- Science goals
  - We have collection of science cases with SOLAR-C (B).

    Some of them are new based on sciences newly identified with Hinode and GBO etc. recently.

    But some of them are even “traditional”. It is also true that we cannot solve all the science problems with the existing instruments.

  - We can do lots of science using SOLAR-C.
  - What are priorities of science goals in SOLAR-C?
    - Some of them can be studied further by data analysis of existing instruments (SOHO, Hinode, and GBOs).
    - Some of them can be studied by instruments coming near future (SDO, IRIS, GBOs).
  - Unique science in SOLAR-C compared with Hinode, GBO, SDO, and IRIS.
  - Synergies among the three instruments.

Mission-wide science goals

Top-level Science Goals

1. Trace energy flow at natural dynamic solar time scales over a large dynamic range from the photosphere into the corona through small spatial-scale elementary solar structures and determine the resulting large-scale structures
2. Understand physical processes such as magnetic dissipation and reconnection in astrophysical plasmas, under a wide variety of physical conditions
3. Understand and spatially resolve elementary atmospheric structures over each temperature domain of the atmosphere and determine how they are created and evolve
4. Understand how small-scale physical processes initiate large scale dynamic phenomena that affect the environment around the Earth (space weather)
5. Understand how physical processes alter coronal properties such as variations in its composition
6. How are energetic particles accelerated during magnetic reconnection?

(Shimizu)

Mission-wide science goals

Mission-wide science goals

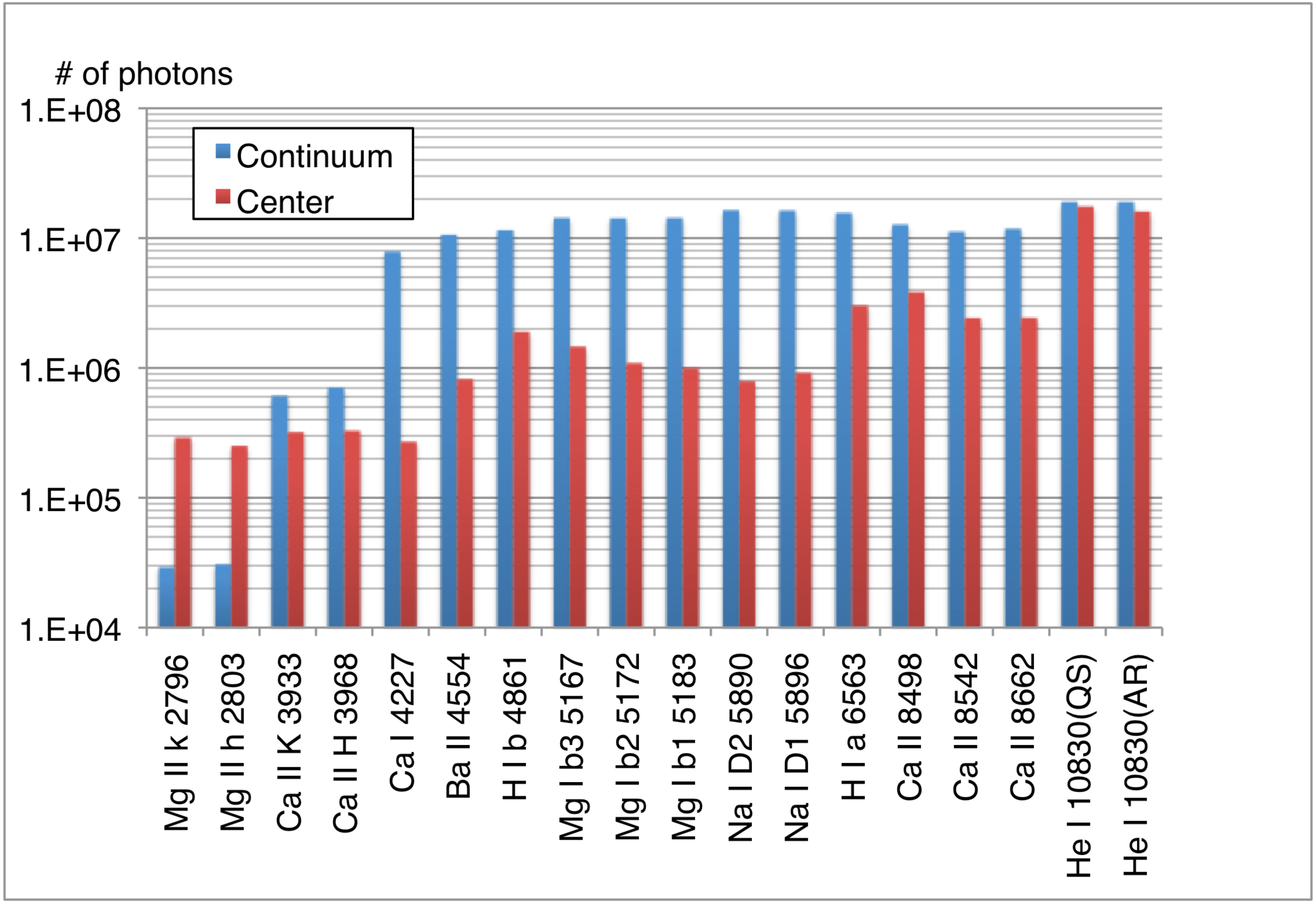
1. Understand elementary structures of the magnetic atmosphere and determine how they are created and evolve.
2. Trace energy and mass flows from the photosphere through the chromosphere into the corona.
3. Understand how small-scale physical processes initiate large scale dynamic phenomena creating space weather.
4. Understand physical processes responsible for magnetic dissipation in astrophysical plasmas.

These are still preliminary. *It is important to combine science goals raised by each subWG.*

(Katsukawa)

HINODE SOT vs SOLAR-C SUVIT

	HINODE SOT	SOLAR-C SUVIT
FOV	320" x 160" (NFI,SP) 220" x 110" (BFI)	200" x 200"
Resolution	0.2" – 0.3"	(0.05") 0.1" – 0.16"
Sampling	0.054"/pix (BFI) 0.08"/pix (NFI) 0.16"/pix (SP)	~0.04" /pix (for filter imaging, low S/N SP) ~0.2"/pix (for high S/N SP)
Spectral coverage Broad filter: R<10,000	Ca II H (398nm) Continuums in 380-670nm	Mg II k/h (280nm) Some continuums
Narrow filter: R~70,000	Mg I b2, Na I D1, 3x Fe I, Hα (517 – 656 nm)	Ca II IRT, and other photo/chrom. lines (500 – 870 nm)
Spectro-polarimeter: R~200,000	Fe I (630nm)	Mg II k/h, Ca II, He I (280nm, 850nm, 1083nm)
# of photo-electrons S/N	~ 4e5/0.16"/sec/Δλ ~10^3 with ~4sec exposure	~1e7/0.1"/sec/Δλ ~10^4 with ~10sec exposure
Average telemetry (total)	~400kbps	> 10Mbps



- Sampling
  - Spatial sampling: 0.1"/pix
  - Temporal sampling: 1sec
  - Wavelength sampling: $\lambda/\Delta\lambda=2\times10^5$

SOLAR-C vs GBO

What Ground-Based Observations Will Likely Accomplish

•Ground-based facilities will excel at short time sequences of small-scale objects *with modest polarimetric precision*. employing:

•Rapid advances in image processing techniques, e.g.:
- Multi-Frame Multi-Object Blind Deconvolution
- Multi-Conjugate Adaptive Optics

•Fine structure of moderate-to-strong field structures of the photosphere

•Dynamics of small-scale chromospheric events

•Some chromospheric field measurements

HAO

(Lites)

SOLAR-C vs GBO

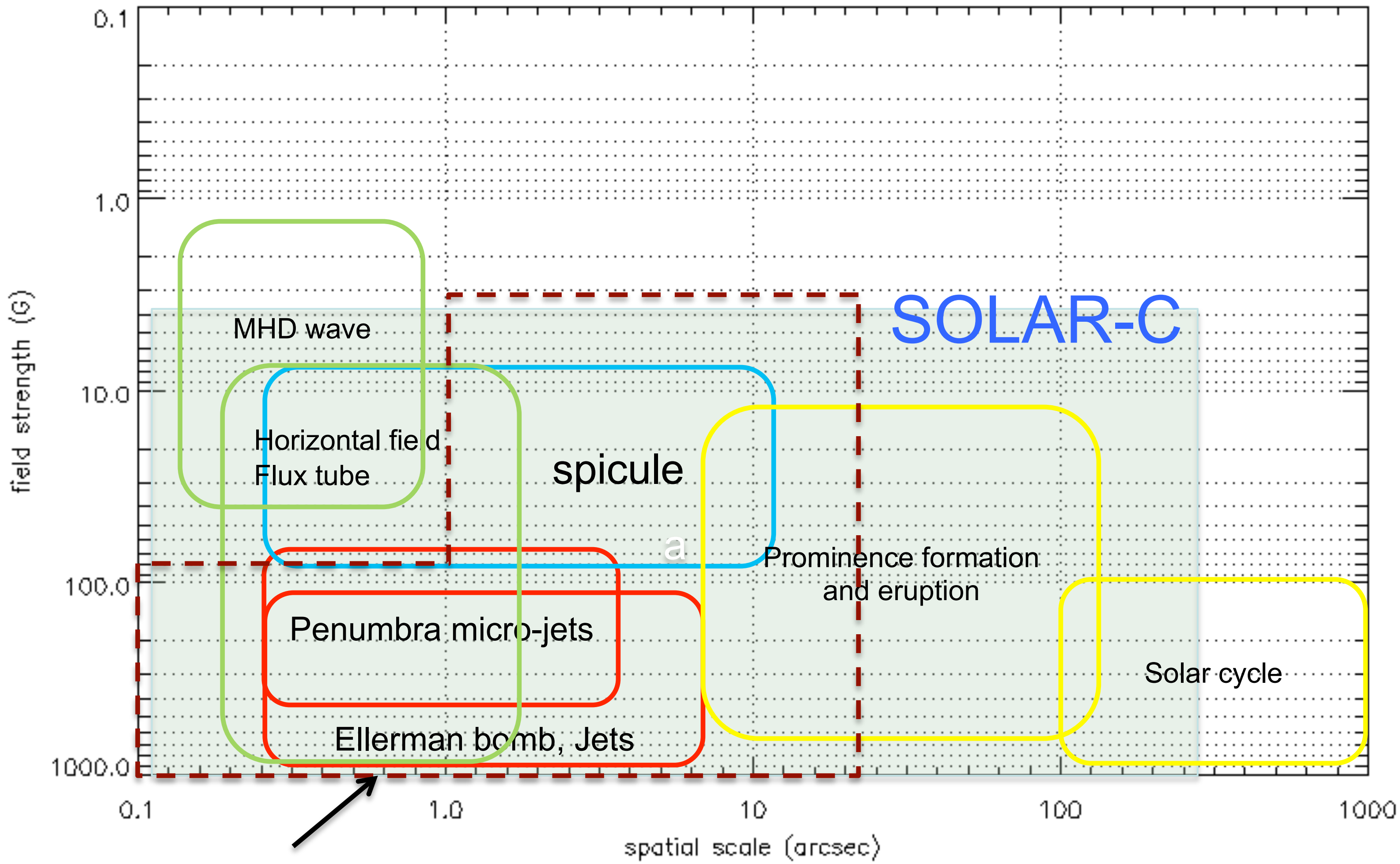
HOWEVER, Ground-based facilities will be challenged by the following:

- **Science goals requiring long time series (active region evolution, filament evolution)**
- **Science goals requiring low instrumental scattering (off-limb measurements of spicules, prominences)**
- **Chromospheric field measurement at high angular resolution, because:**
  1. **High polarimetric accuracy → long integration times (5-10 sec, or more) – image degradation due to residual seeing, blurring**
  2. **High polarimetric accuracy → high instrumental throughput (but MCAO leads to many reflections)**

HAO

(Lites)

Science targets with the diagnostics of chromospheric magnetic fields



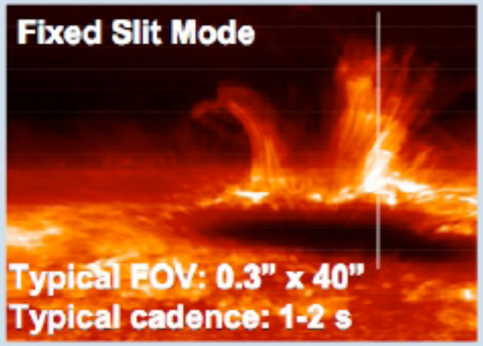
Ground-based telescopes will do a good job in the area.

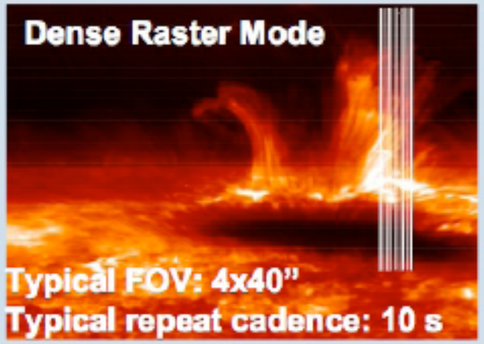
(Katsukawa)

Substantial jumps from IRIS?

- IRIS (Interface Region Imaging Spectrograph) is approved for launch in 2012.
  - Spectral lines in 120-280nm with 0.3” and 1-5s cadence to discover how an outer stellar atmosphere is energized.
  - The spectral lines observed with IRIS are suitable to explore the interface between upper chromosphere and lower transition region.
- Still substantial jumps from IRIS, because the S-C plan-B can provide unique observations which have never been realized:
  - Quantitative measurements of magnetic fields in the chromosphere
  - EUV/UV spectral lines used in Solar-C spectrometer will seamlessly cover from chromospheric temperature through the coronal temperature with 0.1-0.5” and 1-5 s cadence.
  - Energy spectral (thermal and non-thermal) diagnostics in 10^6-10^7 K plasma for flares and active region dynamics.

IRIS spectra and slit-jaw imaging covers the photosphere, chromosphere, transition region and corona - 4,500 to 10,000,000 K





Ion Spectrum	λ	Δλ	Log T	Estimated Count Rate (counts/s/line/spatial pixel)			Detector
	Å	mÅ	K	Quiet Sun	Active Region	Flare	
UV Spectra (effective area of 2.8 cm^2 for far-UV, 0.3 cm^2 for Mg passband, continuum is 1 Å) †: Count rates for Mg II wing, h and k are in counts/s/spectral pixel/spatial pixel							
Si I (3P) Cont	1335	12.5	3.7	40	80	---	1
Mg II wing	2820	25	3.7-3.9	2100†	7500†	7500†	3
O I	1356	12.5	3.8	50	100	250	1
Mg II h	2803	25	4.0	870†	3400†	13000†	3
Mg II k	2796	25	4.0	1100†	4500†	10000†	3
C II	1335	12.5	4.3	540	1970	22000	1
C II	1336	12.5	4.3	500	1780	20000	1
Si IV	1403	12.5	4.8	400	1000	1e6	2
Si IV	1394	12.5	4.8	640	2200	3e6	2
O IV	1401	12.5	5.2	65	116	2e5	2
O IV	1400	12.5	5.2	25	60	1e5	2
Fe XII	1349	12.5	6.2	30	50	500	1
Fe XXI	1354	12.5	7.0	10	40	4e4	1
UV Slit-Jaw Images				**Estimated Count Rate (counts/s/pixel)**			
Effective area 0.005 cm^2 with 5 Å FWHM filter for Mg II; 0.7 cm^2 with 40 Å FWHM for far-UV.							
Mg II wing	2816		3.7-3.9	1500	3500	3500	4
Mg II k	2796		4.0	750	3500	8500	4
C II	1335		4.3	400	1300	13000	4
Si IV	1400		4.8	300	1200	2e5	4

- Strawman concepts of mission instruments were presented from each subWG. We'd appreciate any scientific and technical comments from outside of subWGs.
- An obvious issue is in the spatial resolution
  - UV-Vis-NIR telescope
    - Is 0.05" resolution required?
      - Requirements to optical designs (surface roughness etc.)
      - Requirements to the pointing stability
  - UV/EUV spectrograph
    - Is 0.2" resolution required?
      - Require image stabilization system
  - Next generation X-ray imaging telescope
    - Is 0.2" resolution required?
      - Impact to GI vs NI discussion
- Resources
  - Technical feasibility
  - Community
    - Numerical simulation to understand the complex solar atmosphere
    - Data analysis of specto-polarimetric data

Basic specifications of the three telescopes

Pixel size and FOV

			FOV	Pixel size	Exposure	Note.
UV-Vis-NIR telescope		Broadband	164" x 164"	0.04"	< 1sec	• 2.5 pix sampling of **0.1"** res. • 4Kx4K detector
		Narrowband	246" x 246"	0.06"	< 1sec	• 2.5 pix sampling of **0.16"** res. • 4Kx4K detector
		Spectrometer	246" x 246"	0.06"	1sec (S/N~1600)	• 2.5 pix sampling of **0.16"** res. • 4K pix along slit
				0.12"	10sec (S/N~10^4)	
UV/EUV imaging spectrometer		Spectrometer	1024"x 1024"	0.5"	0.5sec (AR) 5sec(QS)	• **0.5"**pixel size • 2Kx2K MCP+CMOS detector
X-ray telescope	NI	Imaging	410"x410"	0.1"	1sec (AR) 10sec (QS)	• High res imaging with NI telescope • 4Kx4K detector
	GI	Imaging	1024"x1024"	0.5"	1sec	• Imaging spectroscopy with GI • 2Kx2K CMOS detector
		Photon count	1024"x1024"	2.0"	60sec	

Size

	Size (mm)	Weight (kg)
UV-Vis-NIR telescope (telescope)	ϕ2300x4300	500
UV-Vis-NIR telescope (focal plane instruments)	2500x400x3000	200
UV/EUV imaging spectrometer	400x800x4000	120
X-ray telescope	400x400x4000	100