

# Applying AI/ML for NBI ionization and slowing-down simulations using ASCOT/BBNBI

A. Snicker et al.

21/05/2024 VTT – beyond the obvious

# Shine-through of high energy NBI in ITER

- ITER R&D category B issue
- ITPA-EP 17: " Validation of shine-through loads with high energy NBI"
- Can only be explored experimentally in JT-60SA, and numerically -> **strong link to JT-60SA**
- Re-baselining: emphasis from H to D
- In addition: use AI/ML to obtain NBI slowing-down characteristics
  - Power depositions (ions/electrons), losses, current-drive, torque etc...

B.11.2	Validation of shine-through loads with high energy NBI	Perform experiments with high energy NBI ( $E_{\text{NBI}} \sim 500$ keV) to validate models for evaluation of shine-through loads in ITER	2	Tokamaks with high energy NBI and good diagnostics of shine-through power fluxes on PFCs	Required to accurately determine the Hydrogen H-mode operational space which is limited (in the low density side) by shine-through loads	PFPO-2 (FPO is also affected but because shine-through loads of D beams on D or DT plasmas are much lower and thus the consequences of revised shine-through loads are expected to be minor)
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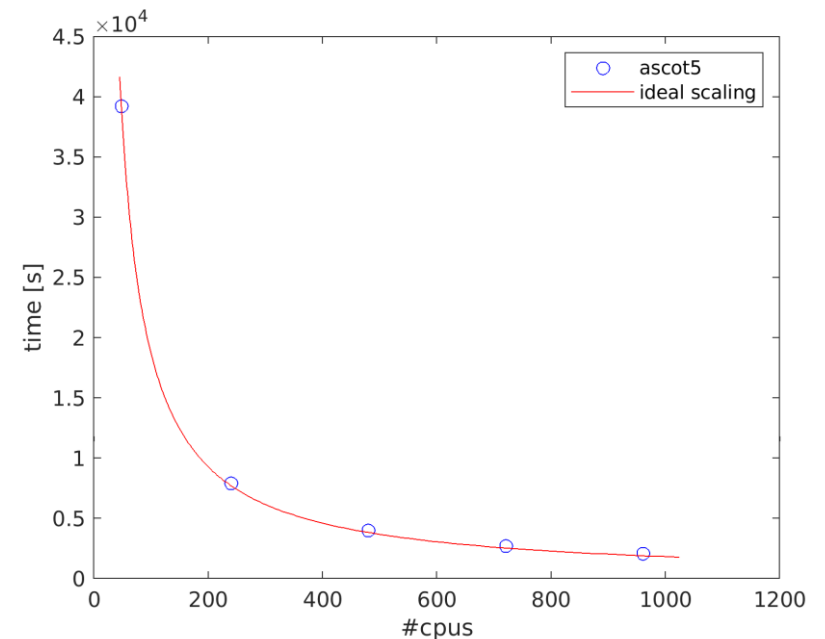
# Project team

- Combination of the physics and AI/ML experts
- VTT:
  - ASCOT core developers/experts
  - AI/ML experts + support of the virtual fusion AI lab/FCAI community
- Consorzio-RFX
  - (BB)NBI expert
  - AI/ML fusion expert

Person	Association	Expertise/role	PMs 2024	PMs 2025
Antti Snicker	VTT	Physics	2	3
Konsta Särkimäki	VTT	Physics	3	3
Daniel Jordan	VTT	AI/ML	3	3
Pietro Vincenzi	Consorzio-RFX	Physics	2	2
Rita S. Delogu	Consorzio-RFX	AI/ML	2	2

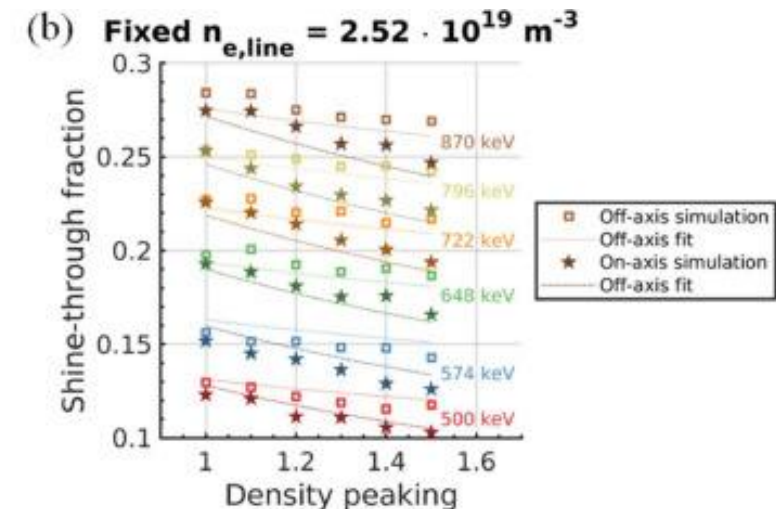
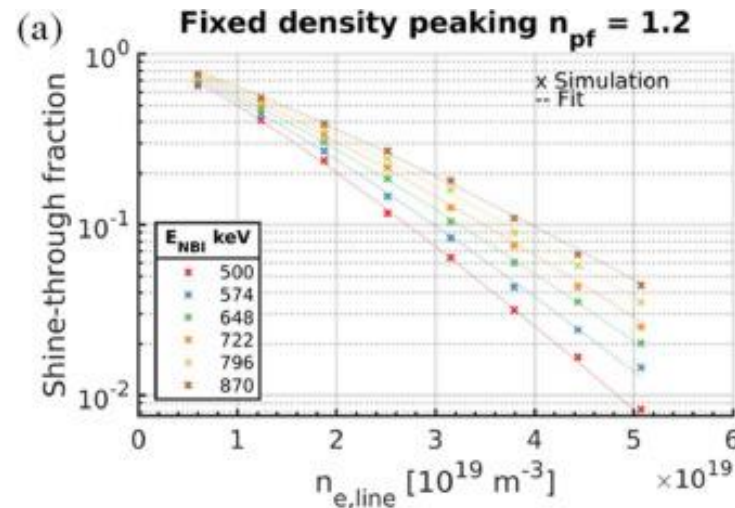
# Project tools

- ASCOT code
  - Open-source software, integrated in IMAS, used widely
- Computation time reservations
  - JFRS-1: " Following the evaluation process as described in the Call for projects, [389,886 ] node-hours will be allocated to your project, (ASCOT\_AI) (Principal Investigator: Antti Snicker)."



# Where are we at?

- BBNBI simulations for H and He using IMAS done
  - Heuristic model fitted to dataset (N=288)
  - Need to repeat with D, using modern AI/ML techniques
- ASCOT code development
  - Latest version (ASCOT5) being IMASified
  - Python interface to facilitate AI workflows
- Project kick-off meeting



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Year	Description
2024.D1	Generation of input datasets for ASCOT/BBNBI simulations
2024.D2	A training database for JT-60SA and ITER neutral beam shine-through as a function of the operational phase-space
2024.D3	Database generation for JT-60SA and ITER neutral beam slowing-down characteristics using active learning methods
2024.D4	A scientific publication describing the progress of the work
2024.D5	AI/ML model for shine-through in JT-60SA and ITER
2025.D1	AI/ML model for NBI slowing-down characteristics in JT-60SA and ITER
2025.D2	Two scientific publications and two conference presentations to publish the work

# bey<sup>0</sup>nd

## the obvious

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