# Biomass In-Orbit Calibration And Performance Verification Overview


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# Presentation Outline

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- The Road to Phase E2
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# Biomass IOC scope

## Usual IOC Cal/Val activities:

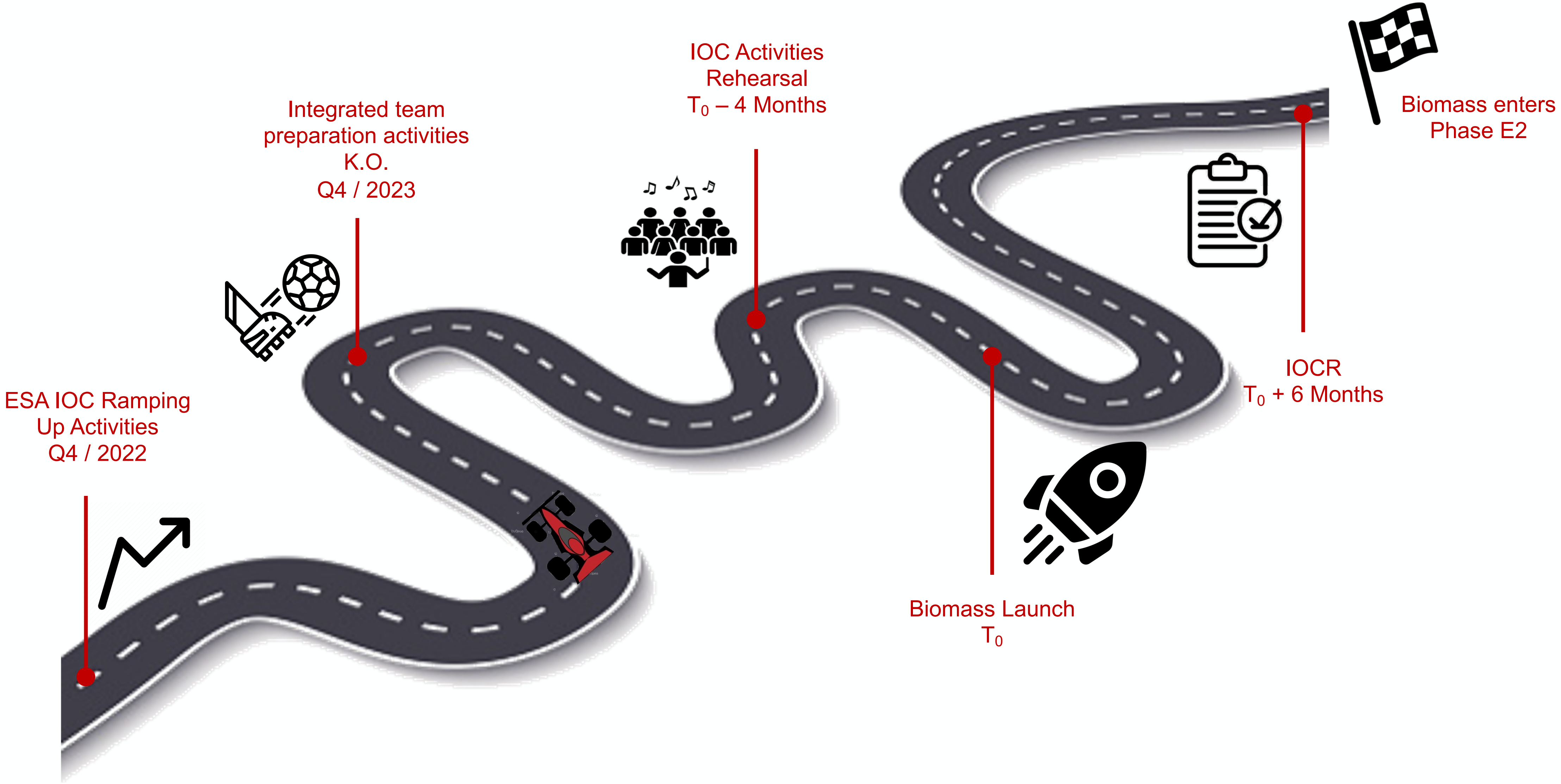
- Performance requirement verification
- Calibration (Absolute Cal. Factor, Pointing, ….)

## Biomass Peculiar activities:

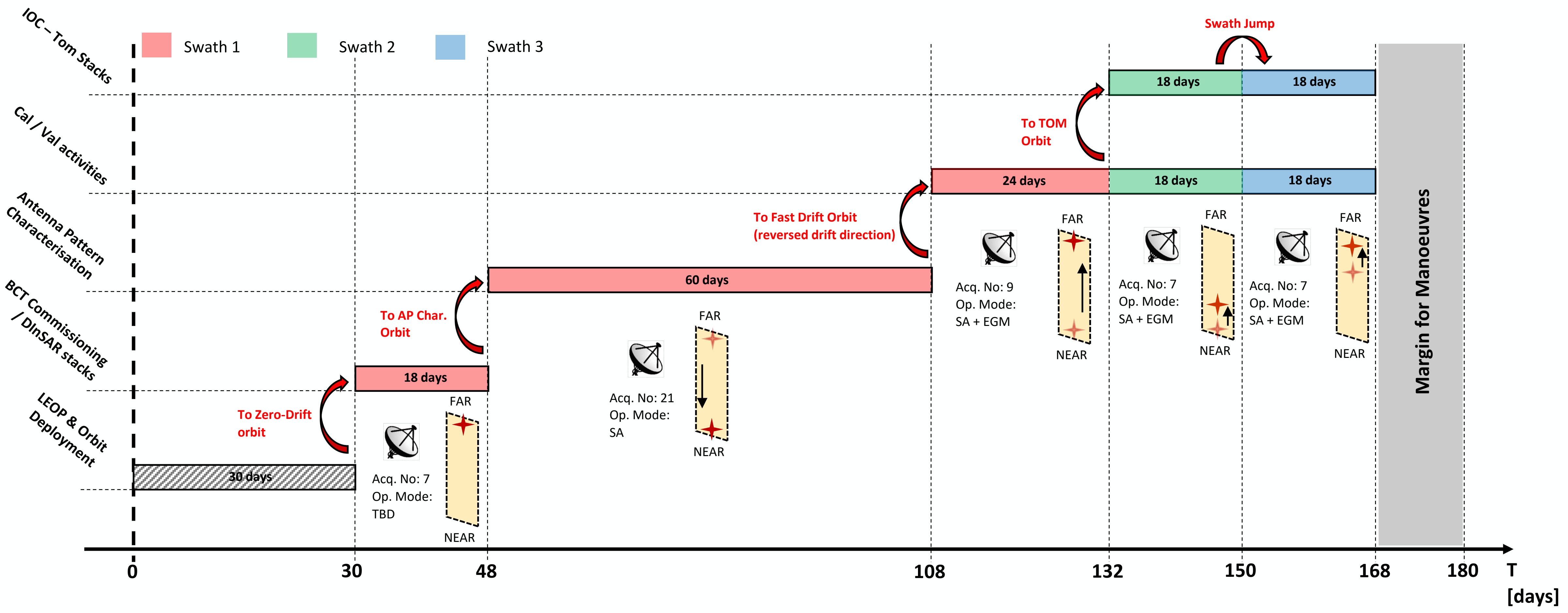
- In-flight Antenna Patterns Characterization
- Polarimetric Verification / Calibration

| Parameter | Value |
|---|---|
| Channel Imbalance | ≤ -25 dB, Tx and Rx combined |
| Cross-Talk | ≤ -30 dB |
| Radiometric bias | ≤ 0.3 dB |
| Radiometric stability | ≤ 0.5 dB |
| Noise Equivalent Sigma Nought | ≤ -27 dB |
| Total Ambiguity Ratio | ≤ -18 dB |
| Spatial resolution,<br>cross-track and along track | 60 m x 50 m |
| Residual phase error, standard deviation | ≤ 10 deg, over pulse travel and data take time (12 min) |
| Peak to Sidelobe Ratio | ≤ -16 dB |
| Integrated Sidelobe Ratio | ≤ -9 dB |
| Geo-location accuracy | Better than 25 m |
| Dynamic range | -30dB to 5 dB |

# The road to Phase E2



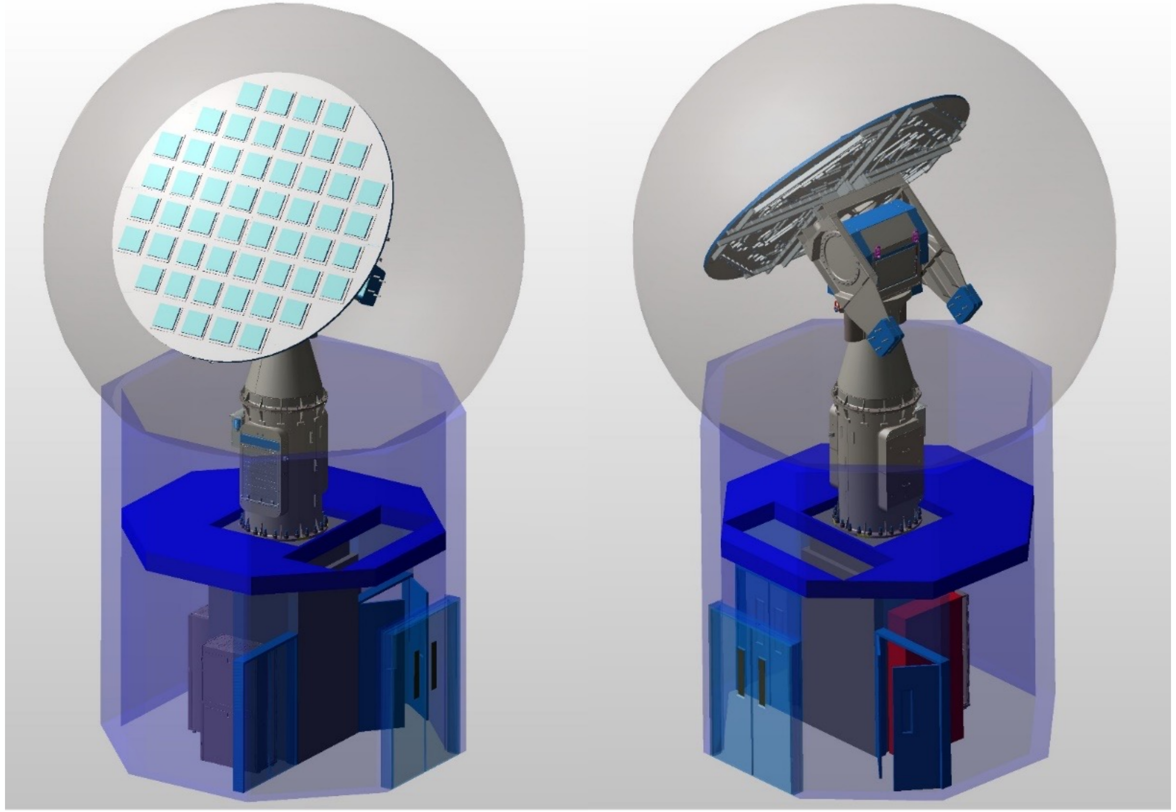
# IOC Baseline Plan



# Polarimetric Active Radar Calibrator (PARC)

- first of its kind active, fully polarimetric P-band transponder, four independent polarimetric signature matrices
- satellite tracking in Azimuth/Elevation: ensure consistent measurements with maximum transponder antenna gain
- control & microwave sub-system including microwave sub-system, digital sub-system
- transponder calibration sub-system, supporting the transponder external calibration

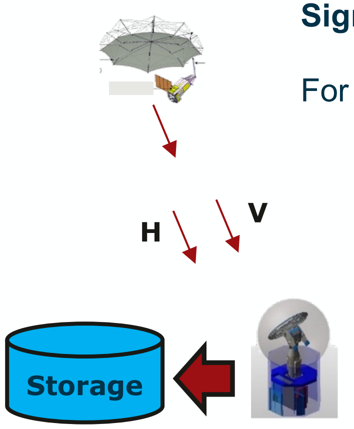
| Feature | Description |
|---|---|
| **Antenna design** | 2D array with a 4.8 diameter. 4 quarter composed by 13 patches each (10 active) |
| **Antenna Beam** | 12 deg HPBW. Gain 22.7 dBi |
| **Simulated RCS** | 85 dB($m^2$) with an uncertainty < 0.2 dB (1σ) |
| **Gain stability** | < 0.1 dB (1σ) over the entire mission lifetime |
| **Sensitivity** | Capability to detect PFD > -90 dBm/$m^2$ |
| **Cross-Polar isolation** | < 40 dB (1-way) in both Tx and Rx |
| **Channel Imbalance** | < 0.1 dB (1σ) in amplitude and < 0.77 deg (1σ) in phase, including the antenna (2-way) |
| **Signal to Multipath Ratio** | > 43.5 dB |
| **Steering** | Azimuth and Elevation. Biomass tracked during the overpass |
| **Absolute pointing error** | < 0.5 deg (3σ) azimuth and elevation combined |
| **Calibration** | Internal calibration network (I-CAL) + External calibration disk with a known RCS (Ex-CAL) |
| **Operational Modes** | 3 operational modes that can be run in any combination (details in the next slide) |



Courtesy of C-CORE

# PARC Operational Modes

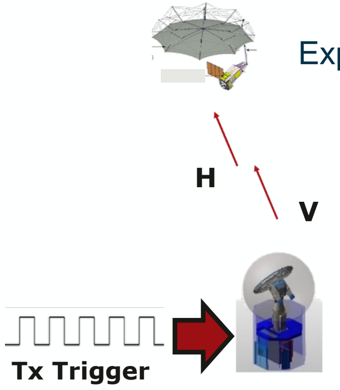
Three mutually inclusive modes:




### Signal Acquisition Mode (SAM)

For Antenna pattern characterisation

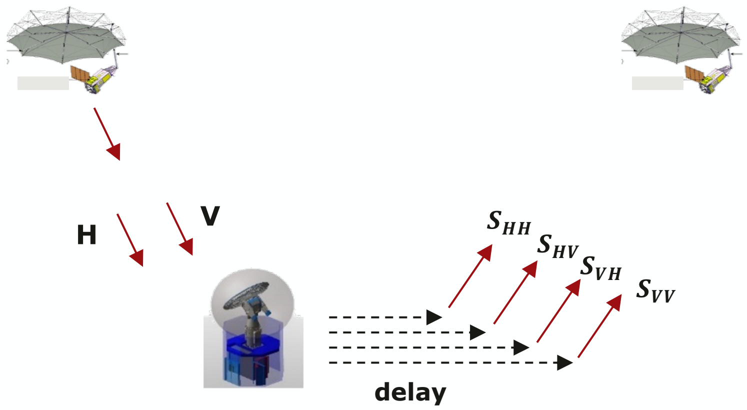
During the observation interval, the transponder records the received signal for both H and V polarisations. Recording is not detection-based




### Self-generated Transmit Mode (STM)

Experimental mode

Transponder transmits toward Biomass delayed H and V pulses generated by the transponder itself. The transmission can be triggered by the detection of a pulse received from Biomass or according to a timeline synchronized with the Biomass Rx window (beacon mode)



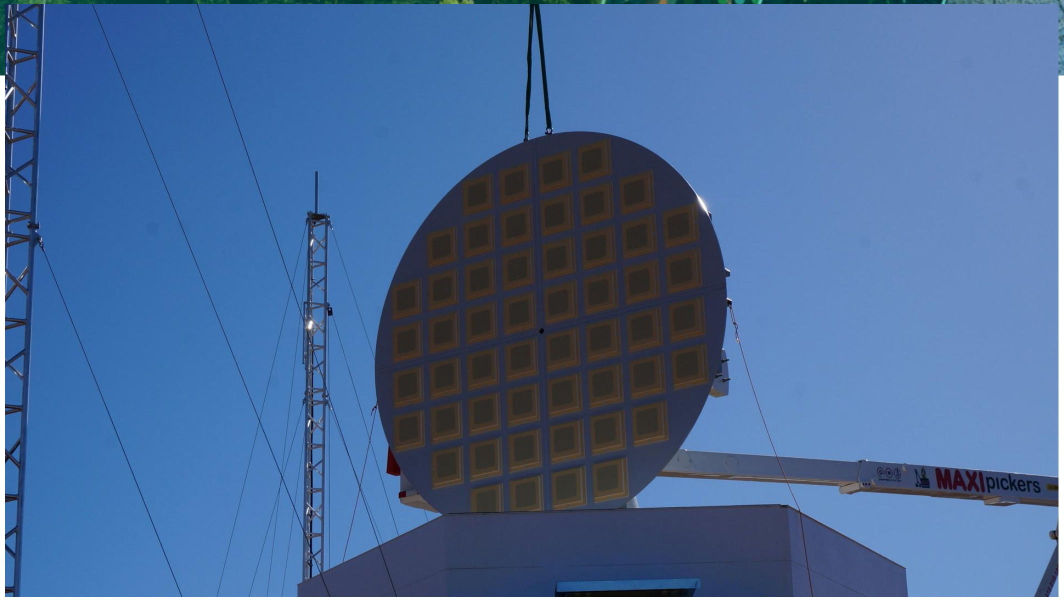

### Echo Generation Mode (EGM)

For system calibration: radiometry, polarimetry, geometry

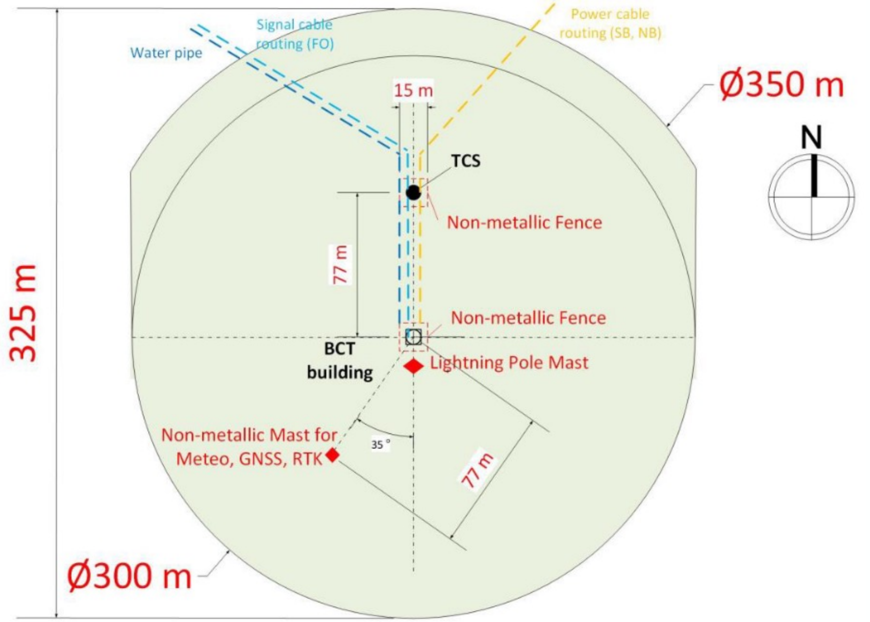
The detection of a received pulse, triggers the re-transmission of four delayed pulses, each one associated with a polarimetric signature and properly amplified to simulate a given RCS.

$$S_{HH} = \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}; \quad S_{HV} = \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix}; \quad S_{VH} = \begin{bmatrix} 0 & 0 \\ 1 & 0 \end{bmatrix}; \quad S_{VV} = \begin{bmatrix} 0 & 0 \\ 0 & 1 \end{bmatrix}$$

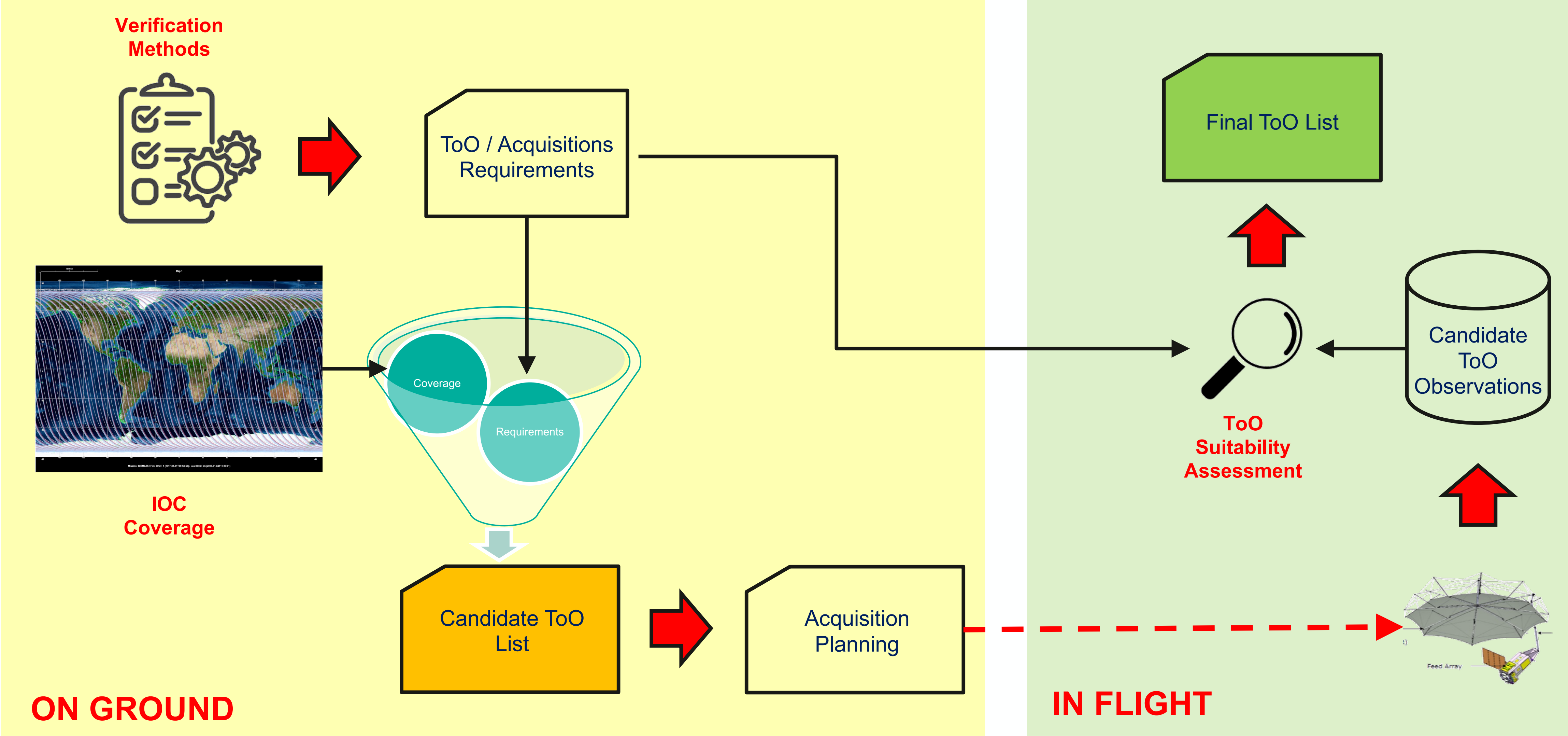
# PARC deployment




Courtesy of Airbus UK and C-CORE



# Identification of ToO for Biomass IOC / Phase E2



# Summary

- Biomass Mission characteristics require an extensive and complex In-Orbit Commissioning. For this reason, ESA ramped-up the related activities well in advance.
- IOC activities will be covered by an integrated expert team that will analyze the collected data from a fully Polarimetric Active Radar and a selected set of Target of Opportunity.
- These Target of Opportunity will be identified according a two step selection process. The first is currently ongoing and is based on analysis. The second one will be evidence-based and will exploit the acquisitions performed in the early phase of the IOC
- The core of the IOC activities will be based on PARC acquisitions. The Biomass PARC has been designed for the system peculiarities. Its deployment on-site is pretty advanced and well in schedule.
- Last but not least, Biomass IOC will be also based on a set of orbit manoeuvres to provide the required acquisition geometries (particularly for transponder overpasses)

# Acknowledgement

**Thank you for all participants to, and supporters of, the Biomass Mission who are contributing significantly to the realization of this challenging mission, including:**

- Members of the ESA core development team, MAG, the ESA Ground Segment: FOS and PDGS teams, the technical support teams in ESA and the DLR Microwaves and Radar Institute

- The Biomass industrial consortium, Airbus Defence and Space Ltd (UK), Airbus Defence and Space GmbH (Germany), C-Core (Canada) and their subcontractors and suppliers