

# RECENT RESULTS FROM GOLEM TOKAMAK

"INDEED, YOU CAN TEACH AN OLD DOG SOME NEW TRICKS"

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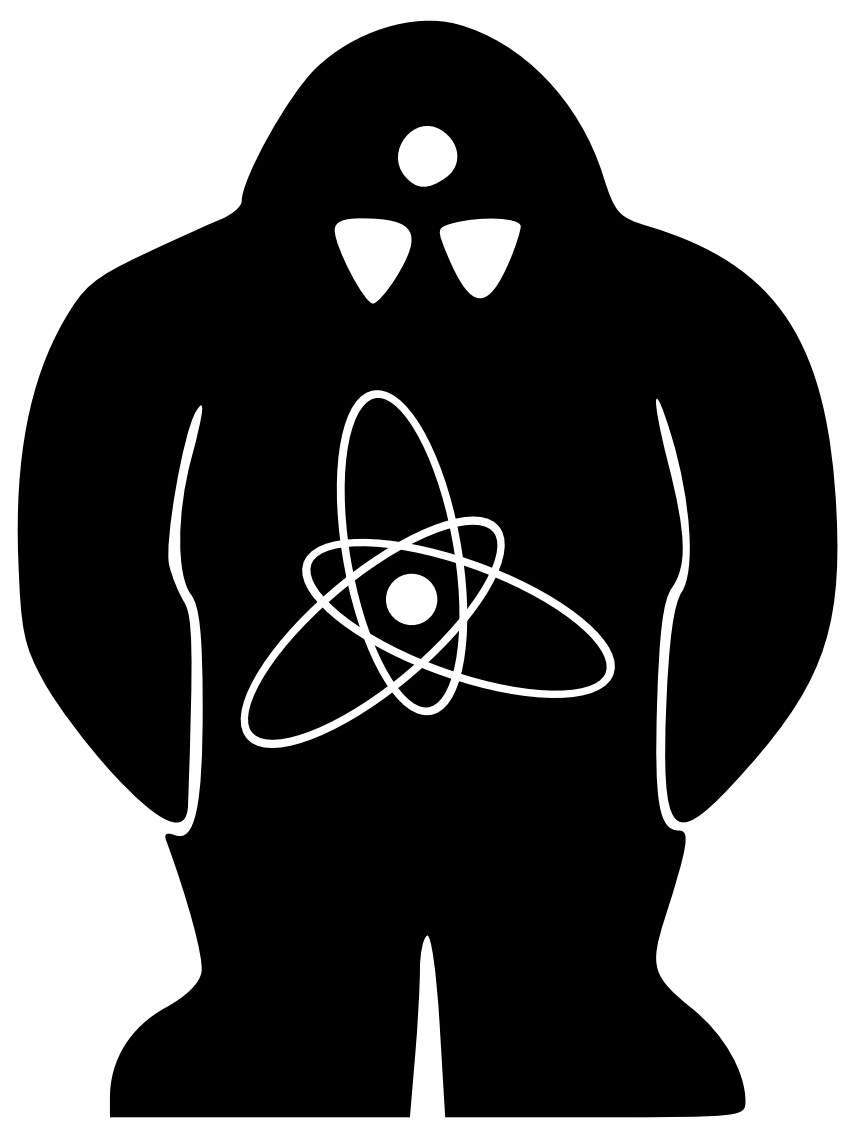
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## The GOLEM tokamak

SMALL UNIVERSITY BASED TOKAMAK:

- aimed at education and training
- study selected innovative concepts particularly in the area of fusion plasma diagnostics and technology

CURRENT RESEARCH HIGHLIGHTS:

- The first tokamak operating with HTS coils
- MHD studies using a new in-vessel ring
- Tests of the two 3D high-temperature Hall sensors
- Comparison of edge plasma turbulence properties in H<sub>2</sub> and He discharges
- Development of advanced plasma breakdown predictor using learning machines

GOLEM OPERATIONAL FEATURES:

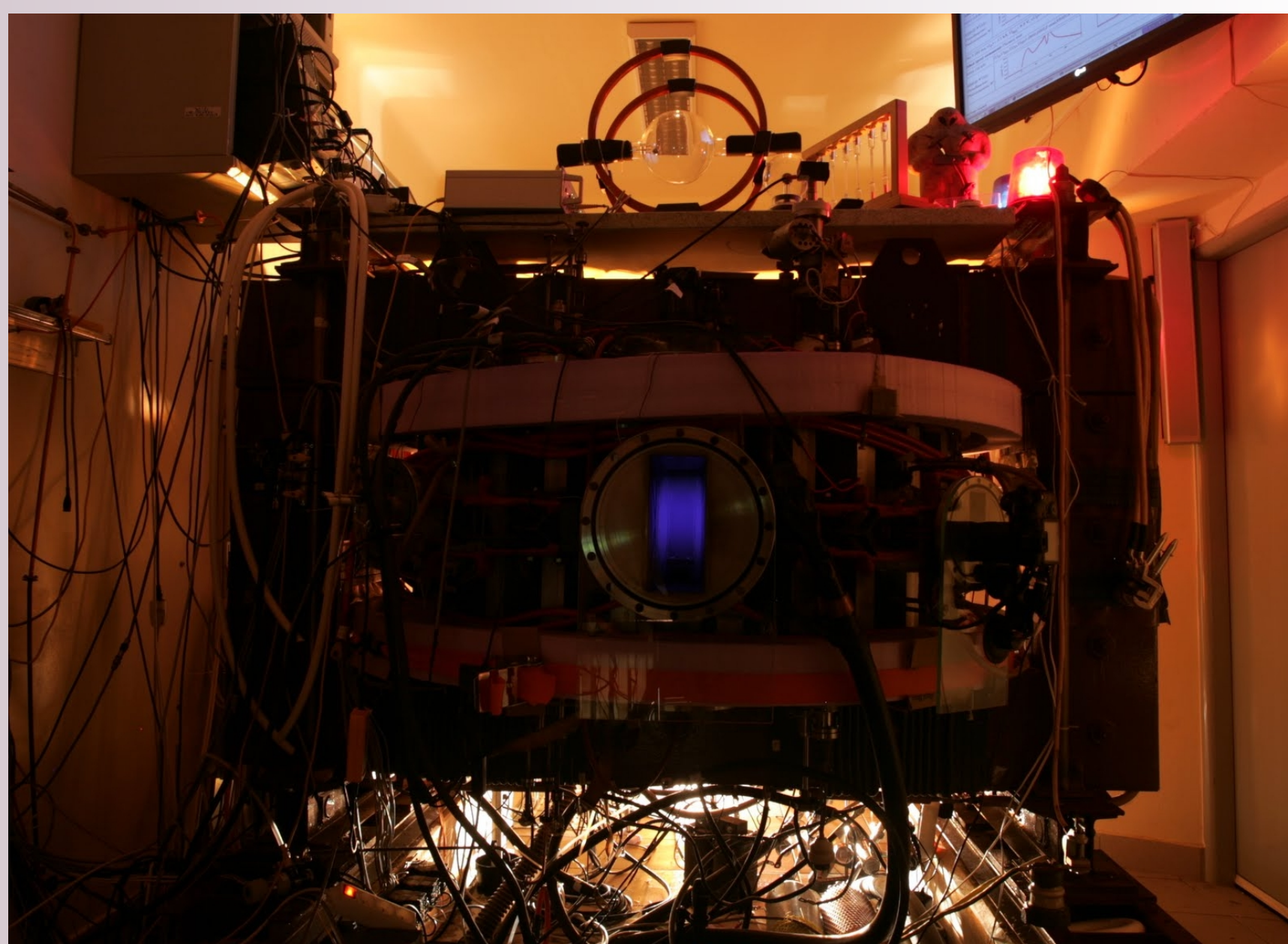
Major/minor radius R/a	0.4/0.085 m
Toroidal magnetic field B <sub>T</sub>	< 0.5 T
Plasma current I <sub>p</sub>	< 8 kA
Discharge length	< 20 ms
Max. plasma temperature T <sub>e</sub>	< 200 eV
Working gas	H <sub>2</sub> or He

DIAGNOSTICS:

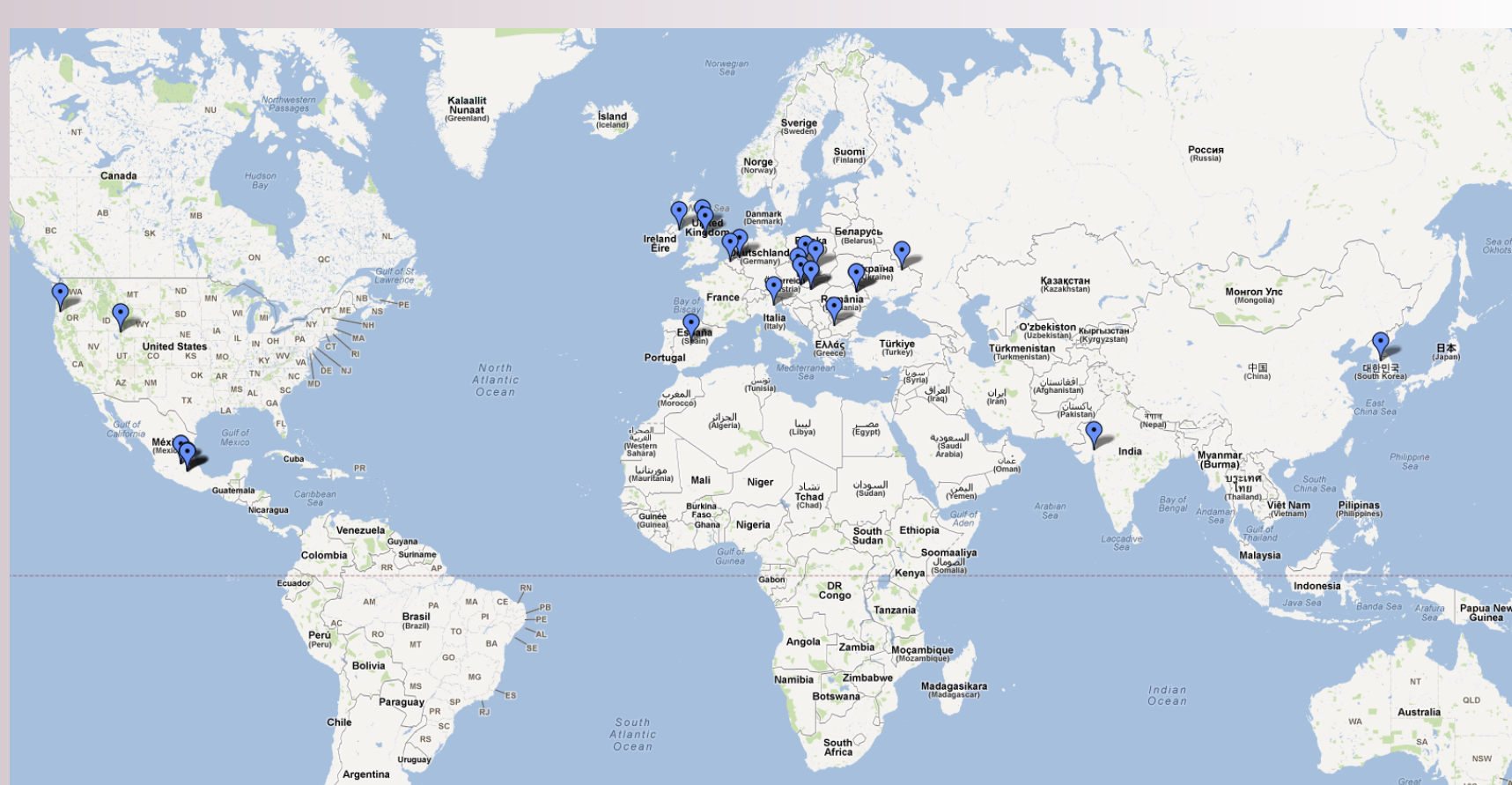
standard set of magnetic sensors, H<sub>α</sub> photodiode, rakes of Langmuir probes, fast cameras, 16 coils on poloidal ring, ...

ADVANCED FEATURES:

full remote control via HTTP/SSH, virtual control room, open-source based control and analysis software, data publically accessible



## GOMTRAIC 2012

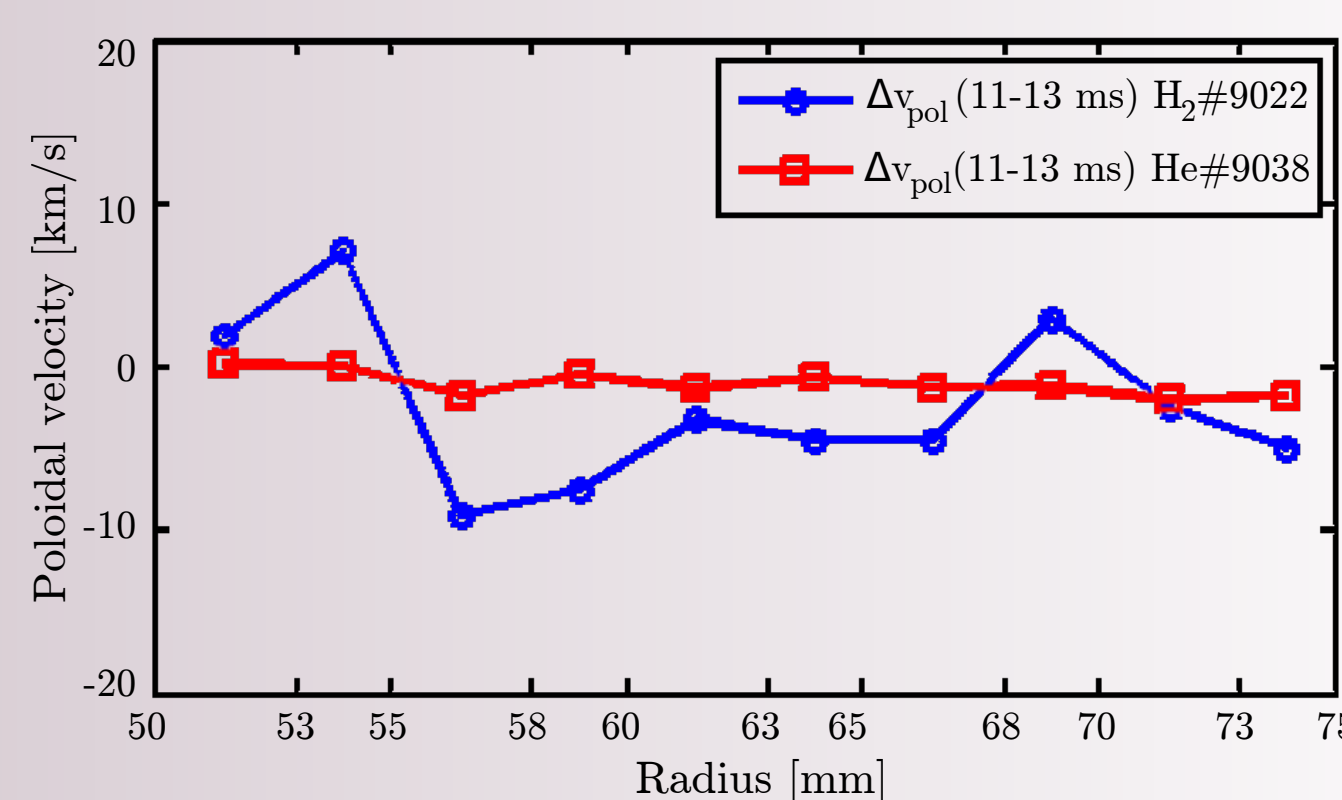


- Remote practical training in tokamak physics on GOLEM
- Participants select from 11 topics
- They propose and conduct real experiments on GOLEM via remote control tools
- Truly global event – 49 participants from 17 countries spread over 3 continents.

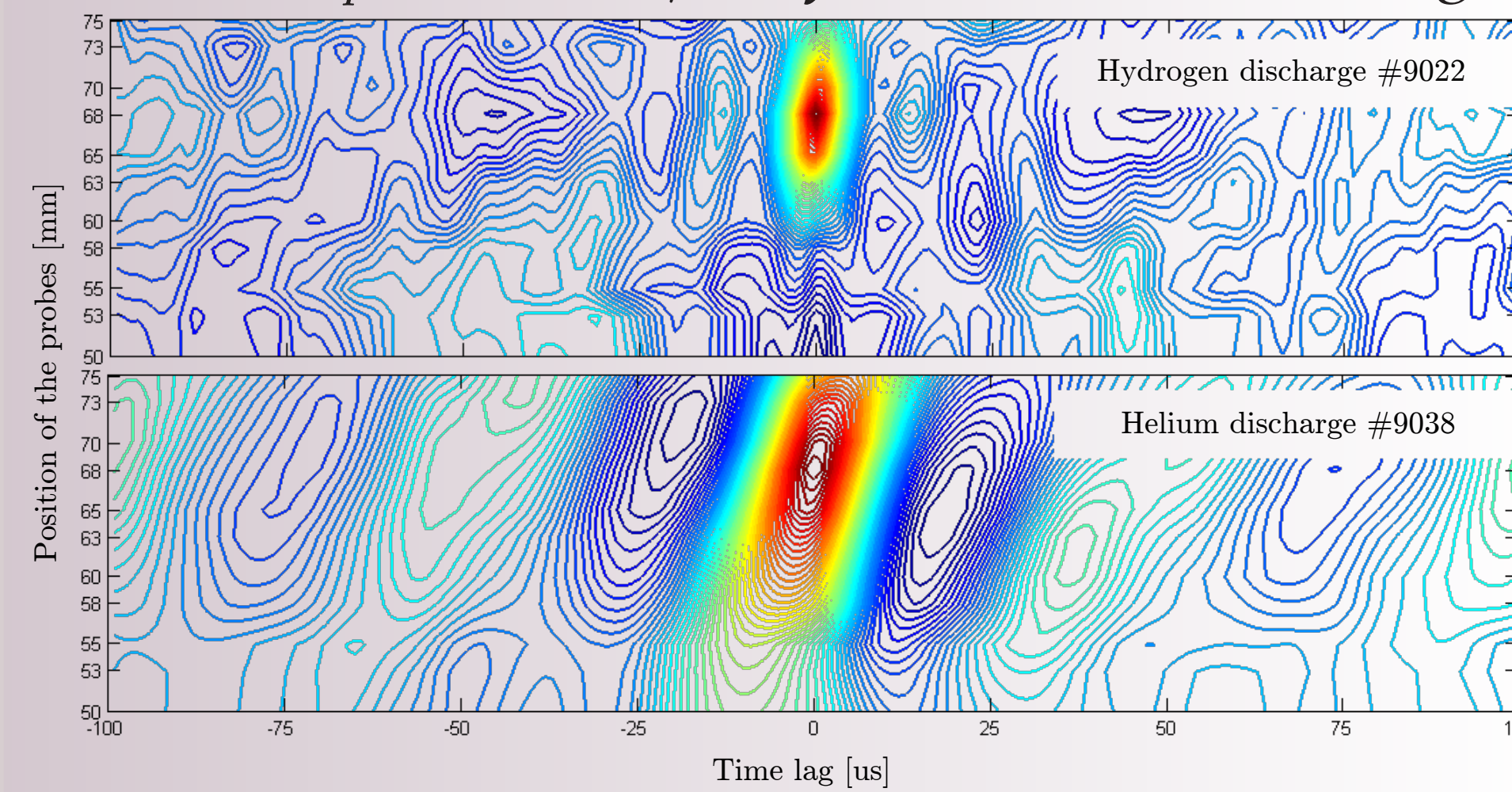
## Edge plasma turbulence

- Study of statistical properties of electrostatic turbulence during hydrogen and helium discharges
- Radially oriented array of 16 Langmuir probes spaced by 2.5 mm

Radial correlation length of plasma floating potential turbulent structures is noticeably lower in Hydrogen discharges compared to those executed in Helium. These findings are consistent with the higher values of shear in radial profile of plasma poloidal velocity measured during H<sub>2</sub> discharges compared to flat profiles observed for He working gas discharges.



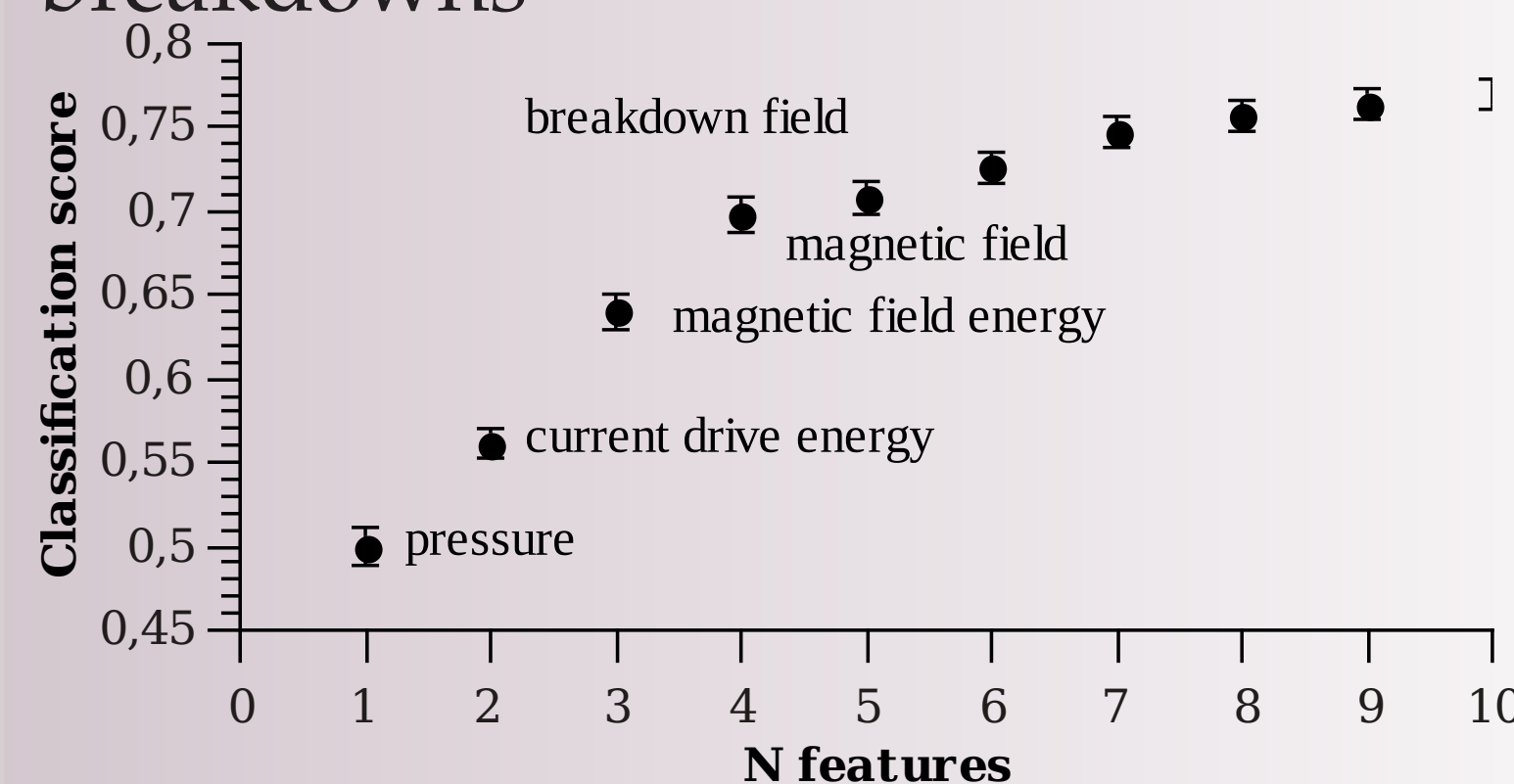
Radial profiles of poloidal plasma velocity determined as  $V_{pol} = E_{rad}/B_T$  for H<sub>2</sub> and He discharges



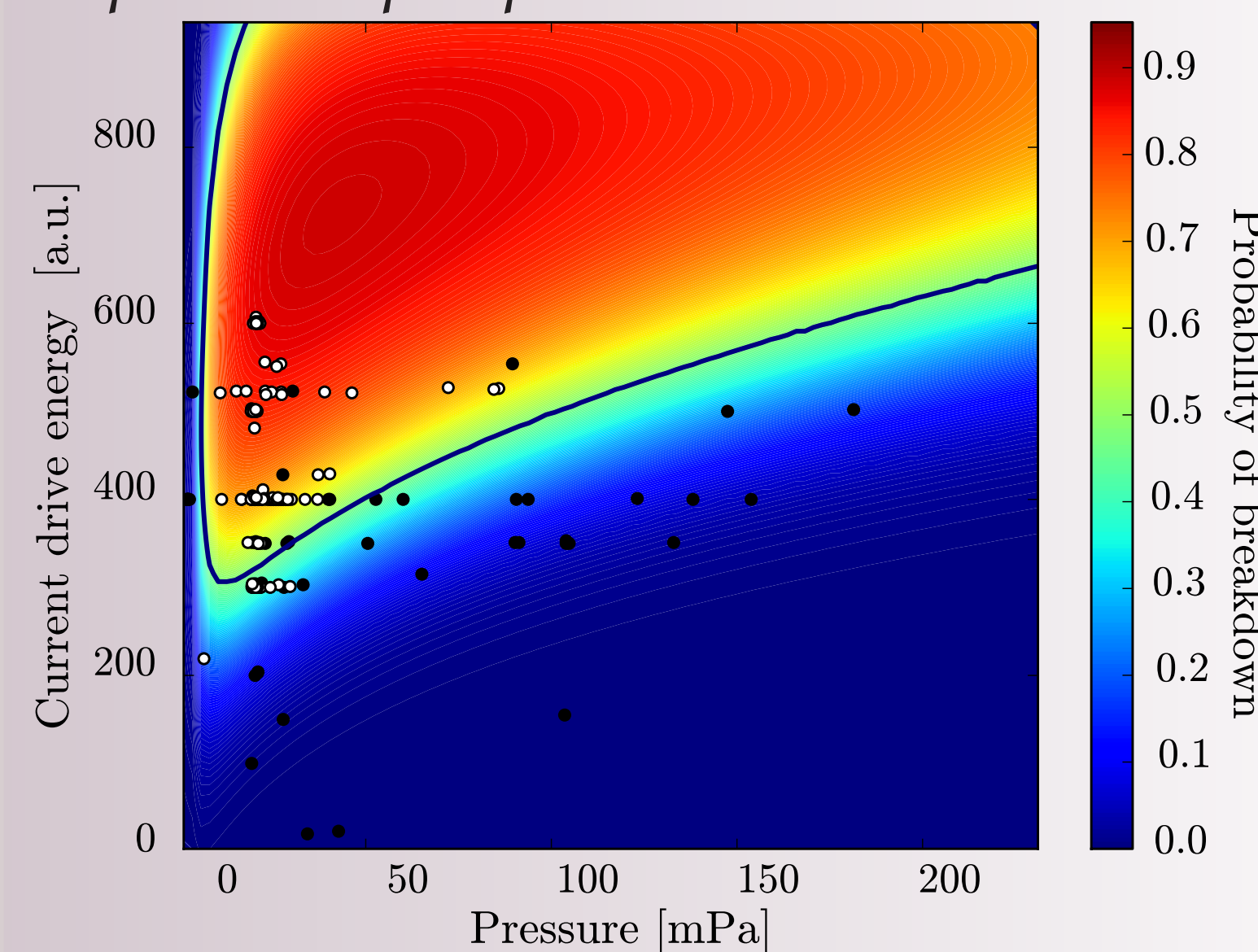
Cross-correlation functions of the plasma floating potential for hydrogen and helium discharge

## Breakdown studies

Prediction of plasma breakdown using support vector learning machine (SVM) algorithm  
1060 successful breakdowns and 370 failed breakdowns

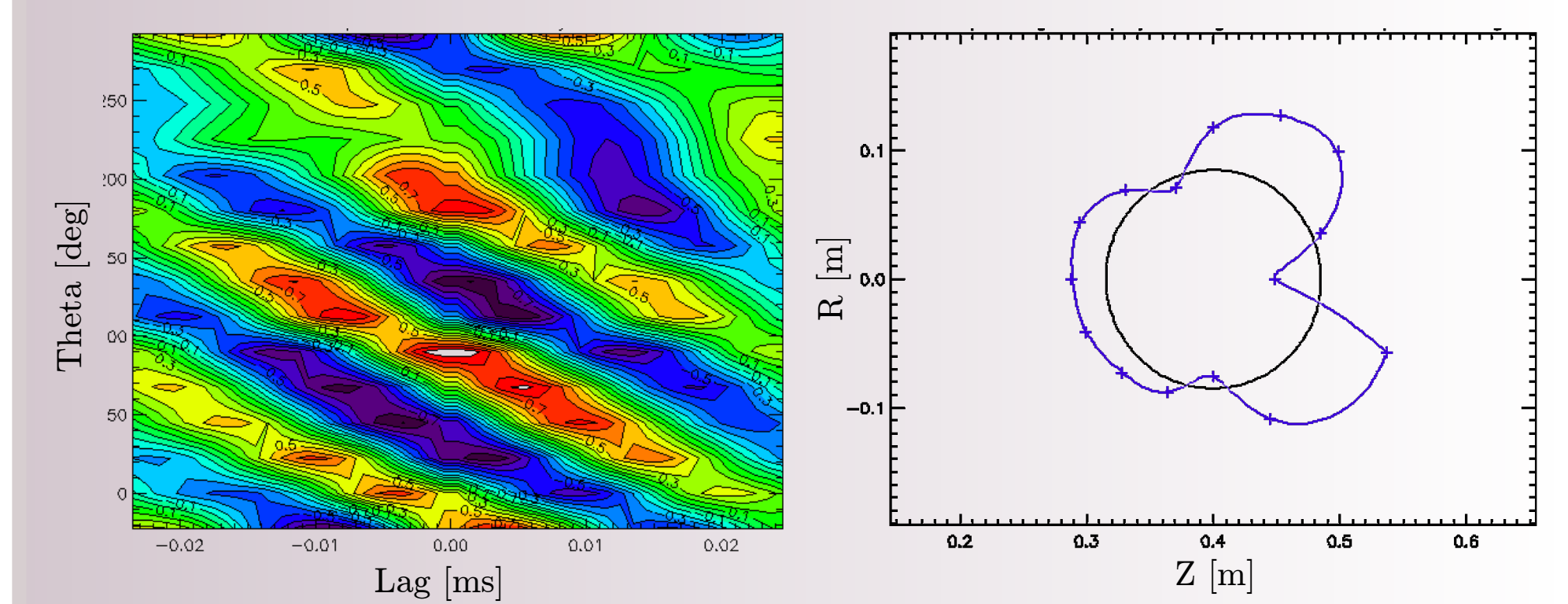


Optimal input parameters have been determined



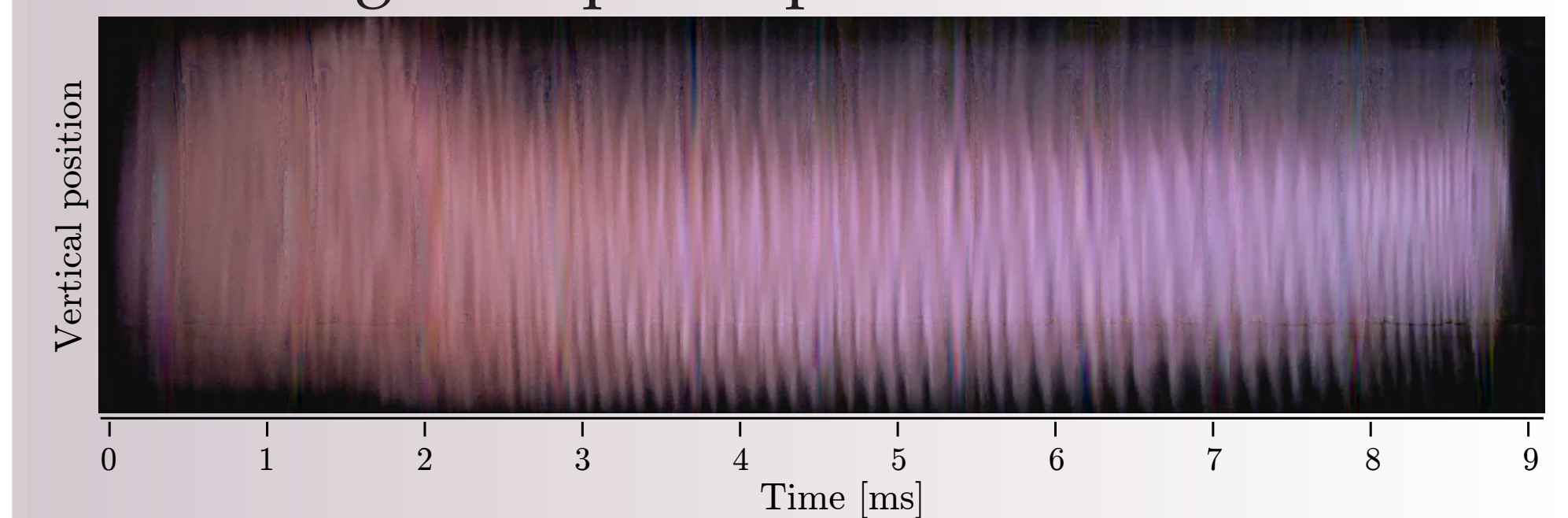
Prediction is compared to the actual experimental data where white circles denote successful breakdown and black circles mean no plasma breakdown

## MHD studies



Basic analysis of mode m=3 in shot #8252

Spatial and temporal characteristics of magnetic turbulence using new full poloidal in-vessel ring of 16 pick-up coils.

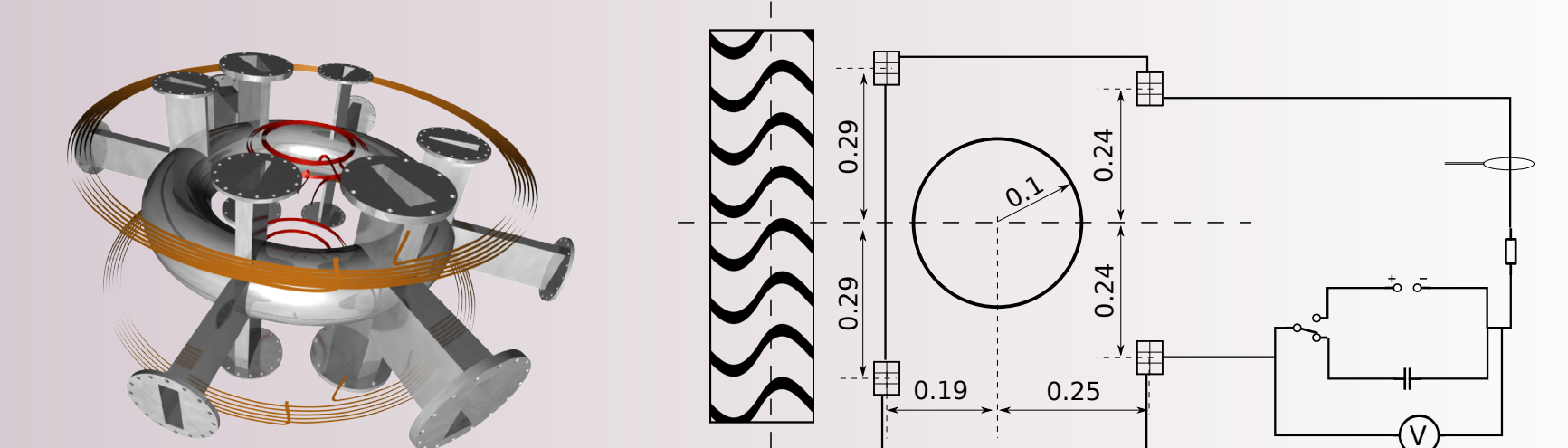


Evolution of vertical position of plasma emissivity during strong MHD activity for He shot #9141 in true colors

## New superconducting coils

(see P2.052 for more details)

- Two ex-vessel poloidal field coils wound from (Re)BCO SCS12050-AP high temperature superconductor tape
- DC currents up to 250A (limited by power supplies available), AC currents up to 1 kA, and the current ramp rates up to 0.6 MA/s were achieved.
- Long term compatibility of HTS coil operation with standard GOLEM plasma discharges was demonstrated.



## Summary

Active research in several directions experimental study of electrostatic and magnetic turbulence, estimation of energy spectrum of runaway electrons, through evaluation of HTS coils performance, to advanced predictive algorithms, is pursued at **the oldest operational tokamak in the world – GOLEM.**

Open minded approach either to GOLEM accessibility for the world wide plasma physics community and also to the new trends in the tokamak physics and technology are essential elements behind this success story.

## Contact us

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