The Frequency Agile Solar Radiotelescope

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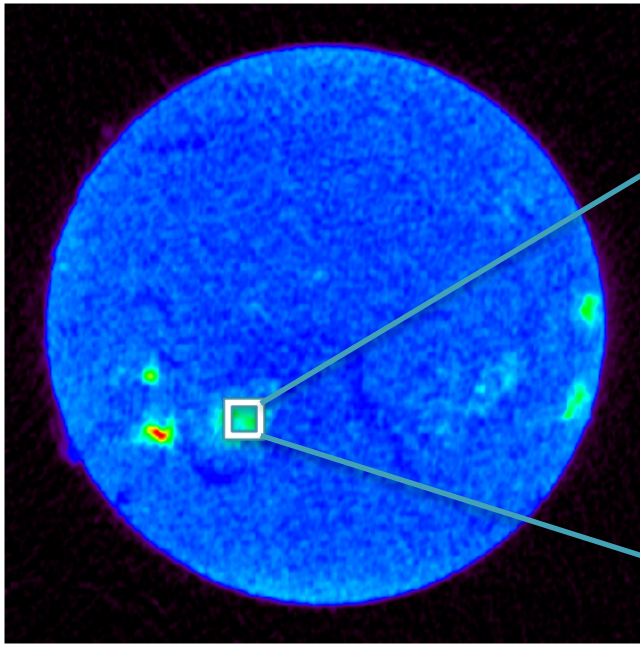
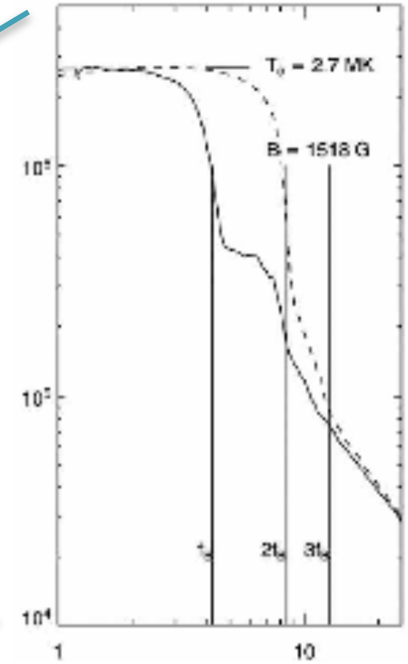
Outline

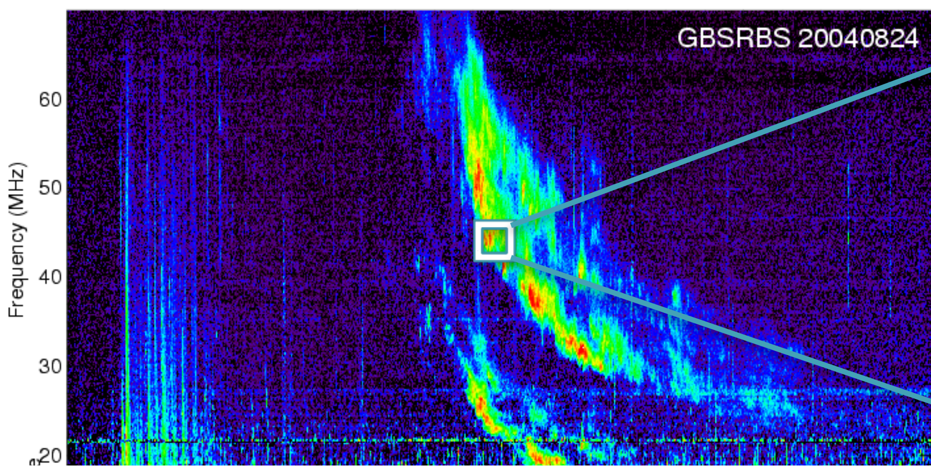
- What is FASR – key innovation?
- What new observables are enabled?
- What are its primary science objectives?
- Who would use FASR?
- What is its operations model?
- Broader perspectives

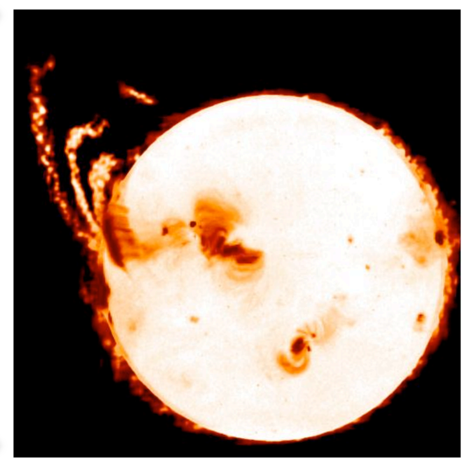
Nobeyama Radioheliograph





NoRH 17 GHz





GB/SRBS LO 18-70 MHz

The Innovation

FASR will perform dynamic, ultra-broadband imaging spectroscopy. It will probe the solar atmosphere from the chromosphere to the outer corona. It will do so with spatial, spectral, and temporal resolution matched to the physical phenomena that occur.

FASR Specifications (descope)

FASR A: ~2.5-21 GHz

FASR B: ~0.25-3 GHz

FASR C: ~50-300 MHz

Proposed site is OVRO

Frequency range	50 MHz - 21 GHz
Data channels, bandwidth, freq. channels, int. time	2/500 MHz/4000/20 ms
Number antennas	A: ~45 (990 pairs) B: ~15 (105) C: ~15 (105)
Size antennas	A: 2 m B: 6 m C: LPD tiles or similar
Polarization	Stokes IV(QU)
Angular resolution	$20/\nu_9$ arcsec
Footprint	~3 km
Field of View	>0.5 deg

Proposed FASR Site

Significant existing infrastructure

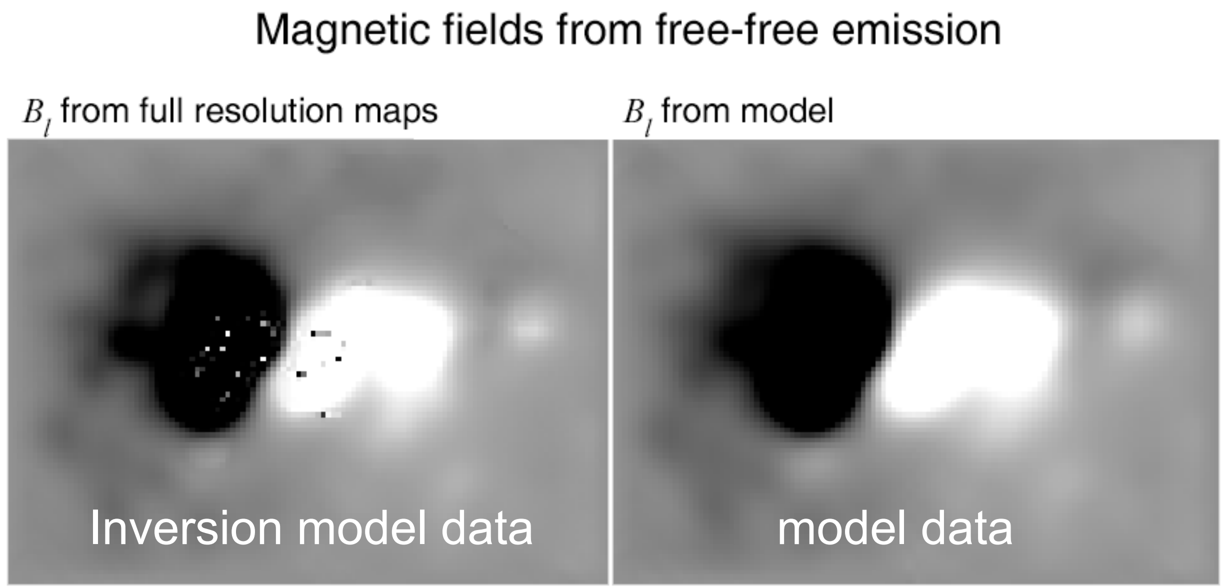
New Observables

Imaging spectroscopy enables the exploitation of a number of techniques to make quantitative measurements of the magnetic field throughout the solar corona

- Thermal free-free emission
  provides measurement of longitudinal field in
  quiet Sun regions, active regions postflare loops
- Thermal gyroresonance emission
  provides measurement of field strength and constrains
  field vector in active regions
- Nonthermal gyrosynchrotron emission
  Provides measurement of field strength and constrains
  the field vector in flaring loops, CME loops

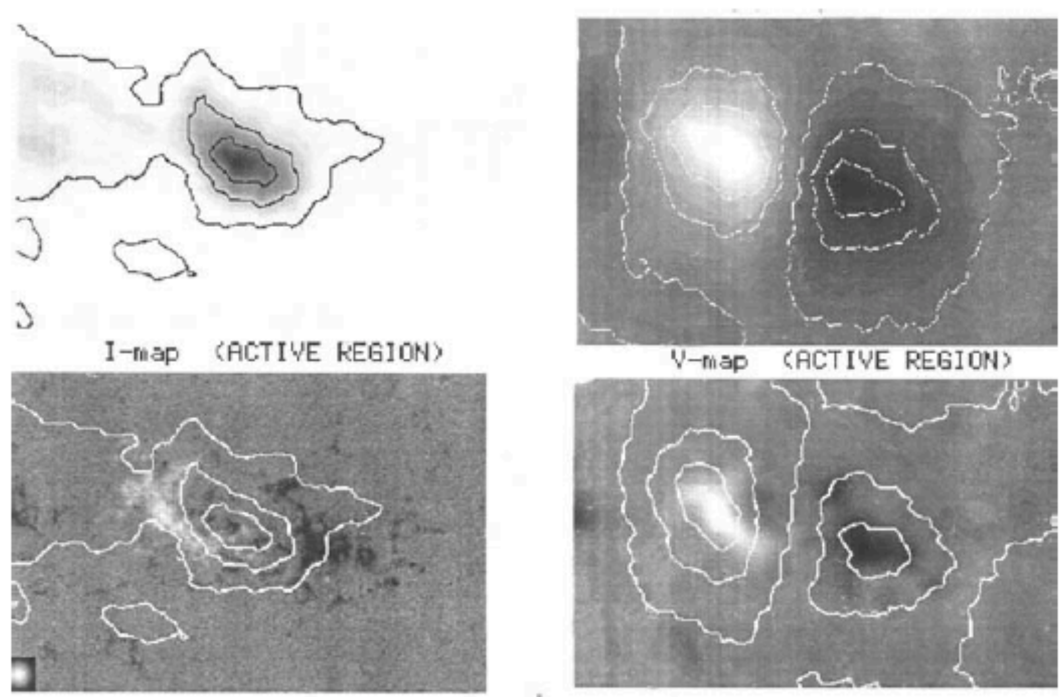
n.b. operative on solar disk and above the limb!

- MHD loop oscillations (coronal seismology)
- Mode coupling phenomenon yield topological constraints
- "Statistical" measurements using polarized radio bursts



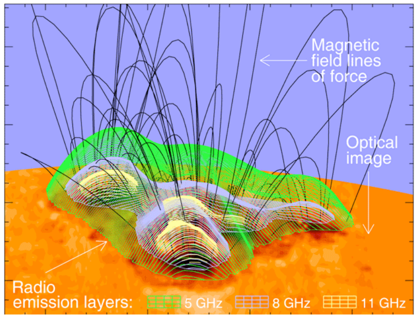
Mok et al 2003

NoRH measurement of AR magnetic field using free-free absorption

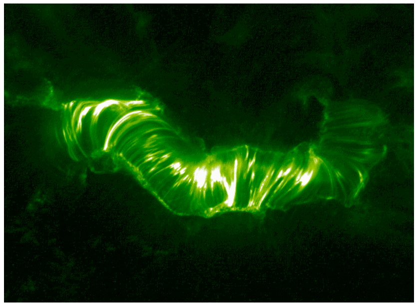


Gelfreikh et al 2005

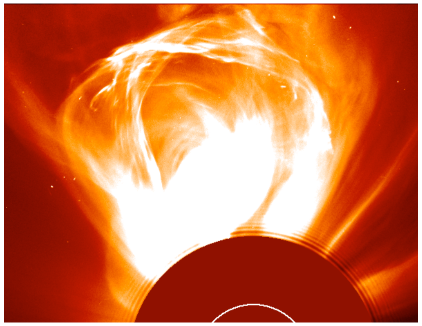
The Science



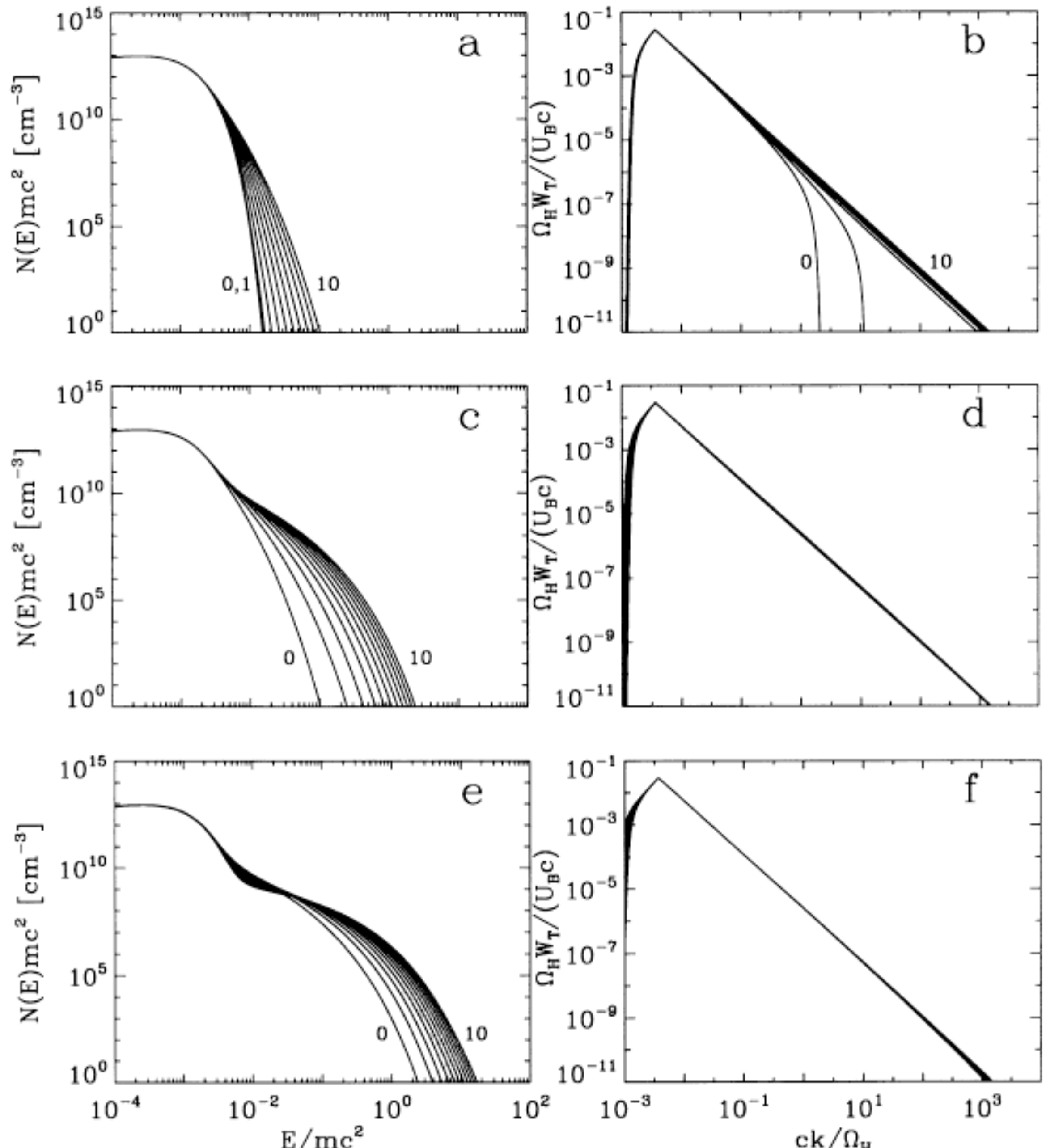
- Coronal Magnetic Fields
  - Coronal magnetography
  - Spatiotemporal evolution of fields
  - Role of electric currents in corona
  - Coronal seismology



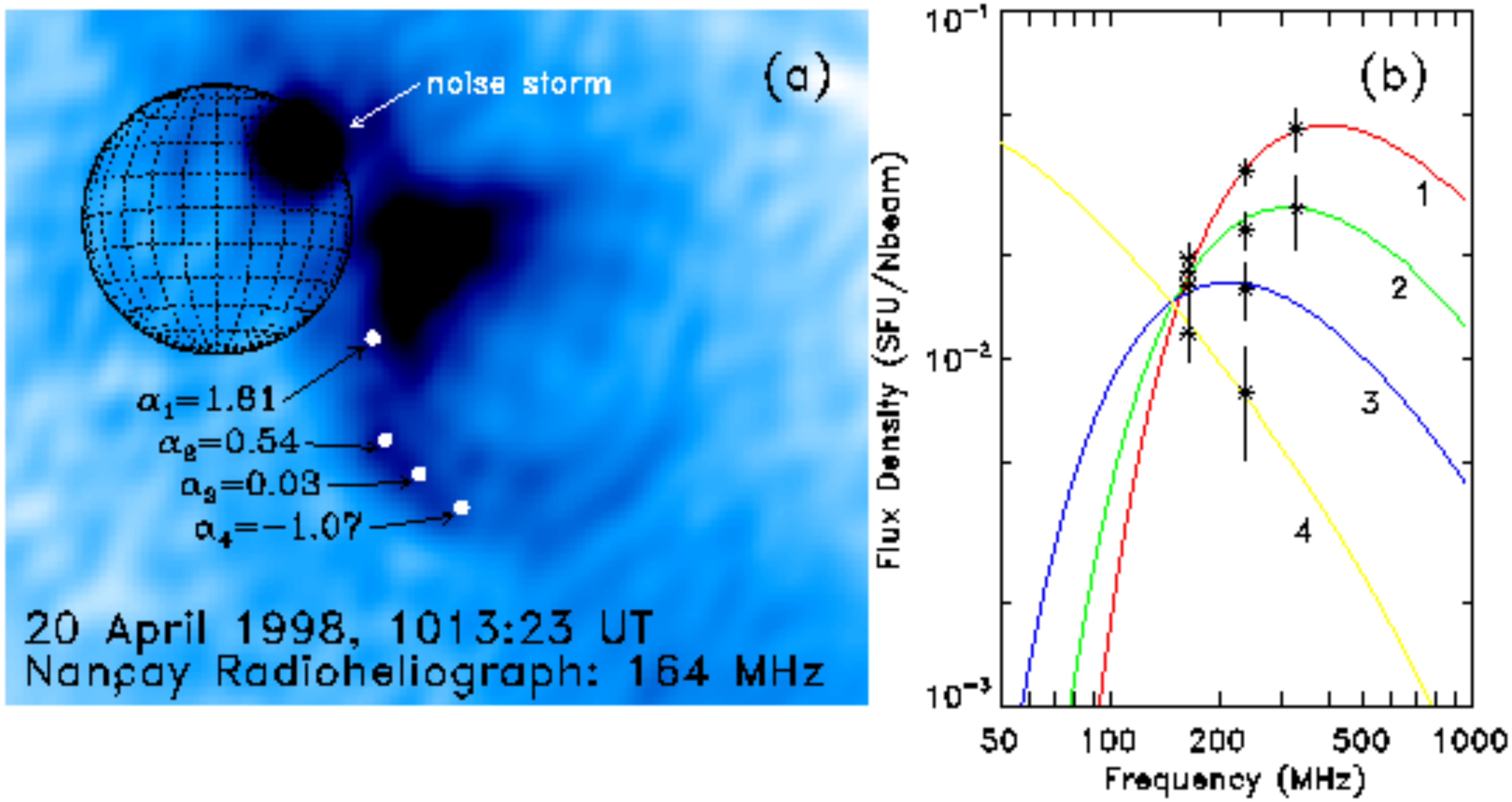
- High energy solar physics
  - Magnetic energy release
  - Plasma heating and dynamics
  - Electron acceleration and transport
  - Origin of SEPs



- Drivers of Space Weather
  - Birth & acceleration of CMEs
  - Prominence eruptions
  - Origin of SEPs
  - Fast solar wind streams

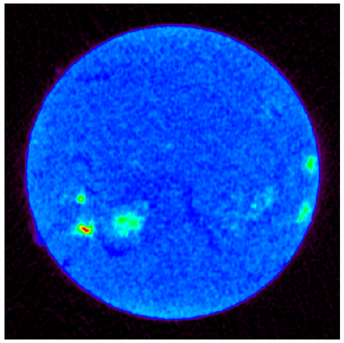


Miller et al 1996

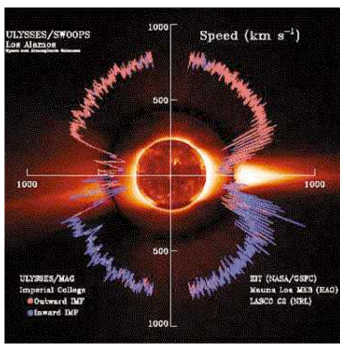


LoS	α	R_{sun}	ϕ (deg)	n_e (cm^{-3})	B(G)	ν_{RT} (MHz)
1	1.81	1.45	234	2.5×10^7	1.47	330
2	0.54	2.05	218.5	1.35×10^7	1.03	265
3	0.03	2.4	219.5	6.5×10^6	0.69	190
4	-1.07	2.8	221	5×10^5	0.33	30

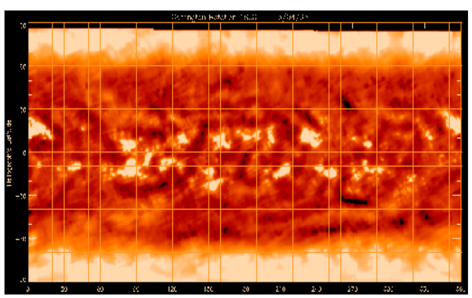
The Science



- The "thermal" solar atmosphere
  - Coronal heating - nanoflares
  - Thermodynamic structure & dynamics
  - Formation & structure of filaments



- Solar Wind
  - Birth in network
  - Coronal holes
  - Fast/slow wind streams
  - Turbulence and waves



- Synoptic studies
  - Radiative inputs to upper atmosphere
  - Global magnetic field/dynamo
  - Flare statistics

FASR Community

FASR is envisaged as a facility that will support the solar and heliophysics communities

Moreover, it is quite possible that FASR will play an operational role in space weather now-casting and forecasting

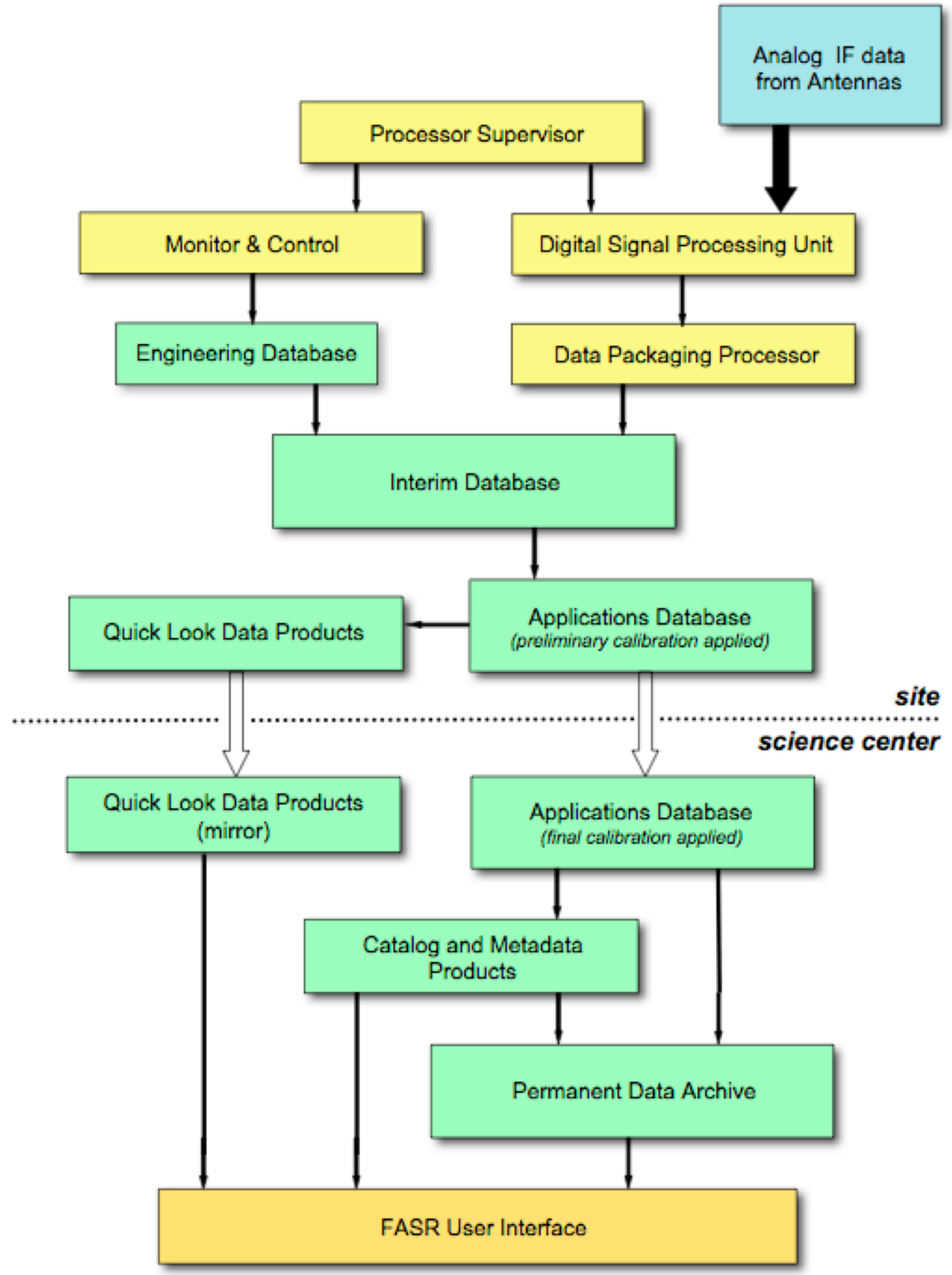
To be successful, FASR must “mainstream” the use of radio imaging and spectroscopic data, much as Yohkoh did for soft X-ray data, SOHO did for EUV data, and RHESSI is doing for hard X-ray data

FASR Operations

Two key goals:

1. Maximize the accessibility and utility of the data to the wider scientific community – mainstream its use.
    - Pipeline data processing to calibrate & reduce data
    - Rich suite of applications data bases (plus "raw visibilities")
    - Data products available through web interface/VO
    - Provide custom data products, software tools for data analysis, visualization & modeling
    - Student training, postdocs, regular community workshops
2. Minimize the cost and complexity of daily operations.
    - Not a PI/GI instrument (akin to current NASA missions)
    - No night time support – calibration only
    - Design instrument with clear operational objectives in mind
      - Simplicity
      - Reliability
      - Maintainability
      - Upgradability

Data Pipeline



Broader perspectives

Ground-based solar physics is in a unique position wrt NSF; both AST and ATM have historically played a role

AST prioritizes (large) investments in facilities via the NRC decadal surveys

Is ATM interested in expanding and diversifying its UARS portfolio?

- If so, how are new facilities planned, prioritized, and funded?
- How will new facility operations be funded?
- What are NSF's obligations toward aging facilities?

There as been some discussion in the NSF and in the wider community of placing solar/heliospheric/space weather science and facilities in a new division, perhaps under GEO. Good idea?