2D Fluid Modeling of the ASDEX Upgrade Far SOL

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Outline

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• Mesh
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• Application to ASDEX Upgrade
• Conclusions
Motivation (I)

Traditional approach to edge plasma modelling

Near SOL: well represented by edge modelling codes

Far SOL: usually not included

Source: www.eirene.de
Motivation (II)

Reasons to focus interest on the far SOL

Plasma conditions in the far SOL affect analysis and prediction of ITER ICRH antenna performance

Limiter plasmas, e.g. First Wall/Limiter (FTU, IGNITOR, ...) and/or divertor start-up (ITER, ...) require FW description

Source: http://ftu.frascati.enea.it
Strategy for SOL Modelling up to FW

- Well developed codes (e.g., B2) exist for near-SOL modelling
  - Finite Volume schemes
  - Structured quadrilateral meshes

- The ASPOEL code is being developed at PoliTo, with emphasis on the far SOL [F. Subba, et al., *J. Nucl. Mater.* (2007)]
  - Control Volume Finite Element (CVFE) schemes (conservative)
  - Triangular (in principle unstructured) meshes → increased geometrical flexibility

Use different codes for different SOL regions
Models

• ASPOEL
  – Two fluids, single ion species + electrons
  – Conserve particles, momentum and energy
  – No neutrals

• B2 (as used here)
  – Reduced to roughly same plasma model as ASPOEL
  – Neutrals (fluid approximation)
Mesh (I)

- **ASPOEL**
  - Fills the far SOL (no far PV at present)
  - ~ 6000 elements
  - Triangular

- **B2**
  - Fills the near SOL
  - ~ 3700 cells
  - Quadrilateral
Mesh (II)

ASPOEL meshes are accurately aligned to B and interpolate the FW geometry.

Nodes are not coincident at the interface surface, interpolation is needed.
B2-ASPOEL coupling (I)

- B2 and ASPOEL are coupled through an interface magnetic surface
- A consistent solution is produced via an iterative procedure
- Information sharing:
  - ASPOEL: use B2 computed fluxes as boundary condition at the interface
  - B2: use ASPOEL computed profiles as boundary condition at the interface
Application: ASDEX Upgrade (I)

Near-far SOL interface

Very low density/vacuum in the farthest regions
Application: ASDEX Upgrade (II)

Density profile @ outer mid-plane

Excellent agreement with experimental data
Application: ASDEX Upgrade (III)

Te profile @ outer mid-plane

Qualitative agreement in edge and near SOL.

Issues (also diagnostic) in far SOL?!
Application: ASDEX Upgrade (IV)

Ti profile @ outer mid-plane

No experimental data available in far SOL
Conclusions

• B2-ASPOEL is proposed as a tool for global SOL modelling up to the first wall
• An iterative procedure provides continuity of fluxes and primary variables
• First application to ASDEX Upgrade shows reasonable agreement with measured profiles
• Perspective: (JET), (ICRH, coupling to TOPICA), ASPOEL/Eirene, ITER
B2-ASPOEL coupling (II)

Convergence of B2-ASPOEL interface fluxes

Under investigation
Application: ASDEX Upgrade (V)

Electron mean free path $\lambda_e$

Connection length $\geq 10$ m $\Rightarrow$ Far SOL barely collisional at midplane