

ACCP Designated Observable Multi-Center Architecture Study

ACCP Architecture Reference Document

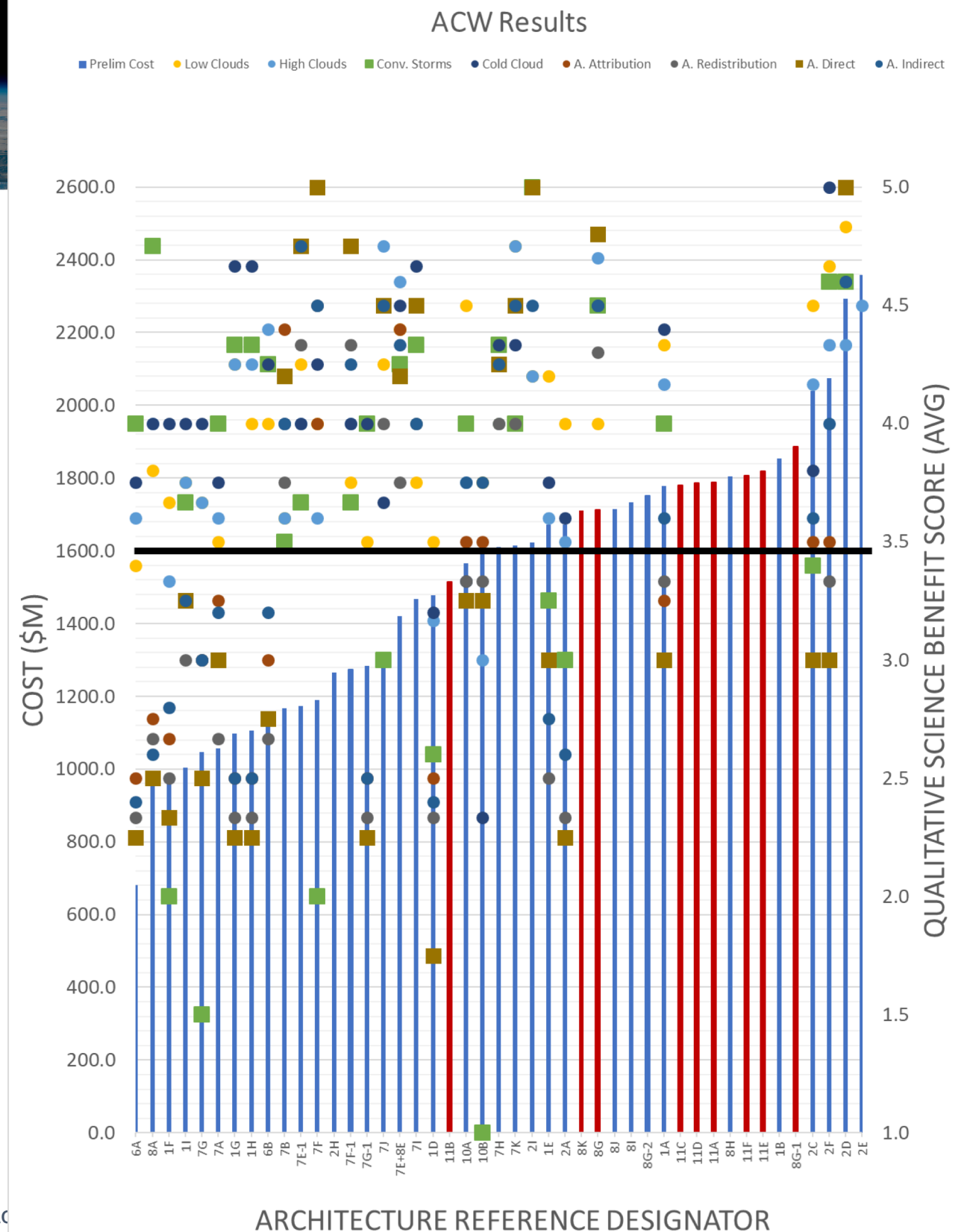
June 17, 2020

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Vickie Moran vickie.e.moran@nasa.gov

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Architectures Constructed To Date (Initial Costing)

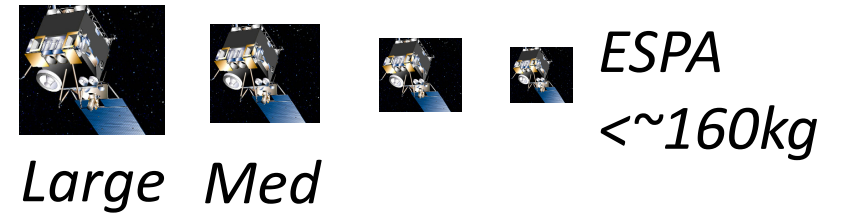
- The chart to the right provides a summary of the 45 Observing Systems that have been constructed to date
- The cost numbers were preliminary and were used for relativistic assessment
- The Science Benefit scores were preliminary and were used for relativistic assessment
- We selected the 9 Architectures in Red for deeper study which is in progress
- The 9 Architectures are associated with ~3 distinct Science Implementations



1. Seasonal Vertically Resolved Cloud & Aerosol Processes At Various Times of Day

Rev 2 Costing

Mission Implementations



SSP: Radar13, Radio07, Spec03, Spec 04, Lidar05, Polar07

8G SSG: Radar13, Radio9b/10, Lidar09, Polar07

8G-1 SSG: Radar12, Radar17, Radio9b/10, Lidar09, Polar07

8G-2 SSG: Radar 12, Radar17 Radio9b

Arch 8G: \$1640
Arch 8G-1: \$1859
Arch 8G-2: \$1699

8K SSP1: Spec03, Spec04, Lidar05, Polar07

8K-1 SSP1: Spec03, Spec04, Lidar05, Polar07

8K-2 SSP1: Spec03, Spec04, Lidar09, Polar07

SSP2: Radar13, Radio07

SSG1: Lidar09, Polar04b

SSG2: Radar12, Radio7

Arch 8K: \$1677
Arch 8K-1: \$1696
Arch 8K-2: \$1440

2. Seasonal Vertically Resolved Cloud & Aerosol Processes Over Several Min Time Scales for Process Evolution With De-Scopes

SSP1 (t=0) Radar13, Radio07, Spec03, Spec04, Camera, Lidar09, Polar07

SSP2 (t=12.5sec) Lidar5, Polar07

dt2 (t=30sec) Radar5b

Arch 11A (DS): \$1542

SSP1 (t=0) Radar13, Radio07, Spec03, Spec04, Camera, Lidar09, Polar07, Radio9b'

SSP2 (t=12.5sec) Lidar5, Polar07

dt2 (t=30sec) Radar5b, Radio9b'

Arch 11F (DS): \$1500

SSP1: Radar13, Radio9b', Spec03, Spec 04, Lidar05, Polar07

SSP-2 Radar17; Radio9b' (t=0s)

Arch 11I : \$1528

3. Seasonal Vertically Resolved Cloud & Aerosol Processes Over Several Min Time Scales for Process Evolution & At Various Times of Day With De-Scopes

SSP1 (t=0) Radar13, Lidar05, Radio07, Polar07, Spec03, Spec04, Camera

dt1 Radar5b (t=45s)

dt2 Radar5b (t=105s)

Arch 11B (DS): \$1403

SSP1 (t=0) Radar13, Lidar05, Radio07, Polar07, Spec03, Spec04, Camera

dt1 Radar5b (t=45s)

dt2 Radar5b, Radio9b' (t=45s)

SOG-1 Radar17, Radio9b'

Arch 11E (DS): \$1698

SSP1 (t=0) Lidar05, Polar07, Spec03, Spec04

SSP2 Radar02'a (t=30s)

SSP3 Radio07 (t=120s)

dt3 Radio7 (t=120s)

SOG1 (t=0) Radar13, Radio07, Camera, Lidar09

Arch 11C (DS): \$1644

SSP1 (t=0) Radar13, Lidar05, Radio07, Polar07, Spec03, Spec04, Camera

dt1 Radar5b (t=45s)

dt2 Radar5b, Radio9b' (t=45s)


SOG-1 Radar17, Radio9b'

Arch 11D (DS): \$1698

1. Seasonal Vertically Resolved Cloud & Aerosol Processes At Various Times of Day

Rev 2 Costing

Mission Implementations

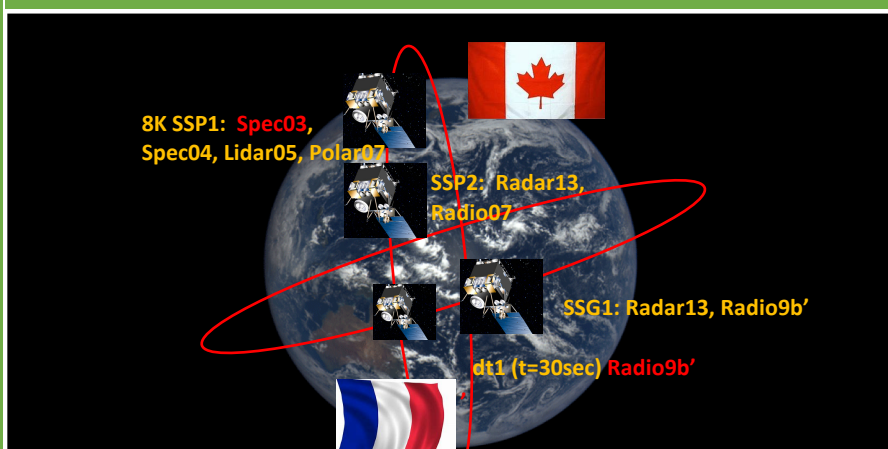


Large Med ESPA
Grande

ESPA
<~160kg

2. Seasonal Vertically Resolved Cloud & Aerosol Processes Over Several Min Time Scales for Process Evolution With De-Scopes

3. Seasonal Vertically Resolved Cloud & Aerosol Processes Over Several Min Time Scales for Process Evolution & At Various Times of Day With De-Scopes



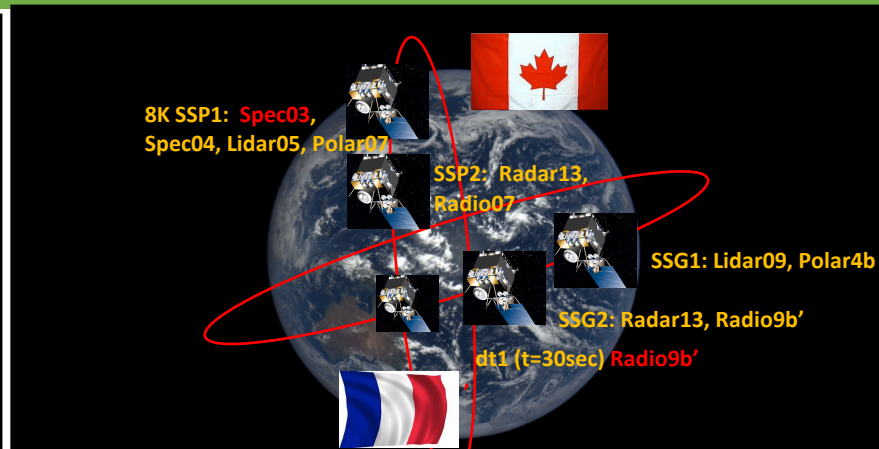
8K SSP1: Spec03, Spec04, Lidar05, Polar07

SSP2: Radar13, Radio07

SOG1: Radar13, Radio9b'

dt1 (t=30sec) Radio9b'

11G: \$1424



8K SSP1: Spec03, Spec04, Lidar05, Polar07

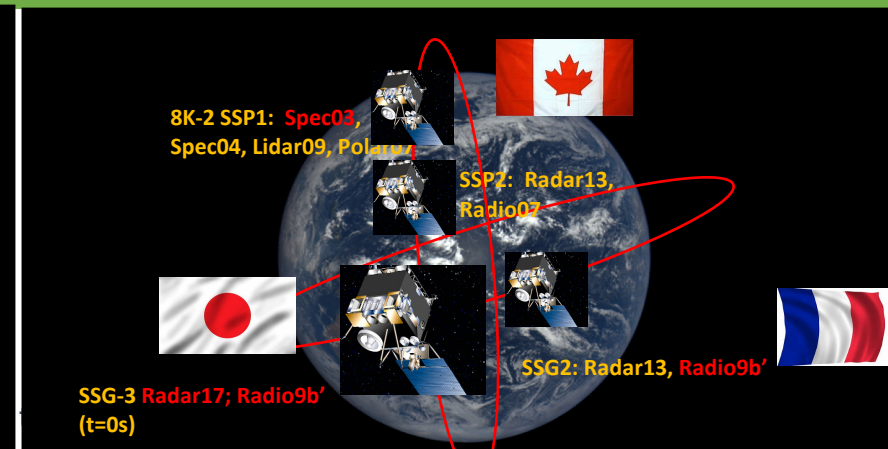
SSP2: Radar13, Radio07

SOG1: Lidar09, Polar4b

SOG2: Radar13, Radio9b'

dt1 (t=30sec) Radio9b'

11H: \$1701



8K-2 SSP1: Spec03, Spec04, Lidar09, Polar07

SSP2: Radar13, Radio07

SOG-3 Radar17; Radio9b' (t=0s)

SOG2: Radar13, Radio9b'

Arch 11J: \$1508

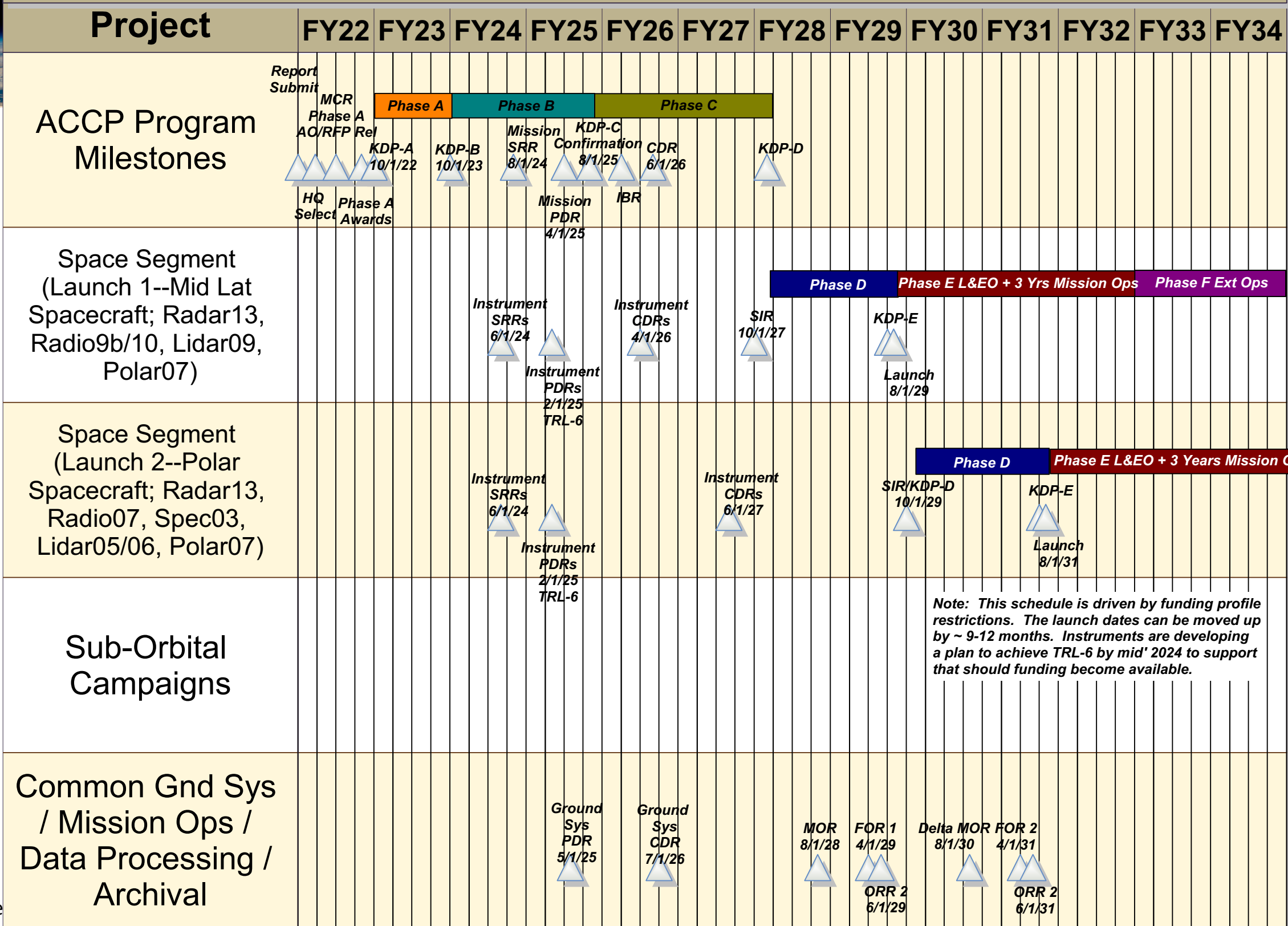
ACCP Notional Mission Schedule

ACCP Program High Level Schedule For Architecture 8G and 8K

Funding profile forces separate launches 2 yrs apart

We need to consider the Science Benefit of

1. the 1st Launch assets alone
2. the 1 year period of overlap
3. the 2nd Launch assets alone



No Diurnal Options

Architecture	Radar	Lidar	Diurnal	Delta t	Programmatic Pros	Programmatic Cons	Cost
11A	Polar 2029: KaD/WD	Polar 2029: BS Polar 2031: 2+1 HSRL	No	Polar 2029: Radar	Meets Funding Profile	No CNES No JAXA	\$1542
11F	Polar 2029: KaD/WD	Polar 2029: BS Polar 2031: 2+1 HSRL	No	Polar 2029: CNES COMODO Radiometers	Meets Funding Profile	No JAXA	\$1500
11I	Polar 2031: KaD/WD/KuD	Polar 2031: 2+1 HSRL	No	Polar 2031: CNES COMODO Radiometers		Does Not Meet Funding Profile Defer Launch to 2031 JAXA & CNES in Polar—not ideal	\$1528

Diurnal + Delta t (Compromise Vertical In One Plane)

Architecture	Radar (Freq; D denotes Doppler)	Lidar	Diurnal	Delta t	Programmatic Pros	Programmatic Cons	Cost
11B	GPM 2029: 2xKa Polar 2031: KaD/WD	GPM 2029: No Lidar Polar 2031: 2+1 HSRL	Yes	GPM 2029: Radar	Meets Cap Meets Funding Profile	No JAXA No CNES	\$1403/~\$1683 (add BS Lidar to GPM Orbit)
11C	GPM 2029: KaD/WD Polar 2031: Ka/W	GPM 2029: BS Polar 2031: 2+1 HSRL	Yes	GPM 2029: Radiometers	Meets Funding Profile	No JAXA No CNES	\$1644
11D	GPM 2029: KaD/WD Polar 2031: Ka/W	GPM 2029: BS Polar 2031: 2+1 HSRL	Yes	GPM 2029: CNES COMODO Radiometers	Meets Funding Profile	No JAXA	\$1668
11G	GPM 2029: KaD/WD Polar 2031: KaD/WD	GPM 2029: No Lidar Polar 2031: 2+1 HSRL	Yes	GPM 2029: CNES COMODO Radiometers	Meets Cap Meets Funding Profile	No JAXA	\$1424
11J	GPM 2029: KaD/WD/KuD Polar 2031: KaD/WD	GPM 2029: No Lidar Polar 2031: BS Lidar	Yes	GPM 2029: CNES COMODO Radiometers	Meets Cap Meets Funding Profile		\$1508

Architecture 8G / 8G-1 Science

Emphasizes Vertical & Diurnal / No Delta t

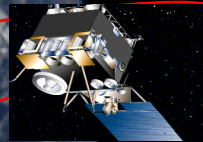
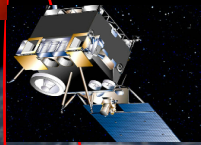
Arch 8G

Arch 8G-1

Arch 8G-2

SSP: Radar13,
Radio07, Spec03,
Lidar05, Polar07

KaD, WD Radar
118/183/240/310/380/660/880 Radiometer
LWIR/FIR Spectrometer
60/10 Angle Polarimeter
532/1064nm Lidar (532 HSRL)



8G SSG: Radar13, Radio9b/10,
Lidar09, Polar07



8G-1 SSG: Radar12, Radar17,
Radio9b/10, Lidar09, Polar07



KaD, WD Radar
183/325 Radiometer
670 Radiometer

8G-2 SSG: Radar 12, Radar17

60/10 Angle Polarimeter

Radio9b

532/1064nm Lidar (No HSRL)



1st Launch—SSG (2029)

Some Aerosol (BS/Polarimeter) & W & Ka
Doppler CCP Capability

2nd Launch—SSP (2031)

Full Aerosol (HSRL/Polarimeter) & W & Ka
Doppler CCP Capability

ACCP Tenet	SSP	8G SSG	8G-1 SSG
Addresses A and CCP	√	√	√
Diurnal Cycle	No	√	√
Polar Regions	√	No	No
Continuity	Lidar, W	Ka?	Ku
Vertical Velocity	Dop. W, Ka	Dop. W, Ka	Dop. Ka, Ku
ΔT	No	No	No
Direct extinction	√	No	No
Radar & lidar	√	√	√



Architecture 8G Mission Implementation Details & Potential De-Scopes

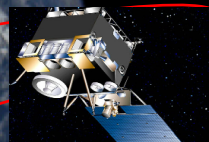
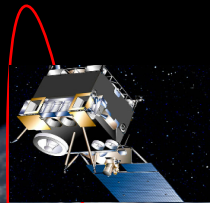
Arch 8G

Arch 8G-1

Arch 8G-2



SSP: Radar13,
Radio07, Spec03,
Lidar05, Polar07



8G SSG: Radar13, Radio9b/10,
Lidar09, Polar07



8G-1 SSG: Radar12, Radar17,
Radio9b/10, Lidar09, Polar07



8G-2 SSG: Radar 12, Radar17
Radio9b



1st Launch—SSG (2029)

1 International Contribution—Radio9b

Potential De-Scopes:

Radar 12 in lieu of Radar 13

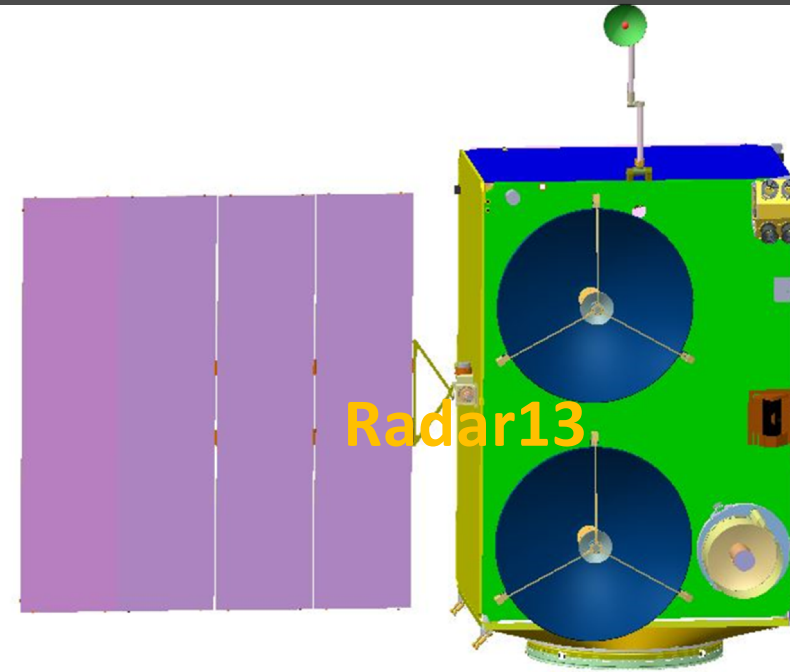
2nd Launch—SSP (2031)

1 International Contribution—Spec03

[Return](#)

8G SSG Instruments

Parameter	S-Radar13
Center Frequencies (GHz)	35.6 / 94.05 (Ka / W)
Doppler Measurement (Yes/No?)	Yes / Yes
Swath Width (Km)	12.5 / NA
Range Resolution (m)	250 / 500
Horizontal Resolution @ nadir (along-track x cross-track, km x km)	2.5 x 2.5 (Ka) 2.0 x 1.0 (W)
Horizontal Resolution @ swath edge (along-track x cross-track, km x km)	2.5 x 2.5 (Ka) NA (W)
Noise-Equivalent Reflectivity (dBZ) (Single-shot reflectivity at 0 dB SNR)	+17.0 / -16.0
Minimum Detectable Reflectivity (dBZ) (Multi-shot reflectivity at 0 dB SNR)	+7.0 / -26.0
Reflectivity Measurement Accuracy (dB)	1.5 / 1.5
Reflectivity Measurement Dynamic Range	80 / 80
Doppler Measurement Precision (m/s) @ specified SNR	0.5 m/s @ 6dB SNR (Ka) 0.2 m/s @ 6dB SNR (W)
Doppler Measurement Unambiguous Range (min – max m/s)	-8.4 to +8.4 (Ka) -3.4 to +3.4 (W)
Range profiling measurement window (km) above surface	25 / 25



407km
65 deg incl

Polar07
Radio10
Radio9b
Lidar09

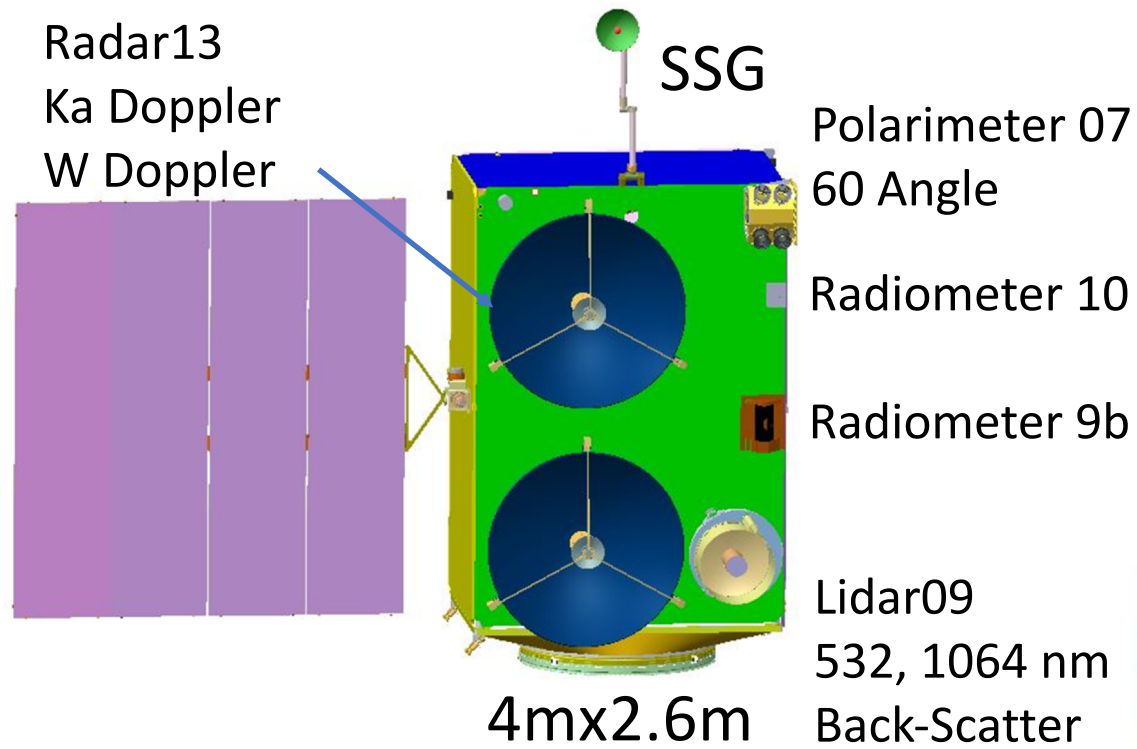
Parameter	S-Polar07
Wavelength range Visible	360*, 380*, 410*, 550*, 670*
Wavelength range VNIR-SWIR	870*, 940*, 1230*, 1380*, 1550*, 1650*
Radiometric	3%
DOLP	0.50%
Stokes Parameters	I, Q, U
Spatial	0.5 cross
Cross-track swath (km)	550
Cross-track swath (deg)	72
Along track viewing	±57° at spacecraft
Number of Angles	60 at 670nm, 10 at others
Calibration	on-board rad & pol

Parameter	S-Radio09 (b)	S-Radio10
Center Frequencies (GHz)	183.31 GHz channel: SSB FI band: DC-7GHz 325.5 GHz channel: SSB FI band: DC-10GHz	670
Polarization (HH, VV, HV, LCP, RCP, etc)	V or H Nadir, H or V Nadir	V, H
Integration Time(s) (ms)	2, 1	10
Bandwidth(s) (MHz)	7000, 10000	17000
NEDT (K)	1 to 2, 2 to 3	0.5
On board calibration targets	sky reflector + blackbody	cold space + black body
Swath Width (km)	770	2000

Parameter	S-Lidar09		
Number of beams	1		
Laser Pulse Repetition Rate (Hz)	4500		
Telescope Diameter (m)	0.6		
Receiver Field-Of-View (FOV; mrad)	125		
Wavelengths (nm)	11 (nm)	12 (nm)	13 (nm)
	1064	532	
Lidar Measurement Technique (i.e., Backscatter, HSRL, other)	Backscatter	Backscatter	
Depolarization (Yes/No)	Yes	Yes	
Depolarization Purity (e.g., > 100:1)	>100:1	>100:1	
Laser Energy Per Pulse (mJ)	3	2	
Optical Transmission of Receiver, Excluding Filters, and Field Stop (%)	60%	60%	
Number of Detector Channels	2	4	
Detector Quantum Efficiency (%)	2	60%	
Range Bin Length or Vertical Resolution (m)	30-60	30-60	
Footprint Diameter (m)	28-42	28-42	

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Architecture 8G SSG Fact Sheet



	Dry Mass/Fuel kg	Load Power W
SSG SC	1103/304	420
Payload		
Radar13	44.2	78
Lidar09	74.1	341.9
Polar07	61.1	59.8
Radio9b	45.5	48.1
Radio10	1.69	10.4
Total P/L	227	538

Launch Options: ACCP Single SC Dedicated
or Shared Ride with Another Program on
ESPA Grande & Falcon-9 to 65 deg Inclined Orbit

Total Obs Mass=1634kg; Pwr=958W



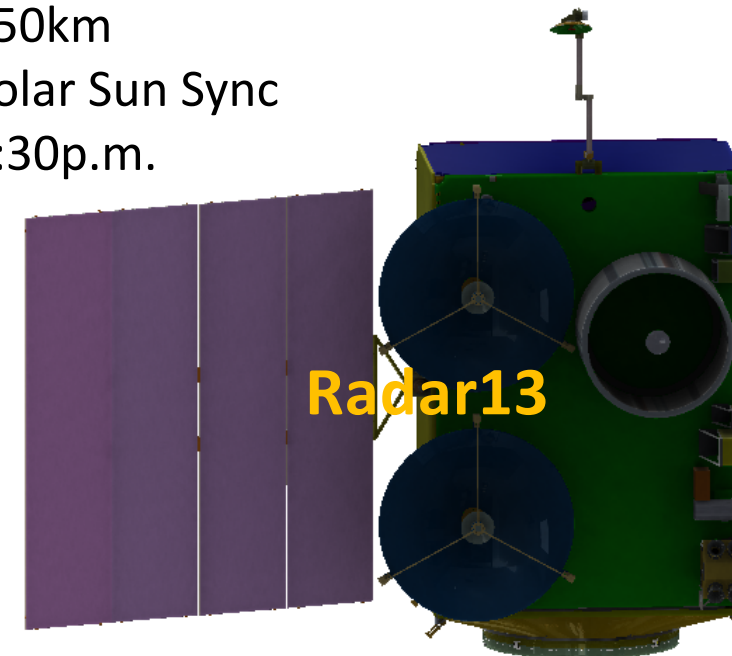
Parameter	S-Radar13
Center Frequencies (GHz)	35.6 / 94.05 (Ka / W)
Doppler Measurement (Yes/No?)	Yes / Yes
Swath Width (Km)	12.5 / NA
Range Resolution (m)	250 / 500
Horizontal Resolution @ nadir (along-track x cross-track, km x km)	2.5 x 2.5 (Ka) 2.0 x 1.0 (W)
Horizontal Resolution @ swath edge (along-track x cross-track, km x km)	2.5 x 2.5 (Ka) NA (W)
Noise-Equivalent Reflectivity (dBZ) (Single-shot reflectivity at 0 dB SNR)	+17.0 / -16.0
Minimum Detectable Reflectivity (dBZ) (Multi-shot reflectivity at 0 dB SNR)	+7.0 / -26.0
Reflectivity Measurement Accuracy (dB)	1.5 / 1.5
Reflectivity Measurement Dynamic Range	80 / 80
Doppler Measurement Precision (m/s) @ specified SNR	0.5 m/s @ 6dB SNR (Ka) 0.2 m/s @ 6dB SNR (W)
Doppler Measurement Unambiguous Range (min – max m/s)	-8.4 to +8.4 (Ka) -3.4 to +3.4 (W)
Range profiling measurement window (km) above surface	25 / 25

Parameter	S-Radio07
Center Frequencies (GHz)	118 +/- 1.1, +/- 1.5, +/- 2, +/- 5, 183 +/- 1, +/- 2, +/- 3, +/- 6, 240, 310, 380 +/-0.75, +/-1.5, +/-3, +/-6, 660, 880
Polarization (HH, VV, HV, LCP, RCP, etc)	H (all channels)
Integration Time(s) (ms)	10 (118 & 183 channels)
Bandwidth(s) (MHz)	400, 400, 10000, 10000, 400,
NEDT (K)	0.5 (118 & 183 channels)
On board calibration targets	blackbody, cold sky
Swath Width (km)	750

8G SSP Instruments

Parameter	S-Polar07
Wavelength range Visible	360*, 380*, 410*, 550*, 670*
Wavelength range VNIR-SWIR	870*,940*,1230*,1380*,1550*,1650*
Radiometric	3%
DOLP	0.50%
Stokes Parameters	I,Q,U
Spatial	0.5 cross
Cross-track swath (km)	550
Cross-track swath (deg)	72
Along track viewing	±57° at spacecraft
Number of Angles	60 at 670nm, 10 at others
Calibration	on-board rad & pol

450km
Polar Sun Sync
1:30p.m.

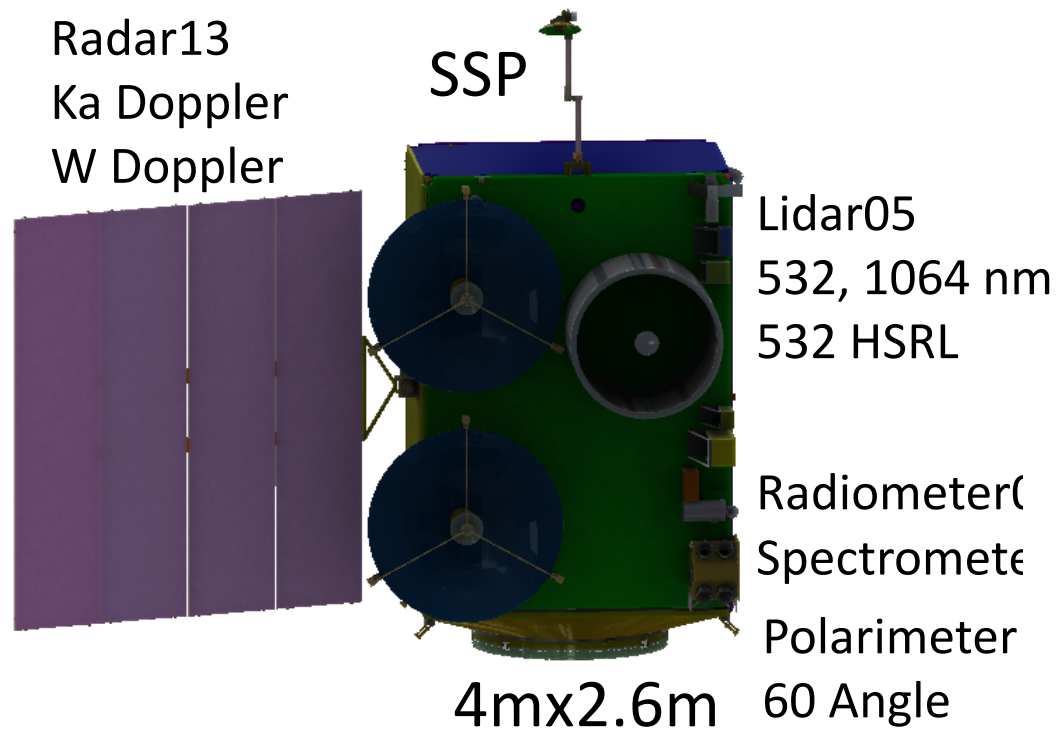


Radio07
Lidar05
Spec03
Polar07

Parameter	S-Lidar05		
Number of beams	1		
Laser Pulse Repetition Rate (Hz)	70		
Telescope Diameter (m)	1		
Receiver Field-Of-View (FOV; mrad)	TBD by the SALT. Currently		
Wavelengths (nm)	I1 (nm)	I2 (nm)	I3 (nm)
	1064	532	
Lidar Measurement Technique (i.e., Backscatter, HSRL, other)	Backscatter	HSRL	
Depolarization (Yes/No)	Yes	Yes	
Depolarization Purity (e.g., > 100:1)	250:1	250:1	
Laser Energy Per Pulse (mJ)	125	125	
Optical Transmission of Receiver, Excluding Filters, and Field Stop (%)	35%	37%	
Number of Detector Channels	2	3	
Detector Quantum Efficiency (%)	40%	25%	
Range Bin Length or Vertical Resolution (m)	60	1	
Footprint Diameter (m)	93	93	

Parameter	S-Spect03
Spectral Regions (e.g., UV, VIS, SWIR)	LWIR, FIR
Wavelengths of channel(s) (µm)	8.7, 11, 13, 17.75, 19.5, 21.5, 25, 40
Channel bandwidths for radiometry (µm)	1.6, 2, 2, 1.5, 2, 2, 5, 20
Cross-track swath width seen in common at all view angles (km)	400
Instantaneous cross-track field of view (deg)	0.44 deg (single pixel, iFOV), 35.2 deg FOV
Footprint per pixel at nadir, center of field (cross-track x along-track) (i.e., best case)	5km x 5km
Footprint per pixel at most oblique view angle, edge of field (cross-track x along- track) (km)	~7.5 km x 5 km
Along-track spatial coverage (continuous, intermittent, targeted) (km)	100 km (along-track, continuous)
Radiometric calibration technique (e.g., on- board, vicarious) page	warm black body on- board (310 K), deep space view needed

Architecture 8G SSP Fact Sheet



	Dry Mass/Fuel	Load Power
SSP SC	1125/262	402
Payload		
Radar13	44.2	78
Lidar05	435.5	643.5
Polar07	61.1	59.8
Radio07	3.9	15.6
Spect03	22.8	43.9
Total P/L	568	841

*Launch Options: ACCP Single SC Dedicated
 or Shared Ride with Another Program on
 ESPA Grande & Falcon-9 to Polar Sun Sync Orbit*

Total Obs Mass=1955kg; Pwr=1243W



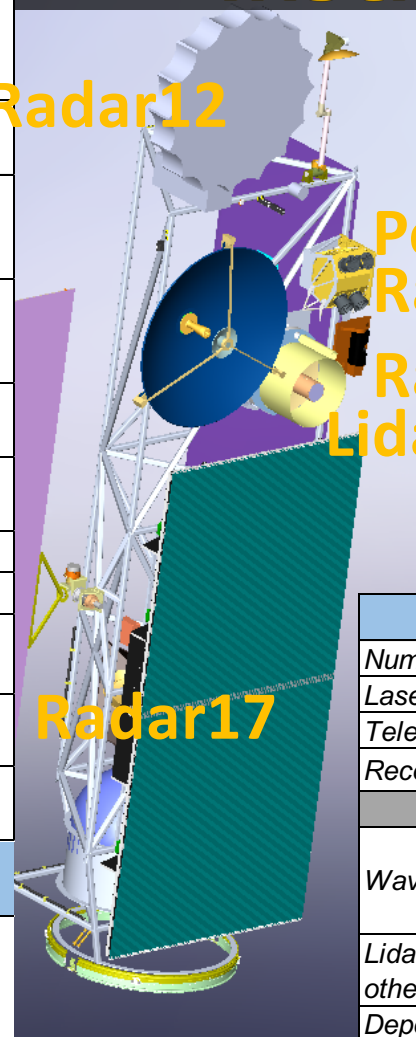
8G-1 SSG Instruments

Parameter	S-Radar12	S-Radar17
Center Frequencies (GHz)	35.6 / 94.05 (Ka / W)	13.6 (Ku)
Doppler Measurement (Yes/No?)	Yes / No	Yes
Swath Width (Km)	12.5 / NA	10 (Doppler) 76 (high lat & polar, non-Doppler) 349 (low & mid lat, non-Doppler)
Range Resolution (m)	250 / 500	500
Horizontal Resolution @ nadir (along-track x cross-track, km x km)	2.5 x 2.5 (Ka) 2.0 x 1.0 (W)	2.5 x 5.0 (Doppler) 5.0 x 5.0 (non-Doppler)
Horizontal Resolution @ swath edge (along-track x cross-track, km x km)	2.5 x 2.5 (Ka) NA (W)	2.5 x 5.0 (Doppler) 5.0 x 5.1 (high lat & polar, non-Doppler) 5.0 x 6.0 (low & mid lat, non-Doppler)
Noise-Equivalent Reflectivity (dBZ) (Single-shot reflectivity at 0 dB SNR)	+17.0 / -16.0	+8.1 (nadir) +0.2/+1.7 (polar/low & mid lat)
Minimum Detectable Reflectivity (dBZ) (Multi-shot reflectivity at 0 dB SNR)	+7.0 / -26.0	-2.6 (nadir) -8.9/-7.2 (polar/low & mid lat)
Reflectivity Measurement Accuracy (dB)	1.5 / 1.5	1
Reflectivity Measurement Dynamic Range	80 / 80	80
Doppler Measurement Precision (m/s) @ specified SNR	0.5 m/s @ 6dB SNR (Ka) NA (W)	1.0 (high lat & polar, 10dB SNR) 1.9 (low & mid lat, 10dB SNR)
Doppler Measurement Unambiguous Range (min – max m/s)	-8.4 to +8.4 (Ka) NA (W)	-52 to +52
Range profiling measurement window (km) above surface	25 / 25	10 (high lat & polar, Doppler & non-Doppler)

Radar12

Polar07
Radio10
Radio9b
Lidar09

Radar17



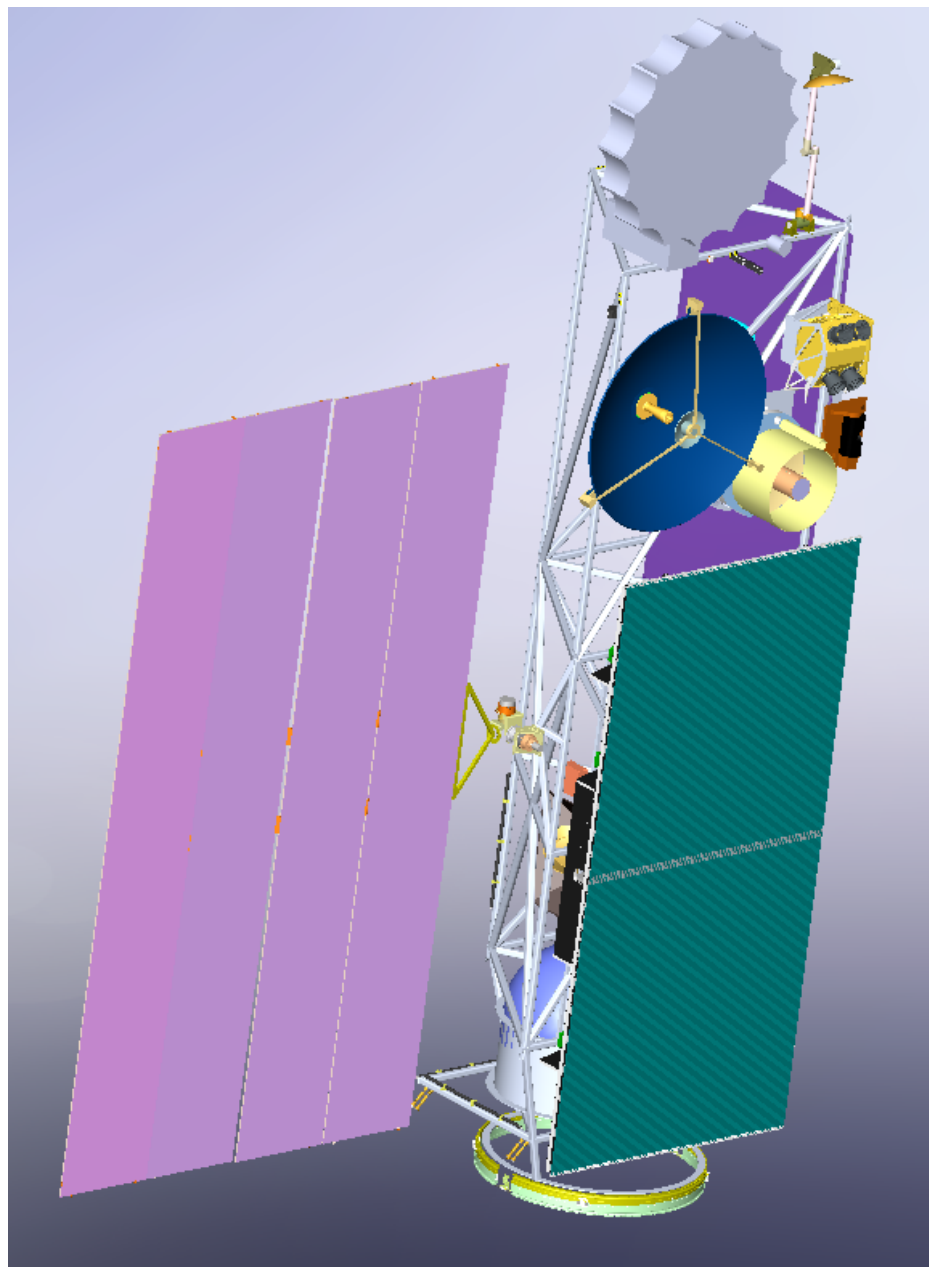
Parameter	S-Polar07
Wavelength range Visible	360*, 380*, 410*, 550*, 670*
Wavelength range VNIR-SWIR	870*, 940*, 1230*, 1380*, 1550*, 1650*
Radiometric DOLP	3% 0.50%
Stokes Parameters	I, Q, U
Spatial	0.5 cross
Cross-track swath (km)	550
Cross-track swath (deg)	72
Along track viewing	±57° at spacecraft
Number of Angles	60 at 670nm, 10 at others
Calibration	on-board rad & pol

Parameter	S-Lidar09		
Number of beams	1		
Laser Pulse Repetition Rate (Hz)	4500		
Telescope Diameter (m)	0.6		
Receiver Field-Of-View (FOV; mrad)	125		
Wavelengths (nm)	I1 (nm)	I2 (nm)	I3 (nm)
	1064	532	
Lidar Measurement Technique (i.e., Backscatter, HSRL, other)	Backscatter	Backscatter	
Depolarization (Yes/No)	Yes	Yes	
Depolarization Purity (e.g., > 100:1)	>100:1	>100:1	
Laser Energy Per Pulse (mJ)	3	2	
Optical Transmission of Receiver, Excluding Filters, and Field Stop (%)	60%	60%	
Number of Detector Channels	2	4	
Detector Quantum Efficiency (%)	2	60%	
Range Bin Length or Vertical Resolution (m)	30-60	30-60	
Footprint Diameter (m)	28-42	28-42	

Parameter	S-Radio09 (b)	S-Radio10
Center Frequencies (GHz)	183.31 GHz channel: SSB FI band: DC-7GHz 325.5 GHz channel: SSB FI band: DC-10GHz	670
Polarization (HH, VV, HV, LCP, RCP, etc)	V or H Nadir, H or V Nadir	V, H
Integration Time(s) (ms)	2, 1	10
Bandwidth(s) (MHz)	7000, 10000	17000
NEDT (K)	1 to 2, 2 to 3	0.5
On board calibration targets	sky reflector + blackbody	cold space + black body
Swath Width (km)	770	2000

407km
65 deg incl

Architecture 8G-1 SSG Fact Sheet



Total Obs Mass=1873kg dry 2313kg wet; Pwr=1803W

	Dry Mass/Fuel	Load Power
SSP SC	1085/440	484
Payload		
Radar12	28.6	78
Lidar09	74.1	341.9
Polar07	61.1	61.1
Radio09b /10	47.2	58.5
Radar17	577.2	780
Total P/L	788.2	1319

Payload: (Radar17&Radio9b contributed)

Note: 8G-2 SSG (option without Lidar09 and Polar07 has not been studied in detail)

Launch Options: ACCP Single SC Dedicated H-3 Contributed Launch

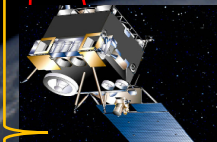


Architecture 8K/8K-1/8K-2 Science

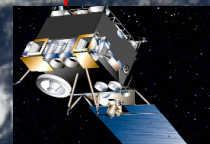
Emphasizes Vertical & Diurnal / No Delta t

Arch 8K
Arch 8K-1
Arch 8K-2

8K SSP1: **Spec03,**
Lidar05, Polar07

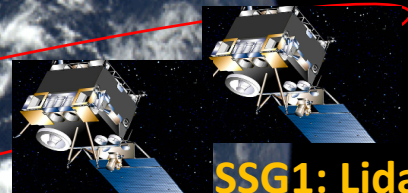


8K-1 SSP1:
Spec03, Lidar06,
Polar07



SSP2: Radar13,
Radio07

8K-2 SSP1:
Spec03, Lidar09,
Polar07



SSG1: Lidar09, Polar04b

SSG2: Radar12, Radio7

KaD, WD Radar
 118/183/240/310/380/660/880 Radiometer
 LWIR/FIR Spectrometer
 60/10 Angle Polarimeter
 8K: 532/1064nm Lidar (532 HSRL)
 8K-1: 355/532/1064nm Lidar (355, 532 HSRL)
 8K-2: 532/1064nm Lidar (No HSRL)

KaD, W Radar
 118/183/240/310/380/660/
 880 Radiometer
 60/10 Angle Polarimeter
 532/1064nm Lidar (No HSRL)

1st Launch—SSG1 & SSG2 (2029)
Some Aerosol (BS/Polarimeter) & W No
Doppler/Ka Doppler CCP Capability

2nd Launch—SSP (2031)
Full Aerosol (HSRL/Polarimeter) & W & Ka
Doppler CCP Capability

ACCP Tenet	8K SSP	8K-1 SSP	8K-2 SSP	8K SSG
Addresses A and CCP	√	√	√	√
Diurnal Cycle	No	No	No	√
Polar Regions	√	√	√	No
Continuity	Lidar, W	Lidar, W	Lidar, W	Ka?
Vertical Velocity	Dop. W, Ka	Dop. W, Ka	Dop. W, Ka	Dop. Ka
ΔT	No	No	No	No
Direct extinction	√	√	No	No
Radar & lidar	√	√	√	√



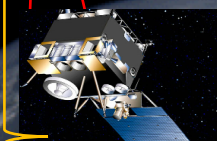
Architecture 8K/8K-1/8K-2 Mission Implementation Details & Potential De-Scopes

Arch 8K

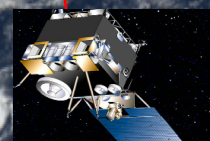
Arch 8K-1

Arch 8K-2

8K SSP1: **Spec03**,
Lidar05, Polar07

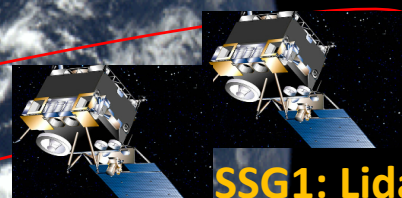


8K-1 SSP1:
Spec03, Lidar06,
Polar07



SSP2: Radar13,
Radio07

8K-2 SSP1:
Spec03, Lidar09,
Polar07



SSG1: Lidar09, Polar04b

SSG2: Radar12, Radio7

KaD, WD Radar

118/183/240/310/380/660/880 Radiometer

LWIR/FIR Spectrometer

60/10 Angle Polarimeter

8K: 532/1064nm Lidar (532 HSRL)

8K-1: 355/532/1064nm Lidar (355, 532 HSRL)

8K-2: 532/1064nm Lidar (No HSRL)

KaD, W Radar

118/183/240/310/380/660/
880 Radiometer

60/10 Angle Polarimeter

532/1064nm Lidar (No HSRL)

1st Launch—SSG (2029)

0 International Contribution

Potential Add: JAXA Case 2

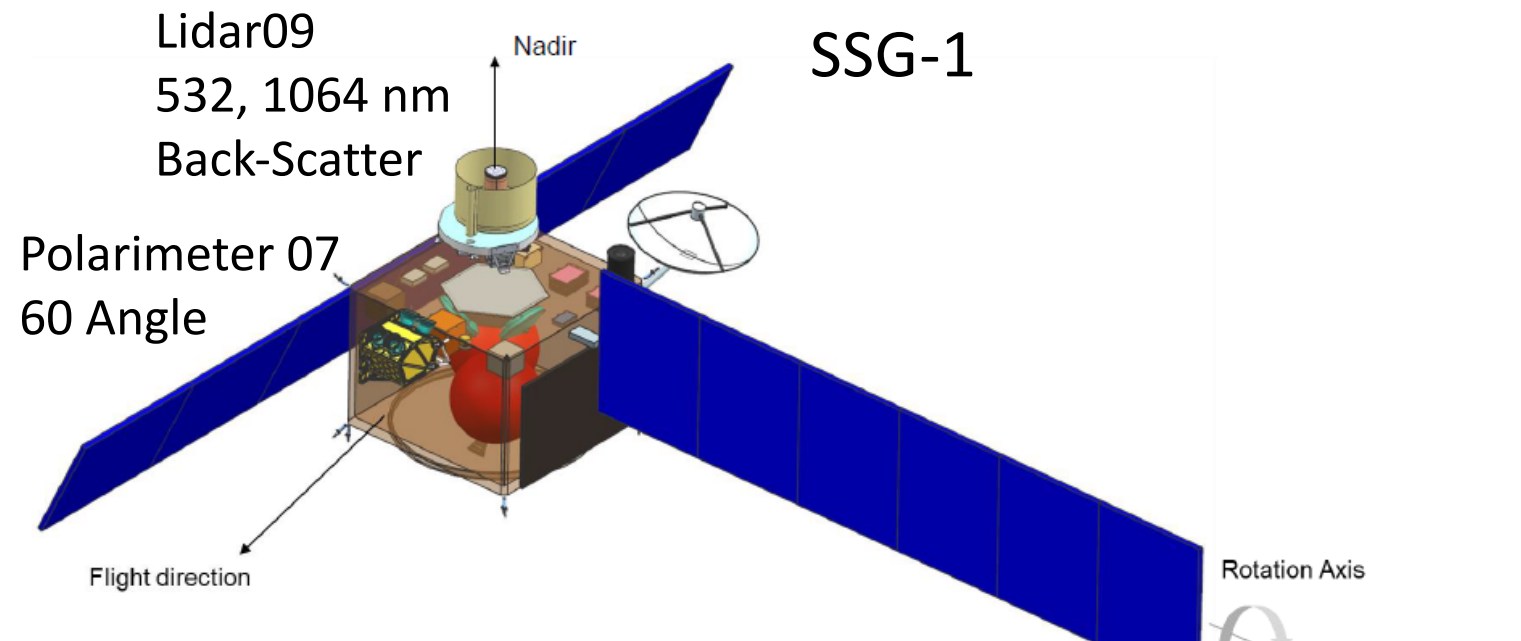
2nd Launch—SSP (2031)

1 International Contribution—Spec03

Potential Add: Spec for Radiation

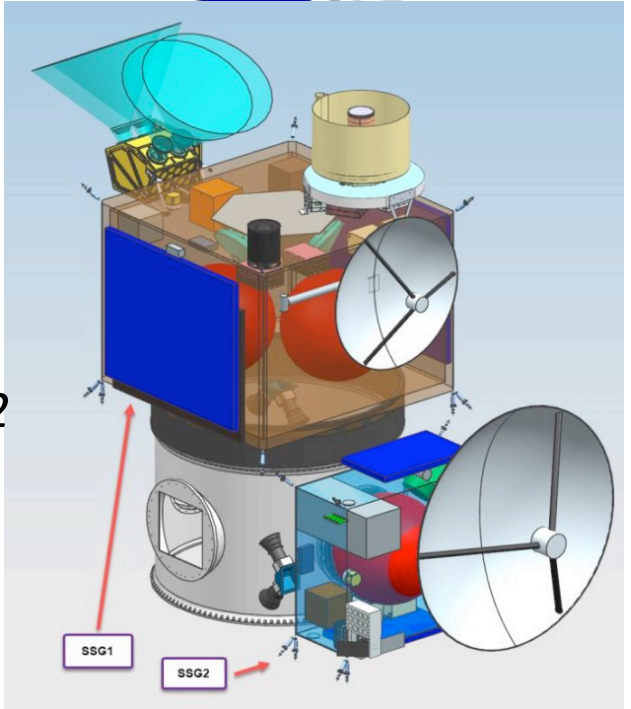
[Return](#)

Architecture 8K SSG-1 Fact Sheet



SSG-1

	<i>Dry Mass/Fuel</i>	<i>Load Power</i>
SSG-1 SC	689/199	326
Payload		
<i>Lidar09</i>	74.1	341.9
<i>Polar04b</i>	27.3	59.8
Total P/L	101.4	401.7



Total Obs Mass=989.4kg; Pwr=728W

Launch Options: ACCP SSG-1 and SSG-2 Share Ride on ESPA Grande in Falcon 9 to 65 deg Inclined Orbit

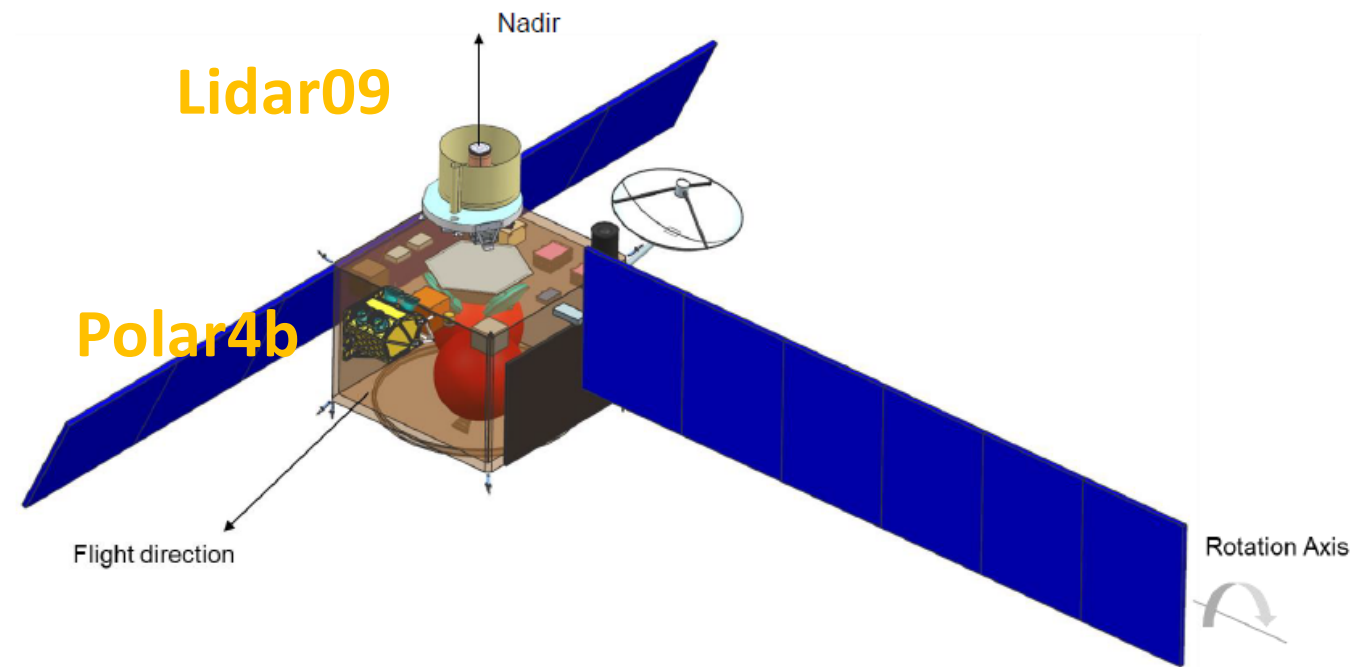


8K SSG-1 Instruments

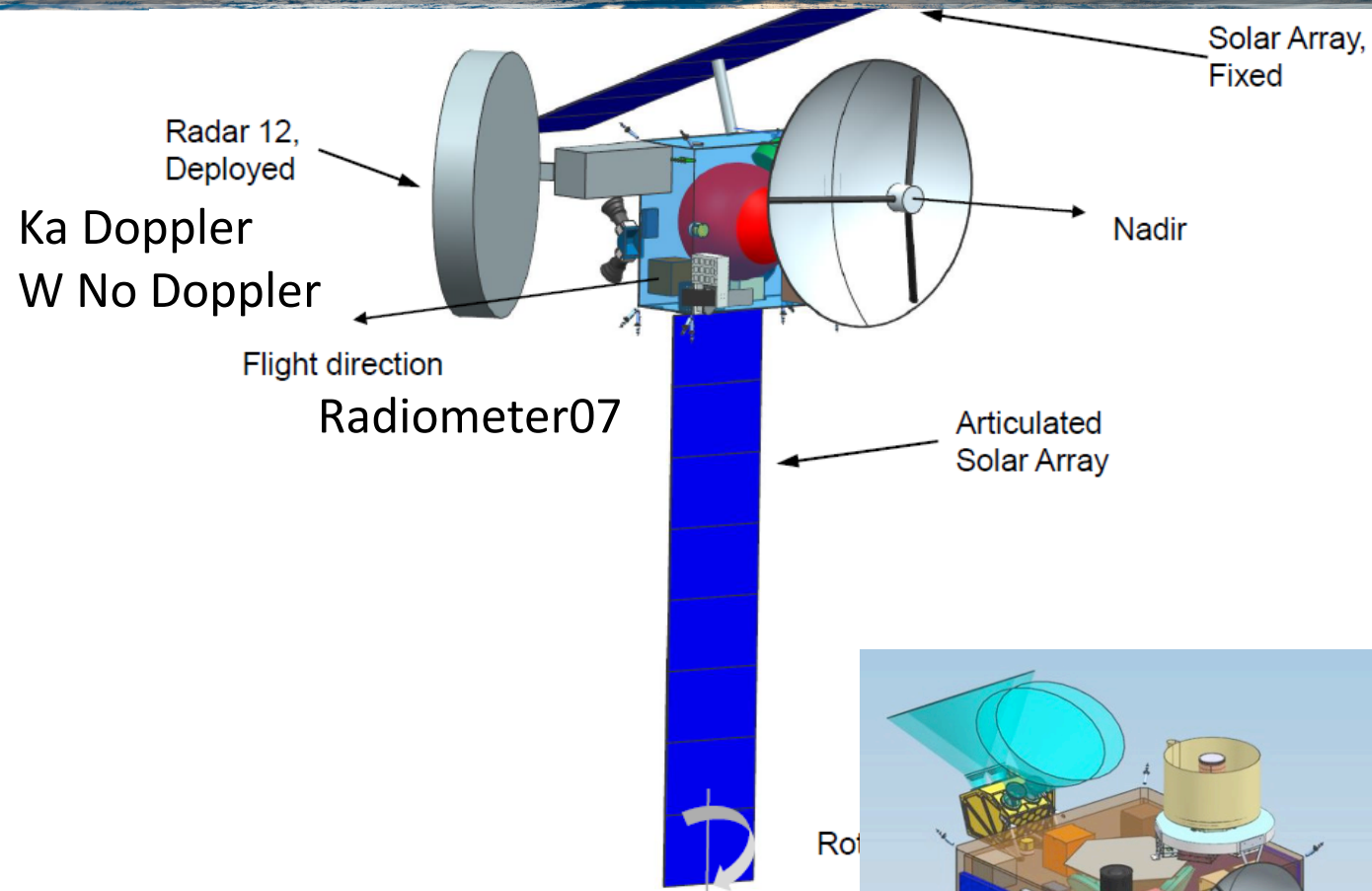
Parameter	S-Lidar09		
Number of beams	1		
Laser Pulse Repetition Rate (Hz)	4500		
Telescope Diameter (m)	0.6		
Receiver Field-Of-View (FOV; mrad)	125		
Wavelengths (nm)	I1 (nm)	I2 (nm)	I3 (nm)
	1064	532	
Lidar Measurement Technique (i.e., Backscatter, HSRL, other)	Backscatter	Backscatter	
Depolarization (Yes/No)	Yes	Yes	
Depolarization Purity (e.g., > 100:1)	>100:1	>100:1	
Laser Energy Per Pulse (mJ)	3	2	
Optical Transmission of Receiver, Excluding Filters, and Field Stop (%)	60%	60%	
Number of Detector Channels	2	4	
Detector Quantum Efficiency (%)	2	60%	
Range Bin Length or Vertical Resolution (m)	30-60	30-60	
Footprint Diameter (m)	28-42	28-42	

Parameter	S-Polar04 (b)
Wavelength range Visible	360*, 380*, 410*, 550*, 670*
Wavelength range VNIR-SWIR	870*, 1230*, 1380*, 1550*, 1650*
Radiometric	3%
DOLP	0.50%
Stokes Parameters	I, Q, U
Spatial	1
Cross-track swath (km)	1130
Cross-track swath (deg)	144
Along track viewing	±57° at spacecraft
Number of Angles	60 at 670nm, 10 at
Calibration	on-board rad & pol

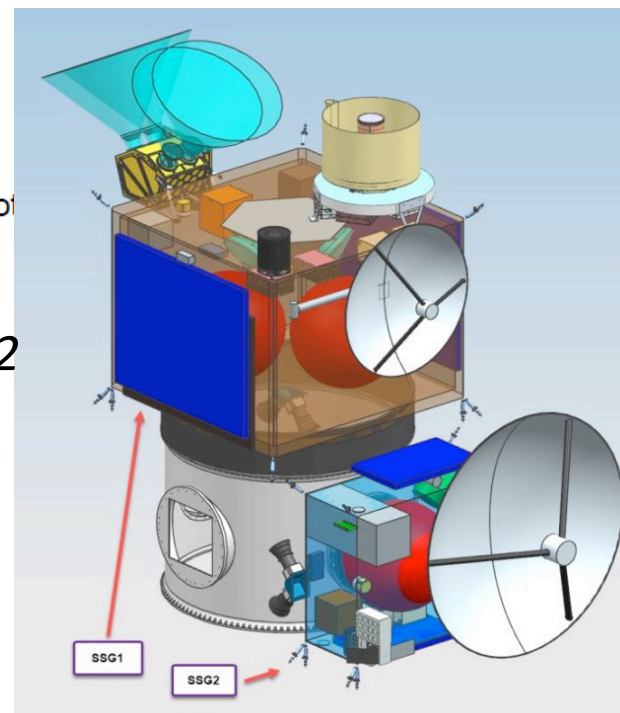
407km
65 deg incl



Architecture 8K SSG-2 Fact Sheet



	Dry Mass/Fuel	Load Power
SSG-2 SC	394/122	467
Payload		
Radar12	28.6	78
Radio07	3.9	15.6
Total P/L	32.5	93.6



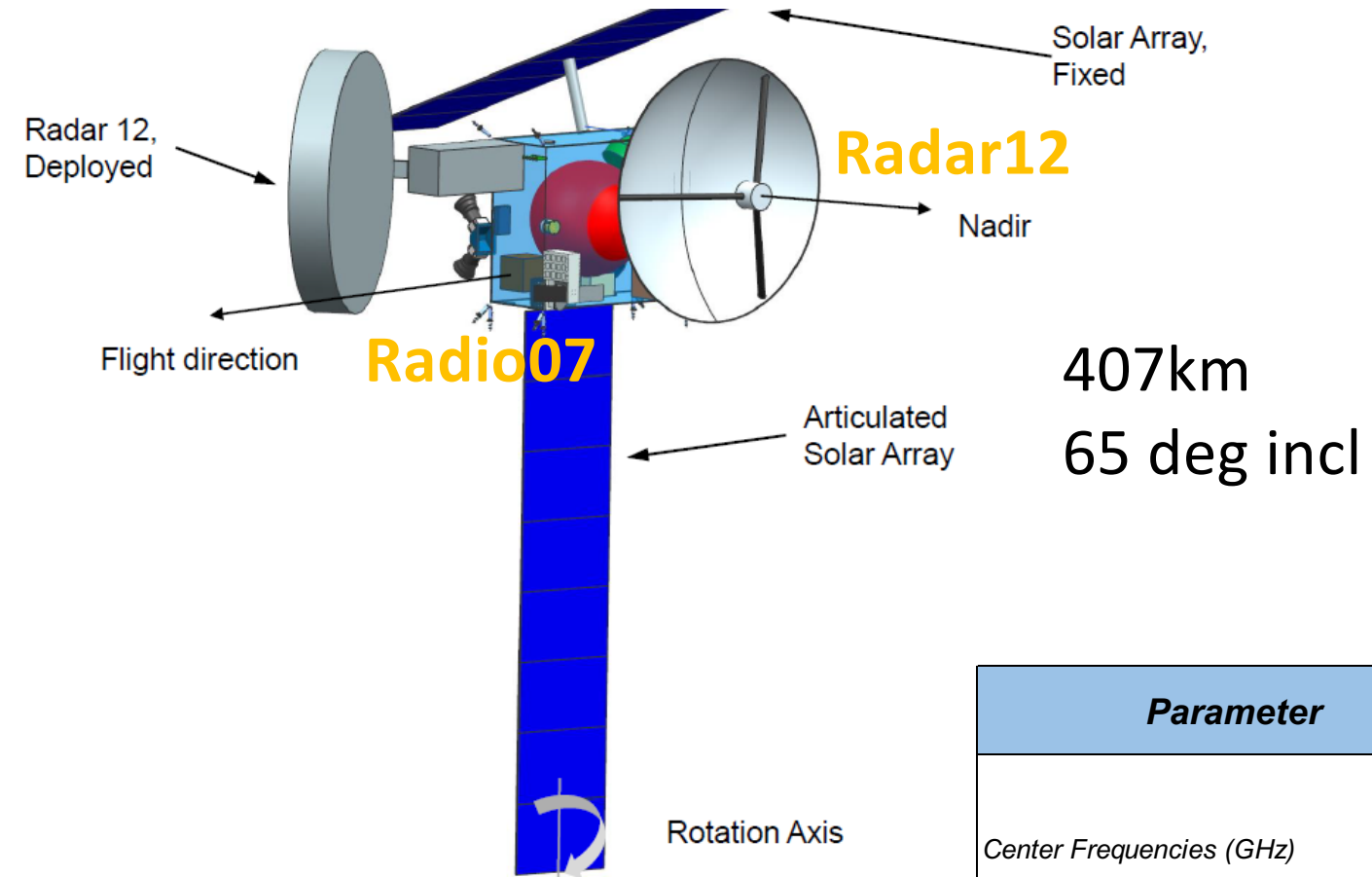
Total Obs Mass=548.5kg; Pwr=560.6W

Launch Options: ACCP SSG-1 and SSG-2
Share Ride on ESPA Grande in
Falcon 9 to 65 deg Inclined Orbit



8K SSG-2 Instruments

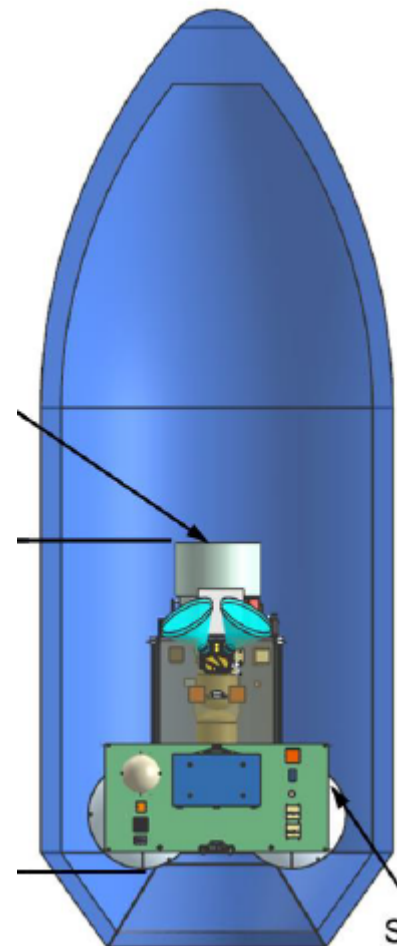
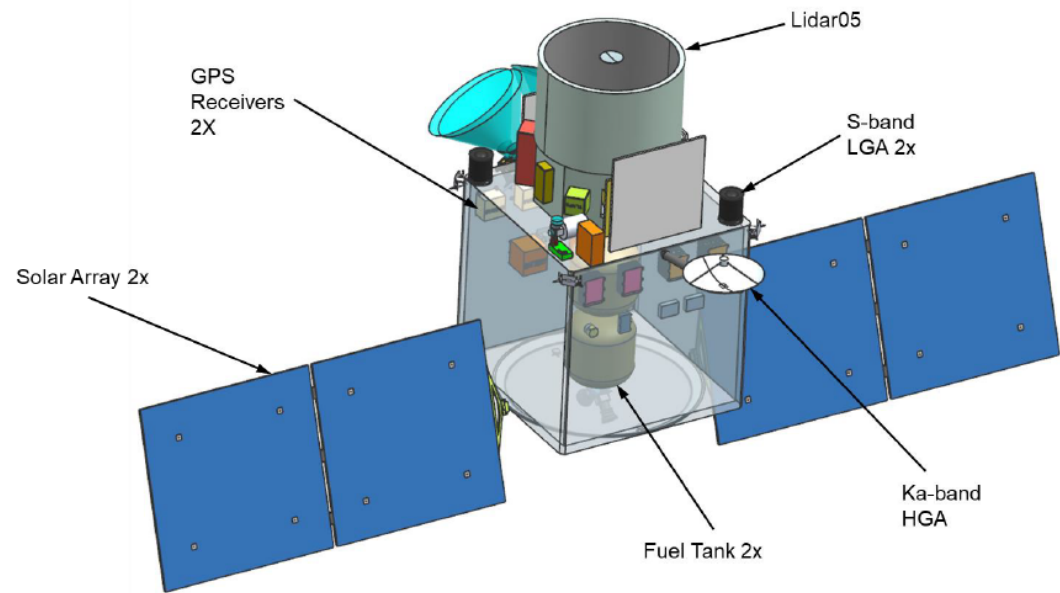
Parameter	S-Radar12
Center Frequencies (GHz)	35.6 / 94.05 (Ka / W)
Doppler Measurement (Yes/No?)	Yes / No
Swath Width (Km)	12.5 / NA
Range Resolution (m)	250 / 500
Horizontal Resolution @ nadir (along-track x cross-track, km x km)	2.5 x 2.5 (Ka) 2.0 x 1.0 (W)
Horizontal Resolution @ swath edge (along-track x cross-track, km x km)	2.5 x 2.5 (Ka) NA (W)
Noise-Equivalent Reflectivity (dBZ) (Single-shot reflectivity at 0 dB SNR)	+17.0 / -16.0
Minimum Detectable Reflectivity (dBZ) (Multi-shot reflectivity at 0 dB SNR)	+7.0 / -26.0
Reflectivity Measurement Accuracy (dB)	1.5 / 1.5
Reflectivity Measurement Dynamic Range	80 / 80
Doppler Measurement Precision (m/s) @ specified SNR	0.5 m/s @ 6dB SNR (Ka) NA (W)
Doppler Measurement Unambiguous Range (min – max m/s)	-8.4 to +8.4 (Ka) NA (W)
Range profiling measurement window (km) above surface	25 / 25



Parameter	S-Radio07
Center Frequencies (GHz)	118 +/- 1.1, +/- 1.5, +/- 2, +/- 5, 183 +/- 1, +/- 2, +/- 3, +/- 6, 240, 310, 380 +/-0.75, +/-1.5, +/-3, +/-6, 660, 880
Polarization (HH, VV, HV, LCP, RCP, etc)	H (all channels)
Integration Time(s) (ms)	10 (118 & 183 channels)
Bandwidth(s) (MHz)	400, 400, 10000, 10000, 400,
NEDT (K)	0.5 (118 & 183 channels)
On board calibration targets	blackbody, cold sky
Swath Width (km)	750

Architecture 8K SSP-1 Fact Sheet

Deployed



	Dry Mass/Fuel kg	Load Power W
SSG-1 SC	1142/184	437
Payload		
Lidar05	435.3	643.5
Polar07	61.1	59.8
Spec03	22.8	43.9
Total P/L	519.2	747.2

Total Obs Mass=1845.2kg; Pwr=1184.8W

Launch Options: ACCP SSP1 & SSP2
Share Ride on ESPA Grande in
Falcon 9 to 65 deg Polar Orbit



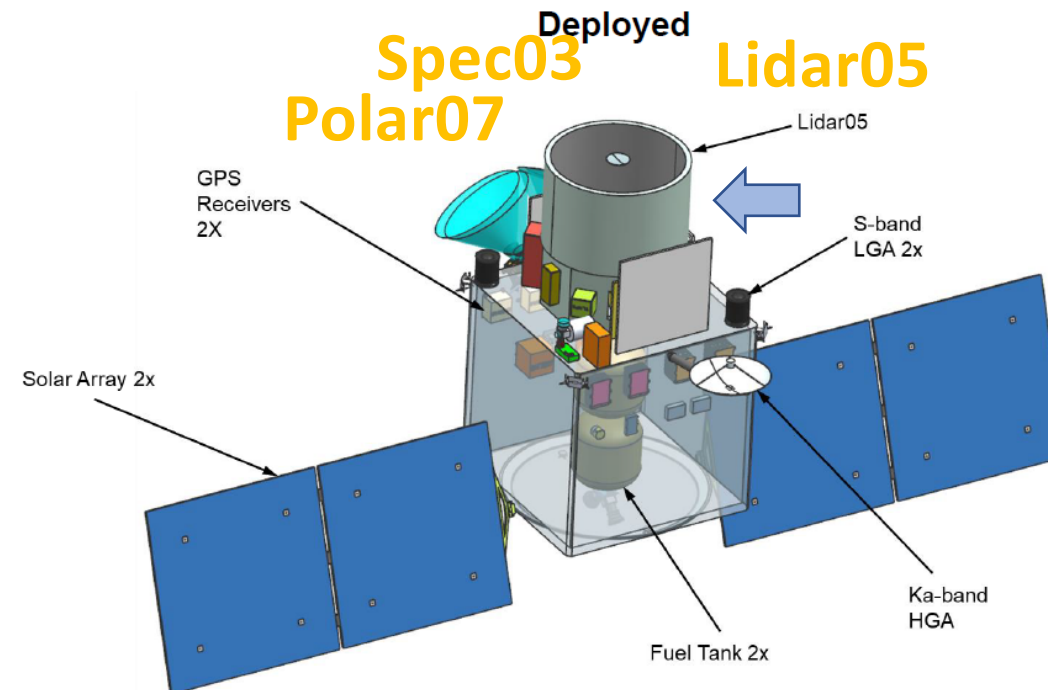
8K SSP-1 Instruments

Parameter	S-Spect03
Spectral Regions (e.g., UV, VIS, SWIR)	LWIR, FIR
Wavelengths of channel(s) (μm)	8.7, 11, 13, 17.75, 19.5, 21.5, 25, 40
Channel bandwidths for radiometry (μm)	1.6, 2, 2, 1.5, 2, 2, 5, 20
Cross-track swath width seen in common at all view angles (km)	400
Instantaneous cross-track field of view (deg)	0.44 deg (single pixel, iFOV), 35.2 deg FOV
Footprint per pixel at nadir, center of field (cross-track x along-track) (i.e., best case)	5km x 5km
Footprint per pixel at most oblique view angle, edge of field (cross-track x along-track)	~7.5 km x 5 km
Along-track spatial coverage (continuous, intermittent, targeted) (km)	100 km (along-track, intermittent, targeted)
Radiometric calibration technique (e.g., on-board, vicarious)	warm black body on-board (310 K), deep space view needed

Parameter	S-Lidar05		
Number of beams	1		
Laser Pulse Repetition Rate (Hz)	70		
Telescope Diameter (m)	1		
Receiver Field-Of-View (FOV; mrad)	TBD by the SALT. Currently		
Wavelengths (nm)	I1 (nm)	I2 (nm)	I3 (nm)
	1064	532	
Lidar Measurement Technique (i.e., Backscatter, HSRL, other)	Backscatter	HSRL	
Depolarization (Yes/No)	Yes	Yes	
Depolarization Purity (e.g., > 100:1)	250:1	250:1	
Laser Energy Per Pulse (mJ)	125	125	
Optical Transmission of Receiver, Excluding Filters, and Field Stop (%)	35%	37%	
Number of Detector Channels	2	3	
Detector Quantum Efficiency (%)	40%	25%	
Range Bin Length or Vertical Resolution (m)	60	1	
Footprint Diameter (m)	93	93	

450km
Polar Sun Sync
1:30p.m.

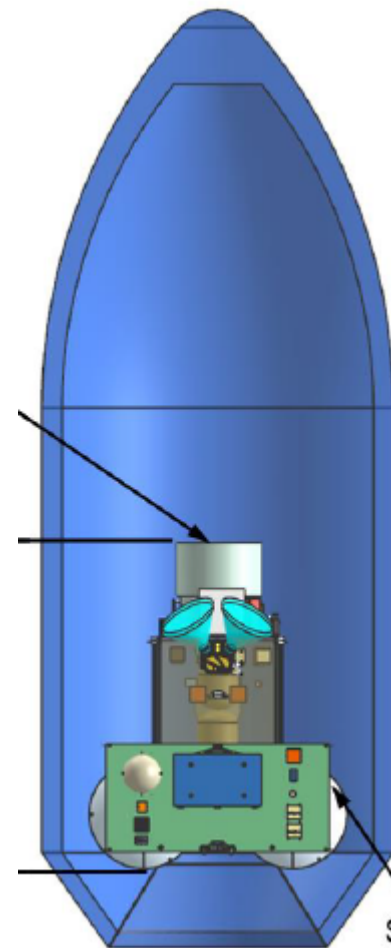
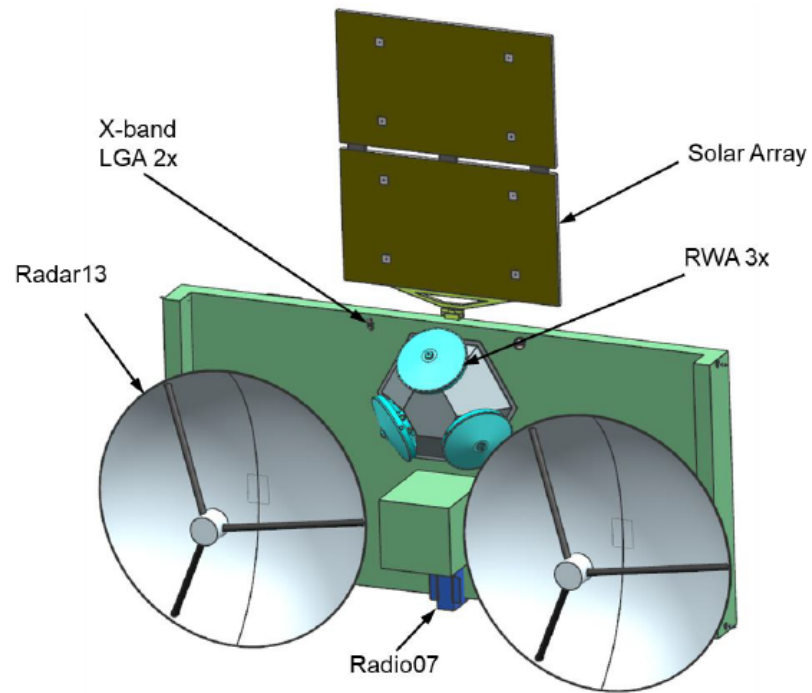
Parameter	S-Polar07
Wavelength range Visible	360*, 380*, 410*, 550*, 670*
Wavelength range VNIR-SWIR	870*, 940*, 1230*, 1380*, 1550*, 1650*
Radiometric	3%
DOLP	0.50%
Stokes Parameters	I, Q, U
Spatial	0.5 cross
Cross-track swath (km)	550
Cross-track swath (deg)	72
Along track viewing	±57° at spacecraft
Number of Angles	60 at 670nm, 10 at others
Calibration	on-board rad & pol



Need picture that better shows Instrument layout

Architecture 8K SSP-2 Fact Sheet

Deployed



	Dry Mass/Fuel	Load Power
SSP-2 SC	256/51	157
Payload		
Radar13	44.2	78
Radio07	3.9	15.6
Total P/L	48.1	93.6

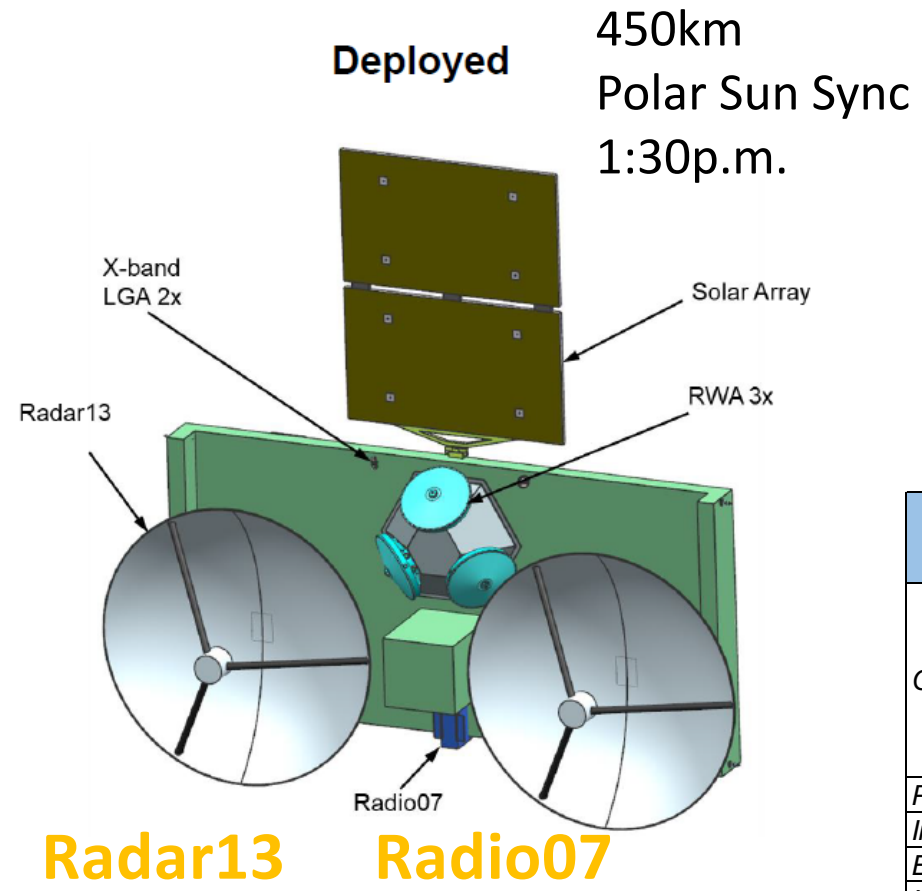
Total Obs Mass=355.1kg; Pwr=250.6W

Launch Options: ACCP SSP-1 and SSP-2
Share Ride on ESPA Grande in
Falcon 9 to 65 deg Inclined Orbit



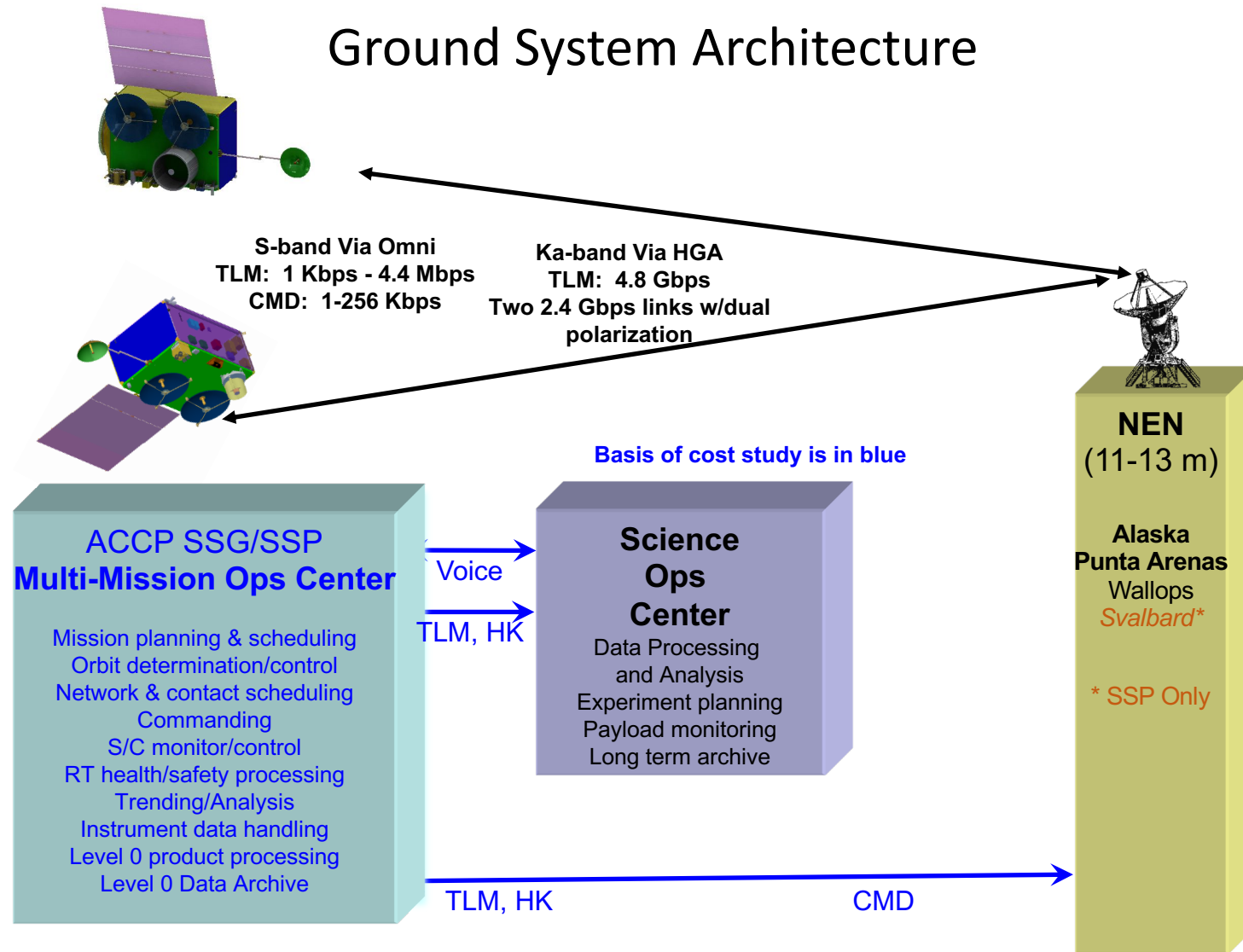
8K SSP-2 Instruments

Parameter	S-Radar13
Center Frequencies (GHz)	35.6 / 94.05 (Ka / W)
Doppler Measurement (Yes/No?)	Yes / Yes
Swath Width (Km)	12.5 / NA
Range Resolution (m)	250 / 500
Horizontal Resolution @ nadir (along-track x cross-track, km x km)	2.5 x 2.5 (Ka) 2.0 x 1.0 (W)
Horizontal Resolution @ swath edge (along-track x cross-track, km x km)	2.5 x 2.5 (Ka) NA (W)
Noise-Equivalent Reflectivity (dBZ) (Single-shot reflectivity at 0 dB SNR)	+17.0 / -16.0
Minimum Detectable Reflectivity (dBZ) (Multi-shot reflectivity at 0 dB SNR)	+7.0 / -26.0
Reflectivity Measurement Accuracy (dB)	1.5 / 1.5
Reflectivity Measurement Dynamic Range	80 / 80
Doppler Measurement Precision (m/s) @ specified SNR	0.5 m/s @ 6dB SNR (Ka) 0.2 m/s @ 6dB SNR (W)
Doppler Measurement Unambiguous Range (min – max m/s)	-8.4 to +8.4 (Ka) -3.4 to +3.4 (W)
Range profiling measurement window (km) above surface	25 / 25



Parameter	S-Radio07
Center Frequencies (GHz)	118 +/- 1.1, +/- 1.5, +/- 2, +/- 5, 183 +/- 1, +/- 2, +/- 3, +/- 6, 240, 310, 380 +/-0.75, +/-1.5, +/-3, +/-6, 660, 880
Polarization (HH, VV, HV, LCP, RCP, etc)	H (all channels)
Integration Time(s) (ms)	10 (118 & 183 channels)
Bandwidth(s) (MHz)	400, 400, 10000, 10000, 400,
NEDT (K)	0.5 (118 & 183 channels)
On board calibration targets	blackbody, cold sky
Swath Width (km)	750

Ground System Development & Mission Operations



Arch 8G, 8G-1 and 8K Traditional NEN Ground System

All Architectures assume Common Mission & Science Operations Centers

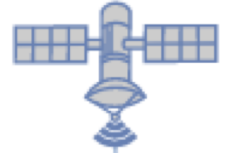
All Architectures have \$84M Wedge For Ground System Dev/Ops (Architecture 8G priced at \$75M)

This does not include >L0 product generation (Algorithm Dev, Data Assimilation) or Modeling

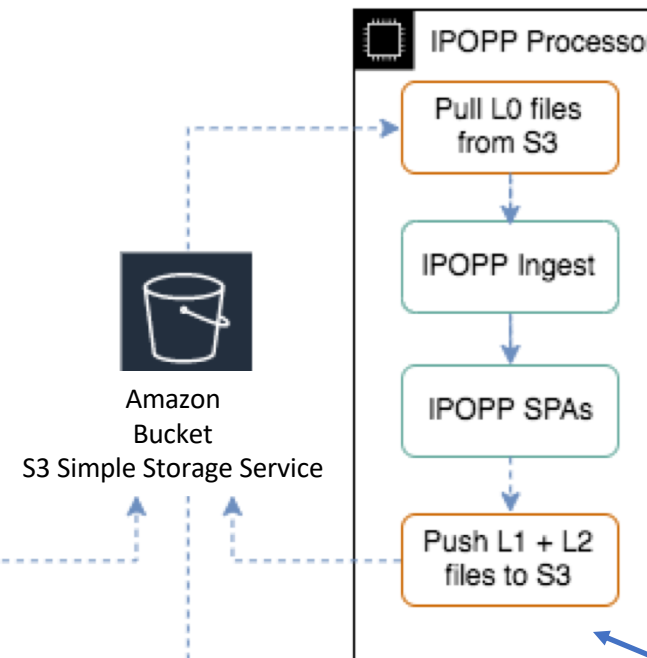
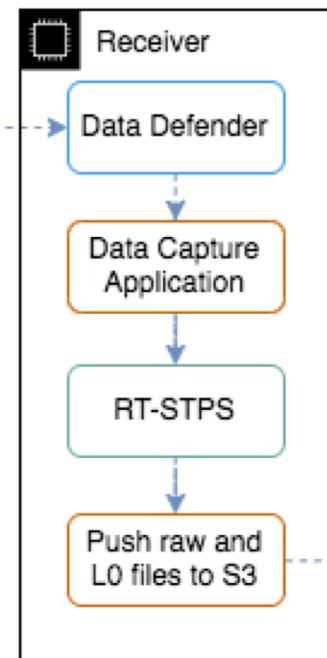
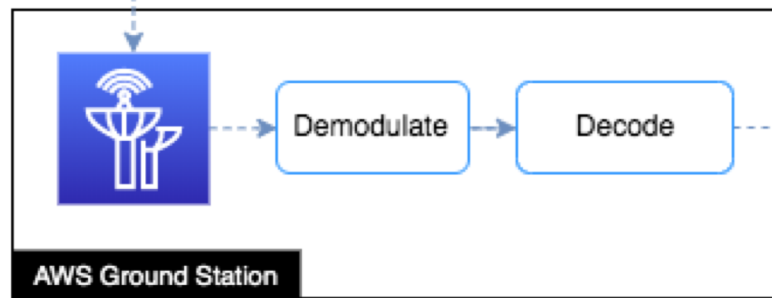
Unclear if this can be covered in WBS 4.0 Science

Architecture 11 Possible Ground System Architecture Amazon Web Services

Satellite



For Architectures 11 Where ≥ 3 Spacecraft are Operating in Same Orbit Plane, NEN, may not be a good option. SET is looking at Amazon Web Services (>5 Ground Stations)

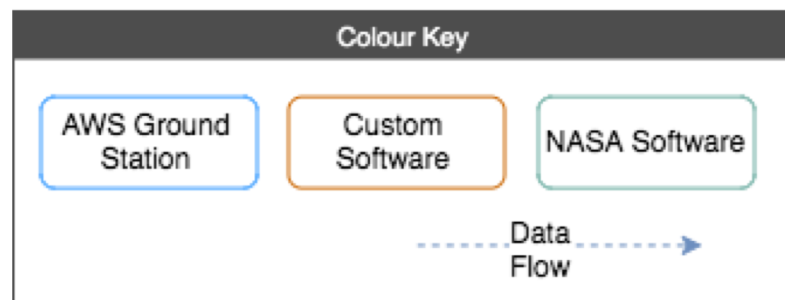


Blocks are executed on the Amazon Elastic Compute Cloud.

RT-STPS & IPOPP are Public domain software Developed by GSFC for Data decommutation & Science data processing.

Details of NASA software At [Direct Readout Lab](#)

Contact time is Very affordable: <\$100K/year



Scientists & Users

L1, L2 & L3 software Exists here



TDRS Option To Reduce Latency For Applications (~\$20M)

Science Data Volume

SSG = 8.55 Tbits Per Day (99Mbps avg. rate)

SSP = 9.85 Tbits Per Day (114 Mbps avg. rate)

A Dual Polarization design allows all the science data to be transmitted via Ka/NEN. Sufficient passes and coverage time was found on 59 of 60 days of simulation. Coverage shows possibility to transfer 9.64 of 8.55 Tbits on worst-case day and up to 16.57 Tbits on an average day.

- SN – TDRS KaSA
 - Would significantly reduce scheduling challenges and provides solutions for any level of latency goals.
 - Would require 65 dBW EIPR to close KaSA Rtn link rate of 1.2 Gbps
 - 70 Watt TWTA & 2-meter HGA
 - Would require ~2 hours of contact per day.
 - \$91 per minute results in fairly high operations costs of ~\$12M compared to ~\$3M for NEN contacts.
 - Estimated SWAP Impacts:
 - Would increase S/C Comm System Mass from 19.6 to 24 kg.
 - Would increase S/C Comm System Cost from \$8.6M to \$9.6M
 - Would increase S/C Comm System Average Power from 25W to 157W.