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# MARGOT Project

User Consultation Platform 2020 – Maritime and Ocean Monitoring Session

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Organised by:



European  
Global Navigation  
Satellite Systems  
Agency



Under the auspices of:



EU Space Programme:



Copernicus

EGNOS





# Project overview

## Multipath & Interference Error Mitigation Techniques for Future Maritime e-NAV Services

ESA NAVISP Element I

### Objectives:

- Determine over-bounding multipath and interference error models for the maritime environment
- Determine mitigation methodologies for multipath and interference
- Determine L-band channel models for the maritime environment

# Project overview



Prime



Subcontractors



Third party



Support



# Data collection campaigns

Piggyback and dedicated data collection campaigns were conducted on three vessels, from May 2018 until June 2019.

**Istros**



**Length:** 32 m

**Navigation types:** fluvial navigation on the Danube river, coastal navigation in the Black Sea, port navigation

**Collected data:** 651 hours

**Mare Nigrum**



**Length:** 82 m

**Navigation types:** coastal navigation, open sea navigation and port navigation in the Black Sea

**Collected data:** 1666 hours

**Cpt. Cdor. Alexandru Catuneanu**



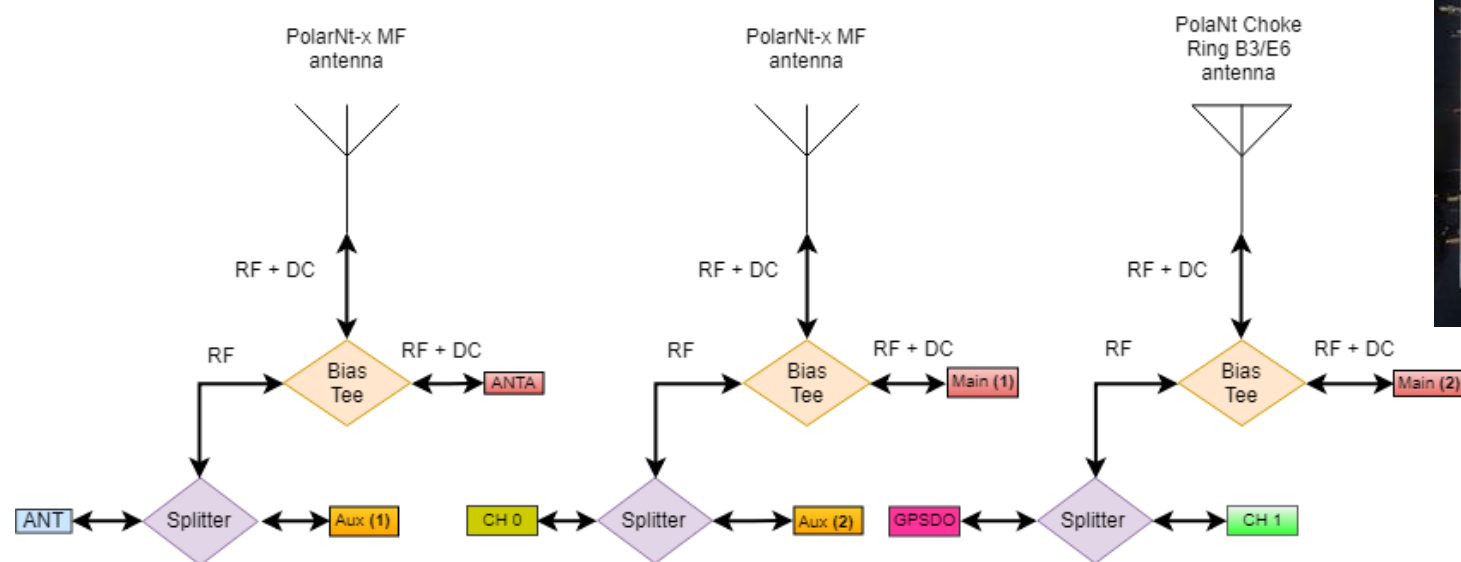
**Length:** 64.7 m

**Navigation types:** port navigation, open sea navigation and coastal navigation in the Black Sea and Aegean Sea

**Collected data:** 531 hours



# Data collection equipment



ANTA Septentrio AsteRx-m2  
ANTB

Main (1) Septentrio AsteRx-U receiver (1)  
Aux (1)

ANT GMV receiver

Main (2) Septentrio AsteRx-U receiver (2)  
Aux (2)

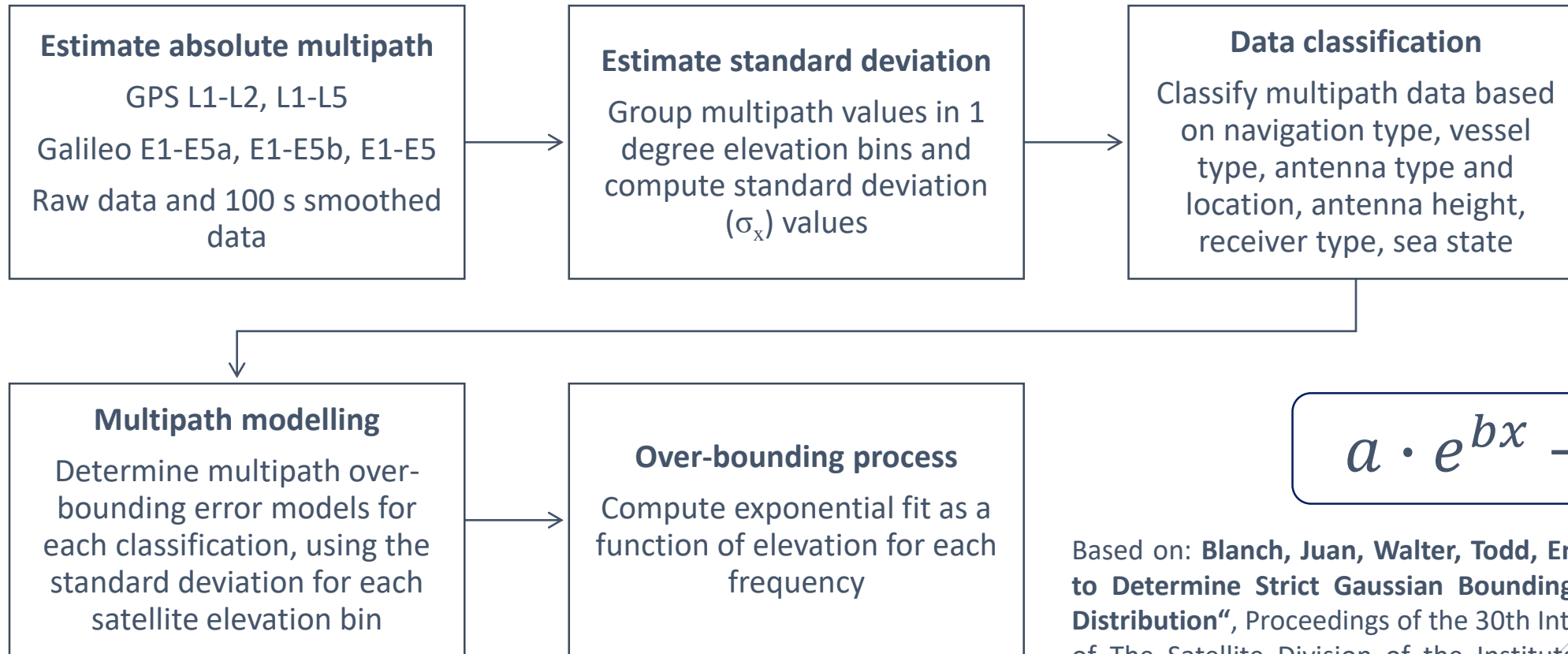


CH 0 NI USRP 2954R  
CH 1

BNO055 USB stick



# Multipath over-bounding models methodology



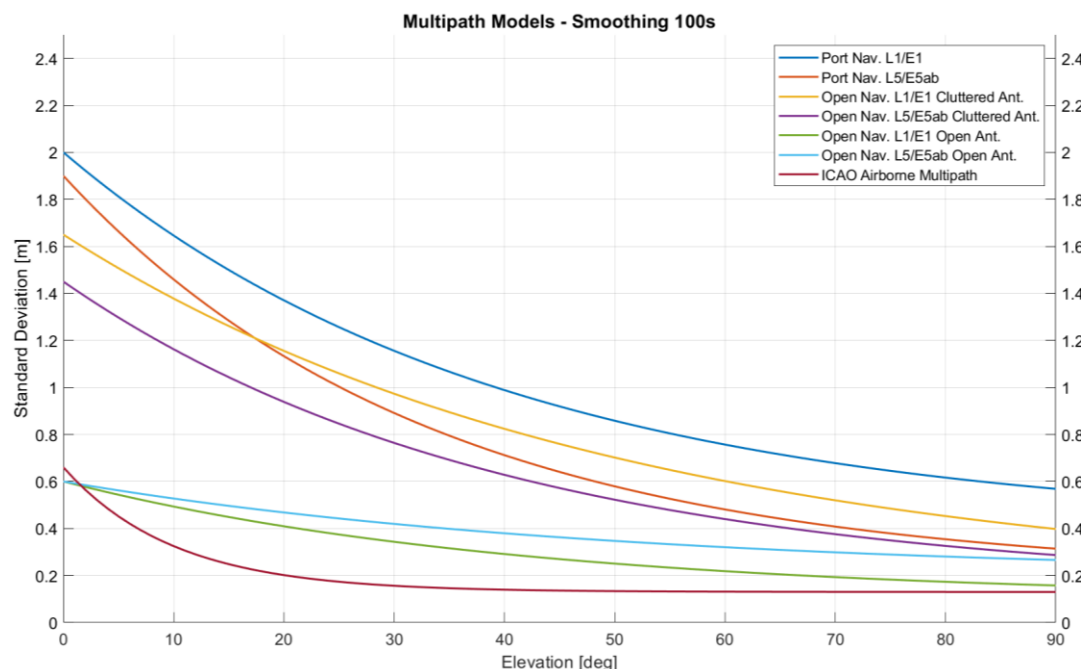
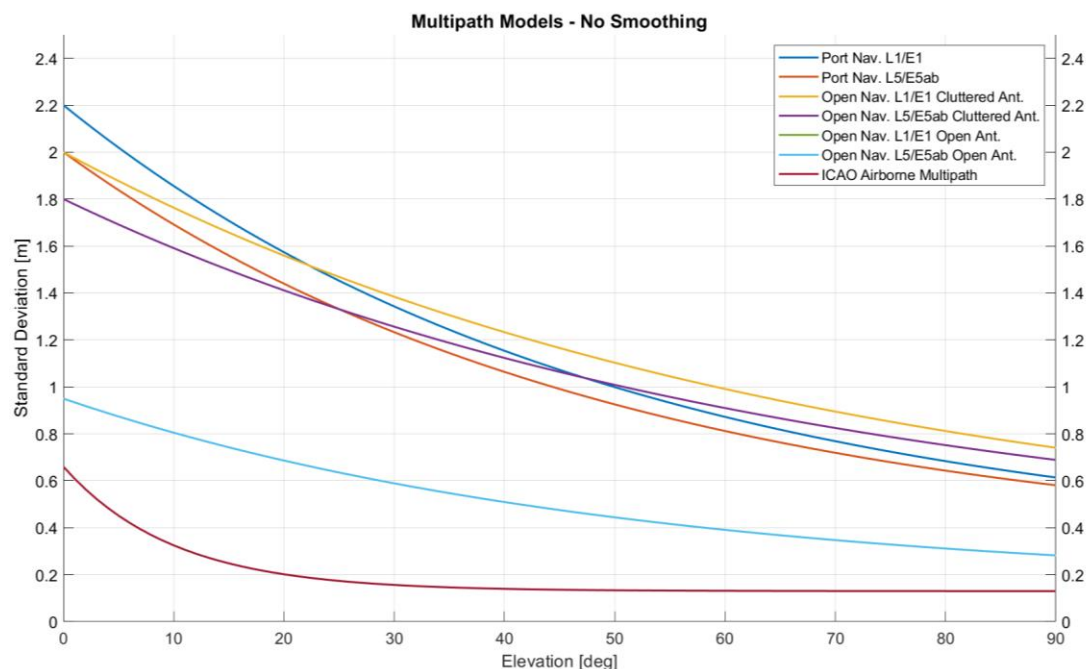
$$a \cdot e^{bx} + c$$

Based on: **Blanch, Juan, Walter, Todd, Enge, Per, "A MATLAB Toolset to Determine Strict Gaussian Bounding Distributions of a Sample Distribution"**, Proceedings of the 30th International Technical Meeting of The Satellite Division of the Institute of Navigation (ION GNSS+ 2017), Portland, Oregon, September 2017, pp. 4236-4247

# Proposed multipath models

1. **Port navigation model** - all vessels
2. **Cluttered antenna environment in open navigation model** - coastal navigation, open sea navigation and port approach with Mare Nigrum and Catuneanu
3. **Open antenna environment in open navigation model** - coastal navigation, fluvial navigation and port approach with Istros

The chosen frequencies are L1/E1 and L5/E5, disregarding the constellation differences.



# Conclusions of the multipath analysis

- There is a very small difference between coastal navigation, open sea navigation and port approach.
- Port environment has very similar multipath effects on all three types of ships.
- The antenna environment has the **highest impact**.
- Methods for reducing the impact of multipath, such as **choke ring antennas** and **smoothing**, may be used with very good results.
- Antenna height has a small impact on multipath.
- The receiver type does not have a significant impact on multipath.
- Ship movement has a small impact on multipath. Multipath models should be determined for **calm weather and low ship movement**.
- Differences between GPS and Galileo are small.



## Recommendations regarding multipath for maritime

- Navigation phases can be grouped in **open navigation** (open sea, coastal, fluvial, port approach) and **port navigation**.
- Ships should be classified based on the amount of cluttering around the GNSS antenna. A mapping of the masking surfaces should be considered.
- The ICAO multipath model used in aviation is not suitable for maritime and fluvial navigation.
- Fluvial navigation should be divided into **open fluvial navigation** (wide navigation lanes, no bridges) and **port fluvial navigation** (high buildings on both shores, bridges).
- A **minimum 20° elevation mask** is recommended.
- Multipath models should be built based on measurements recorded in calm weather.
- The requirements on positioning accuracy should depend also on ship movement.
- At least **100 s smoothing** is recommended.
- **Additional integrity methods** should be used at receiver level.

# THANK YOU!



For questions and ideas:

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# Linking space to user needs



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