

Differential Loran Measurement results in the Tampa Bay Harbor

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ILA 2004

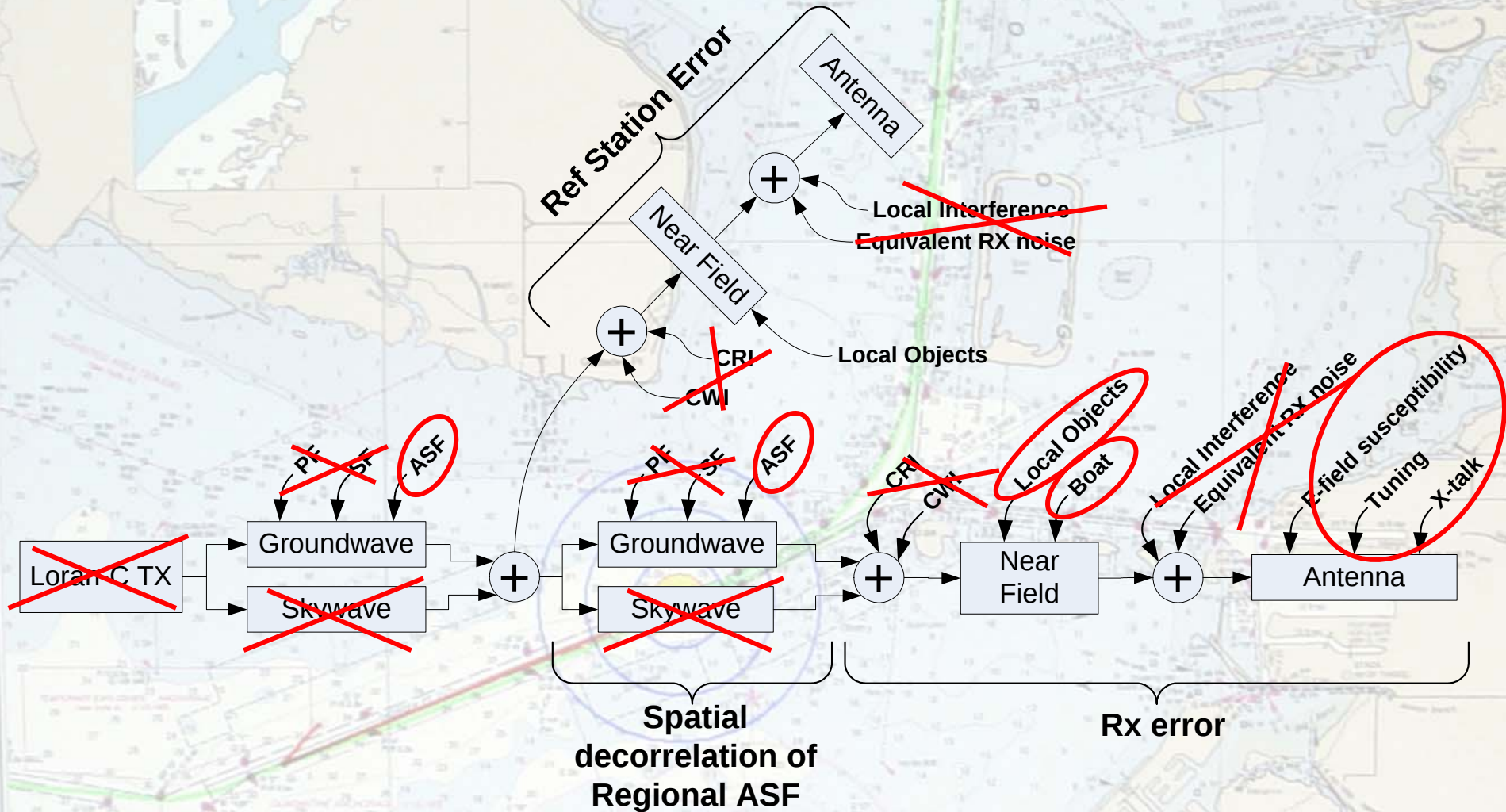
Tokyo, Japan, 25-27 October 2004

The Loran Evaluation Specifics

- Determine whether an enhanced Loran could provide the:
 - *Accuracy*
 - *Availability*
 - *Continuity*
 - *Integrity*
- a) to support Lateral Navigation through all phases of flight – including Non-Precision Approach (NPA)
- b) to support Harbor Entrance and Approach (HEA) for maritime users

* Not a part of the Technical Evaluation

Error Budget

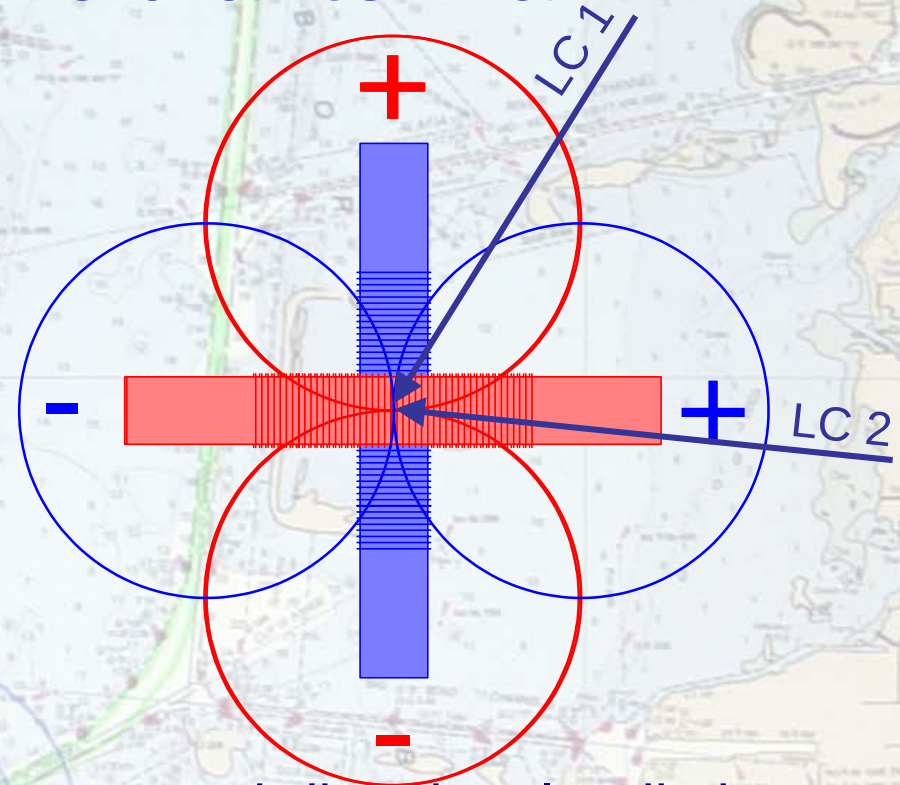


H-field Antenna Design Issues

Why use a H-field antenna and not an E-field

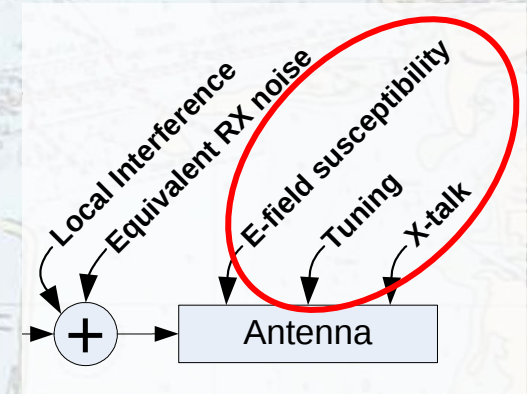
- 'no' P-static susceptibility
- Less susceptible to near-field phenomena (?)
- no grounding needed
- Low profile

Rotating a H-field antenna



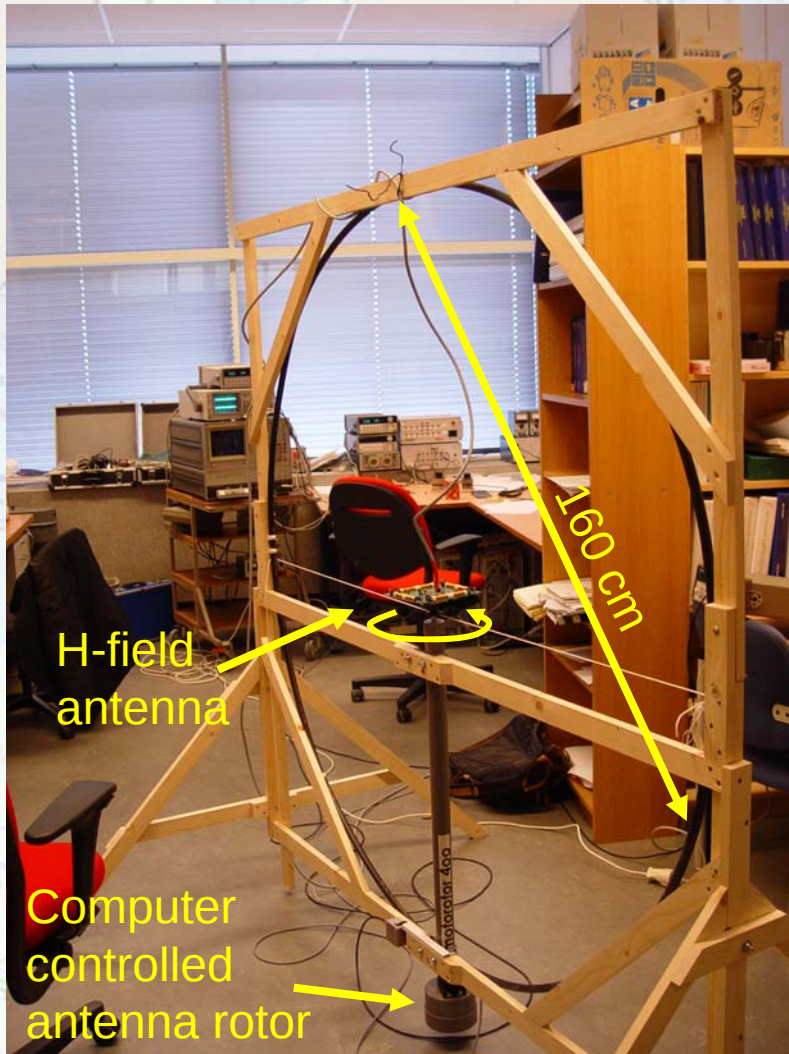
- We need 2 H-field antennas for an omni-directional radiation pattern
- H-field antenna bias-errors are heading dependant
- So they are different for all tracked stations
- And therefore they degrade positioning accuracy

H-field Antenna Heading Dependant Errors

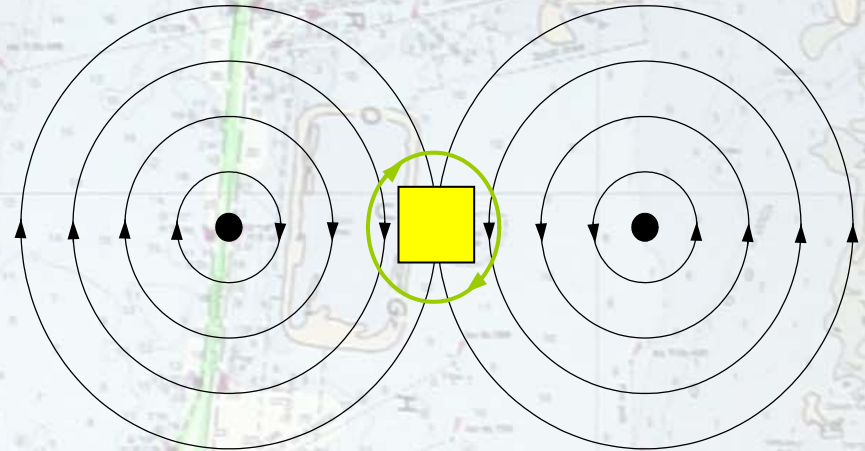


- E-field susceptibility
 - Tuning
 - Cross-talk
- Shielding / balancing
} correction

X-talk: Measurement of parameters



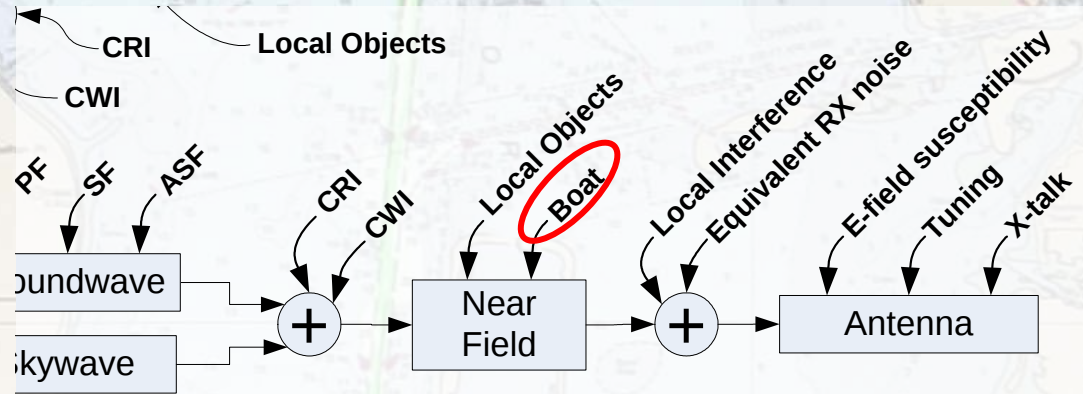
Measurement Setup



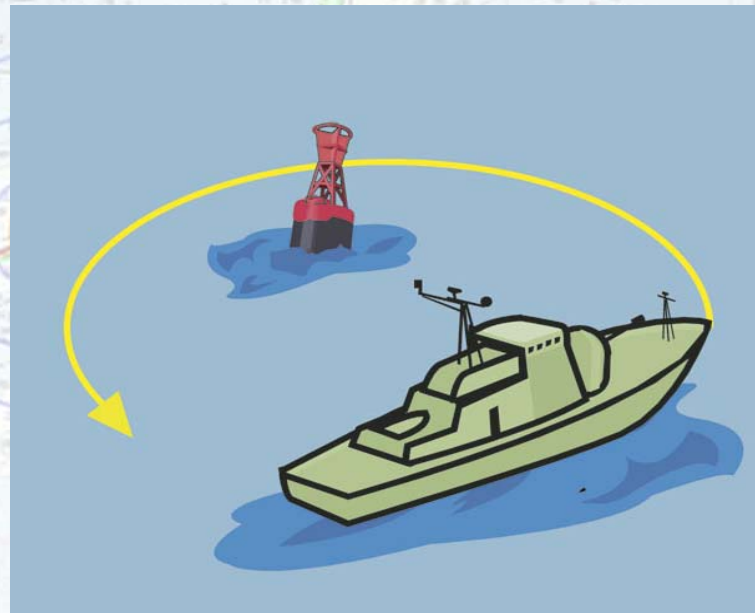
Cross-section of measurement setup

The H-field antenna (yellow box) is rotated inside a measurement loop. The field at the centre of the loop is quite homogeneous due to the large diameter of the loop (1.60m)

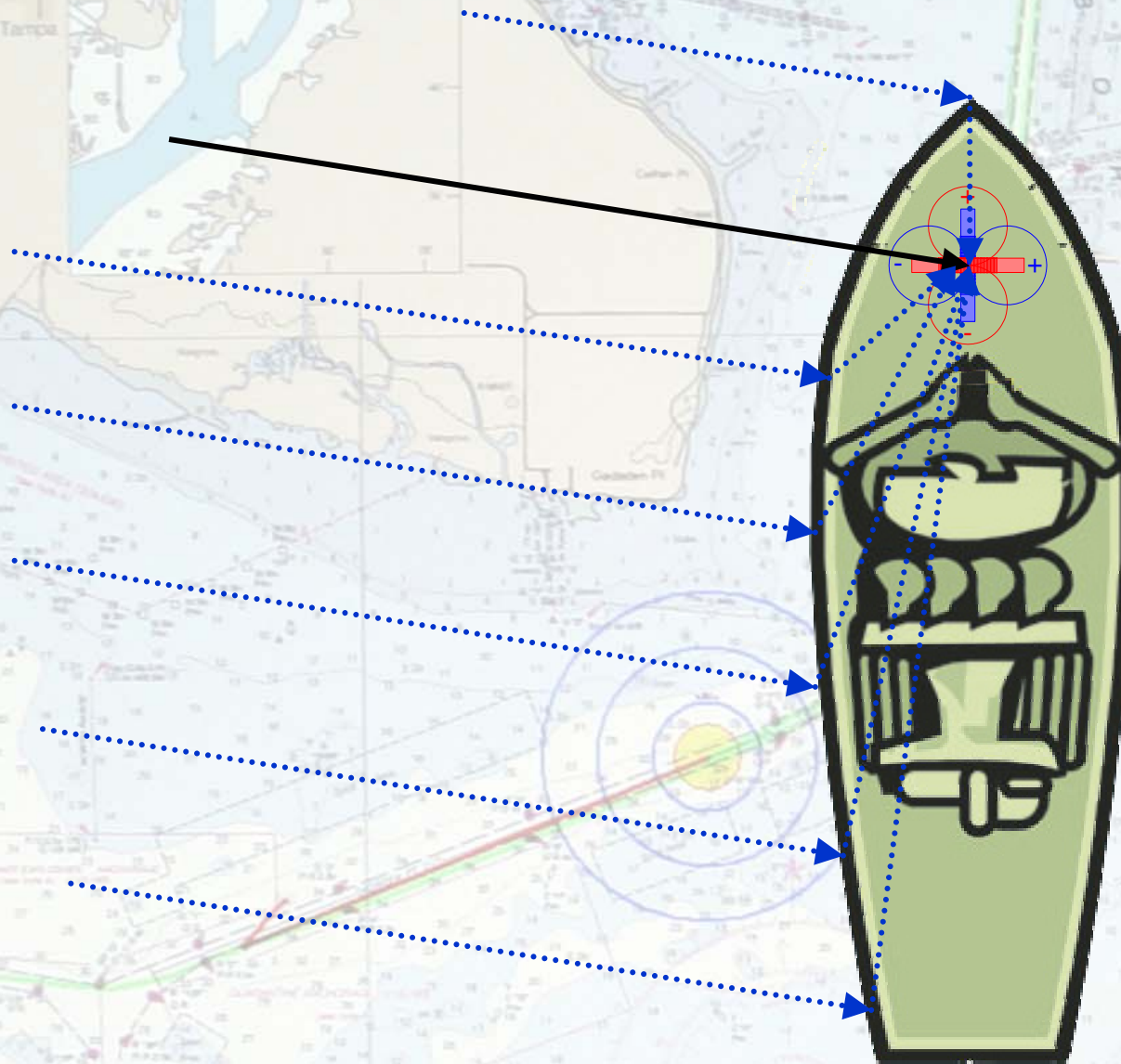
Now We Can Rotate the Antenna...



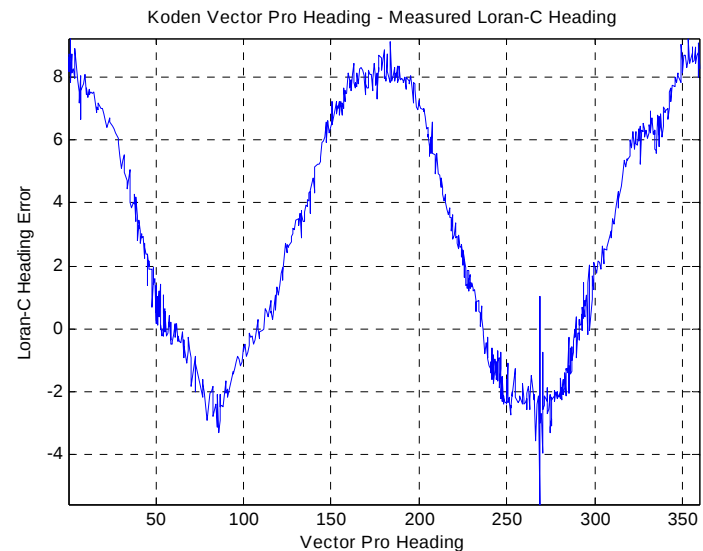
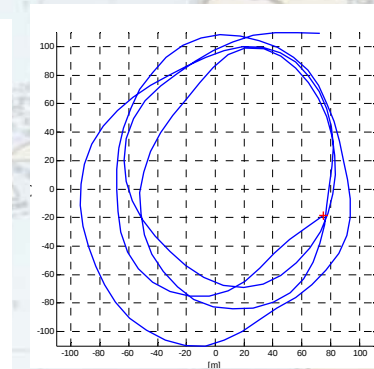
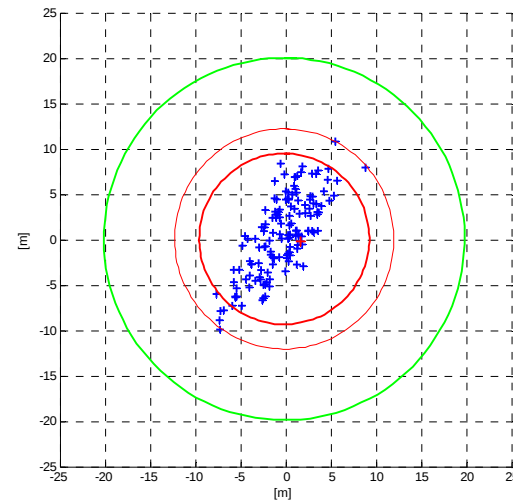
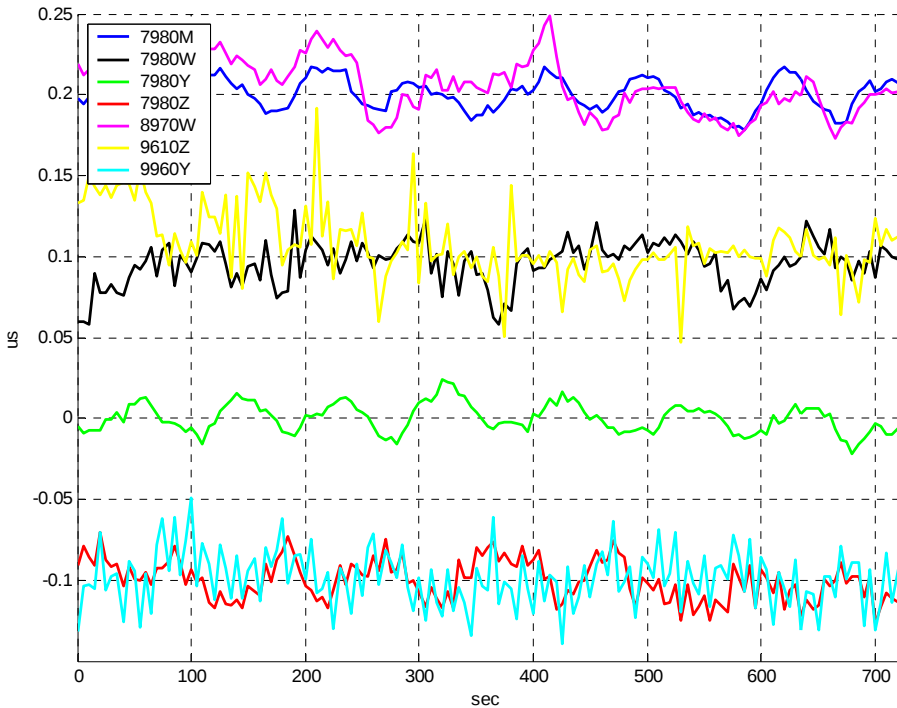
... rotate the vessel



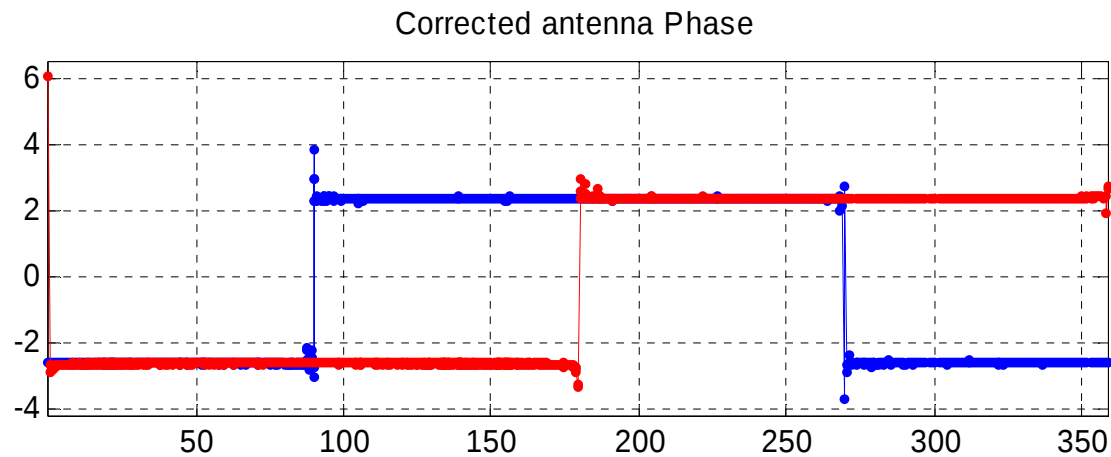
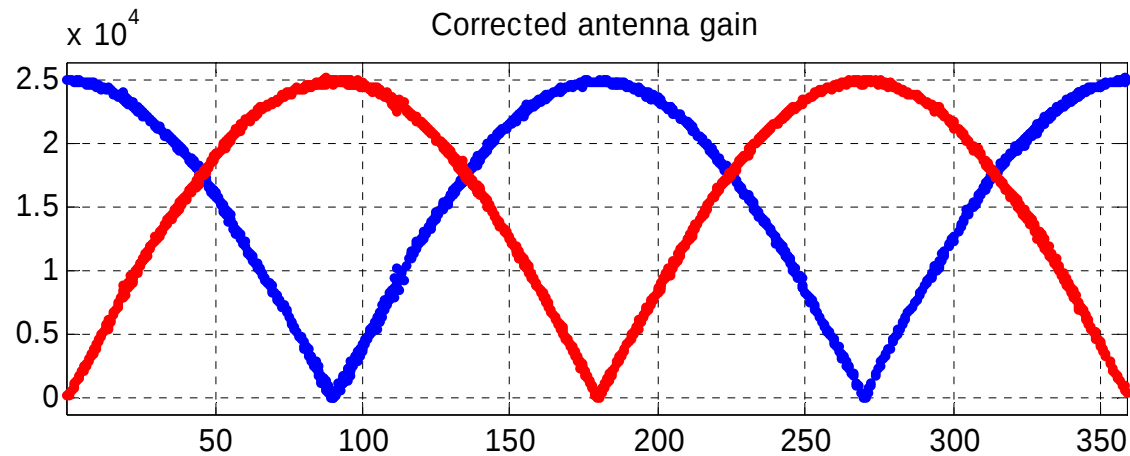
Influence of Vessel on Received Phase



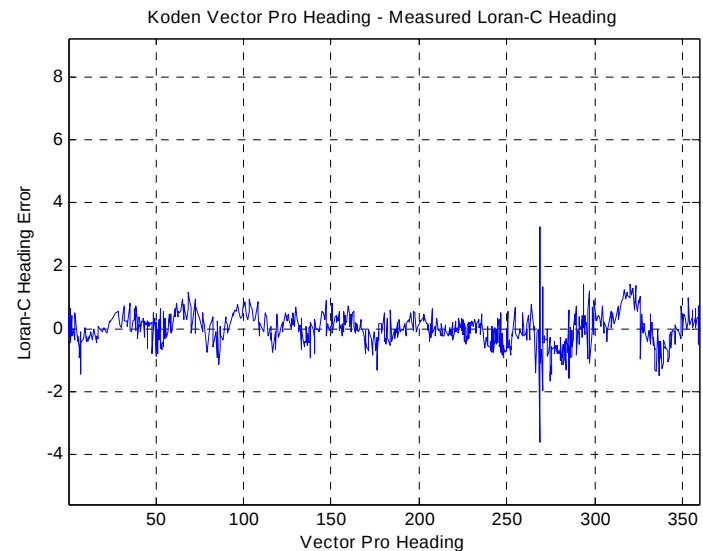
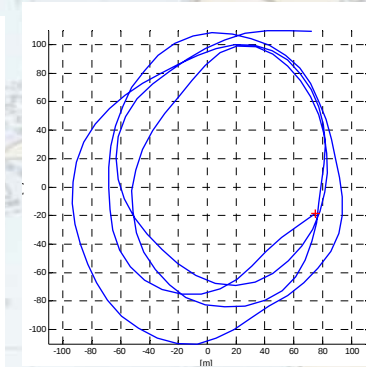
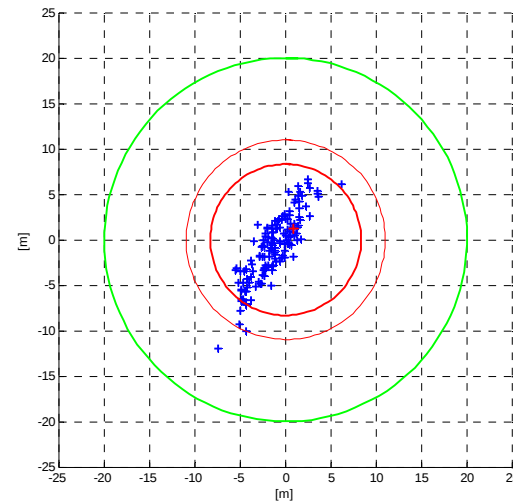
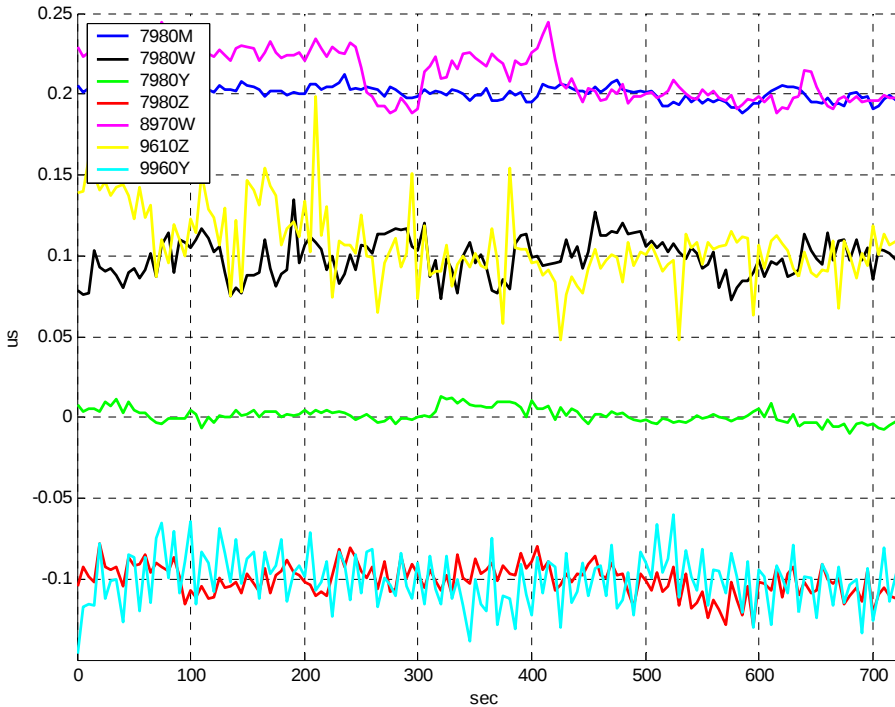
Take the Boat for a spin...



Compensating for the Vessels influence

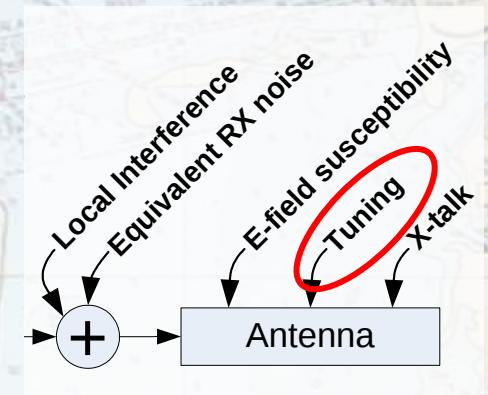
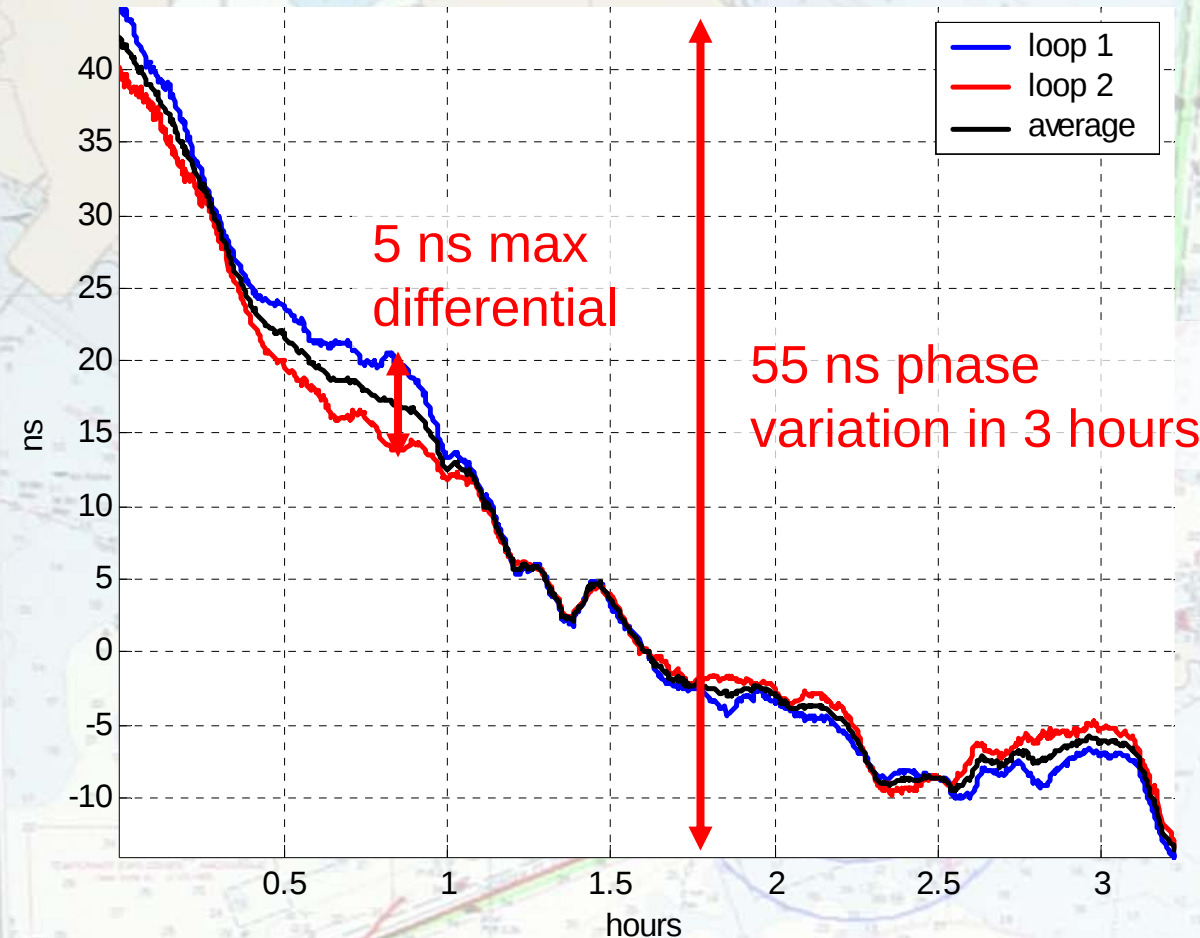


Before and After Calibration



Temperature Compensation H-field Antenna

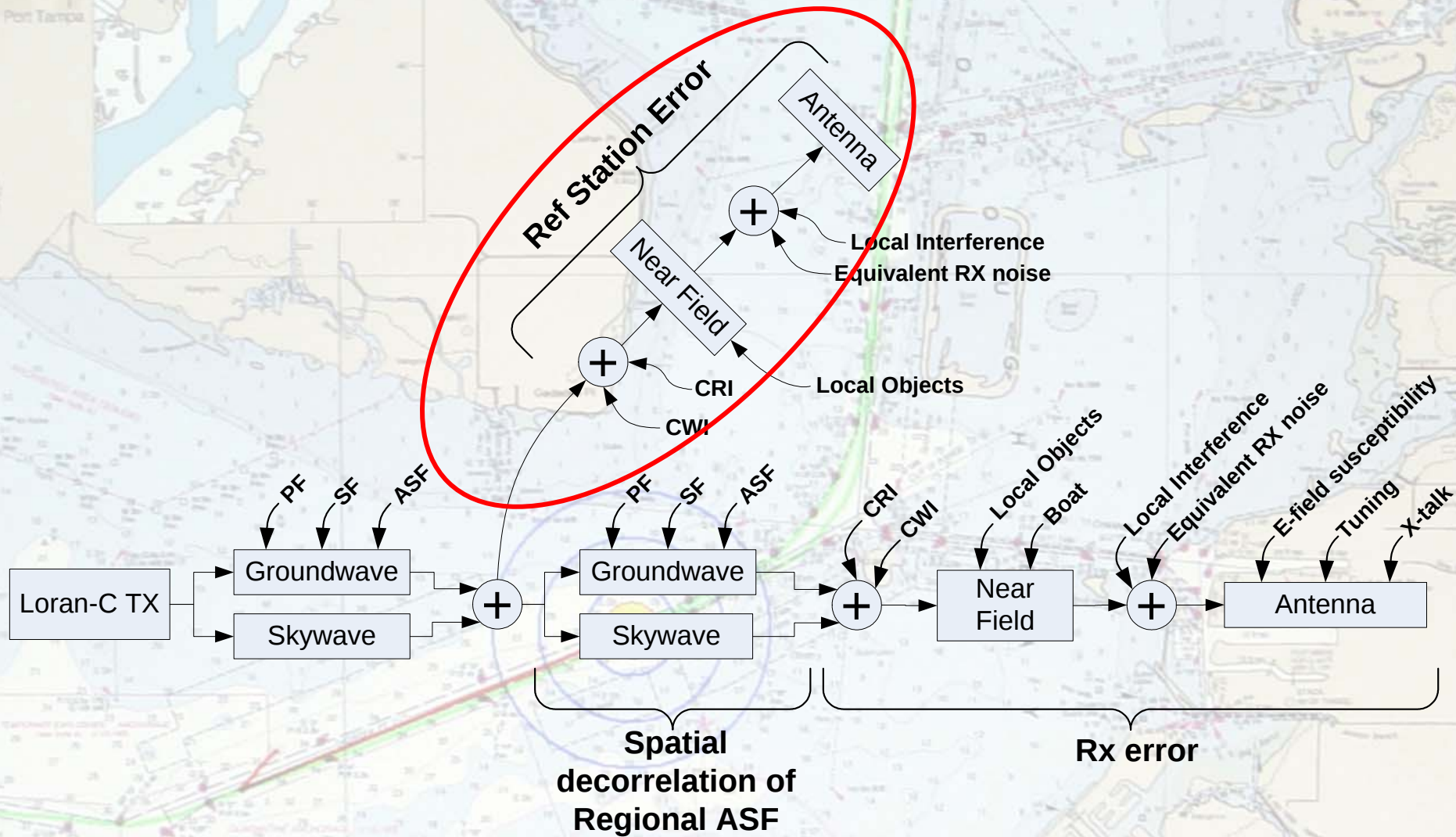
Measured simulator response



Phase drift common on both loop is NOT a positioning issue...

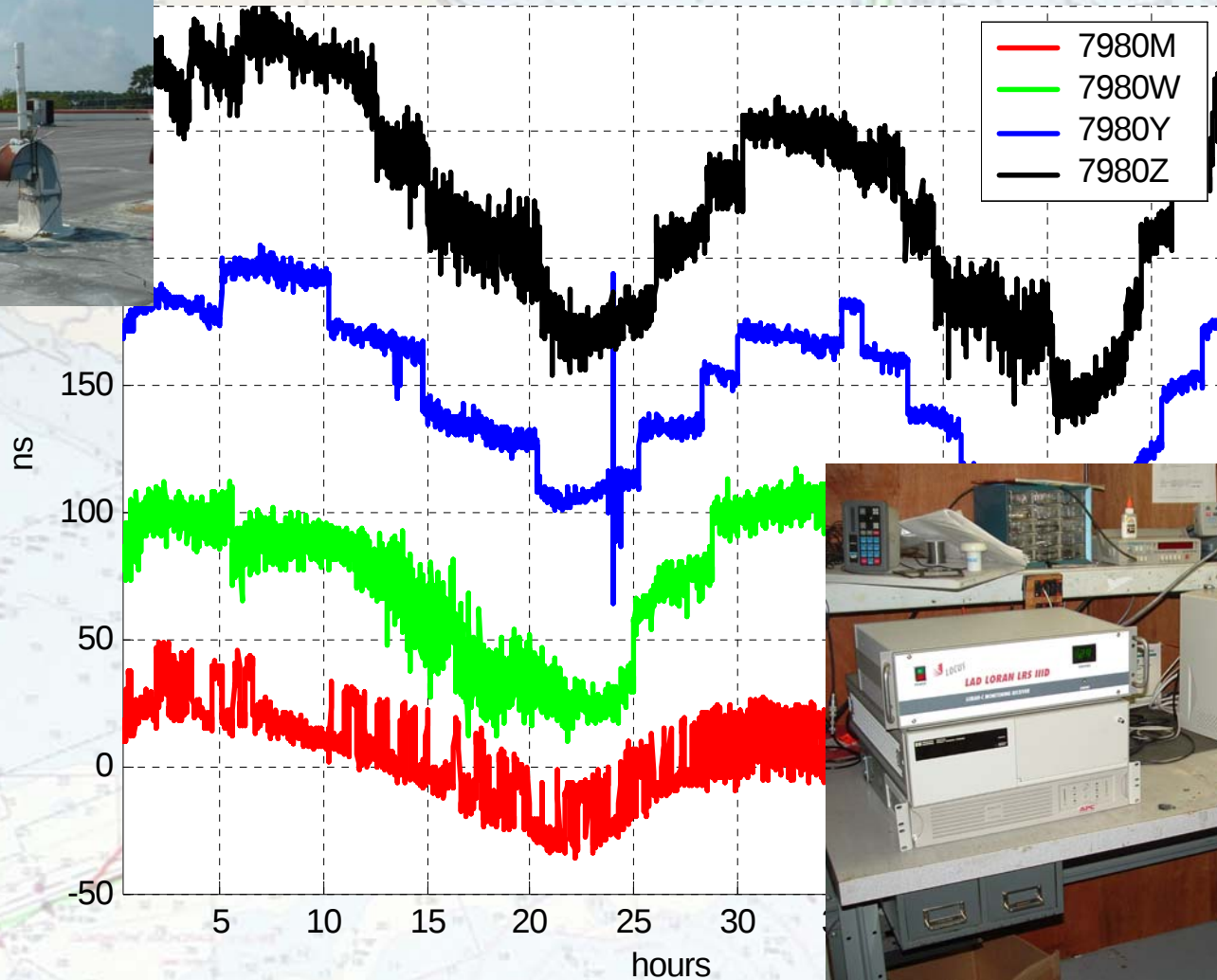
... But degrades ASF / Timing measurement accuracy!

Reference Station



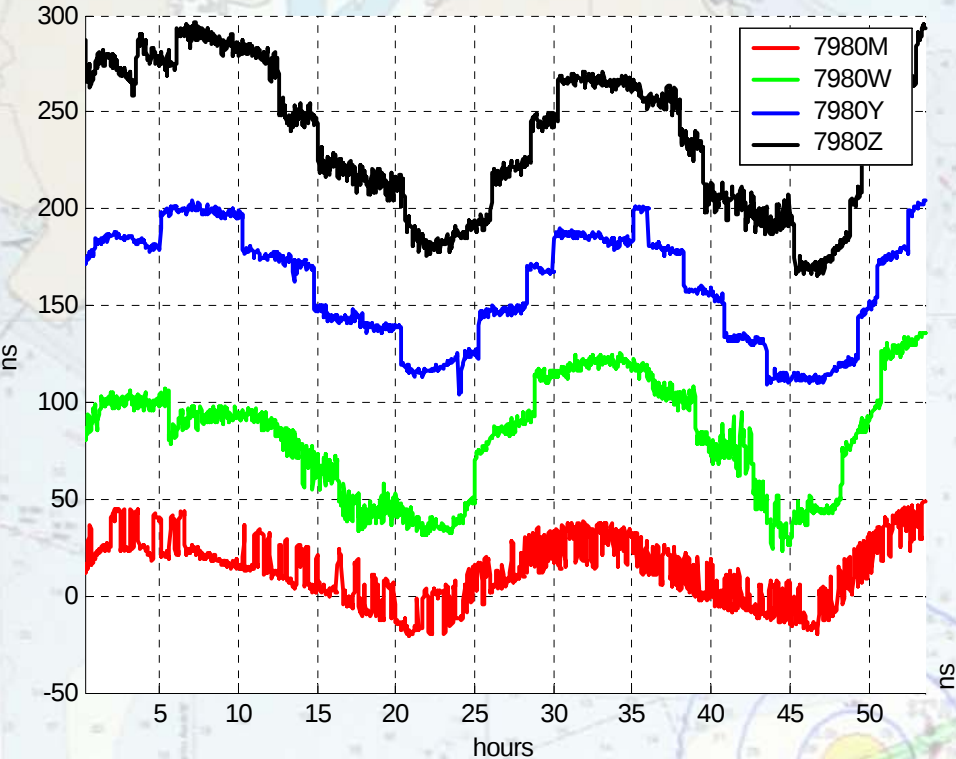
Diurnal + TX Timing → Refstation

Reference Station TOA - 30 seconds averaged

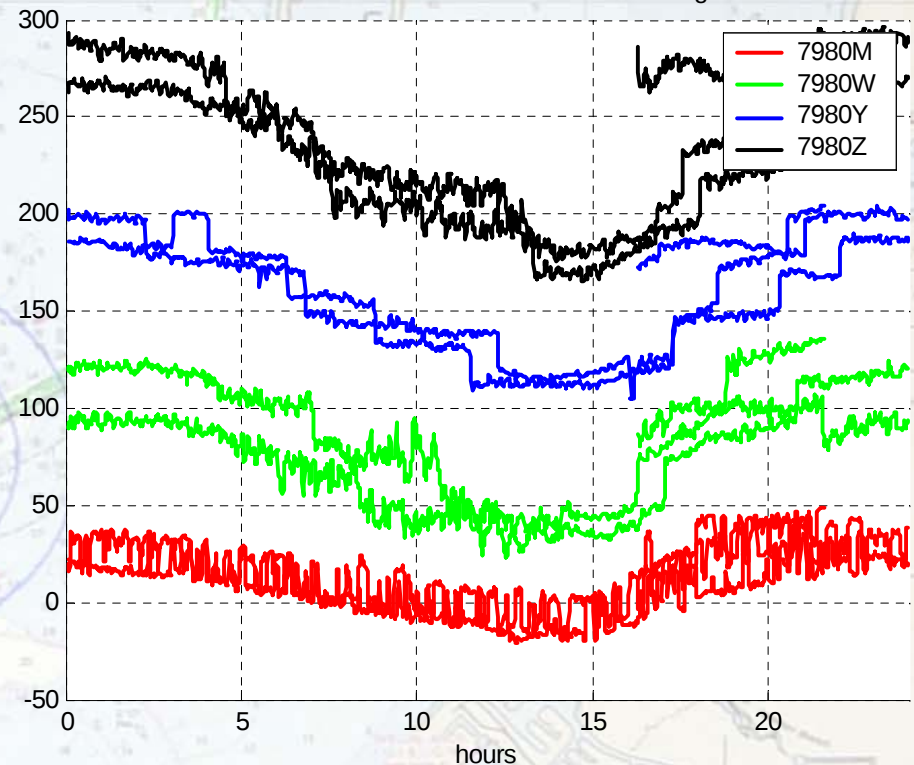


SAM Control & Diurnal Effects

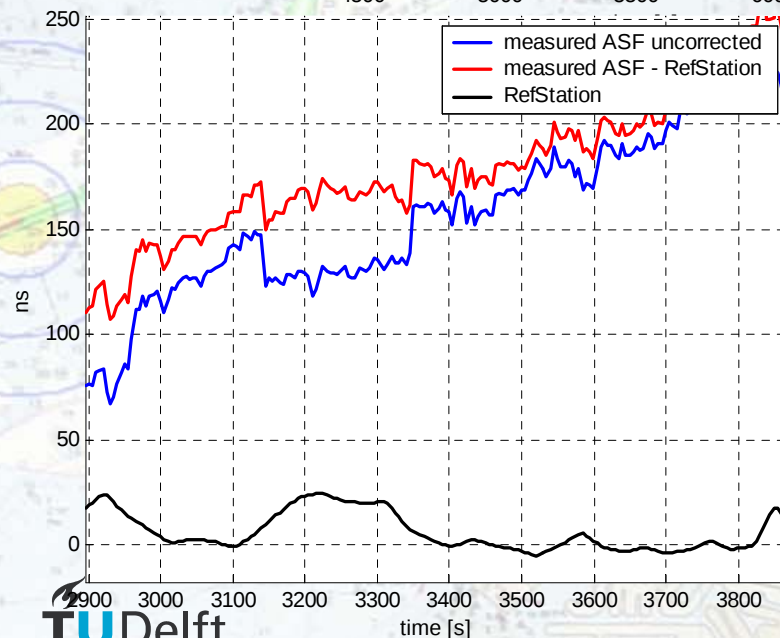
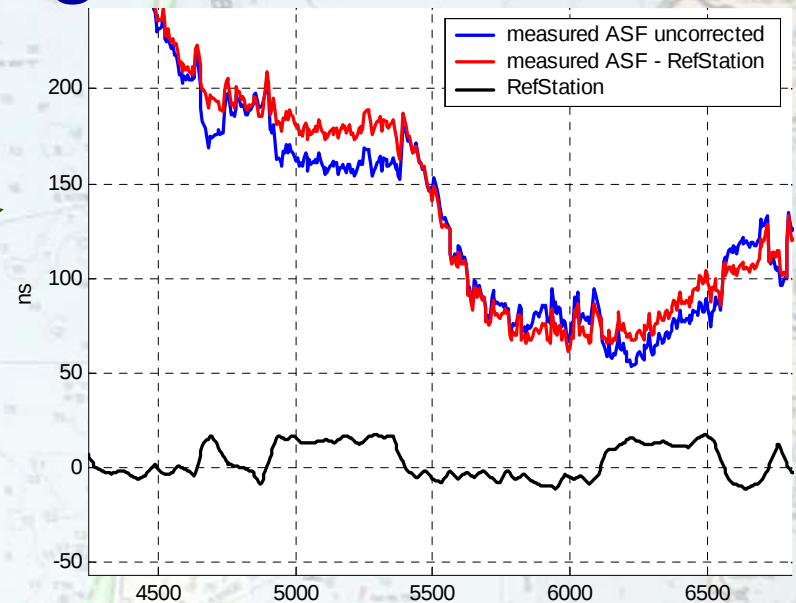
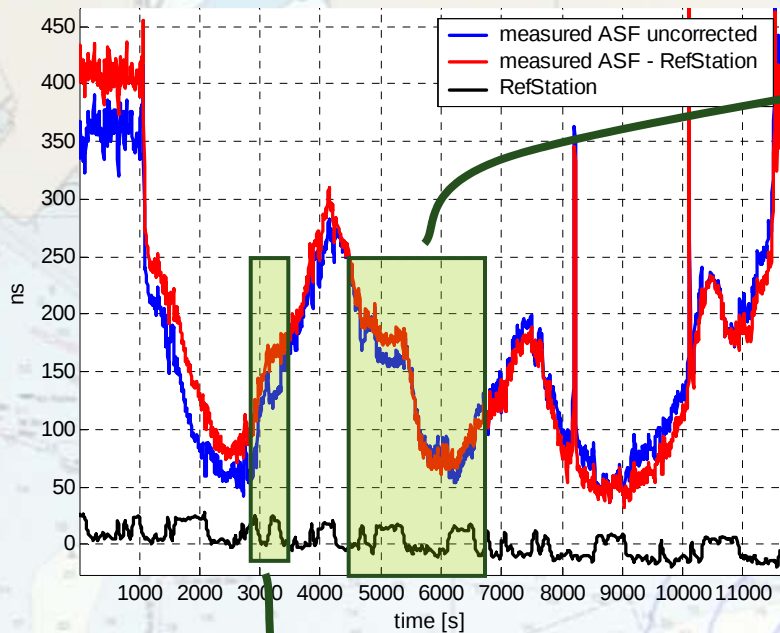
Reference Station TOA - 5 minutes averaged



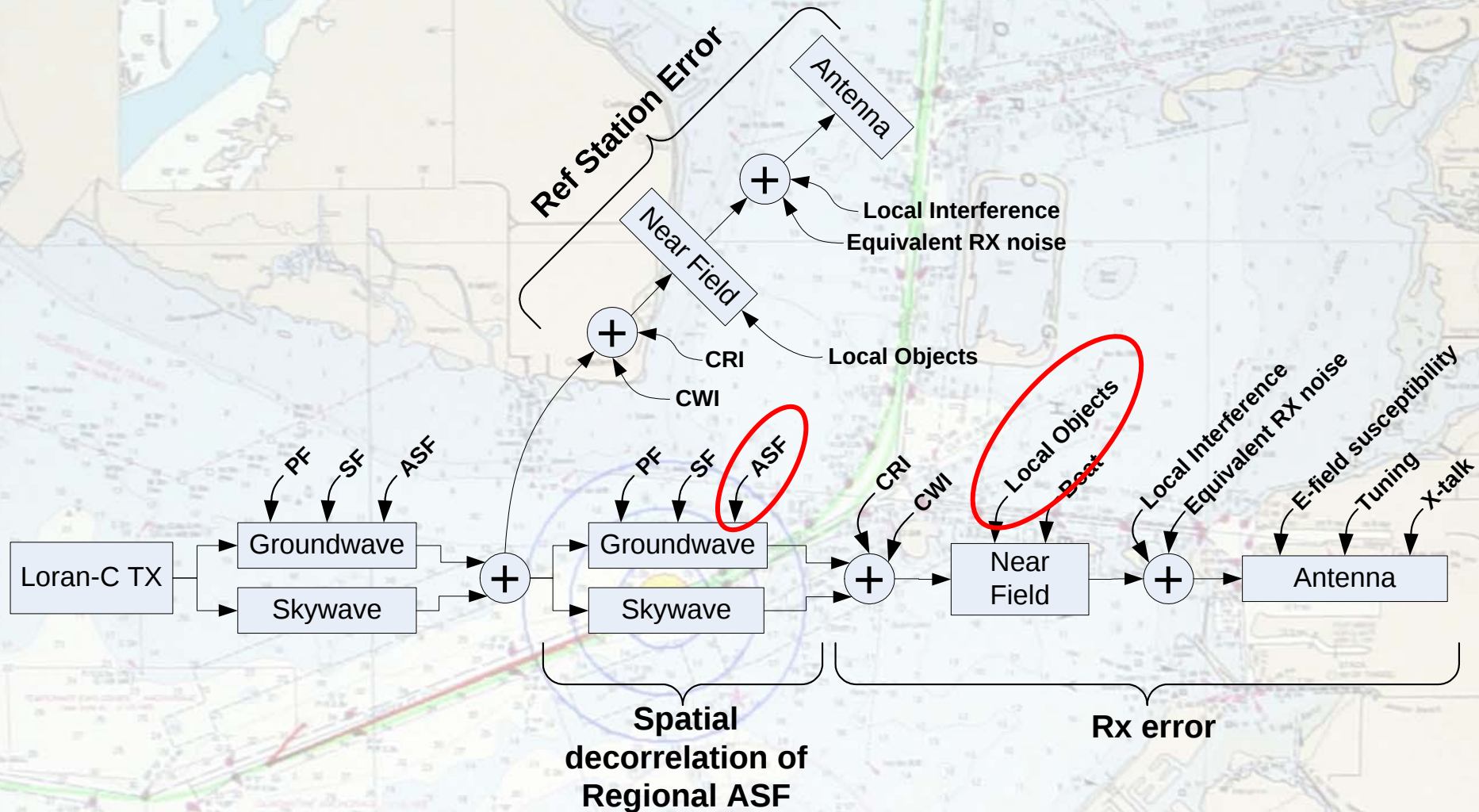
Reference Station TOA - 5 minutes averaged



LPA Removal using RefStation



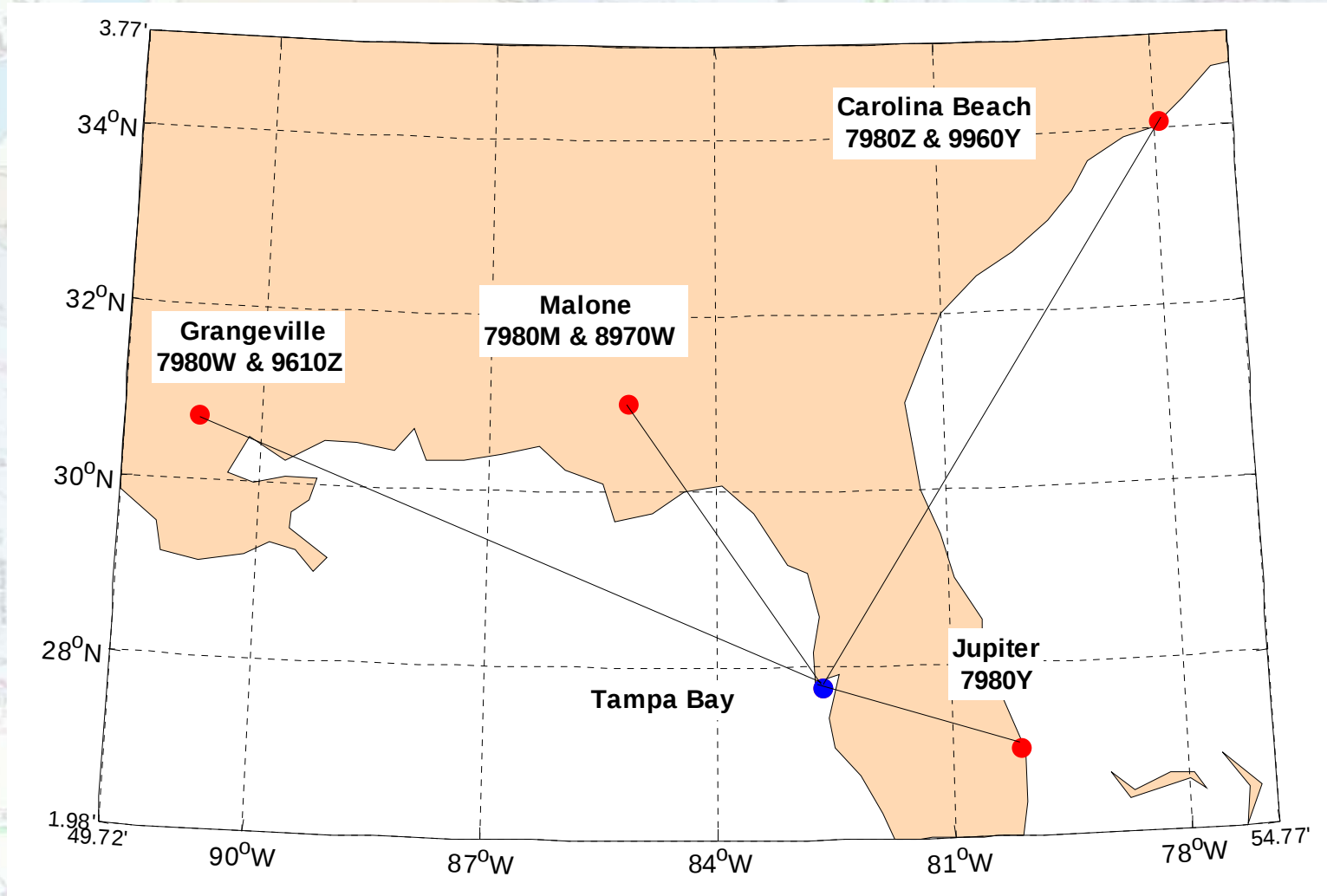
Error Budget: ASF & Local Objects



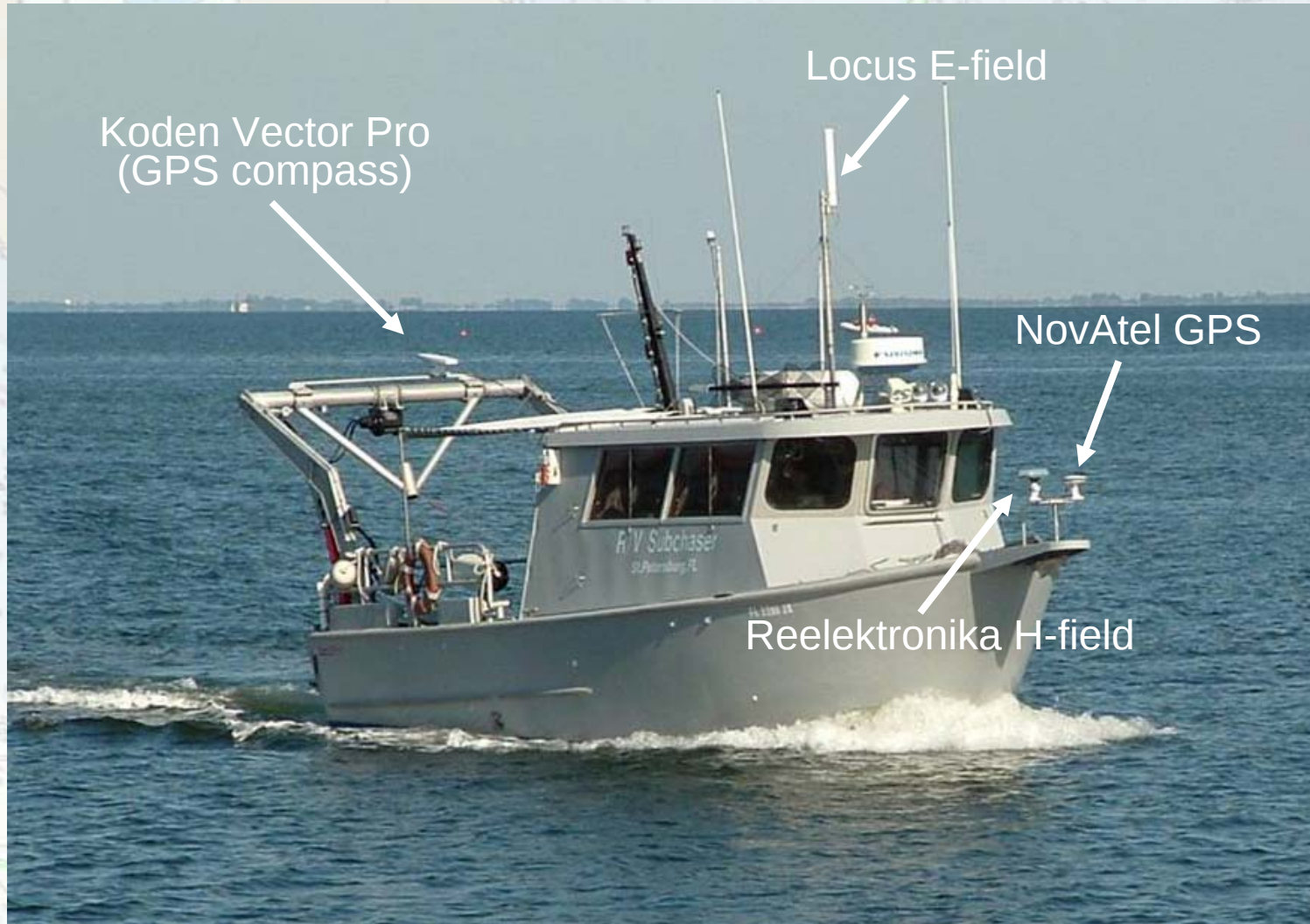
Time to go to Florida!



eLoran station constellation at Tampa Bay



R.V. Subchaser

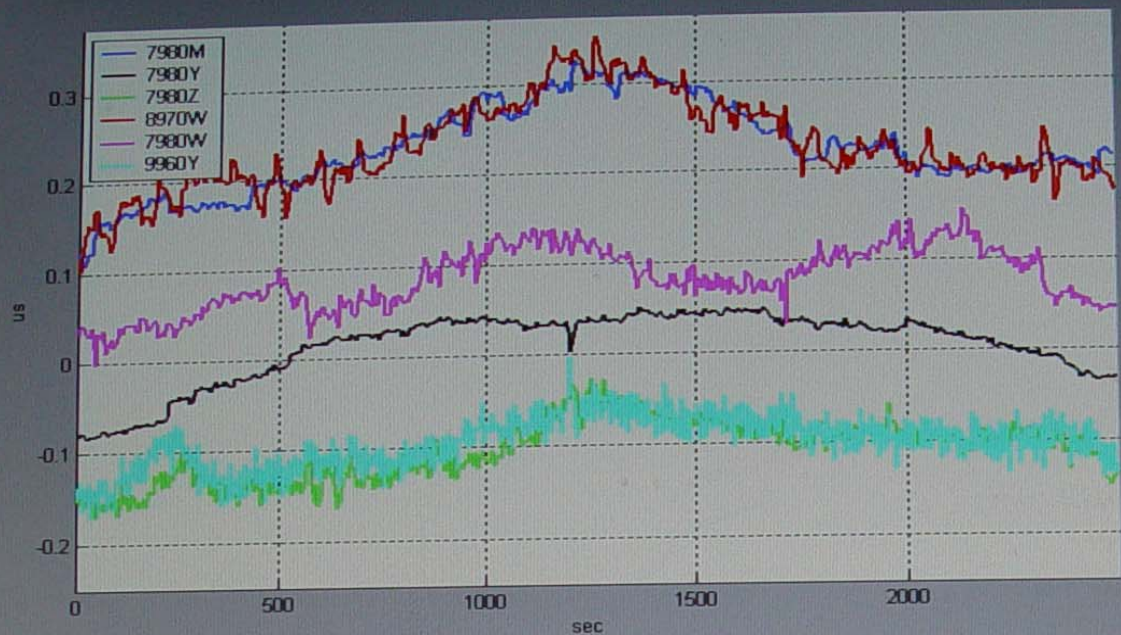


Measuring under rough conditions

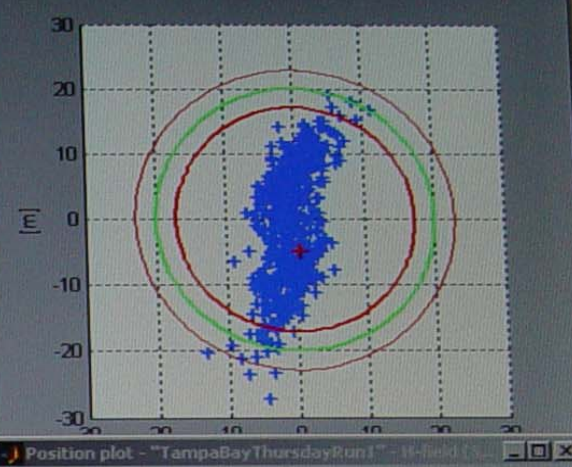
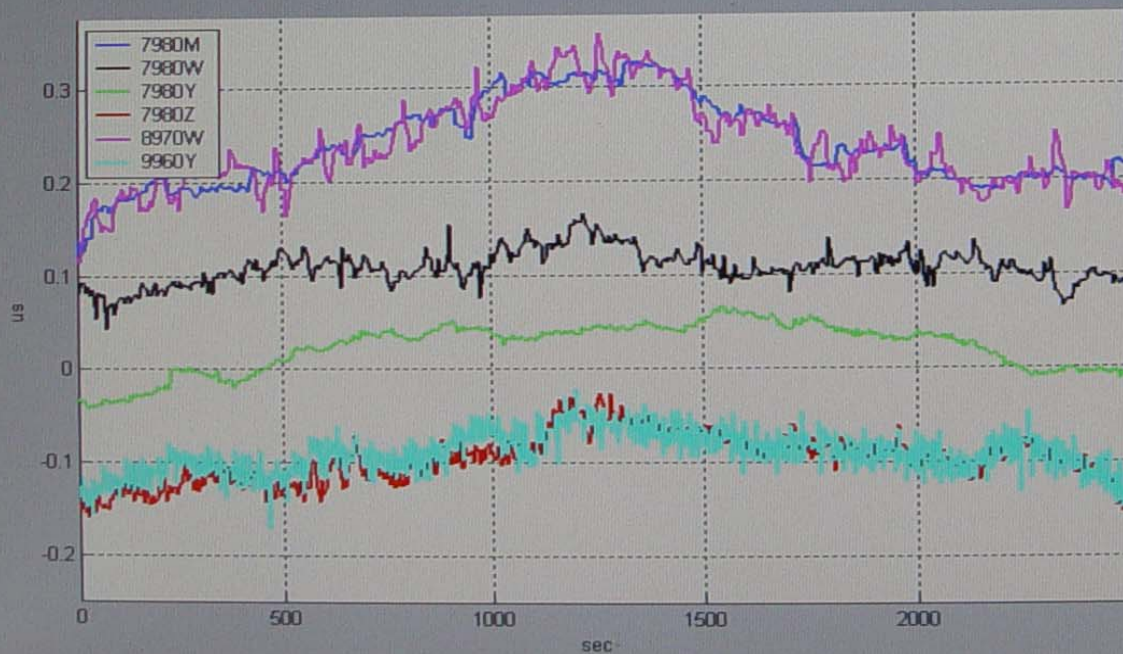
High seas and strong winds



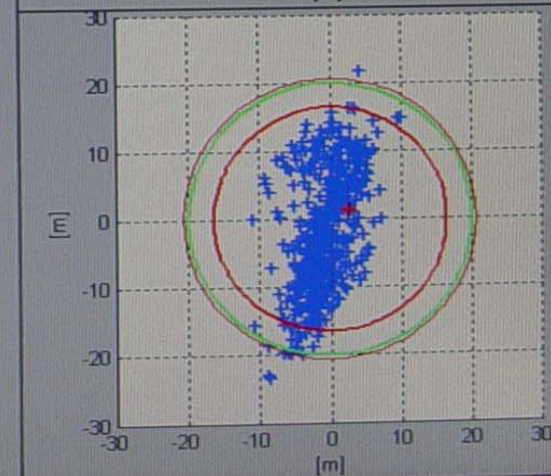
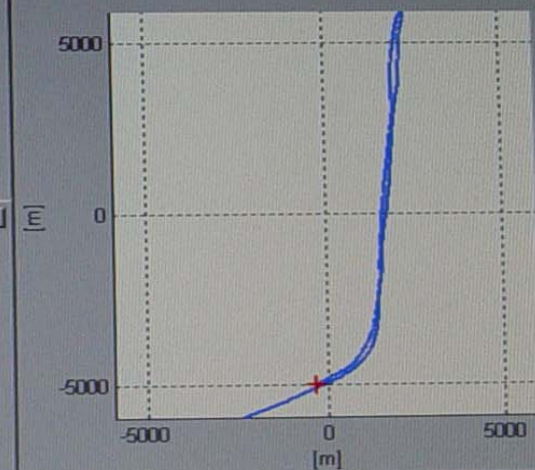
Measurements taken at an average speed of 20 knots



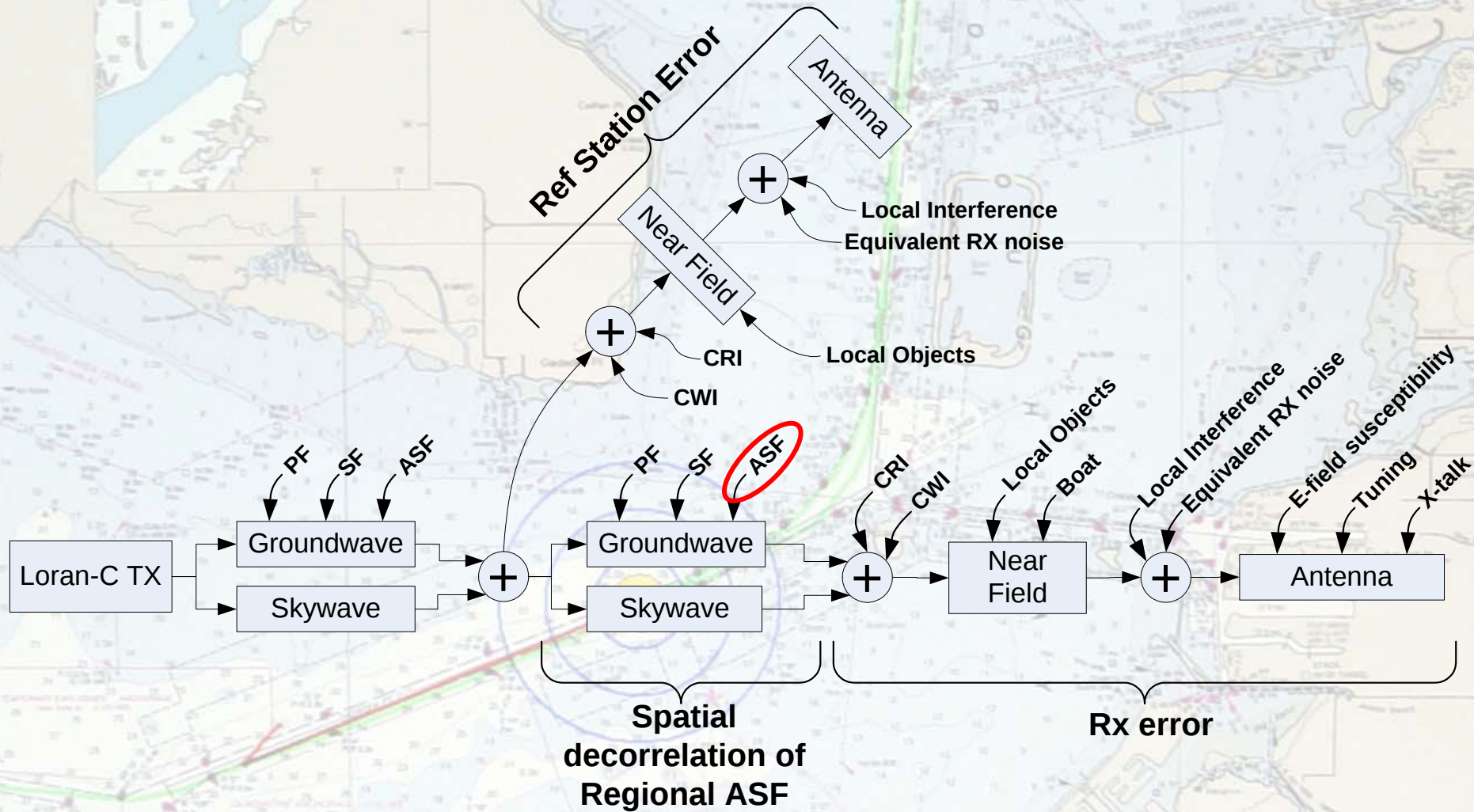
dASF plot - "TampaBayThursdayRun1" - E-field (5416.09)



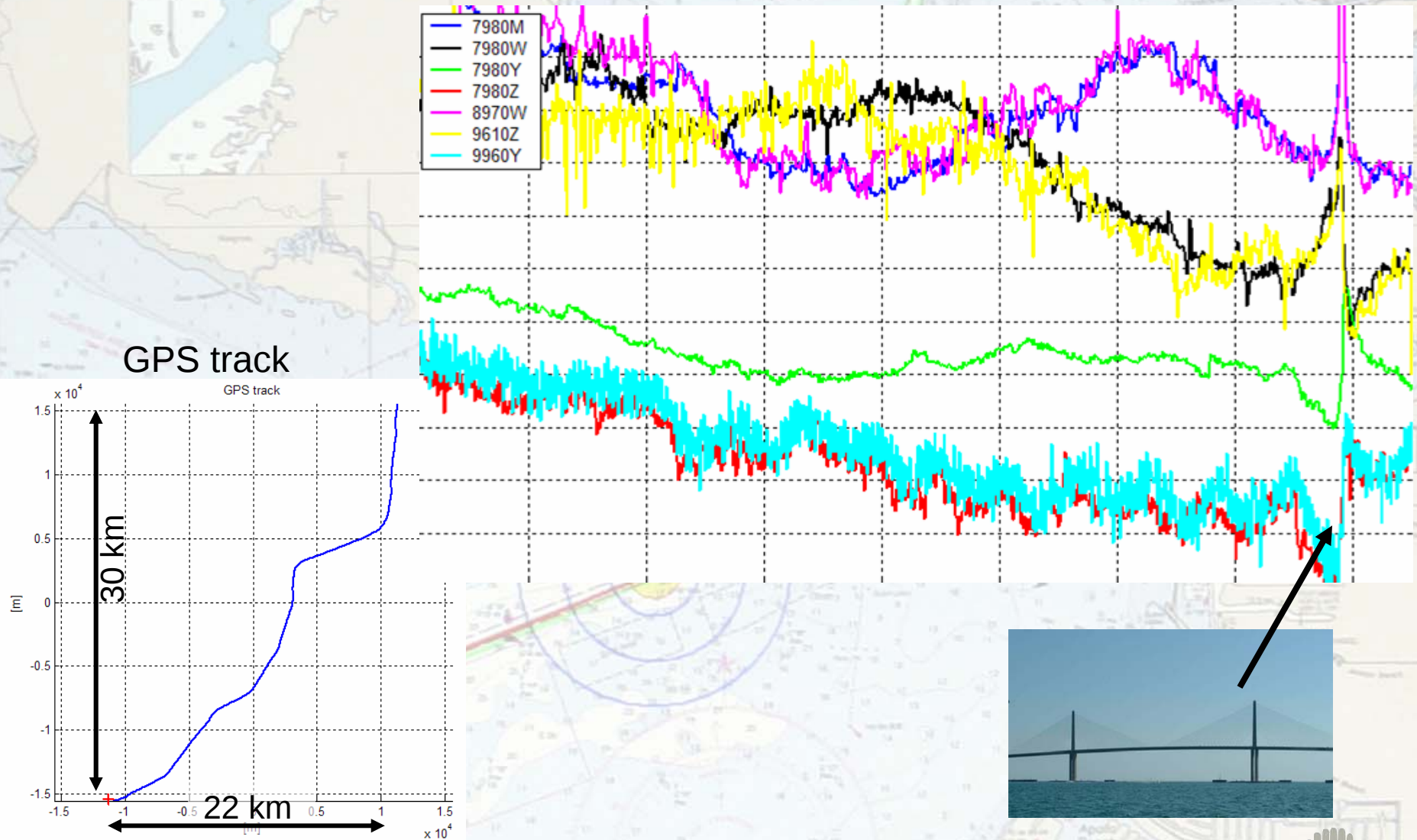
Position plot - "TampaBayThursdayRun1" - W-field (5416.09)

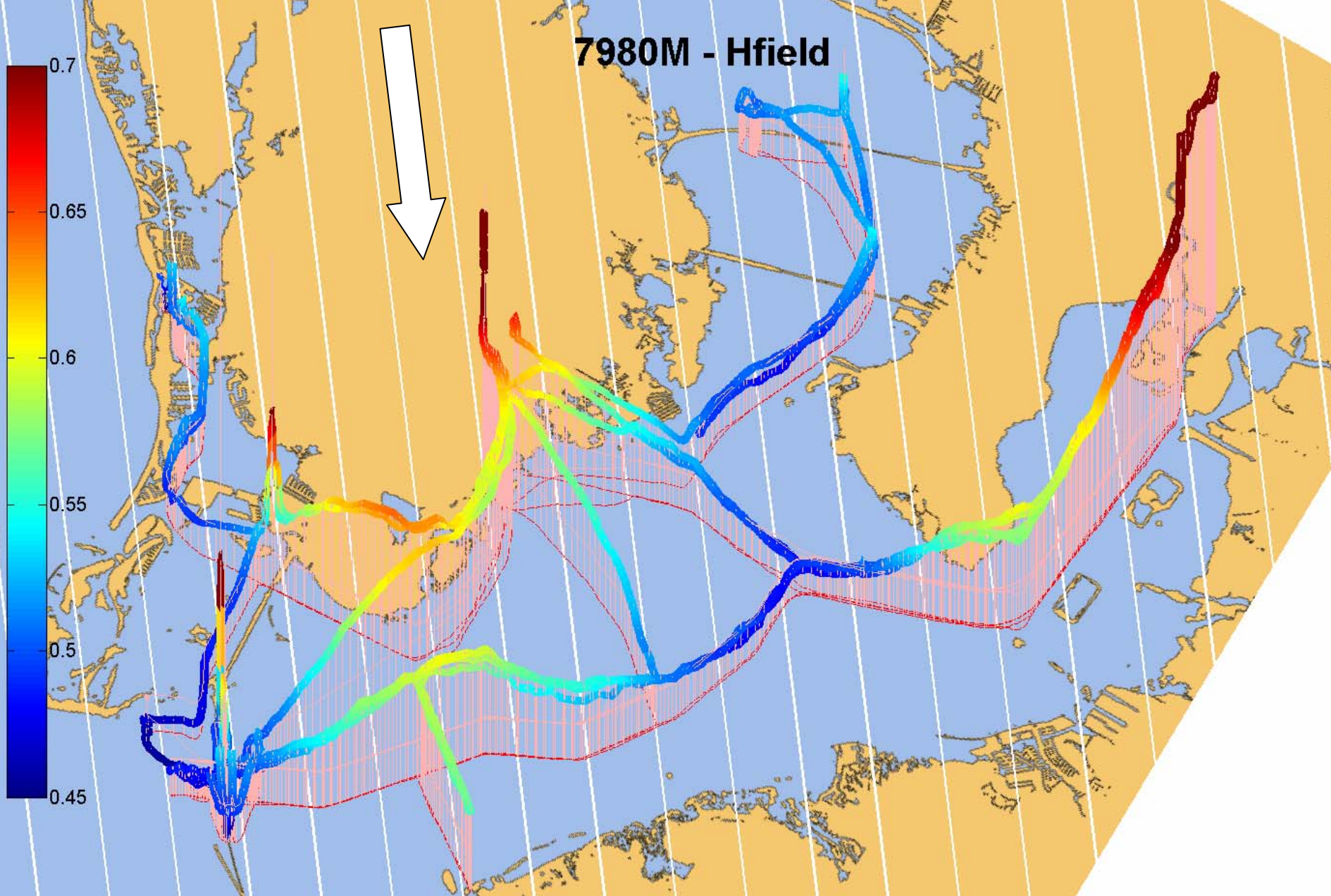


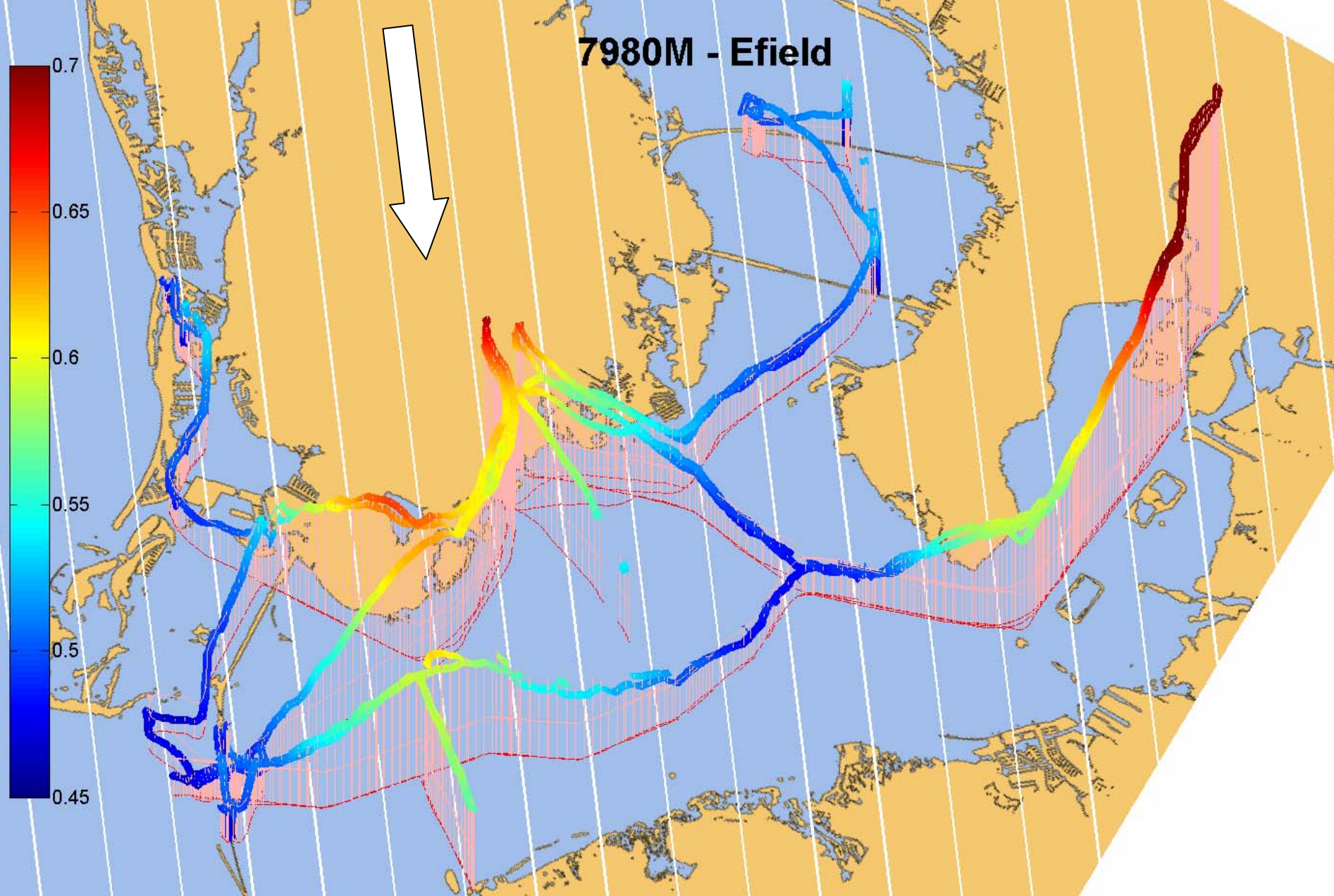
Error Budget: ASF



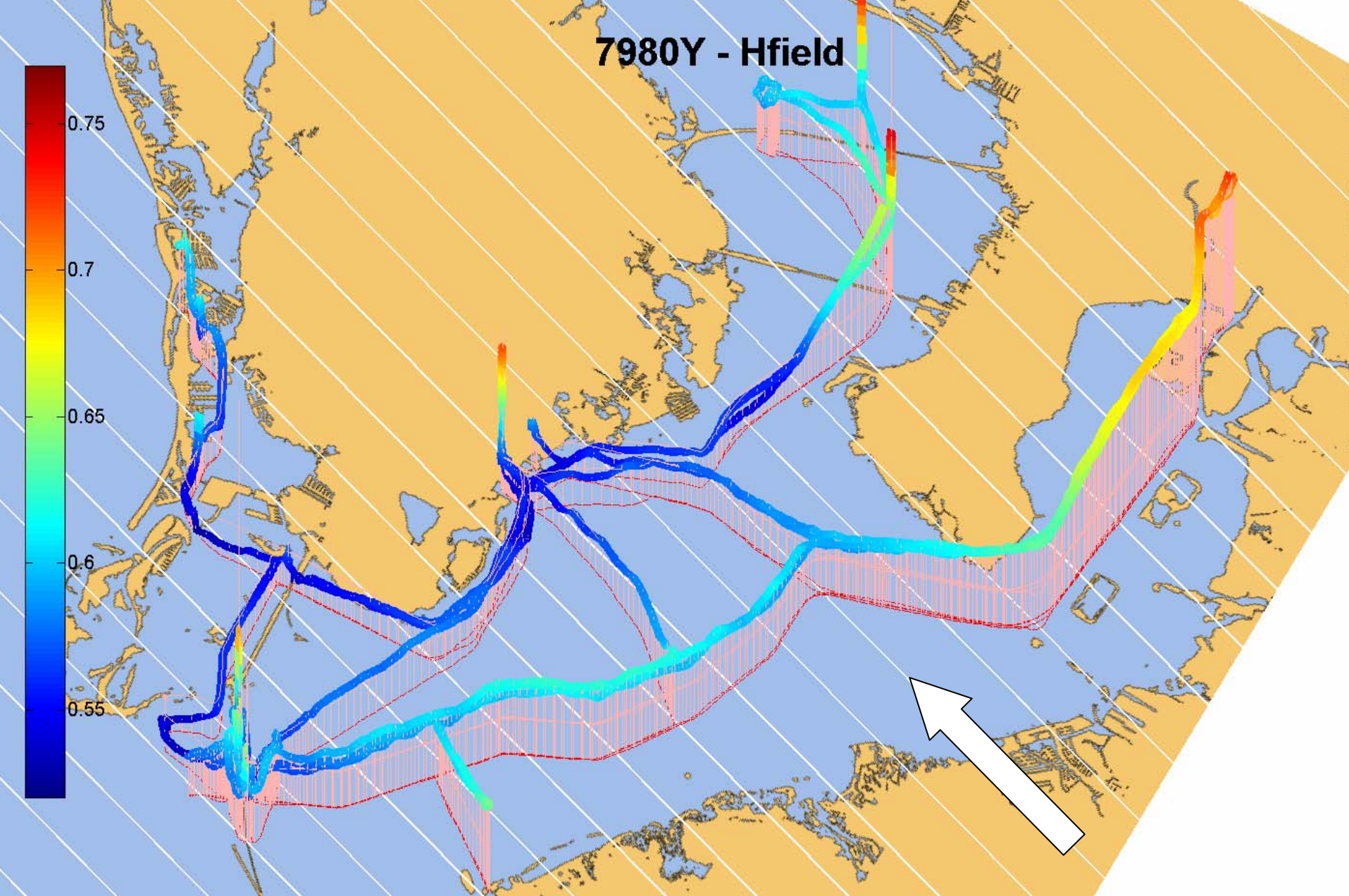
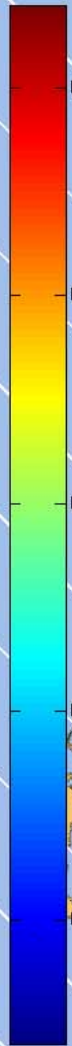
Measured ASFs on Channel (H-field)



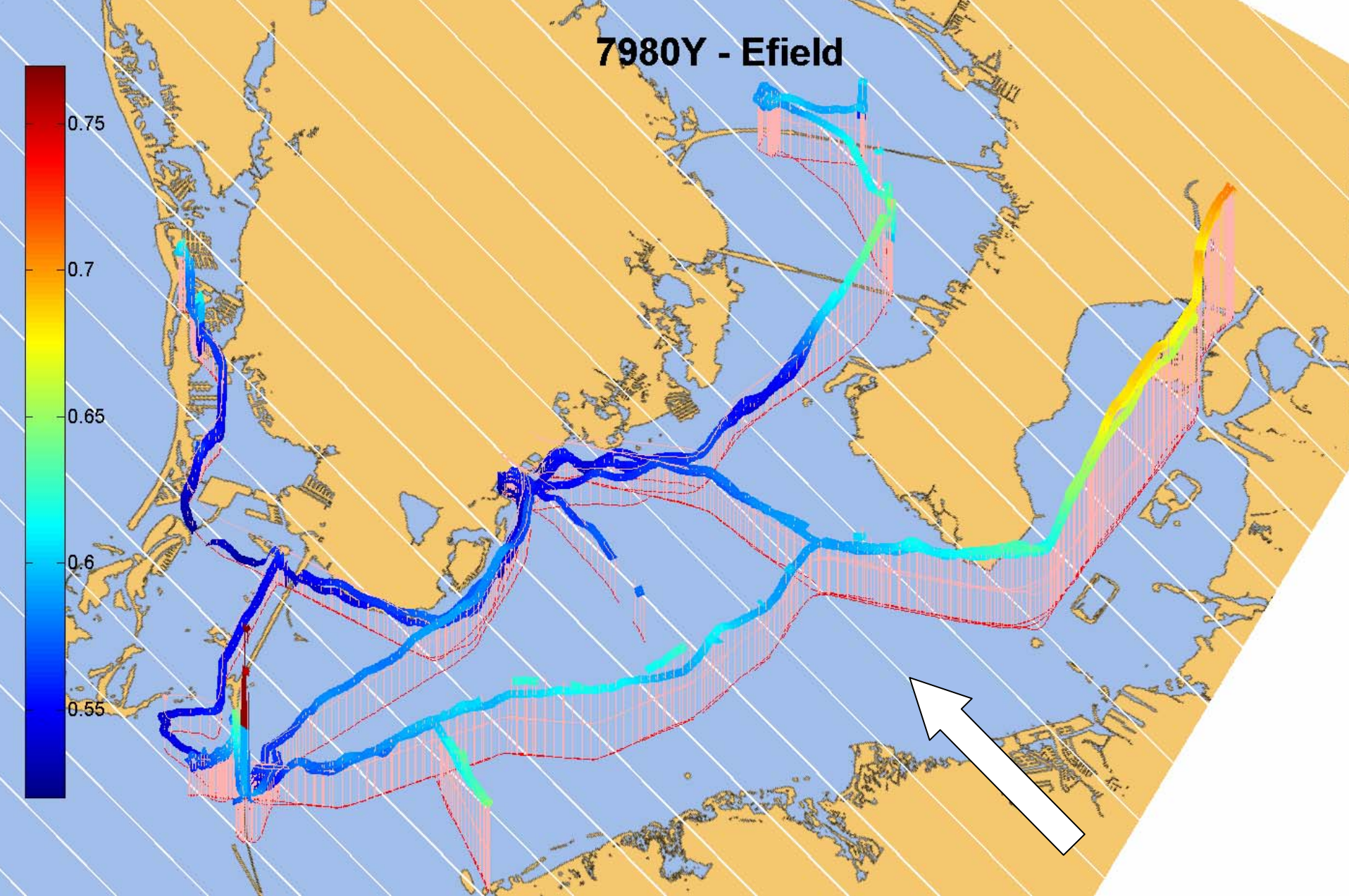
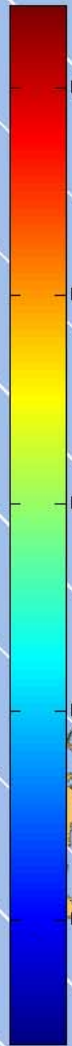


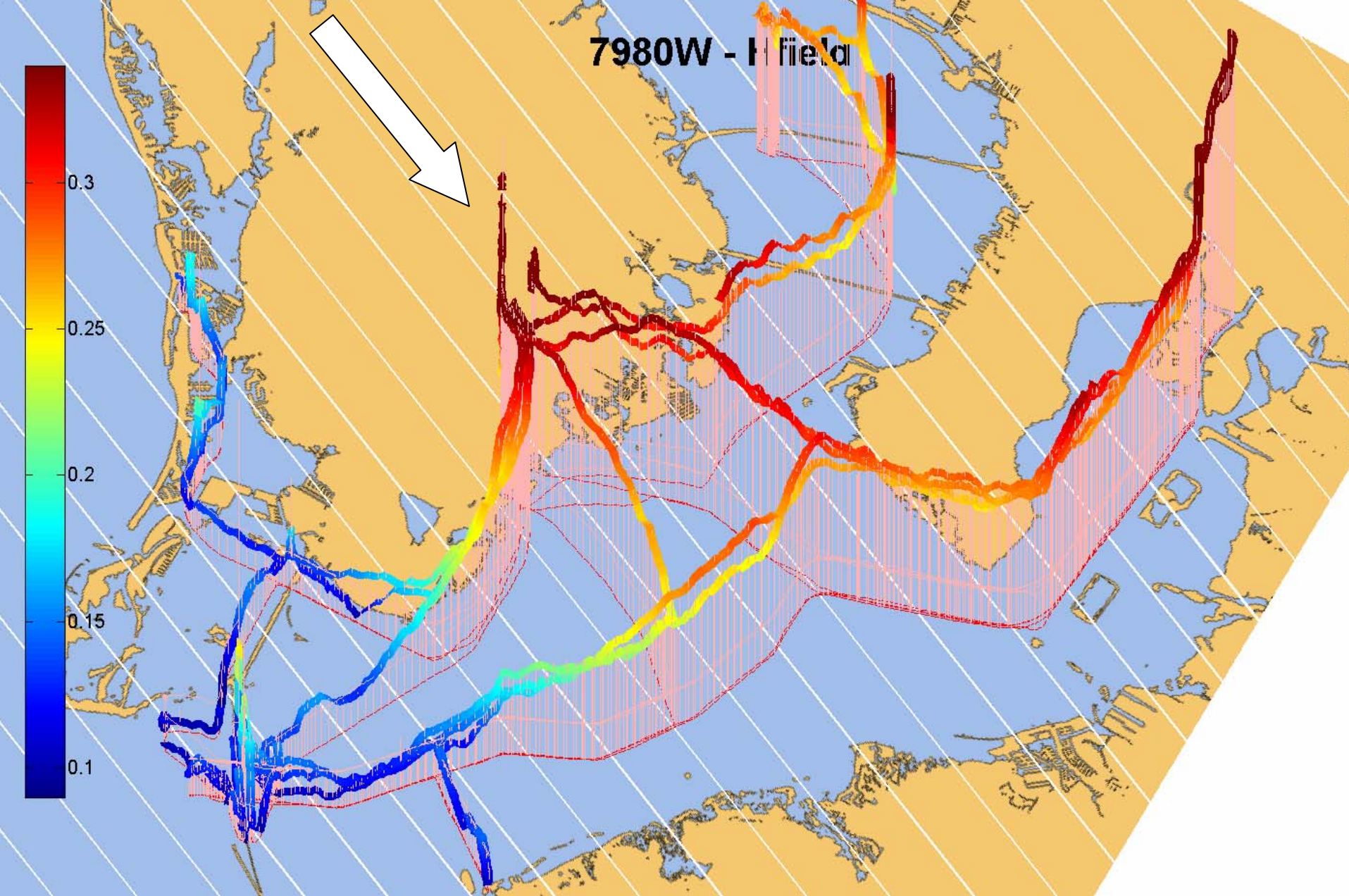


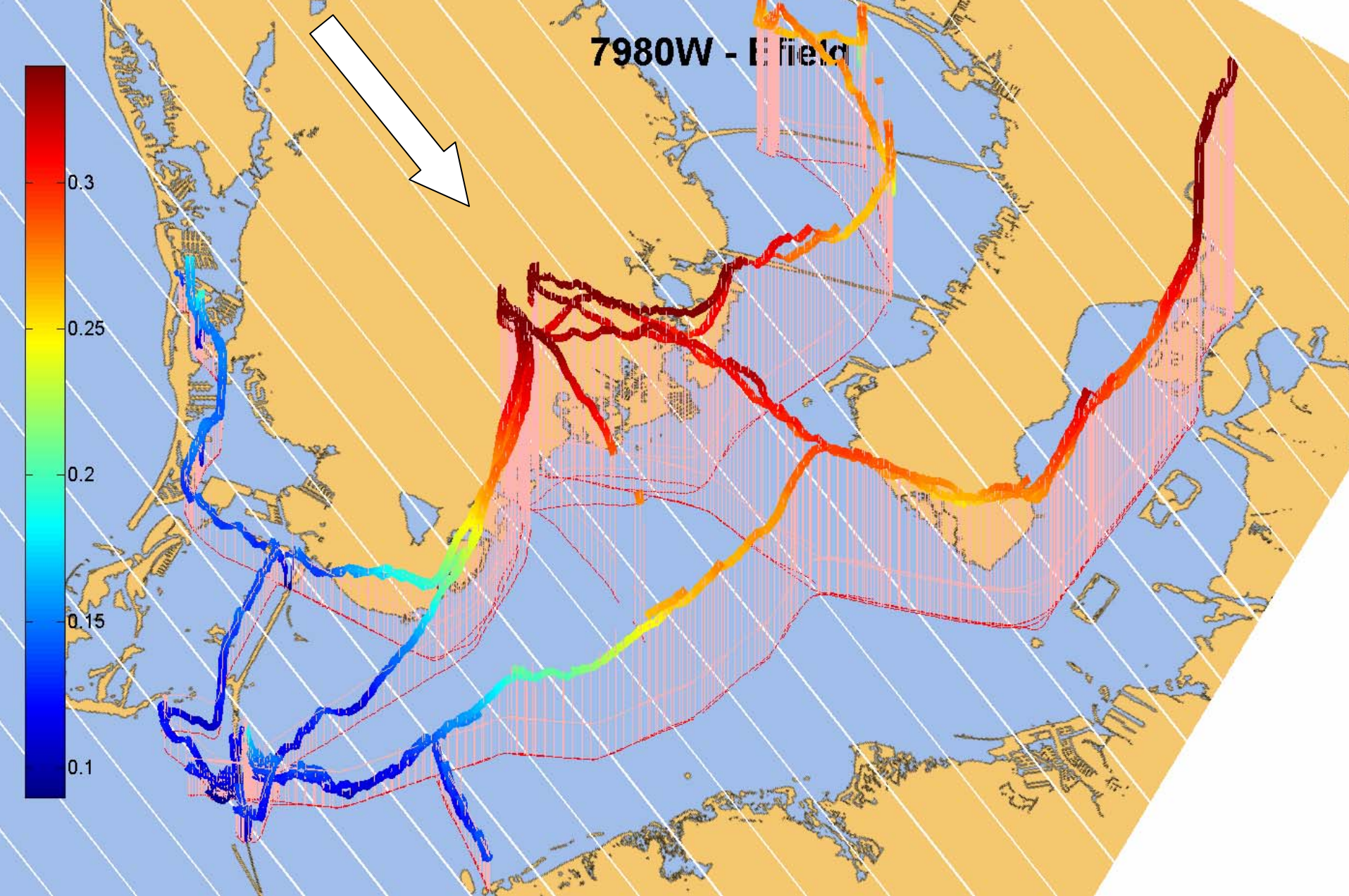
7980Y - Hfield

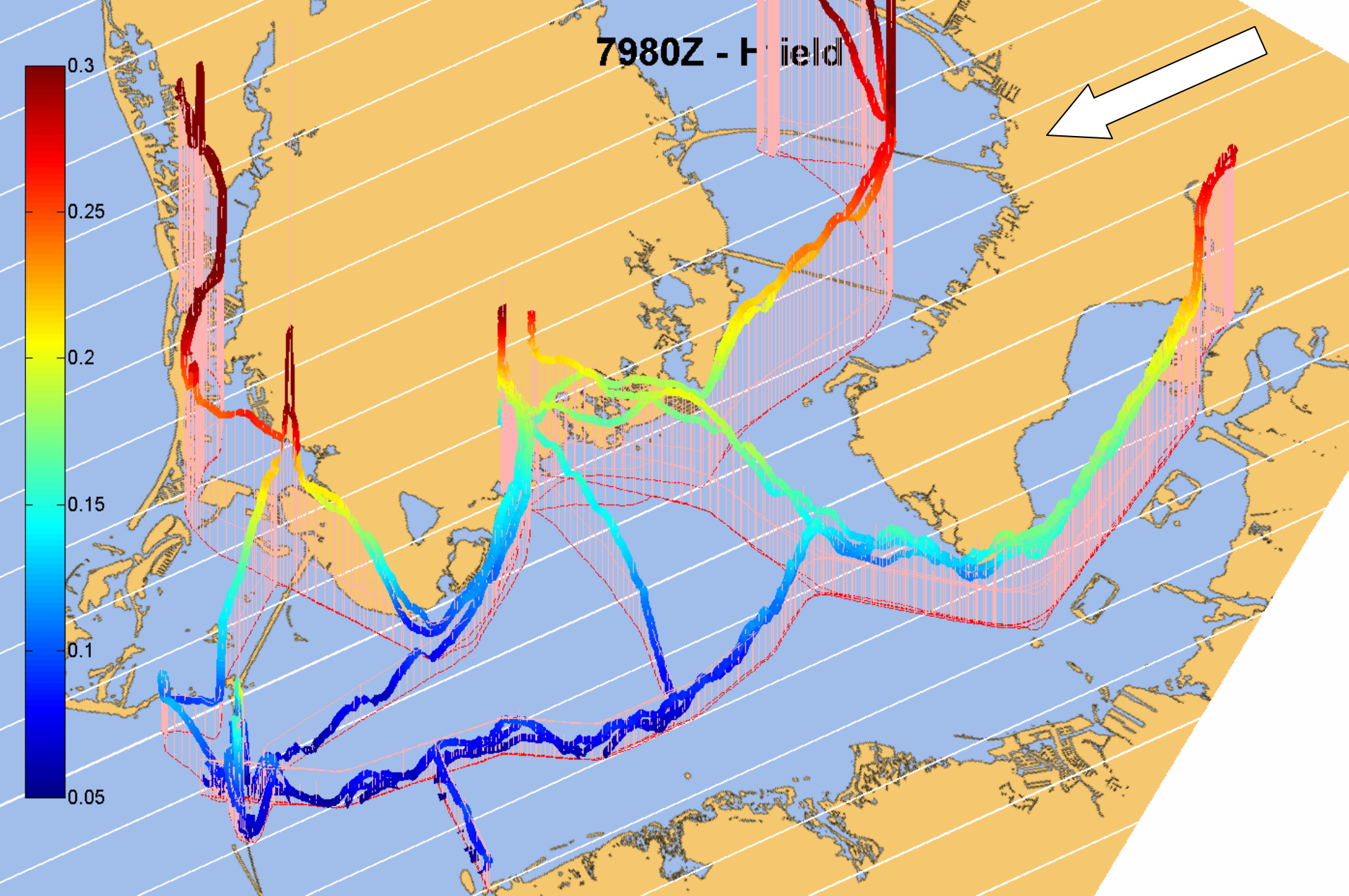


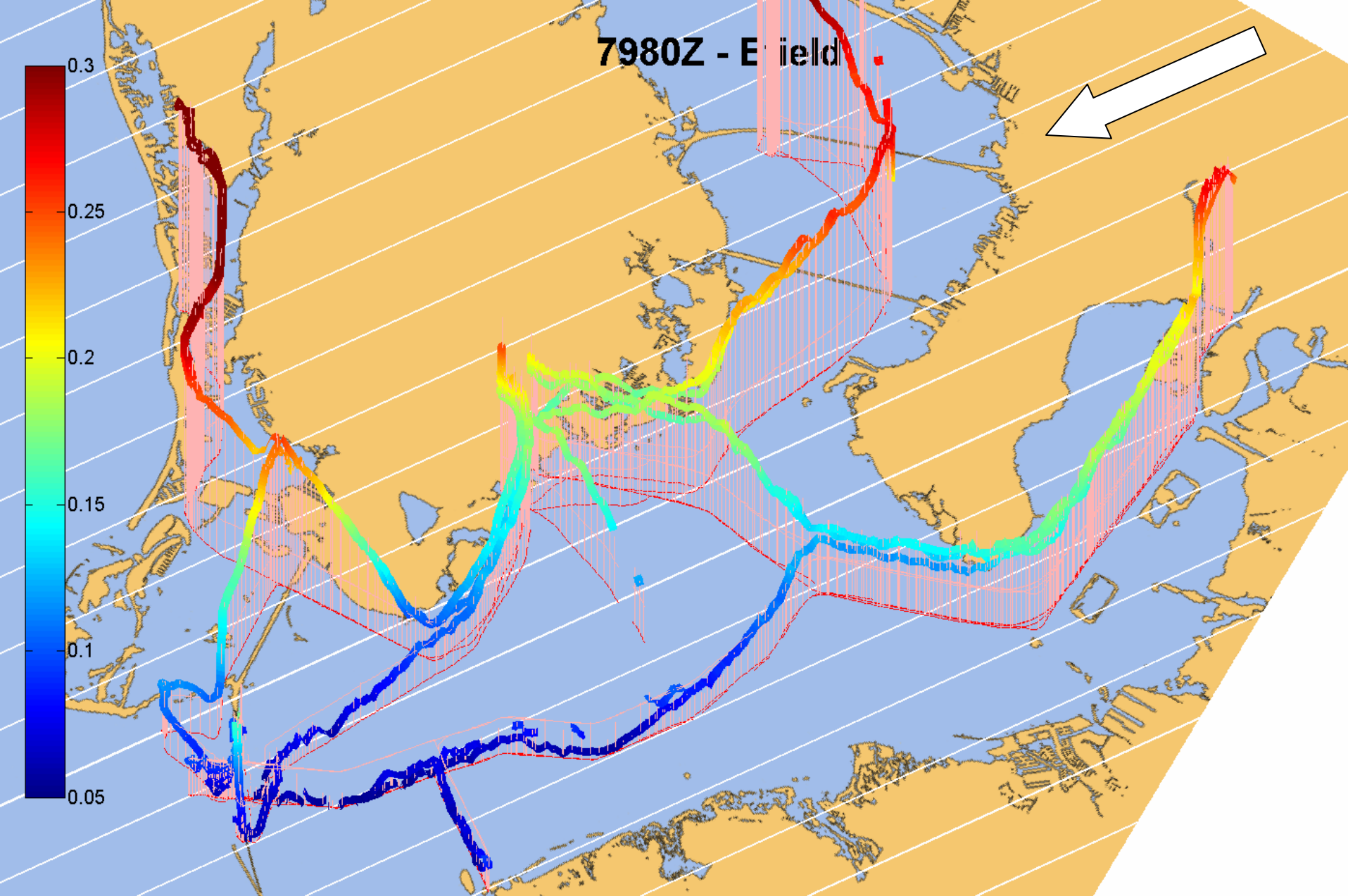
7980Y - Efield



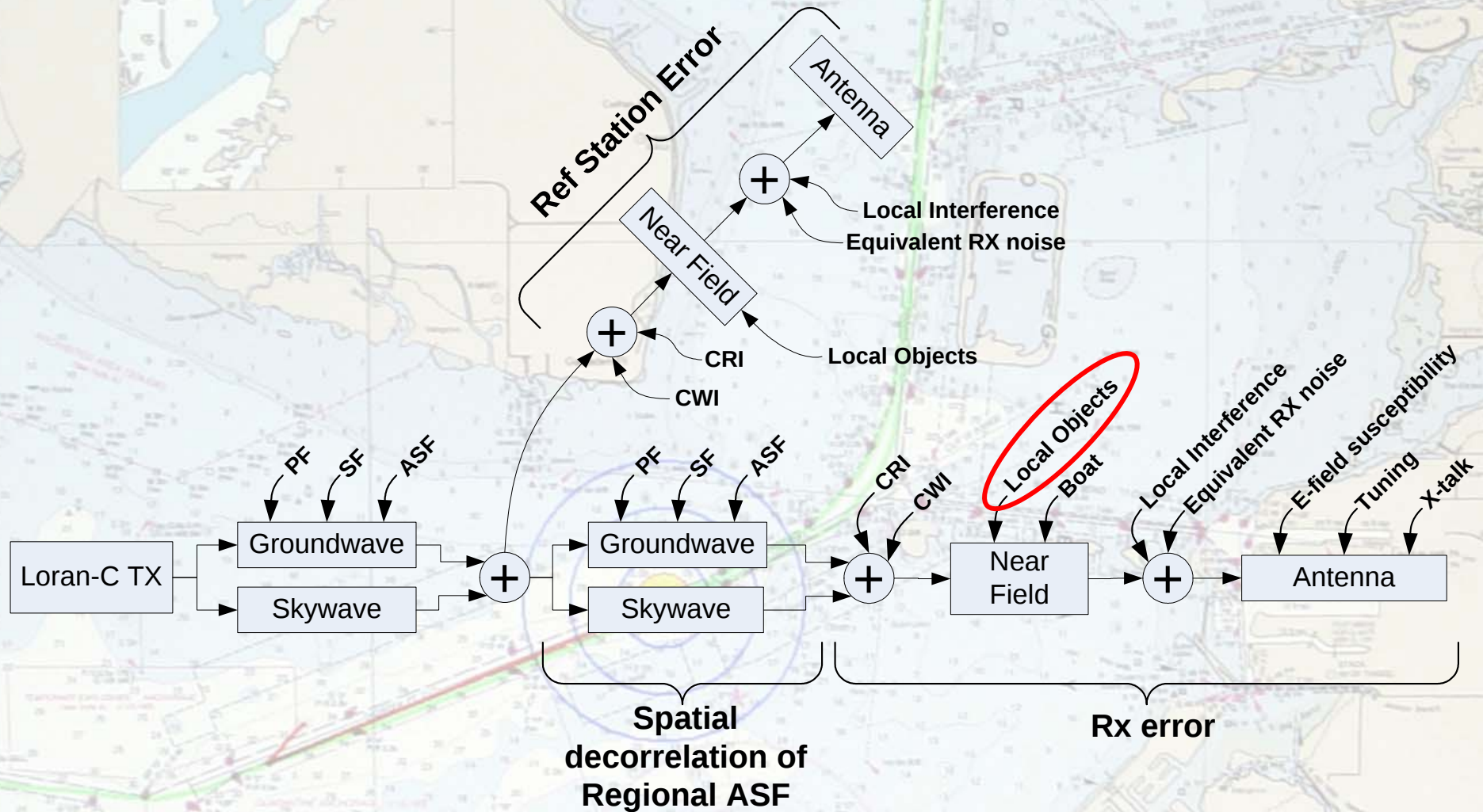




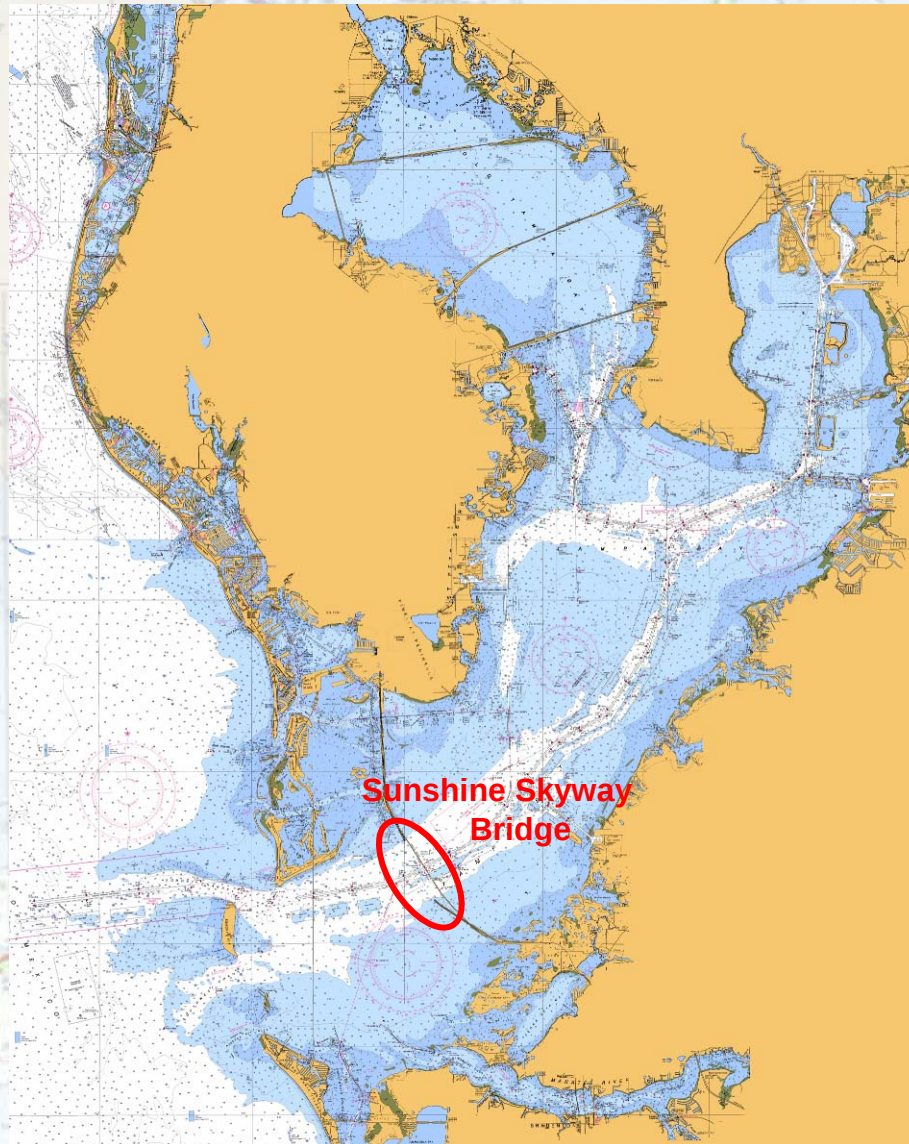




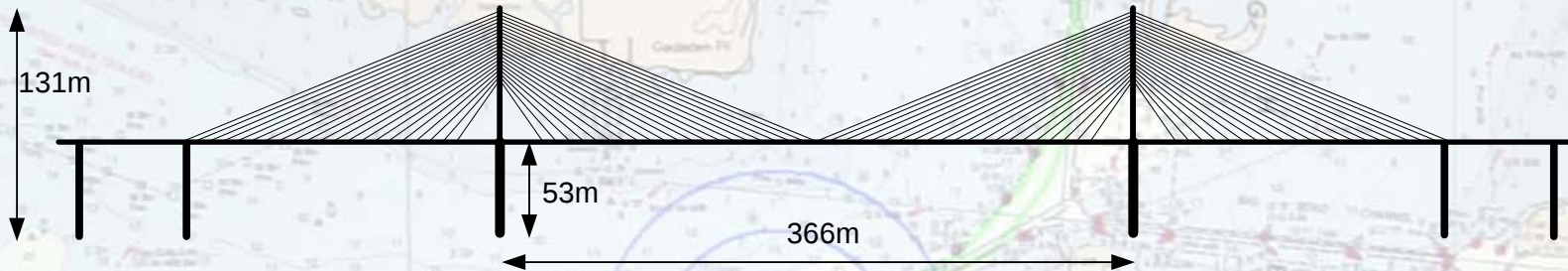
Error Budget: Local Objects



Sunshine Skyway Bridge



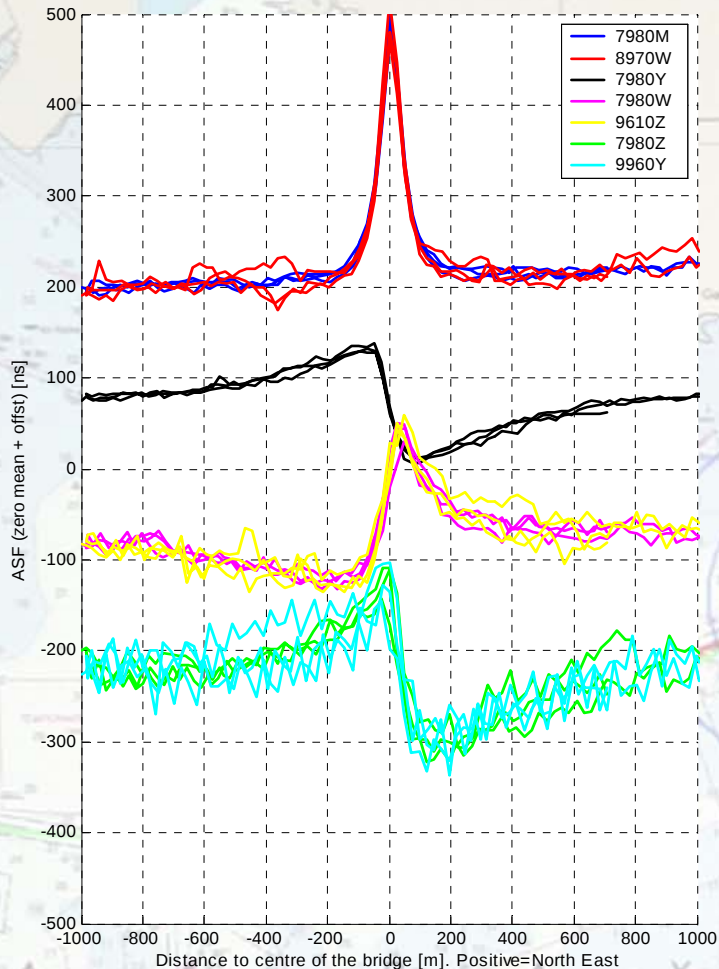
Sunshine Skyway Bridge



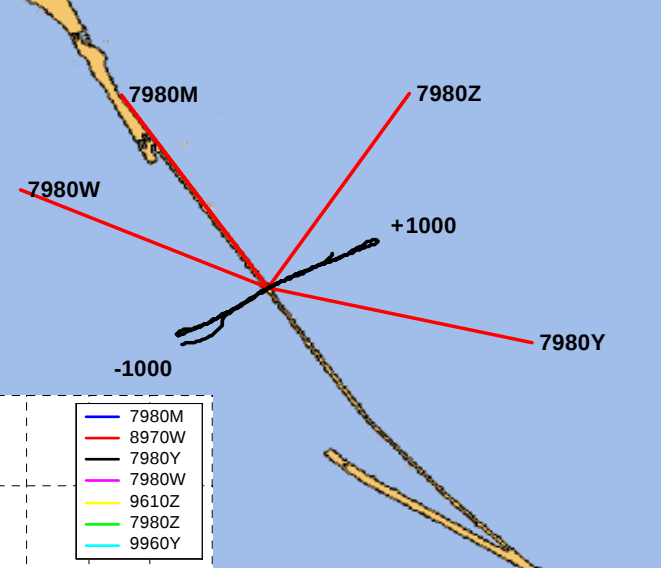
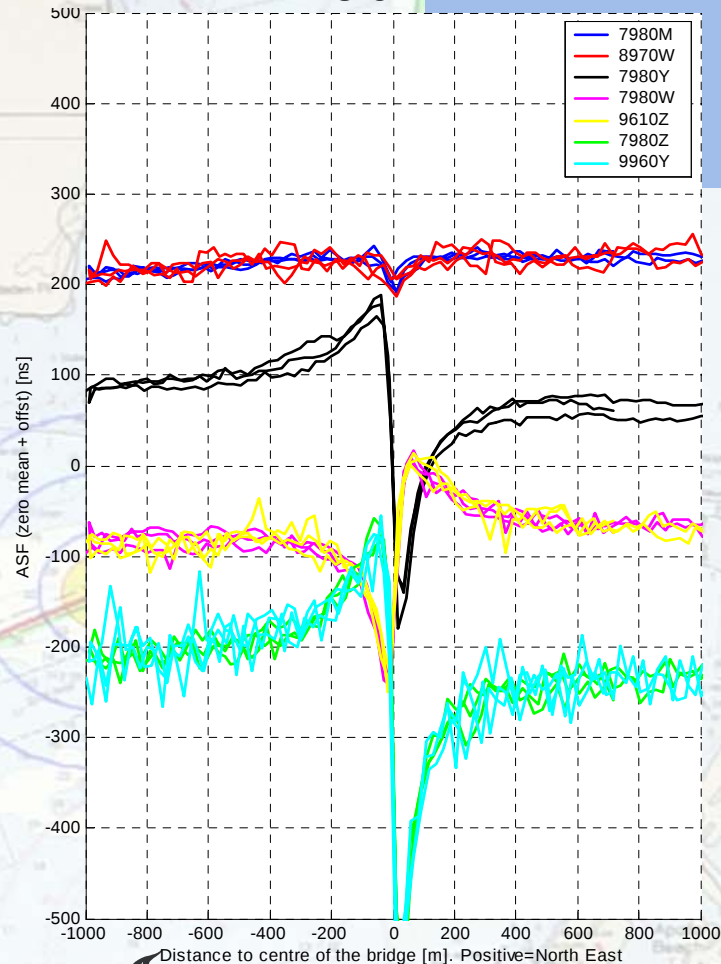
Length: 2.7 km
Main span: 366 m
Shipping clearance: 53 m
Pylon height: 131 m
Stay cables: 21 stays each pylon
Deck width: 29 m

Sunshine Skyway Bridge

H-field



E-field

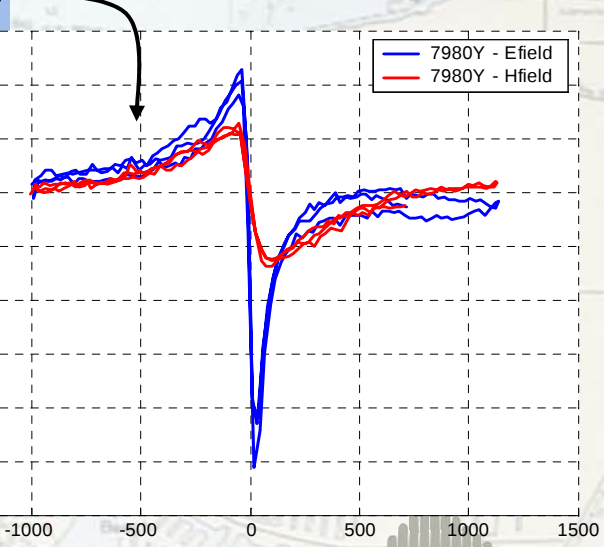
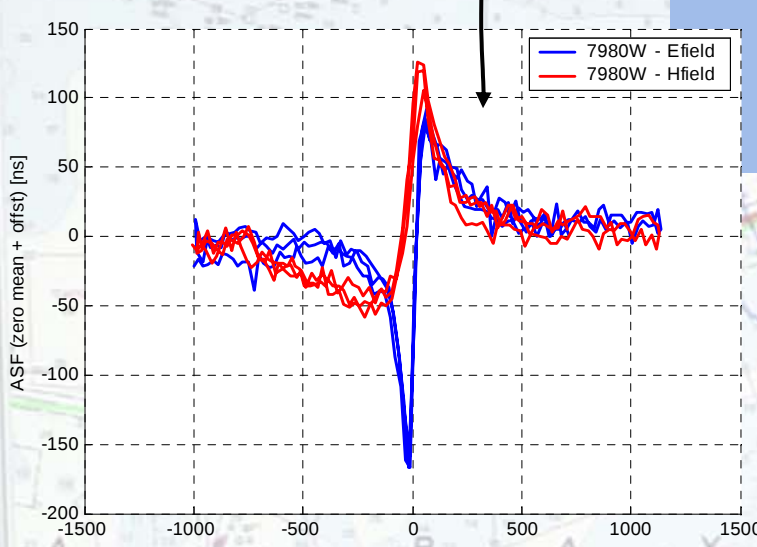
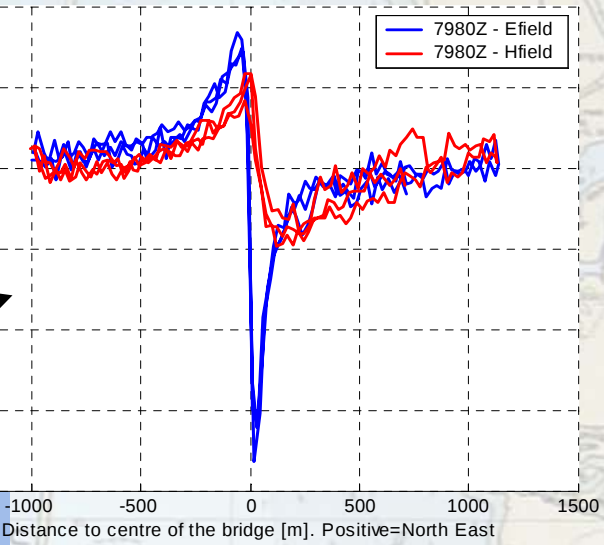
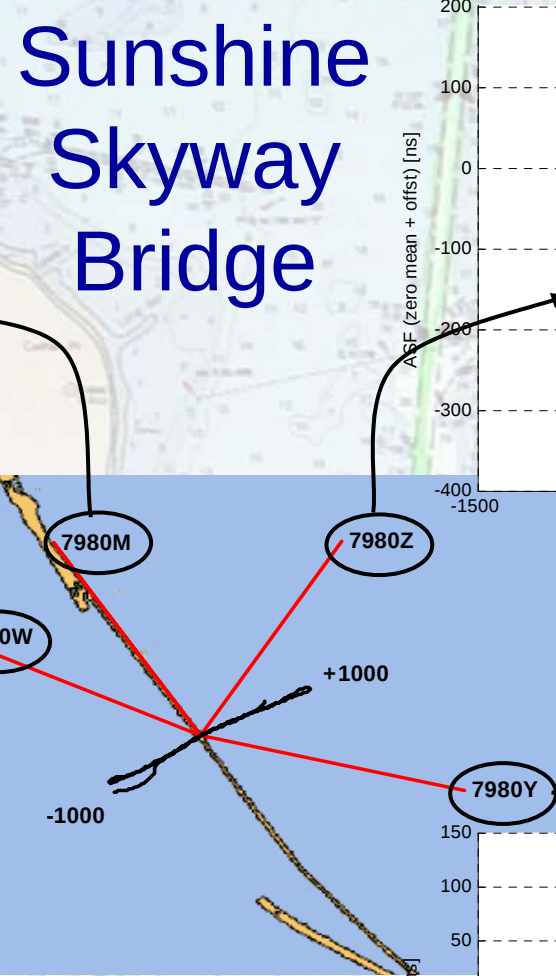
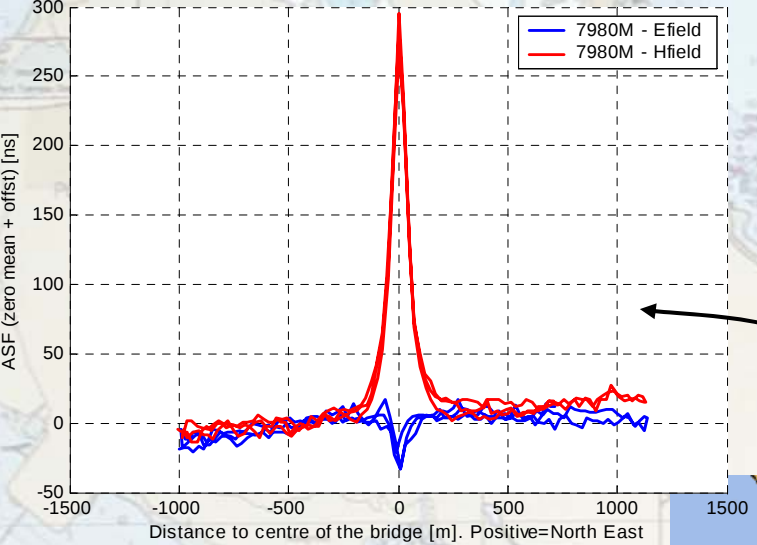


7980M & 8970W

7980Y

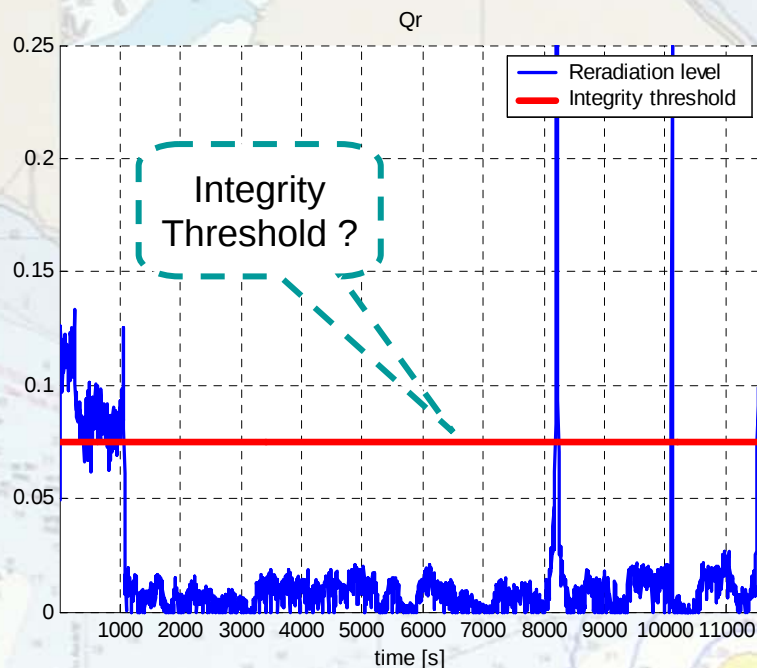
7980W & 9610Z

7980Z & 9960Y

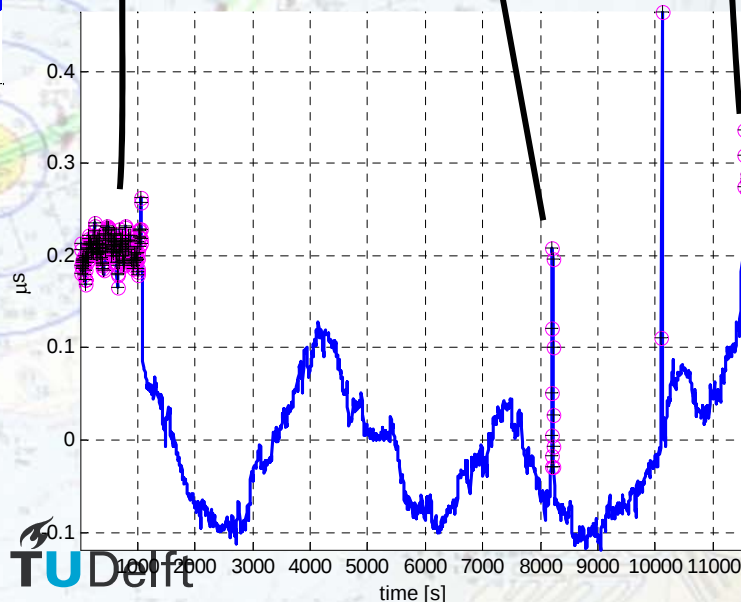
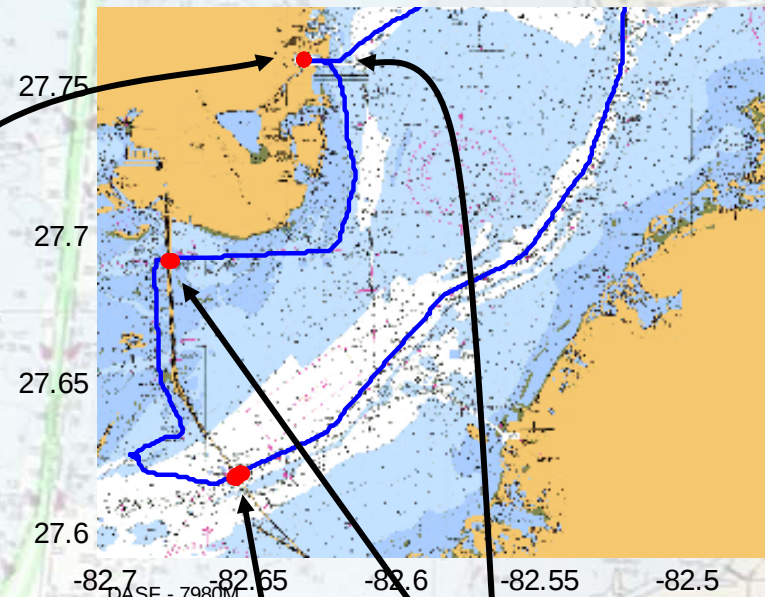


E-field
VS
H-field

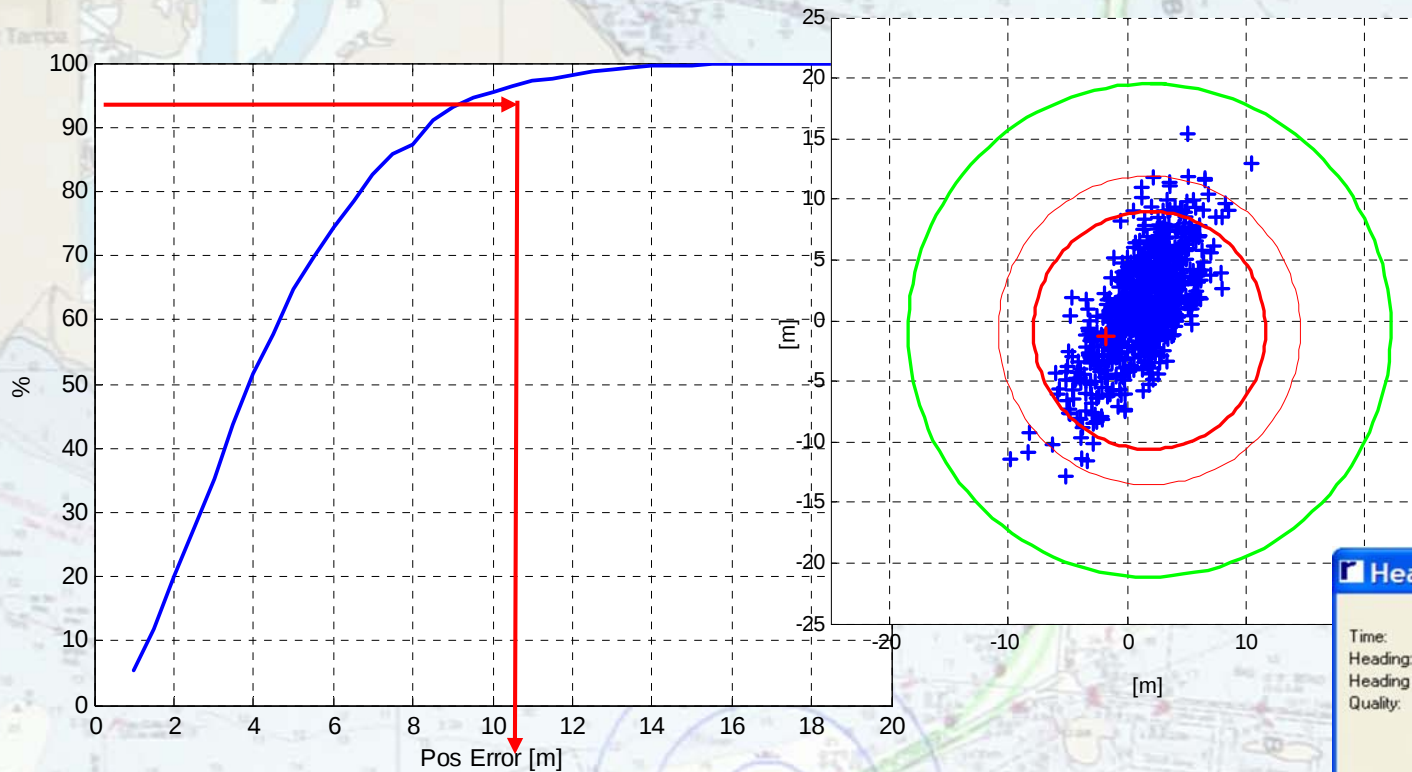
Reradiation Detection



- RASIM doesn't like RAIM reduce operational Loran coverage area
 - RASIM – Receiver Autonomous Signal Integrity Monitoring
- Threshold level is function of Missed Detection and False Alarm probabilities



9.6m 95%



- Thursday measurements corrected with ASFs measured on Tuesday
- Reference station corrections applied
- Calibrated H-field antenna
- 5 sec integration
- 9.6 m 95%, 12.5m 99%
- With Sunshine Skyway Bridge included: 10.5 m 95%

