

Progress of the Directional Electron Probe design for JT-60SA

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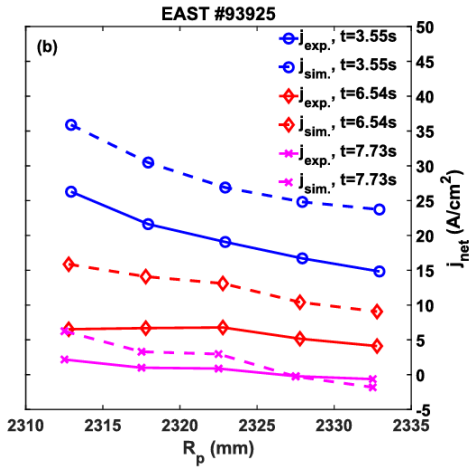
Contents

- Feasibility of a Directional Electron Probe (DEP) on JT60-SA
- Verification of the scientific outcome
- Conceptual design
- Design of the data acquisition (DAQ) system components
- Preliminary layout in the JT-60SA environment
- Draft timeline and sequence of activities
- Draft evaluation of the costs
- Summary

Feasibility of a Directional Electron Probe (DEP) on JT-60SA

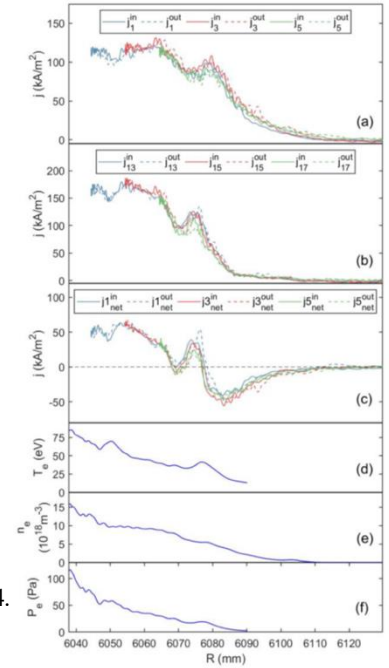
Diagnostic feasibility

LHCD effect on SOL current in EAST

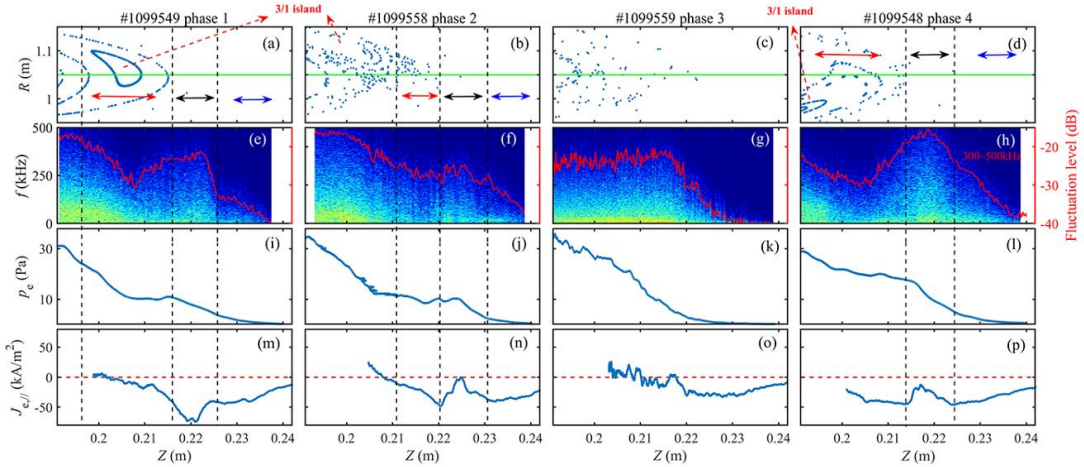


Liu, S. C., et al. Nuclear Fusion 61 (2021): 126004.
Liao, L., et al. Fusion Engineering and Design 215 (2025):114904.
Hua, J., et al. Plasma Science and Technology 28 (2026): 085105.

SOL current structures in W7-X



SOL current structures with a 3/1 island in J-TEXT



The DEP can be adapted for use on JT-60SA, enabling studies of SOL parameters, currents, filamentary structures and so on.

Mechanical feasibility

The DEP will be easily installed on JT-60SA, as its probe head imposes no special installation constraints compared with other probe heads.

The probe's measurement range may be limited under the higher plasma parameter conditions expected on JT-60SA.

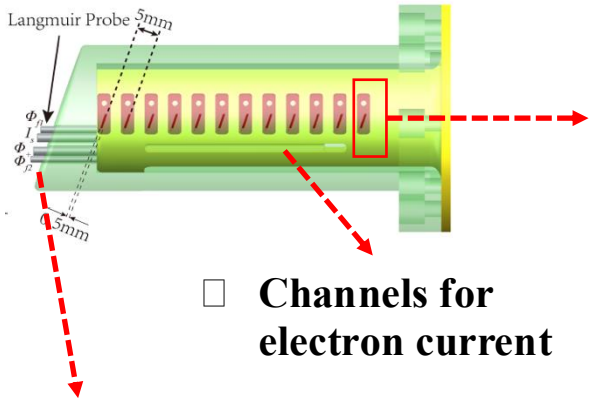
Probes can not be used for the 2026 and 2027 campaigns on JT-60SA

Where to install

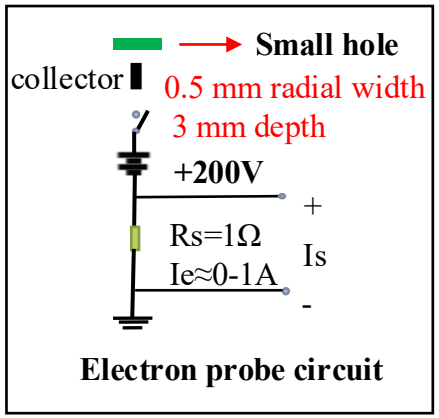
Is there a holder/ manipulator to carry the DEP in future campaigns?

Verification of the scientific outcome

DEP structure



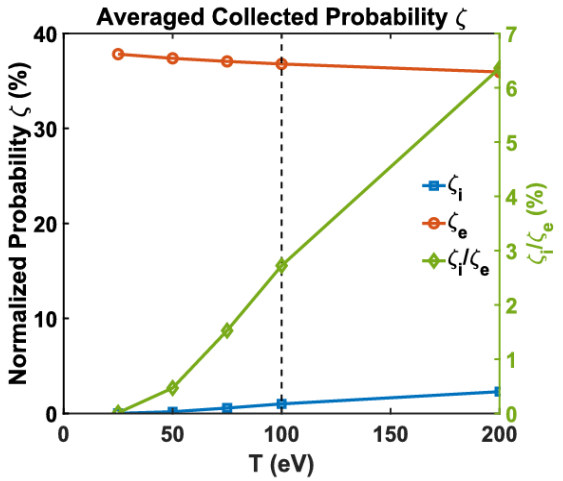
- Channels for electron current

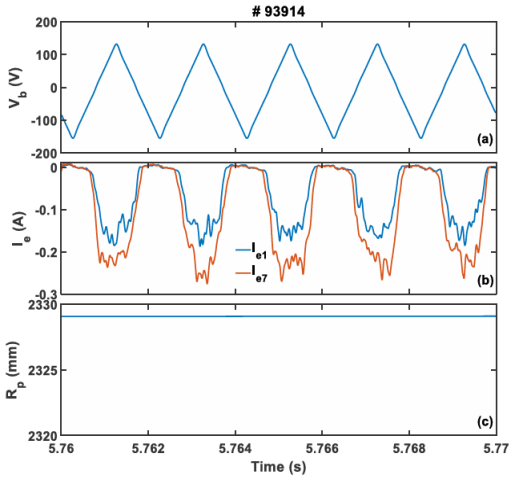


- Four Langmuir probes
  Providing **electron temperature**
  electron density
  fluctuations
  …

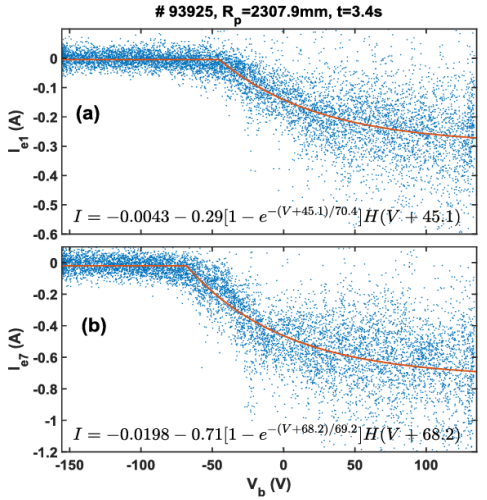
- **Current** along magnetic field lines : $I_{net} = I_{e,1} - I_{e,2}$
  (under positive biasing)
- **Electron energy distribution** on both sides
  (under sweeping)

The collected flux is mainly contributed by electrons





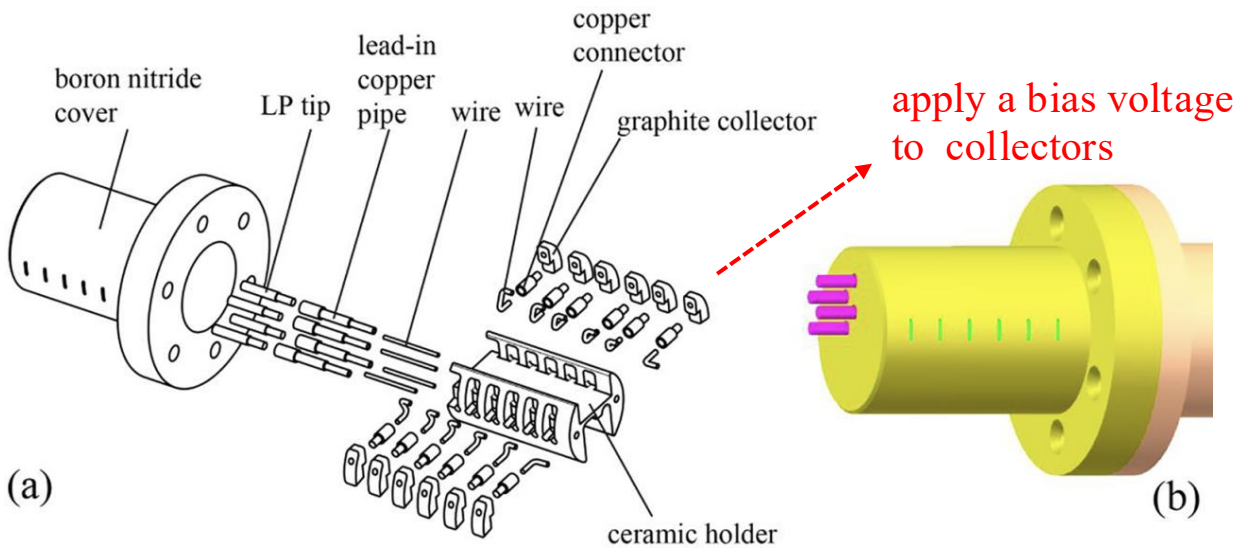
I-U characteristics of DEP



Liu, S. C., *et al. Nuclear Materials and Energy* 29 (2021): 101080.
Liao, L., *et al. Fusion Engineering and Design* 215 (2025):114904.

Conceptual design

Design of DEP for JT-60SA



Sketch of DEP. (a) Exploded drawing; (b) side view

Design of the data acquisition (DAQ) system components

Design of the DAQ system for JT-60SA

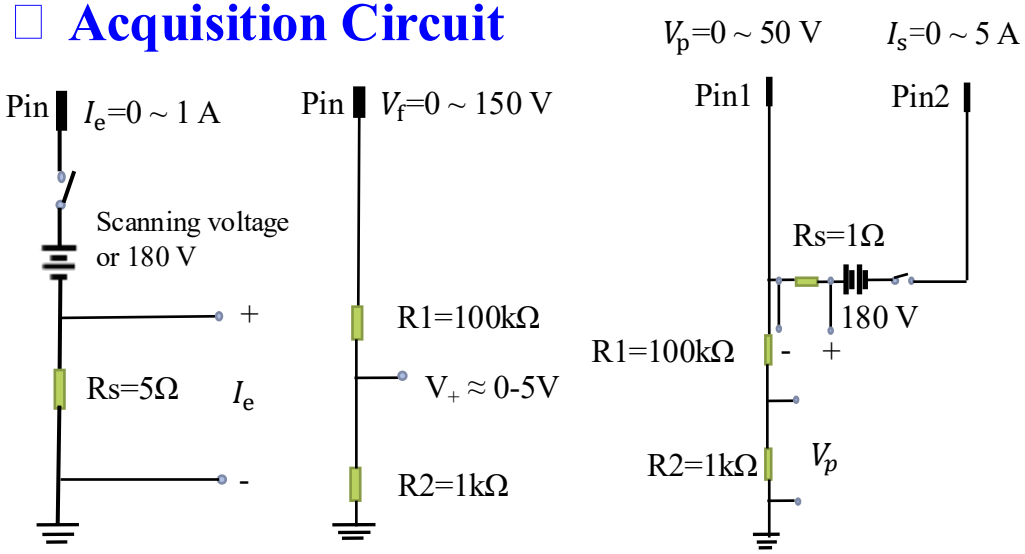
DEP head
Langmuir channels and DEP channels

Power supply

First-stage isolation amplification
Sensor → Preamplifier → Filter → Isolation

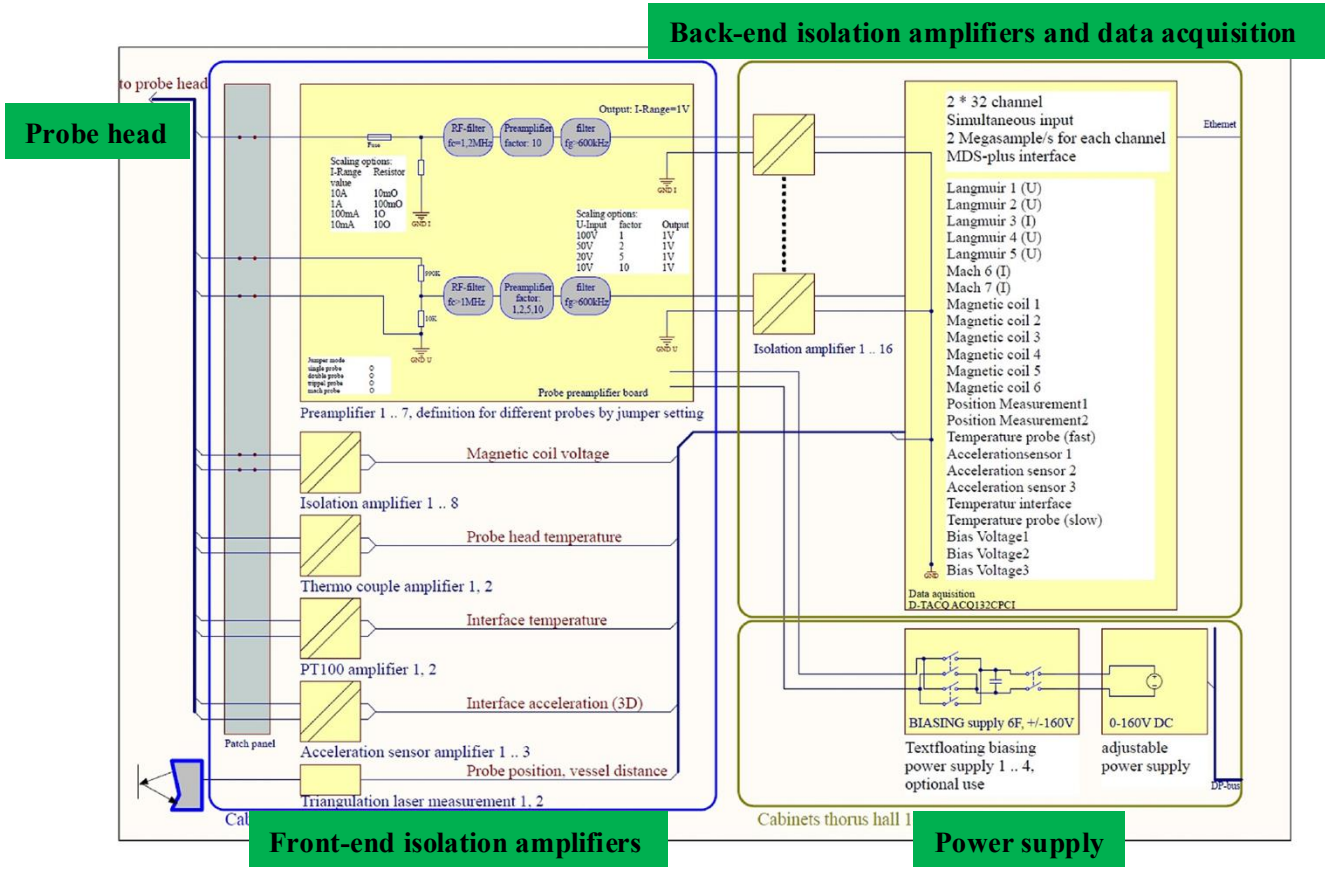
Isolation amplification and data acquisition
16 channels

Acquisition Circuit



DEP circuit | Floating potential circuit | Double probe circuit

DAQ system on W7-X



Nicolai, D., et al. Fusion Engineering and Design 123 (2017): 960–964.

Preliminary layout in the JT-60SA environment

- **Probes can not be used for the 2026 and 2027 campaigns on JT-60SA**
- **Where to install** **Is there a holder/ manipulator to carry the DEP in future campaigns?**

Draft timeline and sequence of activities

- **The preliminary design of the probe has been completed.**
- **Once the installation location and other relevant details are confirmed, we can start optimizing the DEP design for JT-60SA and proceed with probe fabrication and assembly. (half a year)**

Draft evaluation of the costs

Cost category	Estimated cost (€)
Material costs (BN, graphite, copper, ceramics, wires, etc.)	4000
Machining costs (precision machining of all components)	8000
Assembly and testing	3000
Total estimated cost	**15000**

Summary

- At present, the work is therefore limited to the design stage.
  - Is there a holder/ manipulator to carry the DEP in future campaigns?
- The preliminary design of the probe has been completed. Further optimization can be made according to future requirements.
- Typically, the full process from component fabrication to final assembly can be completed within about half a year.

Thanks for your attention!