First Evaluation of Swedish & Finnish Corner Reflectors

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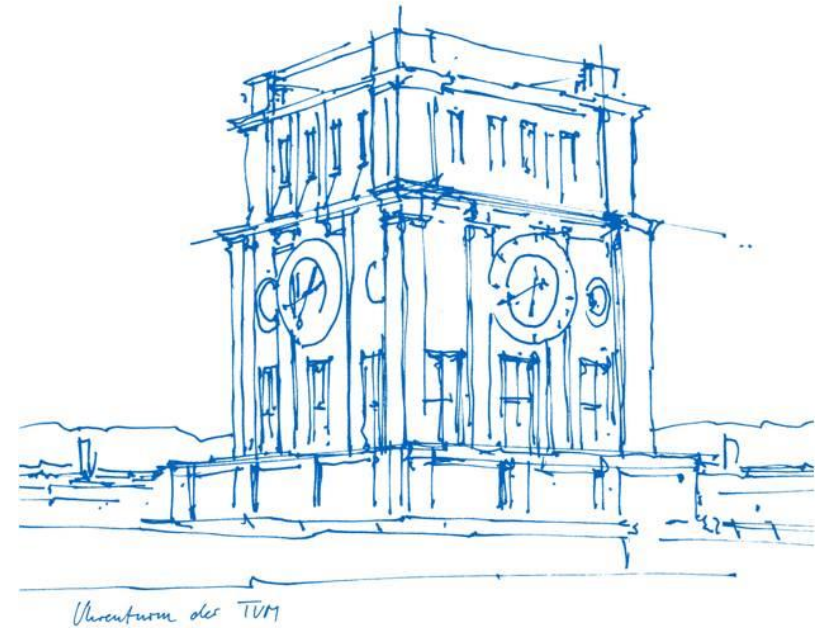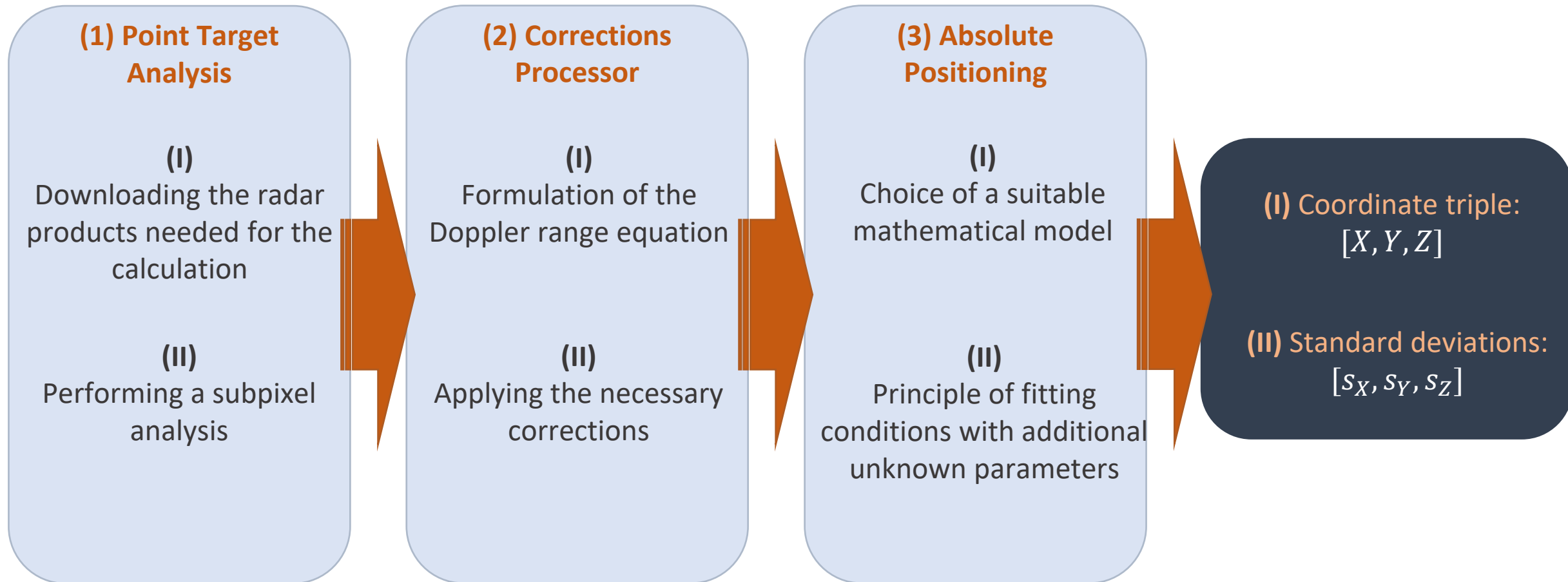
Helsinki, 13th March 2023

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1. Short Introduction

(1) Point Target Analysis

(I)
Downloading the radar products needed for the calculation

(II)
Performing a subpixel analysis

(2) Corrections Processor

(I)
Formulation of the Doppler range equation

(II)
Applying the necessary corrections

(3) Absolute Positioning

(I)
Choice of a suitable mathematical model

(II)
Principle of fitting conditions with additional unknown parameters

(I) Coordinate triple: $[X, Y, Z]$

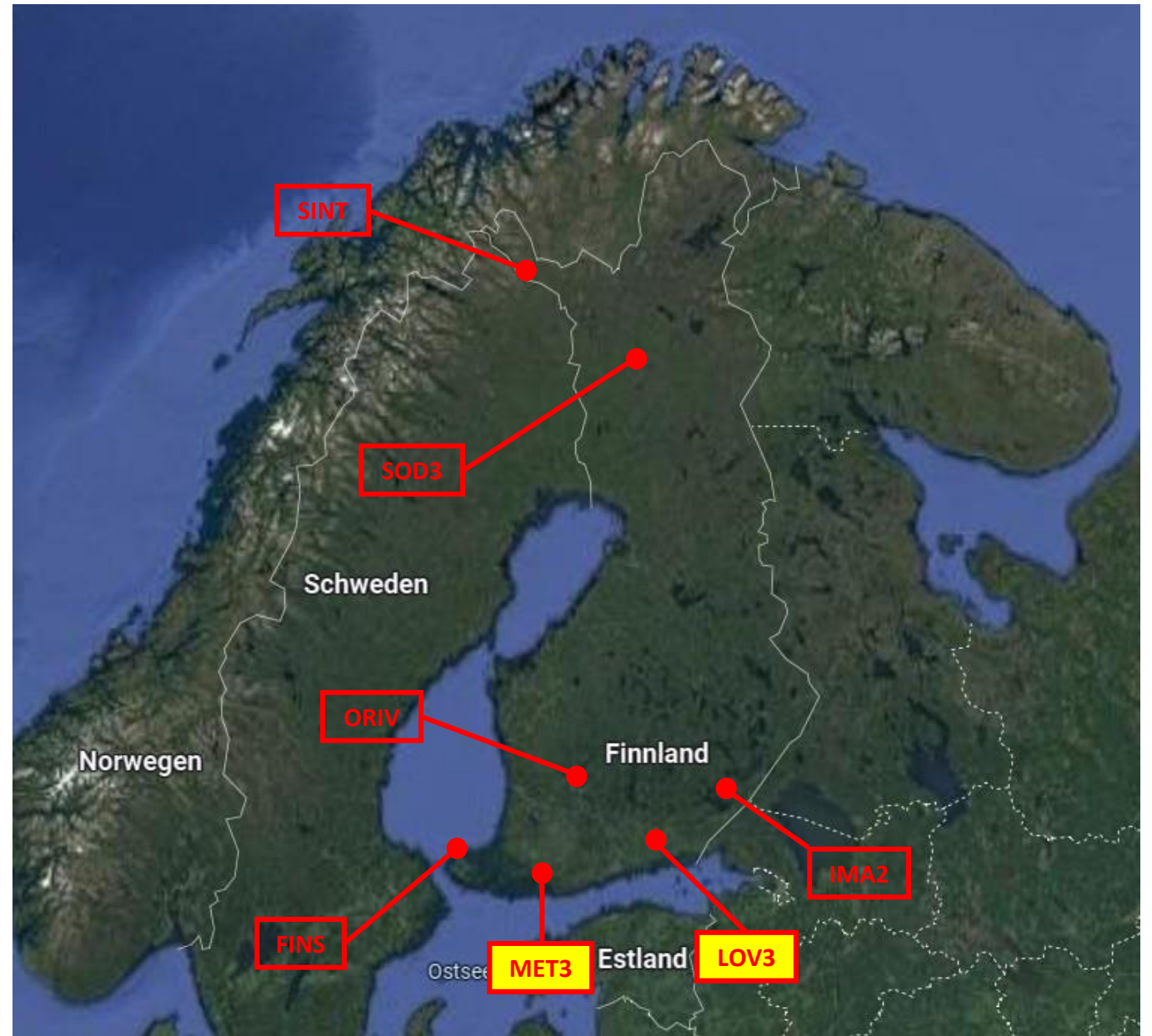**(II)** Standard deviations: $[s_X, s_Y, s_Z]$

2. Finnish Corner Reflectors

Location-specific Analysis
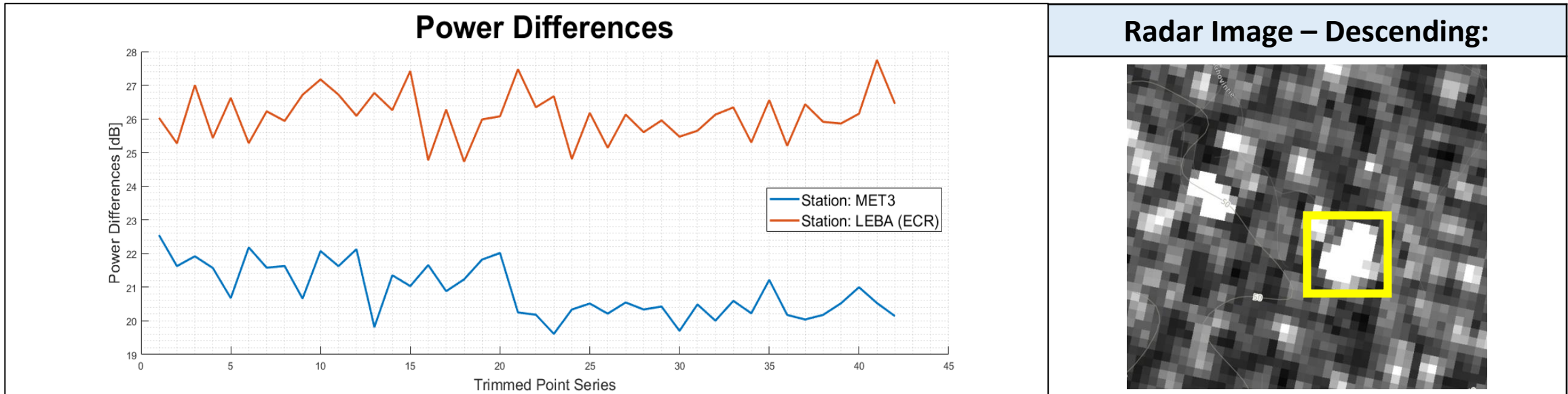
2. Finnish Corner Reflectors

Location-specific Analysis

2. Finnish Corner Reflectors
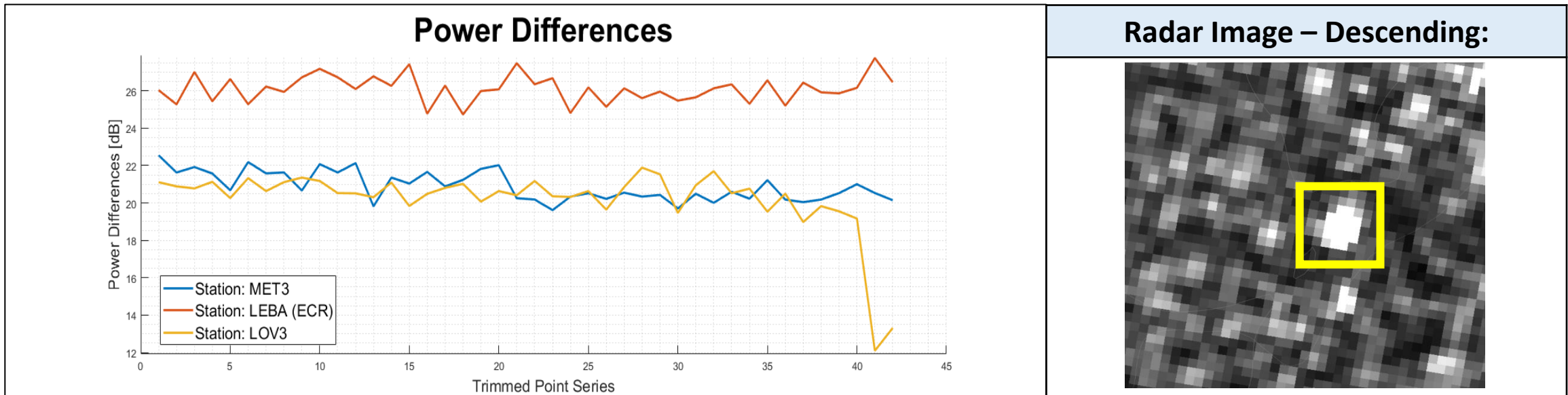
2.1 Location-specific Analysis – MET3

- **Location**: Metsähovintie

- **Corner Direction**: Descending

- **Date of Installation**: Januar 2020

Power Differences

Radar Image – Descending:

2. Finnish Corner Reflectors

2.1 Location-specific Analysis – LOV3

- **Location**: Loviisa

- **Corner Direction**: Descending
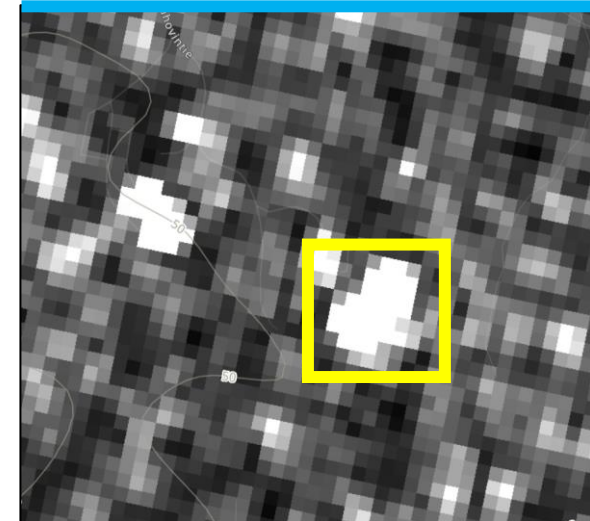
- **Date of Installation**: December 2021

Power Differences

Radar Image – Descending:

2. Finnish Corner Reflectors

2.2 Visualization of the Results – MET3

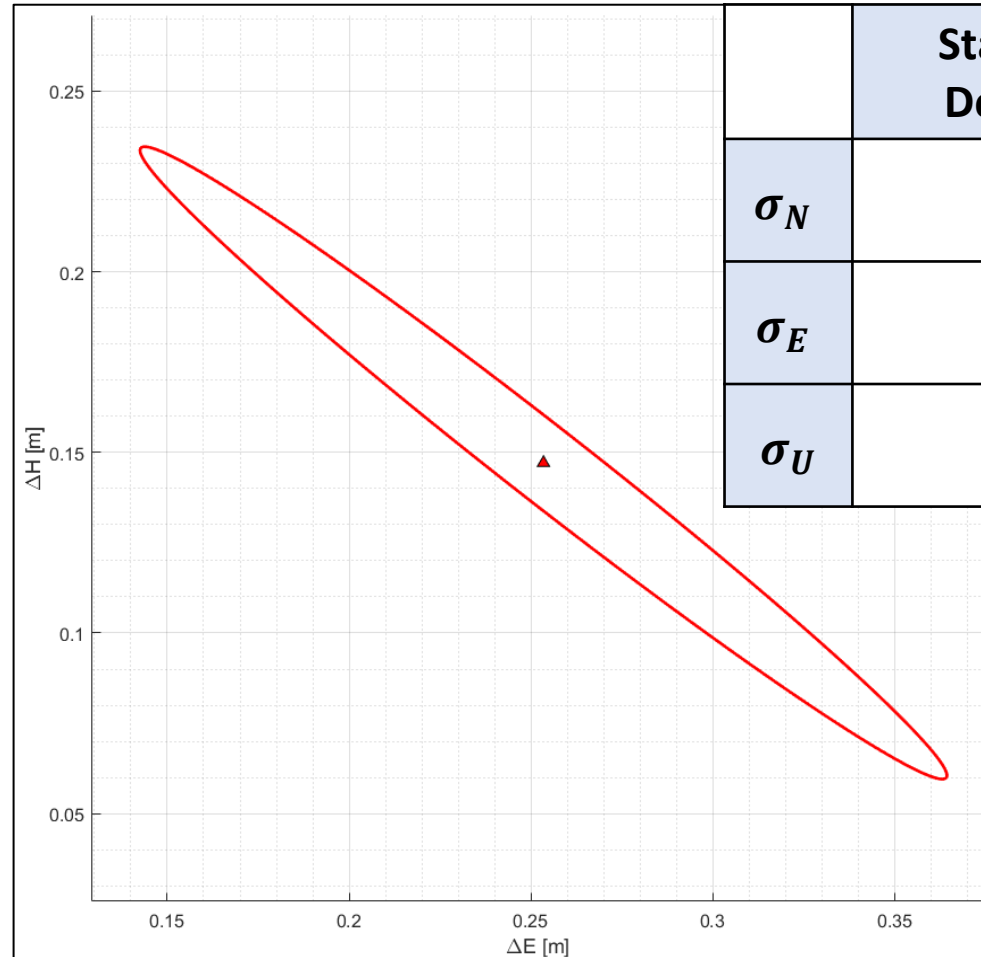|	Coordinates [m]	Standard Deviation [±m]
X	2892592.3127	0.0284
Y	1311868.2060	0.0327
Z	5512593.1975	0.0326

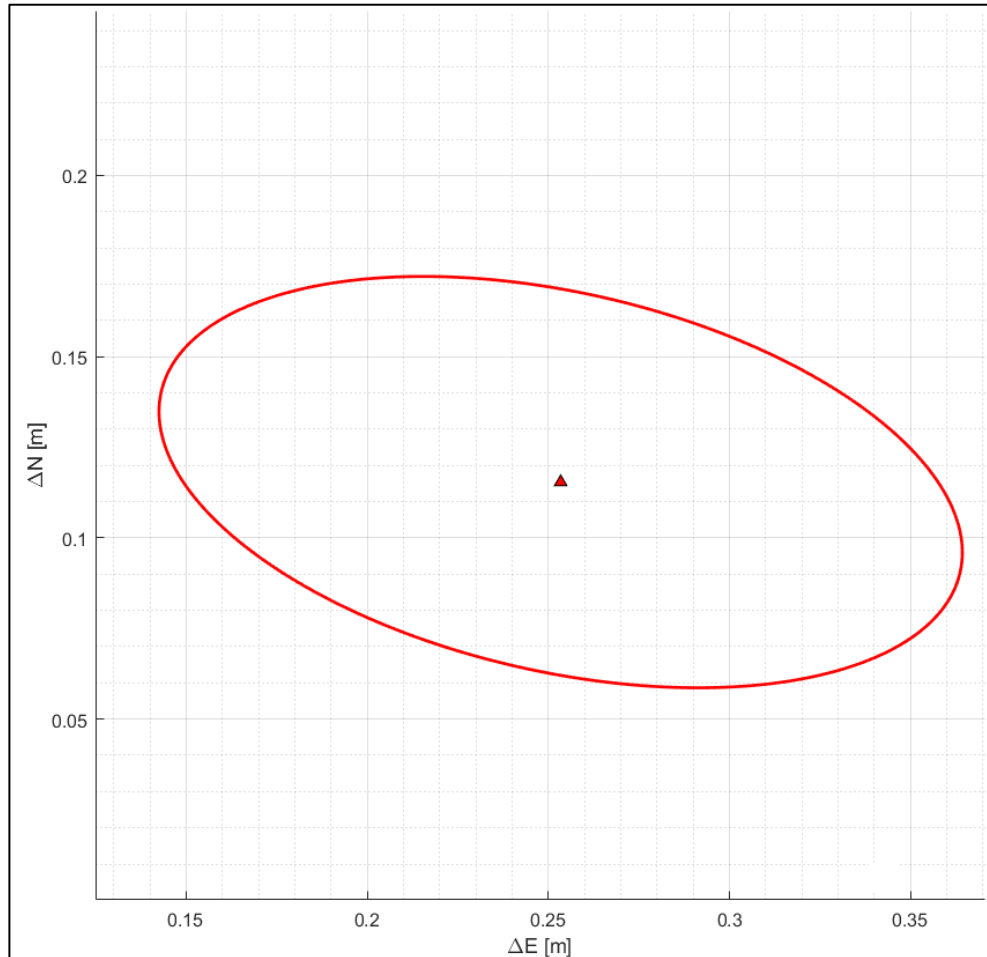**Range Observations:** 201

Azimuth Observations: 203

2. Finnish Corner Reflectors

2.2 Visualization of the Results – MET3

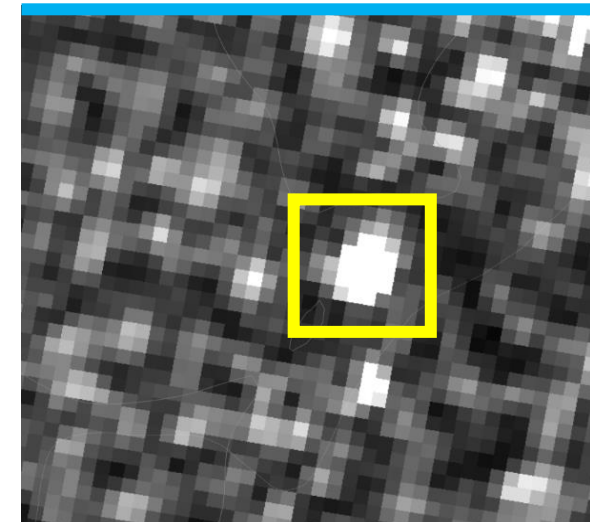**Range Observations:** 201
Azimuth Observations: 203

	Station Standard Deviation [±m]:
σ_N	0.0202
σ_E	0.0395
σ_U	0.0312

2. Finnish Corner Reflectors

2.2 Visualization of the Results – LOV3

	Coordinates [m]	Standard Deviation [±m]
X	2828356.1916	0.0507
Y	1396893.3833	0.0568
Z	5524907.3823	0.0560

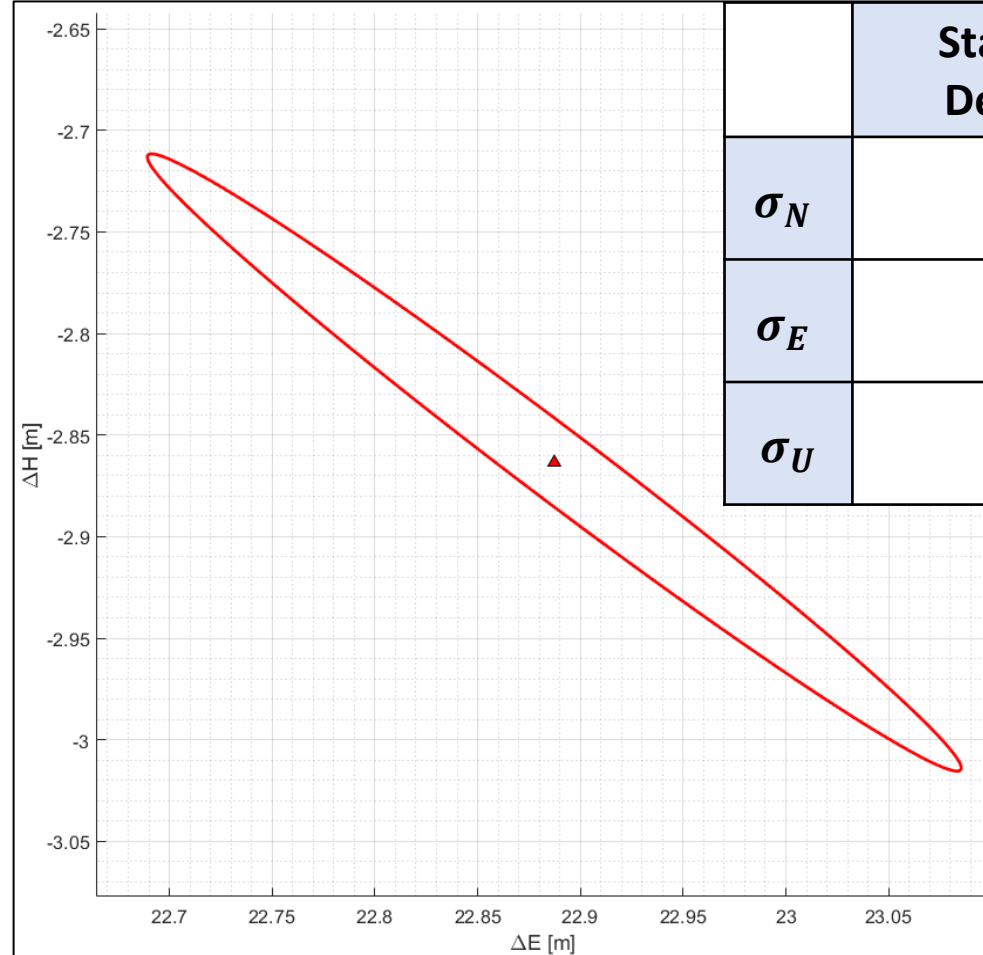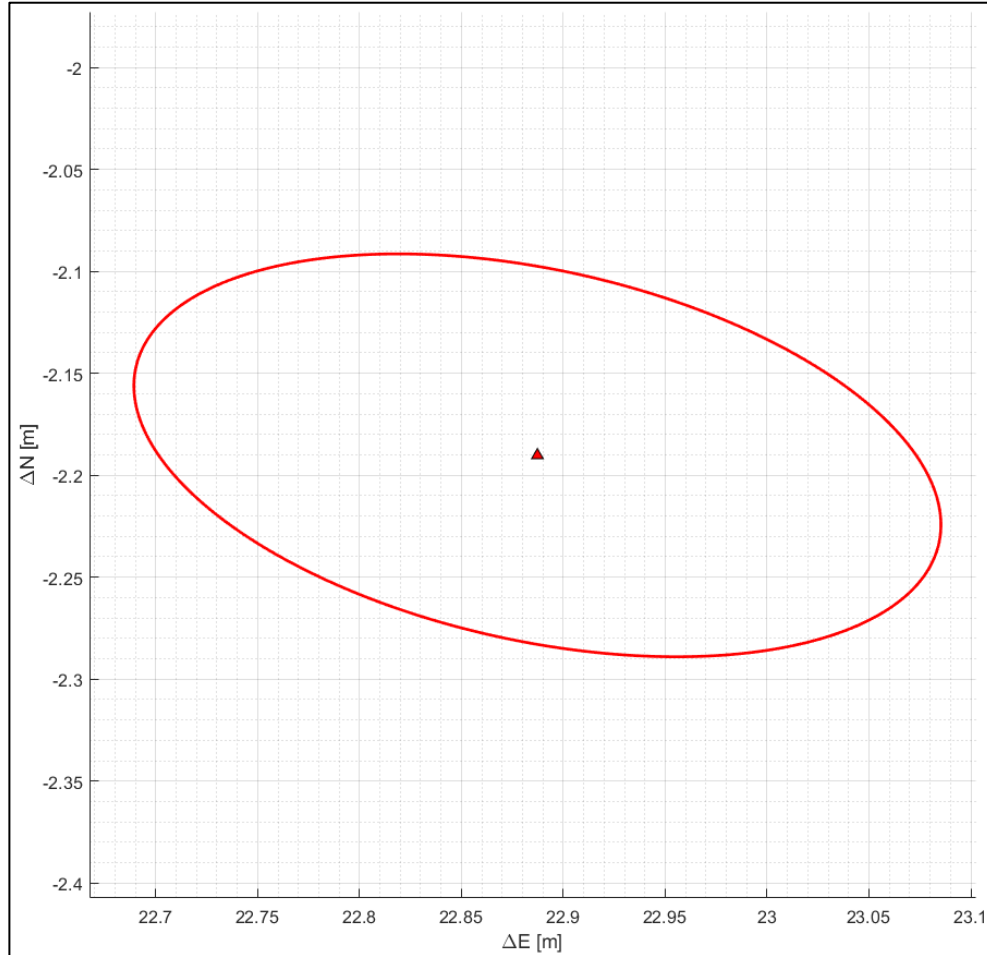**Range Observations:** 53

Azimuth Observations: 51

2. Finnish Corner Reflectors

2.2 Visualization of the Results – LOV3

Range Observations: 53
Azimuth Observations: 51

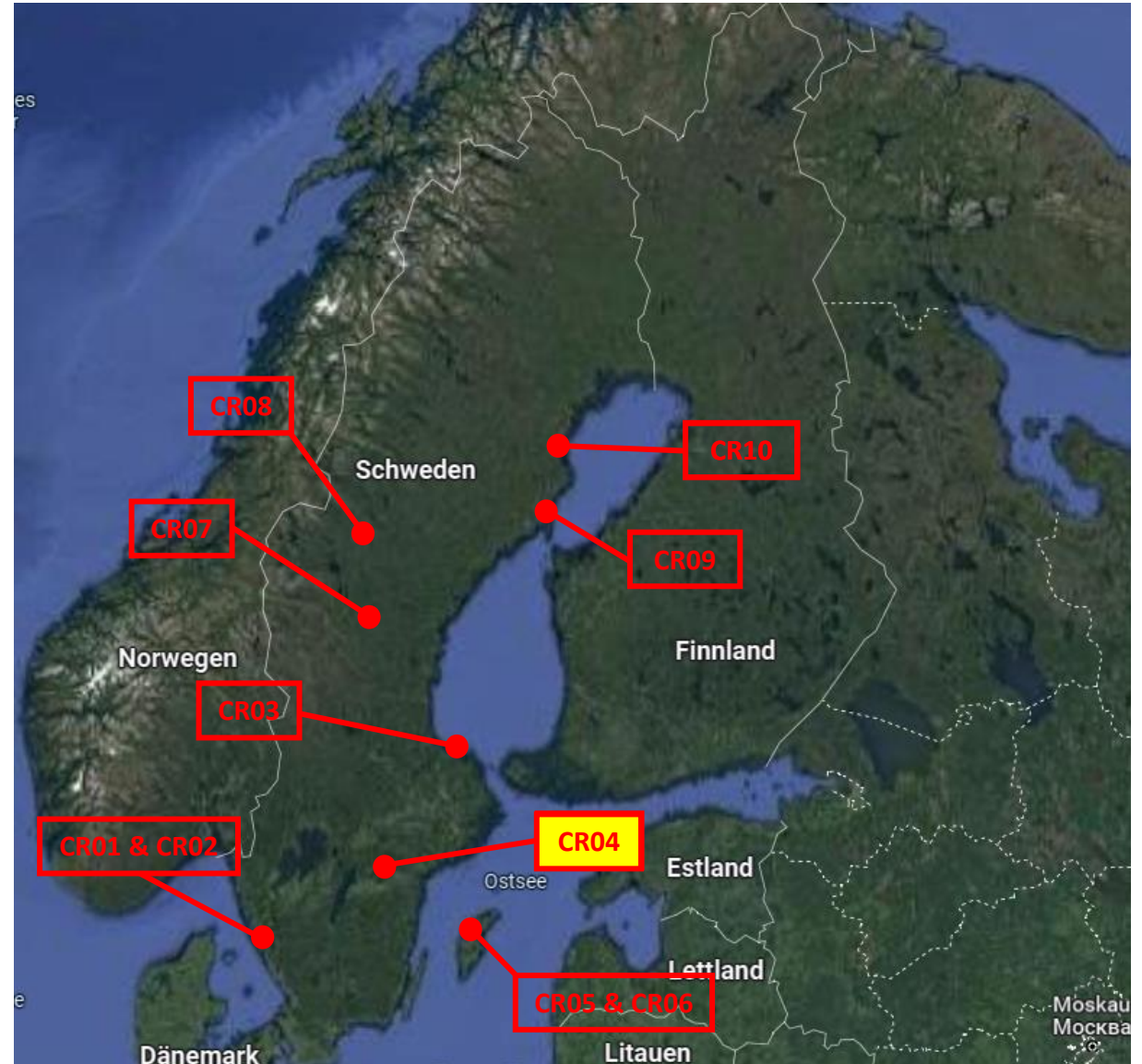|	Station Standard Deviation [±m]:
σ_N	0.0348
σ_E	0.0698
σ_U	0.0535

3. Swedish Corner Reflectors

Location-specific Analysis
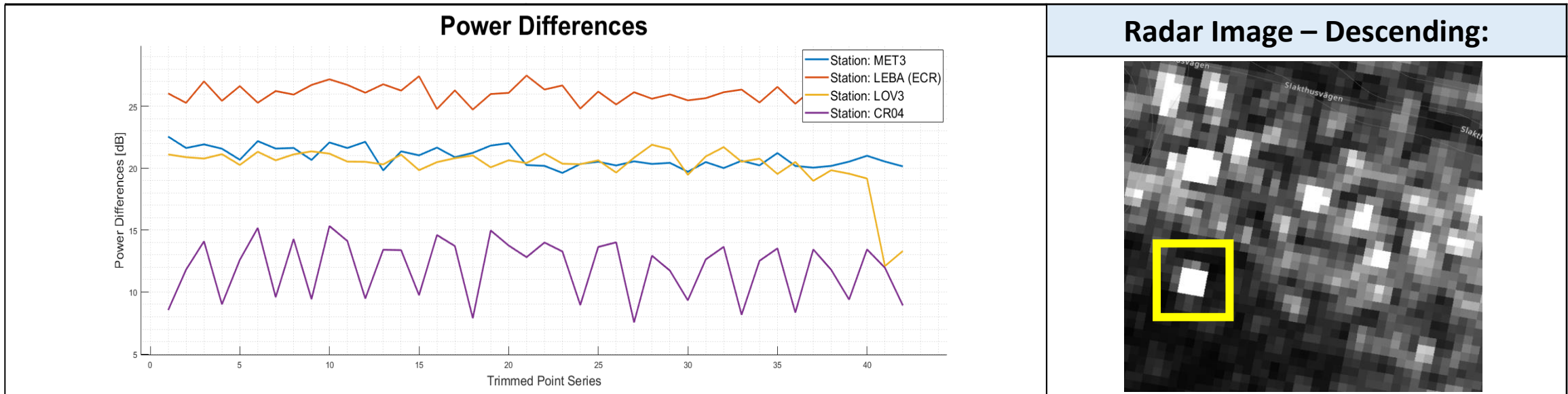
3. Swedish Corner Reflectors

Location-specific Analysis

3. Swedish Corner Reflectors

3.1 Location-specific Analysis – CR04

- **Location**: Norrköping

- **Corner Direction**: Descending and Ascending (Double Back Flipped Square)
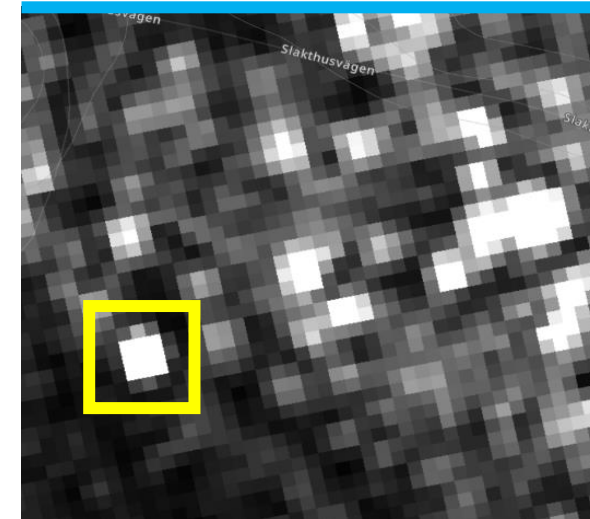
- **Date of Installation**: November 2021

3. Finnish Corner Reflectors

3.2 Visualization of the Results – CR04

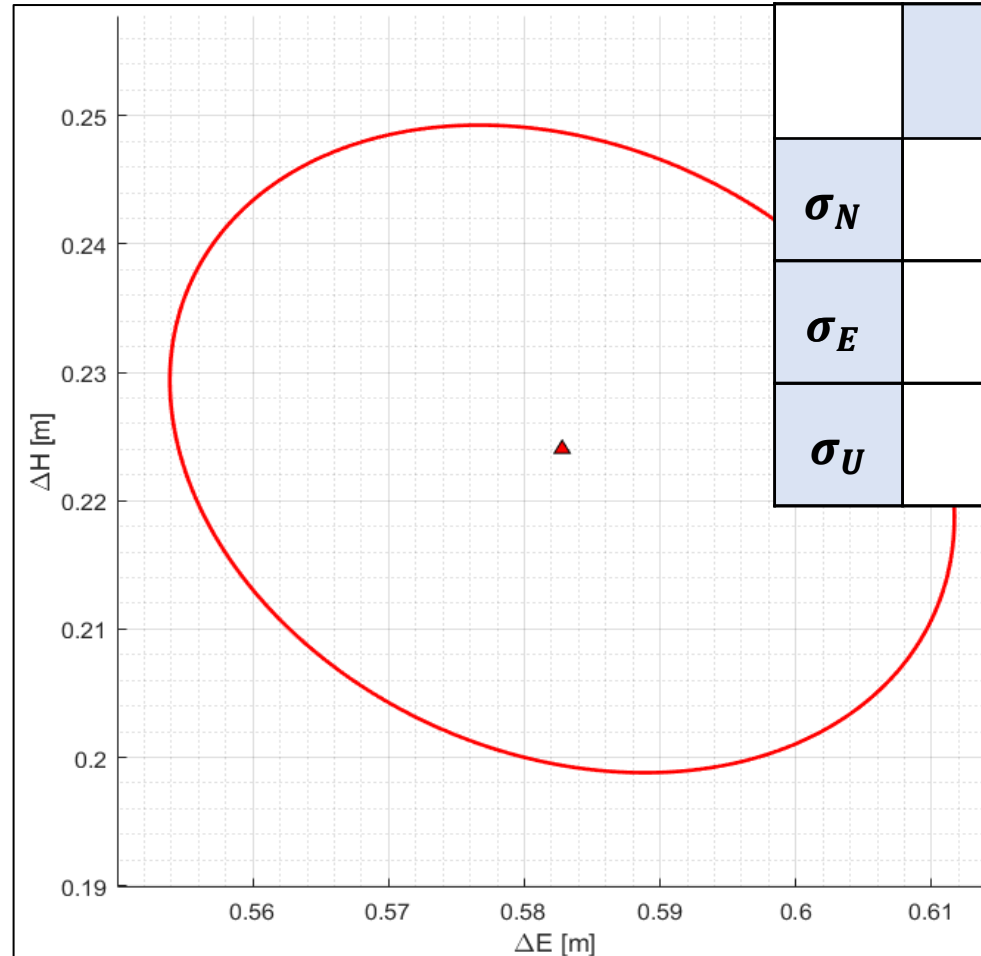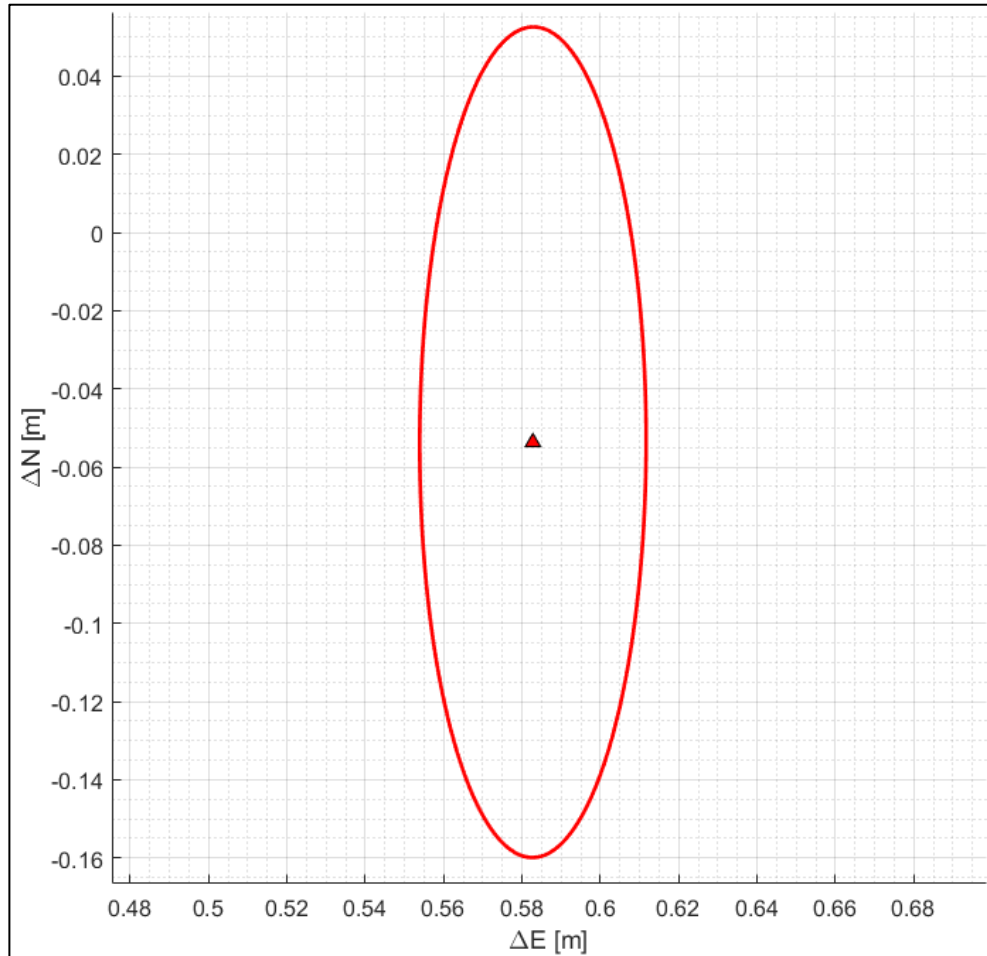|	Coordinates [m]	Standard Deviation [$\pm$m]
X	3199127.4033	0.0311
Y	932167.2413	0.0128
Z	5420307.6903	0.0267

Range Observations: 125

Azimuth Observations: 123

3. Finnish Corner Reflectors

3.2 Visualization of the Results – CR04

Range Observations: 125
Azimuth Observations: 123

	Station Standard Deviation [±m]:
σ_N	0.0408
σ_E	0.0100
σ_U	0.0090

4. Comparison

Observations - MET3 (1 year): 164

Observations - LOV3 (1 year): 104   **Observations - MET3 (2 years):** 312

Observations - CR04 (1 year): 248   **Observations - MET3 (3 years):** 404
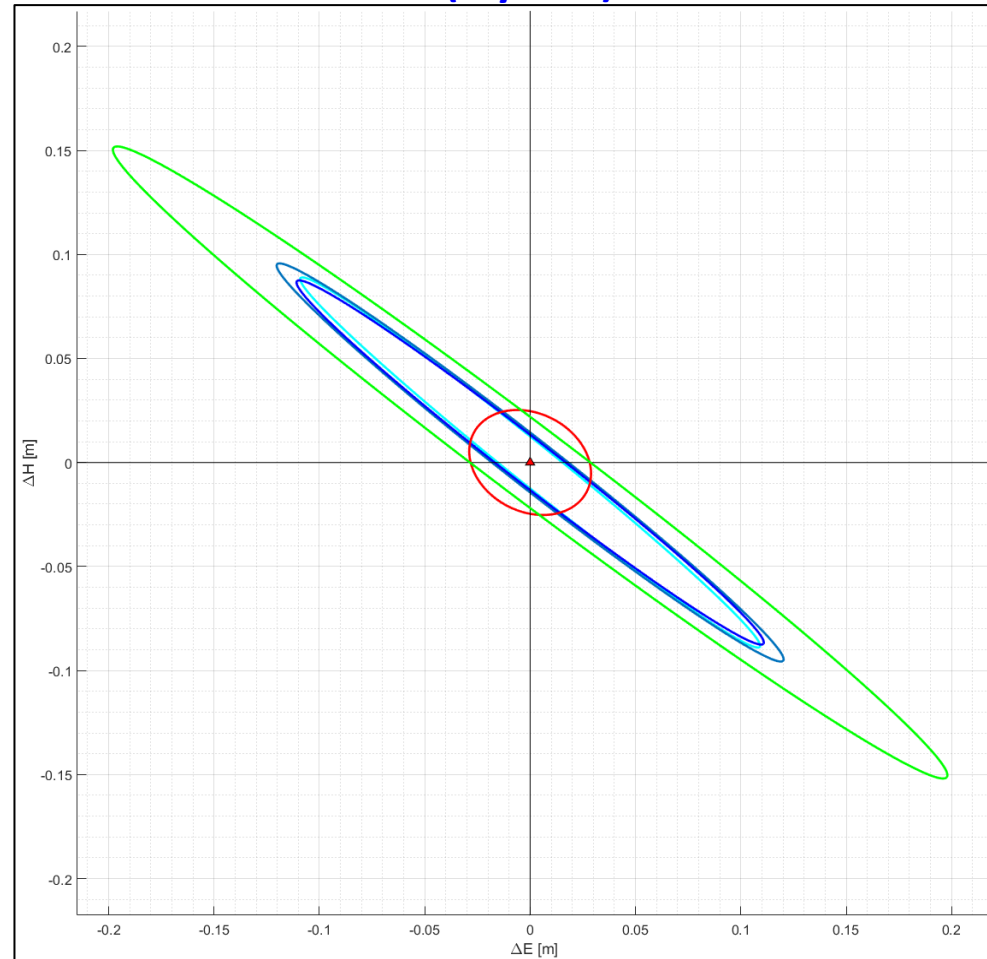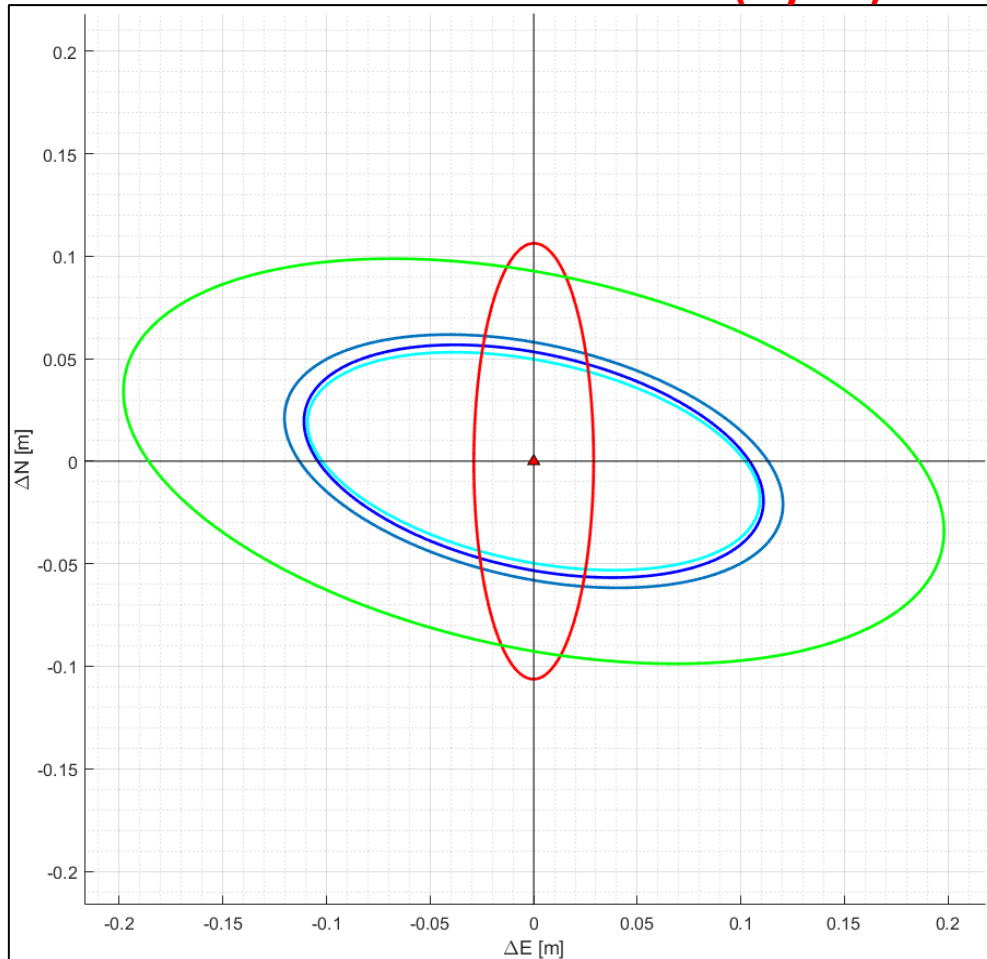
5. Conclusion

➢ **Dependency of the signal response** on the used corner reflectors:

❑ Significant differences between passive and active reflectors

❑ Influenced also by the type of passive reflectors

⎦ **Nevertheless in all examples:** Strong and easily detectable reflection

➢ **Achieving high precisions** in the explored time intervals:

❑ **High precision of positioning results:** 1-6 cm

❑ **Fluctuations and renewed instabilities** detectable over multi-annual observations of MET3 station

➢ **Strong improvement of precision** by using reflectors aligned on **both sides**:

❑ **Homogenization of error ellipses** due to bilateral geometry (Directional behavior detectable in both DSC stations)

❑ **Increasing the number of observations** in the same time → Faster achievement of the required observations

6. Image Sources

- Cover Slide Scandinavia:

https://d-maps.com/m/europa/scandinavie/scandinavie06.gif (Last visited: 01.03.2023).

- Aerial View Images:

https://www.google.de/maps/preview (Last visited: 01.03.2023).

- Radar Images:

https://apps.sentinel-hub.com/sentinel-playground (Last visited: 01.03.2023).