FACETS: Framework Application for Core-Edge Transport Simulations

Presented by

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https://www.facetsproject.org/facets
Framework application: an application designed to allow a series of computations with ever increasing fidelity and, therefore, to include successively more sophisticated models, in particular of each of the aspects of a fusion confinement device.

In-reach:
Fang (Cherry) Liu, Bramley/IU, Dist components
Mahmood Miah, Jardin/PPPL, MHD Eq.
FACETs background

- Part of SciDAC portfolio of the Office of Fusion Energy Sciences
- Proposed in April, 2006
- Funded January 1, 2007
- Multi-institutional main project: Tech-X (Physics, CS/AM), LLNL (Physics, CS/AM), PPPL (Physics), ANL (CS/AM), UCSD (Physics), CSU (AM), ORNL (CS, perf), ParaTools (CS, perf)
- Appended SAP: GA, ORNL
- Advisory: Columbia, LBNL, IU, MIT, NYU, Lodestar
- In collaboration with the CETs: TOPS, TASCs, VACET
FACETS goals

• Provide coupled core-edge-wall computational capability to the fusion community
  – At various levels of detail
  – Serial and parallel

• Make impact on ITER and existing/new machines
  – Device selection (heating)
  – Scenario development
  – Operation
  – Analysis

• Maximal reuse of existing (legacy) software

• Take advantage of petascale computing facilities: a priori parallel

• Have FACETS broadly installed and in use (move beyond “users = developers”)
Core-edge-wall integration involves multiple dimensionalities

Closed field lines: slow perpendicular + fast parallel transport
⇒ Quantities 1-D
Hot plasma
⇒ Collisionless, no significant atomic physics (except beams)

Open field lines: so parallel transport must balance perpendicular
⇒ Quantities are 2-D
Cool plasma
⇒ Collisional, atomic physics is important

Plasma-wall interaction is 2-D
Idealized view: Surfacial couplings between phase transitions

- Core is a collisionless, 1-D transport system with local, only-cross-surface fluxes.
- Edge is a collisional, 2-D transport system.
- Wall: beginning of a particle trapping matrix.

**Surfacial couplings**
Justification for core-edge coupling needs matching

- Sufficiently inside the last closed flux surface, 2-D effects are small.
- Moving out, plasma becomes more collisional.
- Both approximations exist—allows matching.

Basis requires matching theory
FRAMEWORK: Layering set packages not dependent on their layer or higher

Invocation
- facets main
- fcunit Unit tests
- fctest regression tests

Control
- fctrol overall container and control

Implementation
- Transport
- Equilib
- Edge
- Wall
- IO
- Comm

Data and interaction
- fcifcs fusion objects, interactions, access

Tools
- fcstd fusion independent objects

external phys, slv
NUBEAM, UEDGE

external util
MPI, HDF5,

stdc++, txbase
containers
Contacts

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