



Satellite Technology for Health and Air Quality: Instrument Challenges and Opportunities

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Sr. Payload System Engineer

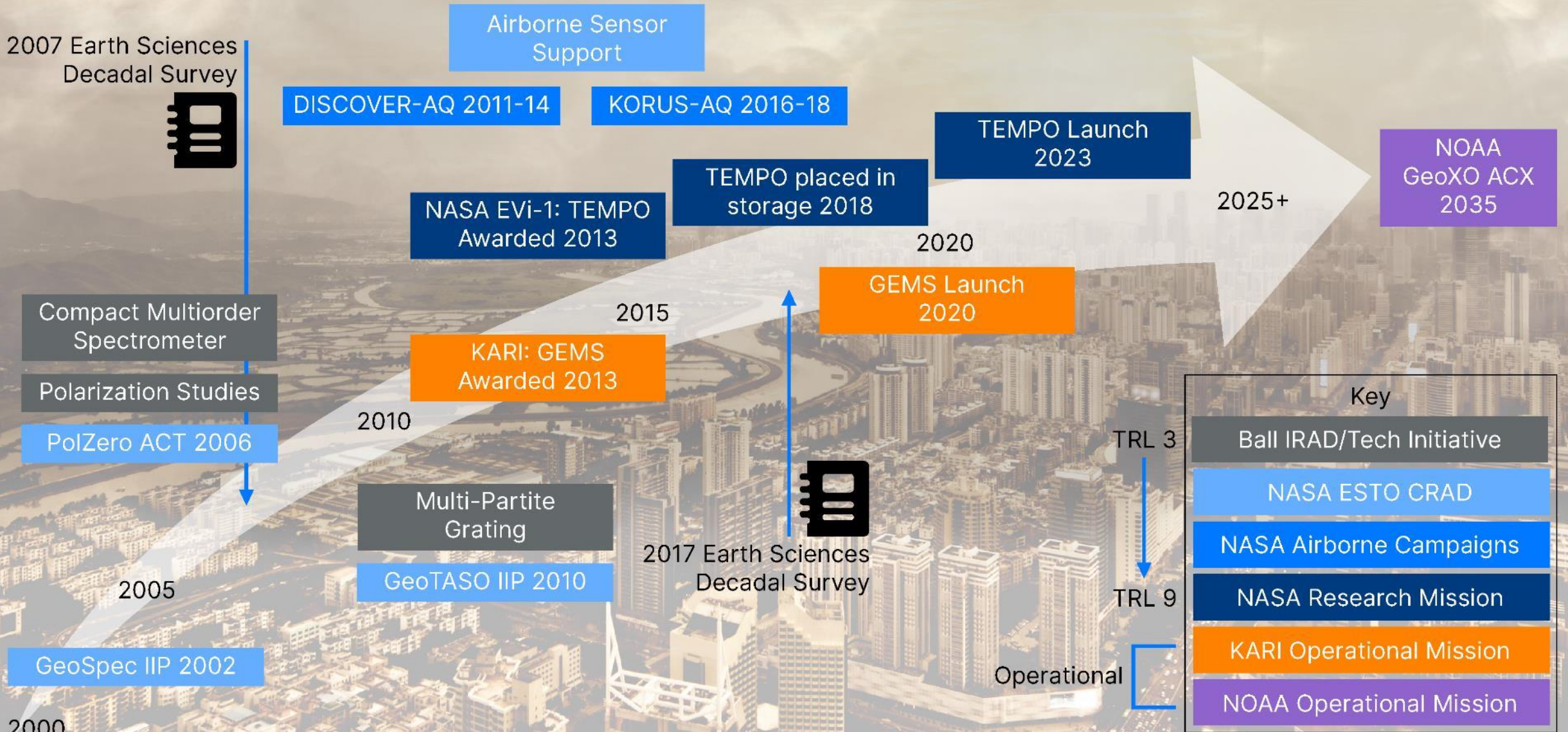
*Panel 3B: Comparing Models and Observations:
Strengths and Limitations of Satellite Data*

HAQAST – UTAH 2023



GO BEYOND WITH BALL.®

Global Air Quality - Research to Operations



REALIZING HOURLY ATMOSPHERIC COMPOSITION FROM GEO



Tropospheric Emissions: Monitoring of Pollution (TEMPO)

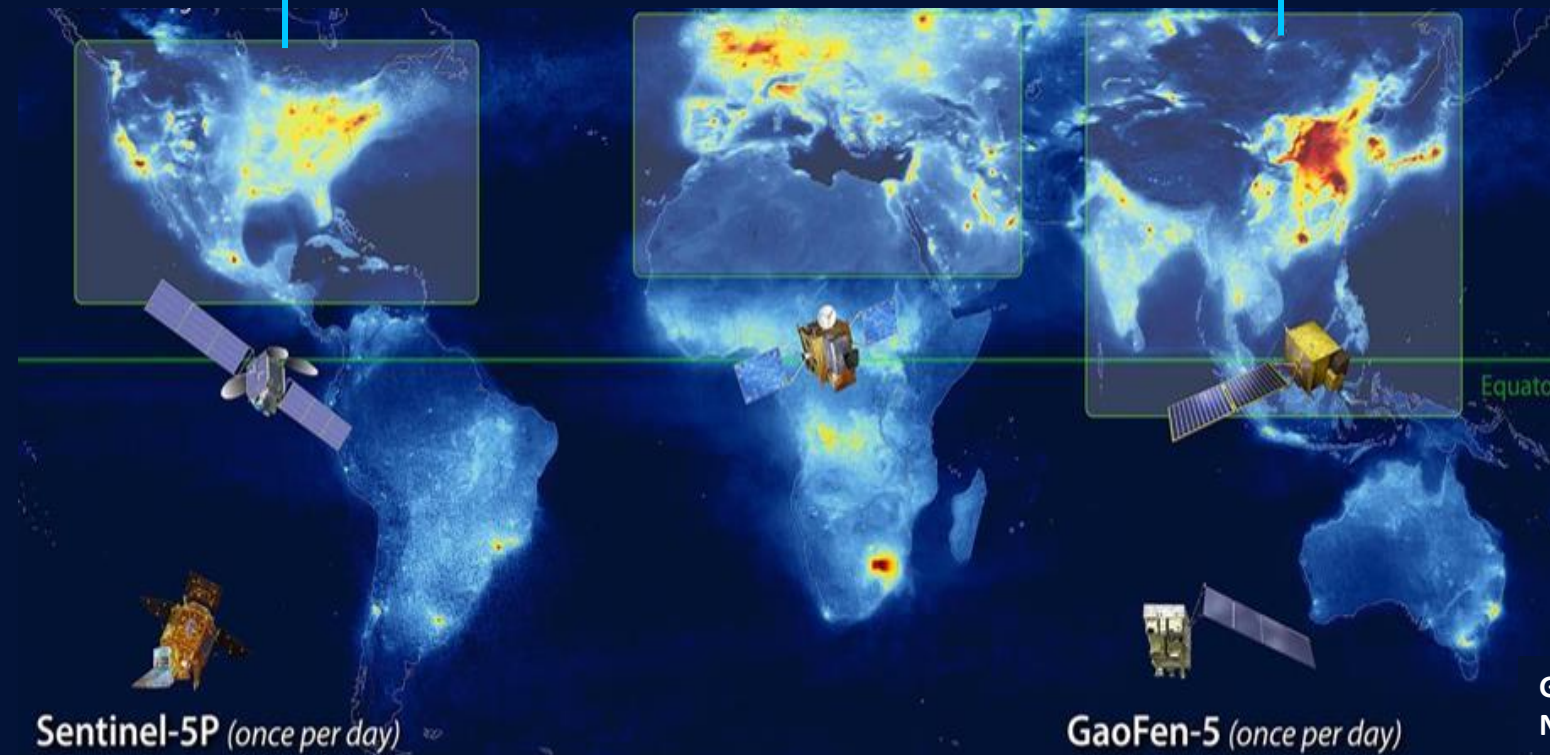
- Launched 2023
- Operational, hourly
- Partners:
 - NASA
 - Smithsonian Astrophysical Observatory
 - Ball Aerospace

Sentinel-4

- 2024 launch
- Hourly

Geostationary Environmental Monitoring Spectrometer (GEMS)

- Launched 2020 – Operational, hourly
- Partners:
 - KARI
 - Yonsei University
 - National Institute of Environmental Research
 - Ball Aerospace



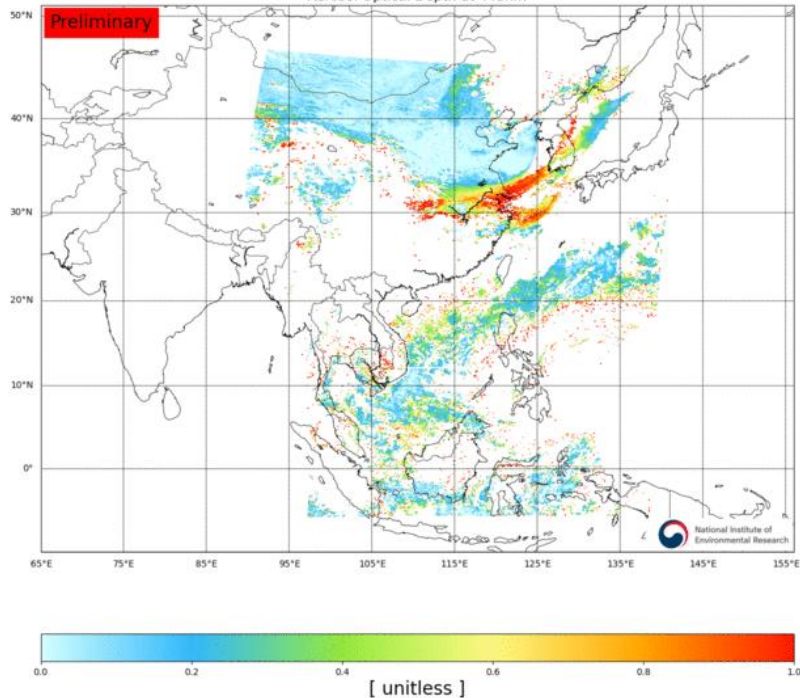
Graphic: NASA LaRC
NO₂ Image: KNMI/ESA

CEOS ATMOSPHERIC COMPOSITION VIRTUAL CONSTELLATION WILL BE REALIZED IN 2024

Geostationary Environmental Monitoring Spectrometer (GEMS)

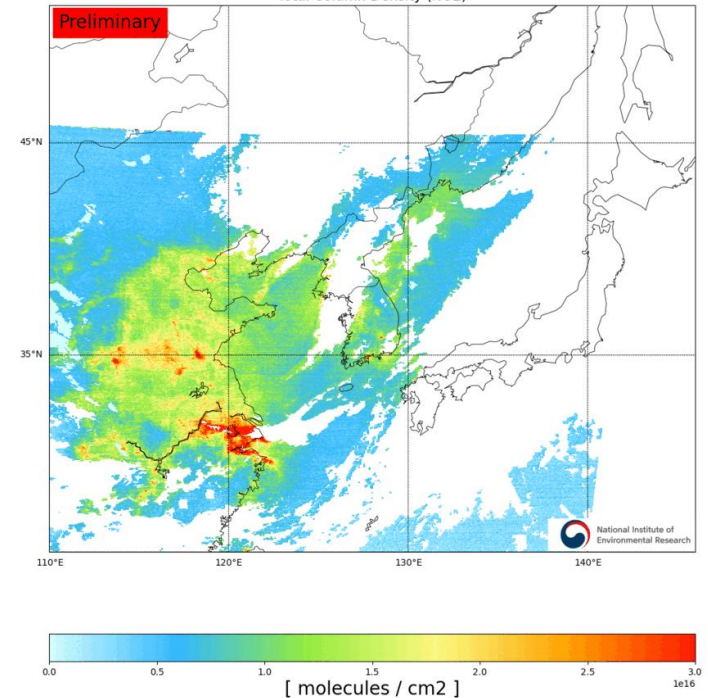
April 17, 2021 Mongolian dust event
(AOD 443nm)

GEMS L2_AERAOD 2021-04-17-00:45 UTC (2021-04-17-09:45 KST) FC-ETC_DPRO ESC
Aerosol Optical Depth at 443nm

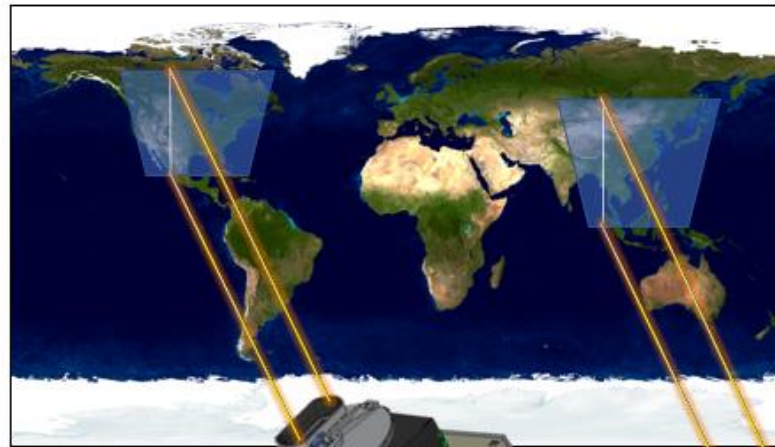


April 17 2021– NO₂ pollution
transport

GEMS L2_NO2 2021-04-17-00:45 UTC (2021-04-17-09:45 KST) FC-ETC_DPRO ESC
Total Column Density (NO₂)



TEMPO AND GEMS MEASUREMENT CONCEPT



Imaging enabled by
step-stare scan
mechanism

TEMPO
(2 CCDs)

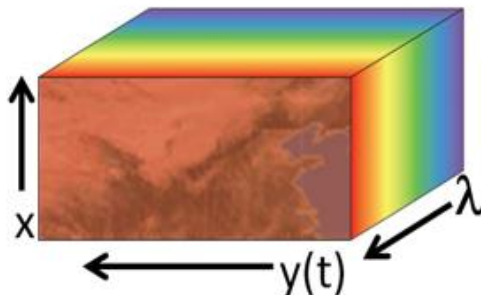
GEMS
(1 CCD)

Spectral Range:

GEMS = 300-500 nm

TEMPO = 290-740 nm

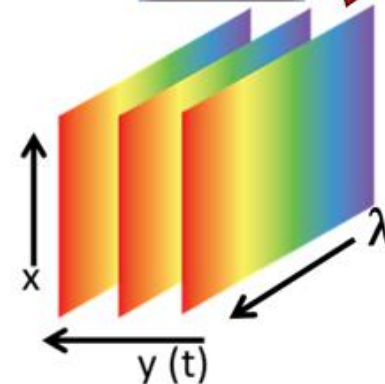
Ground processing
spatially bins and
geo-locates each
co-added image



- GEMS and TEMPO operations are a balance between several requirements:

- Hourly Revisit Requirement
- Signal to Noise
- Saturation
- Field of Regard
- And more!

Images from each
scan mirror
position are co-
added on-board

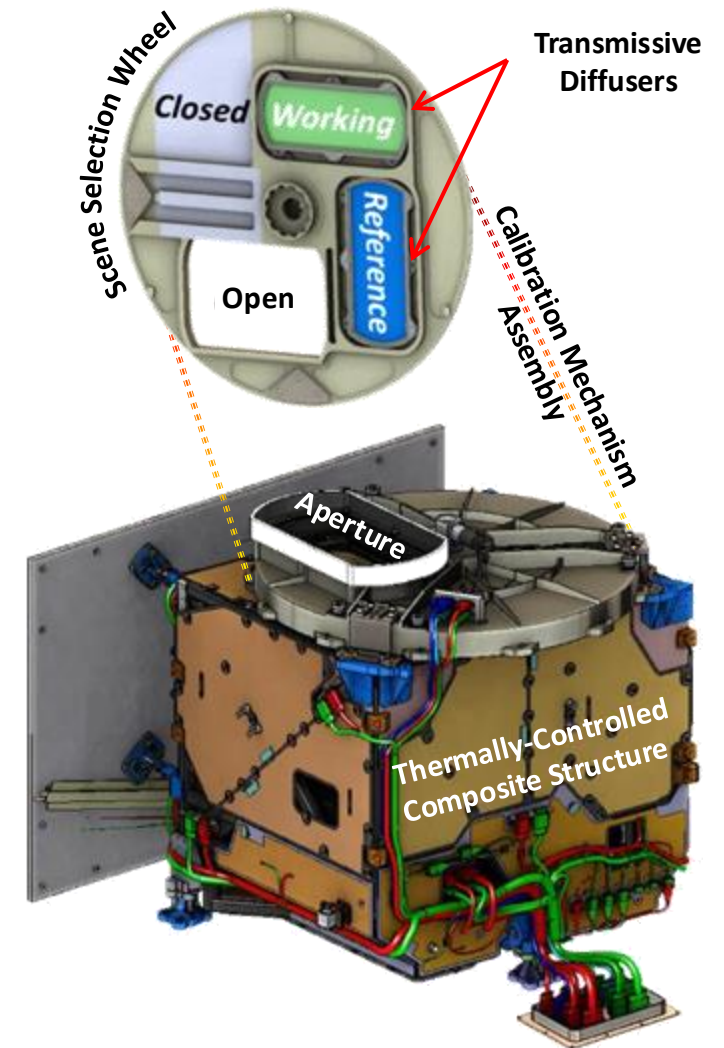
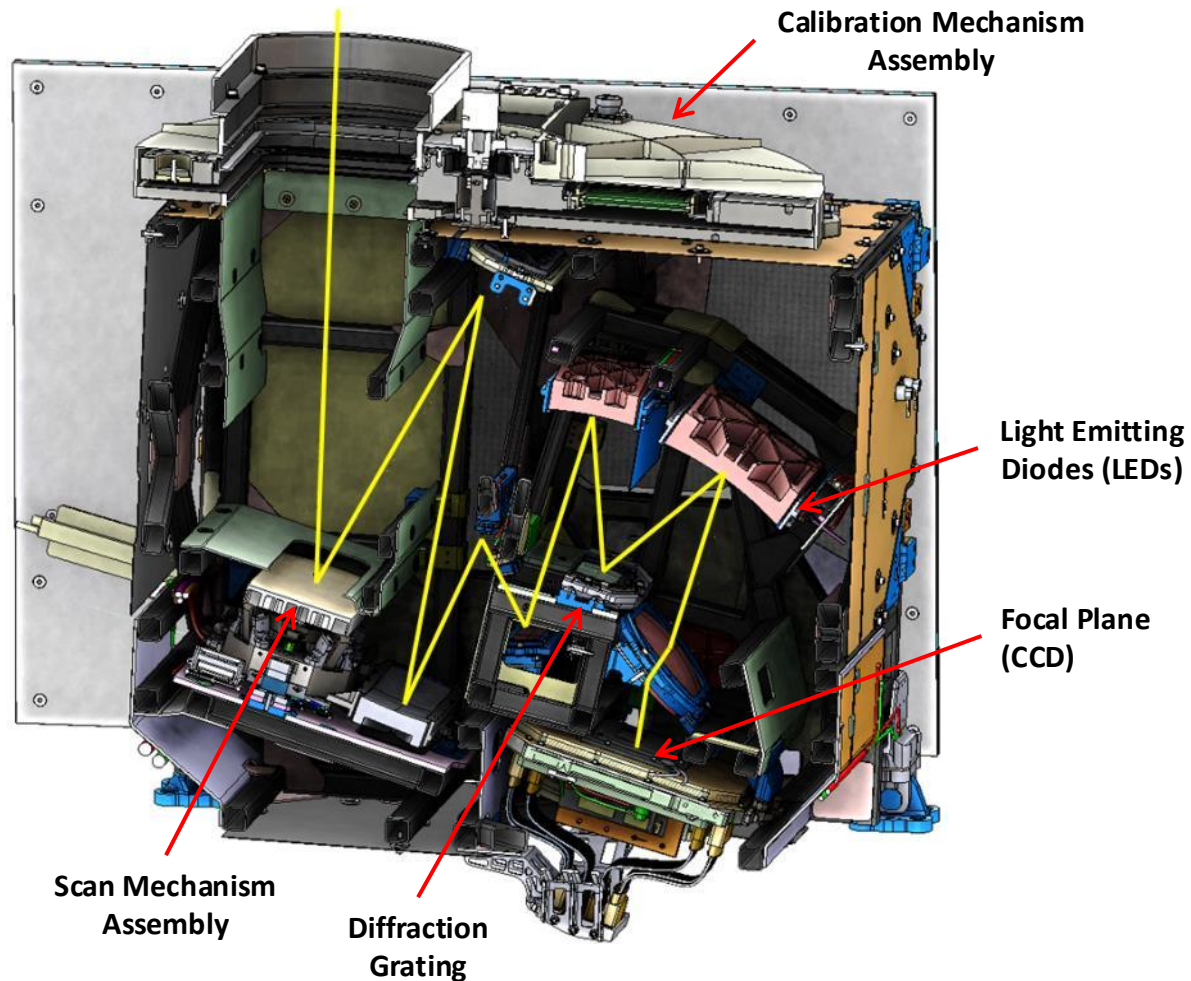


Co-added images are then
transmitted to the ground

INSIDE GEMS AND TEMPO



- GEMS and TEMPO were developed in tandem, capturing efficiencies



GeoXO Constellation



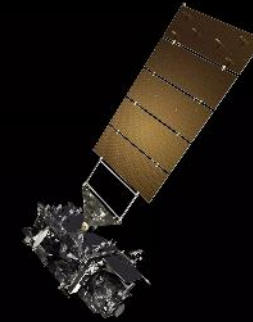
GEO-West

Visible/Infrared Imager
Lightning Mapper
Ocean Color



GEO-Central

Hyperspectral Infrared Sounder
Atmospheric Composition
Partner Payload



GEO-East

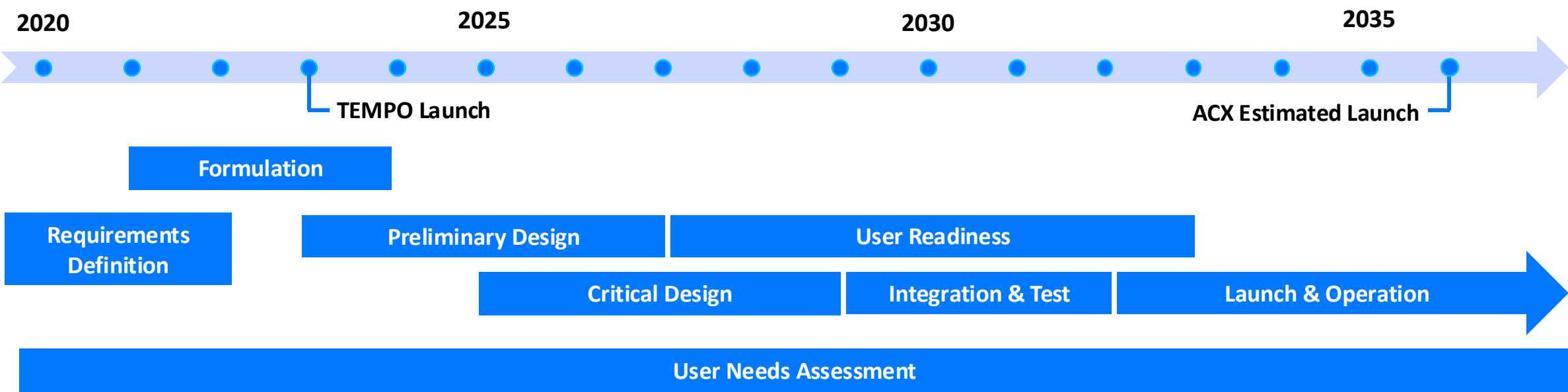
Visible/Infrared Imager
Lightning Mapper
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WHAT IS NEXT?



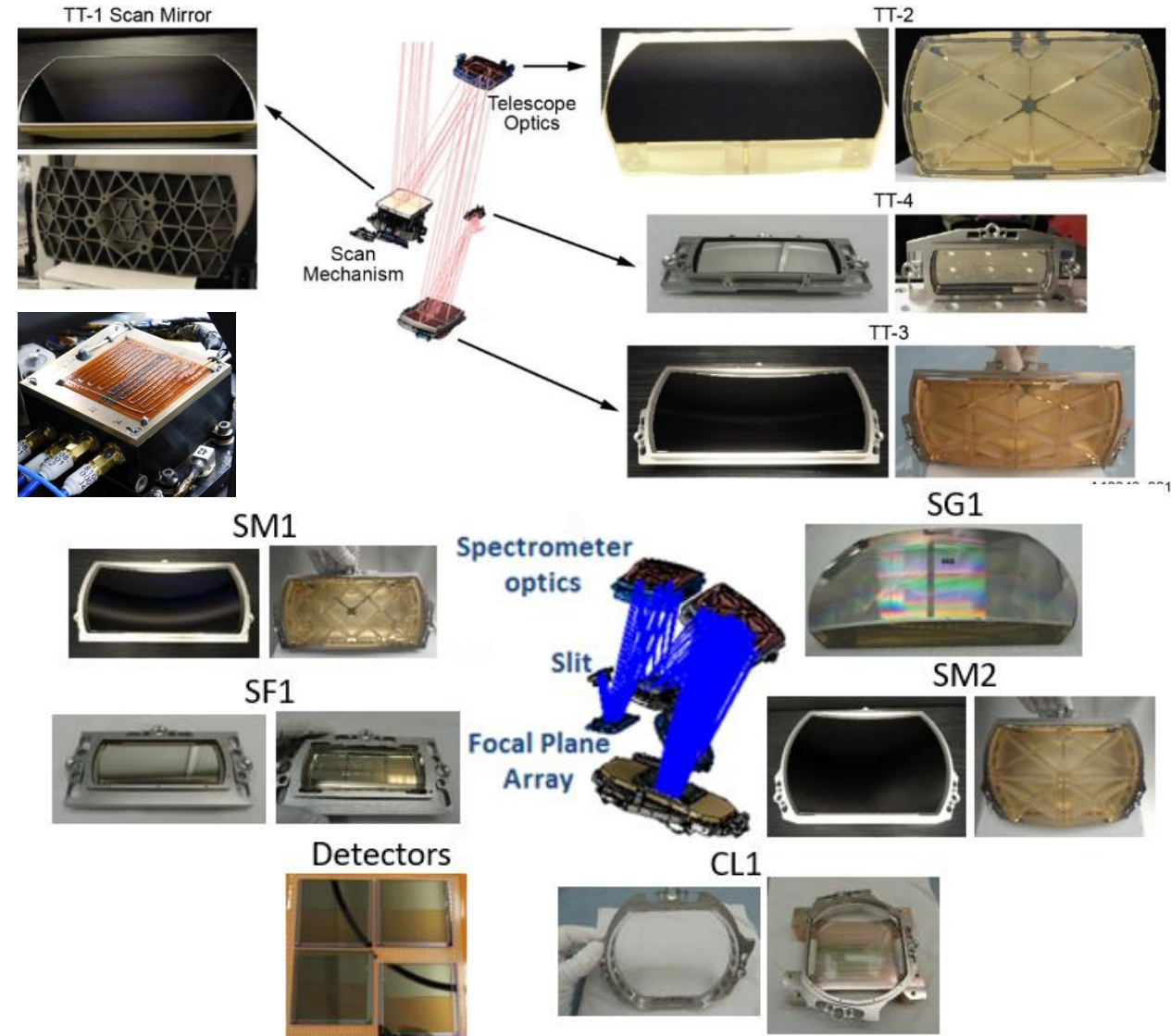
GeoXO Schedule



TEMPO CONTINUITY / ACX PRECURSOR: AN OPPORTUNITY TO BRIDGE THE GAP



- Spares from GEMS & TEMPO available for a gap-filler mission
- Hosted, or free-flyer option
- Ground Processing infrastructure in place
- Science infrastructure is ready: TEMPO Early Adopters
- For 2029 mission launch, need to start planning now

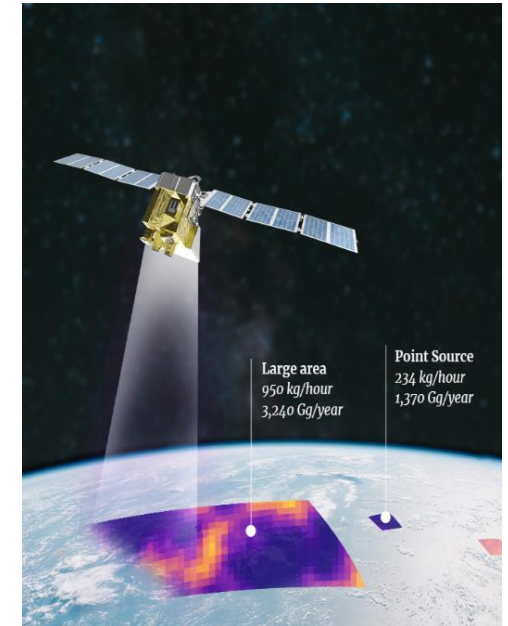
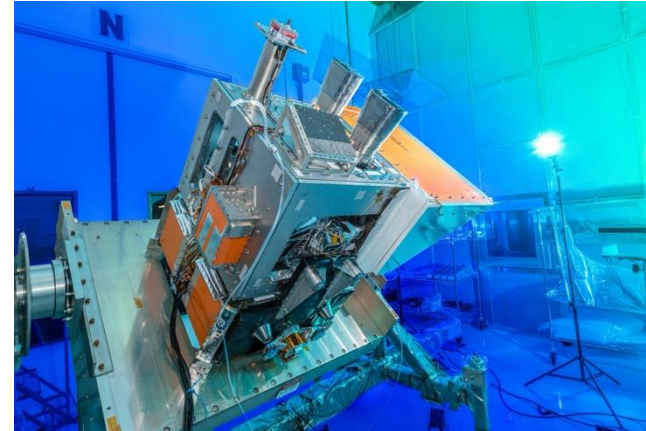


NON-TRADITIONAL APPROACH TO PARTNERING AND BUILDING INSTRUMENTS



- Ball Aerospace is working to spread awareness of the need for measurements in the Southern Hemisphere
- Exploring non-traditional paths and international collaborations
- Ball has experience working with NGOs for successful environmental missions
- Example: MethaneSAT (Launch is planned in early 2024)

MethaneSAT



Credit: MethaneSAT, LLC

MethaneSAT has completed instrument integration and is in environmental testing with vibe, shock and self-compatibility completed. Next it will go to thermal vacuum testing and calibration.

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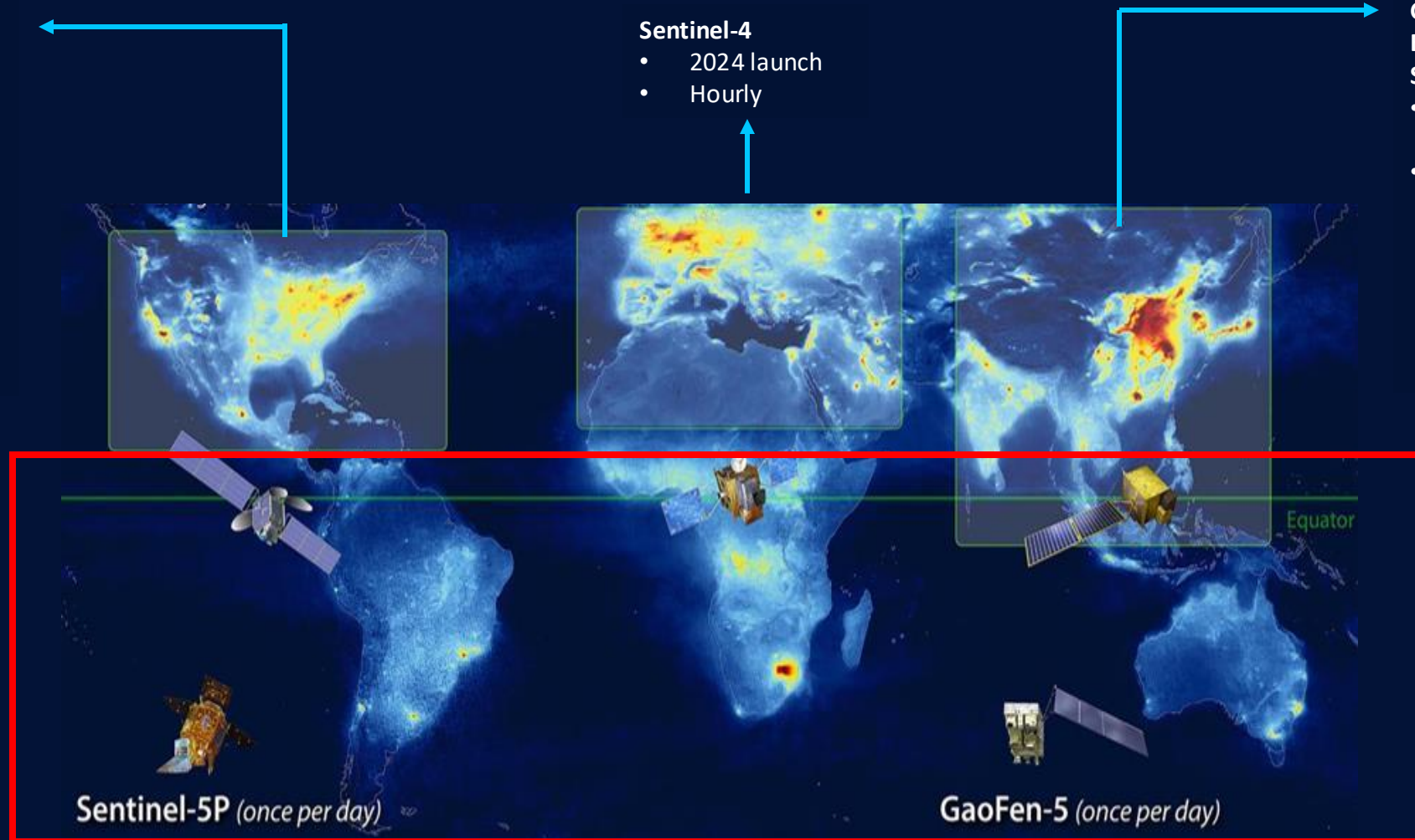
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THANK YOU

