SDAV technologies for the next generation fusion techniques

S. Klasky (ORNL), N. Podhorszki (ORNL), M. Parashar (Rutgers U.), Q. Liu (ORNL), D. Pugmire (ORNL), A. Sanderson (Univ. Utah), N. Samatova (NCSU), K. Schwan (GA Tech), A. Shoshani (LBNL), B. Whitlock (LLNL), J. Wu (LBNL), F. Zhang (Rutgers.Univ), F. Zheng (GA Tech) and the SDAV team

Large-scale I/O with ADIOS

Objectives:

- Fast, adaptable and scalable I/O codes across all platforms
- Provide an unified I/O framework, which hides I/O complexity away from users and manages individual I/O method. The framework can handle both file and stream processing.
- Developed a non-contiguous parallel file format, which is highly scalable and resilient for large scale simulations.

Impact:

- Checkpoint writing in XGC-1, GTC and other large scale codes with low I/O overhead
- E.g. XGC-1, 200k cores on Jaguar, 2TB checkpoint data to write: original parallel I/O >1 hour, ADIOS ~1 min

http://www.olcf.ornl.gov/center-projects/adios

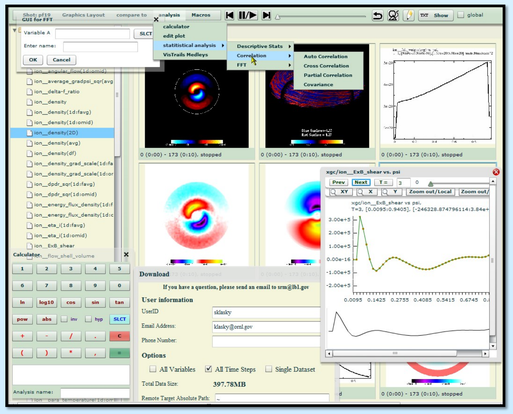
Monitoring simulations with eSiMon

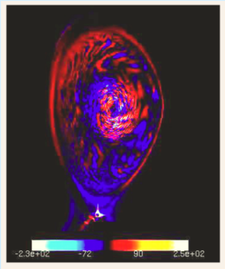
Objectives:

- The eSiMon dashboard
- Uses data, web, and workflow service infrastructure for flexibility and portability.
- Keeping track of the provenance information (complete data lineage) is key for ease of use and efficiency.
- Output can be updated from a running simulation in real time

Impact:

- Allows scientists with different backgrounds and levels of expertise to work together using one single online tool for analysis, visualization, and data movement.
- Allow collaborators to check/analyze a running simulation





Movie frame of XGC1 potential field

An XGC1 run in eSiMon. Movies generated by a workflow are shown as well as interactive vector plotting

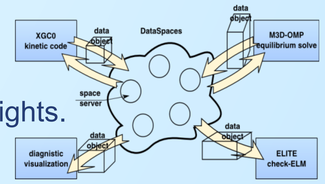
DataSpaces for In Situ / In Transit Data Staging and Analytics

Objectives:

- Combine in-situ/in-transit data analytics execution to move the analytics closer to the data, reduce data movement costs, mitigate disk IO costs, and accelerate the data to insights process.
- Semantically-specialized virtual shared space with geometry-based queries
- Asynchronous coordination and interaction

Impact:

- A novel scalable approach that can help scientists effectively transform large-scale simulations data into insights.
- ADIOS/DataSpaces is a production tool that provides scalable memory-to-memory data transfers



ADIOS / DataSpaces for in-memory code coupling

EFFIS Data Management, Analysis and Visualization Framework for Petascale Simulations

Objectives:

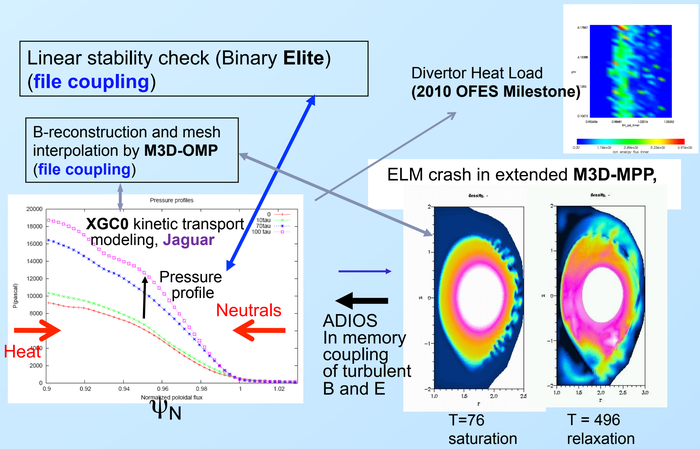
- Create a framework to process simulation output on the fly, allow collaborators to check/analyze running simulation, couple fusion codes

Approach

- ADIOS + DataSpaces + eSiMon + Kepler workflow system

Impact:

- Petascale XGC research enabled by EFFIS



1. Kepler workflow based coupling for testing for ELM crash during pedestal build-up in XGC0 runs
2. ADIOS/DataSpaces based memory-to-memory coupling of XGC0 an M3D-MPP for ELM crash phase

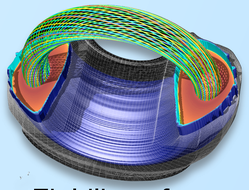
Parallel vector field analysis in VisIt

Objectives:

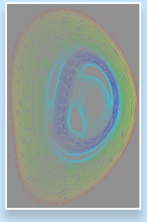
- Enable scientists to understand the nature of velocity and magnetic fields in large scale simulations.
- Research algorithms for efficiently computing integral curves on large scale parallel computing platforms.

Impact:

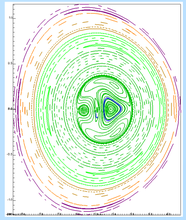
- Production tools that provide scalable, parallel methods for computing integral curves which are the basis for fieldlines, streamlines, and pathlines.
- Multidisciplinary usage, e.g. astrophysics, fusion, radiation transport.



Fieldlines from a M3D simulation



Poincare plot of a DIII-D disruption using M3D-C1



Poincaré plot of a sawtooth crash using M3D-C1

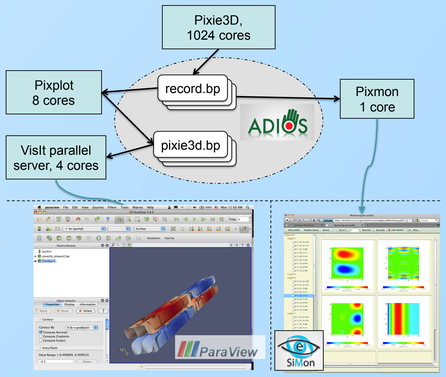
In transit analysis and visualization

Objectives:

- Allow for concurrent analysis and visualization tasks
- Memory-to-memory transfers
- Asynchronous stepping (simulation is running free from analysis)

Impact:

- ADIOS/DataSpaces is a production tool that provides scalable memory-to-memory data transfers using file I/O
- Used for Pixie3D' s non-scalable analysis (PixPlot) and interactive visualization with ParaView



In situ Pixie3D fusion simulation analysis/viz pipeline