University of Glasgow

SOLAR & HELIOSPHERIC PHYSICS COST CONTROL

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On behalf of the solar & heliospheric physics SWG

"**Solar & Heliospheric physics**" Working Group

http://astronomers.skatelescope.org/science-working-groups/solar-heliospheric-physics/

Over **60 members**

solar radio astronomers from **4 continents** and **20 countries** (e.g. UK, Belgium, France, USA, India, China, France, Australia, Greece, Portugal, Kenya, Ireland, Brazil,…)

Broad science interests include: the Sun (both active and quiet Sun), magnetic reconnection, solar corona/solar wind, solar flares, coronal mass ejections, Sun-Earth system, and ionosphere

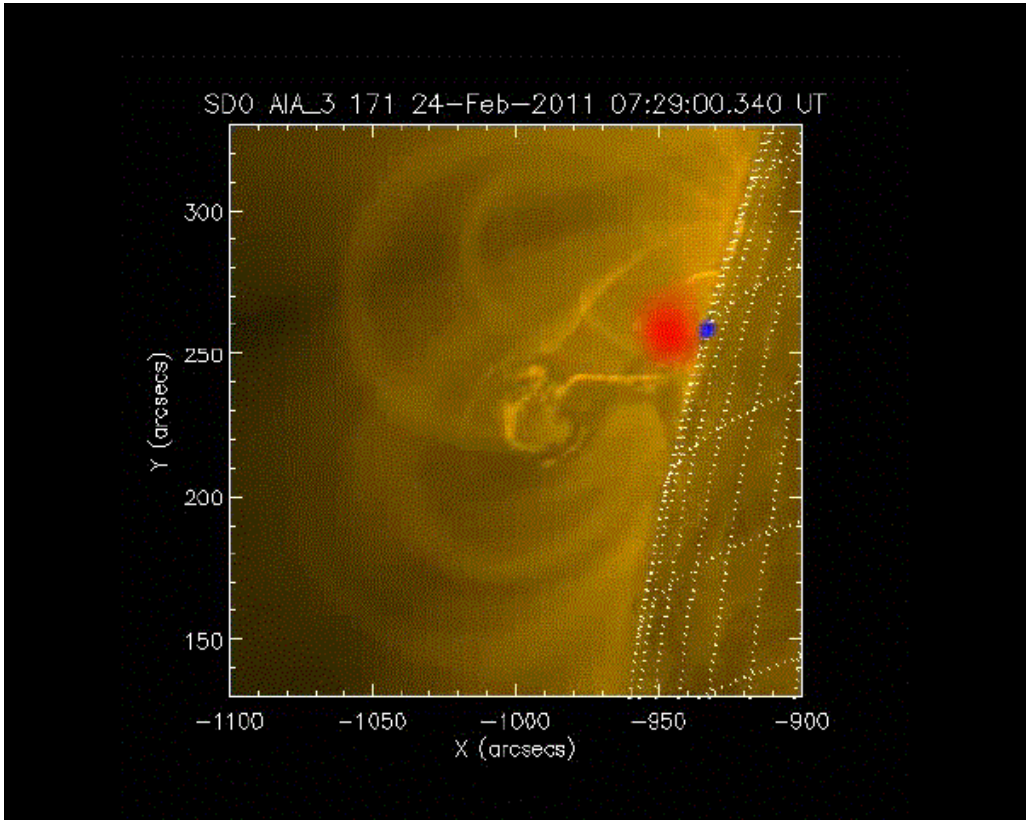
Solar and heliosheric WG

This report is based on:

- Responses from the Solar-Heliosphere WG members
- Face-to-face discussions with a few colleagues

Motivations

1. Solar radio emission as a diagnostic to study **fundamental processes in solar atmosphere** (e.g. conversion of magnetic energy into particle energy, turbulence, particle acceleration, physics of shocks)



2. Sun-Earth connection and ‘space weather’

Basic solar requirements

Sun is highly variable, non-uniform source (1/2 degree); radio sources could be both small (~10 arcsec) and large (~1 degree)

=> large dynamic range

=> snap-shot imaging required

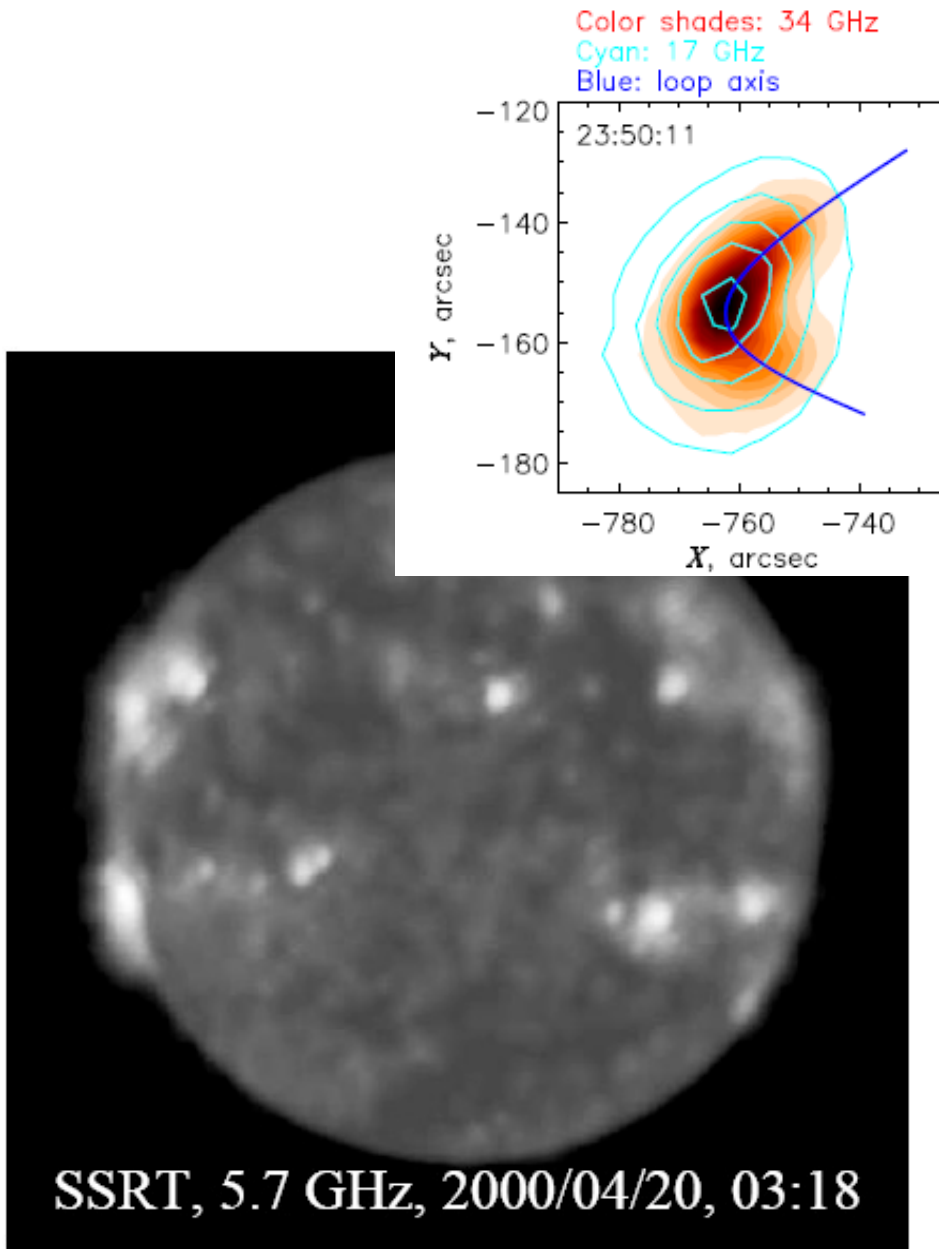
Flux variations ms time scales are known

=> high cadence observations

=> snapshot imaging or multi-beaming

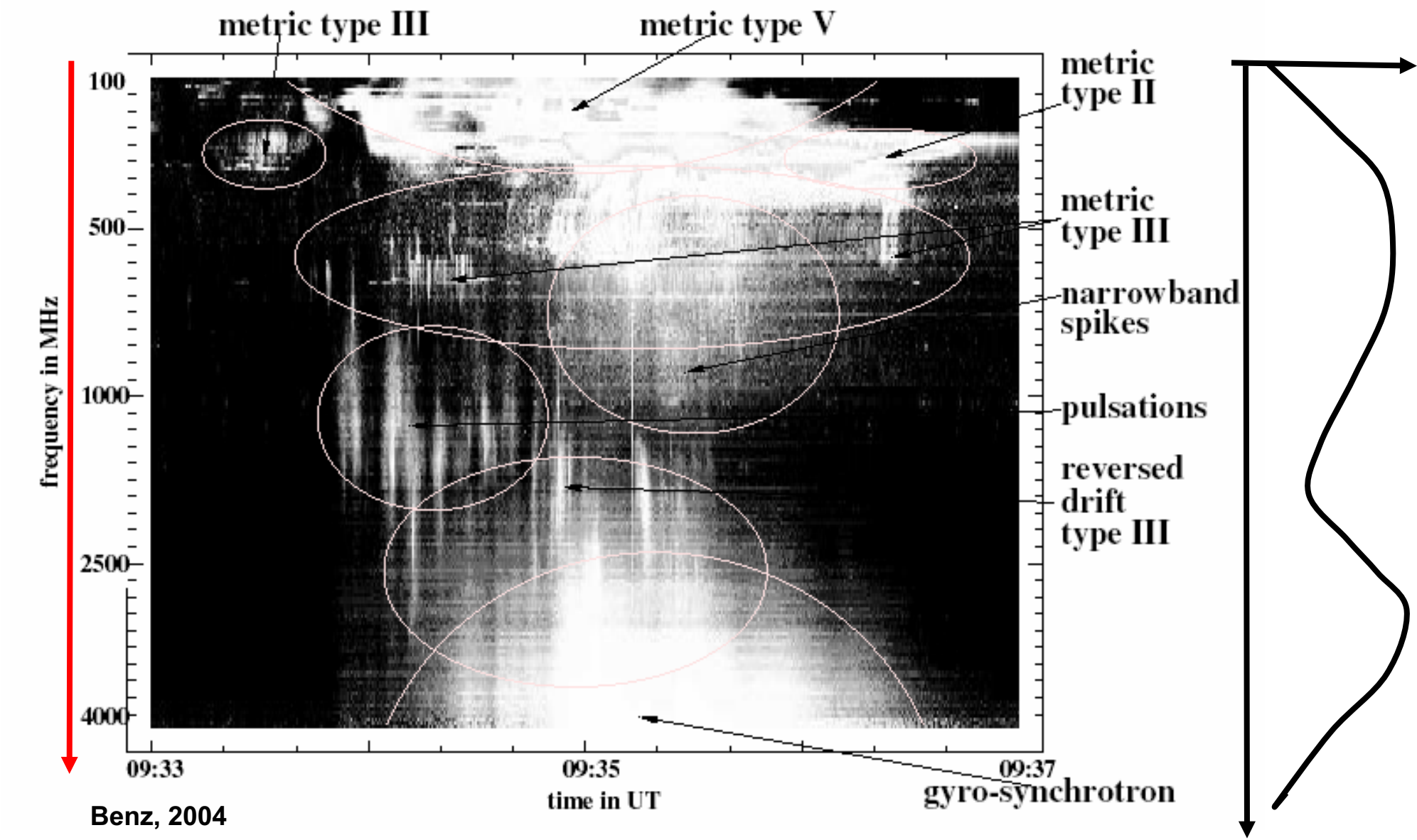
Solar radio spectrum is complex with narrowband features of 1-0.01 % often observed /frequency synthesis often not suitable/

=> modest frequency resolution required



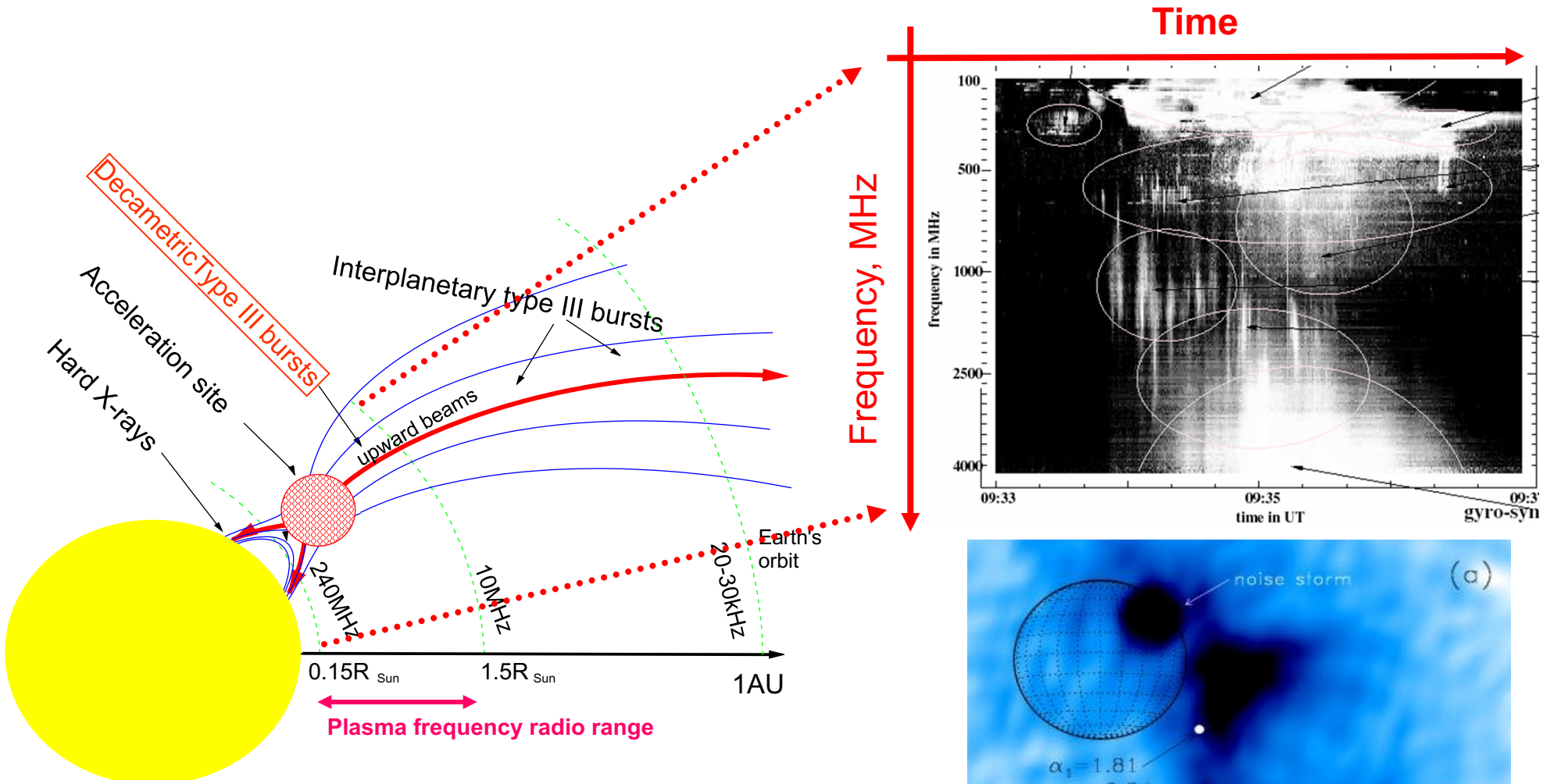
Solar radio emission is complex

A typical dynamic spectrum of an active Sun



Benz, 2004

Large instantaneous band



$$\nu_p = \sqrt{\frac{n_e e^2}{\pi m_e}},$$ <= plasma frequency

Important considerations from a solar science perspective for SKA1-Low and SKA1-Mid:

Large instantaneous bandwidth is the key enabler of new science.

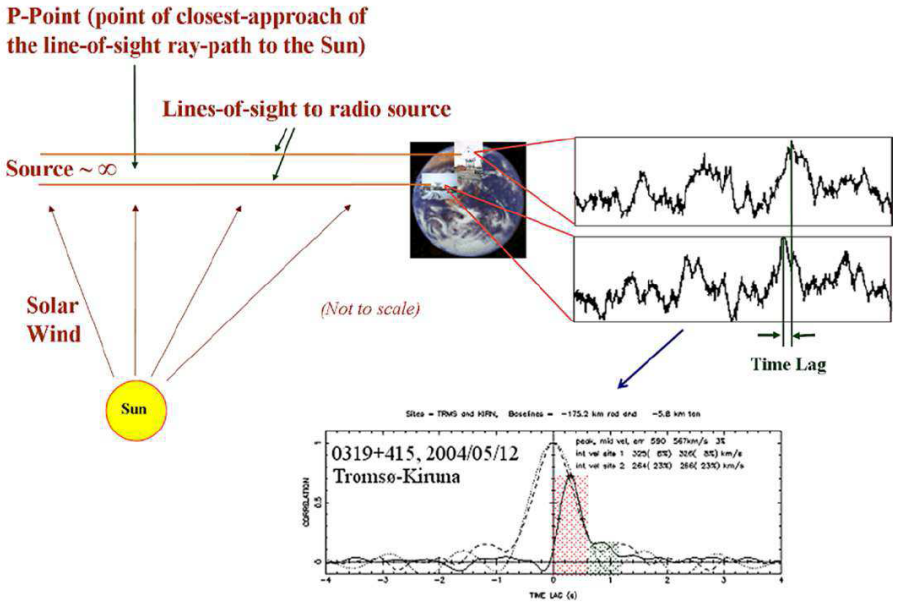
(Some of the key science targets are to study the plasma emission related to energetic events ranging from largest flares to smallest magnetic reconnection events. These comparatively narrow-band coherent emissions arise at the local plasma frequency and its harmonic, and hence the frequency of observation carries direct information about the local plasma density in the region of emission.)

SKA1-low band of 50-350 MHz is only an incremental improvement over the80-300 MHz already available from the MWA and 30 -240 MHz LOFAR

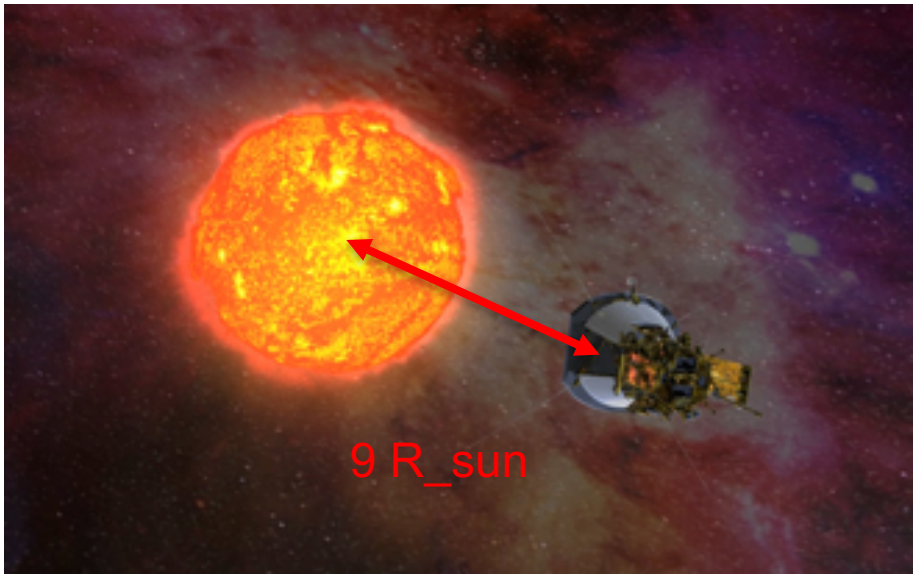
Heliophysics science with SKA1-Low:

Observation of Galactic synchrotron background and the discreet sources to diagnose plasma in the heliopshere.

A key science objective of this science is to measure the 3D magnetic field of coronal mass ejections (CMEs) while they are still in interplanetary space. This requires the use of RM synthesis technique, which in turn, benefits from having simultaneous access large bandwidth or at least the ability to spread the observing bandwidth over a large spectral span.

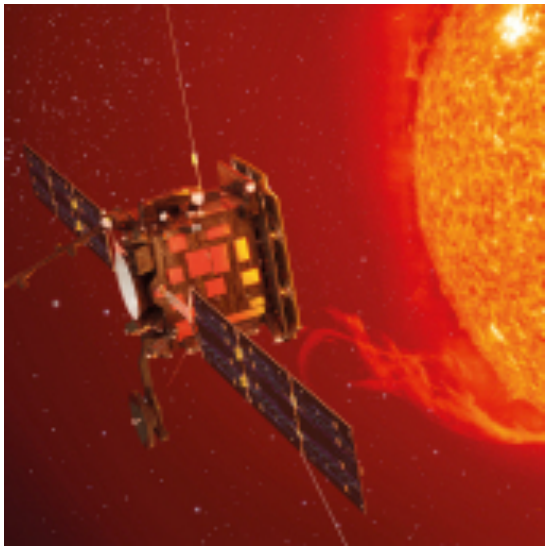


Solar Probe Plus, Solar Orbiter and SKA



NASA Solar Probe Plus is in the definition stage and is scheduled to launch in 2018:
First close approach in December, 2024

Science objectives:
1) Coronal heating and solar wind acceleration
2) Production, evolution and transport of solar energetic particles



SKA observations will be complemented with new in-situ and remote observation of the Sun in the inner heliosphere

ESA Solar Orbiter to be launched in 2018 (approach the Sun ~0.3AU)

General comments:

Possible cost savings with minimum science impact:

- Reducing the number elements in the array for Mid and Low, especially in the core where all the infra-structure is already deployed.

-Savings not only from the reduced cost of construction and installation, but also the attendant reduction in the data transport, correlation process.

-have all the feeds on all the SKA-Mid antennas, but populate a sufficiently dense sub-array at each of the frequencies to start getting reasonable experience with the hardware and instrument performance, and do some interesting science. Perhaps some thought should be paid explore the savings it brings about.

Summary

Reduction of science for reduced instantaneous bandwidth.

SKA-Low 350-50 MHz covers

a) essential range of solar heights
b) complementarity with the major space missions observation (Solar Orbiter and Solar Probe Plus)

Prefer changes which do not lead a lasting impact and are easy to 'undo' once more resources can be made available.