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TAKING THE PULSE OF OUR PLANET FROM SPACE

EUMETSAT ECMWF EUSPA

Status of Aeolus-2 Preparation Activities

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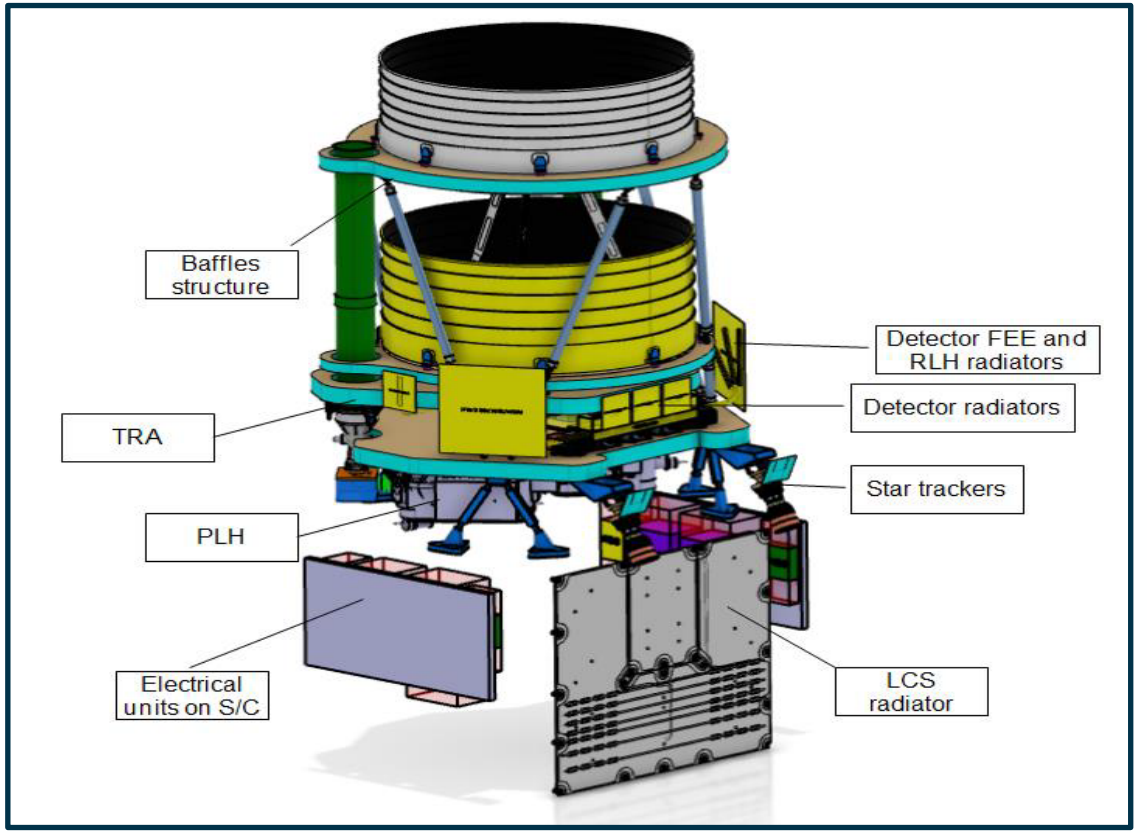
System Accommodation Phase A2/B1

- Instrument ICDs completed December 2021
- Statement of Work and Space Segment Requirements Documents completed and ITT issued end January with strong emphasis on:
  - Aeolus/EarthCARE lessons learned and resolving ALADIN in-orbit performance issues
  - EUMETSAT and ASAG inputs to requirements for a future DWL
  - Lifetime (5.5yrs), operability, robustness, launch date (2030)
  - Risk analysis and identification of critical technologies and needed pre-development activities
  - Compatibility with a VEGA-C launcher
  - Cost reductions via use of heritage platforms and recurrent units wherever possible
- In addition the potential implementation of:
  - A cross polar channel (a preliminary analysis has been performed by the Instrument Team)
  - A Radio Occultation Instrument
- Proposals received from Industry and currently under evaluation
- Key dates:
  - KO (Jun 2022)
  - PCR – end of Phase A2 (Oct 2022)
  - CMIN (Nov 2022)
  - PRR – beg. of Phase B1 (Jun 2023)
  - ISRR – end Phase B1(Dec 2023)

Instrument Consolidation Study - Design

- **Bi-static configuration (ATLID-like) confirmed as baseline**
  - Separates high (emit) and low (receive) intensity paths
  - Safer LID/LIC management
  - Fully redundant emit path (highest risk)
  - Removes several Single Point Failures
- **Stacked design with separate benches confirmed as baseline**
  - Modular concept
  - Best for dynamic mechanical performance

- **Cons:**
  - Higher mass and power (transmitter pressurization, telescope reduction to albedo sensitivity)
  - More sensitive to bias ⇨ need course alignment sensor and beam steering mechanism



Instrument Consolidation Study - Budgets

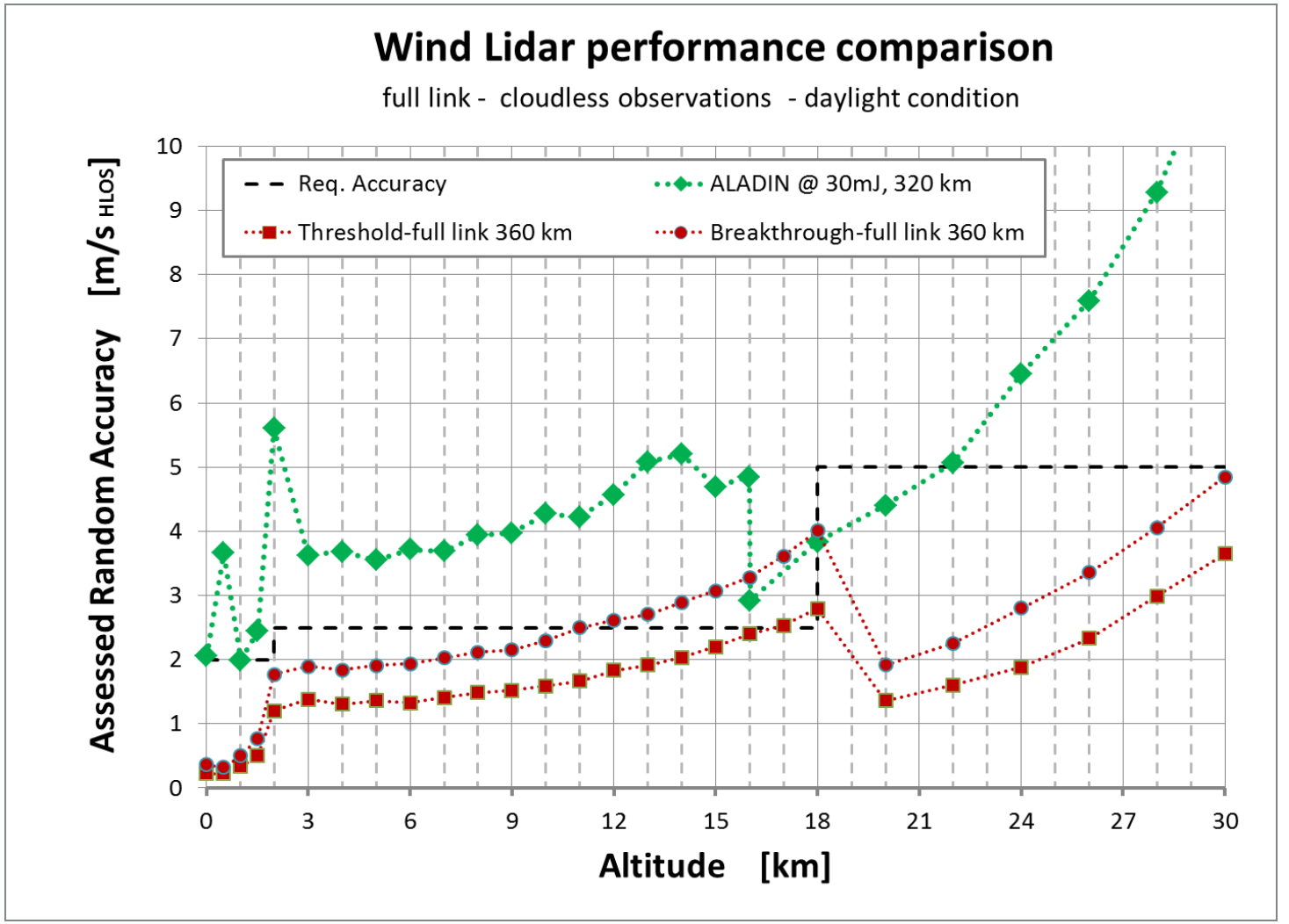
TOTAL MASS	617	17%	724
TOTAL MASS with APPENDAGES	623	17%	731
TOTAL MASS With UNITS ON S/C & APPENDAGES	716	17%	835

- **Mass** of the instrument is 835kg c.f. ALADIN which was 450kg
- Recent dynamic mechanical analysis has shown a first frequency with insufficient margins ⇨ need to increase the stiffness of the instrument
- This may lead to further mass increases
  - Airbus requested to trade the performance gains of the telescope/baffle versus the mass increases (≈60kg)
  - Further iteration to be performed before System Accommodation Phase A2/B1 KO (June)
  - May have implications for the embarkation of a Radio Occultation Instrument (33kg)

- **Power** consumption is 1250W c.f. ALADIN which was 850W
  - Additional solar array panels (more mass)

Rapid consolidation of the above with S/C primes to be performed in first co-engineering workshops

Instrument Consolidation Study – Performance (precision)



Random error performance:

- Compliant to breakthrough requirement up to 12km
- Small non-conformance to threshold requirement 16-18km but this is acceptable (requirement has been amended in the SSRD).
- Impact of solar background noticeable for altitudes >9km
- Note the above assumes full link budget (i.e. recovery of the initial losses found on ALADIN and 125mJ UV energy)

Instrument Consolidation Study – Performance (bias)

- **Bias performance:**
  - Major non-compliance for the zero wind bias (1σ = 1m/s threshold and 0.5m/s breakthrough)
  - Current performance estimate is x8.5 higher at instrument level
  - It is clear that the current instrument configuration cannot meet the bias requirement without utilizing the M1/ECMWF model correction.
- **Corrective actions:**
  - Increase of the primary telescope mirror mass (x1.5) and improved athermalisation in order to reduce the sub-orbital bias (impact still to be analysed)
  - Improved thermal control and temperature monitoring
  - Tightening of laser beam divergence and beam divergence stability requirements (70±5)µrad and 8% (P-V) over ST (1BRC = 12s) – very demanding
  - Trade-off and initiation of pre-development bread-boarding of alternative optical architectures (2 wave, field-compensated interferometer (IFM); fibre source at receive path focal plane)
  - Initial results show that the IFM which should be angularly insensitive could reduce the NC to a factor of x1.6 above the requirement but will require extensive development effort
  - Fibre solution performance being analysed (increased etendue at fibre output, speckle, impact on radiometric budget)
  - Increase pupil at RSP has been discarded (heavy development for limited gain)

Laser Transmitter and Detector Pre-developments

- 2 parallel laser pre-developments (Leonardo (IT) and Fraunhofer Institute of Laser Technology (DE)) and a detector pre-development (Teledyne-e2V (UK))
    - PDR for Wind Lidar Detector successfully completed in Sep. 2021
    - PDR for Laser Transmitter Assembly pre-development with Leonardo successfully completed in Oct. 2021
    - PDR for Laser Transmitter Assembly with Fraunhofer ILT completed Dec. 2021
- Detector pre-development:
    - Aeolus heritage largely retained
    - Architecture compatible with 67 vertical samples (an extension up to 133 vertical samples will also be evaluated)
    - No shots lost (between 2 accumulations)
    - 2 read-out outputs (1 for internal reference and background echo- 1 for atmospheric echo) : reduce Hot pixels. Capability to monitor each ~30s hot pixels (if any).
    - Detector operated at -50degC to reduce hot pixels. CAS has been added to the development via change request.
    - DDR currently running to release wafer manufacture

Summary

- System Accommodation Study Phase A2/B1 nearing tender completion with KO planned in June and PCR planned before CMIN Nov. 2022

- Instrument Consolidation Study extended for 18 months mainly to deal with:

    - Support the S/C primes with the System Accommodation Study activities
    - Consolidate the optical design and performance (including the contributions from the S/C)
    - Refine the co-alignment loop and its performance modelling
    - Support the ongoing laser and detector pre-developments
    - Define the bread-boarding activities needed for the instrument (EBEX, alternative back-up for RSP FP spectrometer,…)

- Laser transmitter developments on-going with parts procurement and manufacturing with the aim to have some performance demonstrations this year

- Detector development in detailed design phase with wafer manufacture to follow