Proposal: 33 – NITRO

Version: 1.2 date: 24/03/2015

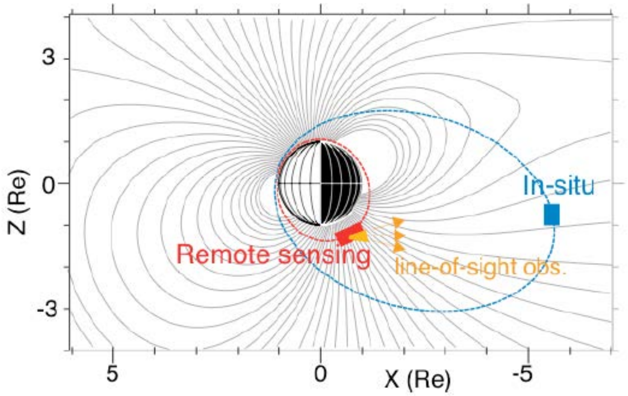
33 – NITRO (Description)

Main science objectives:

- Study of the distribution, budget, dynamics and escape rate of Nitrogen in the upper atmosphere, inner magnetosphere and auroral region of the Earth

Mission profile

- Launch with **two VEGA launchers**; initial orbit **In-situ S/C-1** is 800/2.427 km with i=68.5, final orbit: 800/33.000km by solid rocket
  1 month later launch of **Remote Sensing S/C-2** directly in 500/2.400 km orbit with i=88.35
- Deorbit by on-board propulsion system (hydrazine) to perigee of 60 km with dv of 80 and 120 m/s; 2 year equatorial phase for IS-S/C and then higher latitude phase.
  RS-S/C keeps same orbit.

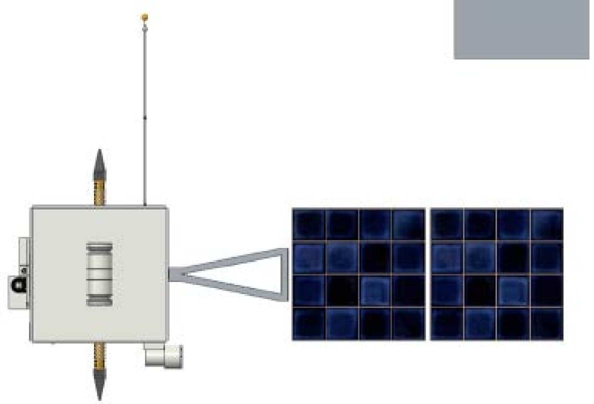


Spacecraft:

- Two S/C: In-situ S/C **spinning** (2-3 rpm), 290 kg
  remote sensing S/C (**3-axis stabilised**), 306 kg dry mass.
- Perigee Kick motor for In-situ S/C to reach final orbit. STAR27H: 361 kg; propane propulsion system for IS s/c for operational phase
- X band comms through LGA (2 W and 5 W RF power) for 5 Mbps for IS s/c and 500 kbps for RS s/c.
- Radiation shielding for IS s/c : 50 krad (100 krad with RDM=2) after 5-6 mm, lower doses for RS s/c.

Payload: (50.3kg +31kg)

- **In-situ S/C**: MIMS: light hot ions; NOID: heavy hot ions; NIMS: cold ions; CHEMS: energ ions; SLP: spacecraft potential; WAVES: wave analyser; SCM: search coil magnetomete PEACE: electron spectrometer; ASPOC: s/c potential control; DPU
- **Remote Sensing**: NUVO; UV/visible light camera; CINMS: cold ions & neutrals; CAAC; airglow& auroral emission camera; NOID-RS: heavy hot ions



Implementation scheme & ESA contribution :

- Role of ESA: Launcher, 2 S/C, DPU, scanning platform for NUVO, ASPOC, MOC and SOC
- Role of Member States: Instruments + US and Japan contributions to payload
- International cooperation: US and Japan

33 – NITRO (Evaluation)

S/C Major challenges & critical issues:

- **One major critical issue identified** is the N+ contamination requirement:
  - Contamination for in-situ S/C critical for any N+ contamination;- > propane propulsion systems, Isp 60 sec for operational phase
  - Integration of PKM into S/C (US engine)
  - Launch of two S/C expected in 1 month timeframe is preferred. (2 VEGA in 31 days)

P/L Major challenges & critical issues:

- **One major critical issue identified** is the N+ contamination requirement
  - Contamination control (N+) on IS spacecraft challenging
  - Scanning platform (ESA provided) has some significant problems with wear (heritage proposed from Venus Express)
  - Background radiation analyses not described which could lead to higher shielding mass

Qualification status (S/C and P/L):

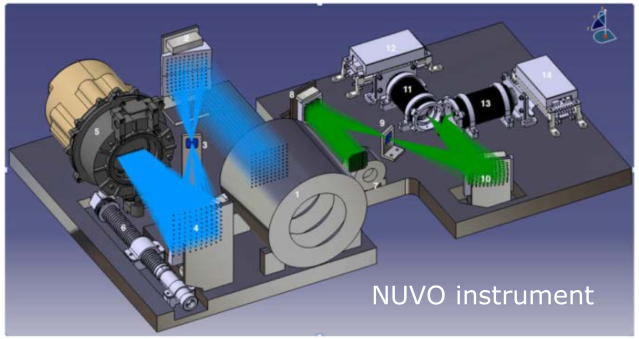
- Propane cold propulsion system; however other propulsion systems have been proposed as well
- Two different spacecraft platform, minimal recurring use of subsystems -> higher cost
- Back-up mission proposed: 1 s/c in-situ with some instruments from RS s/c accommodated.

Programmatic aspects:

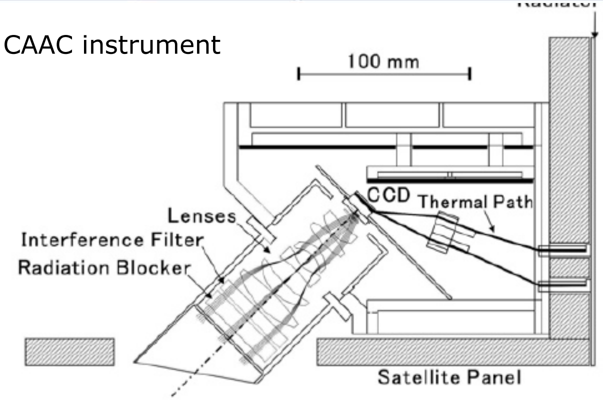
- US delivered PKM to ESA launch site
- Two launches in one month (preferred)

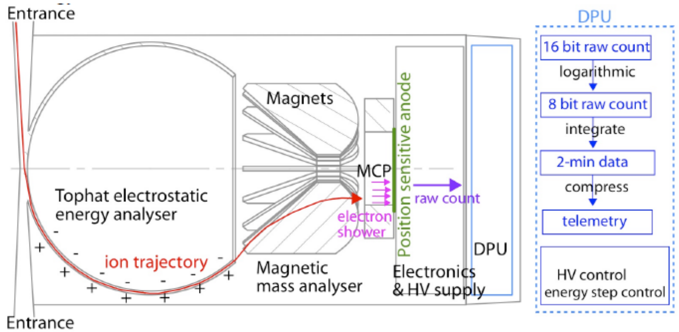
Clarity of implementation scheme, split of responsibilities and interfaces:

- Role of ESA not commensurate with M class budget of 450 M€.


NUVO instrument

CAAC instrument





NOID instrument

33 – NITRO (Summary 2 S/C)

Cost	M€
ESA Project Team	55
Industrial Cost	257
Payload Contribution (ESA)	18
Mission Operations (MOC)	80
Science Operations (SOC)	49
Launcher	90
Contingeny (15%)	62
Total EaC	**611**

Summary Evaluation		Comment
Mission profile	Y	Two launches close in time, Perigee Kick engine
Spacecraft design	Y/R	**Nitrogen cleanliness**
Spacecraft TRL	Y	propulsion, Perigee engine integration
Payload design	Y	nitrogen cleanliness
Payload TRL	Y	Some developments needed
GS & Science Ops.	Y	Two different s/c to control in close collaboration
Programmatic / Cost	R	Cost beyond M4 class, back-up 1 s/c fits cost
Implementation scheme	Y	US PK engine
General summary	R	**Not feasible in M4 class WITH 2 S/C**

Sharing of Responsibility

Element	ESA	MS / (SL)		Int. Partner / SL		comment
Launcher	X					ESA only mission with instruments from Member state contributions and international partners
S/C	X					
P/L		X		X		
G/S & OPS	X					
other						

Conclusion of Evaluation:

1: Cost is outside budget for full mission (2 S/C), for reduced mission **with one satellite cost fits 450 M€**

2: Two different S/C (spinning and 3-axis stabilised) development time requires two teams

3: Large set of payload -> high burden on member states

33 – NITRO (Summary 1 S/C)

Cost	M€
ESA Project Team	34
Industrial Cost	150
Payload Contribution (ESA)	18
Mission Operations (MOC)	40
Science Operations (SOC)	35
Launcher	45
Contingeny (15%)	36
Total EaC	**358**

Summary Evaluation		Comment
Mission profile	G	Single launch
Spacecraft design	Y/R	**Nitrogen cleanliness**
Spacecraft TRL	Y	propulsion, Perigee engine integration
Payload design	Y	nitrogen cleanliness, number of instruments
Payload TRL	Y	Some developments needed
GS & Science Ops.	G	single S/C
Programmatic / Cost	Y	Cost with 1 S/C within M4 class
Implementation scheme	Y	US PK engine
General summary	**Y**	**Feasible in M4 class WITH 1 S/C**

Sharing of Responsibility

Element	ESA	MS / (SL)		Int. Partner / SL		comment
Launcher	X					ESA only mission with instruments from Member state contributions and international partners
S/C	X					
P/L		X		X		
G/S & OPS	X					
other						

Conclusion of Evaluation:

1: Cost is inside budget for backup mission (1 S/C)

2: Nitrogen cleanliness remains risk

3: Large set of payload -> high burden on member states