Projects to help jumpstart FSP

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New projects

- Standardized momentum transport interfaces
- Solvers for stiff transport systems
- Free-boundary equilibrium code

Currently funded projects

- Standardize synthetic diagnostic tools
- Automate sensitivity analysis

FMCFM has become a standard tool within the fusion community

- **FMCFM has standardized the input and output fluxes for many common models within the fusion community:**
  - GLF23
  - NCLASS
  - …
- **Interface aimed at easing parallel flux calculations from the beginning.**
- **Has been extended to include the GA codes:**
  - GYRO
  - NEO
  - TGLF
- **Used by all proto-FSPs and others:**
  - FACETS, SWIM, CPES, (p)TRANSP (to be done)

Standardize Transport Models with Momentum Fluxes

- **Goal**:
  - To better enable standardized methods for momentum transport modeling
- **Issues**:
  - Models for momentum drag due to non-axisymmetric fields are being developed, but not widely available to transport codes
  - Calculating the correct contributions to transport codes from gyrokinetic turbulent codes requires mathematical development
  - Need to handle different equations used in modeling momentum transport
- **Approach**:
  - Propose collaboration between Tech-X, General Atomics, Lehigh, PPPL, UW-Madison to extend current FMCFM to allow all transport codes to use standardized models for momentum transport
  - Deliverable is extension of FMCFM library to provide wide range of support for momentum transport studies
- **Beneficiaries**:
  - Current FMCFM customers: FACETS, SWIM (TSC), CPES (XGC0), TRANSP/pTRANSP

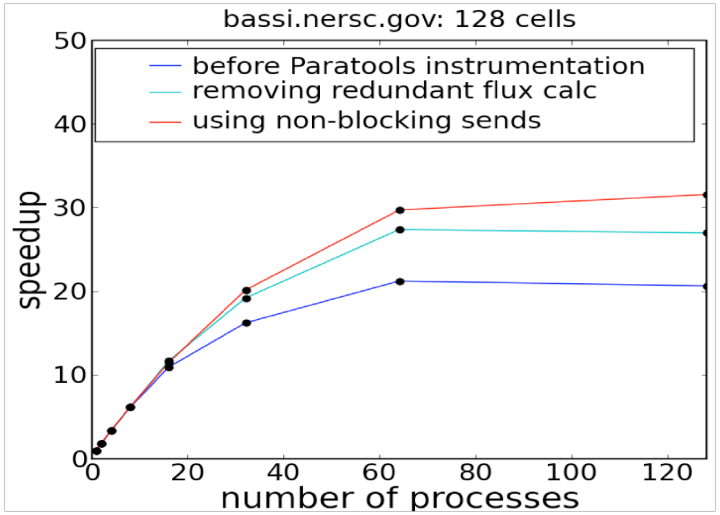
Developing a core transport solver for FSP and the fusion community

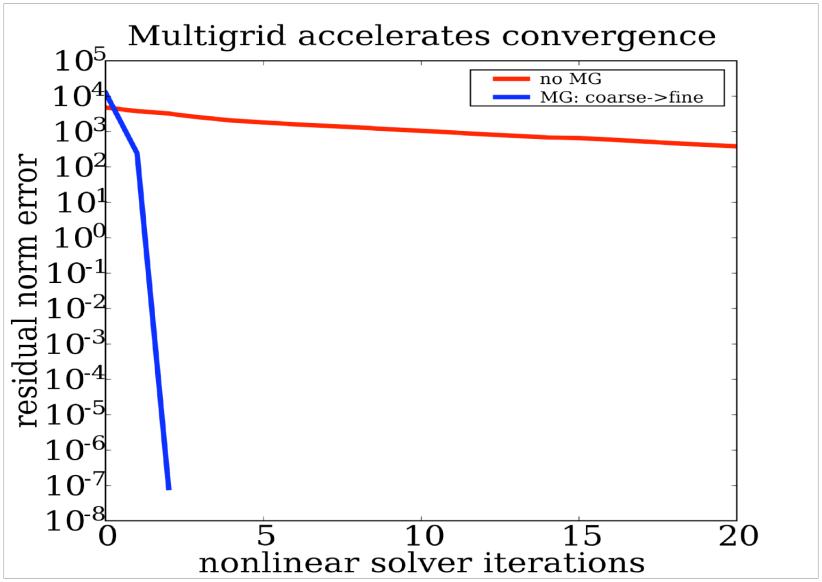
A core solver is needed to advance electron/ion temperatures, densities, momenta, and magnetic flux

- Currently there is no core solver available in the fusion community combining all of the following key features:
  - Parallel and scalable (LCF friendly)
  - Flexible to handle multiple ion species, impurities, ...
  - Accurate for large time steps ~ O(transport time)
  - Robust to handle strong nonlinearities in flux/source calculations
  - Portable to run within FSP and other proto-FSP environments, e.g. pTRANSP

Leveraging FACETS for the development of a new core transport solver

- Parallelism: flux and source computation run as separate processes
- Flexibility: multi-component/multi-equation Application Programming Interface (API)
- Accuracy: implicit time advance (e.g. Diagonally implicit Runge-Kutta)
- Robustness: nested, multigrid iteration using SNES/PETSc solver
- Portability: Fortran and C/C++-callable API (To do)





Beneficiaries: FSP, pTransp, SWIM, FACETS

Parallel, free-boundary equilibrium solver

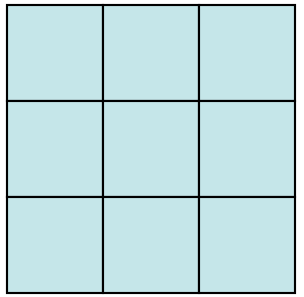
- Use cases:
  - Core-edge coupling
  - Controls
- Previous: TEQ, DINA, unmaintainable?
- Approach:
  - Domain decomposition
  - RZ plane
  - Multigrid, grid sequencing methods
- Beneficiaries:
  - Entire community

Need for fusion applicable (specific?) parallel data redistribution layer

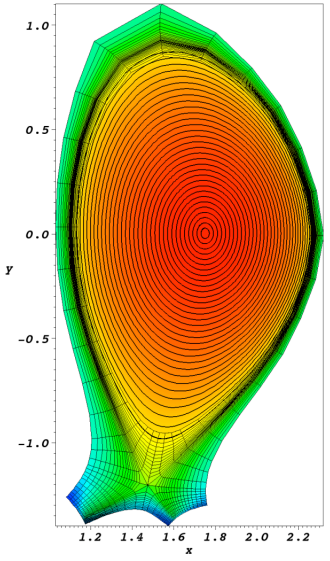
Take data from computational by-processor layout to flux-surface data alignment and vice-versa

MxN

- Use cases:
  - Monte Carlo collection of energetic particle data
  - Flux surface magnetic data needed for equilibrium transport codes
- Approach:
  - Layer for data reorganization
  - Initially with existing MPI calls
- Beneficiaries:
  - All parallel integrated modeling codes
  - Energetic particle codes



Block of data on a processor



Flux surfaces' data on a processor

Standardize Synthetic Diagnosis

- **Use case:**

  Instead of doing one-offs for code and machine, allow all
  - GK codes to generate BES synthetic diagnostics
  - extended MHD codes to generate soft X-Ray diagnostics machine
  - RF code to generate PCI synthetic diagnostic

  for any machine.
- **Approach:**
  - Abstract geometry information for real diagnostic
  - Abstract description of synthetic diagnostic generation
  - Provide workflow tools for generating synthetic diagnostic
- **Beneficiaries:**
  - GK, MHD, and RF codes, and any project that uses their components
  - C. Holland's (GA) synthetic diagnostics for turbulence modeling is an excellent example.

Automating Sensitivity Studies For Fusion Codes

- **DAKOTA tool developed to provide infrastructure for doing sensitivy studies**
  - Provide methods for setting up large scans
  - Provide methods for statistically analyzing results
  - Provide methods for optimization
- **Propose to enable use of DAKOTA for FACETS and SWIM**
  - Working with SWIM/FACETS input files, simplify DAKOTA setup
  - Working with SWIM/FACETS output files, simplify the statistical analysis
  - Apply DAKOTA to particular cases