

First attempt to quantify the W7-X island divertor plasma by local experiment-model comparison

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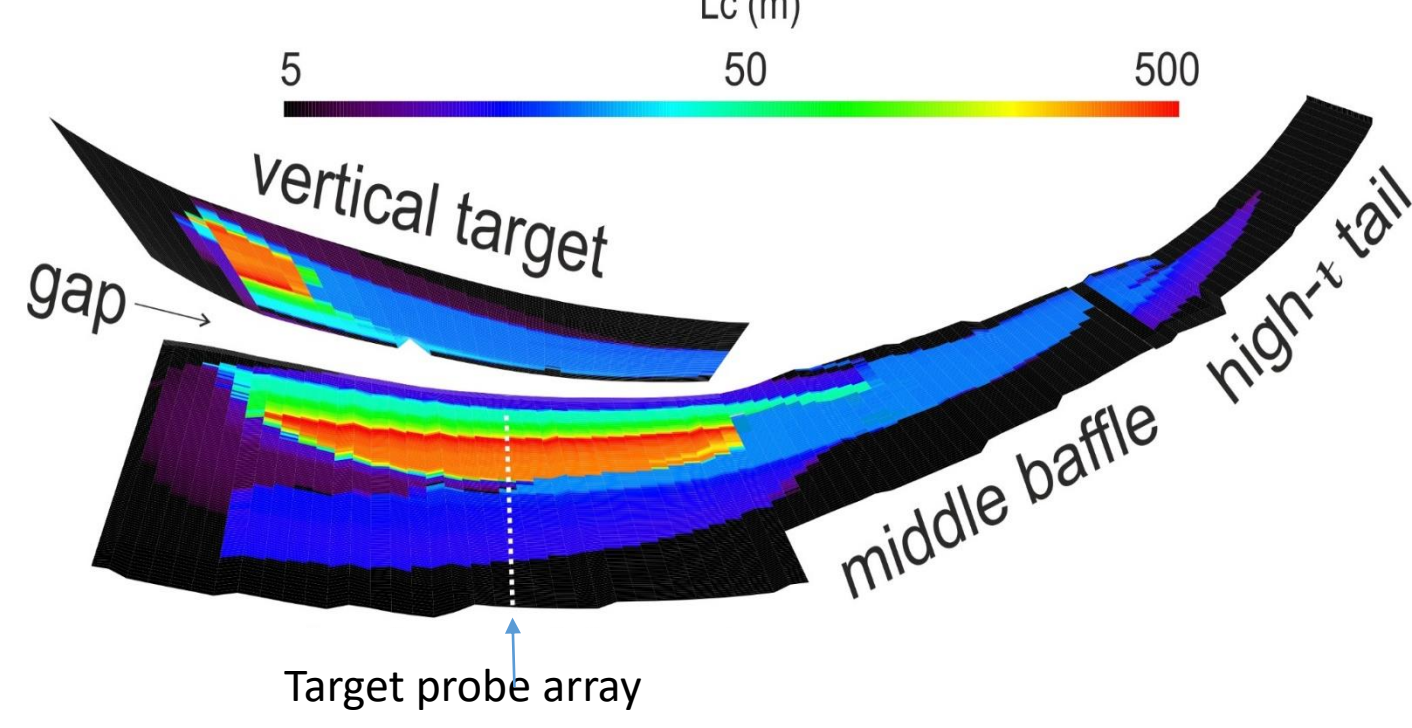
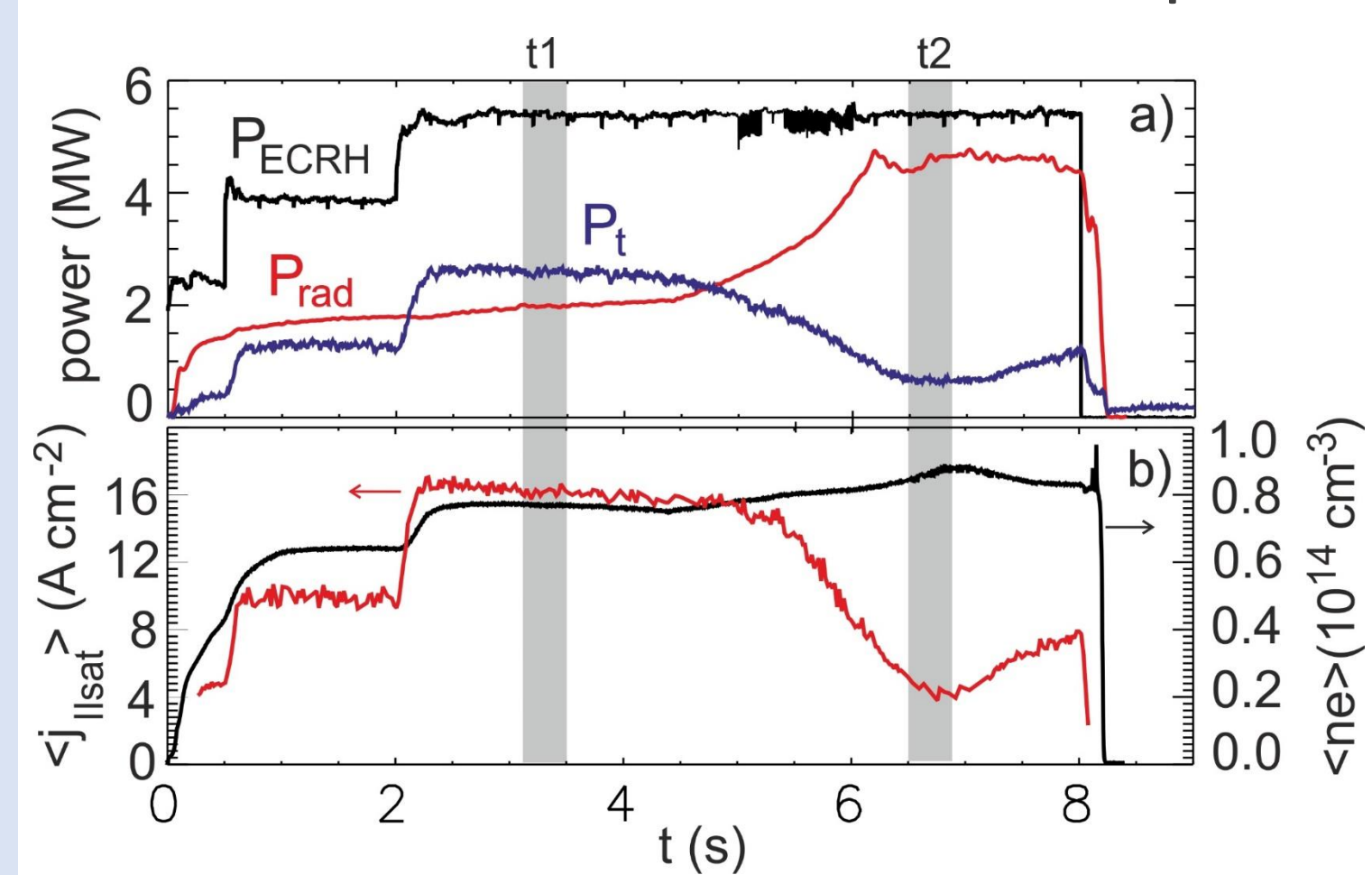
ABSTRACT

EMC3-Eirene simulations are compared with different local diagnostics on W7-X, as a complement to our recent work on “understanding detachment of the W7-X island divertor” [Y. Feng et al, submitted to Nucl. Fusion, 2021]. The main goals are to

- estimate cross-field transport coefficients
- identify the application limitations of the current EMC3-Eirene model
- verify the consistency of different diagnostics
- isolate geometric and physical effects that need to be prioritized in further developing the EMC3-Eirene code and improving diagnostic coverage

Experiment - #20180814.25

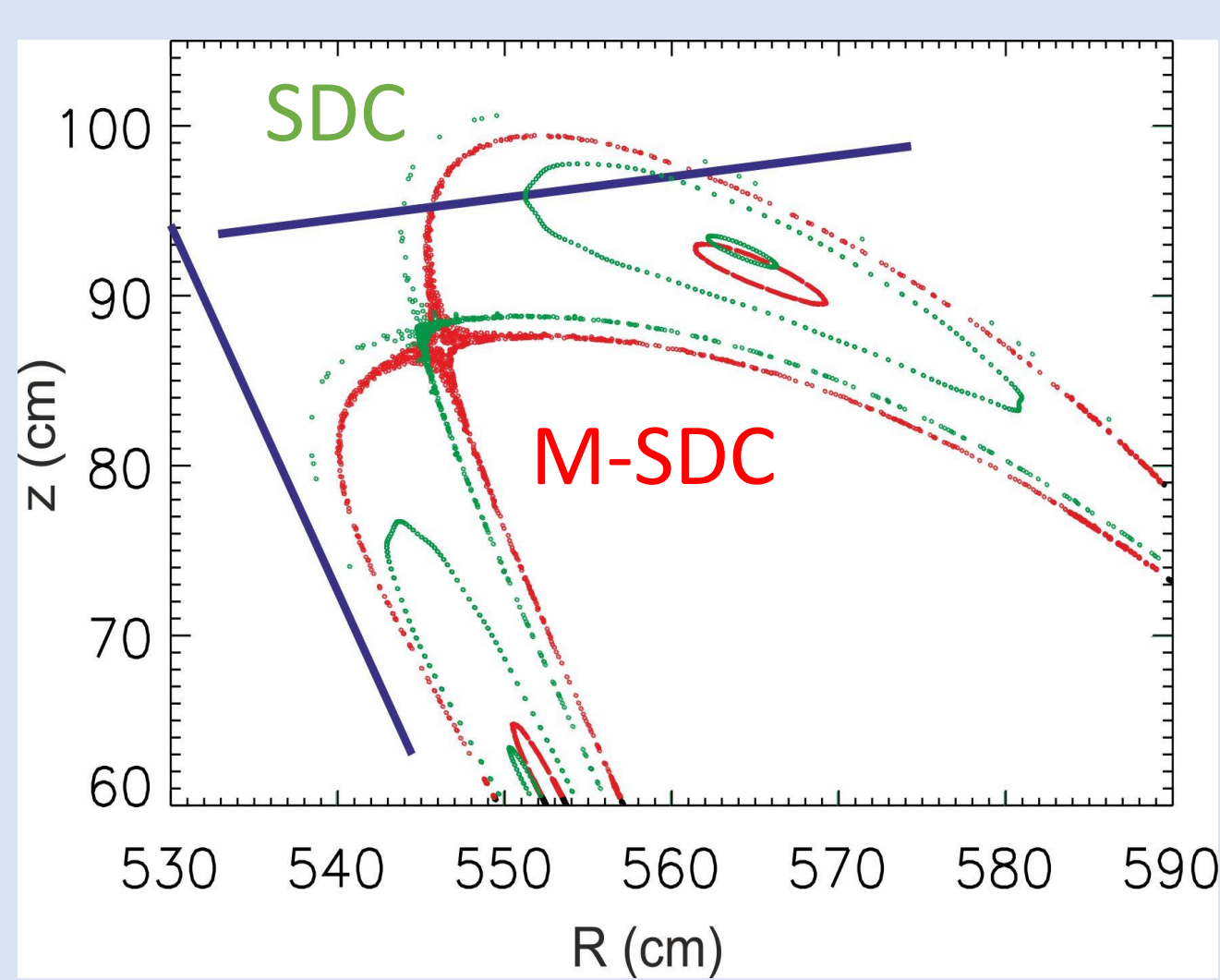
Time windows selected for comparison



- Most of the comparisons are made along the target probe array

Setup of three simulation series

Two configurations



- Error fields + beta-effects

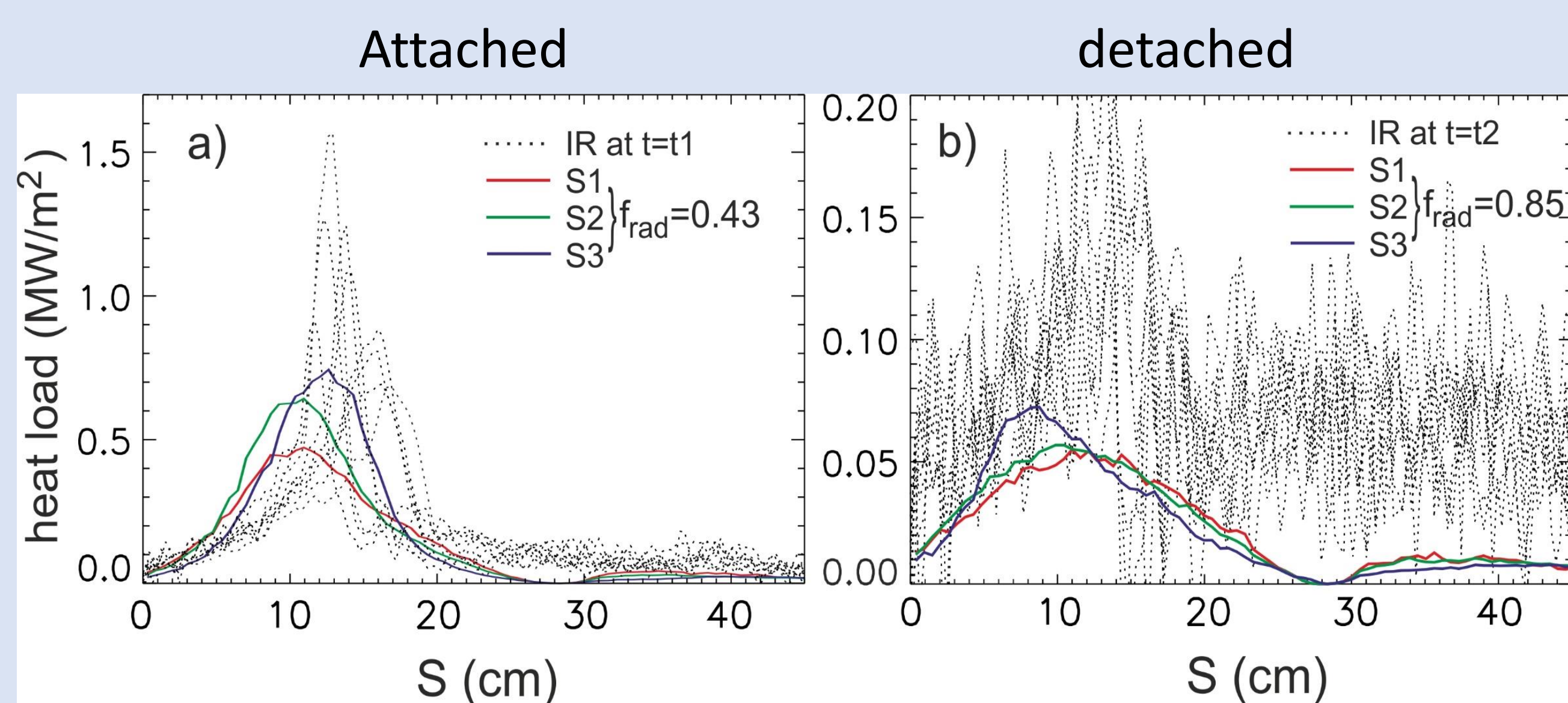
two sets of heat conductivities

series	Config.	P_{SOL} MW	D m^2/s	$\chi_e = \chi_i$ m^2/s
S1	SDC	5	0.5	1.5
S2	SDC	5	0.5	0.75
S3	M-SDC	5	0.5	0.75

- All cross-field transport coefficients are spatially constant.

Comparison results

EMC3 vs IR-cameras along the target probe array

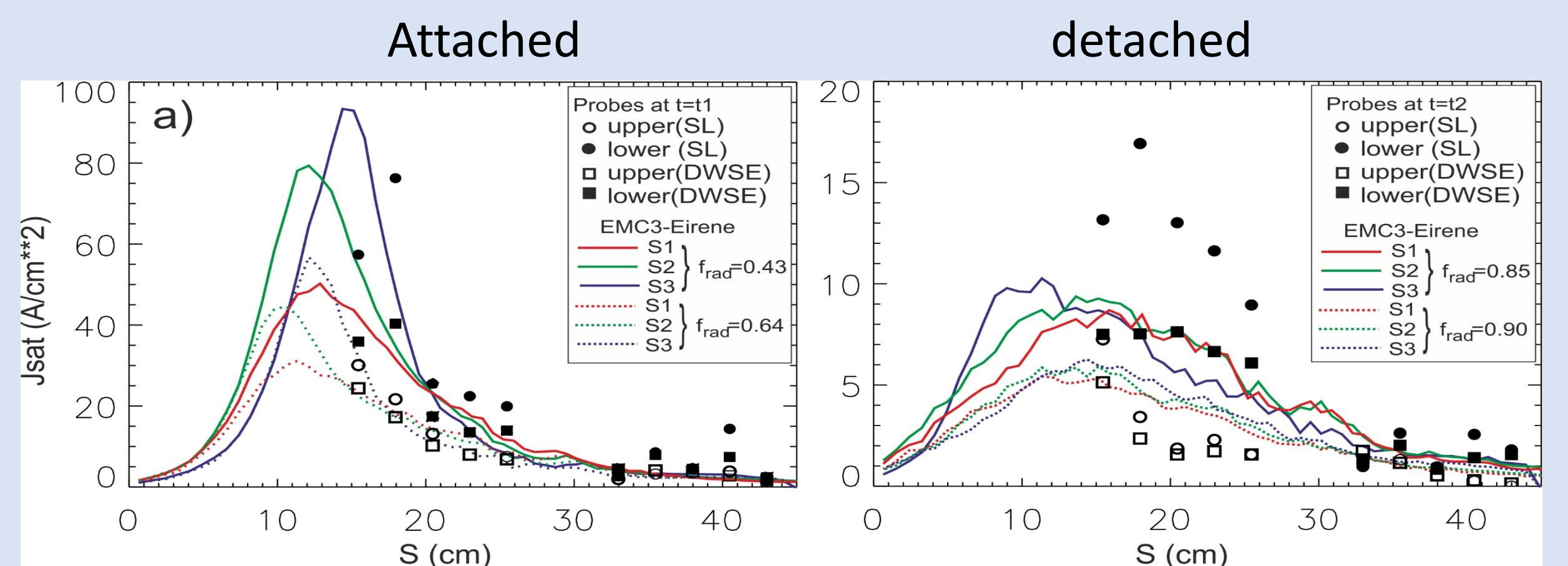


- The diverse IR-profiles indicate error-field and drift effects, which are not accessible to the 3D code.
- “offset” of IR-profiles presumably by radiation not taken into account in the modeling

ACKNOWLEDGEMENTS

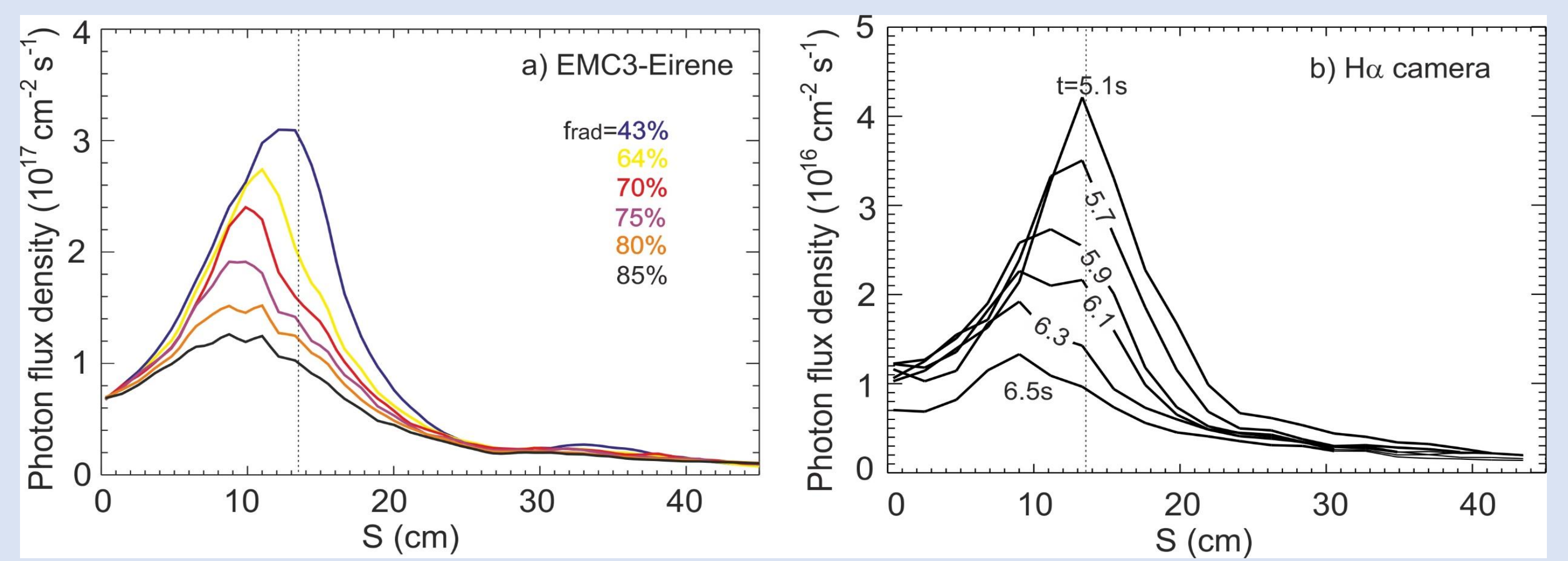
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EMC3 vs target Langmuir probes



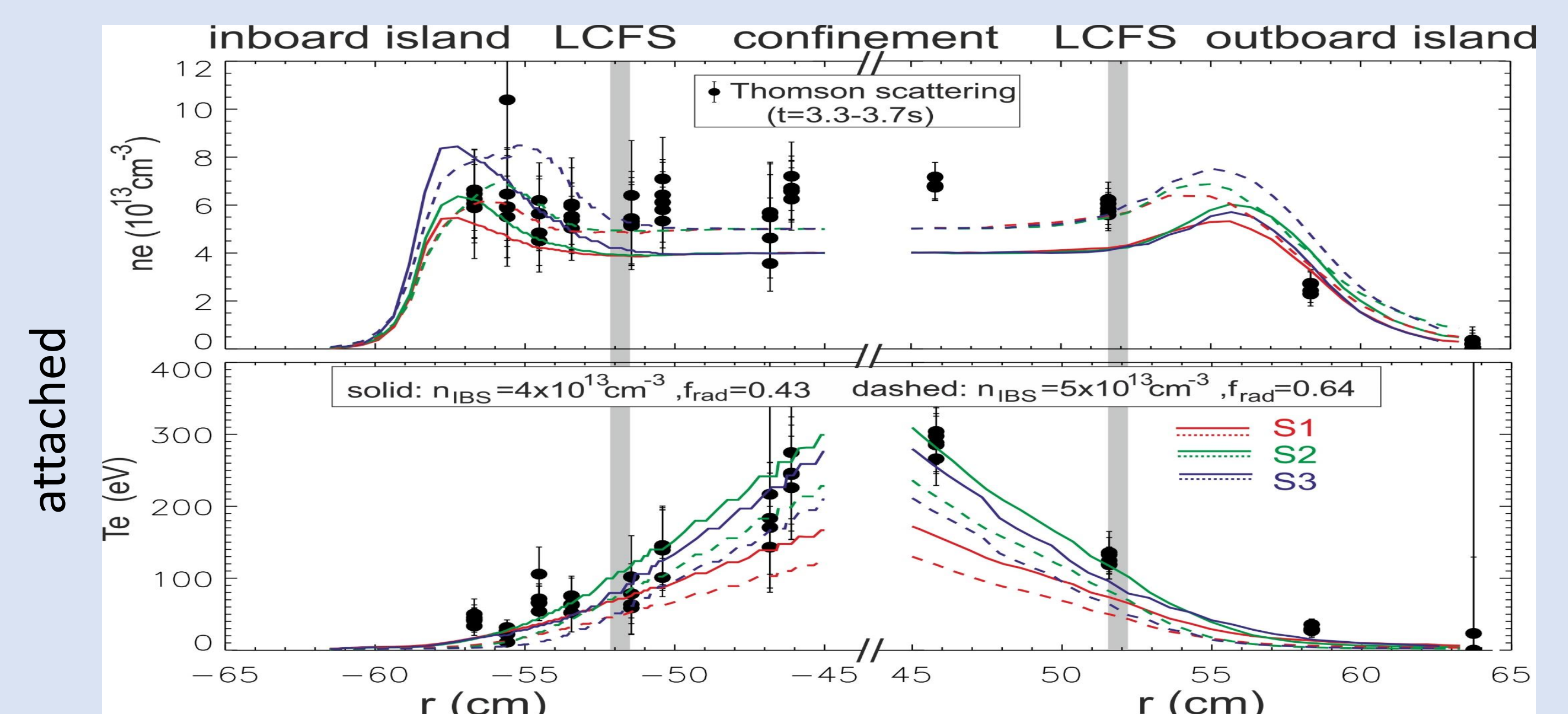
- Agree within the uncertainties in modeling and measurement

EMC3 vs H_{α} -camera (during detachment)

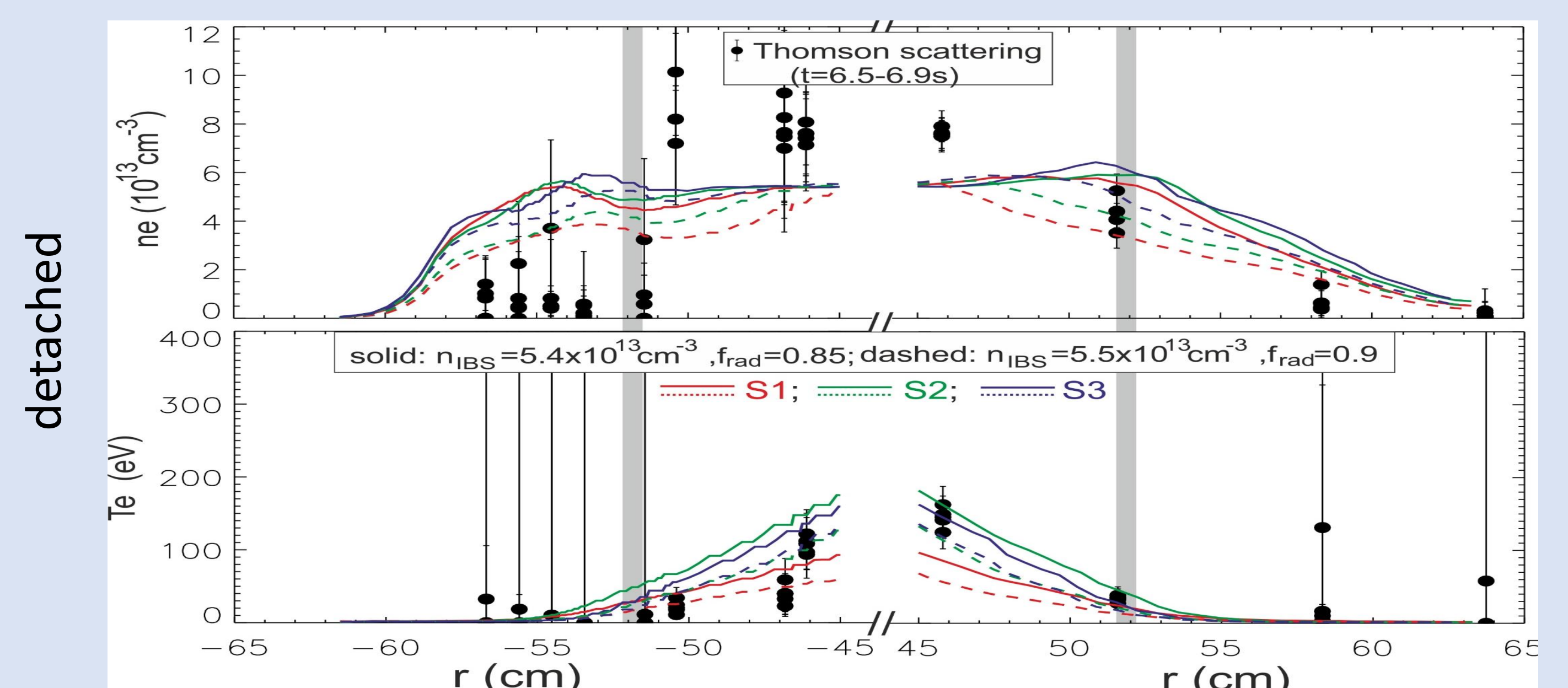


- Agree in form, peak location and dynamics, but not in absolute numbers

EMC3 vs Thomson scattering outside the divertor region



- Reasonable match within modeling and measurement uncertainties



- Mismatch of n_e on the inboard side, to be validated.

CONCLUSION

First comparison results between EMC3-Eirene and various local diagnostics have shown reasonable agreement in many aspects, but there are exceptions:

- At detachment the IR-cameras show diverse heat flux profiles, indicating error-field and drift effects inaccessible to the 3D code.
- There are significant differences in absolute H_{α} -emission flux between the H_{α} -cameras and the EMC3-Eirene code, or more precisely, between the photon flux captured by the H_{α} -cameras and that expected from the target probes.
- At detachment, qualitative discrepancies in n_e on the inboard side are found between EMC3-Eirene and TS, which need to be clarified with improved diagnostic capabilities.