



# NASA Beacon/Ground Enhancement Activities

SAR Controllers Workshop 2023

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# Agenda

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- NASA's Current Focus
- Second-Gen Beacon Type Approval Process Progress
- Real-World Evaluation / SGB Testing
- NASA Support to Crewed Space Missions
- Moving Beacon Testing
- Phased Array Antenna Development



# NASA's Current Focus

- Innovate and develop new technologies to improve search and rescue hardware for national/international use in emergencies
  - Emergency beacons for use in distress
  - Ground stations that monitor and distribute data to rescue forces
  - Space payloads that detect the emergency signal and relay to Earth
- Internal to NASA, the SAR Office supports NASA human spaceflight missions with technical expertise in SAR systems and future development.
- Recent focus is on completion second generation beacon type approval and continued support to the US SARSAT Program.





# Second-Generation Beacon Type Approval Progress

- EPG is the only test facility in the world that is approved to test SGBs and SGB ELT(DT)s.
- Several U.S. Government SGB PLBs have completed testing:
  - NASA ANGEL, testing completed, C/S Letter of Compatibility application is in process
  - U.S. Army PRSS-1B, testing completed, C/S Letter of Compatibility received
  - Approvals are for non-operational use until the MEOSAR ground system is sufficiently SGB-compatible
  - Commercial sales of SGBs and the beginning of public use will lag the declaration of C/S system readiness to support SGBs
- At least one commercial SGB ELT(DT) is in development but has not yet formally submitted a type approval application.

**SGBs are now entering into service with USG and DoD users, within specific use parameters, and are now part of the SAR ecosystem**

# Real-World Testing / SARSAT Beacon Ops for HSF Mission(s)



- NASA performed post-landing testing with Boeing Orbital Flight Test – 2 (OFT-2) and Artemis – I missions, validating space capsule beacon performance among NASA’s programs
- SARSAT beacons are the **primary** method of capsule location during prolonged recovery operations, underlying the need for reliable SARSAT services
- Artemis – II and onward testing will evaluate single-burst detection of Orion SARSAT beacon following activation while spacecraft descends under parachutes, allowing NASA to mitigate geolocation concerns related to landing and ending up in “Stable II” or upside down due to sea states

**NASA use of SGB/FGB combinations exemplifies the type of SAR case where varied types may be used, and field testing shows full compatibility**





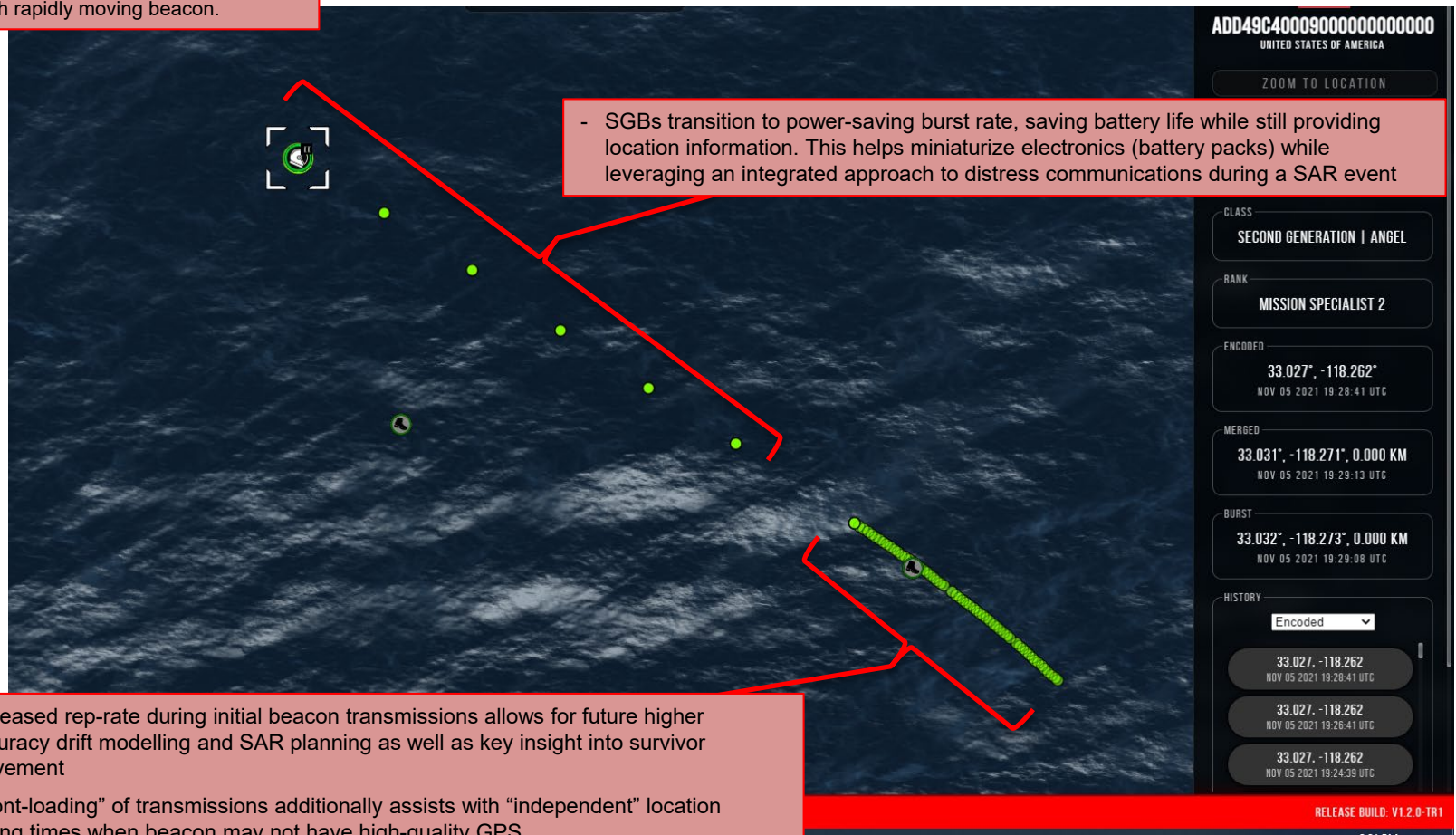


# Second Gen Beacon Benefits Example

Data from November 2021 testing in Pacific Ocean with rapidly moving beacon.

- SGBs transition to power-saving burst rate, saving battery life while still providing location information. This helps miniaturize electronics (battery packs) while leveraging an integrated approach to distress communications during a SAR event

- Increased rep-rate during initial beacon transmissions allows for future higher accuracy drift modelling and SAR planning as well as key insight into survivor movement  
- “Front-loading” of transmissions additionally assists with “independent” location during times when beacon may not have high-quality GPS





# SARSAT Support to Crewed Space Missions

- Commercial spaceflight sector is booming, with plans for orbital and suborbital crewed missions, some carrying SARSAT beacons
- NASA working directly with SpaceX and Boeing under their Commercial Crew Program (CCP) contracts with NASA to ensure vehicle beacons meet SARSAT Letter of Compatibility standards
- Purely private missions will need to meet Type Approval standards for use, owing to international nature of spaceflight landing zones and private versus government use
- NASA working with National Search & Rescue Committee (NSARC) Space Working Group and US SARSAT partners to provide US SAR program position statements on beacon carriage requirements and SAR coordination specific to the Crewed Space Mission use-case

**SAR Controllers are the first line of response to highly dynamic spaceflight landings, and US SARSAT program is working to ensure that capabilities are maintained in this new spaceflight era.**



# Moving Beacon Support Concluded

- The SAR Office completed testing of moving beacon algorithms within the MEOLUT, via UAV/USV test campaigns.
- University of Maryland's UAV Test Site was used to fly a first gen beacon at controlled velocities and patterns.
- Results validated both MEOLUT performance and test methodology.
- Same UAV was subsequently used in commissioning of the Florida and Hawaii MEOLUTs.
- Unmanned surface vehicle (USV) testing was also conducted (with CG support) as an alternate methodology, and to simulate wave motion during testing.



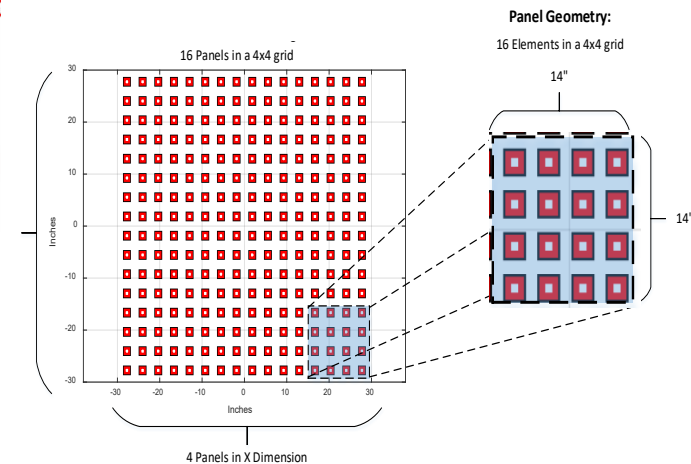
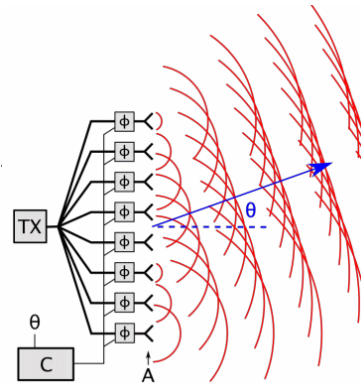
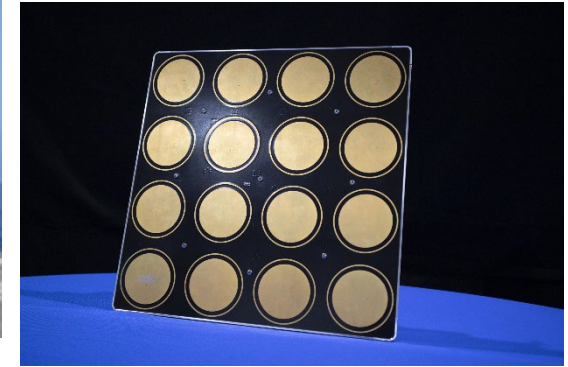


# Phased Arrays & SARSAT

- Historically, C-S MEOLUTs use dish antennas.
  - Steerable (LEO/MEO) or stationary (GEO)
  - Limited to tracking one satellite per dish.
  - Maintenance/refurbishment of antenna and infrastructure
  - Component failures tend to take antenna out of service
- Phased array
  - Fixed structure with multiple antenna elements arranged in an array.
  - Elements are combined to form a “beam” that can be steered to track multiple satellites simultaneously.
- Advantages:
  - Greatly Reduced Physical Footprint and Ongoing Operational Costs
  - Fault tolerant with minimal downtime
  - Quick and simple maintenance
  - Increased # of satellites tracked



Photos courtesy of CDSI, Inc.





# Phased Array: Enhanced performance

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- NASA development of a phased array architecture for SARSAT is nearing completion.
  - Focused on maximizing number of spacecraft tracked (16+) for increased detection probability and location accuracy.
  - Use of digital beamforming (software driven) to “steer” phased array according to a schedule of satellite passes.
  - Installation currently planned for end of CY2023.
- NOAA phased array efforts also underway to insert technology into existing MEOLUTs.
- Together, the NASA and NOAA infrastructure will allow this new technology to work in parallel to current systems, providing enhancements to both operations and R&D capabilities in the program.