Processing Module Development

Rasmus Munk Larsen, Stanford University
rmunk@quake.stanford.edu
650-725-5485
Overview

• New challenges compared to MDI
• Module status and MDI heritage
• Module structure and development strategy
• Community contributions and collaboration
HMI Data Processing Pipeline

• New challenges compared to MDI:
  – Real-time and reliability requirements on ground based observable calculations
  – Level 0-1 of pipeline (telemetry capture, observable calculations) must support instrument ground testing
  – Real-time requirements on high level data products for space weather etc. demands dual pipeline paths:
    › Fast algorithms for preliminary (“quick look”) data products
    › Slower, more accurate process for definitive calibrated data products
  – Pipeline mode generation of high-level data products
  – Automatic on-demand generation of data products, e.g., triggered by VSO queries
    › Requires improved traceability, in particular when using evolving research codes
  – Vastly increased data volume
  – New computationally intensive data analyses, such as time-distance analysis, farside imaging, vector magnetogram inversion
  – Vector magnetic data products and processing

• Ameliorating circumstances
  – Large body of knowledge and software from MDI, GONG & other projects
  – Moore’s law (Disk density, networking bandwidth, computing power)
  – Maturing computing infrastructures (Web technologies, Grids, software tools)
Module status and MDI heritage

Primary observables

- Heliographic Doppler velocity maps
- Spherical Harmonic Time series
- Doppler Velocity
- Tracked Tiles Of Dopplergrams
- Stokes I,V
- Stokes I,Q,U,V
- Continuum Brightness

Intermediate and high level data products

- Mode frequencies And splitting
- Local wave frequency shifts
- Wave travel times
- Wave phase shift maps
- Egression and Ingression maps
- Full-disk velocity, sound speed, Maps (0-30Mm)
- Carrington synoptic v and c_s maps (0-30Mm)
- High-resolution v and c_s maps (0-30Mm)
- Deep-focus v and c_s maps (0-200Mm)
- Far-side activity index
- Line-of-Sight Magnetic Field Maps
- Vector Magnetic Field Maps
- Coronal magnetic Field Extrapolations
- Coronal and Solar wind models
- Brightness Images
- Solar limb parameters
- Brightness feature maps
- Internal rotation
- Internal sound speed

Legend:
- MDI pipeline modules exist
- Standalone “production” code routinely used
- Research code currently used
- Research code exists in the community
- New code under development (HAO)
- Instrument specific code, Stanford is primary developer
Module structure

- Design tasks
  - Identify intermediate and high-level data products desired by research community
  - Establish top level data flow and interface specs to
    › Isolate module development from pipeline infrastructure
    › Allow flexibility for evolving techniques (research codes)
  - Develop/import computational engines in HMI environment, verify:
    › Correctness (test suites)
    › Performance requirements (algorithm improvement, code tuning)
    › Traceability, reproducibility (*: version & configuration info in meta data)
Community contributions and collaboration

• Contributions from co-I teams:
  – Software for intermediate and high level analysis modules
  – Algorithm description (detailed enough to understand the contributed code)
  – Test data and intended results for verification
  – Time
    › Explain algorithms and implementation
    › Help with verification
    › Collaborate on improvements if required (e.g. performance or maintainability)

• Contributions from HMI team:
  – Pipeline execution environment
  – Software resources (Development environment, libraries, tools)
  – Time
    › Collaborate on defining module interface
    › Help with porting code to target hardware
    › Collaborate on algorithmic improvements, code tuning, parallelization
    › Verification