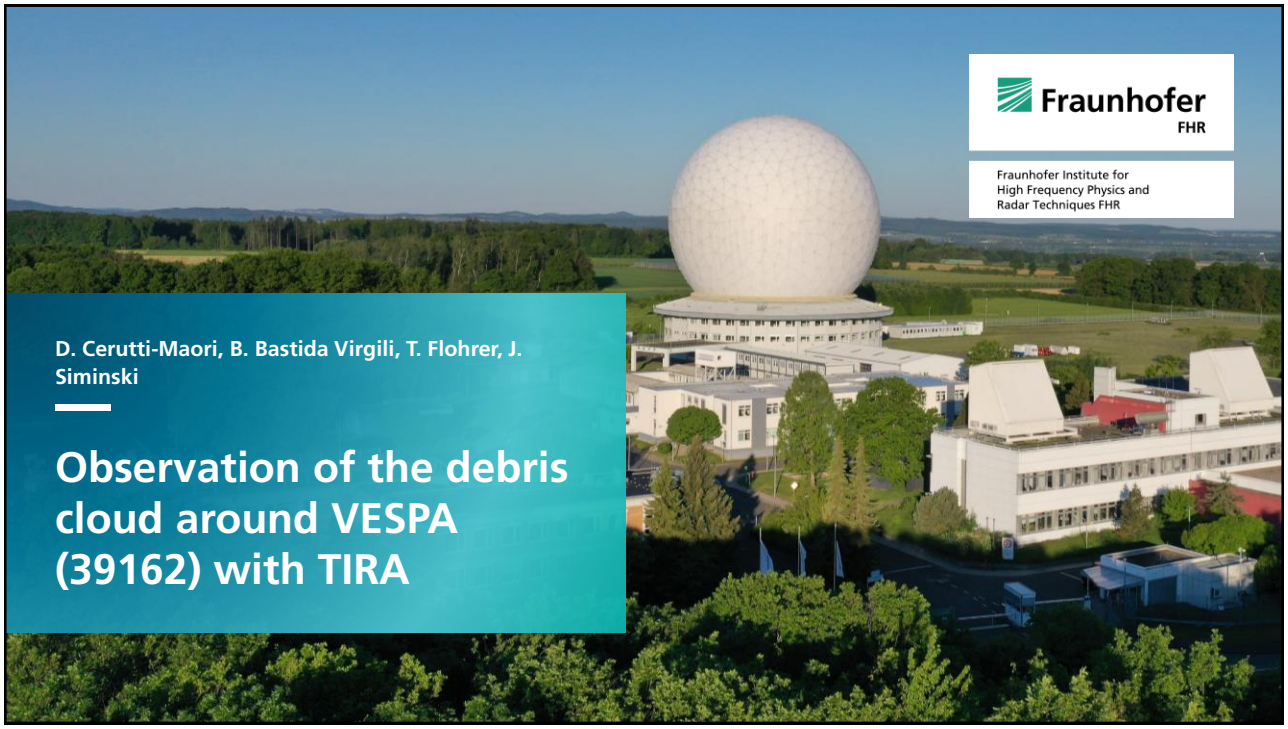

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Observation of the debris cloud around VESPA (39162) with TIRA

01

Conducted observations

Conducted observations

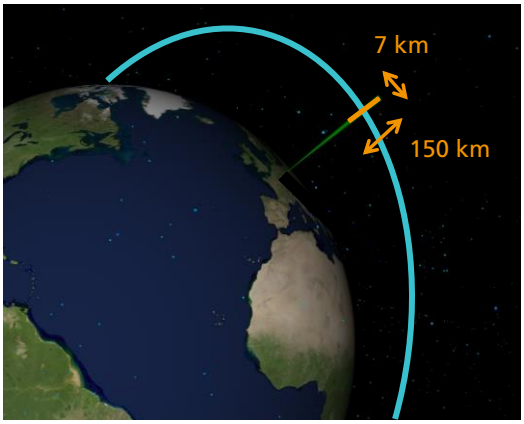
Imaging and spotlight BPE

Observation	Type	Date	Time (UTC)	Range (km)	Elevation (deg)	Duration
1	Imaging	11.08.2023	10:39			
2	Spotlight BPE	11.08.2023	12:15	1650-2850	8-12	905 s (~ 15 min)
3	Spotlight BPE	17.08.2023	10:35	760-1250	33-87	3318 s (~ 55 min)

Spotlight observation mode

Observation geometry

- A TLE data set of VESPA was used to initialize the observation
- The antenna beam was oriented towards a fixed spot on the orbit of VESPA
  - Compensation of the Earth rotation
- The parameters of the compression filter were matched to the expected range and Doppler frequency
  - Range resolution cell: 150 km
  - Range rate resolution cell: 112 m/s
- Average observed volume at a R = 800 km: ~ 5500 km^3



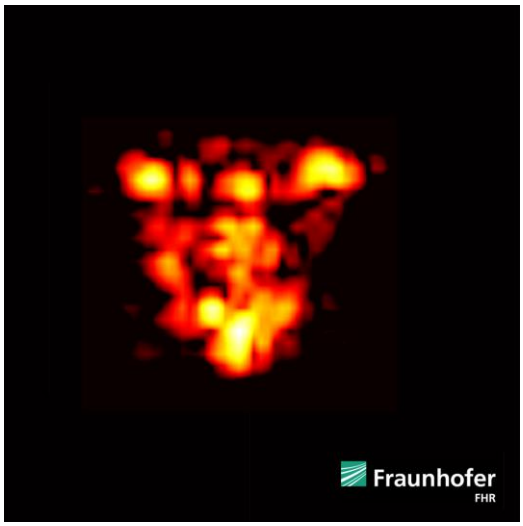
The observation mode is tailored to the fragmentation cloud

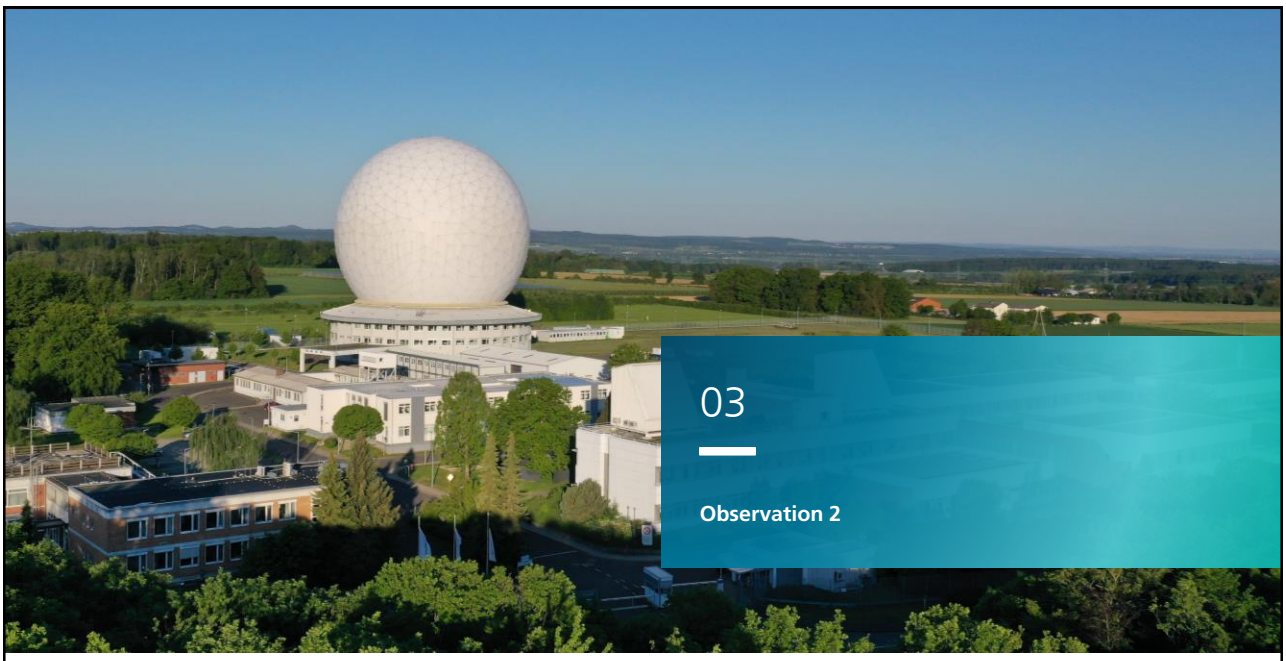
Spotlight observation mode
Detection scheme

- The false alarm rate and the detection threshold are kept constant for all the observations
- An object is detected if it is seen at least 3 times during its beam crossing time
- Multiple detections are clustered into one single detection
  - The object parameters are averaged over the different detections
- Single pulse detection, no pulse integration
- Note that the range changes during the data acquisition
  - SNR variation impacts the detection sensitivity

VESPA
Radar image

- No large-scale external damage
- Attitude motion has changed



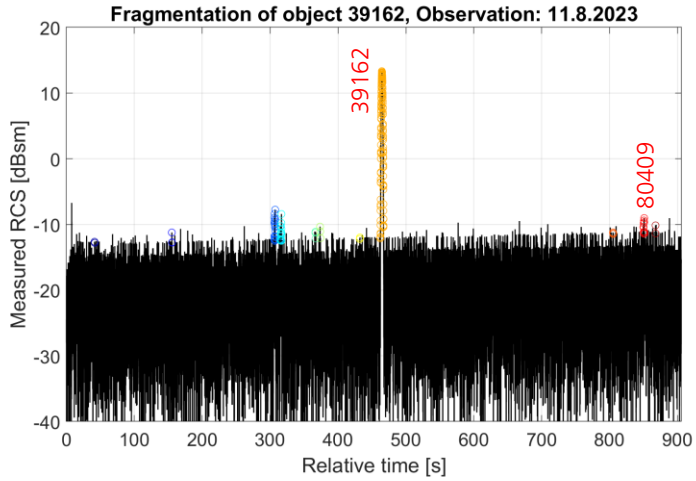


03

Observation 2

Detected debris
Measured RCS

- Detection of 12 objects
- Detection of two catalogued objects (including VESPA)
- **10 objects are uncatalogued debris**



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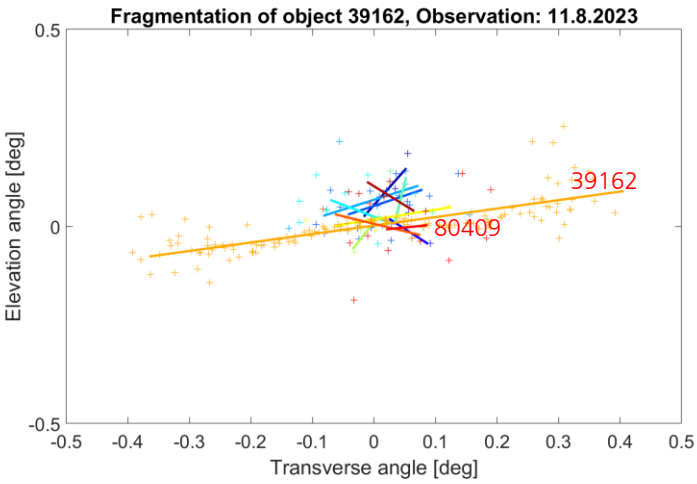
Detected debris
Path through the antenna beam

- Antenna gain loss is computed after LS fit
- Low estimation accuracy for detections with low SNR
- 80409 and 39162 are crossing the beam parallel to each other like most of the detected objects



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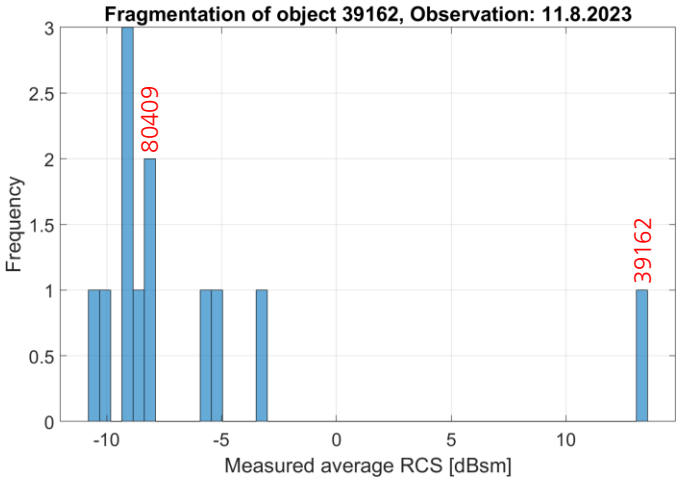
Detected debris

RCS distribution (dBsm)

- Challenging compensation of the antenna pattern modulation and of the processing losses for the low SNR objects
- Correlated objects
  - Object 39162: 13.5 dBsm
  - Object 80409: -8 dBsm

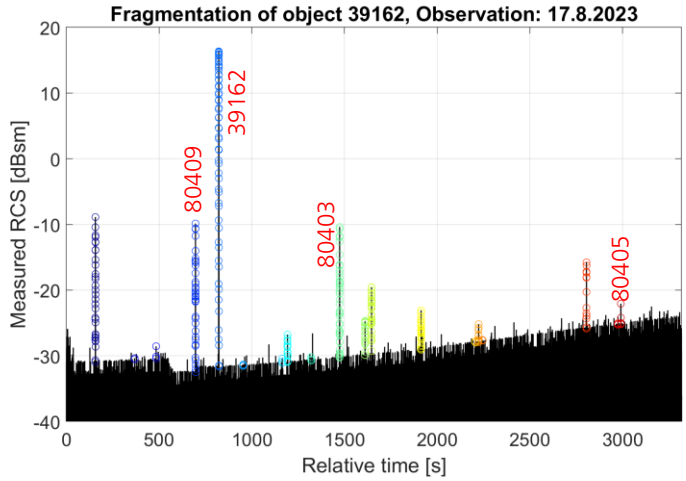


04

Observation 3

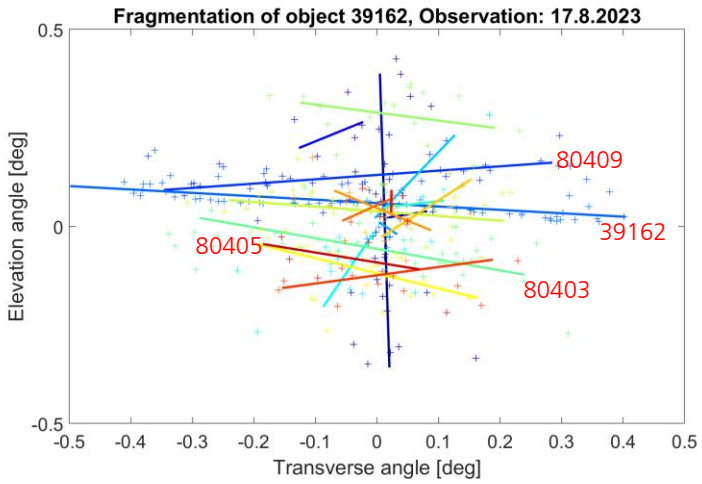
Detected debris
Measured RCS

- Detection of 19 objects
- Detection of four catalogued objects (including VESPA)
- **Remaining 15 objects are uncatalogued debris**



Detected debris
Path through the antenna beam

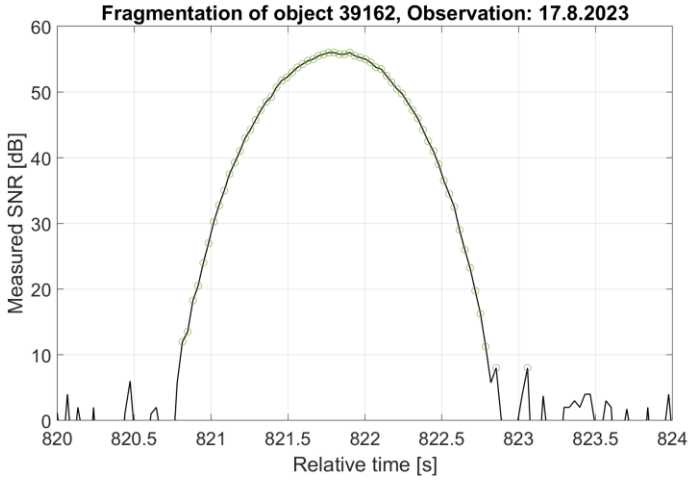
- Antenna gain loss is computed after LS fit
- Low estimation accuracy for detections with low SNR
- Most of the objects are crossing the beam parallel to each other
- Objects crossing the antenna beam differently corresponds to detections with low SNR usually



Detected debris

Antenna crossing of object 39162

- The modulation of the signal strength through the antenna pattern is clearly visible
- This effect is less pronounced for the other objects



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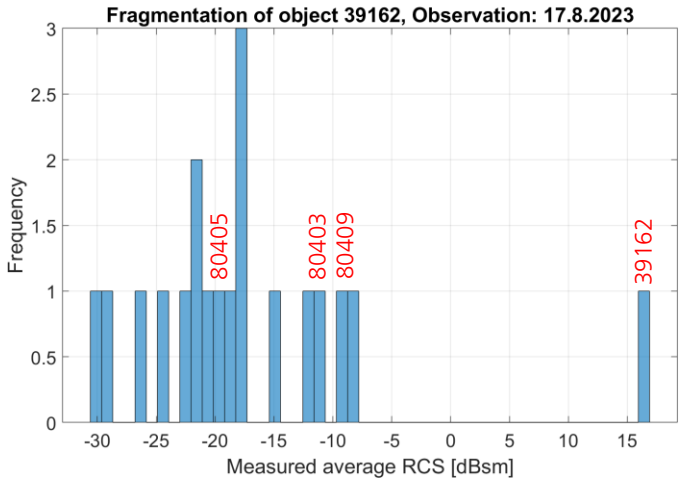
Detected debris

RCS distribution (dBsm)

- Challenging compensation of the antenna pattern modulation and of the processing losses for the low SNR objects
- Correlated objects
  - Object 39162: 16.4 dBsm
  - Object 80409: -8.6 dBsm
  - Object 80403: -11.2 dBsm
  - Object 80405: -19.9 dBsm



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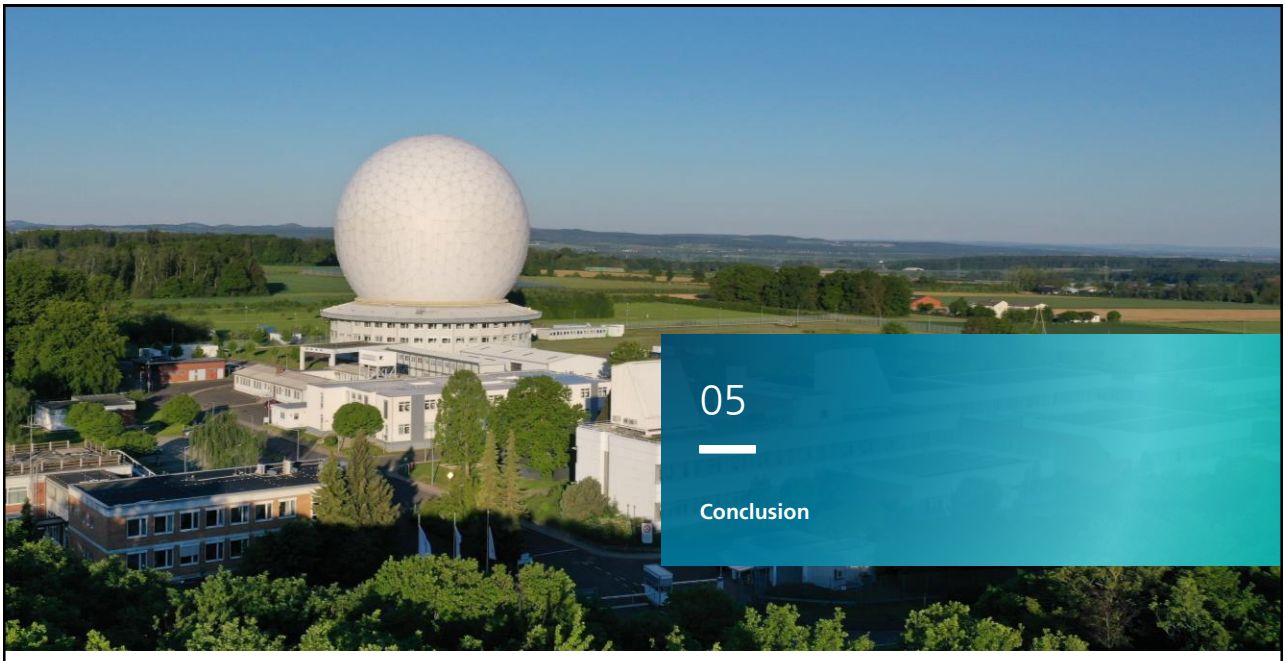

05

Conclusion

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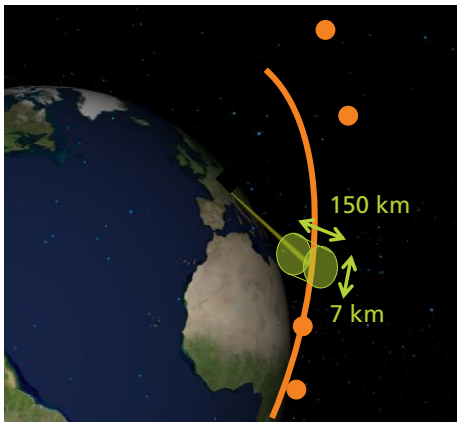
Conclusion

Conducted spotlight BPE observations

- Several spotlight BPEs were conducted to observe the debris cloud around VESPA
  - 11.08.2023: 15 min of observation
  - 17.08.2023: 55 min of observation (~ 55% of the orbit)
- The detection threshold and scheme were equal for all the observations
  - They were chosen to ensure a low number of false detections
- Challenging estimation of the RCS due to the low estimation accuracy of the object parameters (range, range rate, azimuth and elevation) for detections with low SNR
  - The correction takes into account the antenna gain and processing losses
- Challenging estimation of the object size for low SNR detections



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Thank you for your attention! Questions?

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