SEAM

Small Explorer for Advanced Missions

BAASP2014 – Tartu, 20140923

Outline

- Objectives
- Concept
- Requirements
- Status

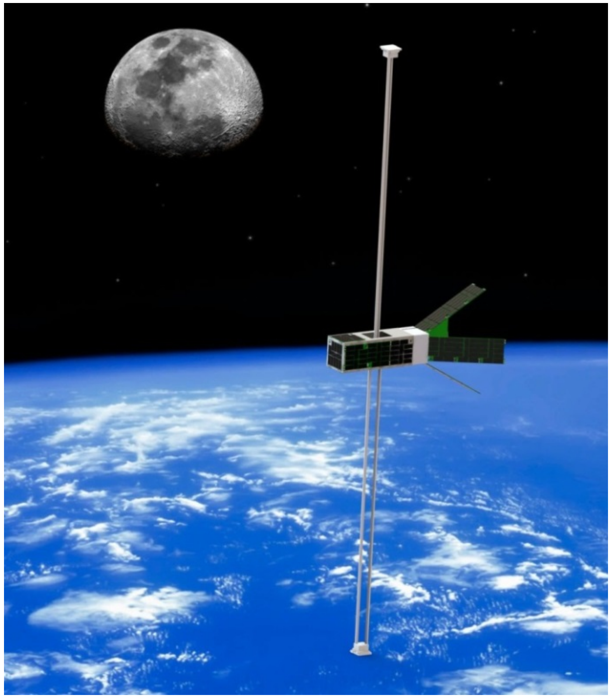
SME-oriented project – science driven

Development of new solutions by SMEs for high-end of the nanosatellite market, funded within EU FP7

- KTH (Sweden)
- ÅAC Microtec (Sweden)
- ECM-Space (Germany)
- LEMI (Ukraine)
- BLE (Hungary)
- GOMSpace (Denmark)
- SSC (Sweden)
- Kayser Italia (Italy)

Science & Technical Objectives

- High-quality DC and AC magnetic field observations on a nanosatellite
- New approach for operation strategy
- High rate TM/TC, use of commercial ground stations on affordable basis



Science 1 – Auroral Currents

Space weather – monitoring

Small scale currents – high res.

Coordination with:

- SWARM mission (Launched!)
- Ground-based optics
- EISCAT
- SuperDARN
- …

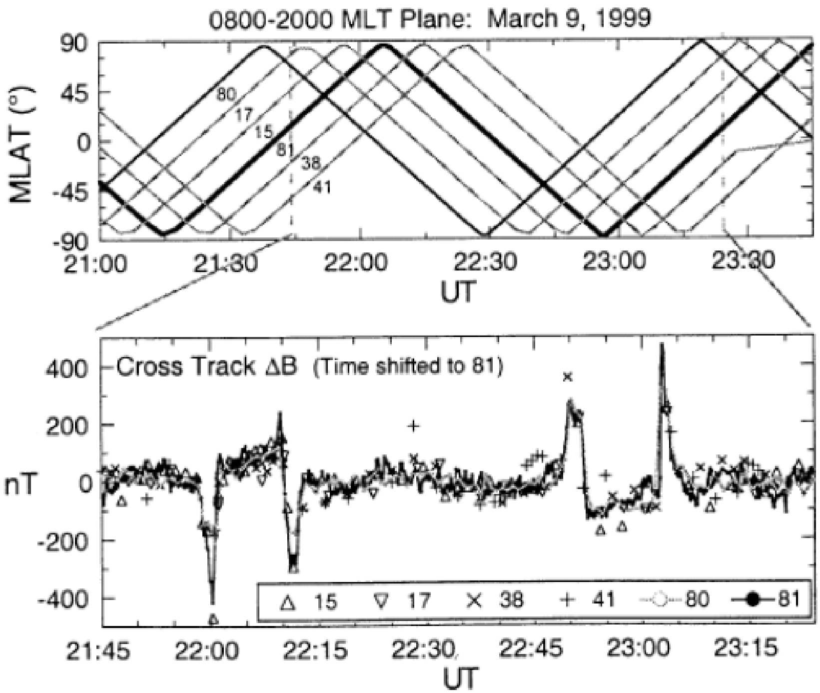


Figure 3. Example of Birkeland current signatures from multiple satellites in the same orbital plane. Magnetic latitudes (top panel) for six satellites and final cross track residuals (bottom). Cross track residuals are time shifted so that the magnetic latitudes of each satellite corresponds to that for satellite 81.

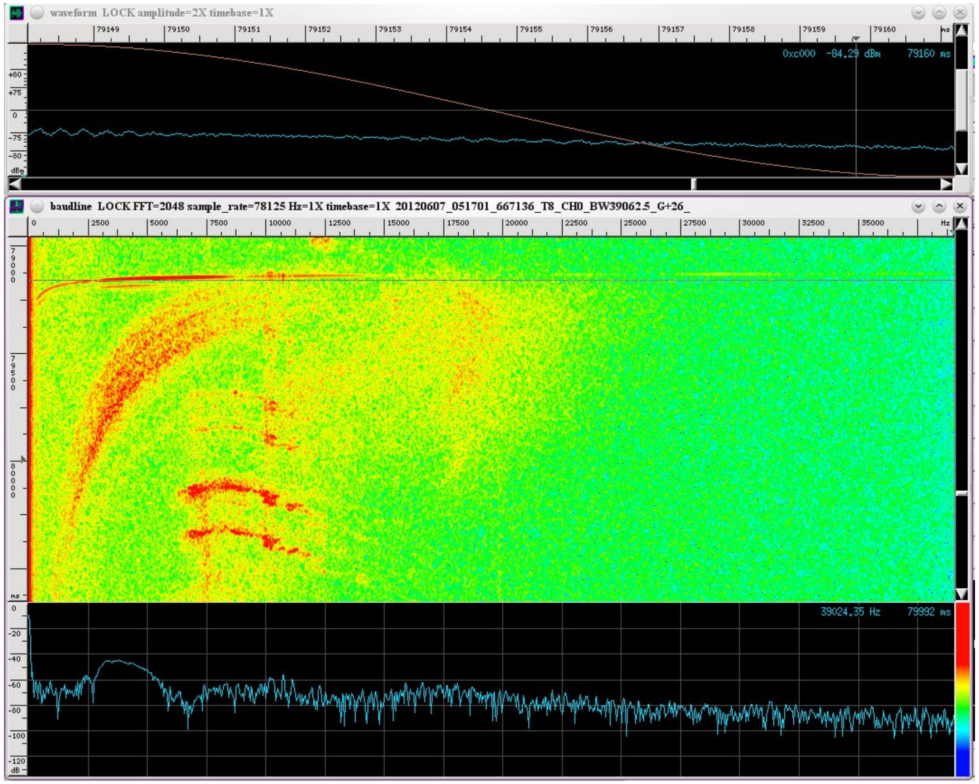
Science 2 – Natural ELF & VLF Waves in the Magnetosphere

Lightning produced waves

Propagation characteristics affect the received spectra. Together with models, plasmasphere density can be reconstructed.

Auroral waves

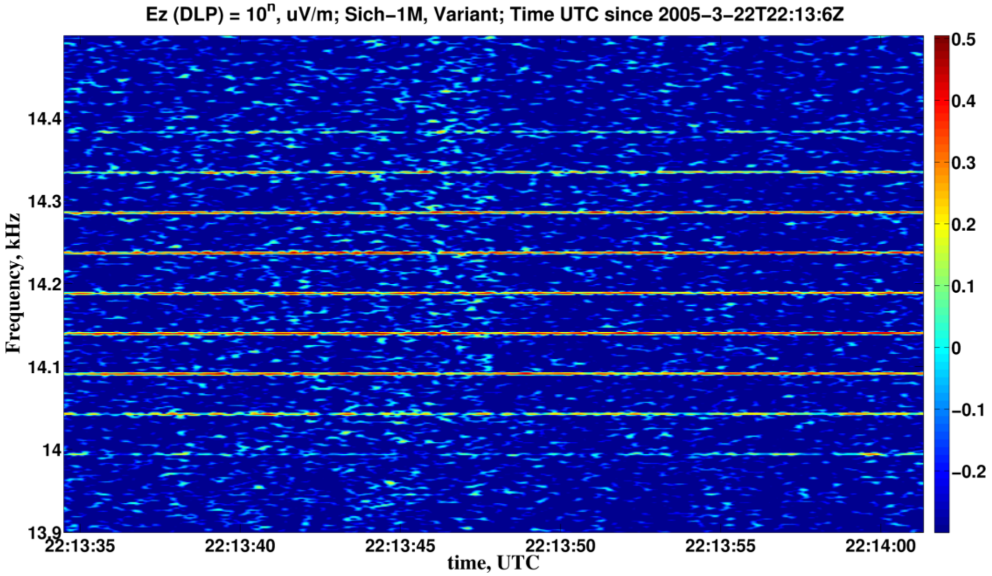
Spectra and occurrence give a ”smoking gun” of auroral acceleration processes.

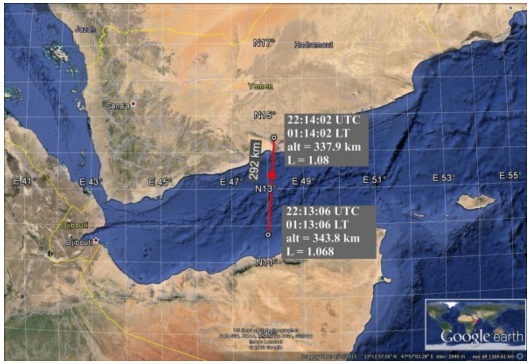


Science 3 – Anthropogenic Emissions

Power line harmonics.

Some observations are reported, but the phenomenon is poorly understood, more data needed!





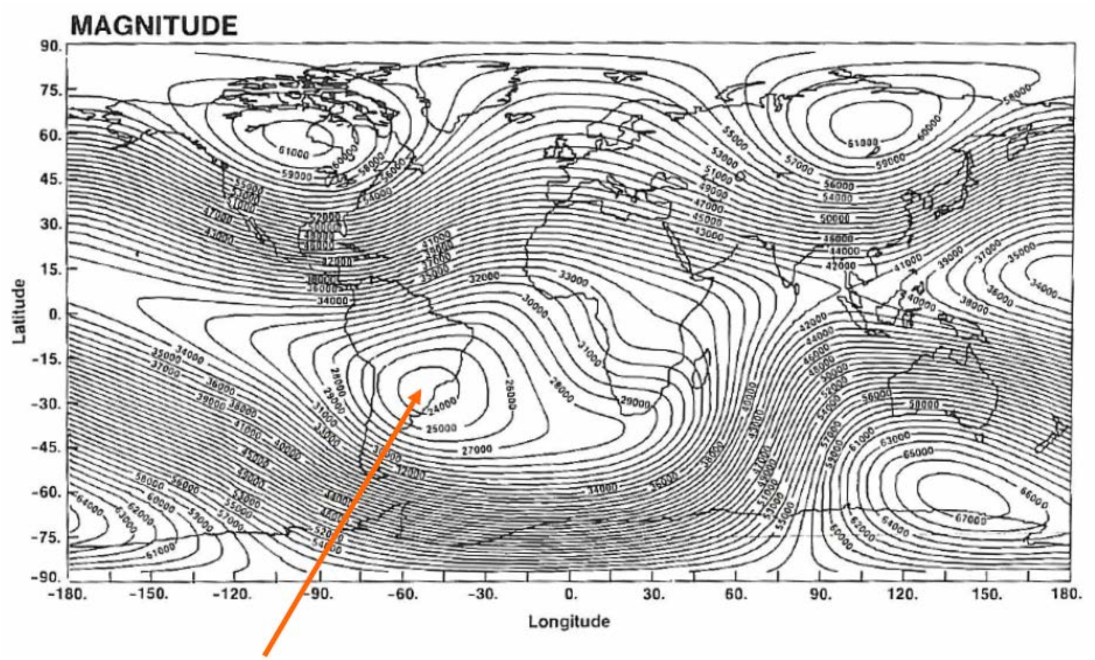
(Science Extra – Earth Field)

Core field – IGRF

(a challenge!
better than 10 nT
is required)

Crust field

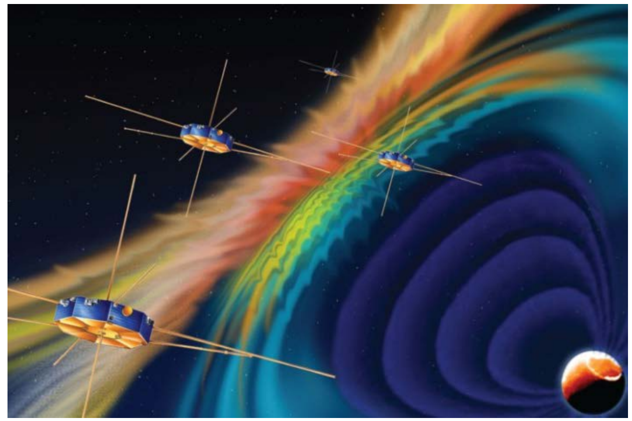
(coordination with
SWARM)



South Atlantic Magnetic Anomaly

Science 4 –
Distributed Measurements in Space

- ESA Cluster mission
- NASA MMS
- REXUS student rockets
- SPIDER rocket
- Nanosatellites



MUSCAT experiment on REXUS-13, May 9, 2013

TISDAG 21 MAJ 2013 KUNDSERVICE PRENUME

DN.se

HANNE
"Alla so
polisen
berätta

FÖRSTASIDAN | STHLM | EKONOMI | SPORT | KULTUR

Nyheter Sverige Politik Vetenskap Världen Quiz Väd

Nasa tar hjälp av svensk spetsteknik

Publicerad 2013-05-20 13:50

Norrsken.

Svensk spetsteknik ska hjälpa amerikanska Nasa att förstå hur solstormar fungerar. Målet är att kunna skydda både satelliter och elnät på jorden från att slås ut.

Det är Kungliga tekniska högskolan i Stockholm som har utvecklat tekniken som ska monteras på satelliter och skickas upp i rymden av den amerikanska rymdstyrelsen Nasa nästa år. Tekniken ska användas till att mäta elektriska fält som uppstår när solen växelverkar med jorden och andra planeter.

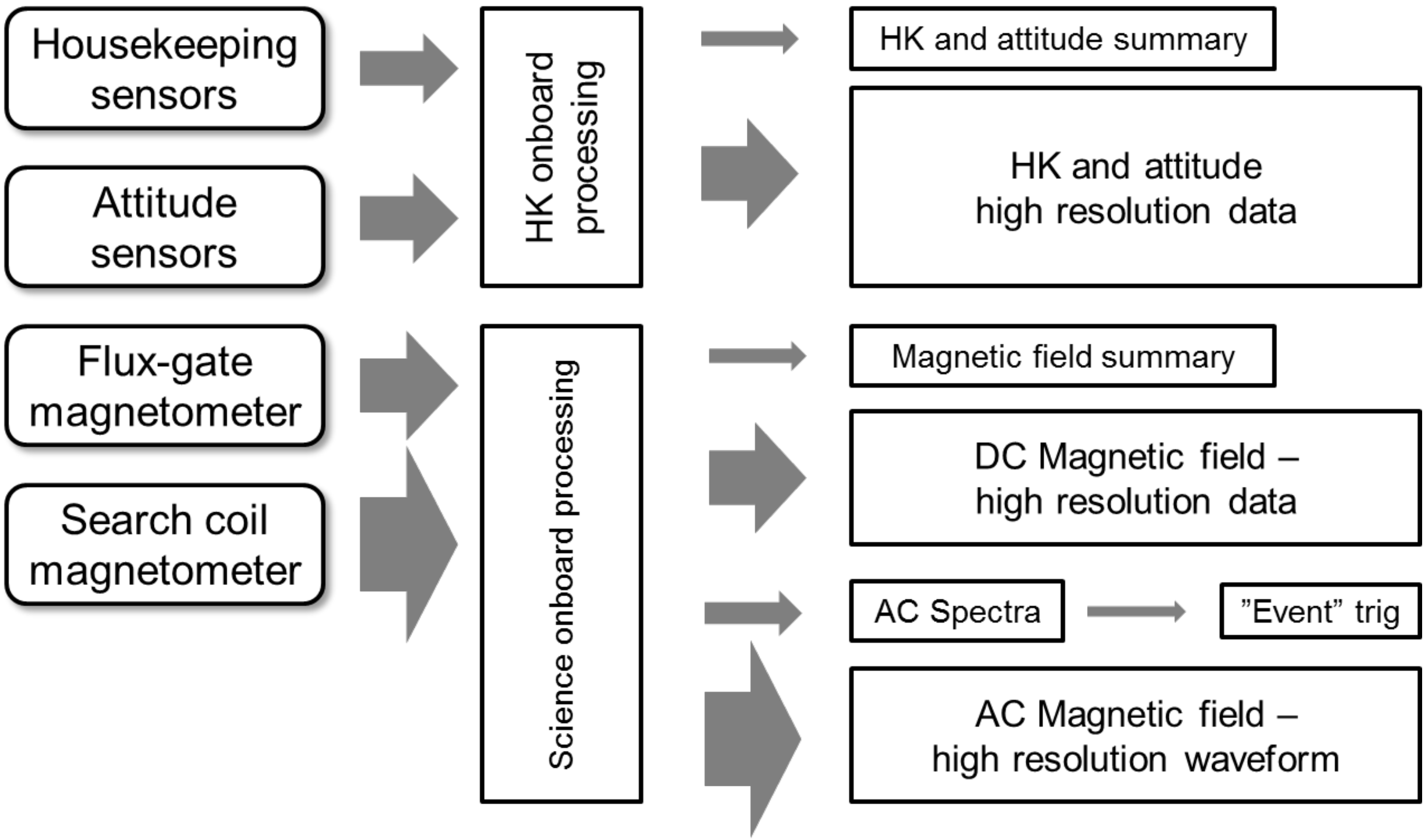
Operation Strategy – 1

We can produce more data than we can downlink!

What to do?

- Compress data
- Schedule burst modes
- Automatic burst (criteria?)
- Save all, human selection for download!

Operation Strategy – 2

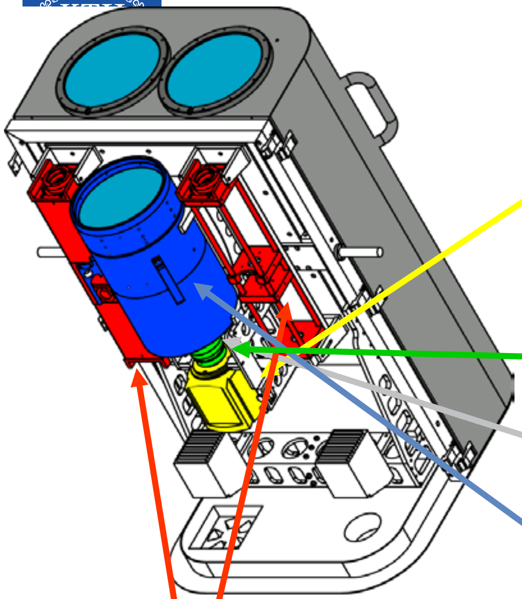


Operation Strategy – 3

1. Record ALL! (overview, triggers, spectra, high resolution waveform, HK overview, HK high resolution)
2. ALL overview data downlinked
3. SELECT high resolution data for downlink
4. GET the selected high resolution data
5. Unused high resolution data EXPIRES!

We have already been doing this on Earth!

(ASK Instrument on Svalbard)



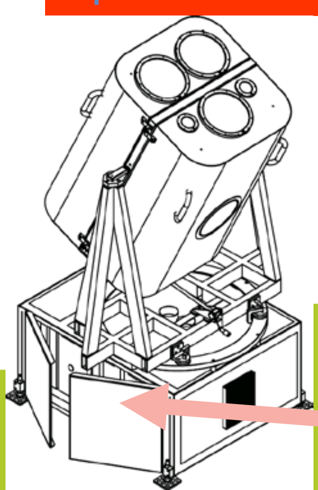
3 of Andor iXon EMCCD
512 x 512 pixels 8.2 x 8.2 mm
up to 20 fps (without binning)
>50 fps (with pixel binning)

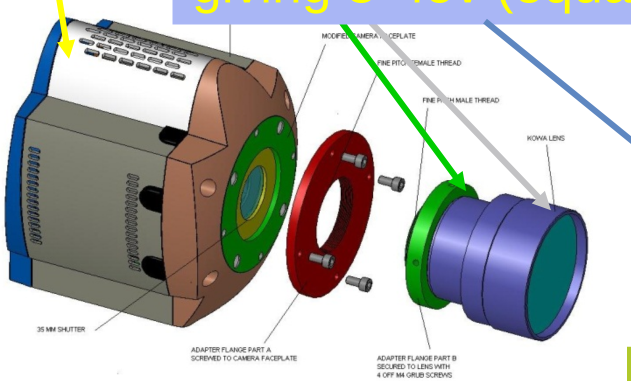
Kowa 75mm F/1 gives 6.2º x 6.2º FOV

narrow passband interference filter selects emissions

A Removable Galilean 2x converter in front of Kowa makes a 150mm, f/1.0 lens, giving 3º fov (equal to 5x5 km @100 km)

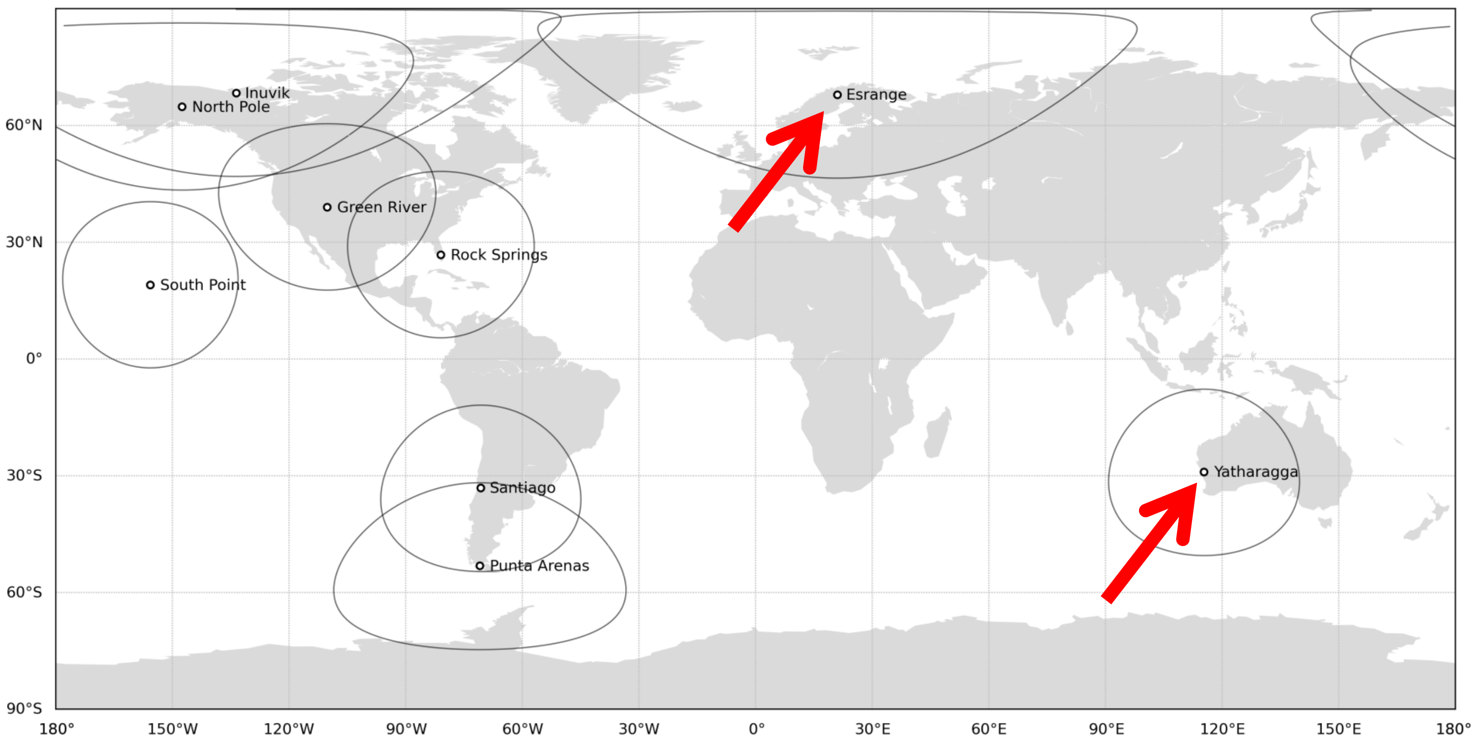
2 photometers
0.25-1.0º FOV
up to 200 samples/s





Computers control the cameras

Use of Commercial Ground Stations



Vision (ground service providers)

- Standard interface for communication.

CCSDS standard for direct use with existing setups.

- End user needs no insight in pass scheduling!

(Semi-)automatic pass scheduling.

- Ground antenna usage is improved!

Idle times available to low priority users at more affordable rates.

Orbit?

Sun-synchronous:

98 degree inclination

600 km altitude

09-21 Local Time

Requirements

- Design lifetime of 1 year
- Orbit inclination of 75 degrees or more.
- Measurement of DC magnetic field with absolute error of less than 20 nT in each component
- Instrument noise of under 20 pT/√Hz at 1 Hz for the fluxgate magnetometer

Requirements

- Instrument noise of under 0.5 pT/√Hz at 1 kHz for the searchcoil magnetometer

- Sampling of the fluxgate magnetometer at 250 Hz or faster.

- Sampling of the AC magnetic field [and electric field component] at 40 kHz or faster.

- Spacecraft-generated noise below the instrument own noise

Requirements

- Position knowledge with error of less than 1 km
- Time knowledge with an error of below 1 ms for the science data.
- High resolution data collection at all times the satellite is operational.
- Downlink of all collected overview data with maximum delay of 12 hours.

Project Timeline

	Start	Duration	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
WP1 Management	1	36																																				
WP2 Preliminary design	1	7																																				
T2.1 Requirement formulation																																						
T2.2 Technology survey																																						
T2.3 E-M cleanliness analysis																																						
T2.4 Mission Analysis																																						
T2.5 Satellite preliminary design																																						
WP3 Technology development	8	13																																				
T3.1 Attitude determination																																						
T3.2 Power system																																						
T3.3 Avionics																																						
T3.4 Magnetic Sensors																																						
T3.5 Deployable boom																																						
T3.6 Telemetry and telecommand																																						
T3.7 O/b processing & op. strategy																																						
T3.9 EM testing and validation																																						
WP4 Implementation	21	16																																				
T4.1 Flight hardware manufacturing																																						
T4.2 Assembly and integration																																						
T4.3 Flight model testing																																						
T4.4 Launch campaign																																						
T4.5 Operations																																						
T4.6 Flight data analysis																																						
WP5 Dissemination	2	35																																				
T5.1 Internal communication																																						
T5.2 Community dissemination																																						
T5.3 Public outreach																																						
WP6 Commercial evaluation	1	36																																				
T6.1 Market potential evaluation																																						
T6.2 Business plan formulation																																						

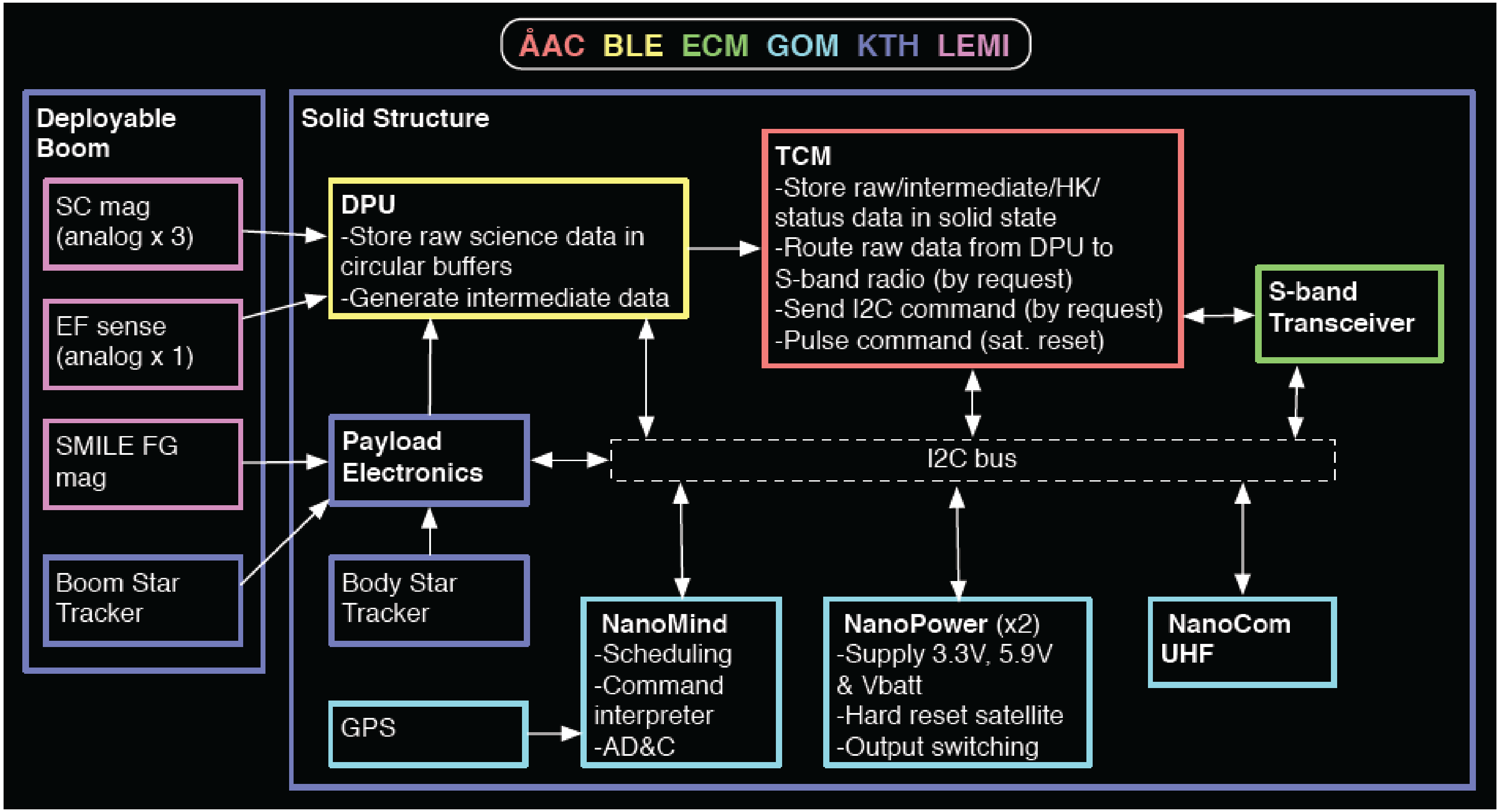
PDR, April 2014

start, October 2013

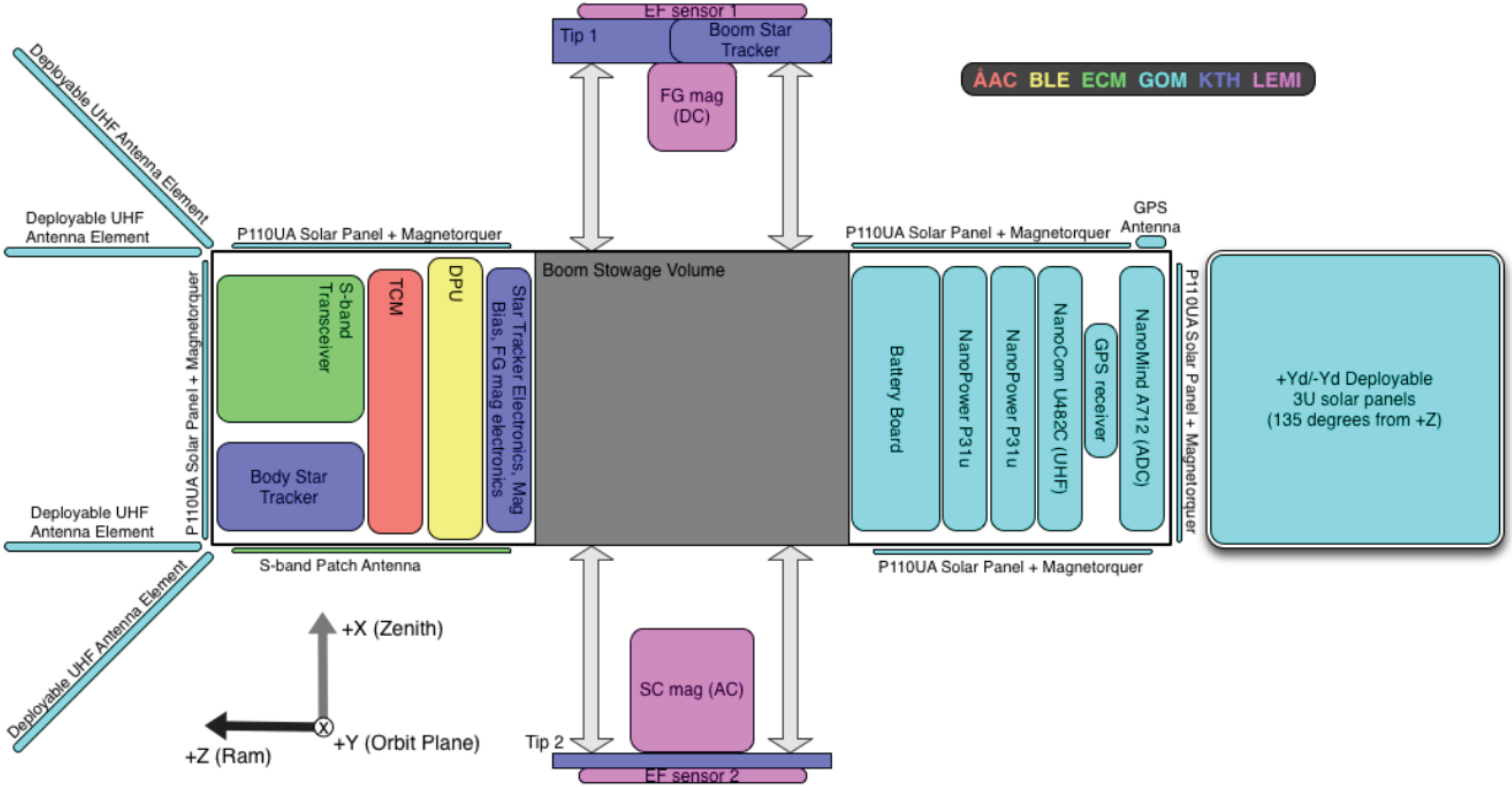
CDR, May 2015

Launch, Spring 2016

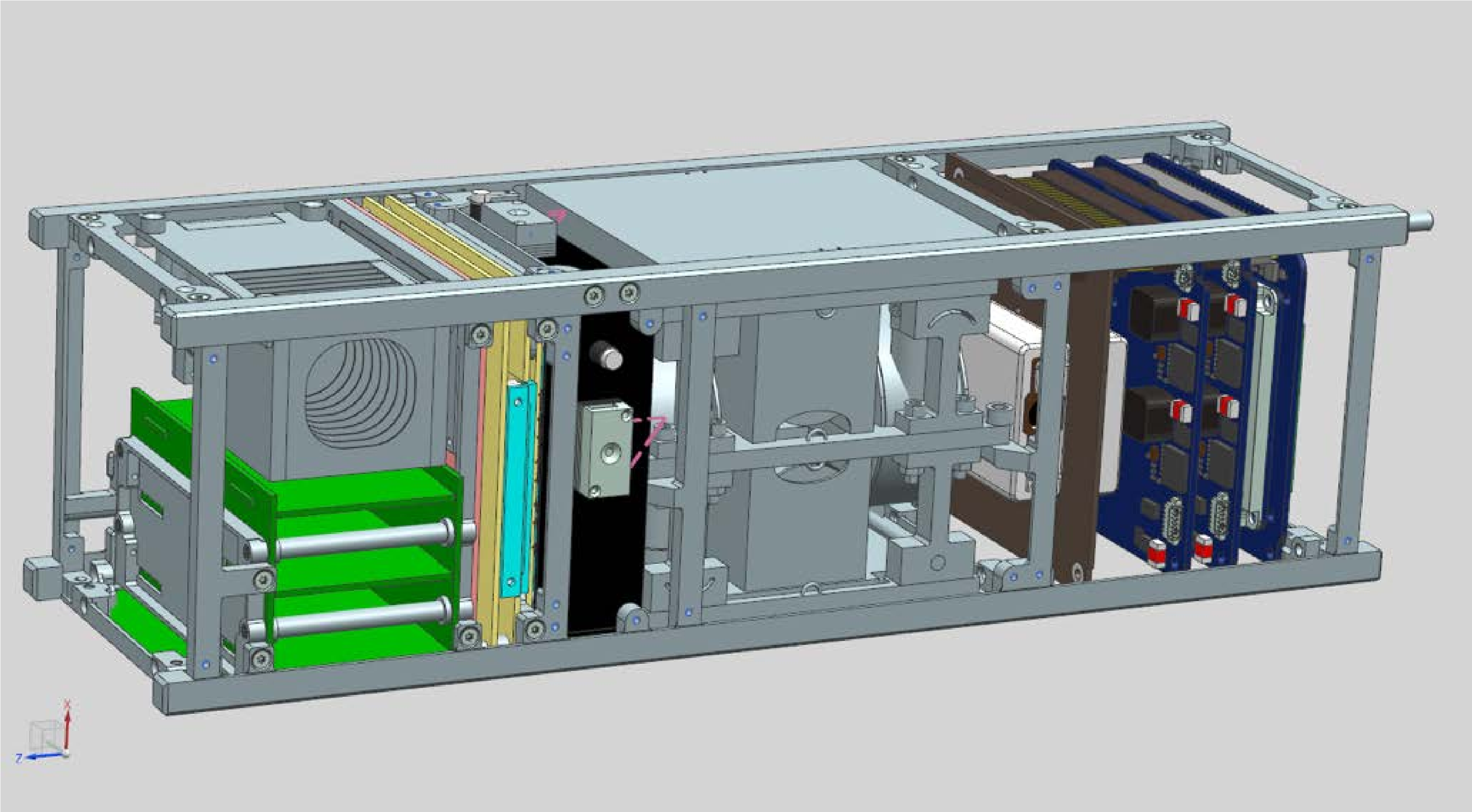
Satellite Configuration



Current Satellite Layout



Mechanical implementation



Summary

- We are developing, building and will fly a scientific 3U CubeSat

- Several developments: magnetic cleanliness, deployable boom, S-band telemetry with CCSDS data structure, commercial ground networks

- Next step is a fleet/swarm of CubeSats.