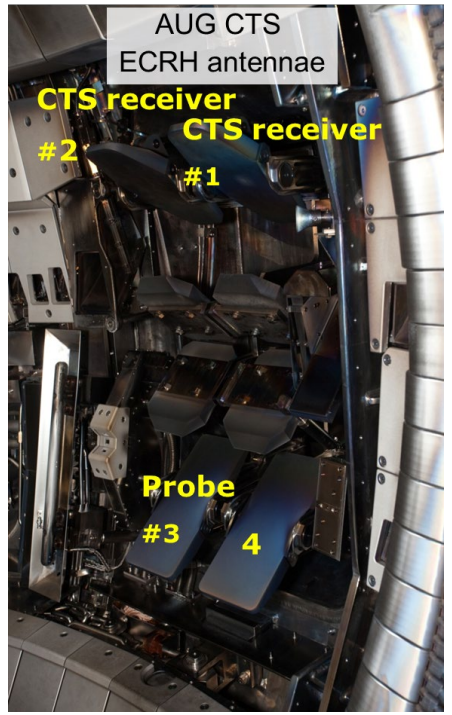
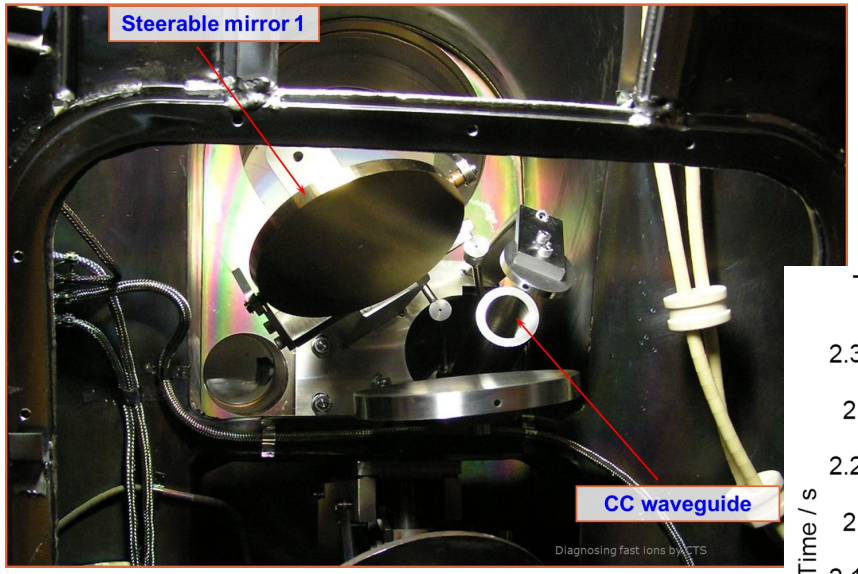
Søren Bang Korsholm, Jesper Rasmussen et al

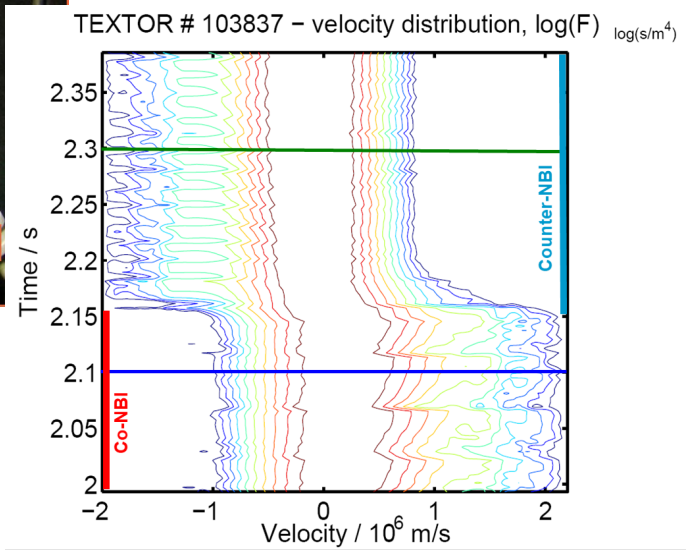
Collective Thomson Scattering – for JT-60SA

Fast- and bulk-ion CTS diagnostics

- Depending on setup and scattering geometry the CTS spectrum can be sensitive to the fast and/or the bulk ion features in the velocity distribution function.
- Demonstrated on several present-day machines; e.g.:
  - TEXTOR
  - AUG
  - W7-X
  - LHD
  - and HL-2A







- S.B. Korsholm et al. NIMA **623** (2010)
- H. Bindslev et al, PRL **97** (2006)
- S.B. Korsholm et al, PRL **106** (2011)
- F. Meo et al, RSI **79** (2008)
- S.K. Nielsen et al, Phys. Scr. **92** (2017)
- M. Stejner et al, PPCF **59** (2017)
- D. Moseev et al, RSI **90** (2019)
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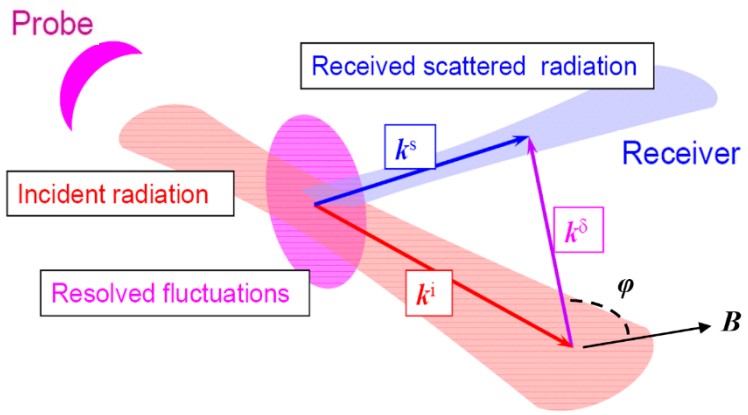
- W.C. Deng et al, JINST **17** (2022)

Collective Thomson scattering for JT60-SA: Background & measurements

Principle of CTS



Need:

$$\alpha_s = \frac{1}{|\mathbf{k}^\delta|\lambda_D} > 1 \rightarrow \text{microwaves}$$

High P_{probe} → gyrotrons

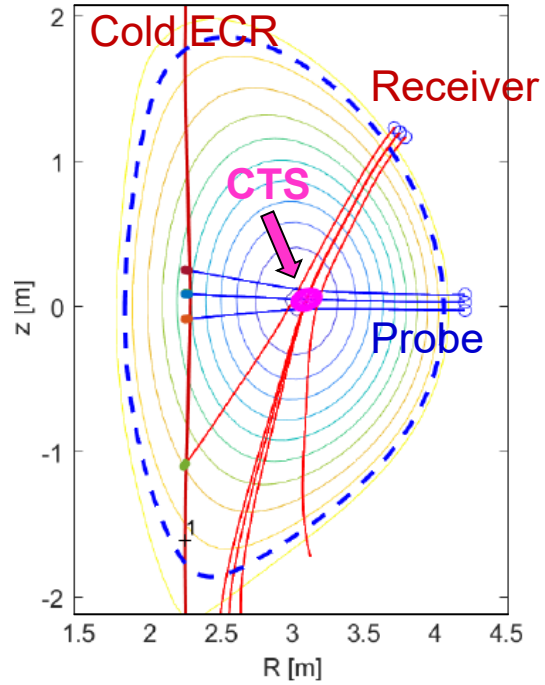
Possible measurements

- T_i
- v_{tor}
- $f_{fast}(v)$ in 1D
- For $\varphi \approx 90^o$: n_H/n_D, n_{He}, n_{imp}

All spatially resolved with, e.g.

- ΔR = 10–40 cm
- $\Delta t \approx$ 50-100 ms (depending on setup)

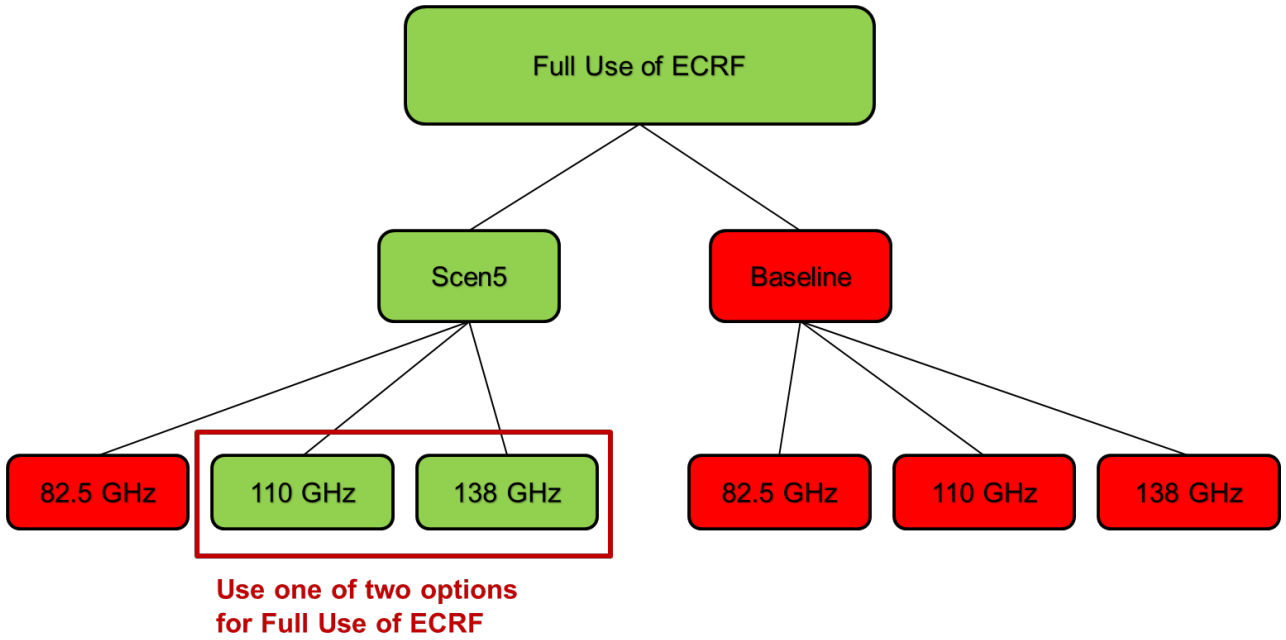
Potential implementation



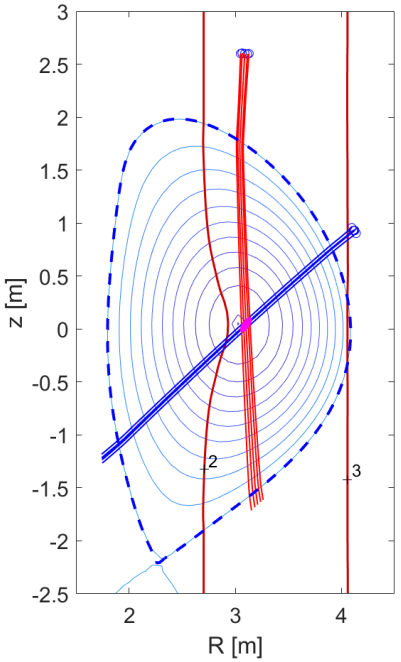
82 GHz, O-mode: φ = 71º / 88º

Using existing ECRH infra-structure, port P-1, P-4, P-8, or P-11

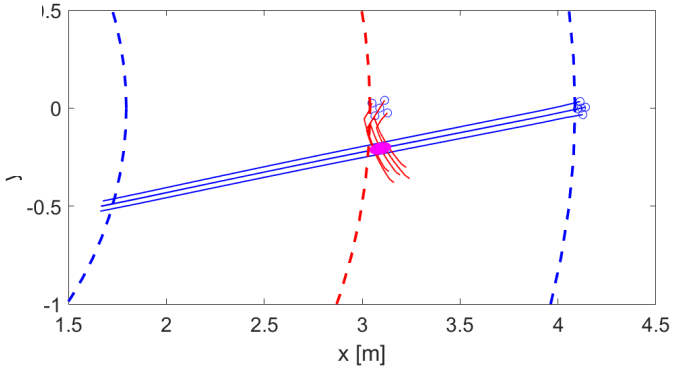
Initial CTS feasibility work in 2025



Using a dedicated in-vessel CTS receiver mirror in top-top port



Beam tracing of a CTS diagnostic for JT-60SA using the *138 GHz ECRH gyrotron* and system as the probe beam (blue) and a dedicated receiver quasi-optical mirror and transmission line system from a top port. (a) Poloidal view and (b) Top view.



Scope for the JT-60SA CTS work in 2026

Task title:

- *Feasibility of a Collective Thomson Scattering system for JT-60SA*

Task description:

- The aim of the 2026 feasibility studies will be to assess the measurement accuracy of a JT-60SA CTS system with
  - 1) using the existing in-vessel structures of the ECRH system and
  - 2) a dedicated in-vessel CTS receiver mirror (which cannot easily be installed before 2029)

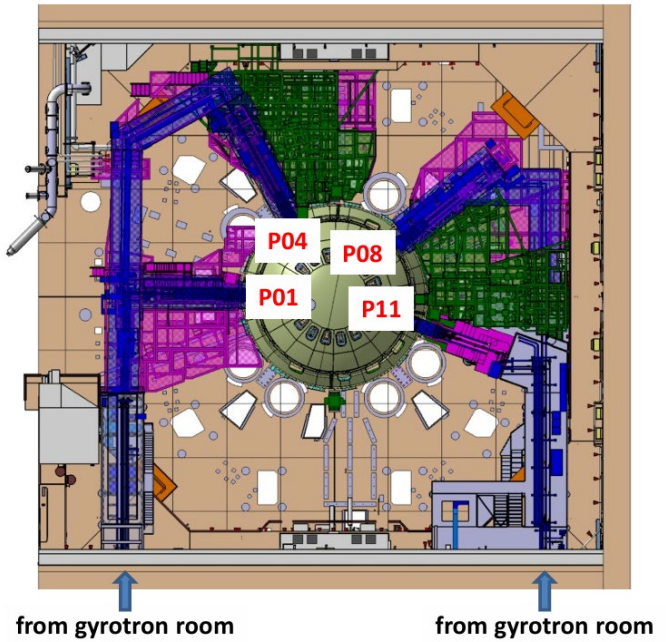
The report will include:

- Feasibility study of a Collective Thomson Scattering system
- Specification/verification of the scientific outcome (measurement performance)
- Conceptual design (space reservation requests at JT-60SA and main components definition).

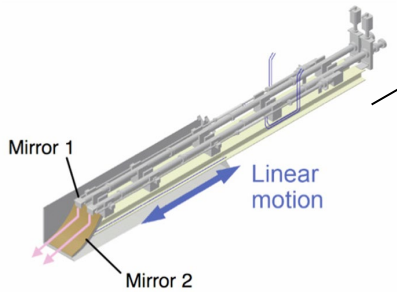
Budget: 1 PM (DTU applied for 5 PM in 2026 and 6 PM in 2027)

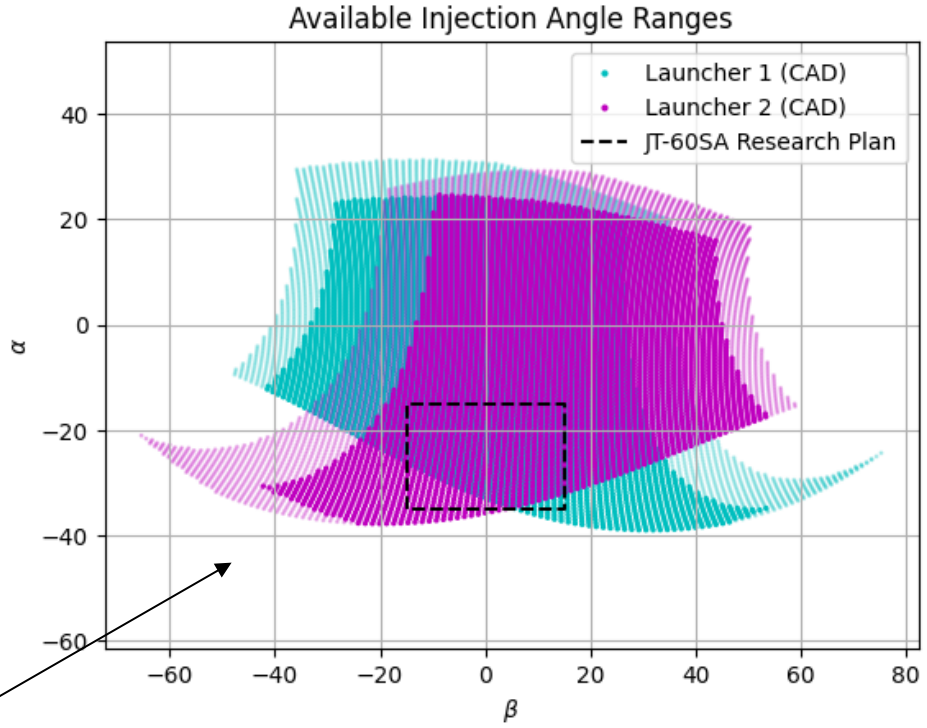
Desired inputs

- Precise definition of ECRH mirror movement angles
- Status of ECRH transmission lines and the different frequency gyrotrons



Credit: Plant Integration Plan (2024)





Ranges of injection angles as suggested by newer CAD drawings. The blue area indicates

the range for launcher 1, and the purple area indicates launcher 2. The dashed black box indicates

the minimum range specified in JT-60SA's Research Plan from 2019.