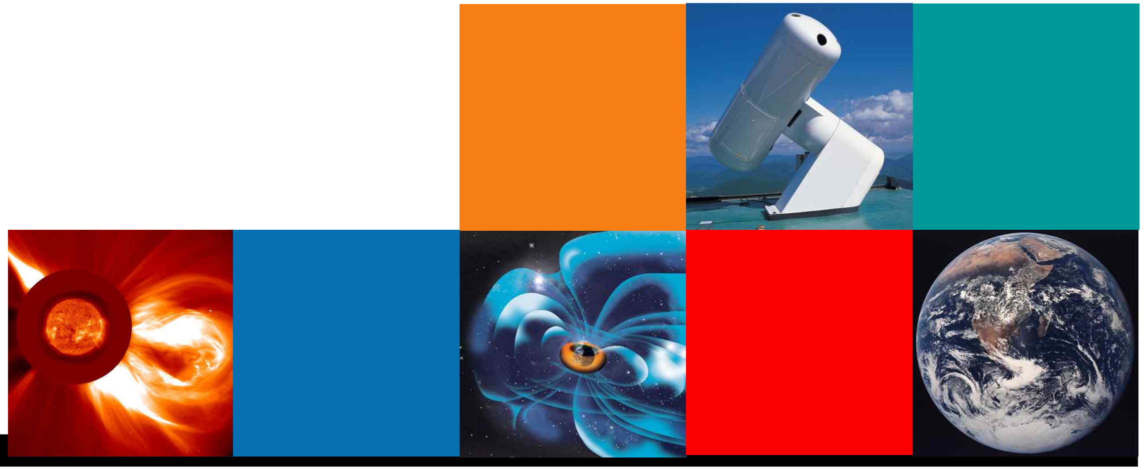


Space Weather Activities in KASI

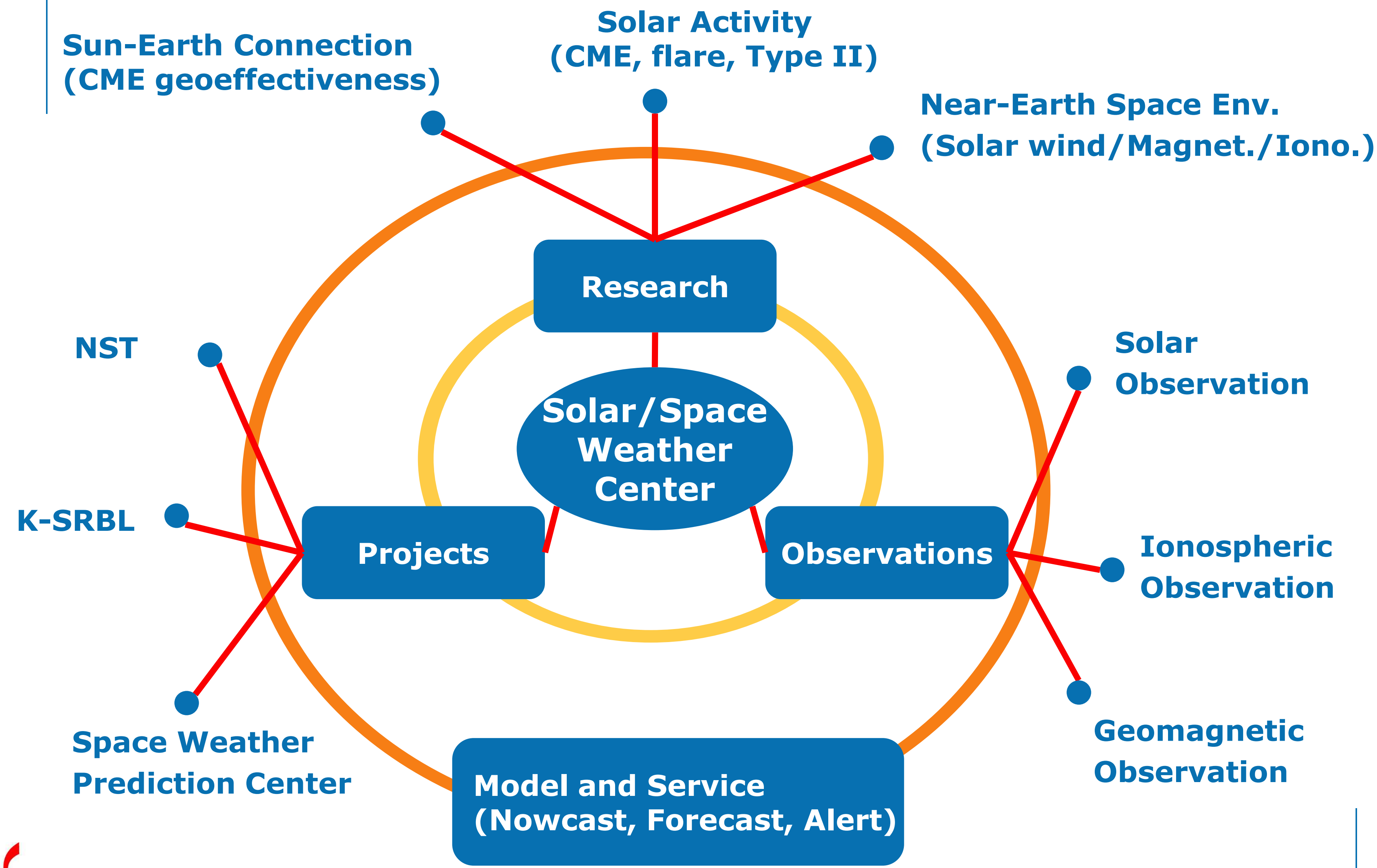
Yeon-Han Kim
Space Science Division(SSD)
Korea Astronomy and Space Science Institute(KASI)

Outline

SSD in KASI

- For solar physics and space weather research, KASI is the leading institute in Korea.
- The division is in charge of solar physics and space weather research in KASI and the development and management of related instruments.
- Originally, KASI has 3 optical solar observing facilities; Solar Sunspot Telescope (SST, since 1987), Solar Flare Telescope (SOFT, since 1995), and KASI Solar Imaging Spectrograph (KSIS, since 2002).
- Since 2004, we have participated in the development of 1.6 meter New Solar Telescope (NST) in USA and developed Korean Solar Radio Burst Locator (KSRBL) in cooperation with NJIT.

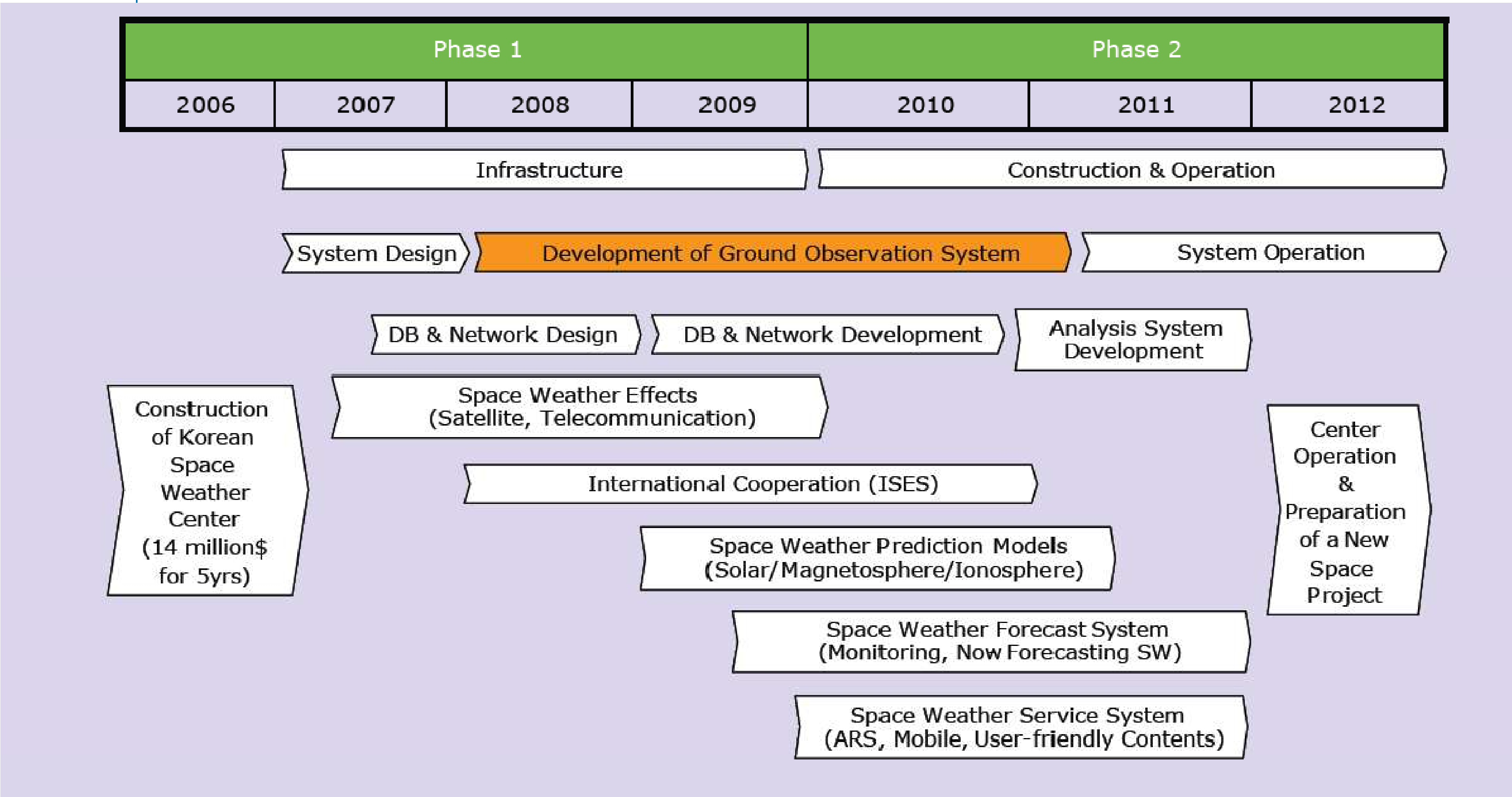
SSD in KASI


Sun-Earth Connection
(CME geoeffectiveness)
Solar Activity
(CME, flare, Type II)
Near-Earth Space Env.
(Solar wind/Magnet./Iono.)
Research
NST
Solar/Space
Weather
Center
Solar
Observation
K-SRBL
Projects
Observations
Ionospheric
Observation
Space Weather
Prediction Center
Geomagnetic
Observation
Model and Service
(Nowcast, Forecast, Alert)

Major Projects and Budget

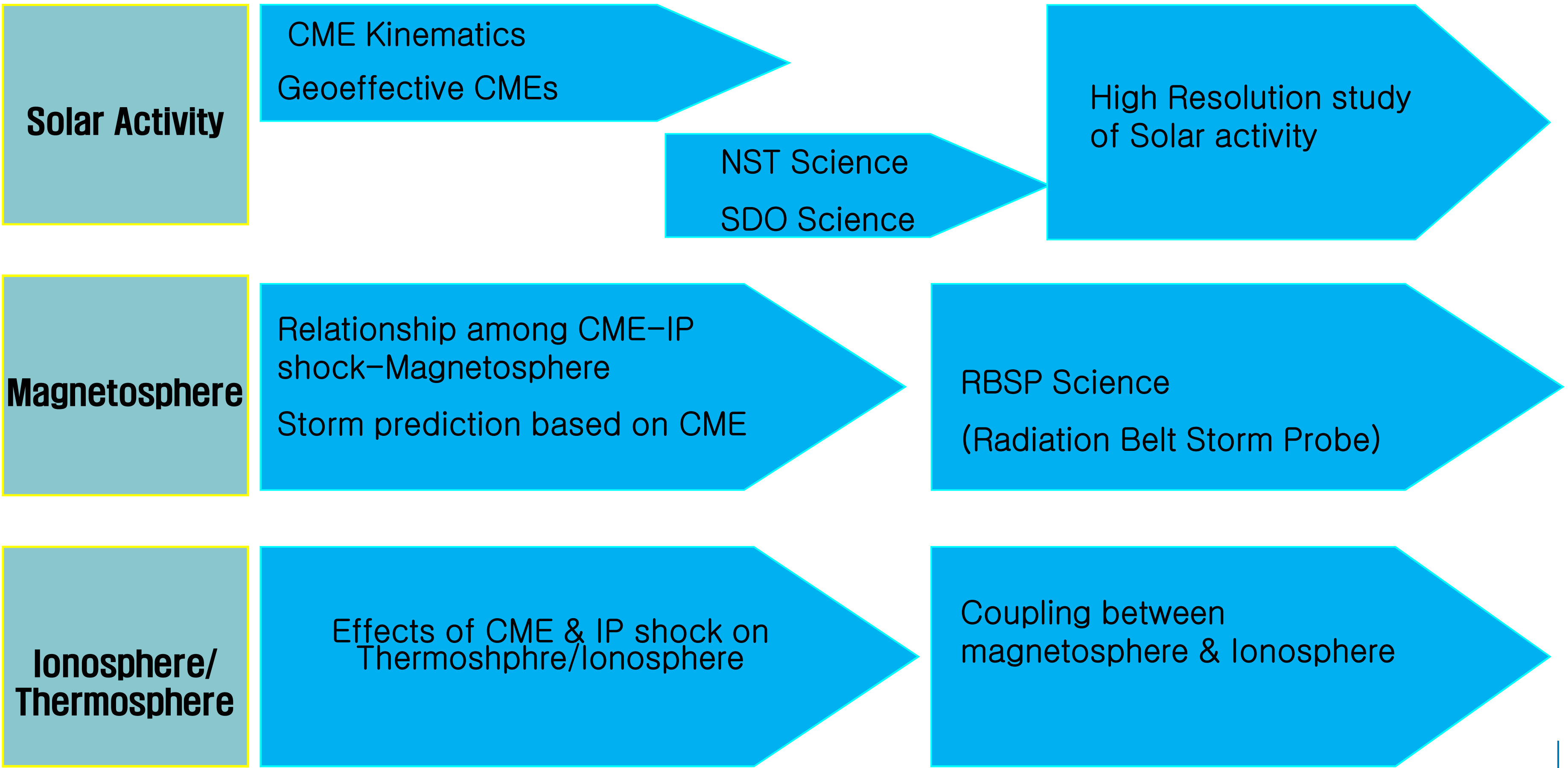
Projects	Annual Budget in average
Construction of space weather prediction center (space weather project)	$1.5 M
Study on effects of CMEs and high-speed solar wind in the near-Earth space (leading research project)	$0.2 M
Operation of solar observation systems (instrument operation project)	$0.2 M

Roadmap for K-SWPC



Science Roadmap

Phase 1			*Phase 2*			Phase 3			
2007	2008	2009	2010	2011	2012	2013	2014	2015	2016

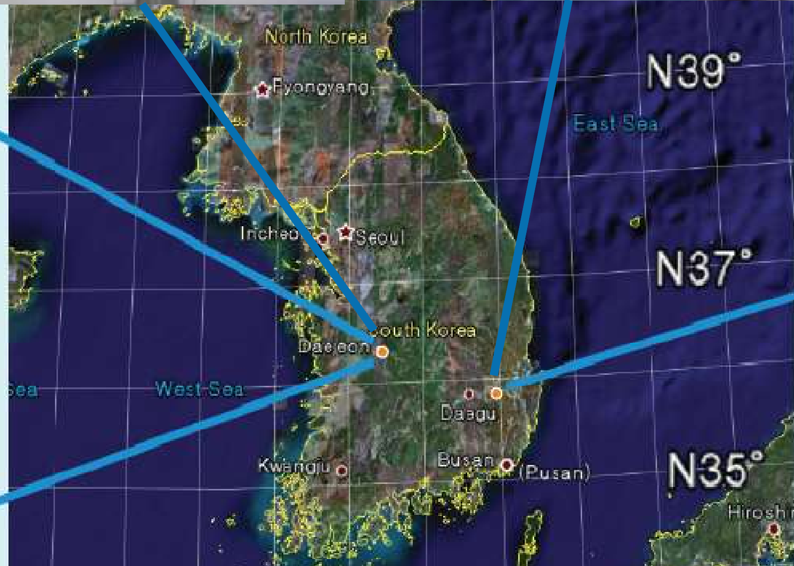


* NST(New Solar Telescope) * SDO(Solar Dynamics Observatory)

II. Instrument Construction

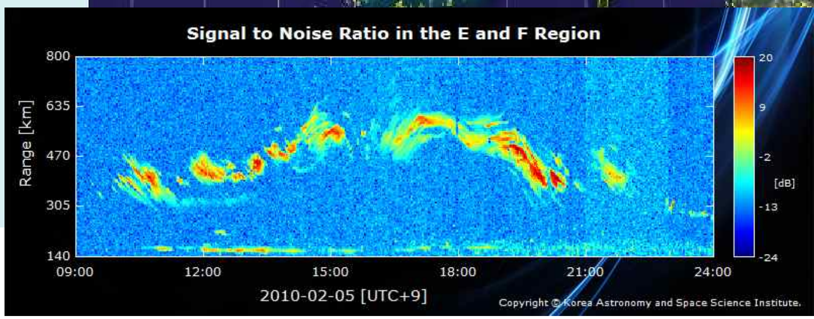
- **SWML (2007): space weather monitoring**
- **e-CALLISTO (2007): solar radio burst, spectrum**
- **Magnetometers: geo-magnetic field**
  - Fluxgate (2007), Proton (2009), MI sensors (2009)
- **All Sky Imager (2008): ionosphere, optical (97, 250 km)**
- **SCINTMON (2008): ionosphere, scintillation**
- **KSRBL (2009): solar radio burst, spectrum, source location**
- **VHF Radar (2009): ionosphere E-, F-layer irregularity**
- **1.6m NST: world largest ground-based optical solar telescope (photosphere, chromosphere)**
  - CT (2009), FISS (2010)

Daejeon (KASI)
- SWMS
- E-CALLISTO
- SCINTMON

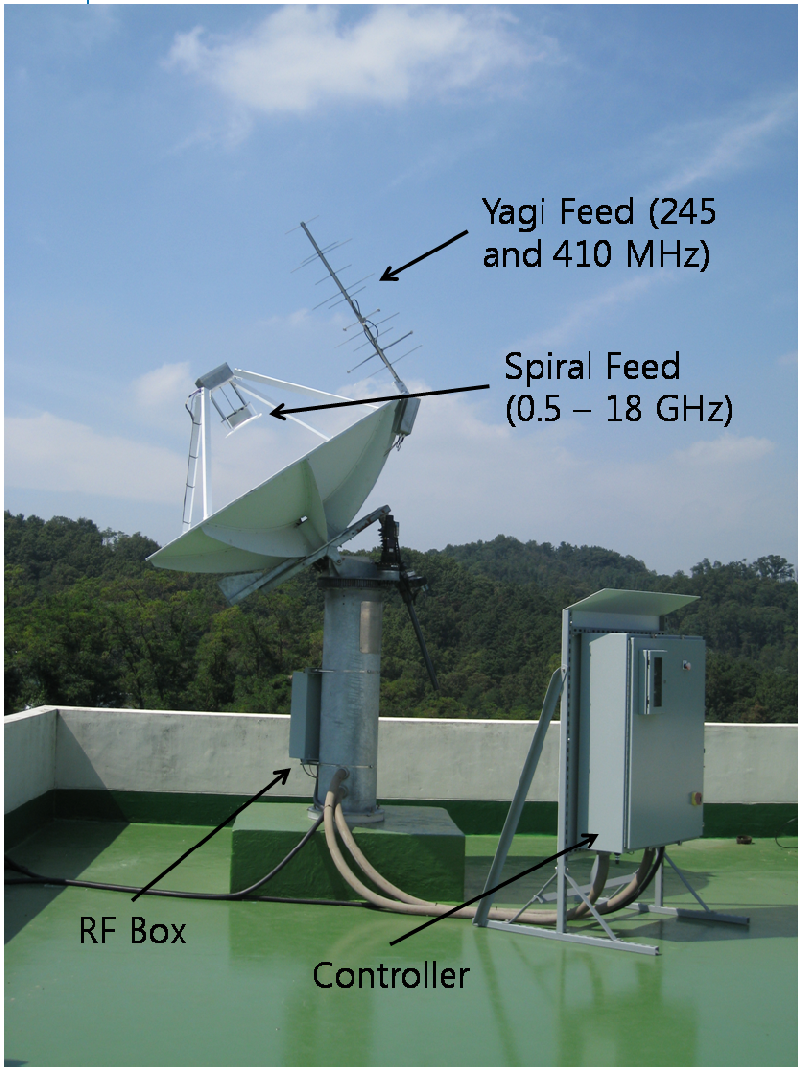


Mt. Bohyun
- Magnetometer
- ASC

Daejeon (Gyeryong)
- CSR



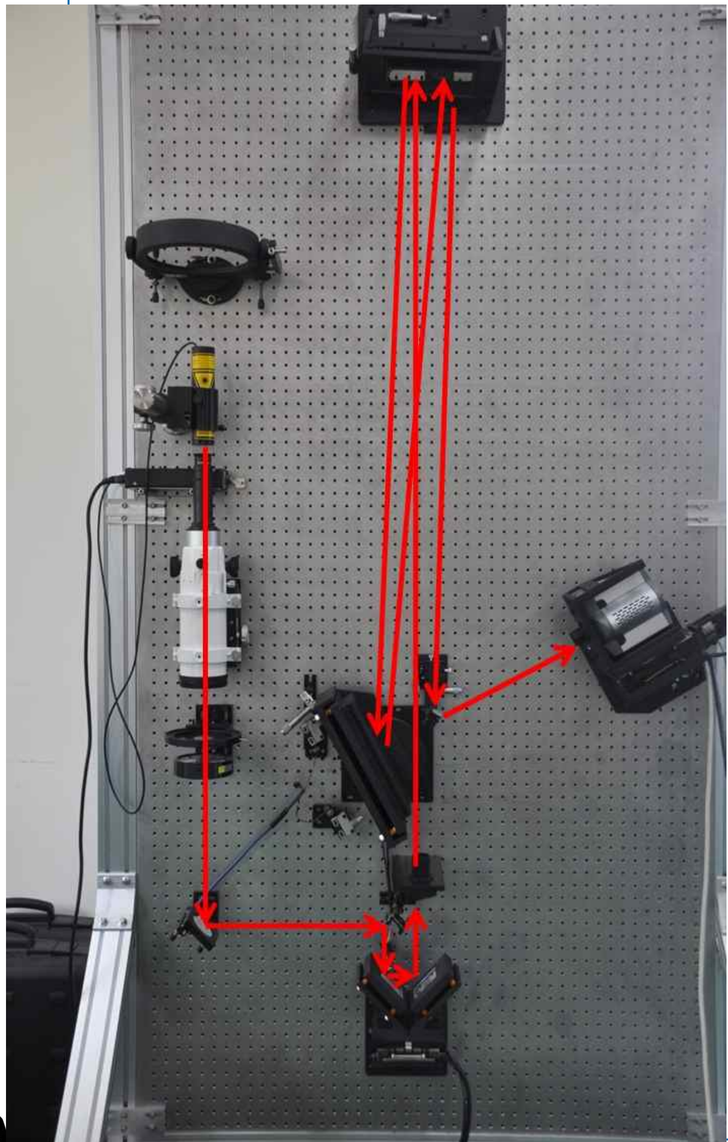
Korean Solar Radio Burst Locator (KSRBL)

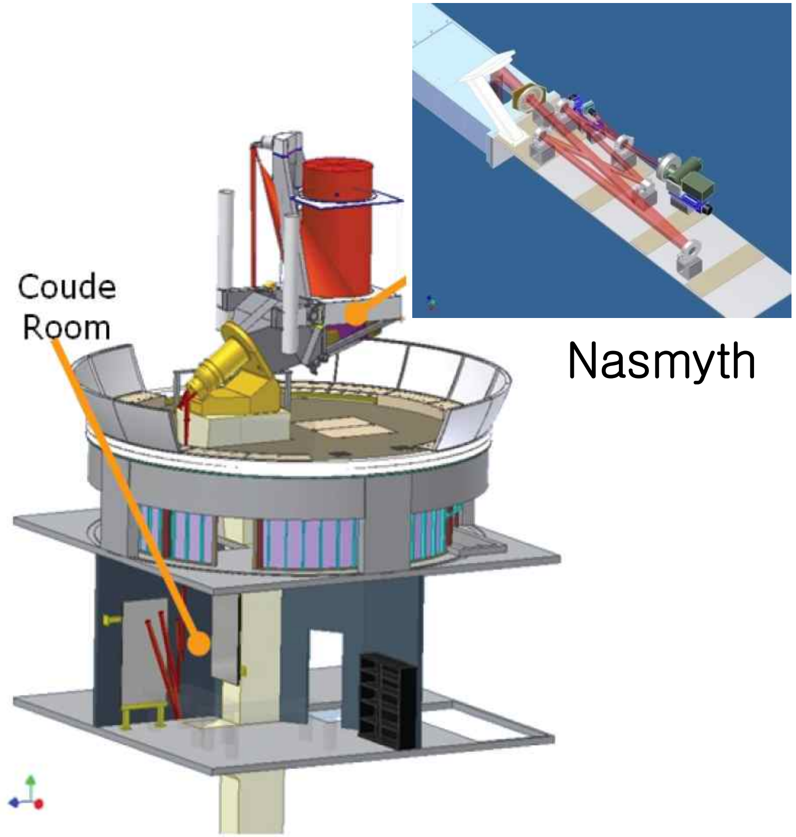


Korean Solar Radio Burst Locator (KSRBL) is a single dish radio spectrograph, which has been developed in collaboration with New Jersey Institute of Technology and installed at KASI in August 2009. KSRBL records the spectra of solar microwave bursts with high time and frequency resolution, and locates their positions on the solar disk.

Frequency range	245,410MHz , 0.5-18GHz
Frequency resolution	1MHz
Time resolution	1s
Location accuracy	0.03°

FISS (Fast Imaging Solar Spectrograph)



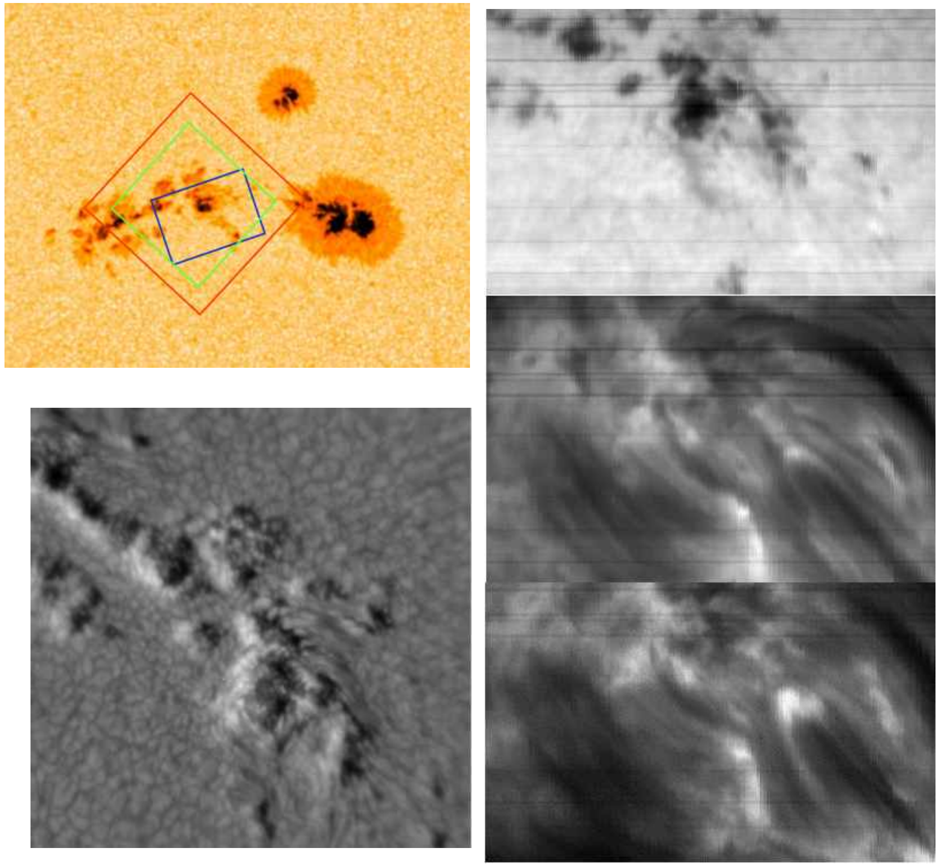


Item	Specification
Lines of interest	Ca II (H, K, 8542), Hα, He I 10830Å and so on
Spectral resolving power (λ/Δλ)	1.4×10^5
Field of view	40" × 60"
Best cadence	10 seconds
Incident F ratio	26
Slit width	16μm
CCD pixels / size	512 × 512 / 16μm × 16μm

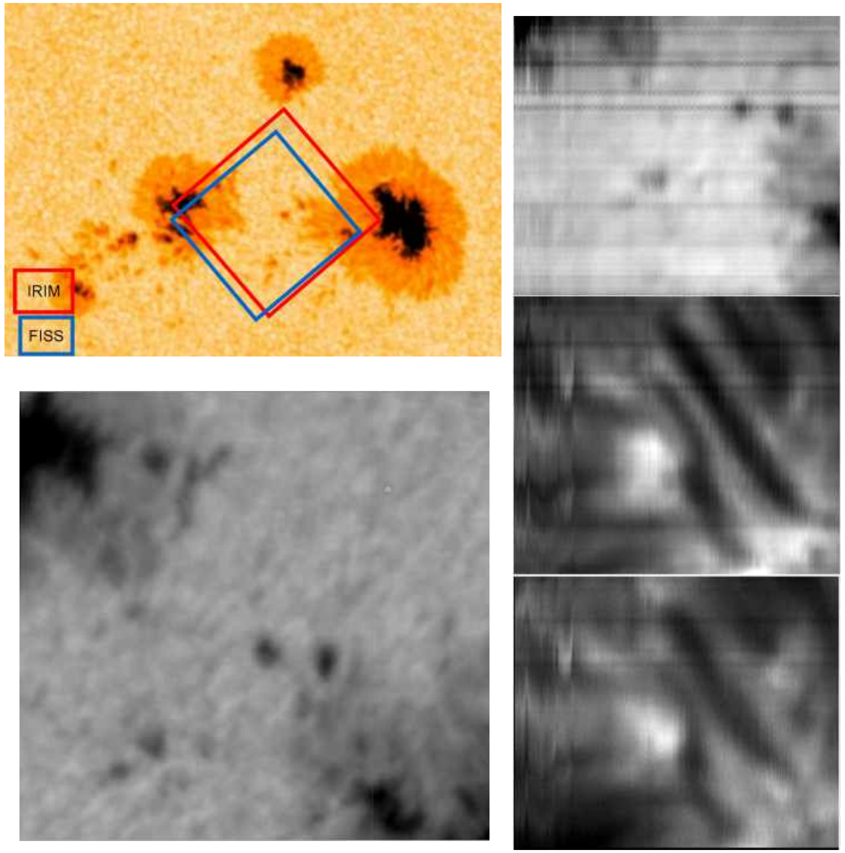
FISS Observation

NST-Hinode joint obs.

Oct. 26 2010



Oct. 27 2010



Ⅲ. KASI Space Weather Researches

- **CMEs geoeffectiveness**
  - Forecast of geoeffective CMEs
  - Earthward direction of CMEs
- **Empirical relationship between CMEs initial speed and solarwind dynamic pressure**
- **IP shock propagation model**
- **High resolution study of solar activities**
  - Small pores, spicule oscillations, solar tornado
- **Satellite drag during strong solar and geomagnetic activities**
- **Satellite anomalies due to space weather effect**
- **High lat. thermospheric density depending on IMF**
- **Auroral observation by STSAT-1**

KASI

CME geoeffectiveness

Q

What CME parameters control geomagnetic storms ?

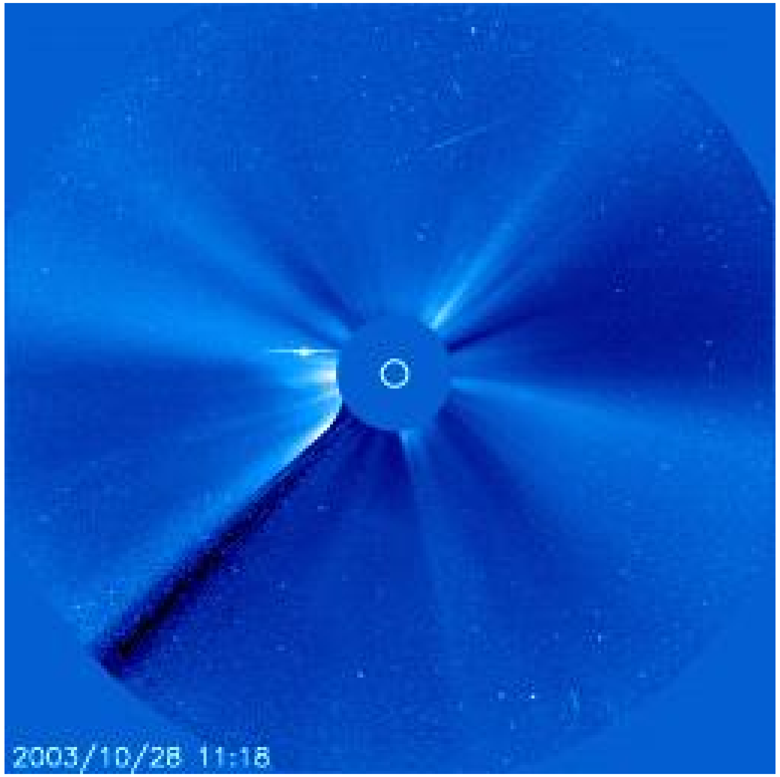
How can you estimate the probability to produce a geomagnetic storm ?

A

Speed

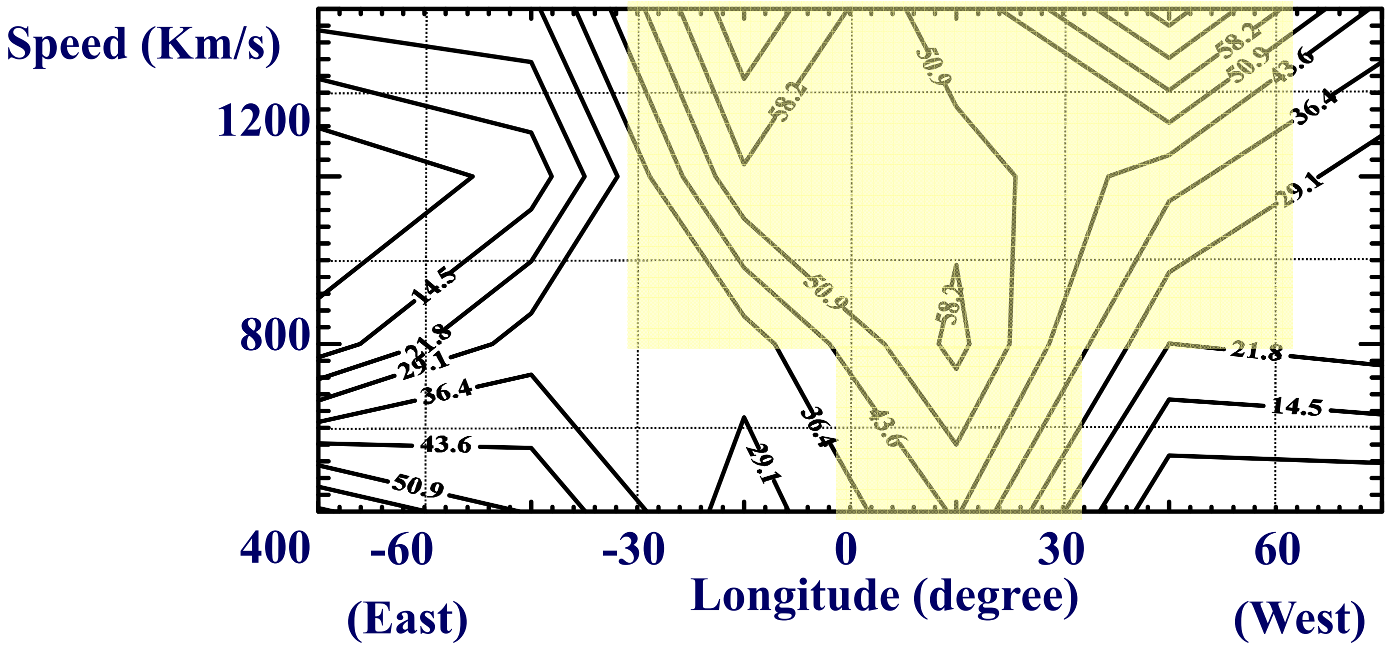
Location

Direction



Forecast of geoeffective CMEs (I. Speed & Location)

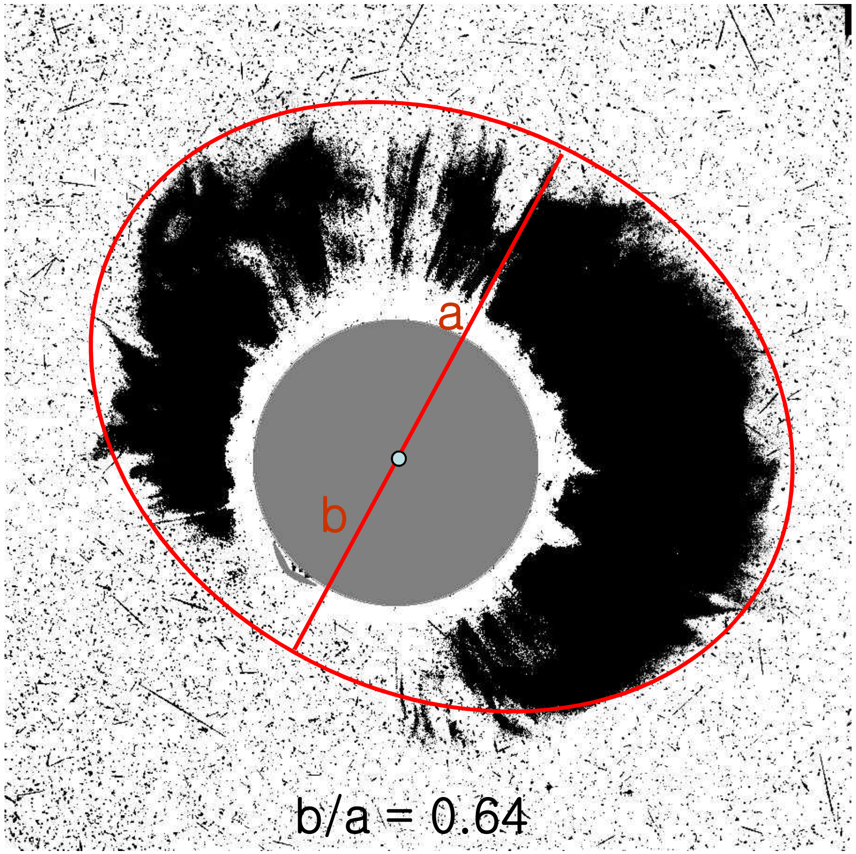
- Probability map of the CME geoeffectiveness (Dst < −50nT)
  - The high probability area becomes wider for fast CMEs
  - Third criterion : for fast CME (≥ 800km/s), −30 < Lon. < +60
    for slow CME (< 800km/s), 0 < Lon. < +30

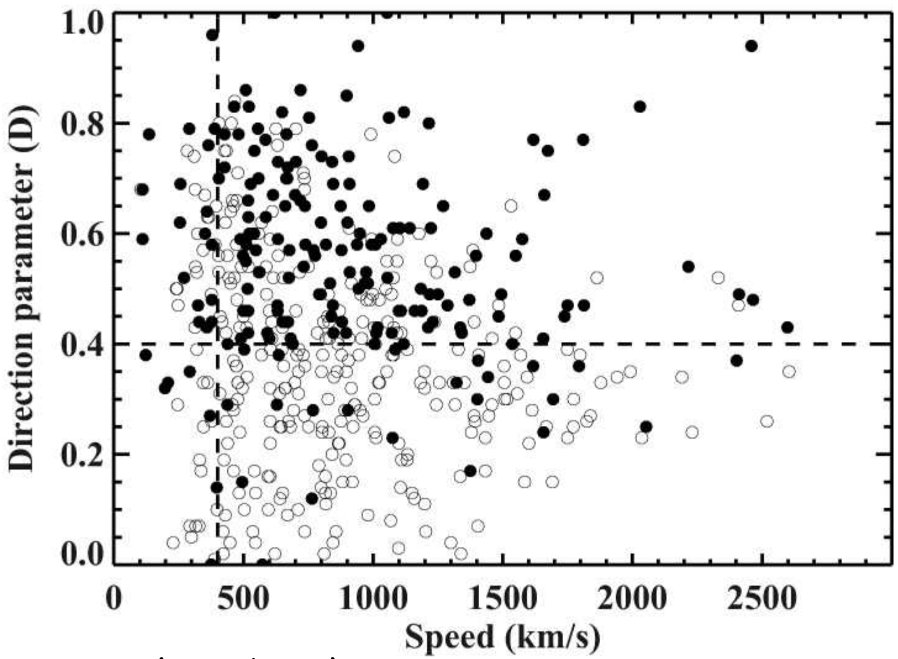


(R. S. Kim et al. 2005)

We propose a new quantitative direction parameter !

▣ Degree of symmetry : (b/a)





- 86% (161/188) of geoeffective CMEs have large direction (D ≥ 0.4)
- CMEs with large D are more geoeffective than fast CMEs

(Moon et al. 2006) **(R. S. Kim et al. 2008)**

IV. Space Weather Monitoring System (2007~)

Contents of SWMS

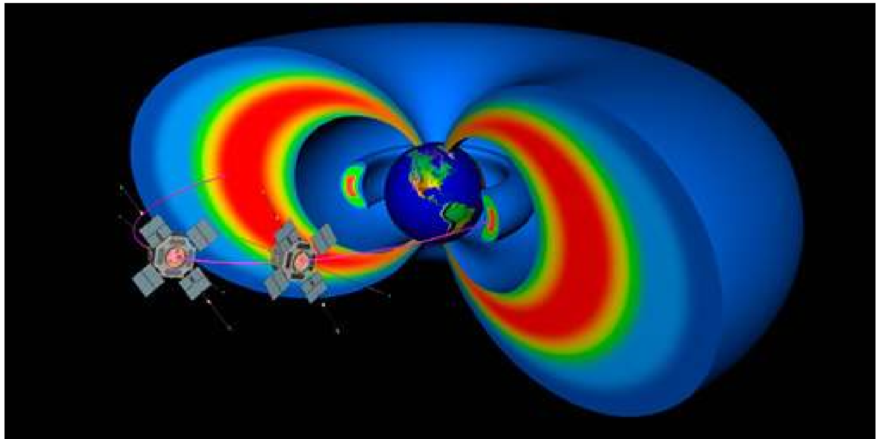
1. **Observational data from oversea and domestic**
2. **Shock propagation models**
   - ❖ Empirical models for shock arrival time
3. **Geomagnetic storm forecast**
   - ❖ CME initial speed, source location, direction para. -> probability forecast for geomag. storm occurrence
4. **Solarwind prediction**
   - ❖ Coronal hole information -> solarwind information
5. **Space weather monitoring for GEO sat.**
   - ❖ Magnetopause monitor, satellite anomaly region, meteor information, etc.
6. **Space weather monitoring for polar route flight**
   - ❖ Information for high E. ptcls. & communication

V. Future Plans

▣ KASI-NASA collaboration (LOA, 2010)

1. To obtain the real-time space weather data from satellite obs.
2. SDO data center
    - Storage (1.5TB/day)
    - Data analysis server
    - Gloriad (inter-cont. network)
    - Real-time monitoring

3. RBSP receiving station
    - Antenna (6m)
    - Receiver
    - Data server
    - Real-time monitoring



SDO, Solar Dynamics Observatory

Launched on 11 February 2010

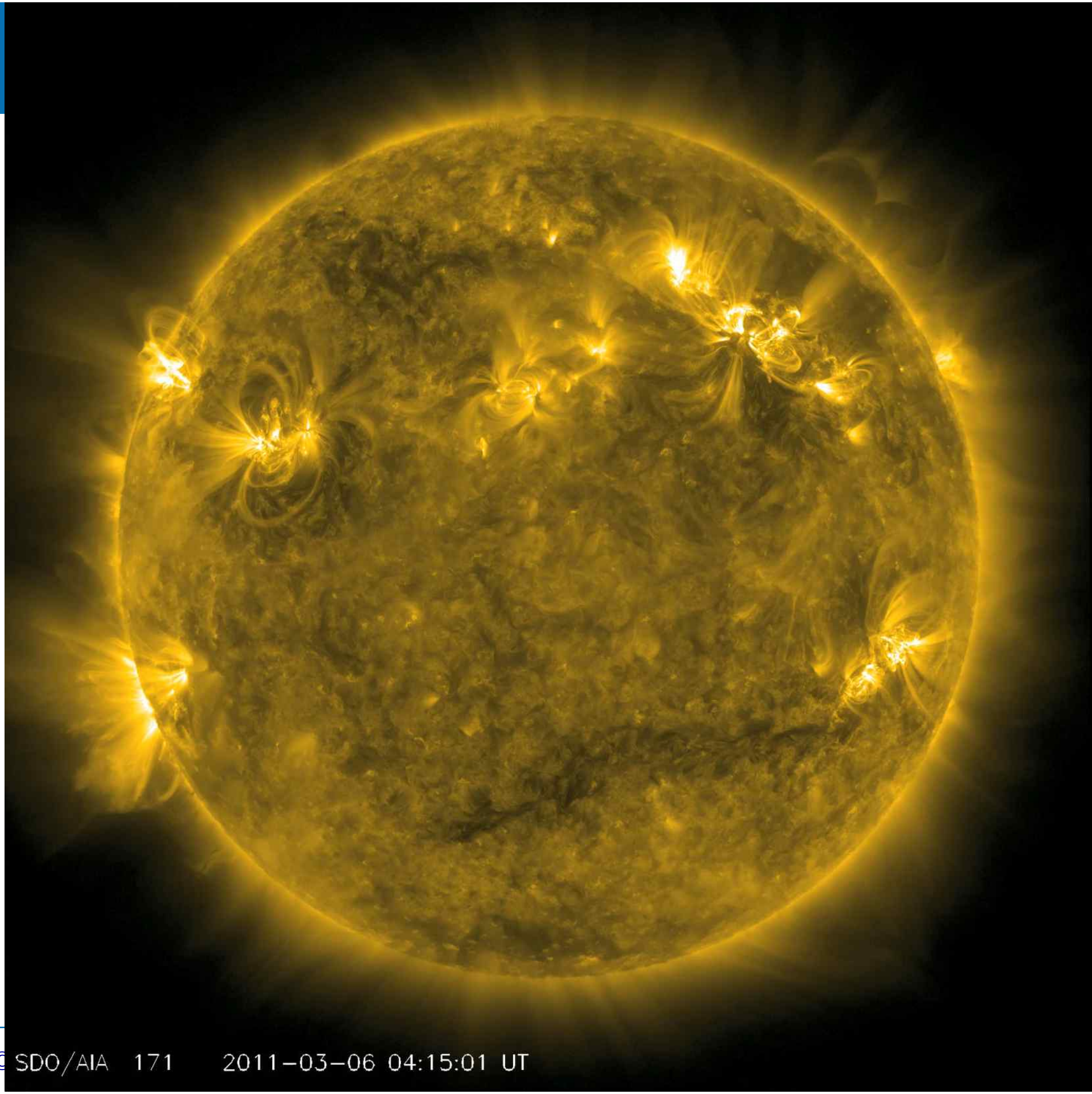
Helioseismic and Magnetic Imager

EUV Variability Experiment

Colorado
University of Colorado at Boulder

Atmospheric Imaging Assembly

LOCKHEED MARTIN
Solar and Astrophysics Lab


© SDO/AIA 171 2011-03-06 04:15:01 UT

Why should KASI construct KDC for SDO?

▣ For solar and space weather research

- ❖ High cadence and high resolution data

▣ Very large data size

- ❖ It is not easy to successfully download large scientific data of SDO from NASA.
- ❖ It is totally impossible through public network.

▣ For space weather applications

- ❖ Realtime or quasi realtime SDO data

Data Centers for SDO

UClan, United Kingdom

SDO at SIDC ROB, Belgium

IAS, France

GDC for SDO DLR, Germany

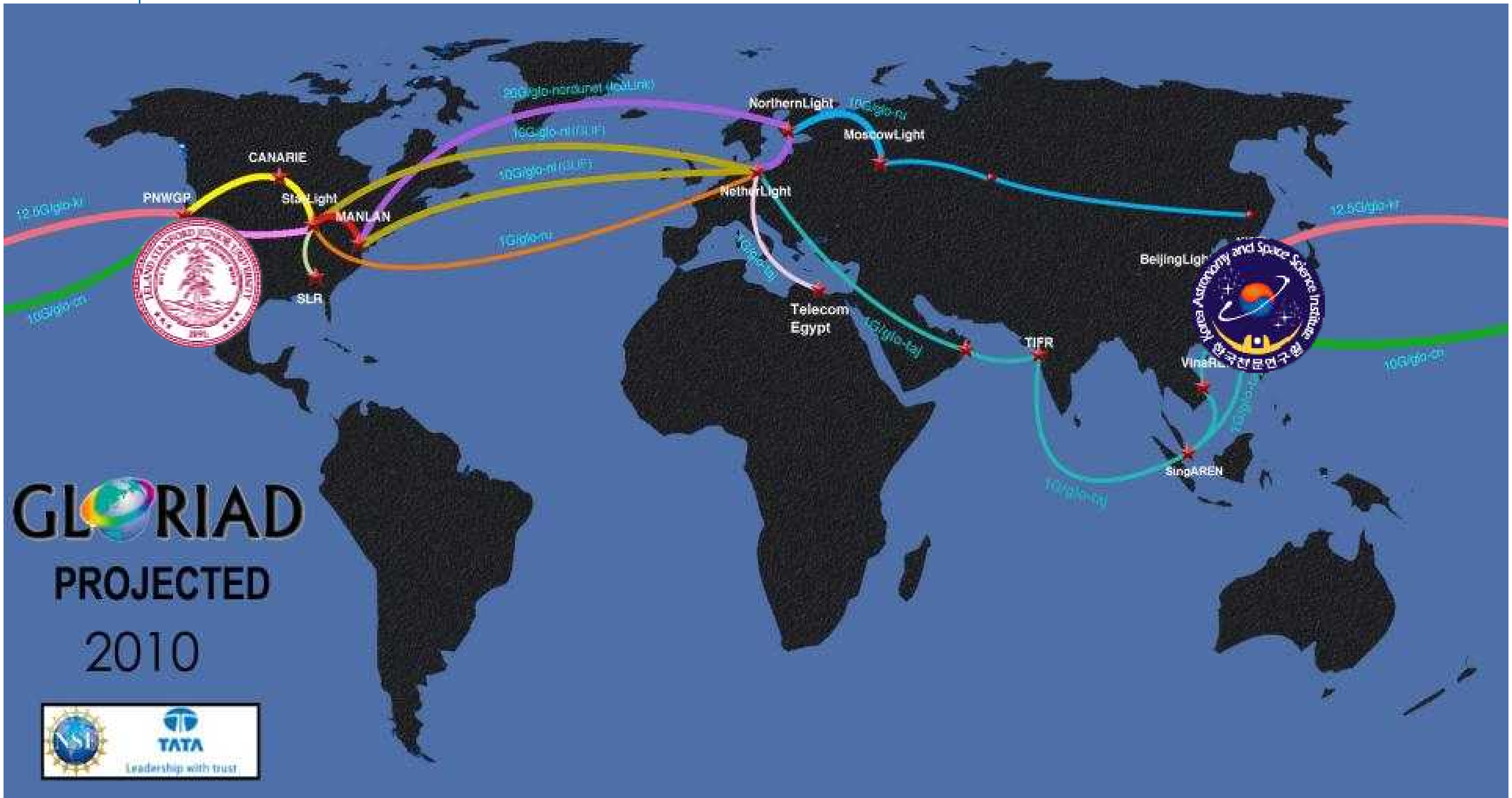
KDC for SDO KASI , Korea

JSOC (AIA and HMI) Stanford Univ. and LMSAL, USA

EVE Univ. of Colorado at Boulder, USA

DLR, Deutsches Zentrum für Luft- und Raumfah (German Aerospace Center)
GDC, German Data Center
IAS, Institut d'Astrophysique Spatiale
JSOC, Joint Science Operations Center
KDC, Korean Data Center
LMSAL, Lockheed Martin Solar and Astrophysics Lab
ROB, Royal Observatory of Belgium
SIDC, Solar Influences Data Center
UCLan, University of Central Lancashire

GLORIAD



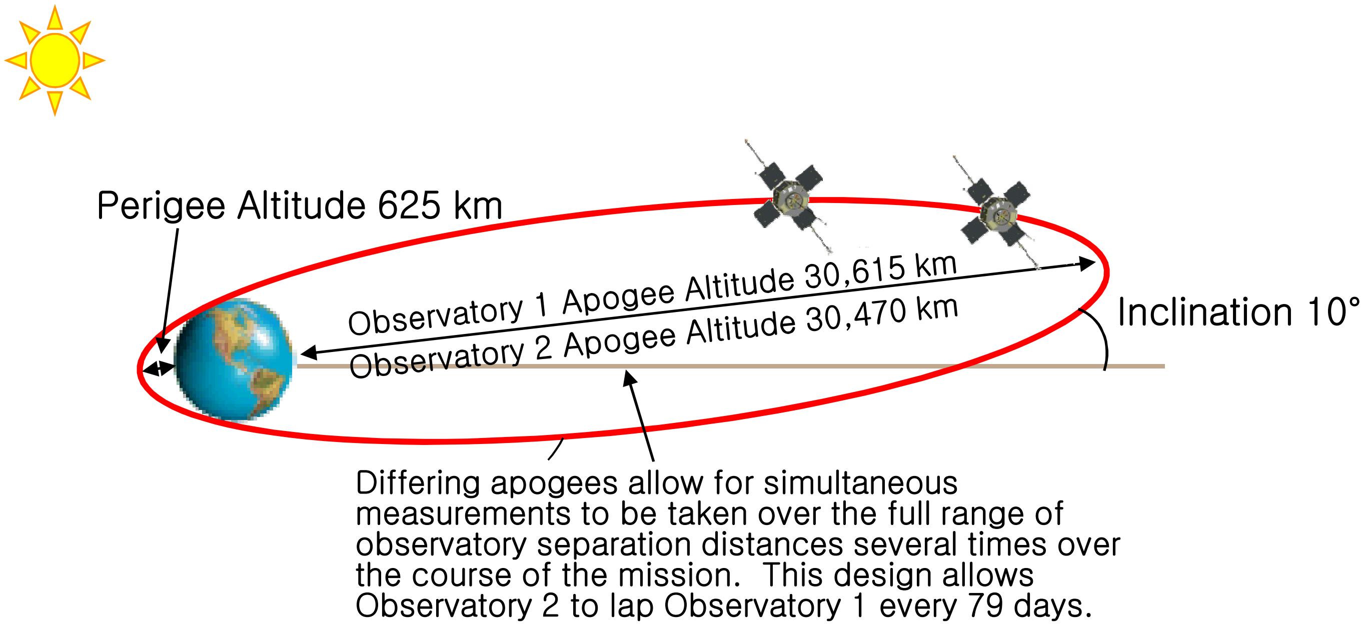
CANARIE
PNWGP
StarLight
MANLAN
SLR
NorthernLight
MoscowLight
NetherLight
Telecom
Egypt
TIFR
BeijingLight
SingAREN
GLORIAD
PROJECTED
2010
TATA
Leadership with trust

The Radiation Belt Storm Probes (RBSP)

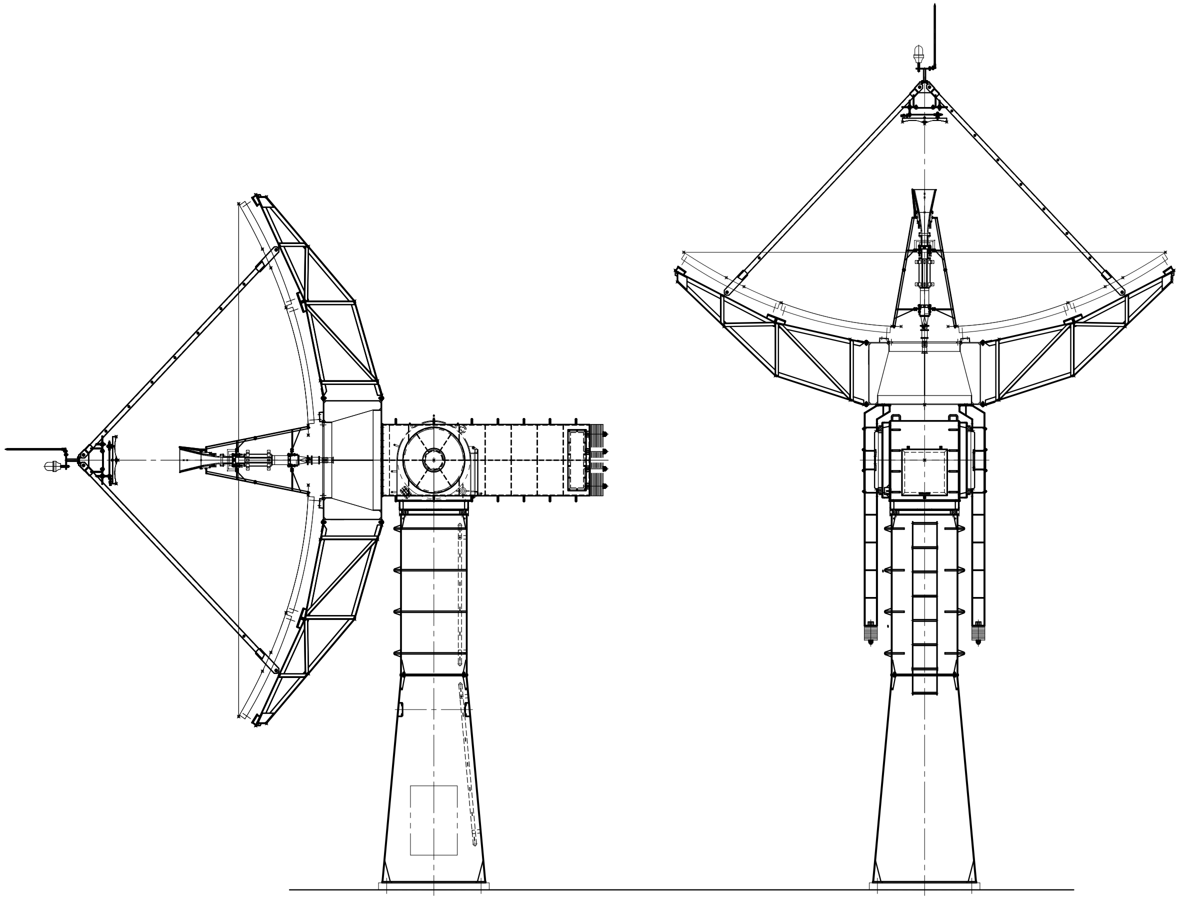
- **NASA will launch two identical probes into the radiation belts to provide unprecedented insight into the physical dynamics of near-Earth space.**
- **The radiation belts are now part of our technology infrastructure.**
  - If we can understand the belts, we can improve our mission planning, and spacecraft o peration and system design
- **Data collected by the probes will help researchers develop and improve various models for the radiation belts that can be used by:**
  - **engineers to design radiation-hardened spacecraft**
  - **forecasters to predict space w eather phenomena and alert astronauts and spacecraft op erators to potential hazards**
  - **spacecraft operators for ano maly resolution**

RBSP Mission Summary

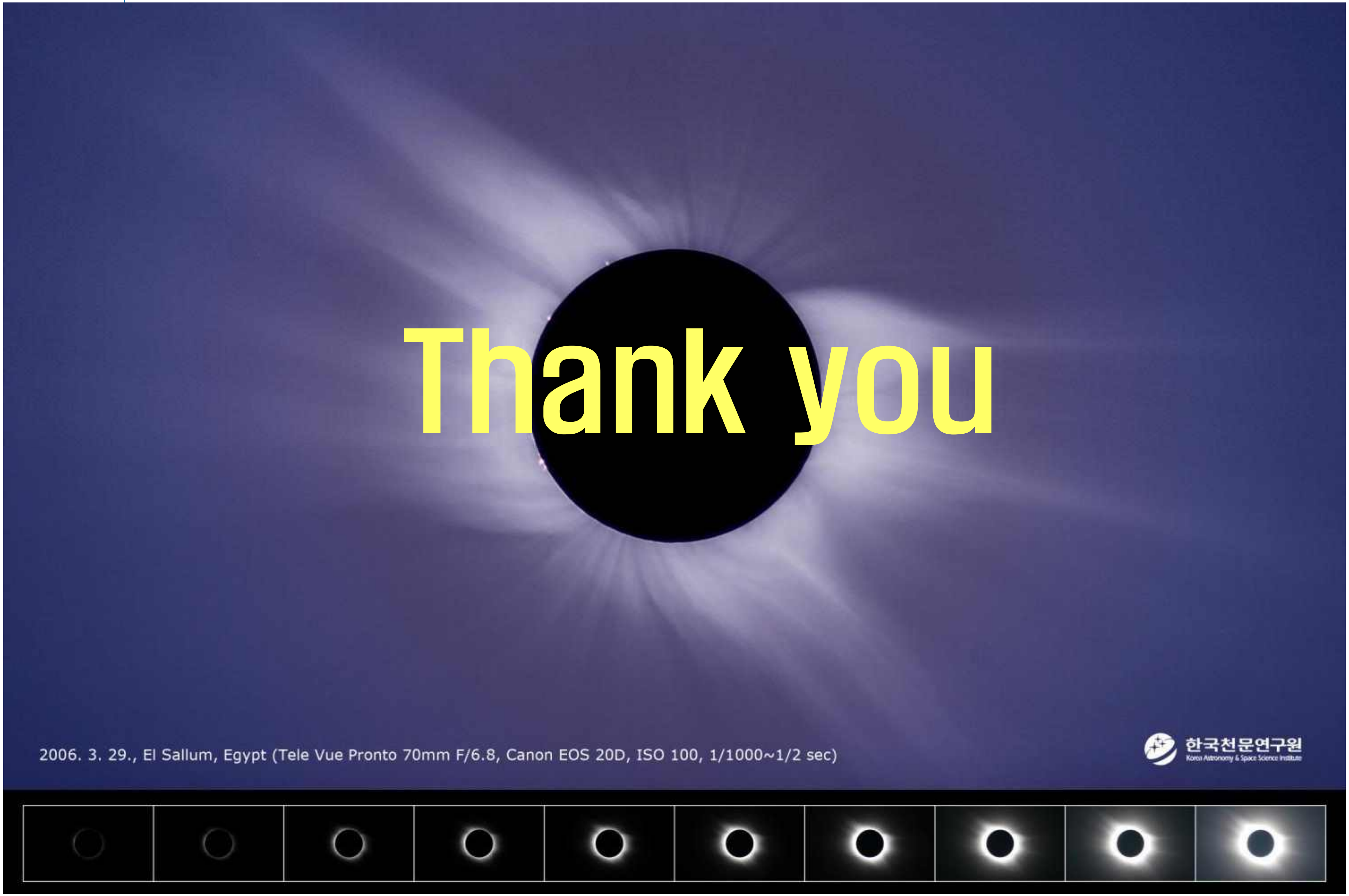
- 2 Near-Sun Pointing Observatories
- Spin Stabilized ~5 RPM
- Spin-Axis 15°-27° of Sun
- Operational Design Life of 2 years (additional propellant will be carried to allow for extended mission



S-band 7m Antenna assembly in KASI



Korean RBSP receiving station started to construct last month and will be completed before June 2012.


Thank you
2006. 3. 29., El Sallum, Egypt (Tele Vue Pronto 70mm F/6.8, Canon EOS 20D, ISO 100, 1/1000~1/2 sec)
한국천문연구원
Korea Astronomy & Space Science Institute