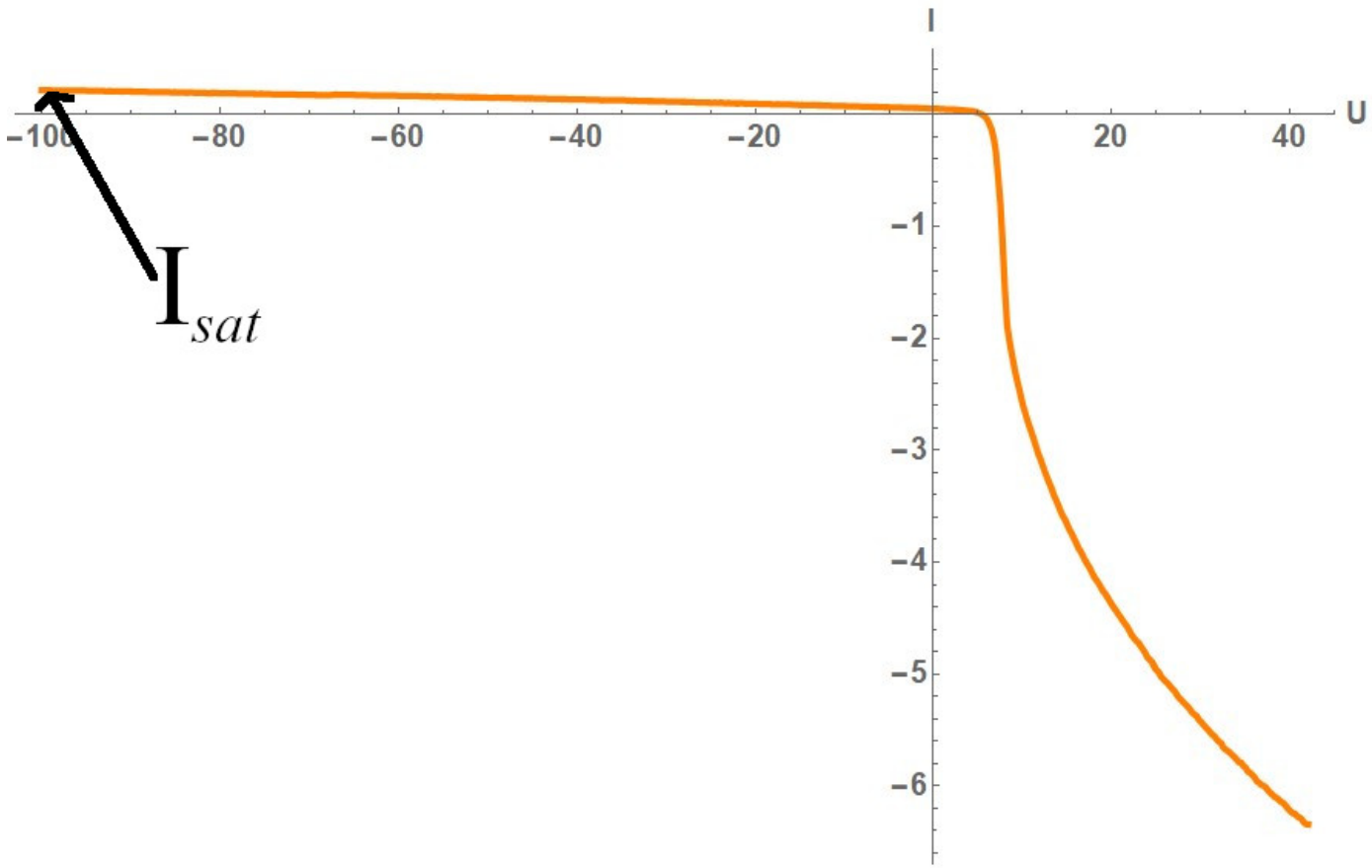


Figure: *I(U) characheristics of a Langmuir probe*

Measuring limitations

- Measured voltage on the resistor from $-10\,\mathrm{V}$ to $10\,\mathrm{V}$
- $I_{sat} \propto An\sqrt{T}$
- Not all discharges lasted the same
- No knowledge of the probe orientation

Basic shot parameters

- Gas pressure $p = 10\,\mathrm{mPa}$
- Gas : Hydrogen
- Preionization: Electron gun
- Magnetic field capacitor voltage $U_{B_t} = 1300\,\mathrm{V}$
- Electric field time delay $t_{E_t} = 0\,\mathrm{ms}$
- Electric field capacitor voltage $U_{E_t} = 500\,\mathrm{V}$
- Probe voltage $U_P = -100\,\mathrm{V}$
- Stabilization was used

Simulation

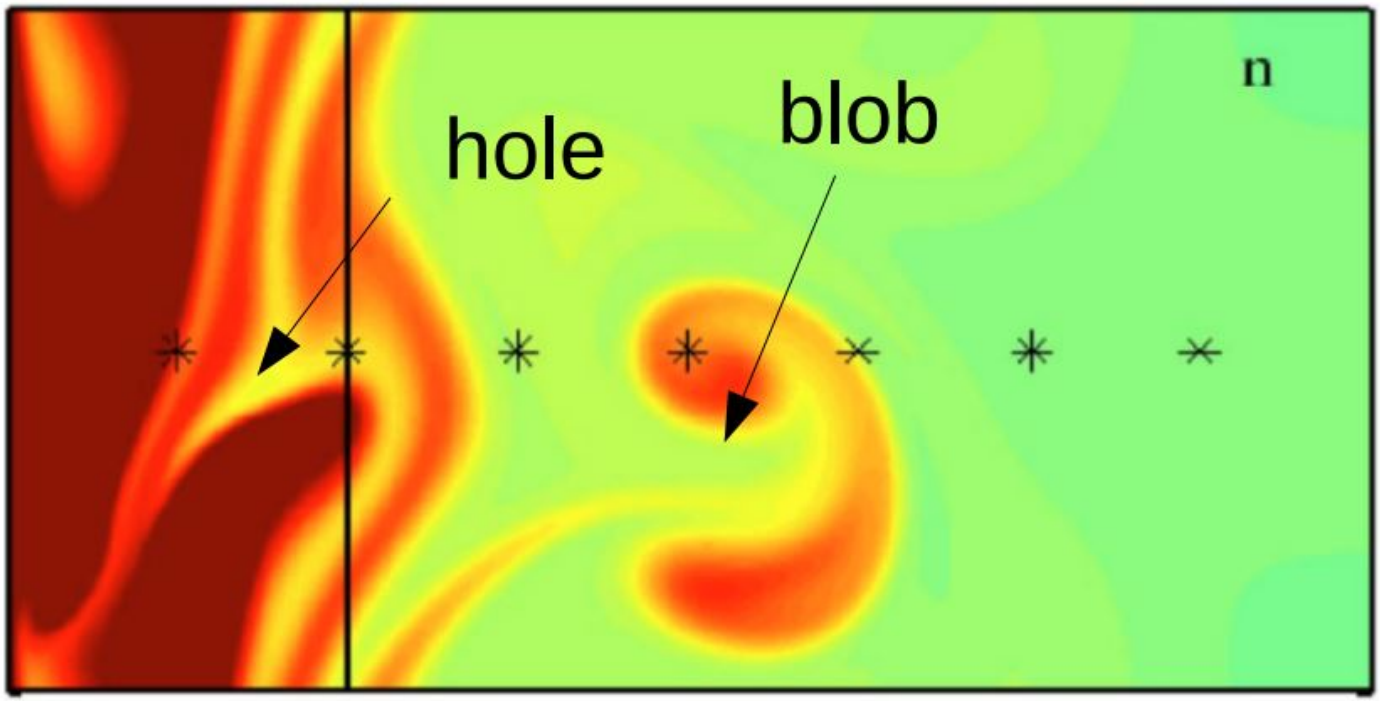


Figure: *Plasma edge simulation*

Loop voltages and plasma currents

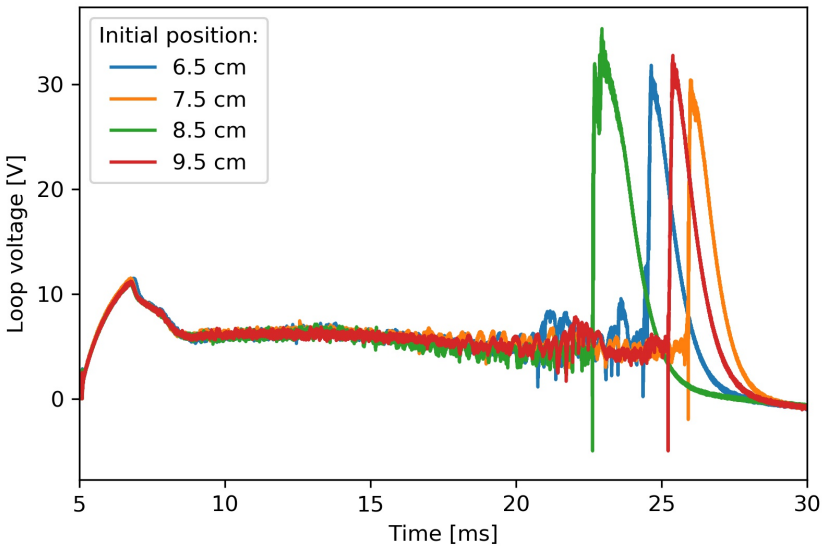


Figure: *Loop voltage of the 4 shots*

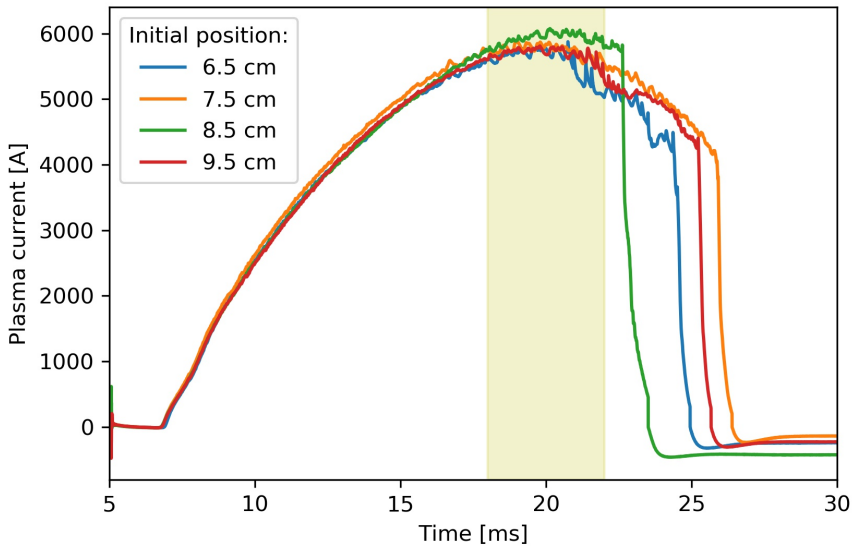
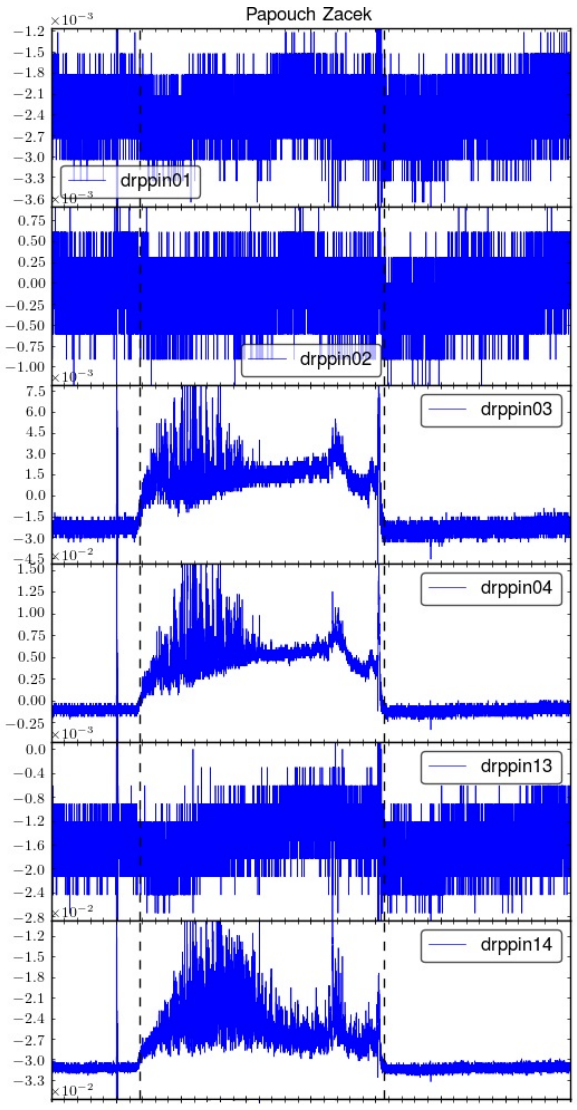
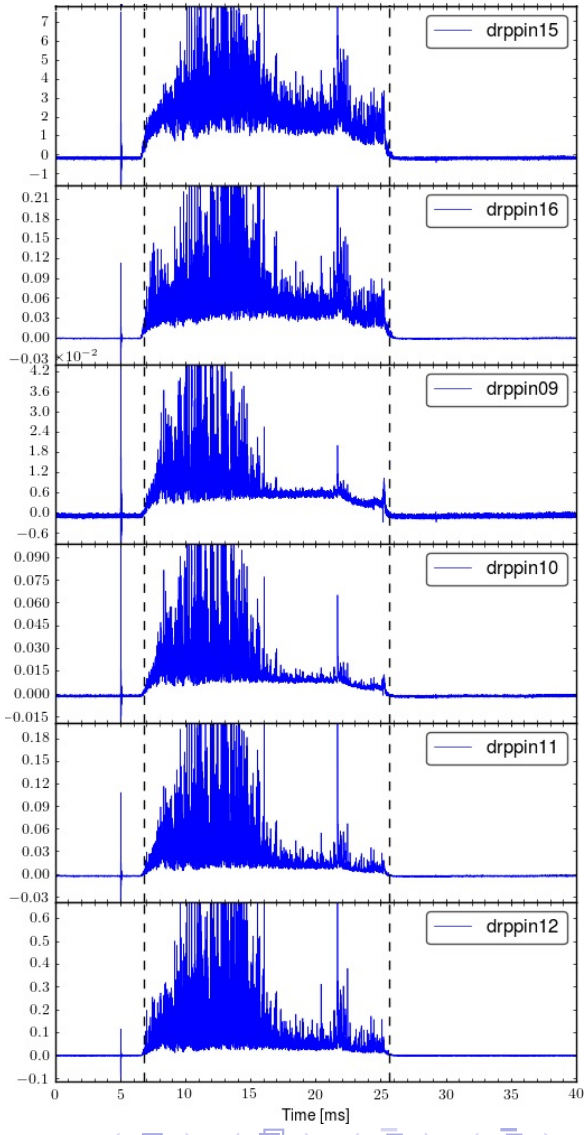


Figure: *Plasma currents*

- Initial position - distance of the pin closer to the center of the tokamak

Raw data


Papouch Zacek
drppin01
drppin02
drppin03
drppin04
drppin13
drppin14


drppin15
drppin16
drppin09
drppin10
drppin11
drppin12
Time [ms]

Saturation current

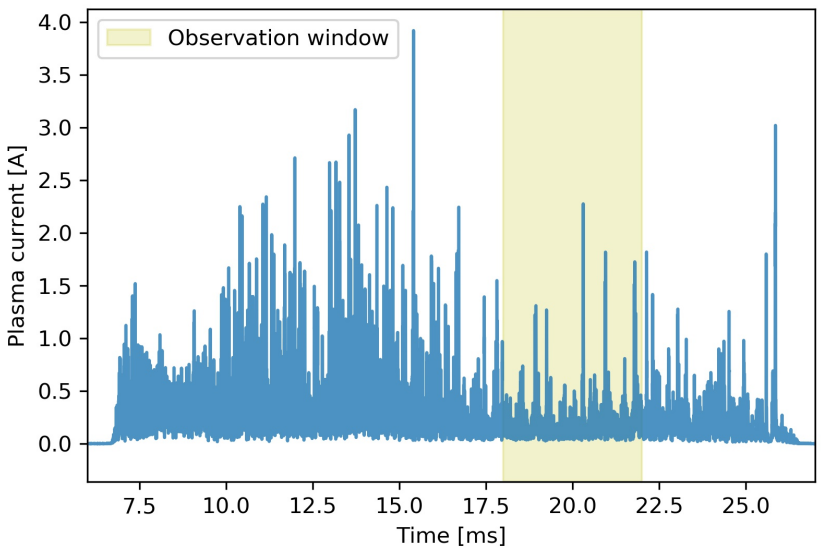


Figure: *Observation window*

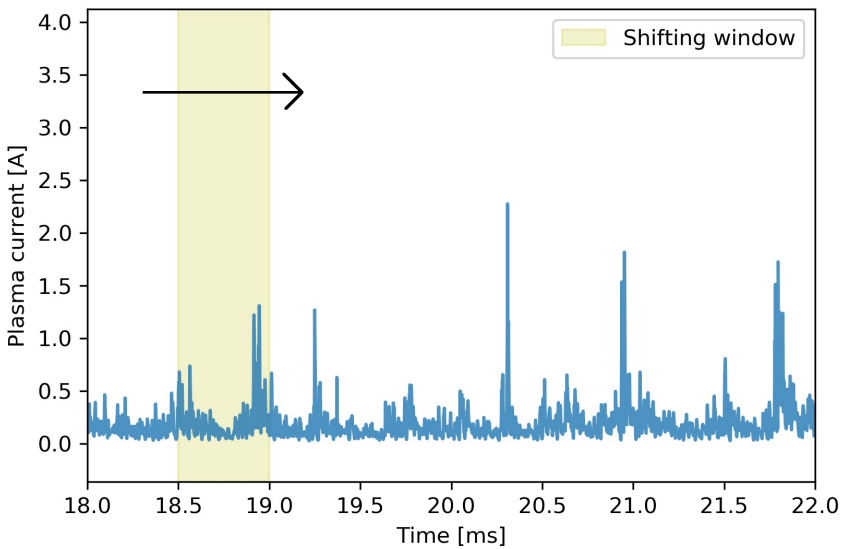


Figure: *Moving window*

Zoom on the moving window

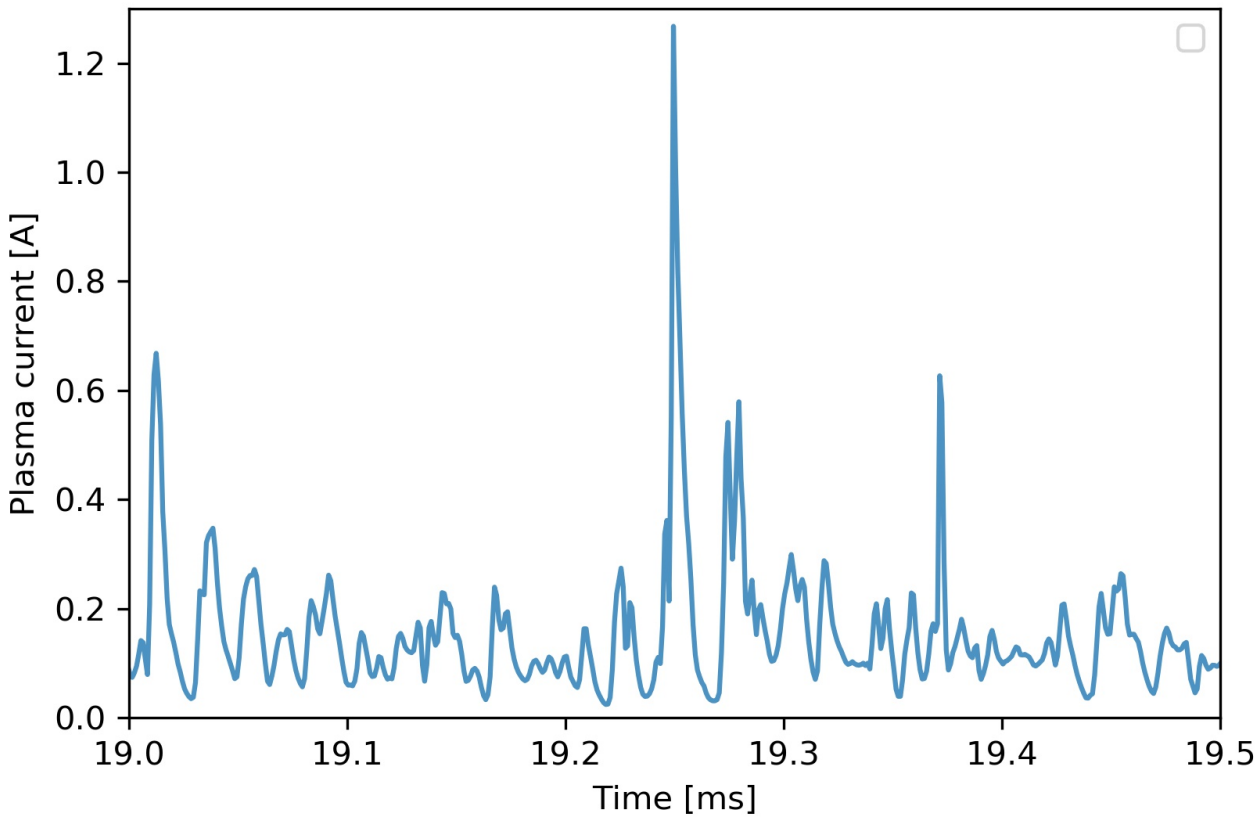
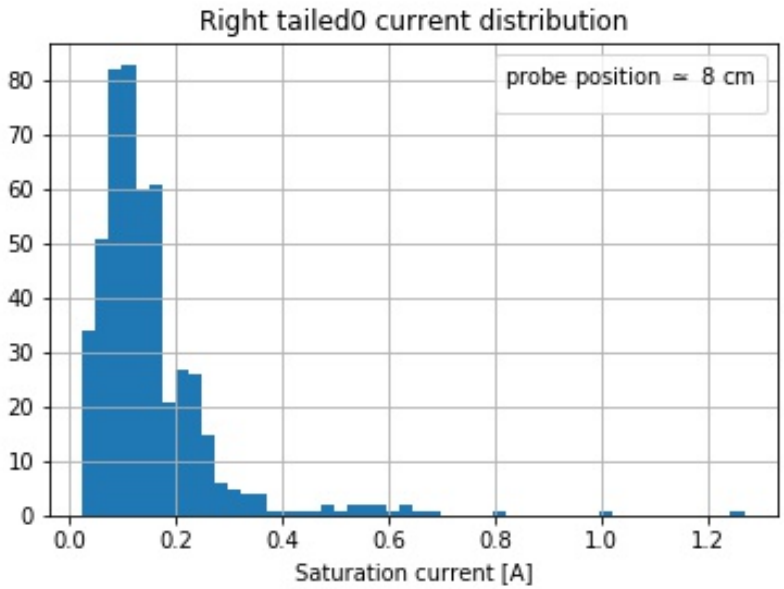
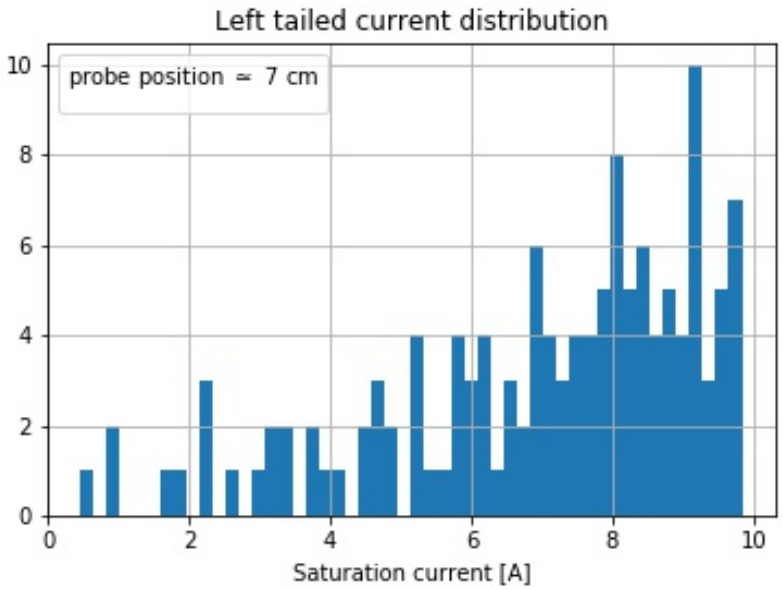


Figure: *Zoom on the sampling window*

Probability distribution





- The tail of the distribution

Skewness

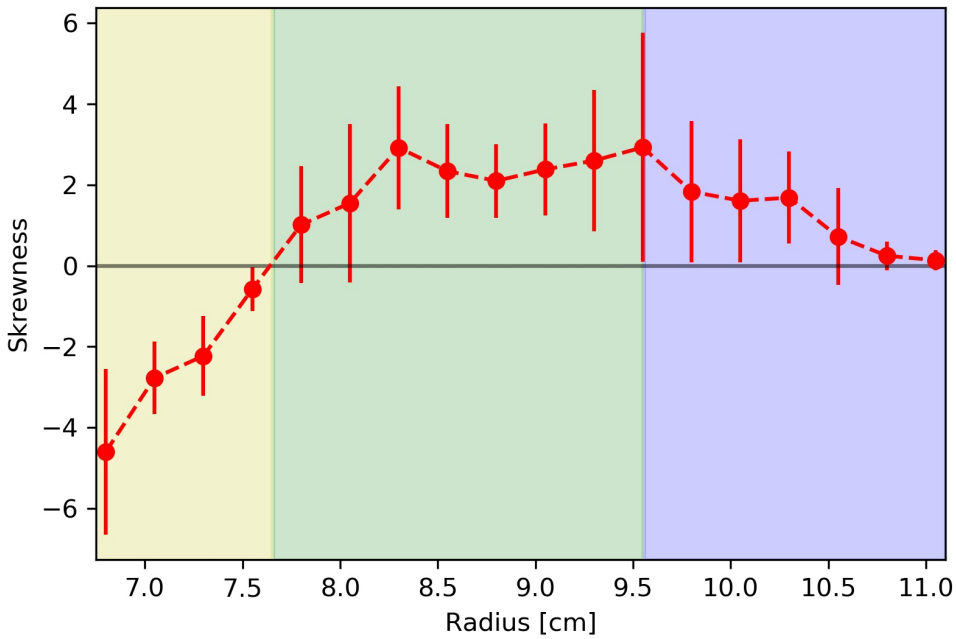


Figure: *Averege over time*

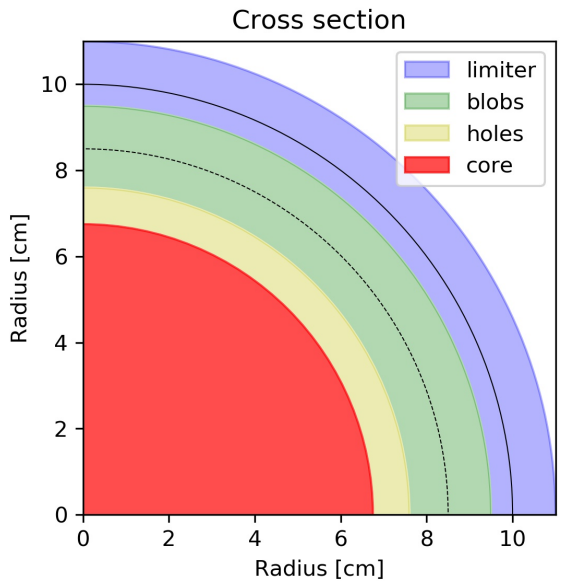


Figure: *Graphic depiction*

- Borders

Literature (Images)

- https://ionds.com/skewness-in-r/
- http://golem.fjfi.cvut.cz/wiki/TrainingCourses/PlasmaSchools/GOMTRAIC.cz/19/tasks/KJ_probes_on_golem.pdf
- http://golem.fjfi.cvut.cz/wiki/Diagnostics/ParticleFlux/RakeProbe/index