Initial assessment of Langmuir probes for JT-60SA

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This work has been carried out within the framework of the EUROfusion Consortium and has received funding from the Euratom research and training programme 2014-2018 and 2019-2020 under grant agreement No 633053. The views and opinions expressed herein do not necessarily reflect those of the European Commission.

Task: determine the “best position” for divertor probes

Main constraints:

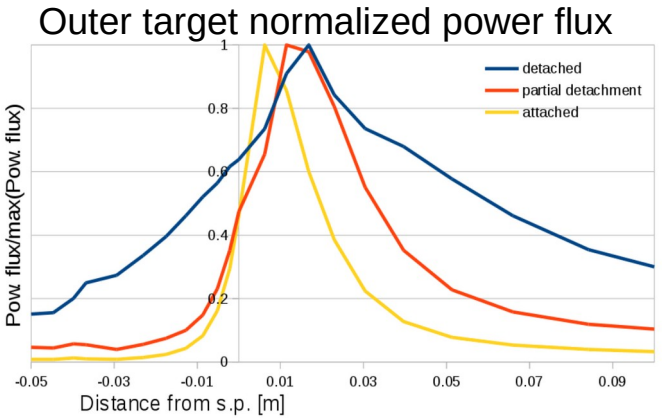
- Limited number of probes → 16 triple probes each tar.
- Limited flux expansion → ~5
- Low heat flux decay length → ~1-2mm at o.m.p.
- Minimum probes distance → 15mm
- Probes spatial definition → 4mm
- Many strike point positions
  - Corner
  - Half vertical target

Methodology

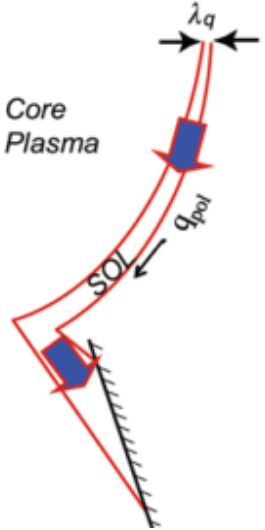
Choose probes position according to estimated power, temperature and particle deposition profiles on divertor targets

- Geometrical approximation
- 2D modelling (SOLEDGE2D/SOLPS) and probes simulation

We focused on attached cases since they have stiffer profiles



Geometrical approximation



$$\lambda_{q,out.tar.} = \lambda_{q,OMP} f_{Ex,OMP}$$

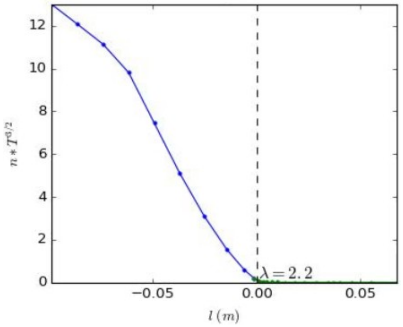
Eich scaling

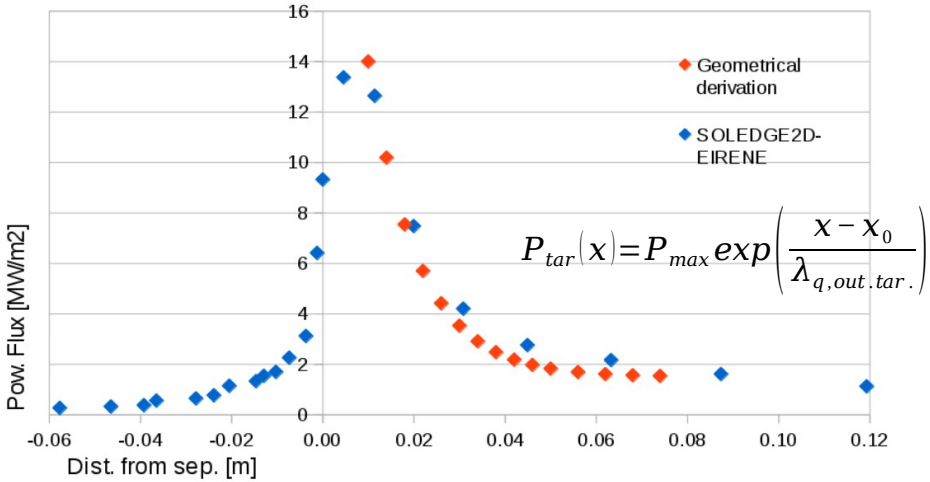
~5 for scenario #2 and #3 outer target

	SC. 2	Initial res. Phase II	Sc. 3
$\lambda_{q,OMP}$[mm]	1.40	1.35	1.45
f.e.out.div.	5	5	5
$\lambda_{q,out.tar.}$[cm]	0.7	0.7	0.7

- Typical length < minimum probes distance
- No information on other scenarios

How do this compare with more precide 2D modelling





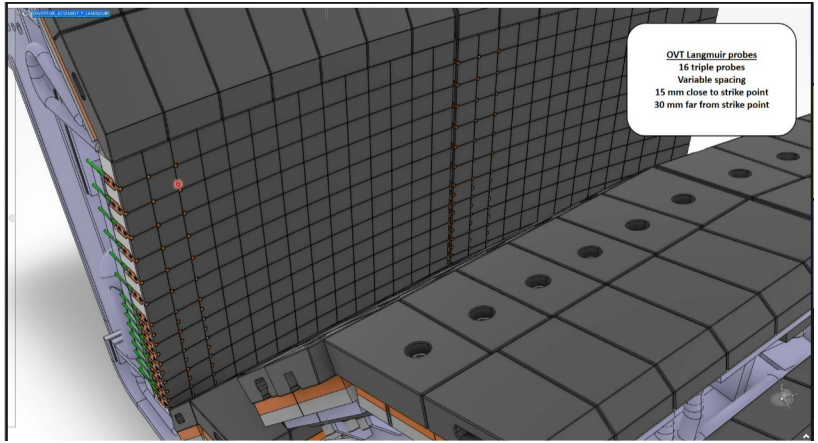
The estimated $\lambda_{q,otut.tar.}$ is *"consistently"* underestimated, the estimation is good within a 20/30% factor

- Minimum probe distance is required
- Sweeping may be needed if an accurate target plasma profile is required

Task: determine the “best position” for divertor probes

Constraints

- 16 triple probes each divertor
- Inner and outer div. poloidal length: ~40cm
- Probe dimension: 4mm
- Minimum probe distance: 15mm

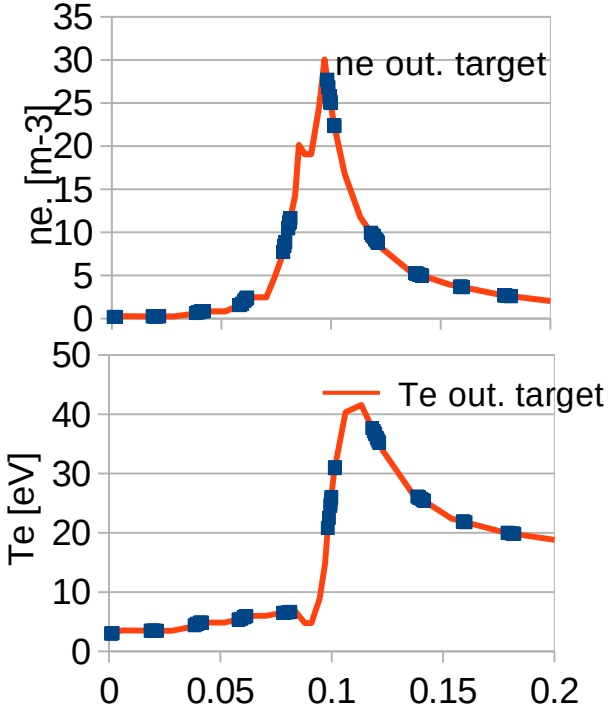


Probes simulation from 2D edge modelling

- Assume SOLEDGE2D-EIRENE (Sc. 2) or SOLPS-ITER (Sc. 3) simulations output as plasma background
- Assume probe initial position
- If sweeping is considered, a random position within the sweeping rage is assumed
- Physical values averaged over the probe physical dimension

Probes simulation: some examples

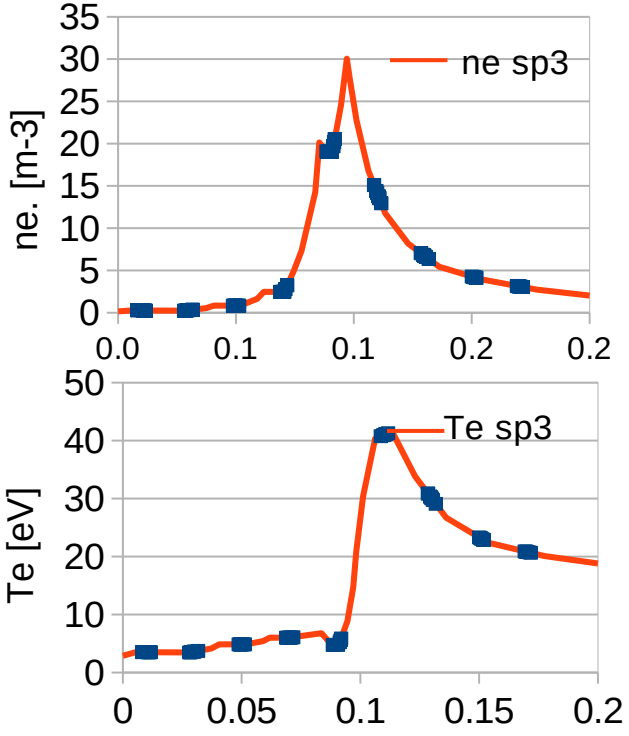
Influence of relative position of the s.p. with respect to the probes?



With **20mm** distancing between the probes the spatial definition is not high enough to reproduce the background plasma

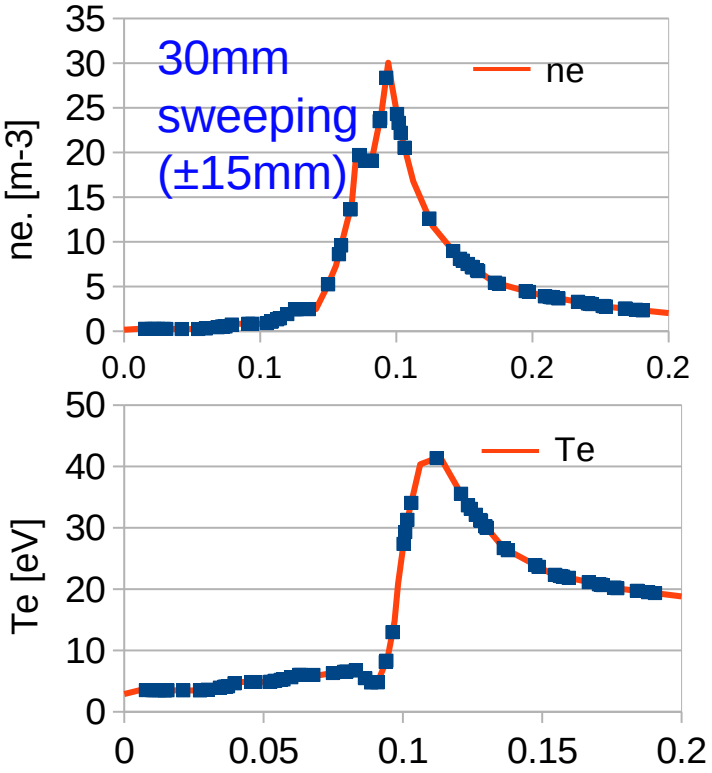
A different background plasma would have been assumed from the synthetic diagnostic data even if the background is the same

Some sweeping is needed for better definition



Probes simulation: some examples

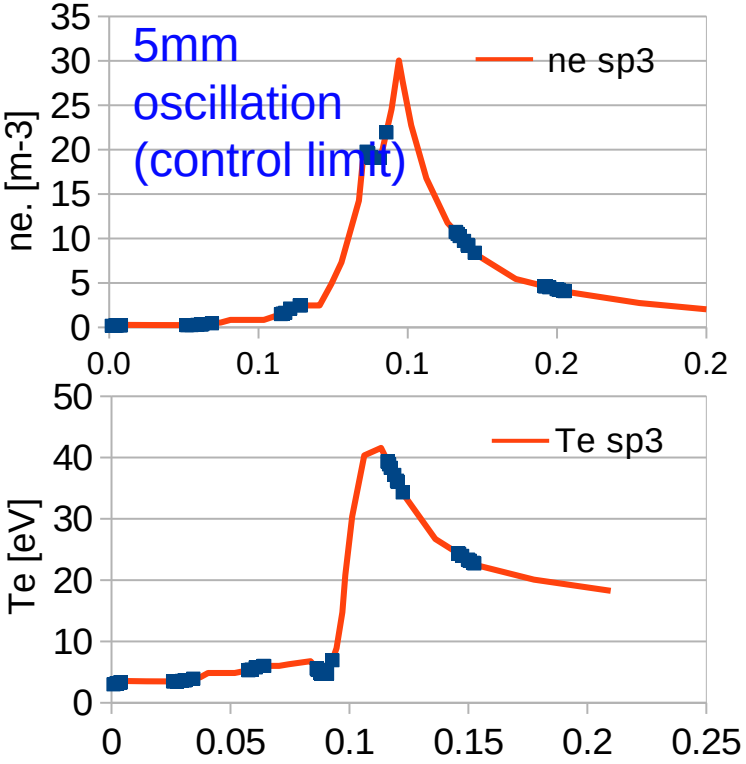
Assuming 20mm between the probes

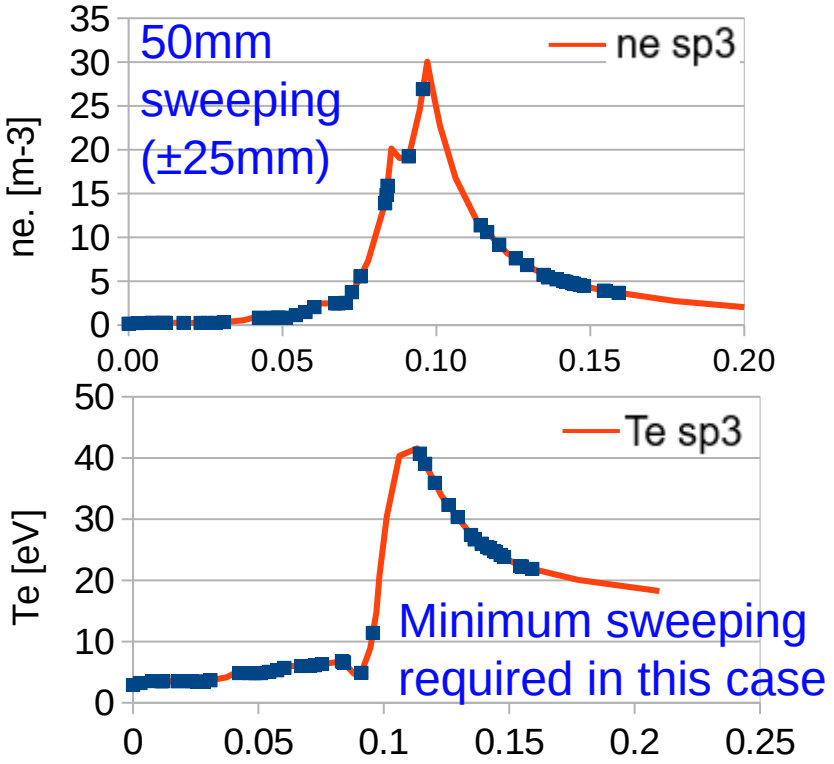


Very good reproduction of background plasma

Probes simulation: some examples

If the s.p. is a position where the probes distance in 30mm (or if a probe fails)





Probes simulation: some examples

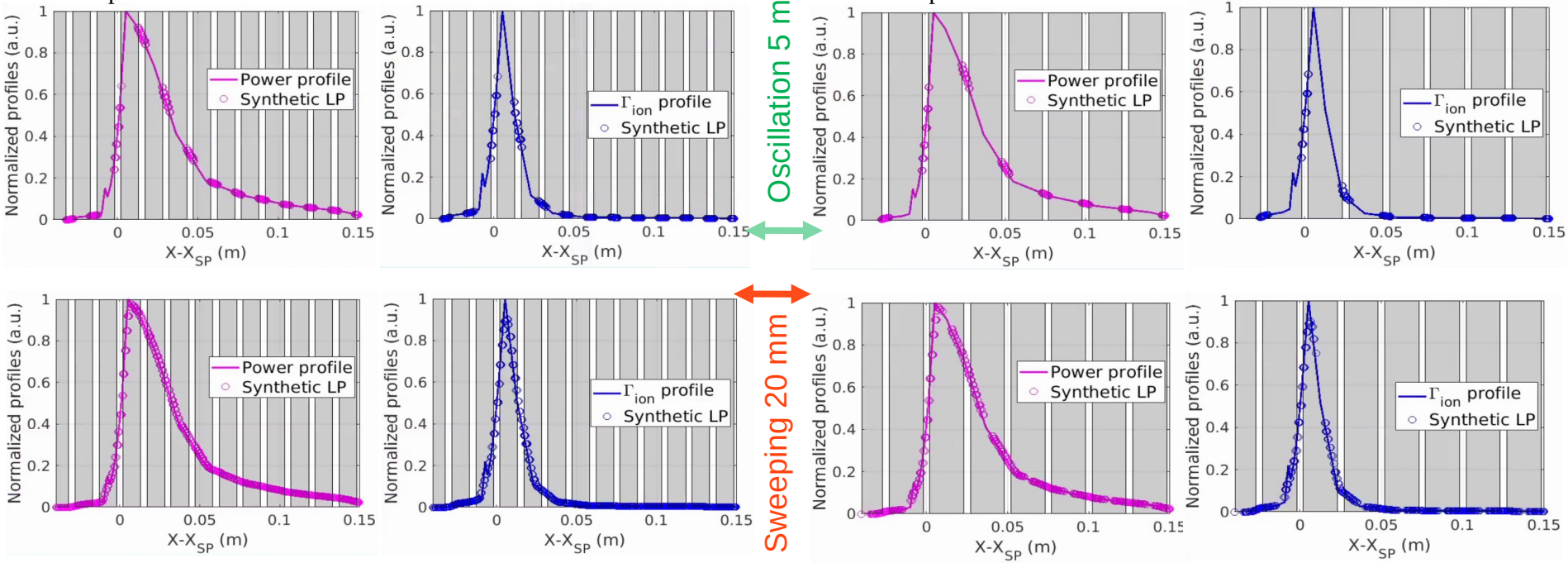
And about current and power profiles? (scenario 3)

Δx_{probe} = 15 mm

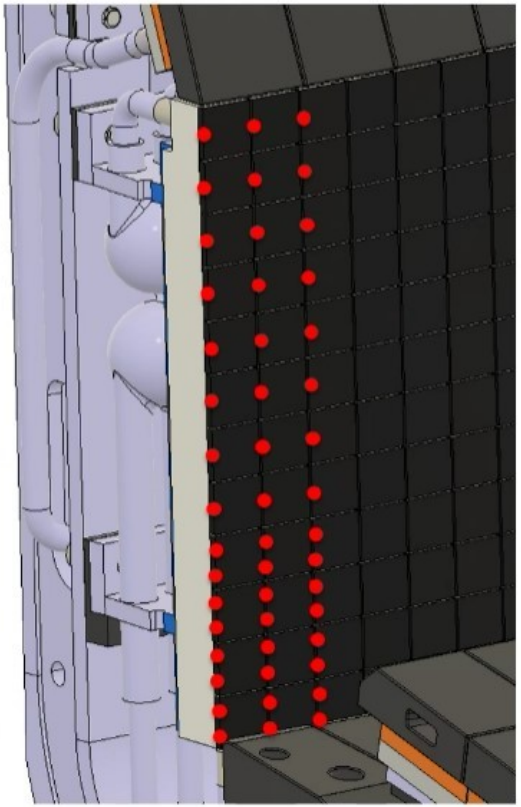
Δx_{probe} = 25 mm

Oscillation 5 mm

Sweeping 20 mm



Proposed solution



- First 8 probes distanced by 15mm
- Next 8 distanced by 30mm

- With this solution, the first 30mm gap goes from 12cm to 15cm from the divertor corner
  - 10cm from the strike point position in sc. 2 (corner)
  - 6cm from the strike point position in sc. 3 (vertical)

- In both cases the spatial resolution decreases far from the strike point since $\lambda_{q,out.tar.}$~1cm
- If a higher s.p. position is required, a 5cm sweeping will be sufficient

Conclusions / discussion points

- ✓ Synthetic LP data are obtained from edge simulations of both scenarios 2 and 3
- ✓ Different parameters were taken into account:
  - Distance between probe
  - Oscillation
  - Active sweeping
- ✓ 5cm sweeping allows to reproduce the background plasma and the target profiles (attached) even in case of a single probe failure
  - ➢ We would need information on strike point position control and/or sweeping capability and control?
- ✓ Probe distribution was proposed: denser in the proximity of the corner, less dense elsewhere
  - ➢ Is there interest in scenarios with strike point higher than the half of the vertical target
  - ➢ If so, will sweeping be possible for the main scenarios?