Virtual Solar Observatory

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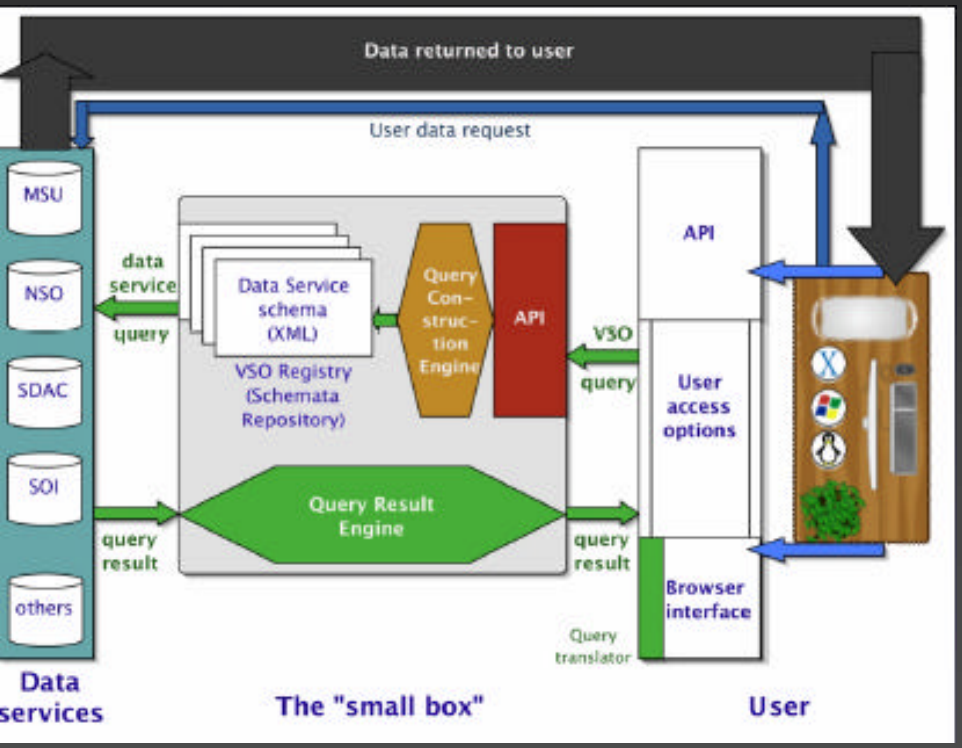
BRAVO Workshop – 5-Feb-200

Summary

- Brazilian solar initiative
- The Virtual Solar Observatory (USA)
- Observatories and databases: ROI, SST
- Proposed applications:
  - Magnetic field extrapolation
  - Flare spectra modeling
  - Solar atmosphere model

The Virtual Solar Observatory (USA)



- Browser query interface offers multiple search methods, including combinations
- GUI allows sorting by columns, viewing of thumbnails (where available)

Gurman et al.

VSO

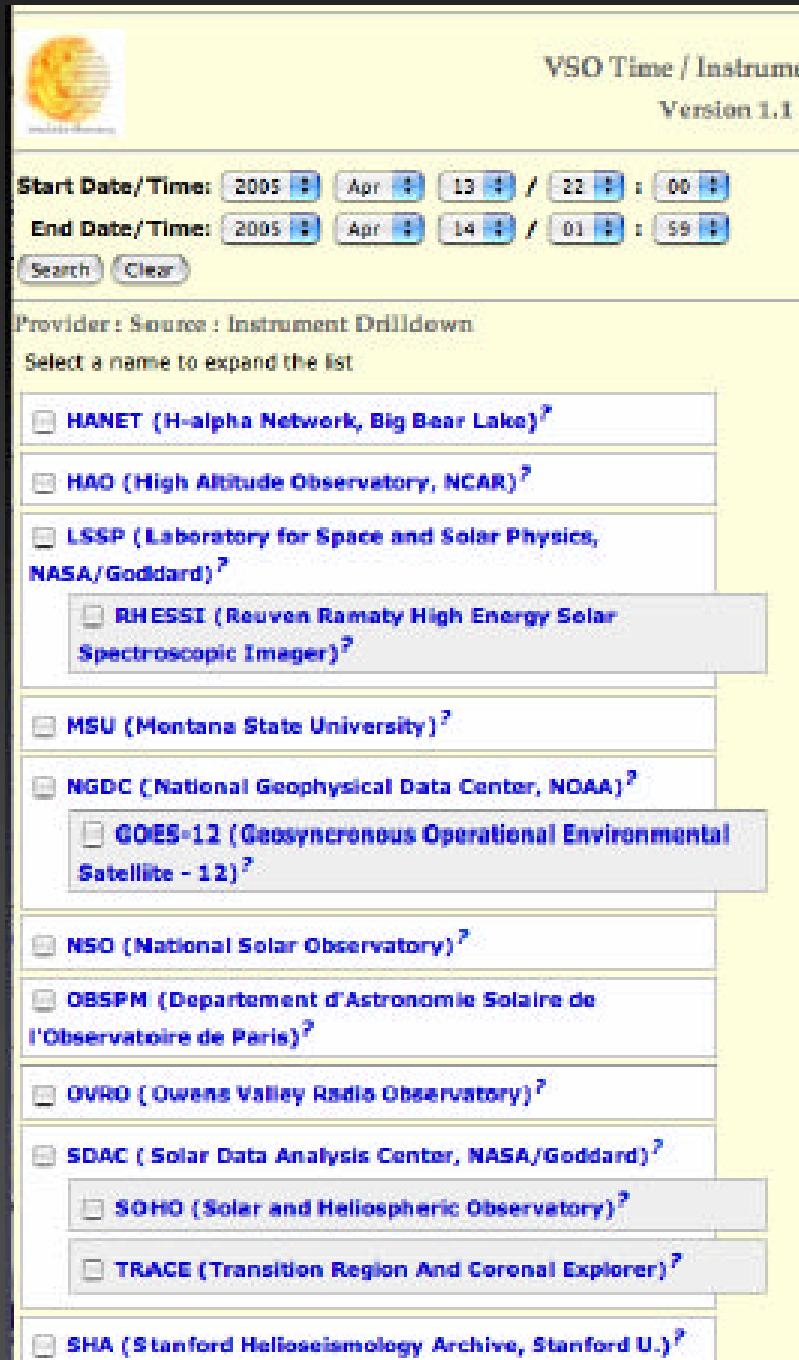
- Since 12/2002
- http://sdac.virtualsolar.org
- Search by:
  - Time
  - Observable
  - Instrument/Source/Provider
  - Spectral range
  - Nickname

Instruments

- 512-CHANNEL MAGNETOGRAPH
- 60-FT SHG
- BCS - Yohkoh
- BIG BEAR
- CDS
- CELIAS
- CERRO TOLOLO
- CFDT1
- CFDT2
- CHP
- COSTEP
- DPM
- EIT - SOHO
- EL TEIDE
- ERNE
- GOLF
- HXT - Yohkoh
- IMPACT
- LASCO – SOHO
- LEARMONTH - GONG
- MAUNA LOA
- MDI - SOHO
- MK4
- MOF/60
- MOTH
- O-SPAN
- OVSA
- PLASTIC
- RHESSI
- S/WAVES
- SECCHI
- SOLAR FTS SPECTROMETER
- SPECTROHELIOGRAPH
- SPECTROMAGNETOGRAPH
- SUMER
- SWAN
- SXI-0
- SXT - Yohkoh
- TENERIFE
- UDAIPUR
- UVCS
- VIRGO
- VSM
- WBS - Yohkoh

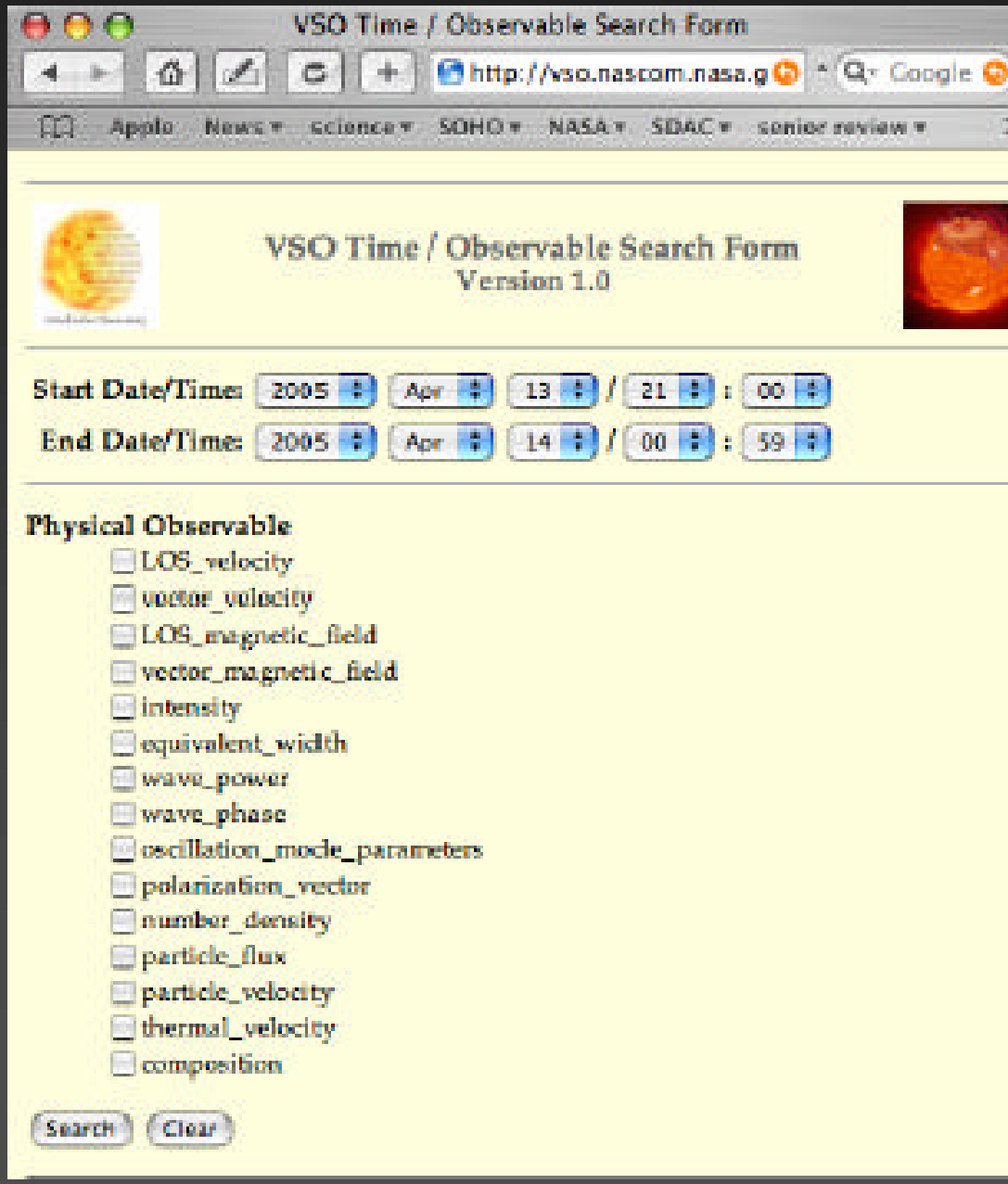
Search and Selection

- Search by data source and observatory or instrument



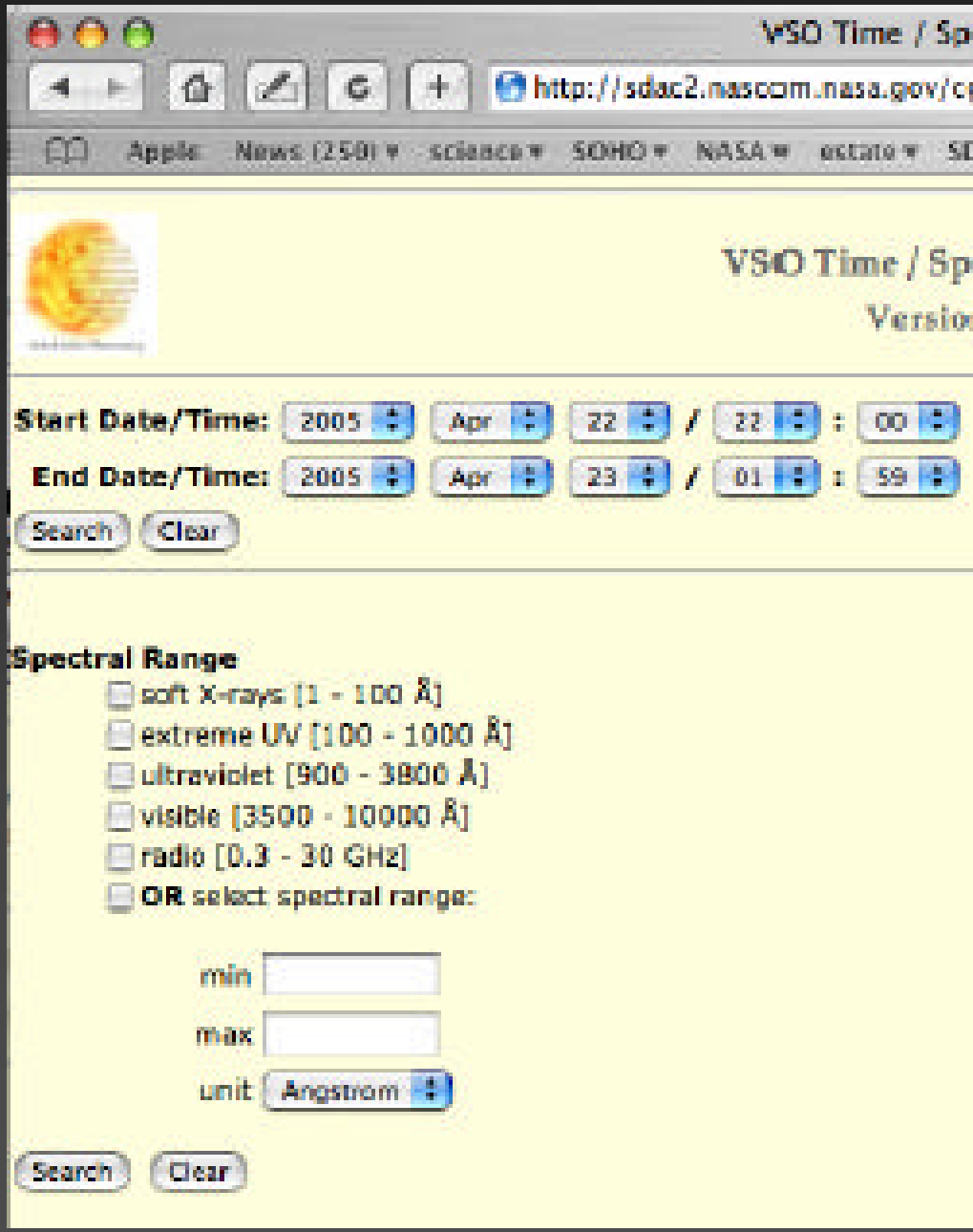
Search and Selection

- Or by physical observable



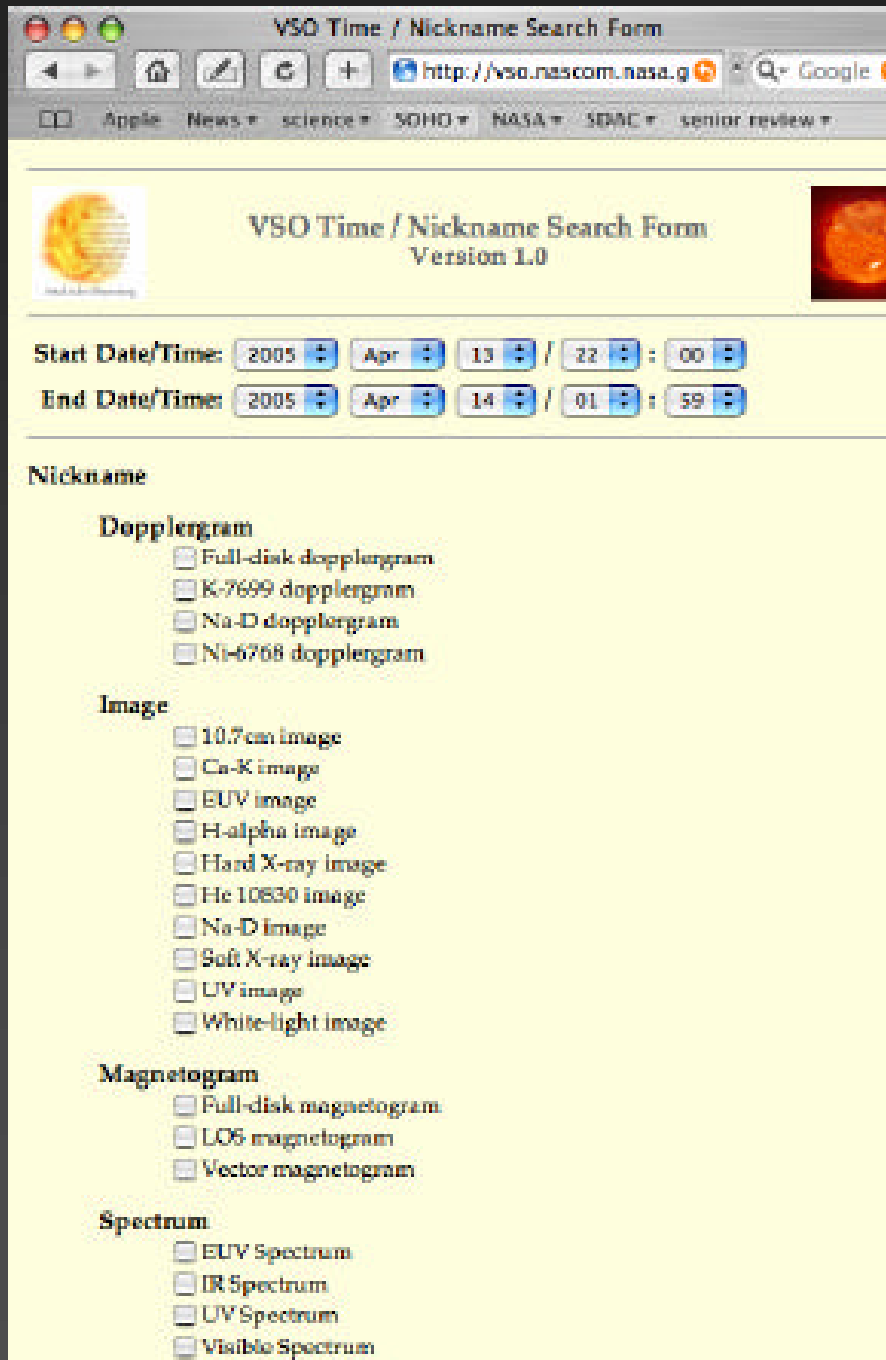
Search and Selection

- Or by wavelength or frequency



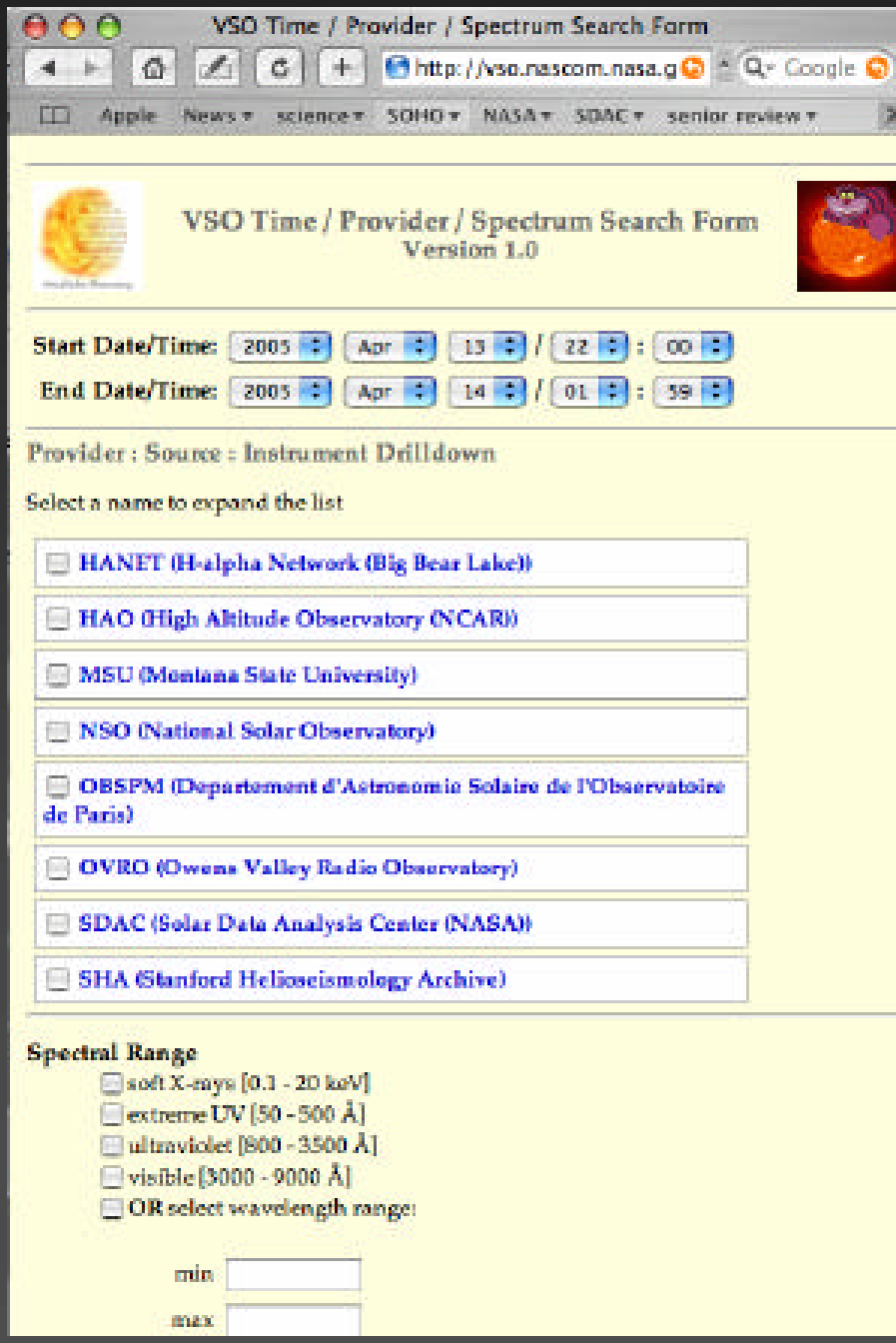
Search and Selection

- Or by “nicknames”, commonly used names for specific data types

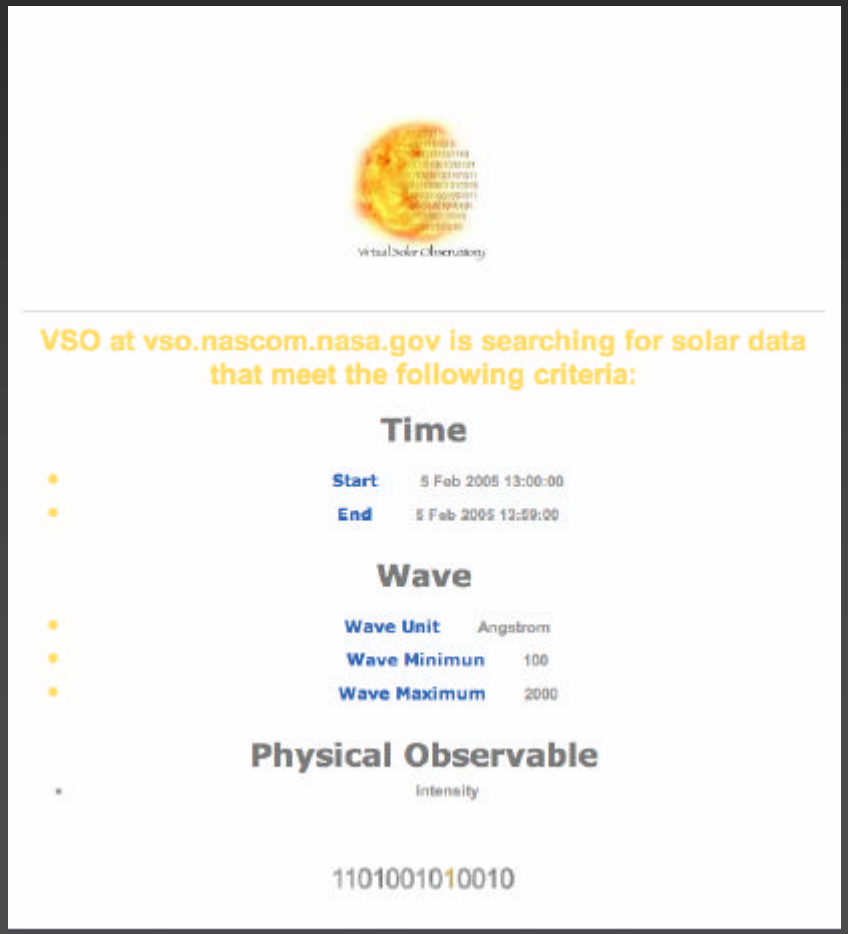


Search and Selection

- Or by combination of search methods

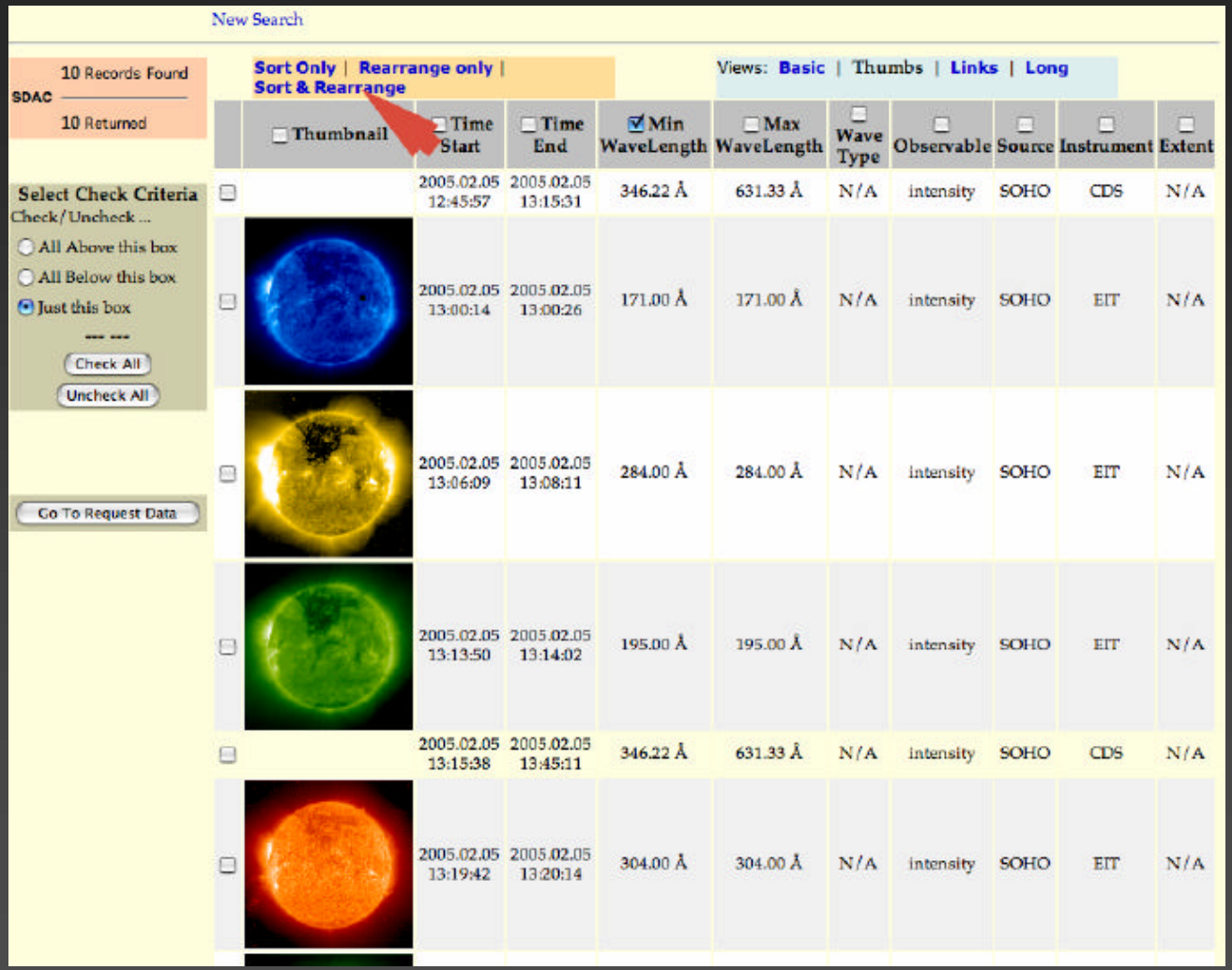


Example



- Search by:
- Time interval (default)
- Nickname = EUV image (wavelength range)
- Physical Observable = Intensity

Search results



- Shopping cart: data request
- Delivery method (depends on data provider): e-mail or link

The Brazilian Virtual Solar Observatory

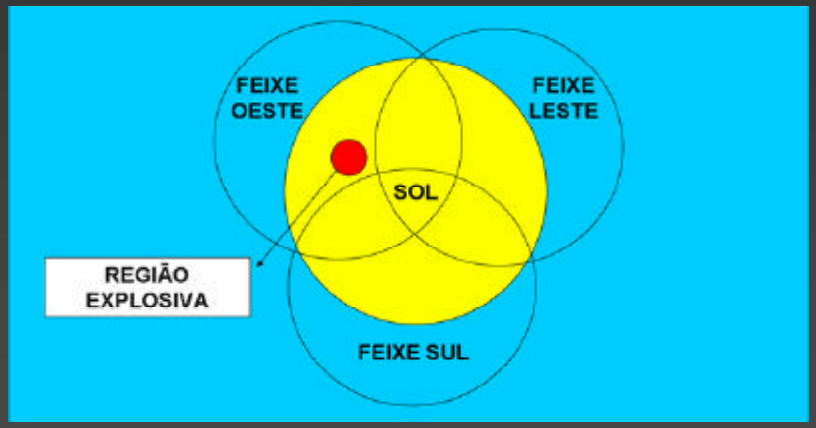
- Multi-frequency data from different Observatories: 12, 22, 48, 212 & 405 GHz;
- Probe different heights in the atmosphere: emission at higher radio frequencies originate deeper than that at lower freqs. – determine temperature and density of various layers of the solar atmosphere;
- Time profiles of flux density for flares;
- Flare spectra: emission mechanism, energetic particle population, magnetic field, etc;
- Maps/images: active regions, limb brightening, coronal holes, etc.

Database

Database – 12 GHz

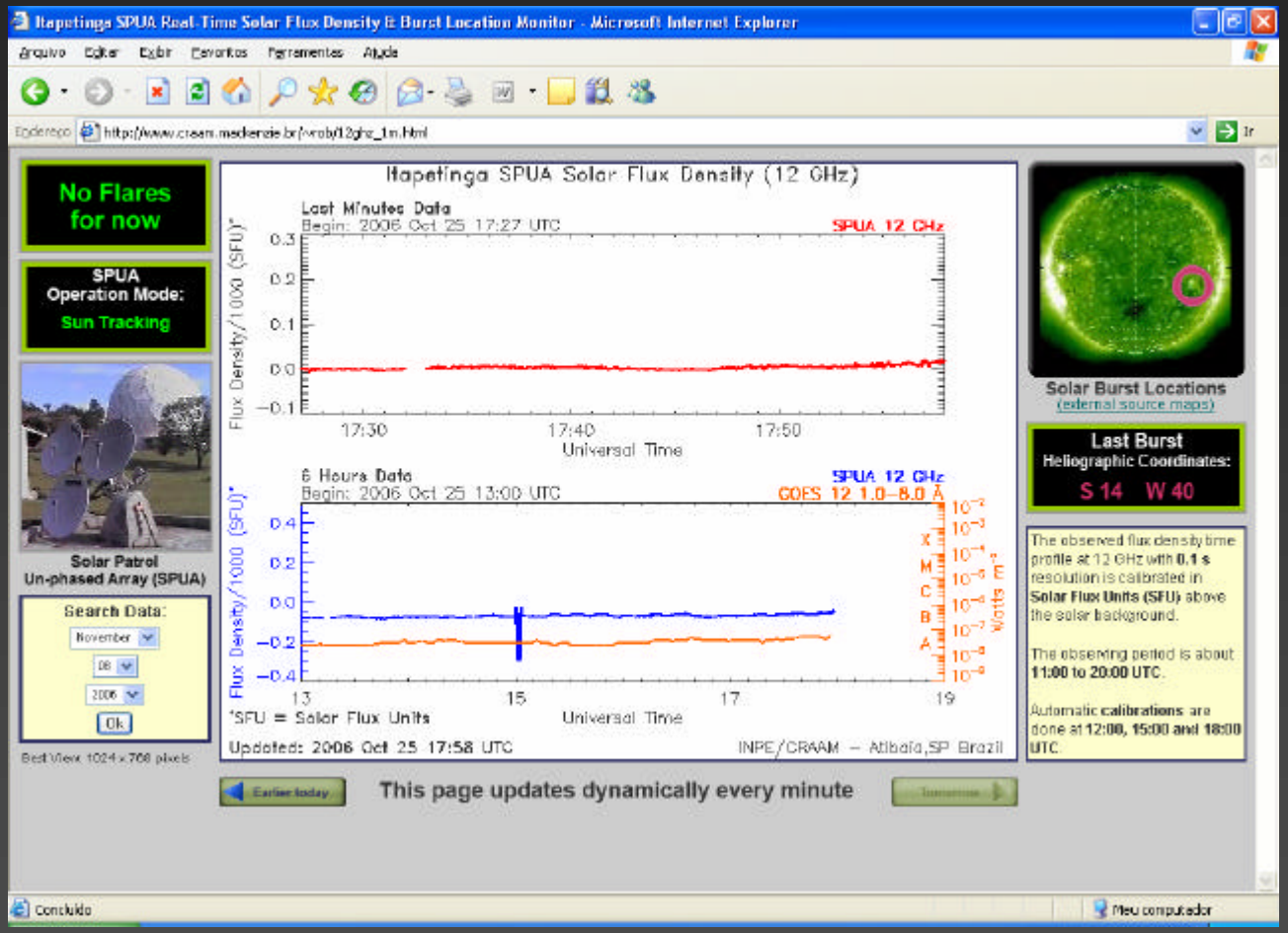
- Radio Observatory of Itapetinga (ROI), in Atibaia, SP;
- Patrol telescope;
- Flux density of solar flares and position in heliographic coordinates daily from 11 - 19 UT;
- Temporal resolution of 100 ms, spatial resolution of 30 arcsec, and sensitivity of 1 sfu;
- Real time international alert for microwave burst occurrence.

Burst location – 12 GHz



- Measured flux density in the three antenna allows for location of the burst.
- Information used for pointing of other telescopes for burst observation.

SPUA



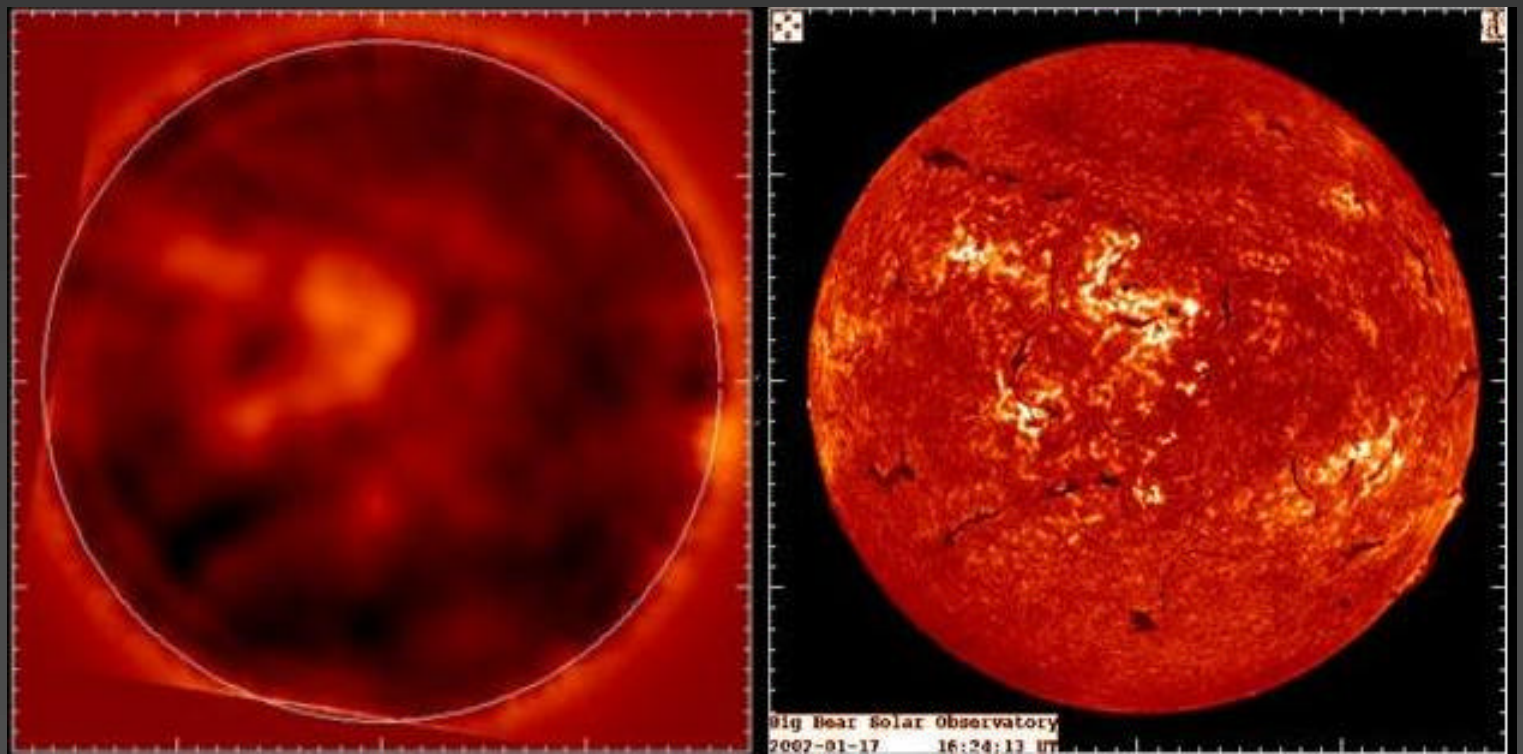
- Solar Patrol Un-phased Array
- Monitoring and alert of solar bursts at 12 GHz
- www.craam.mackenzie.br/~rob/12ghz_1m.html

Database – 22 & 48 GHz

- ROI (Atibaia, SP)
- Observing campaigns
- Flux density of solar flares with 0.01 sfu sensitivity and temporal resolution of 1 ms.

Maps/Images – 22 & 48 GHz

- Maps at both frequencies composed of raster scans
- Images of the solar chromosphere: observe bright active regions and dark coronal holes.



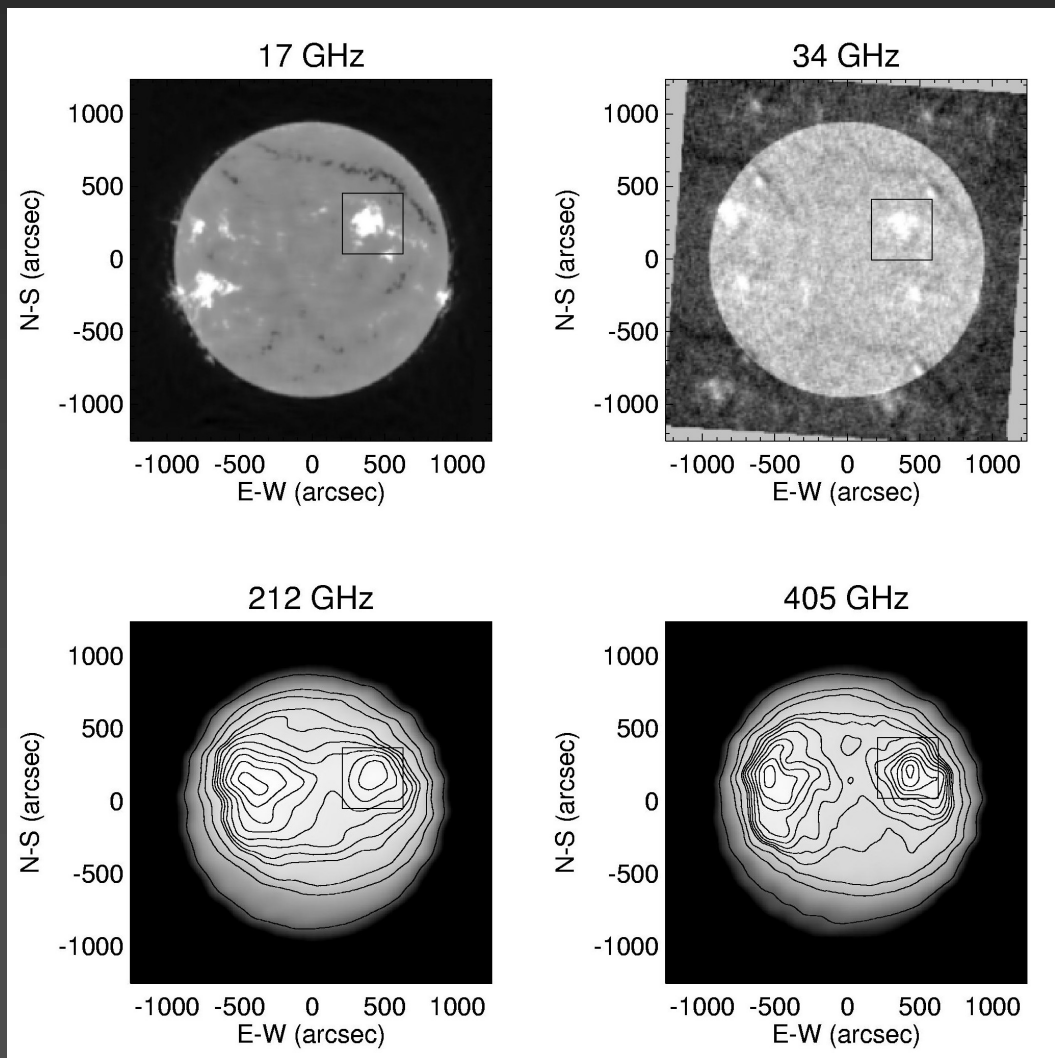
Database – 212 & 405 GHz

- Submm Solar Telescope (SST), at CASLEO Obs. – Argentina at 2500 m
- Since 1999
- Flare observations and daily maps of the Sun
- 4 receivers at 212 GHz and 2 receivers at 405 GHz
- 5 ms temporal resolution

Solar maps – 212 & 405 GHz

(Silva et al. 2006)

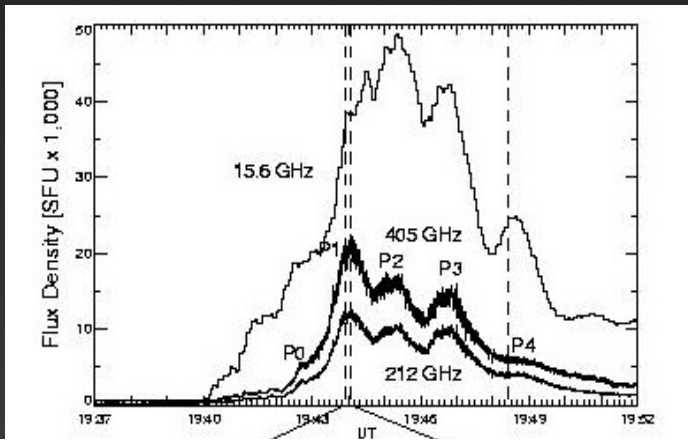
- 4500 Solar maps at each frequency;
- Study:
  - Quiet Sun's atmosphere
  - Active regions
- Improve models of the atmosphere;
- Infer magnetic fields of AR.

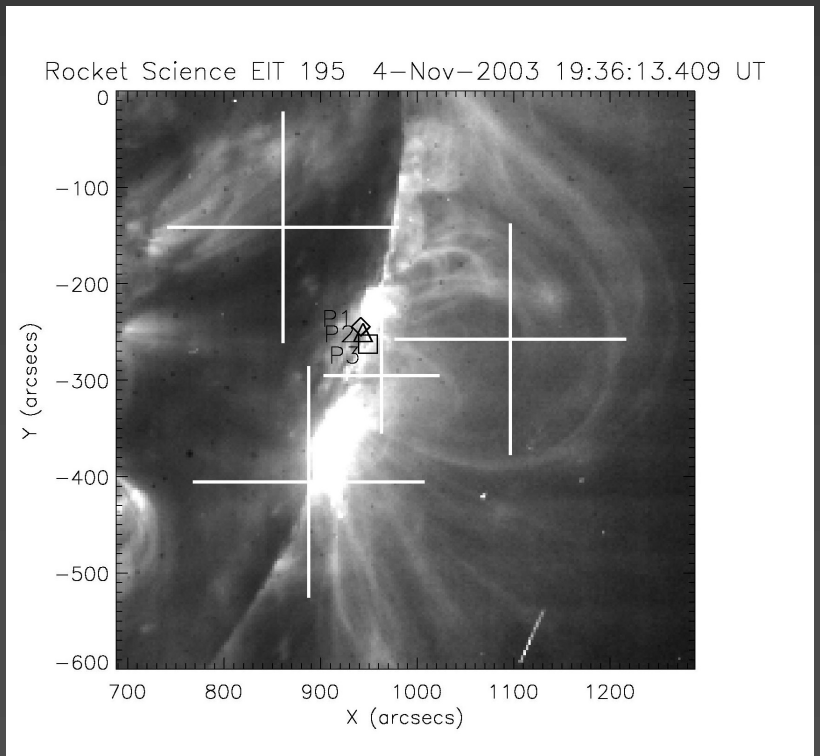


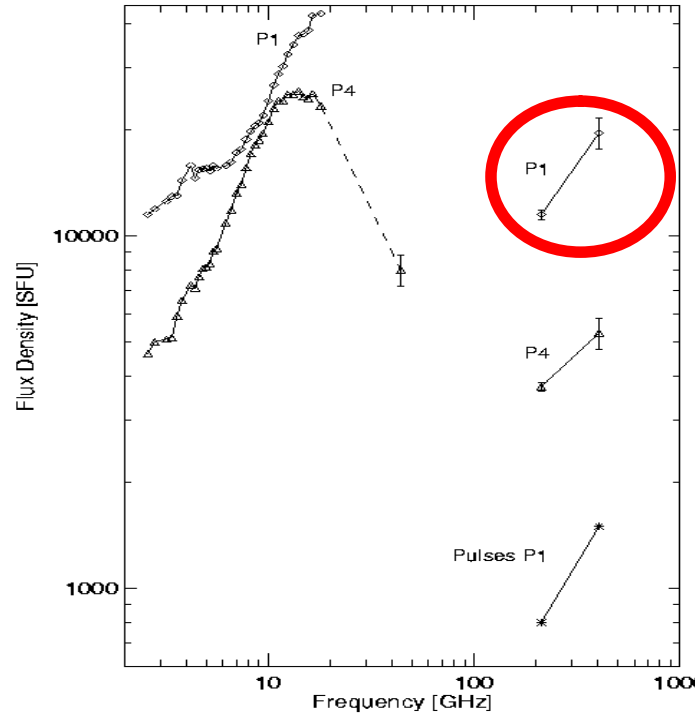
Flare – 212 & 405 GHz

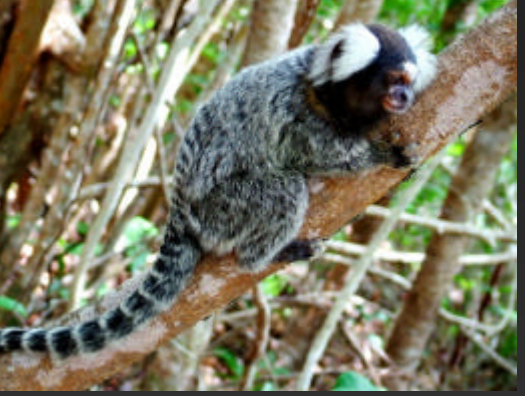
(Kaufmann et al. 2004)

- Time profile – evolution
- Spectra – emission mechanism
- Position (centroid)



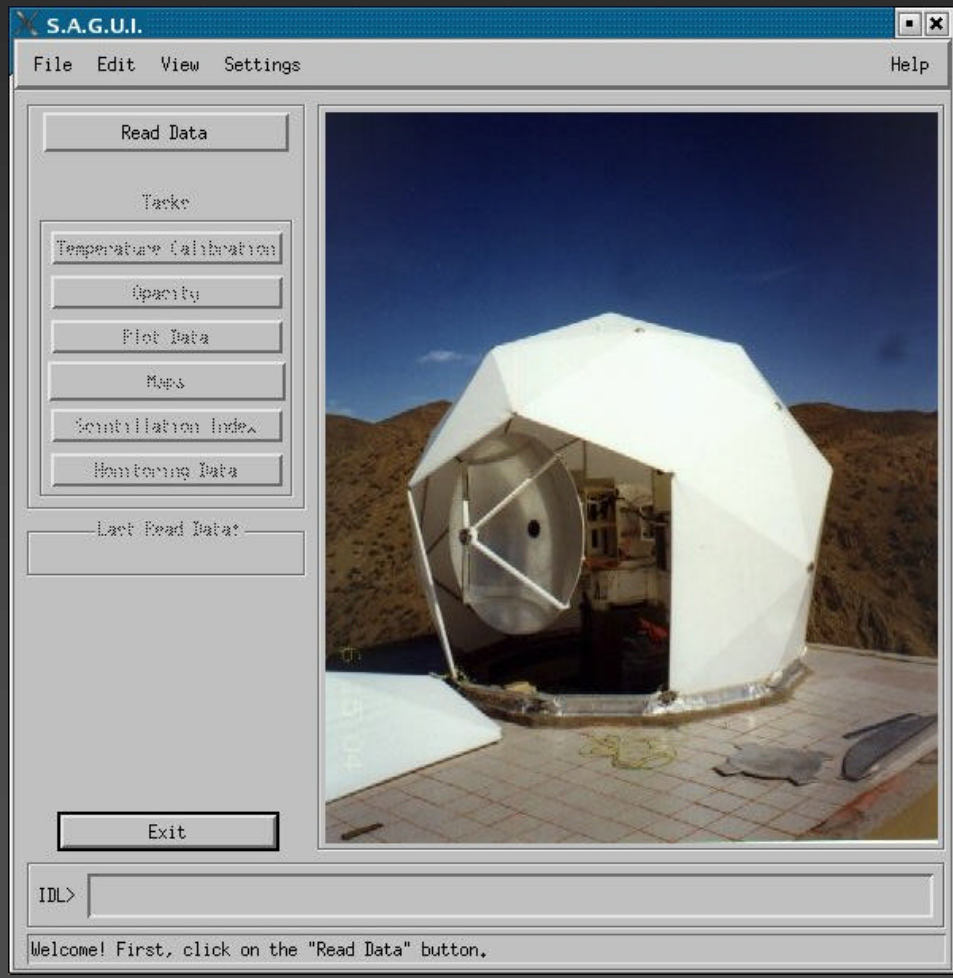




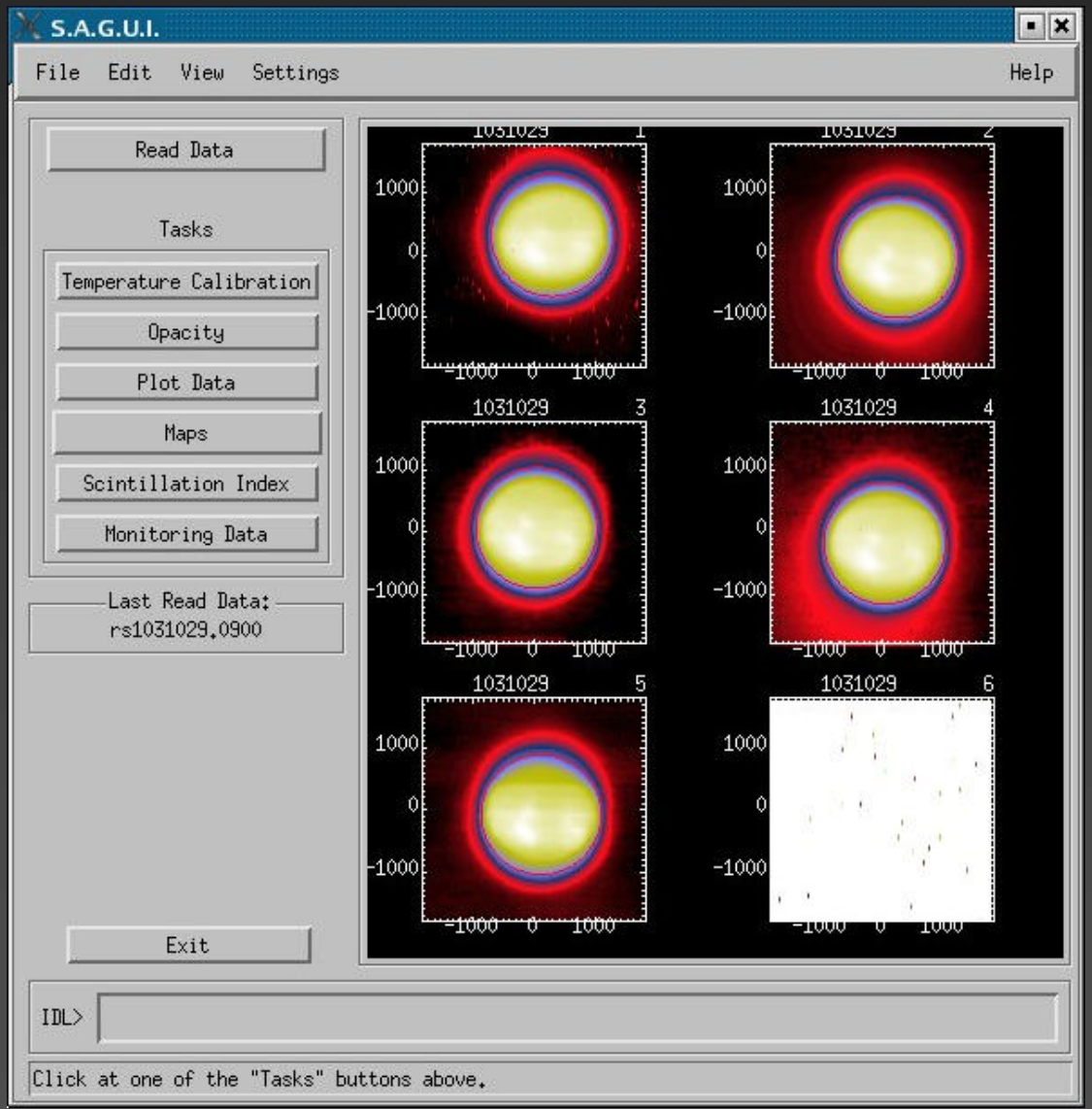


S.A.G.U.I.

- Solar Analysis Graphical User Interface
- Software developed for data visualisation, extraction, and calibration.
- Data from ROI and SST.



Solar Maps


S.A.G.U.I.
File
Edit
View
Settings
Help
Read Data
Tasks
Temperature Calibration
Opacity
Plot Data
Maps
Scintillation Index
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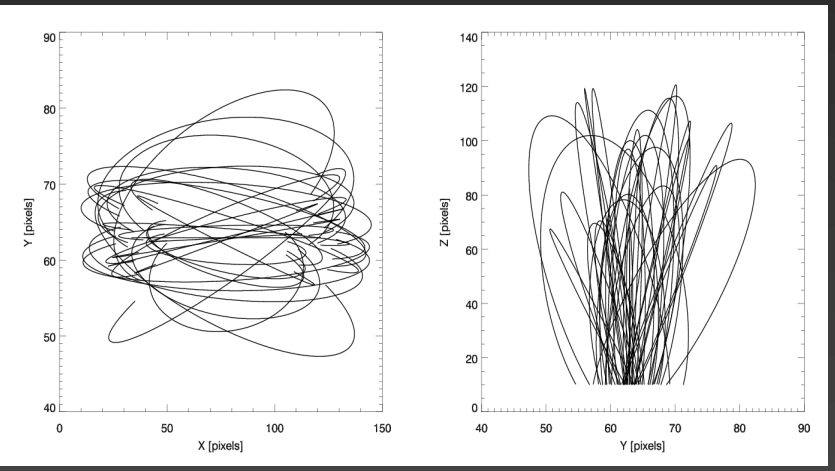
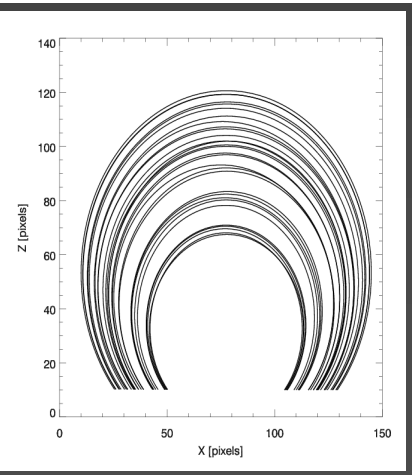
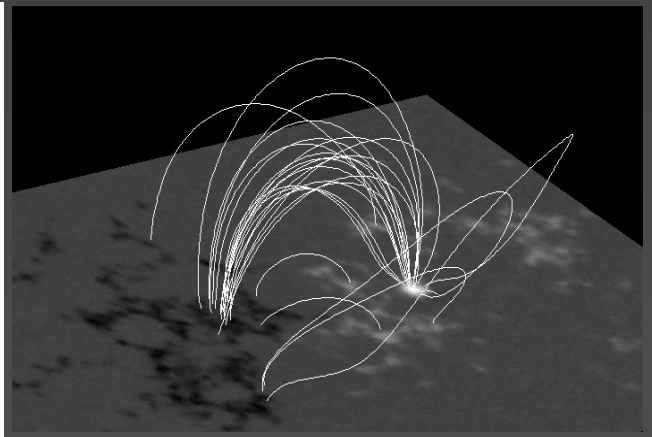
Click at one of the "Tasks" buttons above.

Applications

1) Magnetic field topology





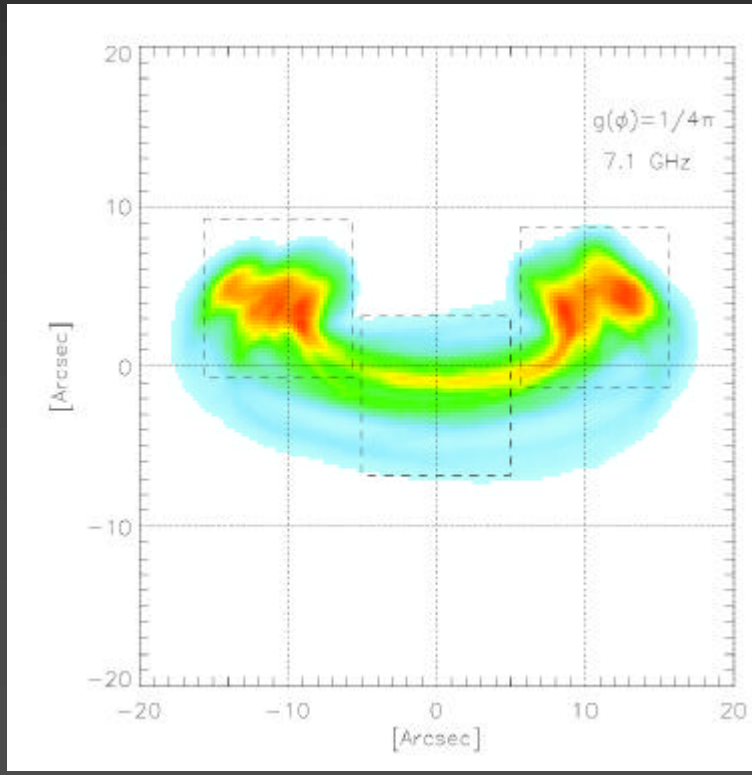


- Extrapolation of cromospheric/coronal magnetic field lines
- From photospheric line-of-sight magnetograms from MDI/SOHO.

2) Flare spectra

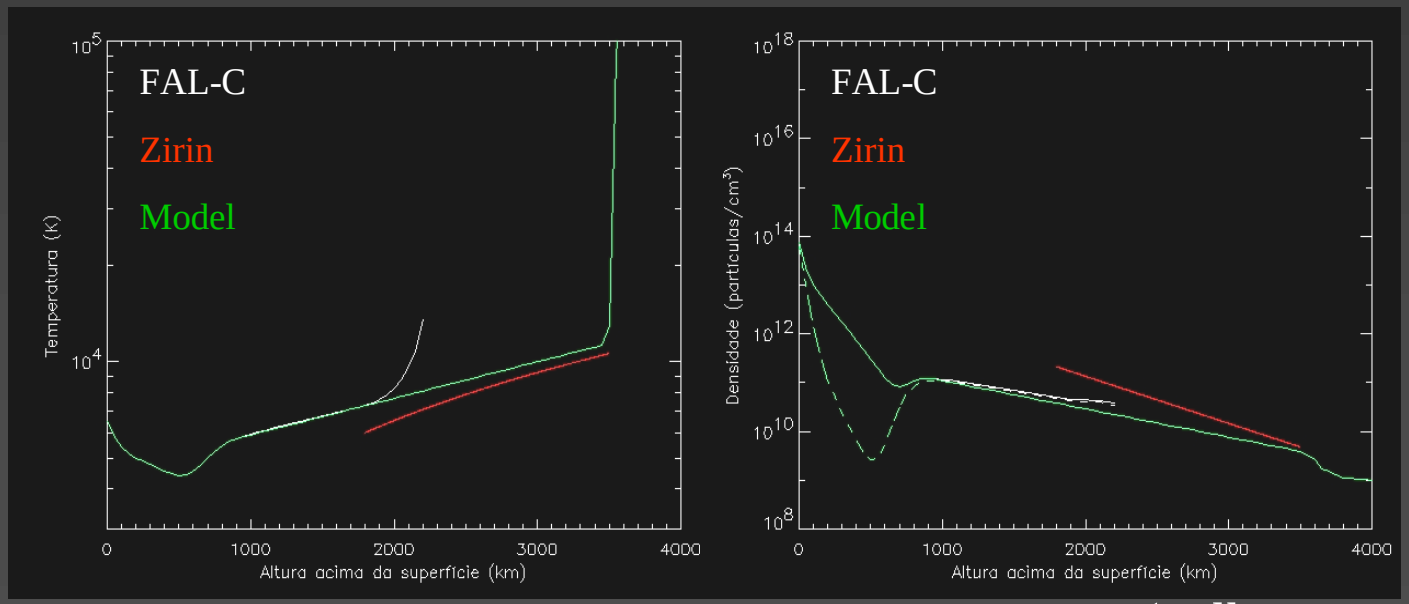
- Spectral analysis of microwave cm-mm solar bursts with gyro-synchrotron emission from general energy/pitch angle distributions.
- Thermal relativistic and non-thermal (simple or multi-power law) energy distribution is included.
- Radiation transfer is included in 3D topology of the magnetic field.

(Simões and Costa 2006)



3) Model of the solar atmosphere

- Temperature and density distributions
- Based on 17 GHz maps from NoRH (Japan): measurement of the radius and limb brightening.
- Extend and improve the model including maps at 22, 48, 212, and 405 GHz.



(Selhorst et al. 2005)

The Brazilian Virtual Solar Observatory

- Database:
  - Multi-frequency data from different observatories: 12, 22, 48, 212 & 405 GHz;
  - Time profiles of flux density for flares;
  - Maps/images of the Sun.
- Application:
  - Magnetic field reconstruction;
  - Flare spectra;
  - Solar atmosphere model.