EFDA

EUROPEAN FUSION DEVELOPMENT AGREEMENT

Task Force
INTEGRATED TOKAMAK MODELLING

ACT1: Predictive (Te, Ti, current diffusion, NBI, etc.) modelling of Hybrid Scenarios and comparison to experimental data

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ISM Working Session, JET, 23 November 2012

Goal for this week

What we want to do...

To simulate JET pulse #77922 with the ETS and compare with experiment

...And how we want to do it

- ★ ~~ETS_A workflow using UAL 4.09a~~
- ★ ~~Experimental profiles in an ITM database (from TRANSP)~~
- ★ ~~NBI power deposition (from TRANSP)~~
- ★ **Bohm/gyro-Bohm for core transport (available in ETS_A)**
- ★ ~~NCLASS actor for current diffusion (resistivity and bootstrap current)~~
- ★ ~~Pedestal model (available in ETS_A)~~

~~**Since the official NCLASS actor will first be released for UAL 4.09a it's important for the continuation of this work to keep supporting the 4.09a ETS_A workflow in parallel with the upcoming 4.10a ETS_A*~~

Bohm/gyro-Bohm in ETS_A...

- ★ The Bohm/gyro-Bohm actor available in ETS_A was for L-mode only, so...
- ★ An H-mode Bohm/gyro-Bohm model was needed, and it was suggested by Irina...
- ★ To implement in ETS_A the exact same Bohm/gyro-Bohm model used in JETTO, provided by Florian, particularly useful for ITM modelling of JET pulses
- ★ A **new Bohm/gyro-Bohm actor** has been built and incorporated in ETS_A this week
- ★ The actor should circulate within the ITM (Innsbruck Code Camp) so it can be
  - ➢ Incorporated in the main release of ETS_A (IMP3), and
  - ➢ Become an official ITM transport model (IMP4)

...Bohm/gyro-Bohm in ETS_A...

Non-local Bohm-gyroBohm transport model in JETTO (F. Koechl)

Default Bohm / gyroBohm model for L-mode as implemented in JETTO (using IBOHMOLD = 1 in the namelist settings):

Bohm contribution:

$$\chi_{Be} = 2\cdot 10^{-4}\frac{a_0}{B_0}\frac{|\partial p_e/\partial\rho|}{n_e}q^2,\quad a_0 = \frac{R_{out}-R_{in}}{2},\quad \rho = \sqrt{\frac{\Phi}{\pi B_{ref}}}$$

$$\chi_{Bi} = 2\chi_{Be}$$

Default Bohm / gyroBohm model with non-local multiplier as implemented in JETTO:

Bohm contribution:

$$\chi_{Be} = 8\cdot 10^{-5}\frac{a_0}{B_0}\frac{|\partial p_e/\partial\rho|}{n_e}q^2\frac{|T_e(\rho_{ped.})-T_e(\rho_{int.})|}{T_e(\rho_{ped.})},\quad a_0 = \frac{R_{out}-R_{in}}{2},\quad \rho = \sqrt{\frac{\Phi}{\pi B_{ref}}},\quad \rho_{int.} = \rho(R_{ped.}-0.1085)$$

$$\chi_{Bi} = 2\chi_{Be}$$

gyroBohm contribution:

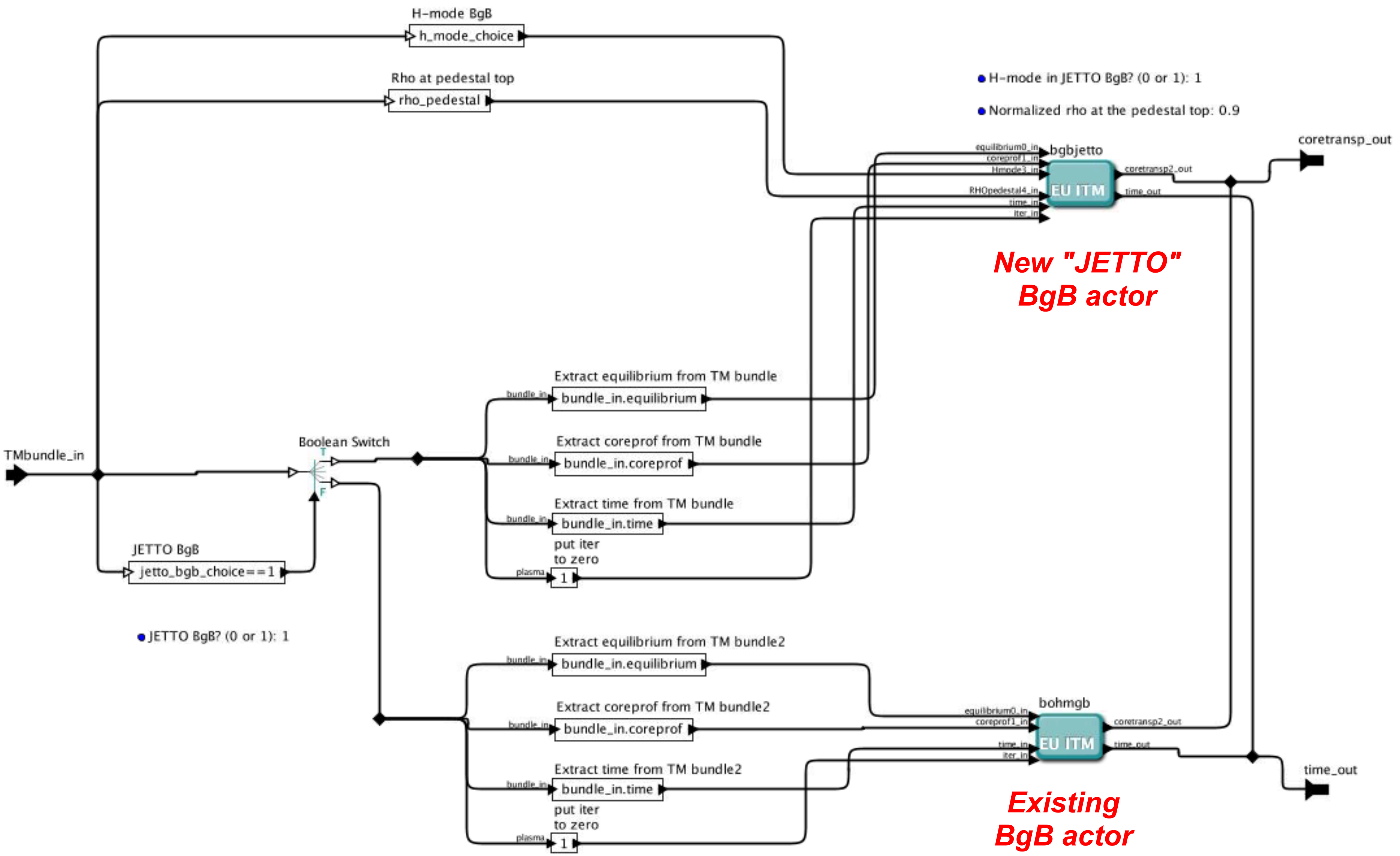
$$\chi_{gBe} = 5\cdot 10^{-6}\frac{\sqrt{T_e}}{B_0^2}\left|\frac{\partial T_e}{\partial\rho}\right|,$$

$$\chi_{gBi} = 0.5\cdot\chi_{gBe}$$

- ***slightly different normalisation of BgB in ASTRA***
- ***χ= 0.4χB_ASTRA*|Te(ρ_ped-10 cm) - Te (ρ_ped)| / Te(ρ_ped) + χgB***

All quantities are in SI units except for Te which is in eV (and pe in eV m^{-3}).

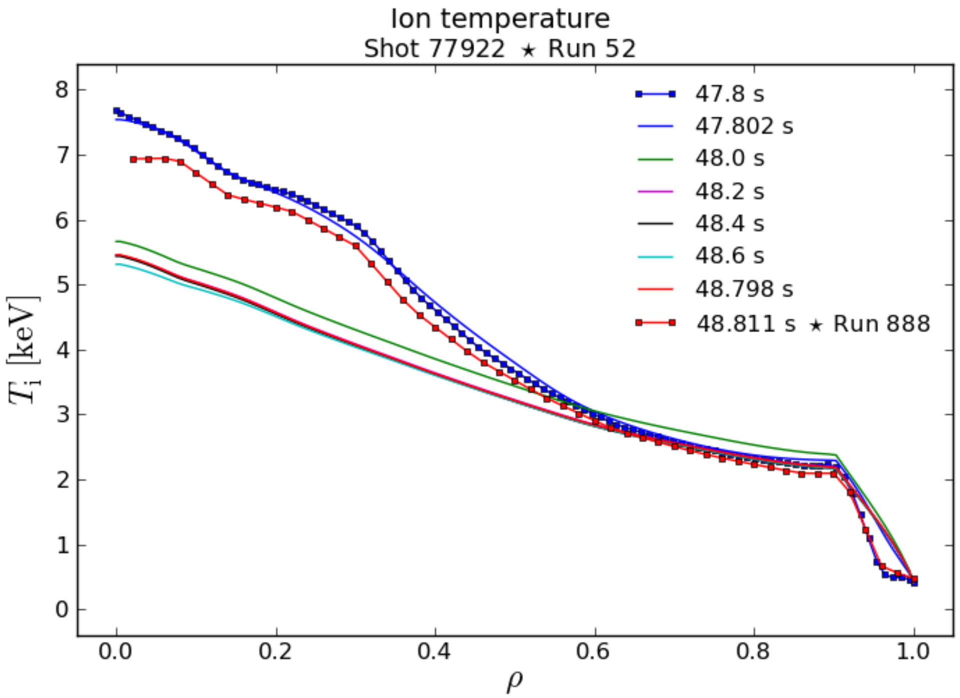
...Bohm/gyro-Bohm in ETS_A



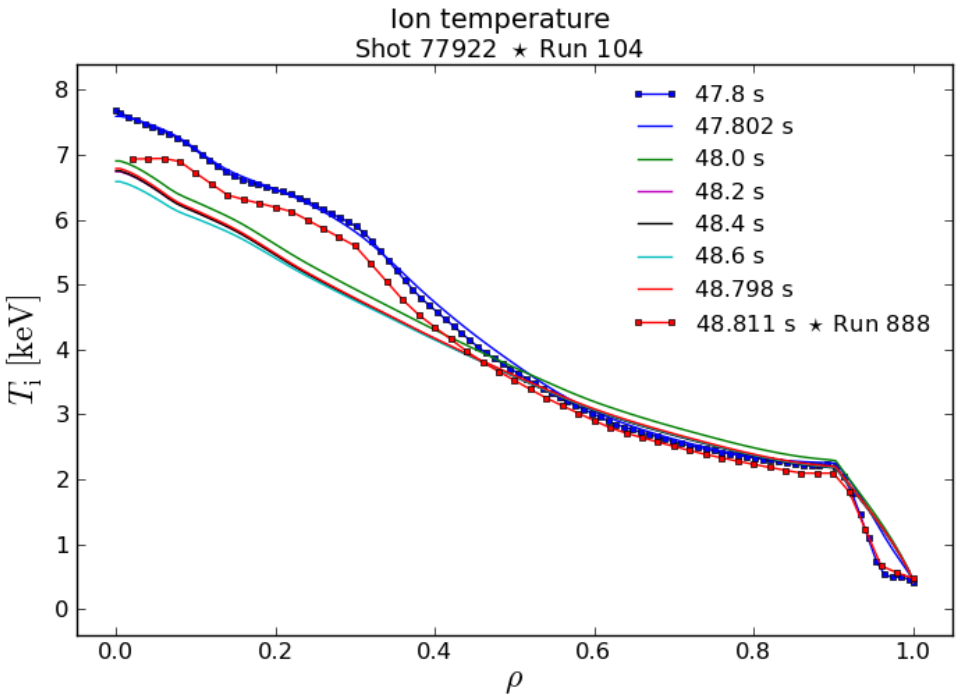
Existing vs. JETTO BgB...

- ★ T_e and T_i evolve from 47.8 s to 48.8 s with a 2 ms timestep
- ★ Pedestal at 0.90 with χ_e = 2.0 m^2/s & χ_i = 0.4 m^2/s inside ETB

Ion Temperature



Existing BgB Model (L-mode)

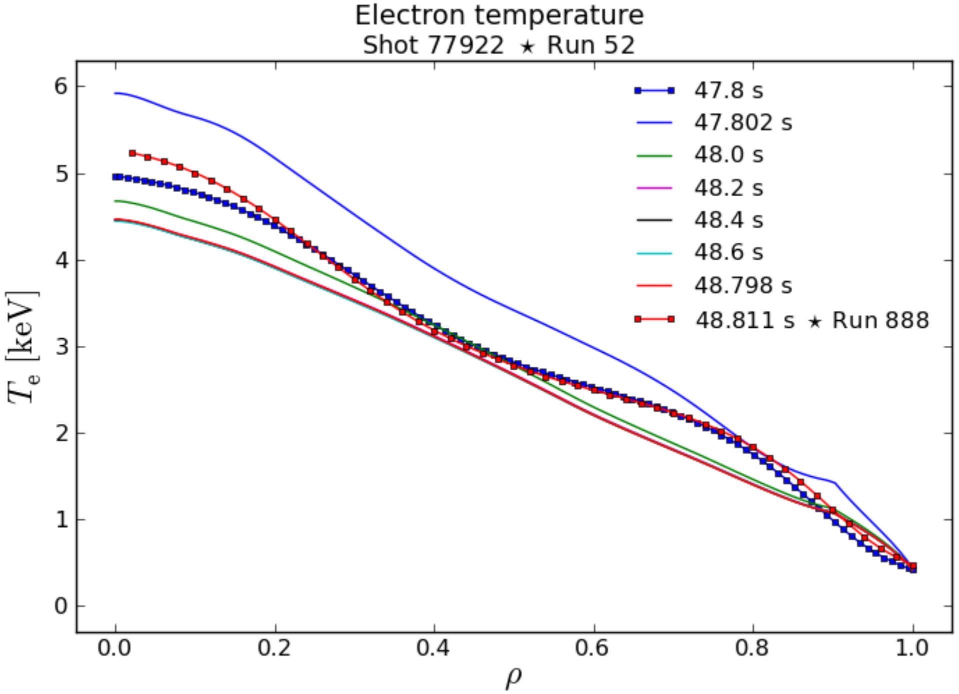


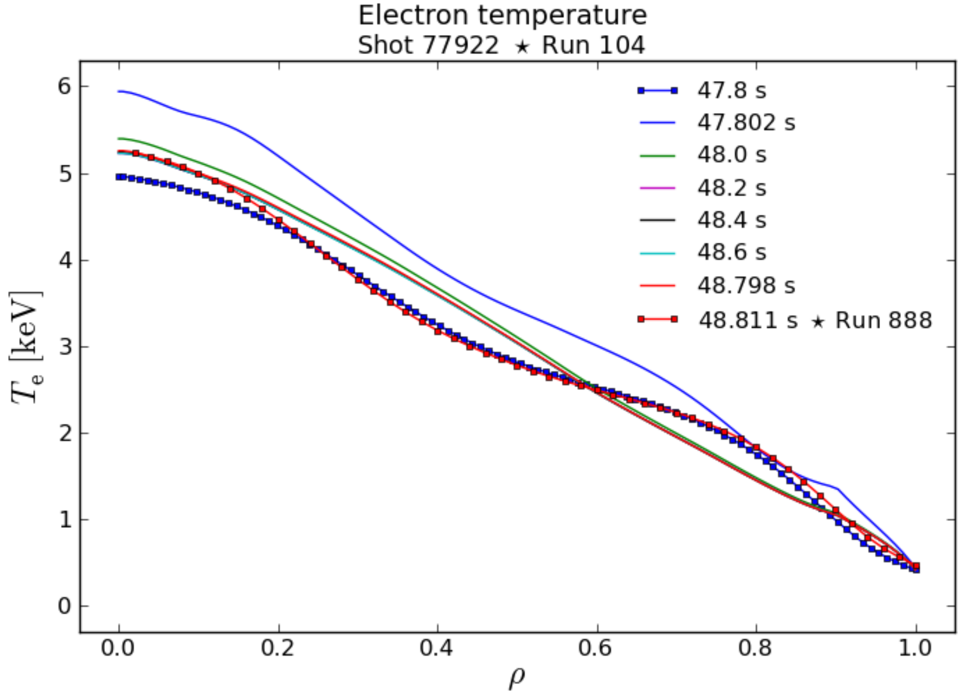
JETTO BgB Model for L-mode

★ Difference in core temperatures is reduced with the JETTO model

...Existing vs. JETTO BgB

Electron Temperature





Existing BgB Model (L-mode)

JETTO BgB Model for L-mode

★ Electron temperature is also improved with the JETTO model

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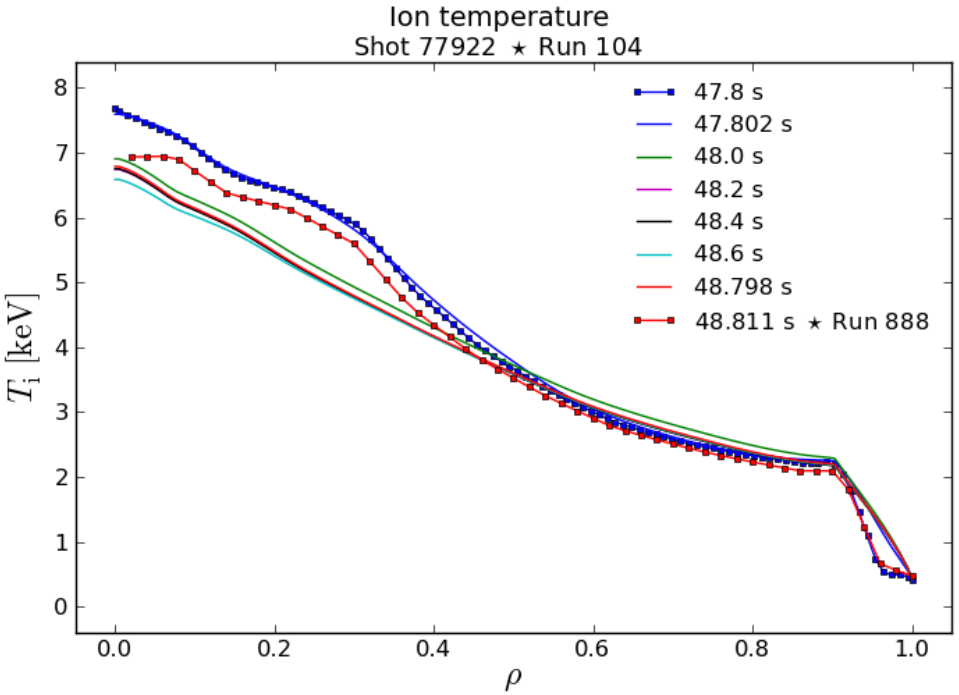
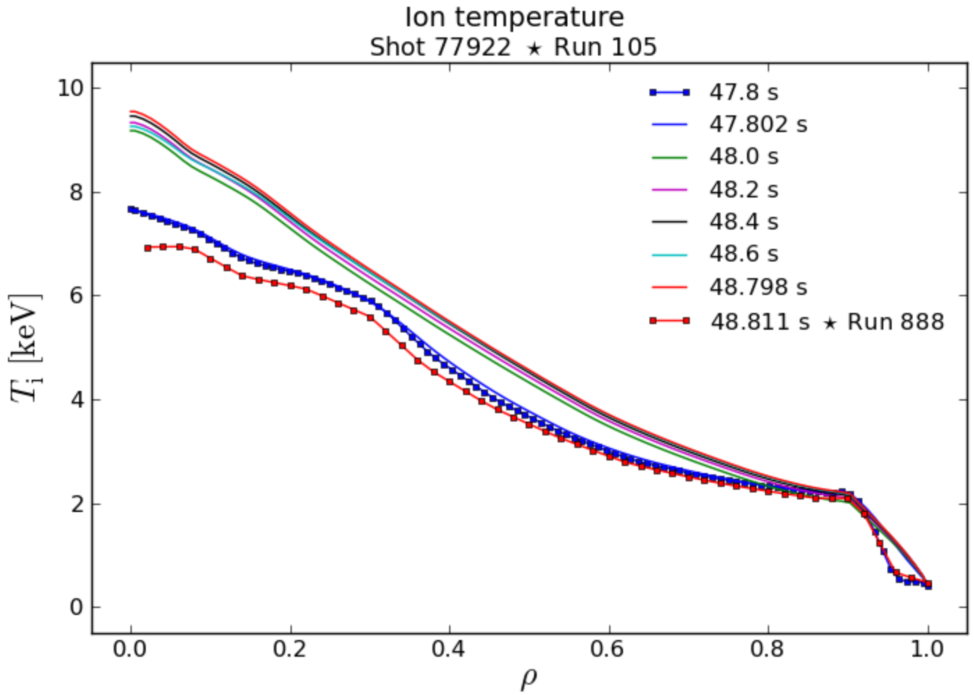
JETTO BgB: L- vs. H-mode...

Ion Temperature



JETTO BgB Model for L-mode

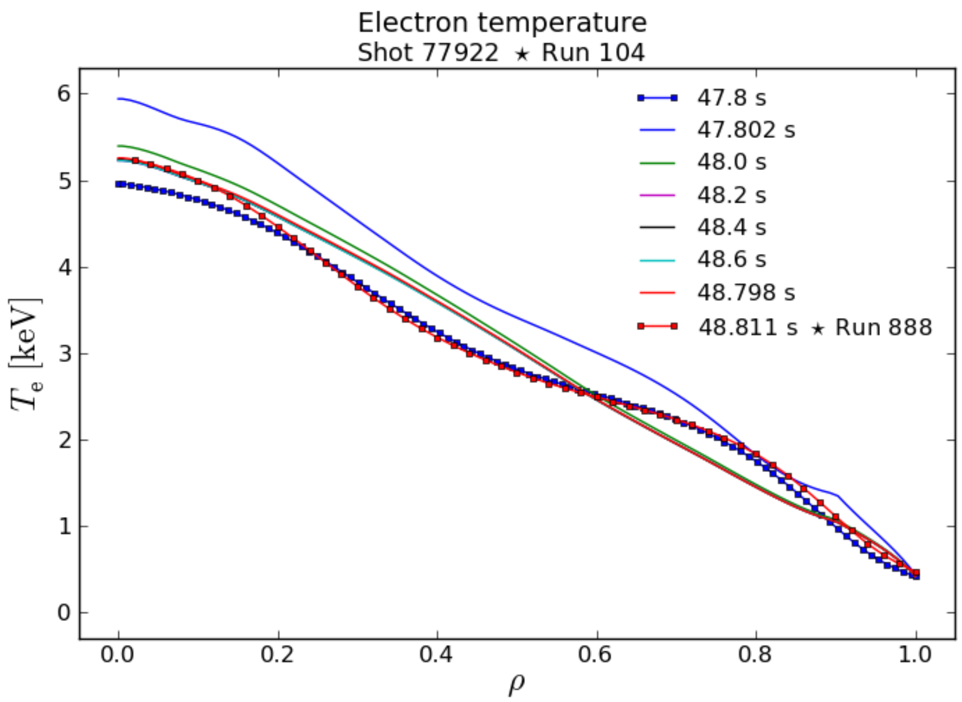


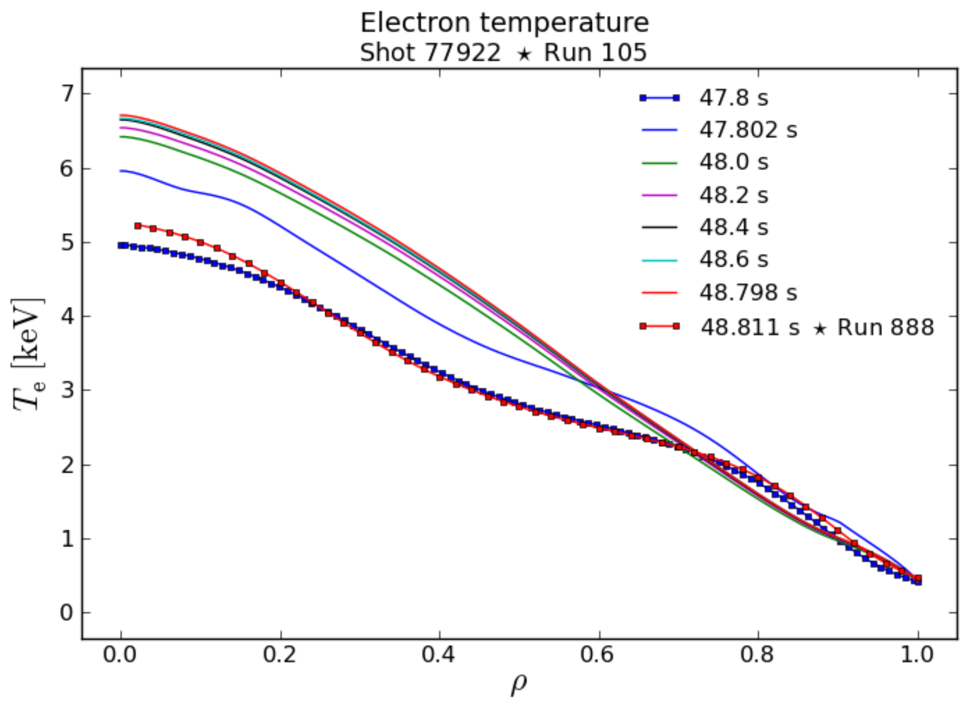
JETTO BgB Model for H-mode

★ Higher temperatures with H-mode model, but more distant from experiment

...JETTO BgB: L- vs. H-mode

Electron Temperature



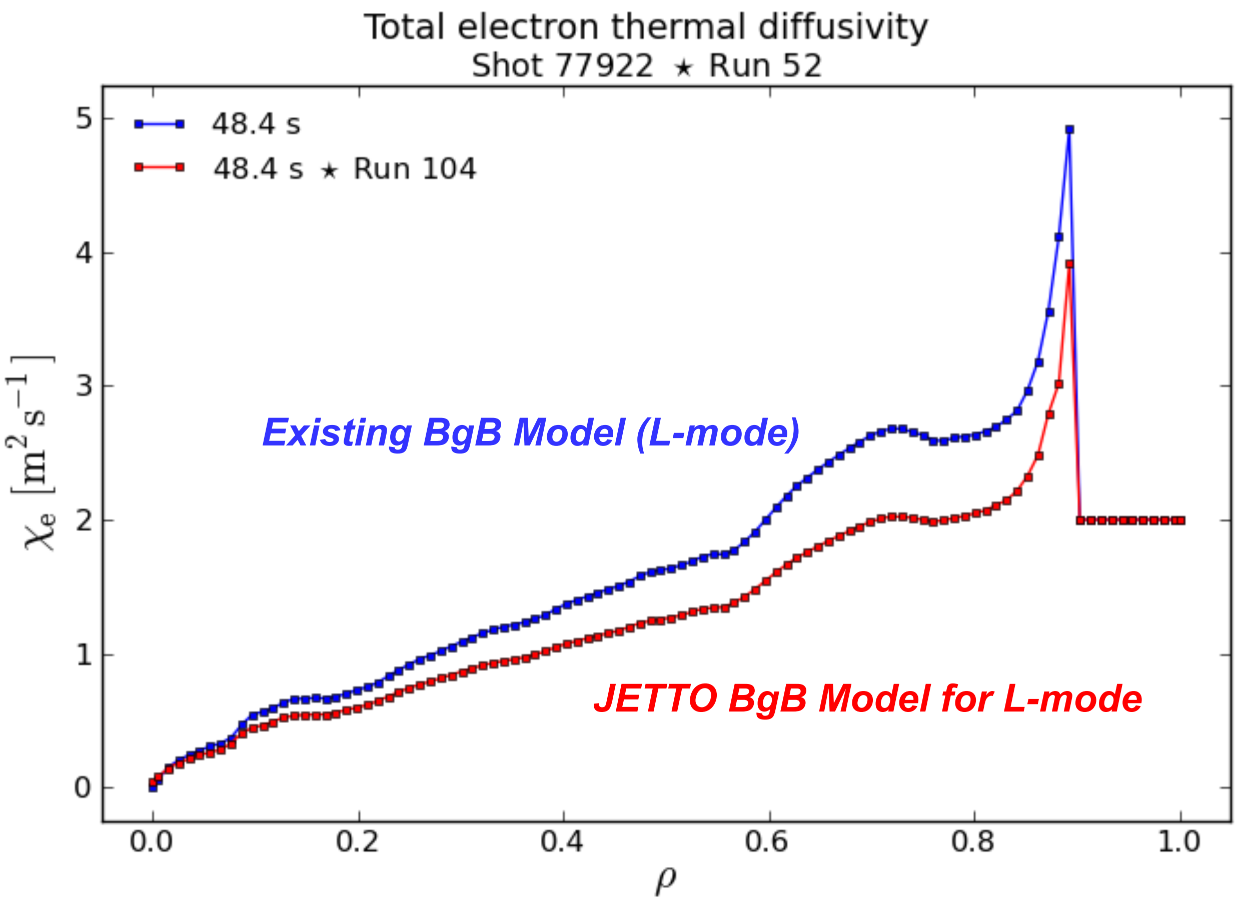


JETTO BgB Model for L-mode

JETTO BgB Model for H-mode

Electron thermal diffusivities...

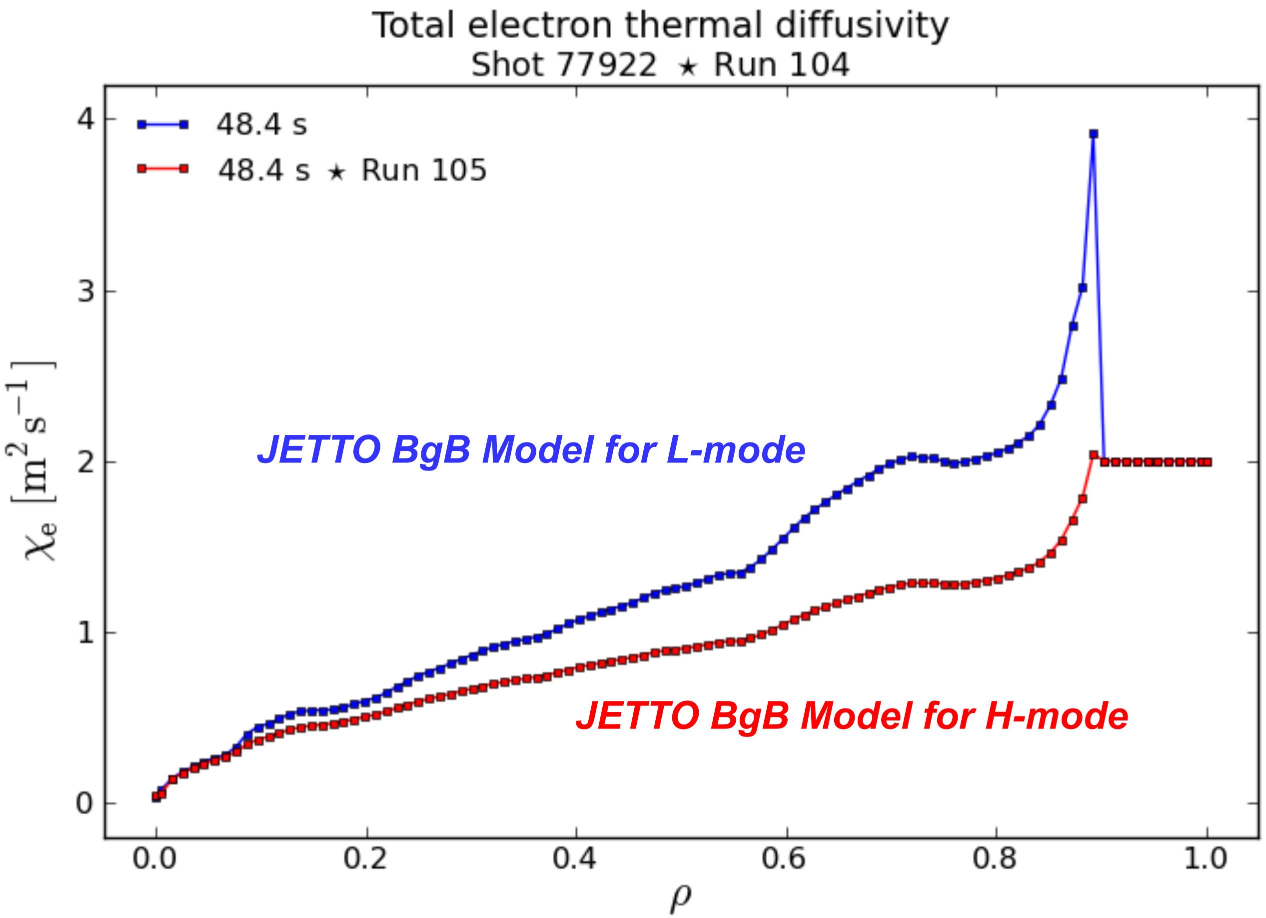
Existing vs. JETTO BgB



★ Lower values with the JETTO model

...Electron thermal diffusivities

JETTO BgB: L- vs. H-mode



★ Lower values with H-mode model