First results of GLOBUS-M2 ASCOT5 modelling

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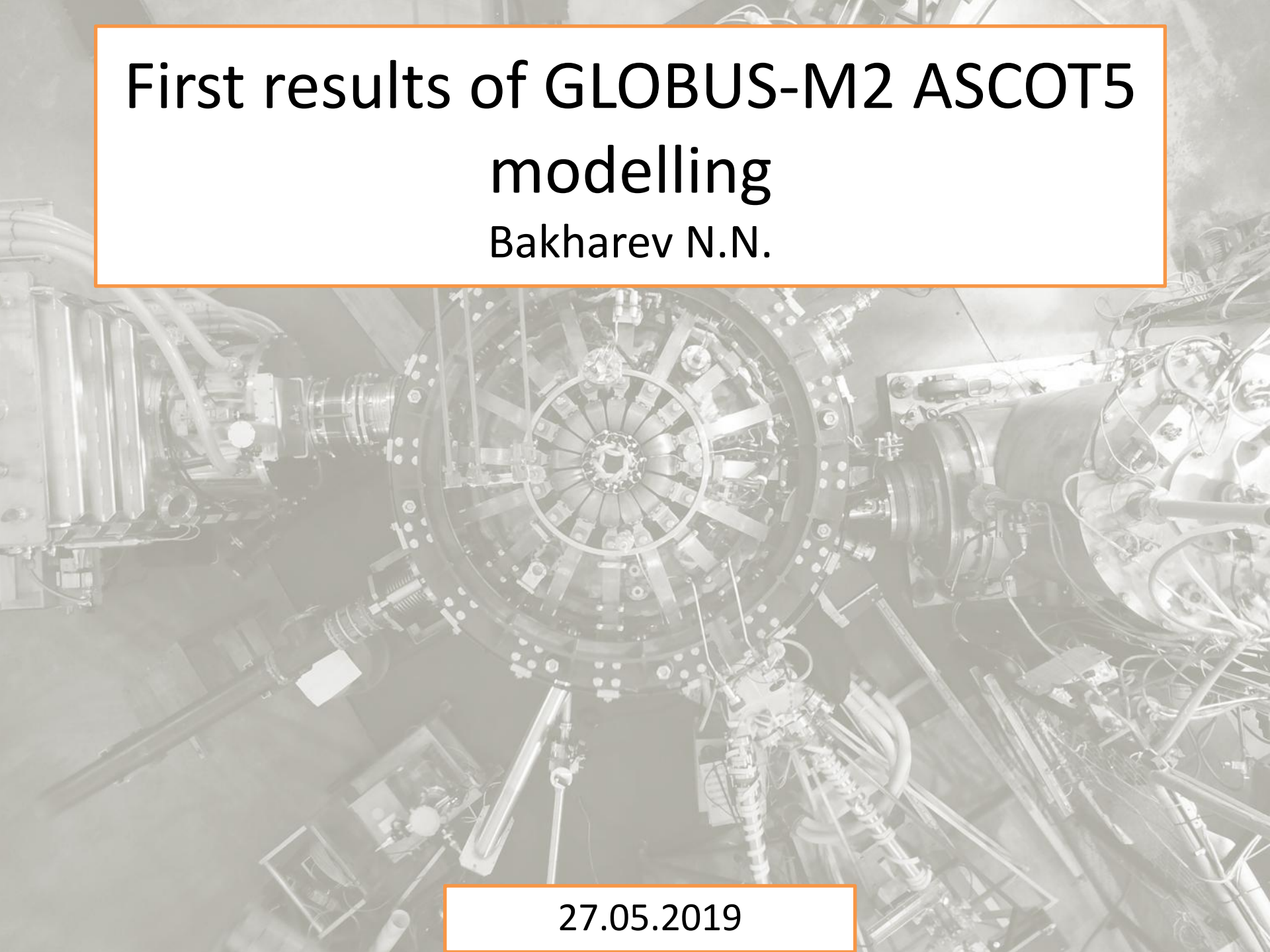


27.05.2019

Motivation

Tests and benchmarks for future use in

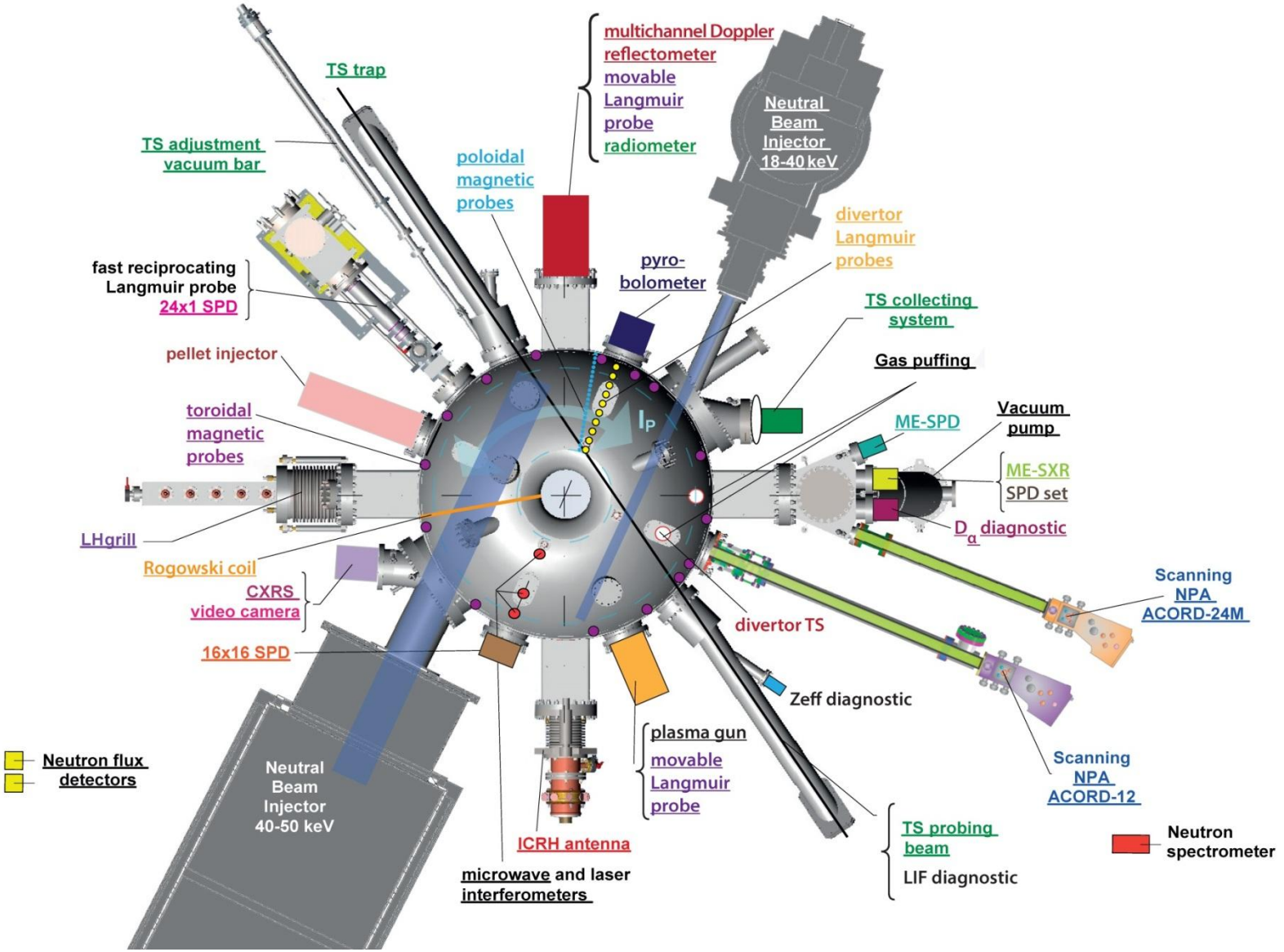
- Modeling of FI distribution in the NBI-heated experiments -calc. of P_{abs}, losses, neutron rate, NPA signals, CD etc. (CX required)

- Modeling of the TAE-induced losses/redistribution. (MHD required)

Globus-M2

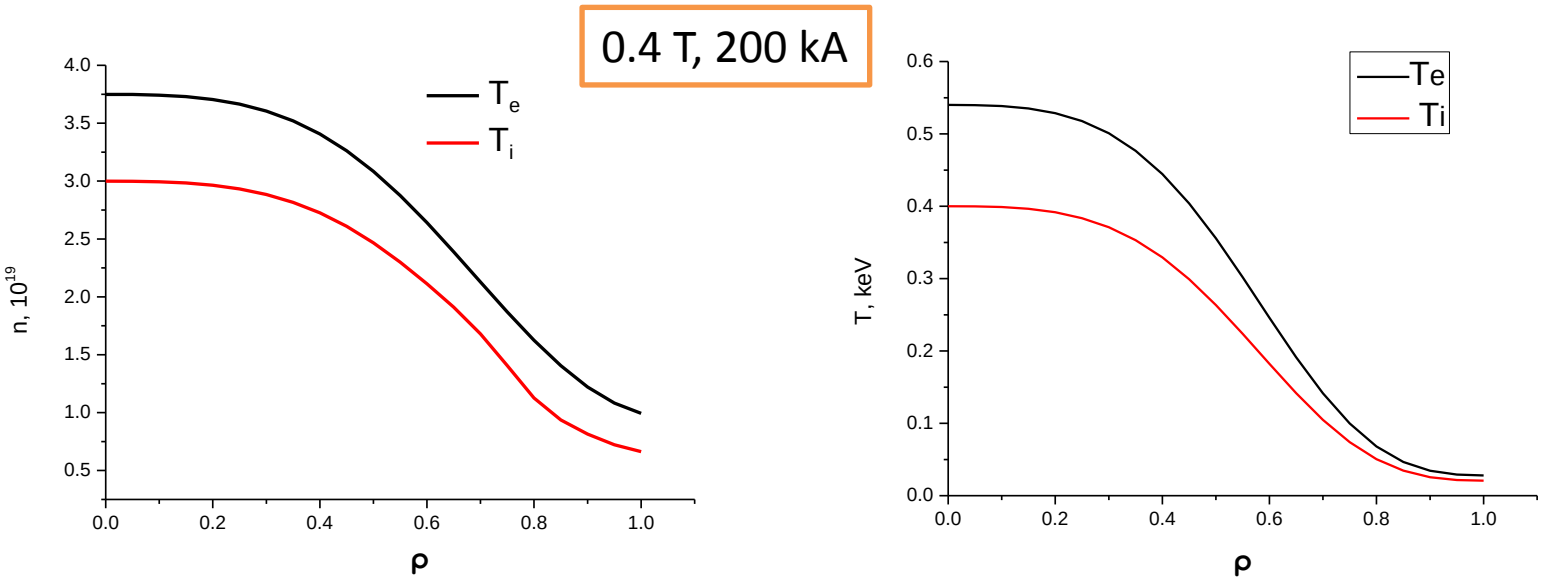
- **New machine (first campaign - 2019)**
- **R [cm]/a [cm]= 36/24 = 1.5**
- **B_T = 1T, I_p = 500 kA**
- **Extreme P_{heat} /V = 6 MW/m^3**
- **Diverse diagnostics, heating and CD systems, including 2 x 1 MW NBI, ICRH, LHCD, plasma gun**

Globus-M2

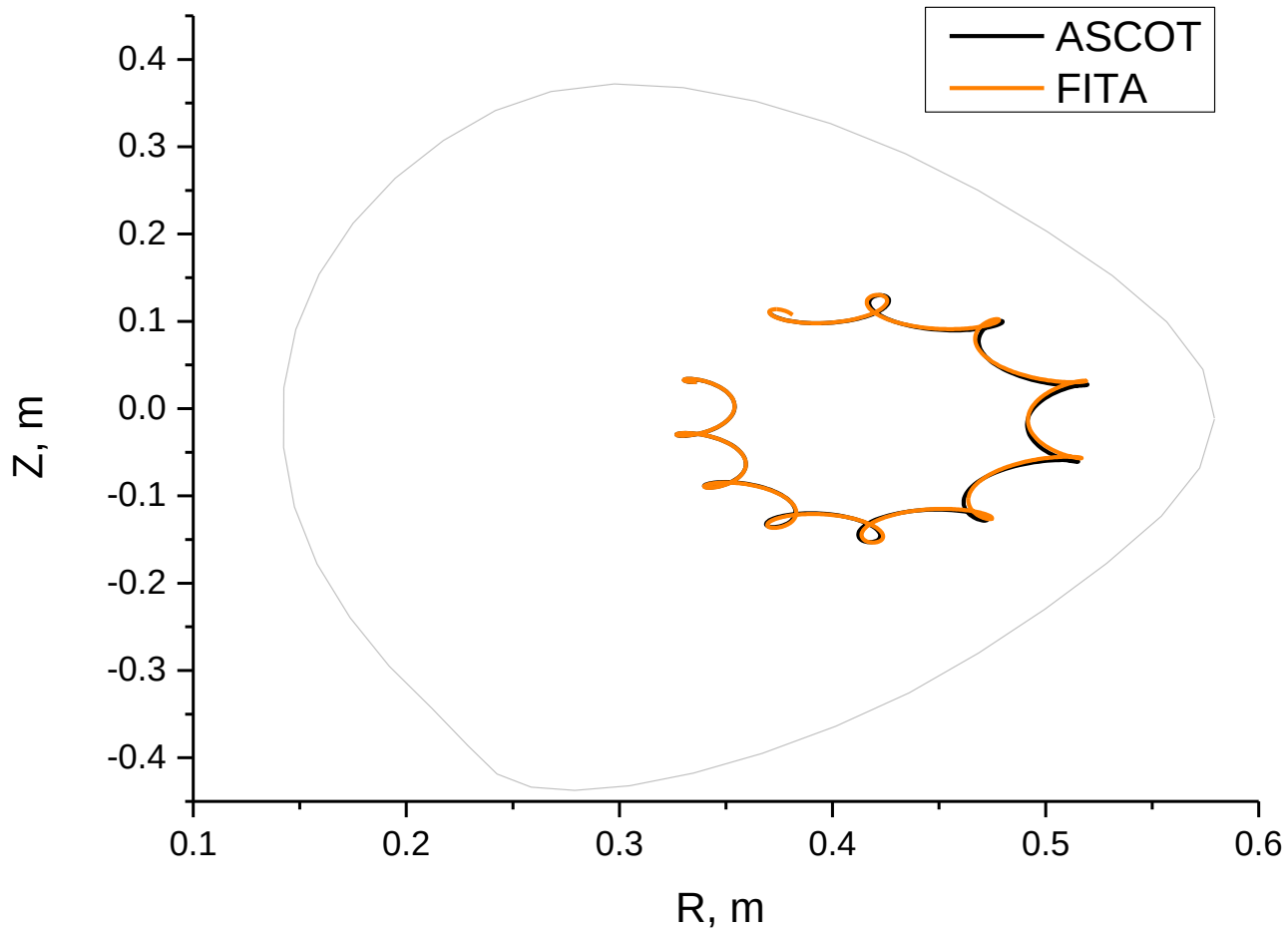

multichannel Doppler reflectometer
movable Langmuir probe
radiometer
TS trap
TS adjustment vacuum bar
poloidal magnetic probes
Neutral Beam Injector 18-40 keV
divertor Langmuir probes
fast reciprocating Langmuir probe 24x1 SPD
pyro-bolometer
TS collecting system
pellet injector
Gas puffing
toroidal magnetic probes
I_P
ME-SPD
Vacuum pump
ME-SXR
SPD set
D_α diagnostic
LHgrill
Rogowski coil
CXRS video camera
Scanning NPA ACORD-24M
divertor TS
16x16 SPD
Zeff diagnostic
plasma gun
movable Langmuir probe
Scanning NPA ACORD-12
Neutron flux detectors
Neutral Beam Injector 40-50 keV
ICRH antenna
TS probing beam
LIF diagnostic
Neutron spectrometer
microwave and laser interferometers

Modelling overwiev

- 18 keV H (#32994-98)and D (#32952-57) NBI is considered.
- MHD-stable, neutron and NPA measurements exist (CX needed).
- Comparison with NUBEAM and homegrown GO simulations – fast in tracking algorithm(FITA).



Orbit modelling



✓ **Sanity check of Magnetic eq. and marker inputs**

Comparison with NUBEAM

NUBEAM

- uses GC approx. + Finite Larmor radius adjustment
- Slightly different options

NUBEAM markers -> ASCOT

Problems:

- Represented in GC approximation
- Not completely compatible with ASCOT:

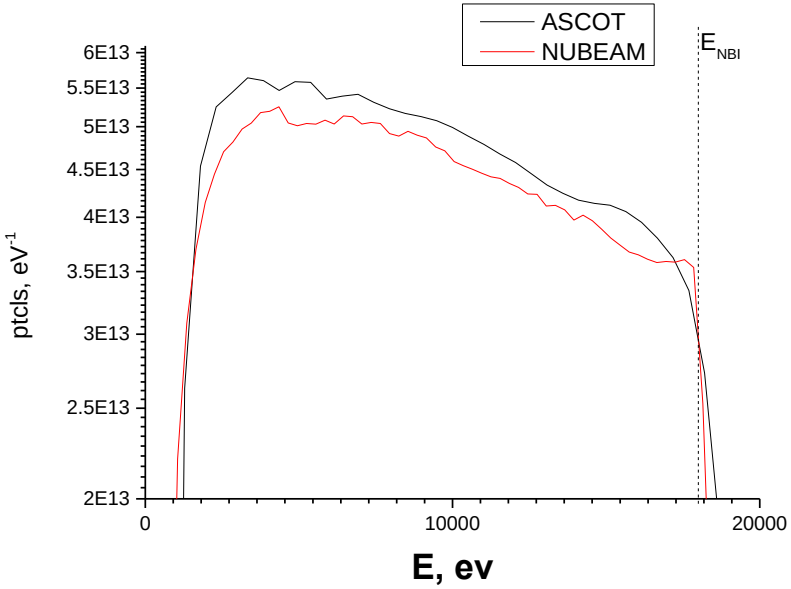
e. g. first order GCTRANS on leads to mu < 0 error

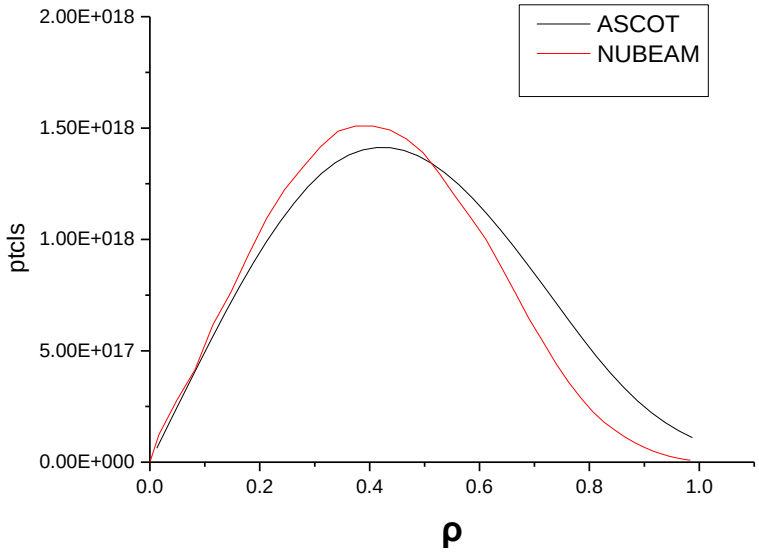
and other errors (~3% of markers)

- NUBEAM uses irregular grid and increased central statistics.
- Not very precise σ_{CX} for such low energies.

Comparison with NUBEAM

We will consider monoenergetic 18 keV beam



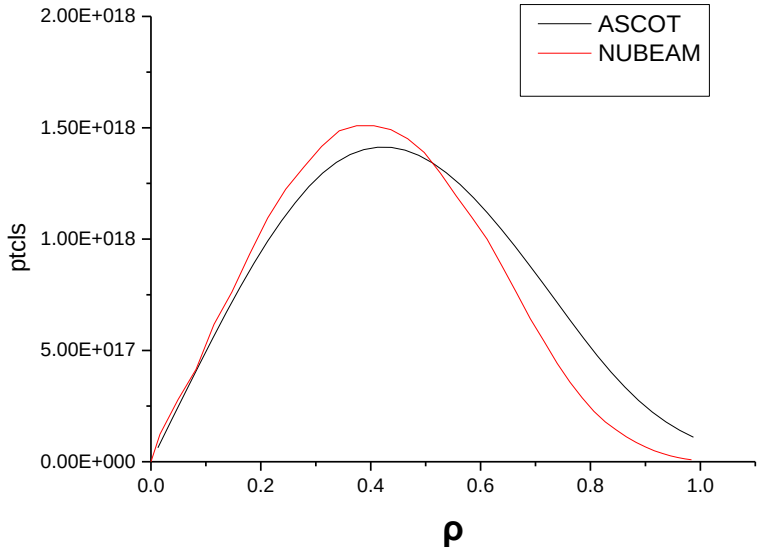


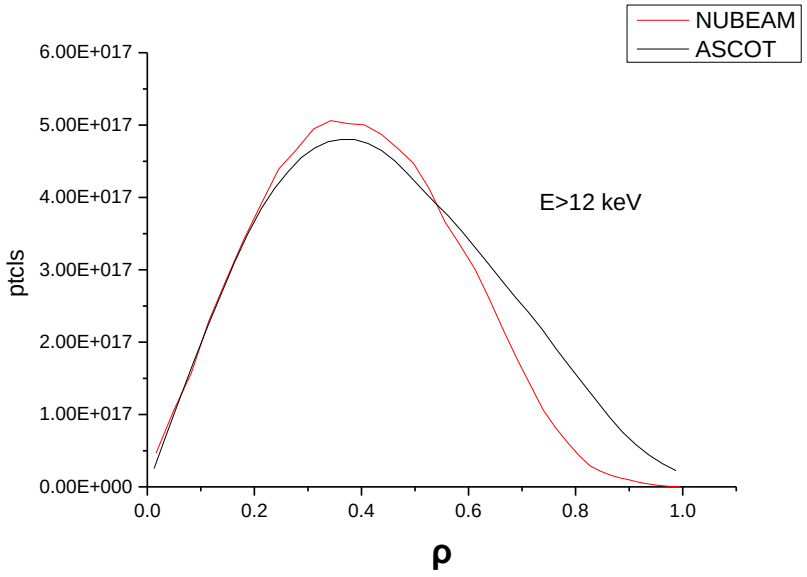
- ✓ Almost similar slowing-down.
- ✓ Density, predicted by NYBEAM is shifted inwards.

? Density, predicted by NYBEAM is lower.

? Different FI acceleration near E_{NBI}

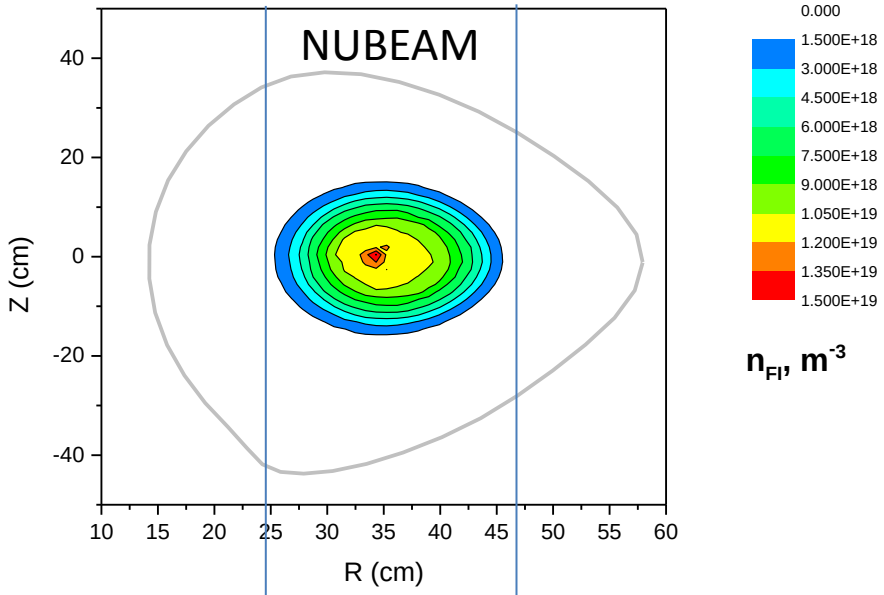
Comparison with NUBEAM

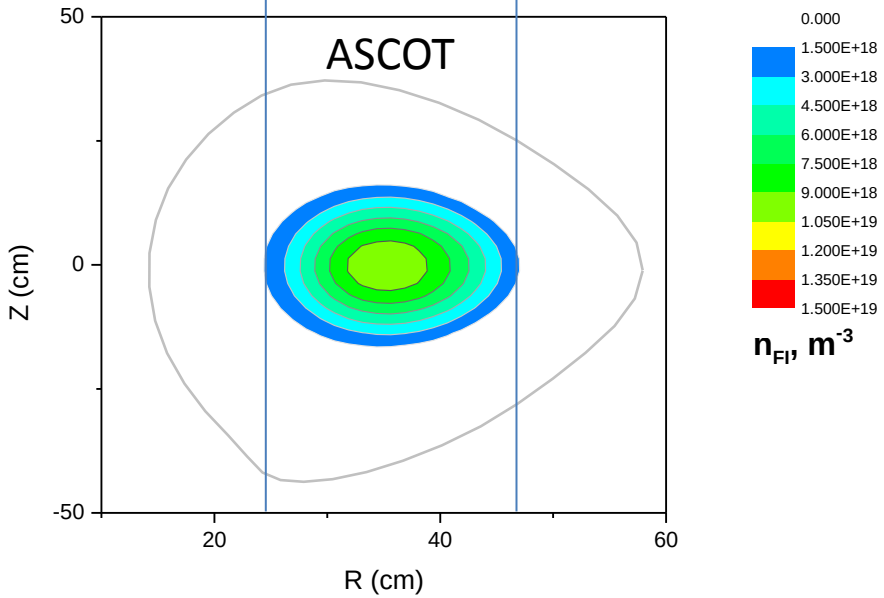




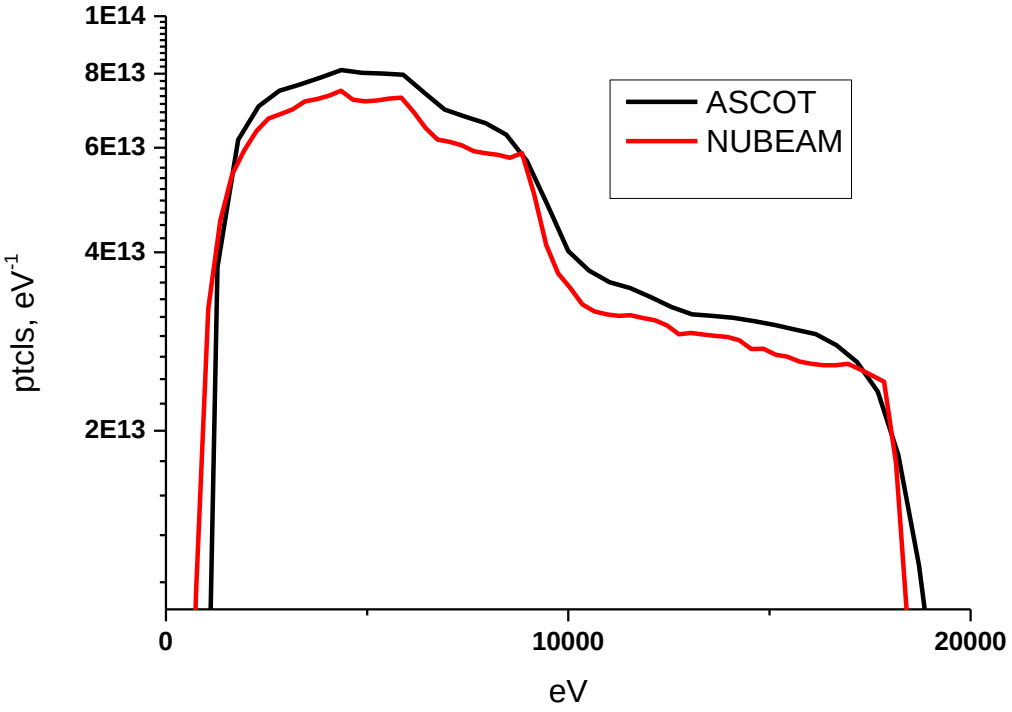
The difference near LCFS is even higher
-> GC approx. plays the main role

Comparison with NUBEAM distributions



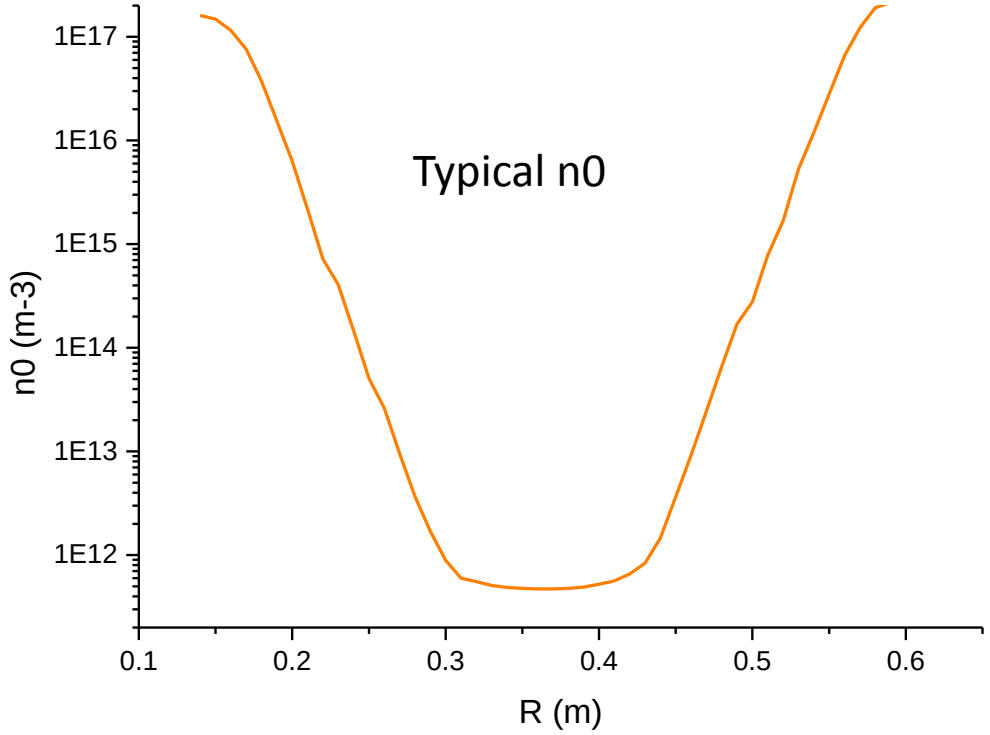


3-component beam



- **Same features**.

CX losses



- **CX and increase in E_{beam} will result in even higher differences with NUBEAM which fails to reproduce the experiments.**

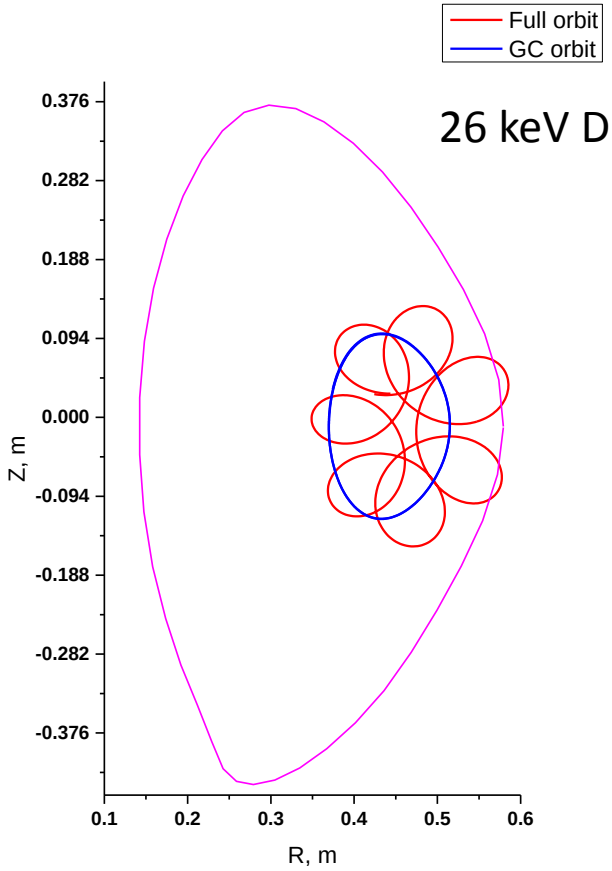
FI losess

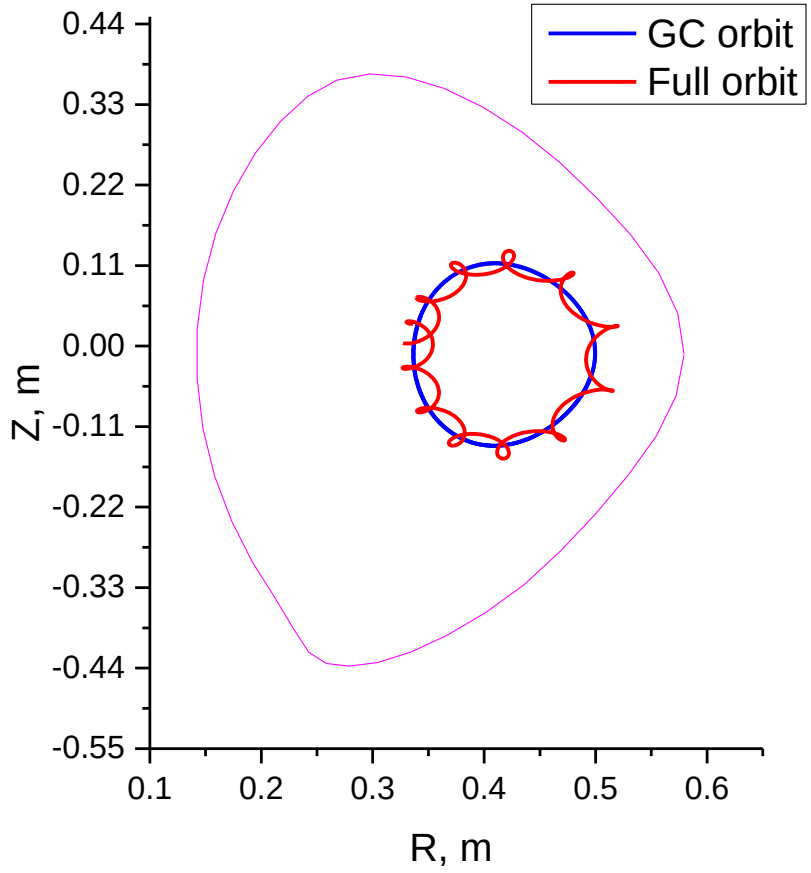
Losses	ASCOT (NO n0)	FITA	NUBEAM (NO n0)
Shine-through, %	-	8	6
wall	5% of markers	-	6% of P
CX, %	-	-	
FO(rho > 1), %	13(NUBEAM markers) 12 (FITA markers)	16	15

FO losses in ASCOT are a bit lower than in other codes

GC approximation in ASCOT

Good opportunity to compare GO and GC, implemented in one code

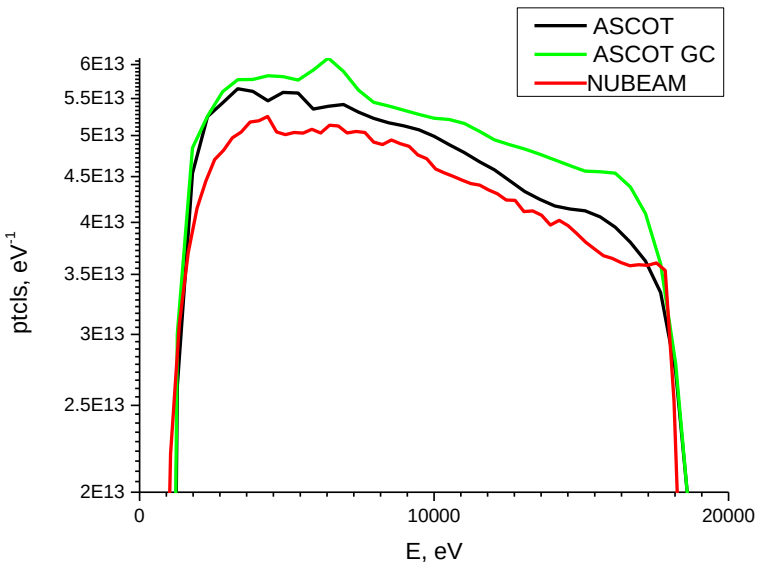


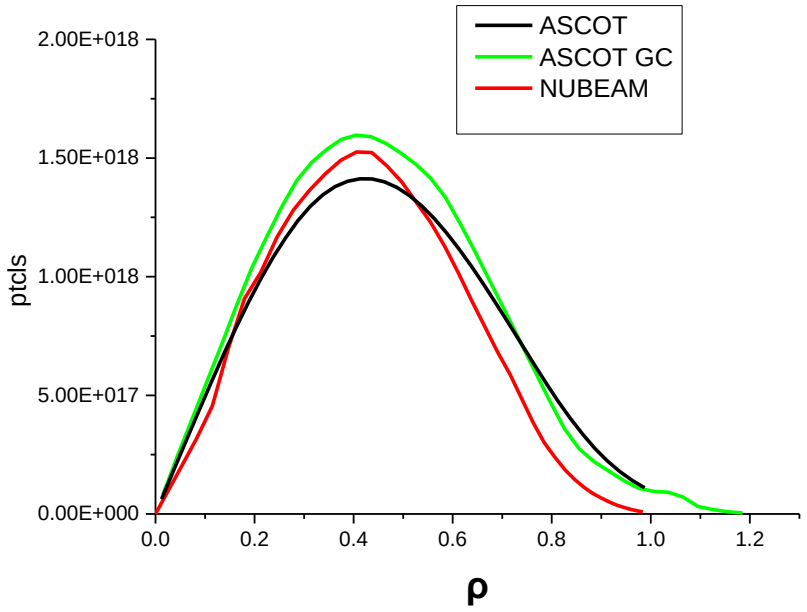


Not all orbits are easy to describe with GC

GC approximation in ASCOT

Good opportunity to compare GO and GC, implemented in one code





- ✓ **Higher FI density with GC approximation.**
- ✓ **NUBEAM is somewhere between ASCOT's GO and GC.**

SUMMARY

- **Comparison with NUBEAM and FITA was performed.**
- **Modelling shows reasonable results, however some peculiarities are unclear**
  -> “smoke” test of input scripts is needed.
- **After that we are ready for the real-world simulations:**
  -FI distribution (CX is needed)
  -TAE or other MHD(MHD is needed)
- **Consultations are needed.**

ASCOT user-experience:
Great design – transparent (almost a “white-box”) and flexible. :3
No backward compatibility. (╯°□°)╯(┻━━┻)

Thanks to the ASCOT team and especially Konsta for his time


Thank you for your attention!