Terminal Area Surveillance at Innsbruck Airport

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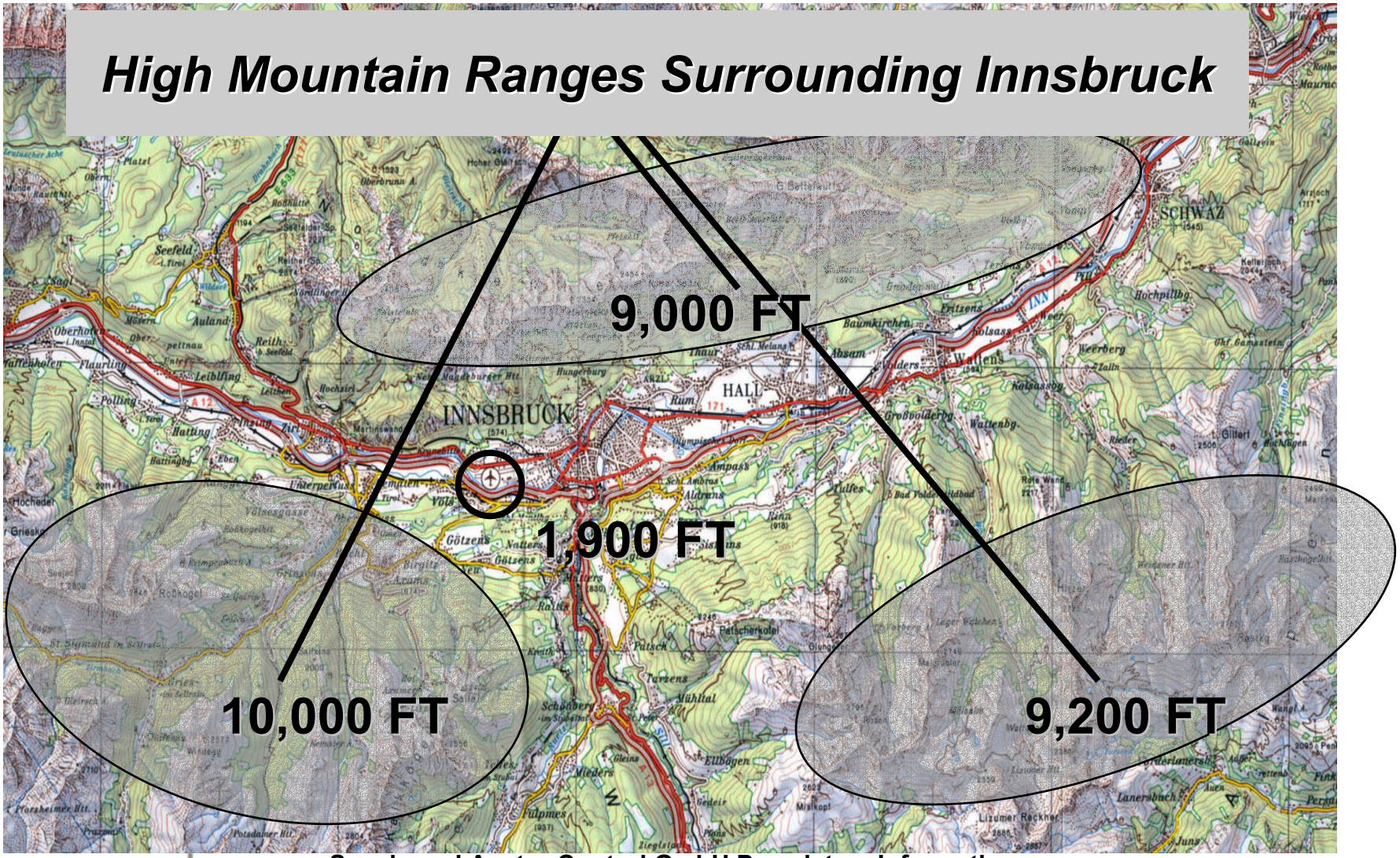
Agenda

- Innsbruck's Unique Situation
  - Terrain, Procedures and Environment
- Technical Challenges
- Technical Solution
- System Architecture
- Preliminary Results
- Outlook for Austria
  - Planned WAM systems
  - Integration of WAM in standard surveillance architecture

Innsbruck Location in Europe

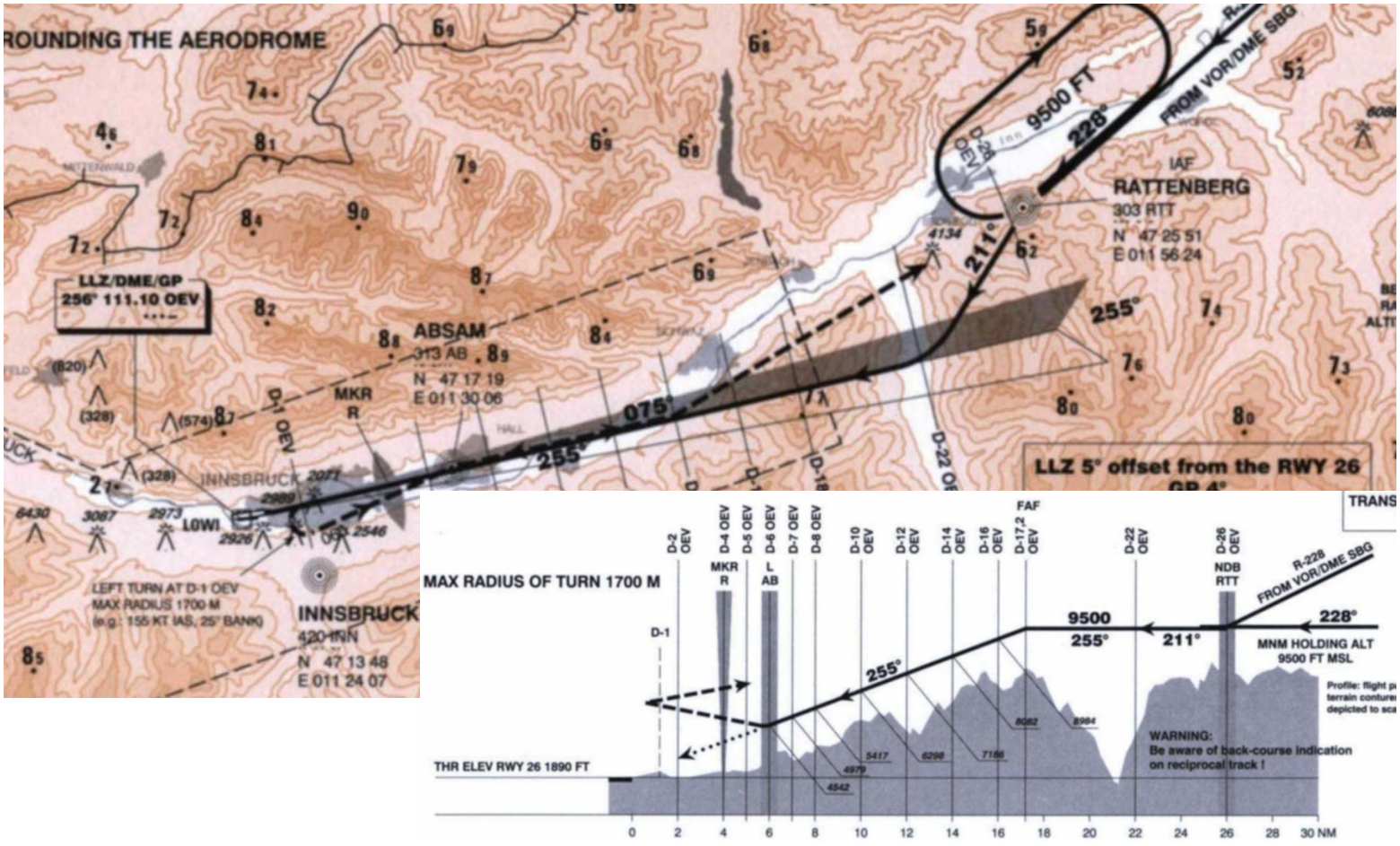
Airport Innsbruck



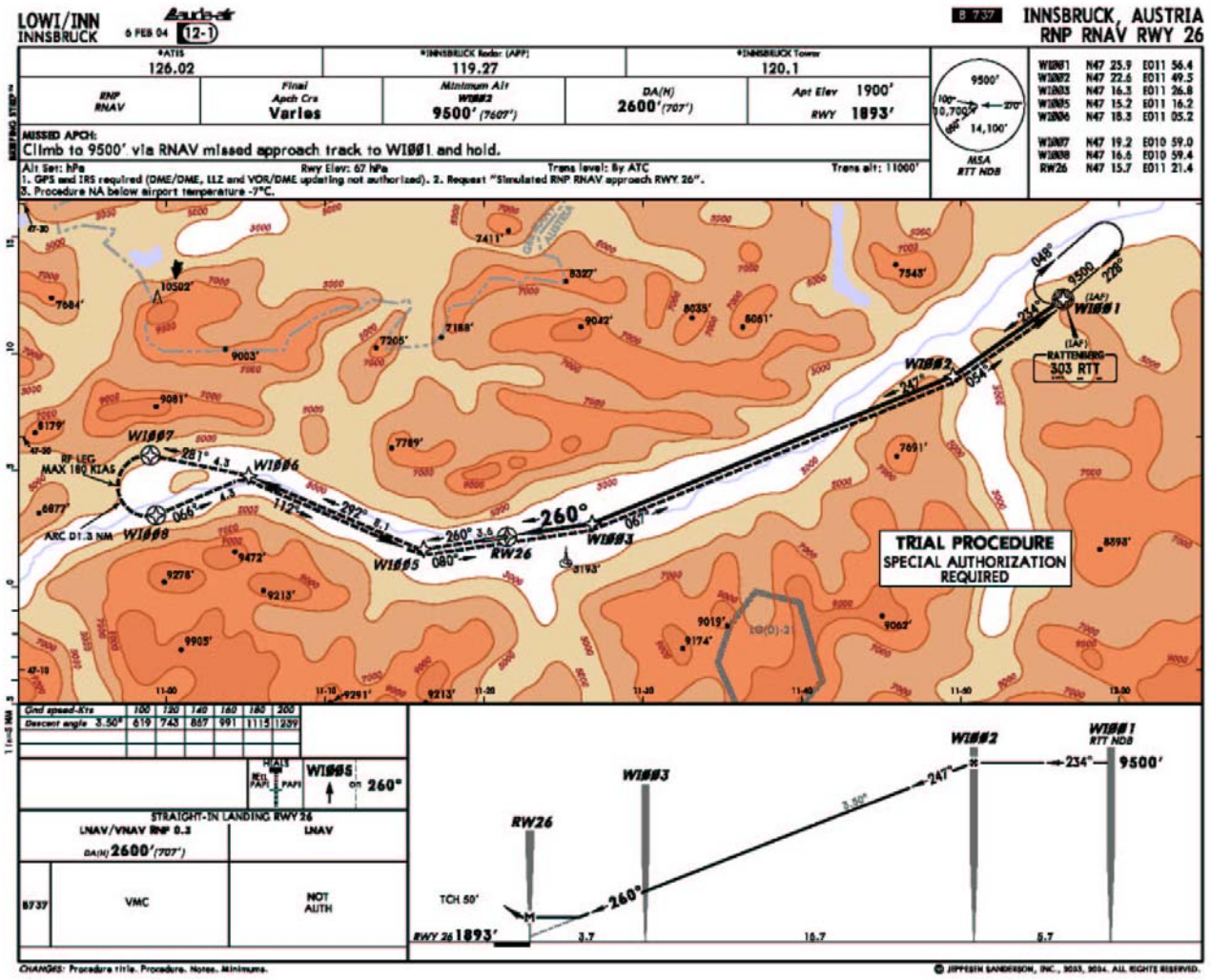
Status of IFR Ops into Innsbruck

- High mountains in the north and the south, approx. 8,000ft AAL. Narrow valley, especially in the west.
- Strong traffic mix VFR-IFR-Gliders with an average of 200 movements per day, charter peaks 360+.
- NAV: off-centerline LLZ/DME approach with Glidepath.
- Approach procedures still limited to either high minima and/or special permission with operational penalties and additional training.
- Departure procedures still partly VMC and/or special procedures and training required.
- ATC/airport capacity limited by “one way in/out” procedures.
- Surveillance coverage at FL110 and above, only.

Special Instrument Approach Procedure East



Future RNP0.3 Procedure East



The Way Ahead

- New RNP0.3 procedures with fixed RF-Terminator currently under validation.

- Installation of a SURVEILLANCE System for the Terminal Area.

Surveillance Challenges

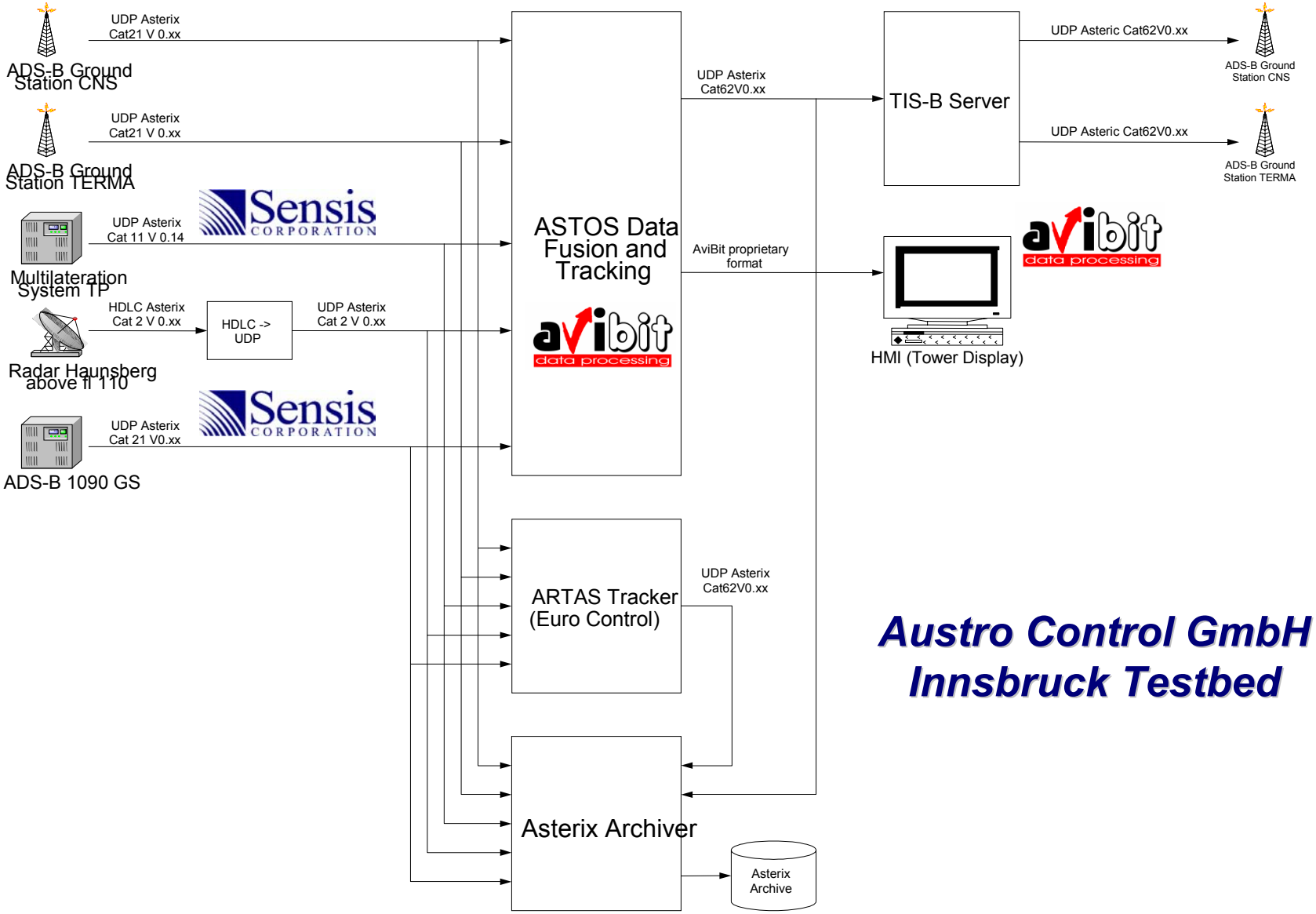
- Radar would be technically, logistically and politically difficult:
  - Radar coverage would be limited within mountainous region.
  - Logistics costs and maintenance actions requires more time for Mean Time Between Repairs.
  - Radar requires additional environmental considerations for RF issues.
- Radar solution would be highly expensive in terms of initial acquisition and Life Cycle Costs.

- Solution for Austro Control is
WIDE AREA MULTILATERATION – combined with ADS-B

- The SENSIS MDS System

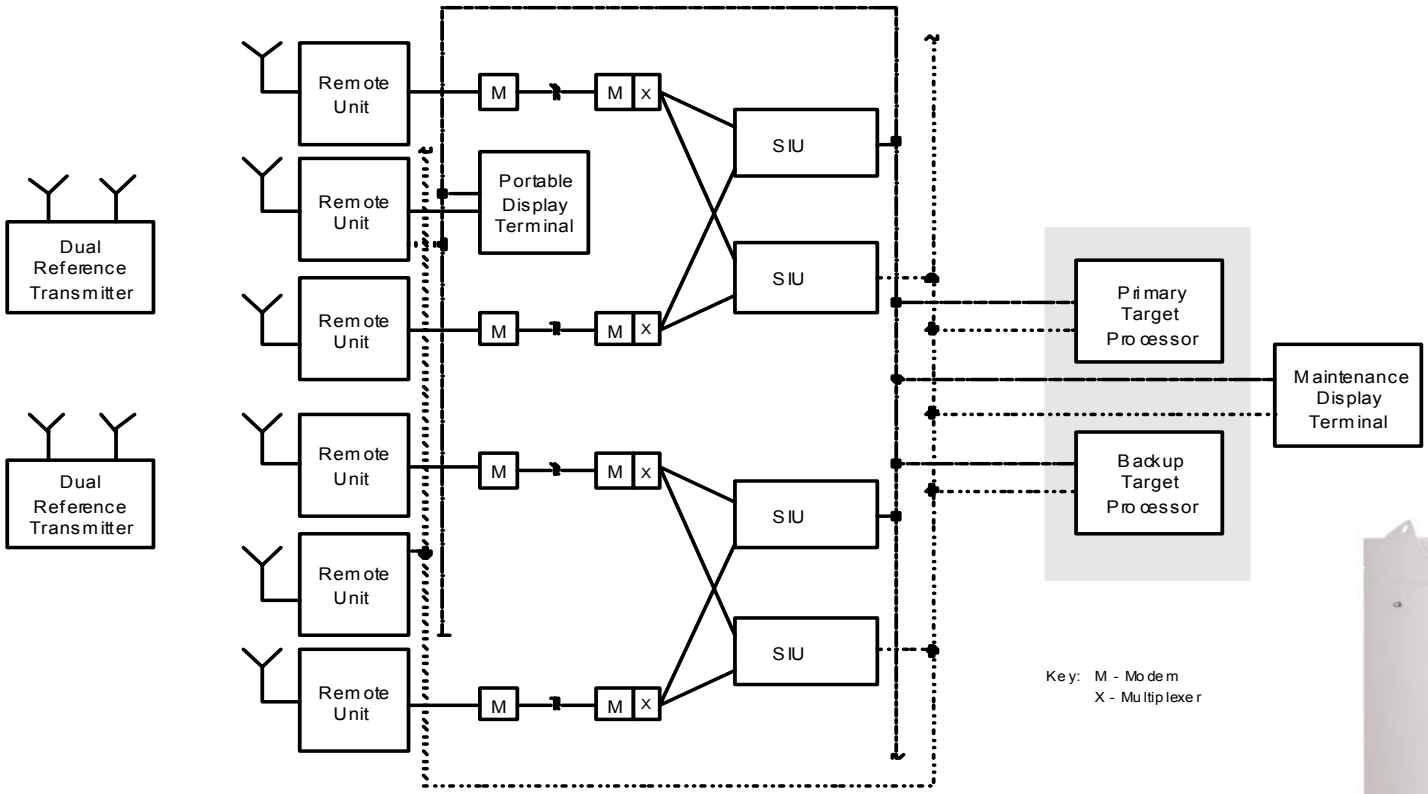
Surveillance System Architecture Overview

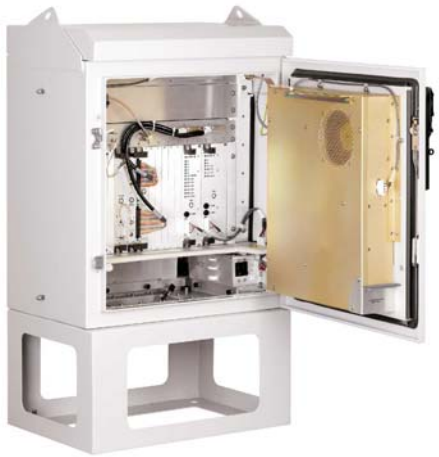
- Innsbruck Testbed Components:
  - Wide Area Multilateration Detection System (SENSIS MDS)
  - 1090 ES ADS-B (SENSIS MDS)
  - VDL Mode 4 ADS-B (CNS Systems and Terma)
  - Radar above FL110
  - Flightplan data
  - ASTOS Datafusion and Tracking System (Avibit)
  - Parallel ARTAS Tracker v7.0 (for validation purposes)
  - TIS-B server
  - Display processor with HMI
  - CDTI for vehicles and cockpit



Austro Control GmbH Innsbruck Testbed

SENSIS MDS System Architecture





MDS OVERVIEW

- A Concept based on Time Difference of Arrival (TDOA) processing:
  - A TDOA-based system measures the difference in time between reception of a signal at multiple known positions and uses this information to calculate the location of the signal source.
  - In the two-dimensional problem of surface surveillance, the TDOA at each pair of sensors has a single distinct curve upon which the transponder is located. Data from three sensors permits the system to create three solution arcs—the intersection of which is the location of the transponder.
- A key features of the Sensis MDS system:
  - Ability to track and identify Mode S, Mode A/C and ADS-B equipped aircraft at a high update rate.
  - The interrogation capability and advanced target processing.
  - GPS INDEPENDANT time reference system.

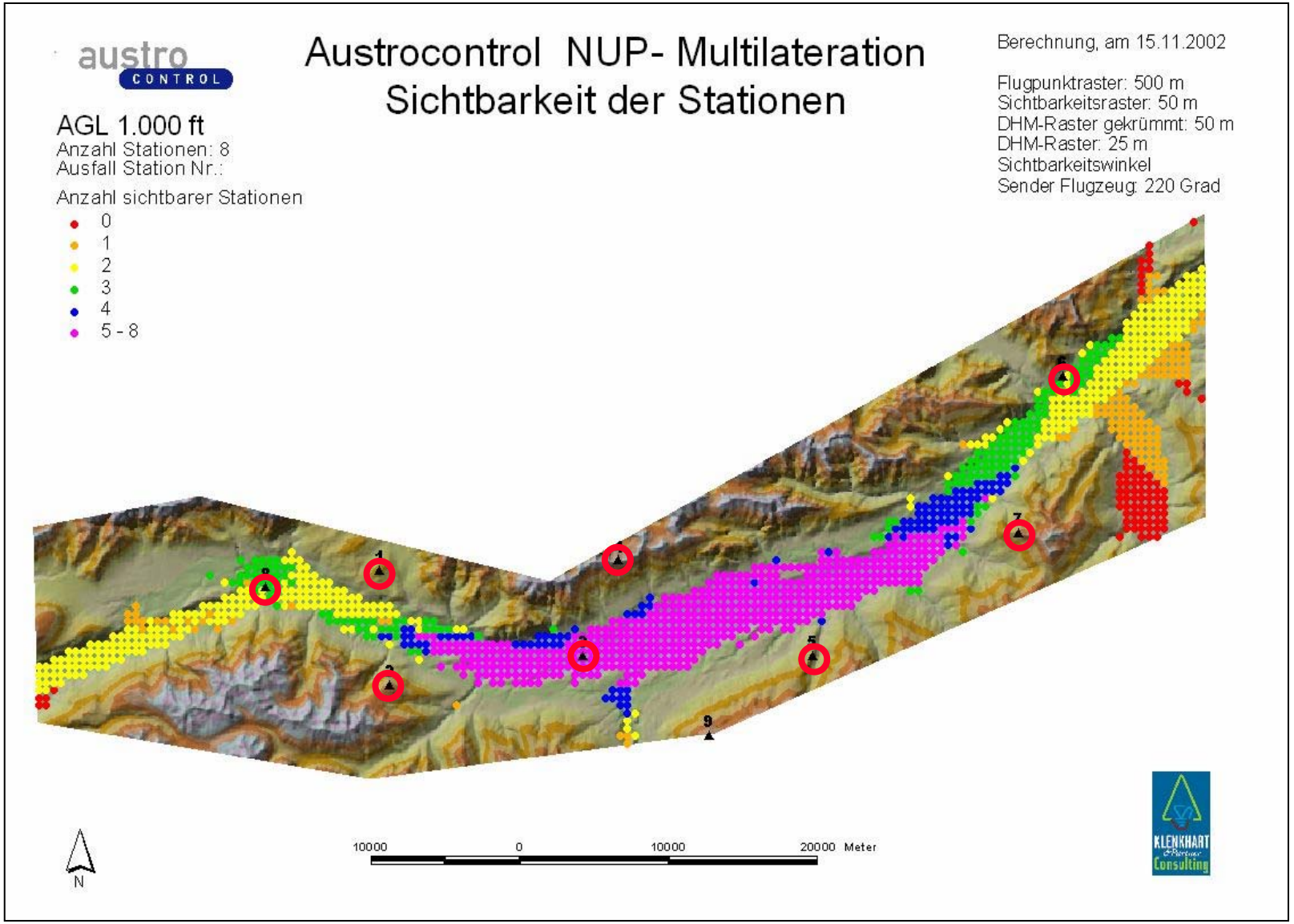
System Considerations/Constraints

- Valley is narrow with high mountain ranges to the north and south of both approaches.
- Multilateration sensors are distributed to optimize performance in tracking aircraft on either of the two difficult approaches:
  - 8 Remote Units (3 Receive Transmit, 5 Receive Only)
  - 2 Dual Redundant Reference Transmitters
  - Redundant Central Processing System
  - Maintenance Display Terminal
  - Portable Display Terminal

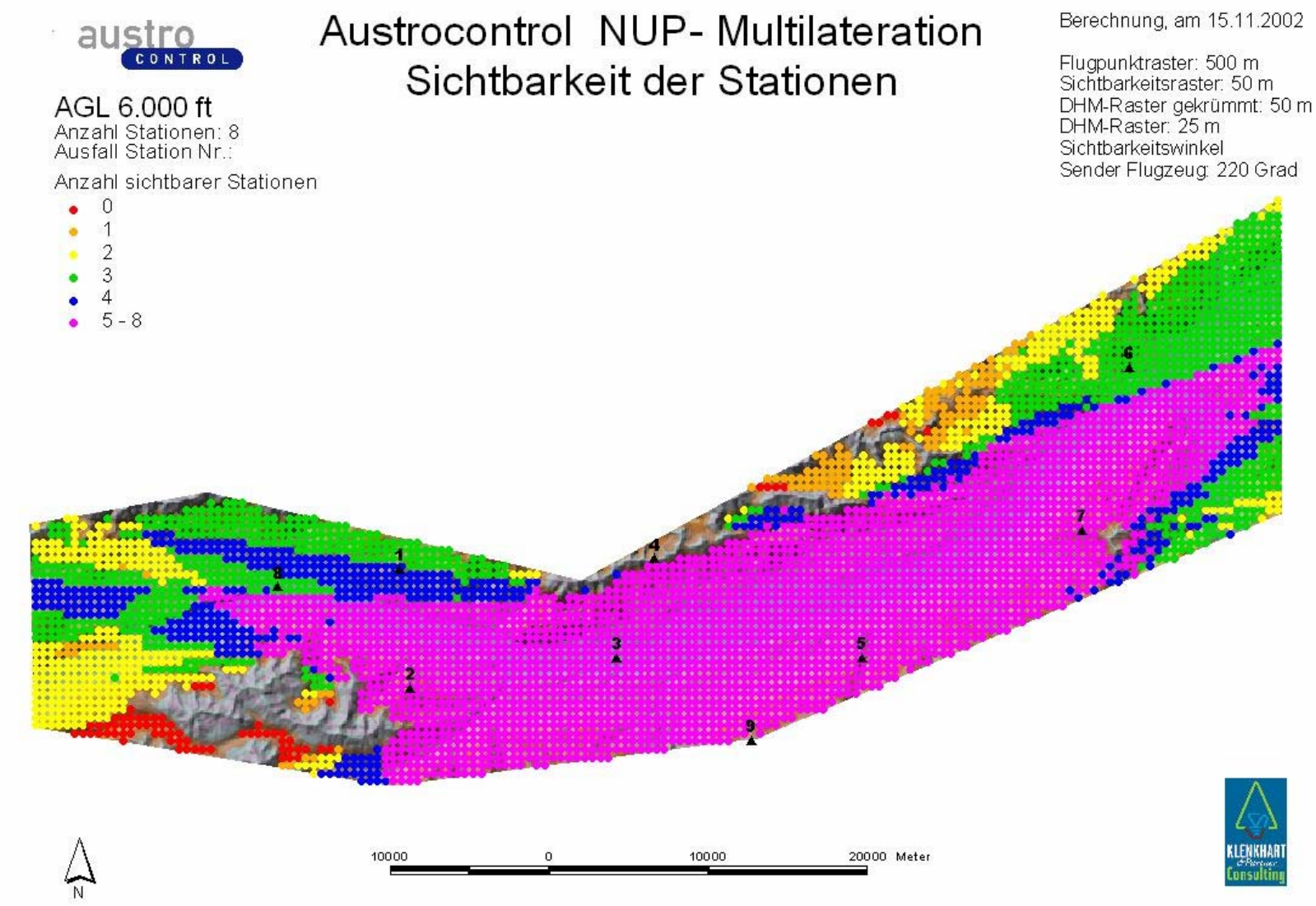
Sites – placed throughout Inn Valley

Location	Unit	Antenna(s)	Latitude	Longitude	Altitude (meters)
Patscherkofel	Reftrans	Omni x 2	47 12 31.4	11 27 36.7	**2245**
Flughafen	RT/Reftrans	Omni/Omni x 2	47 15 28.2	11 21 9.8	**616**
Hafelekar	RO	Omni	47 18 46.4	11 23 10.3	**2336**
Rangger Köpfl	RT	Omni	47 14 37.4	11 10 51.9	**1910**
Tulferer Berg	RO	Omni	47 15 11.6	11 33 20.9	**1360**
Hecher	RT	Omni	47 19 15.7	11 44 30.8	**1895**
Kanzelkehre	RO	Omni	47 24 34.6	11 47 15.1	**1006**
Telfs	RO	Omni	47 18 11.9	11 04 23.1	**605**
Gschwandtkopf	RO	Omni	47 18 49.3	11 10 39.5	**1459**

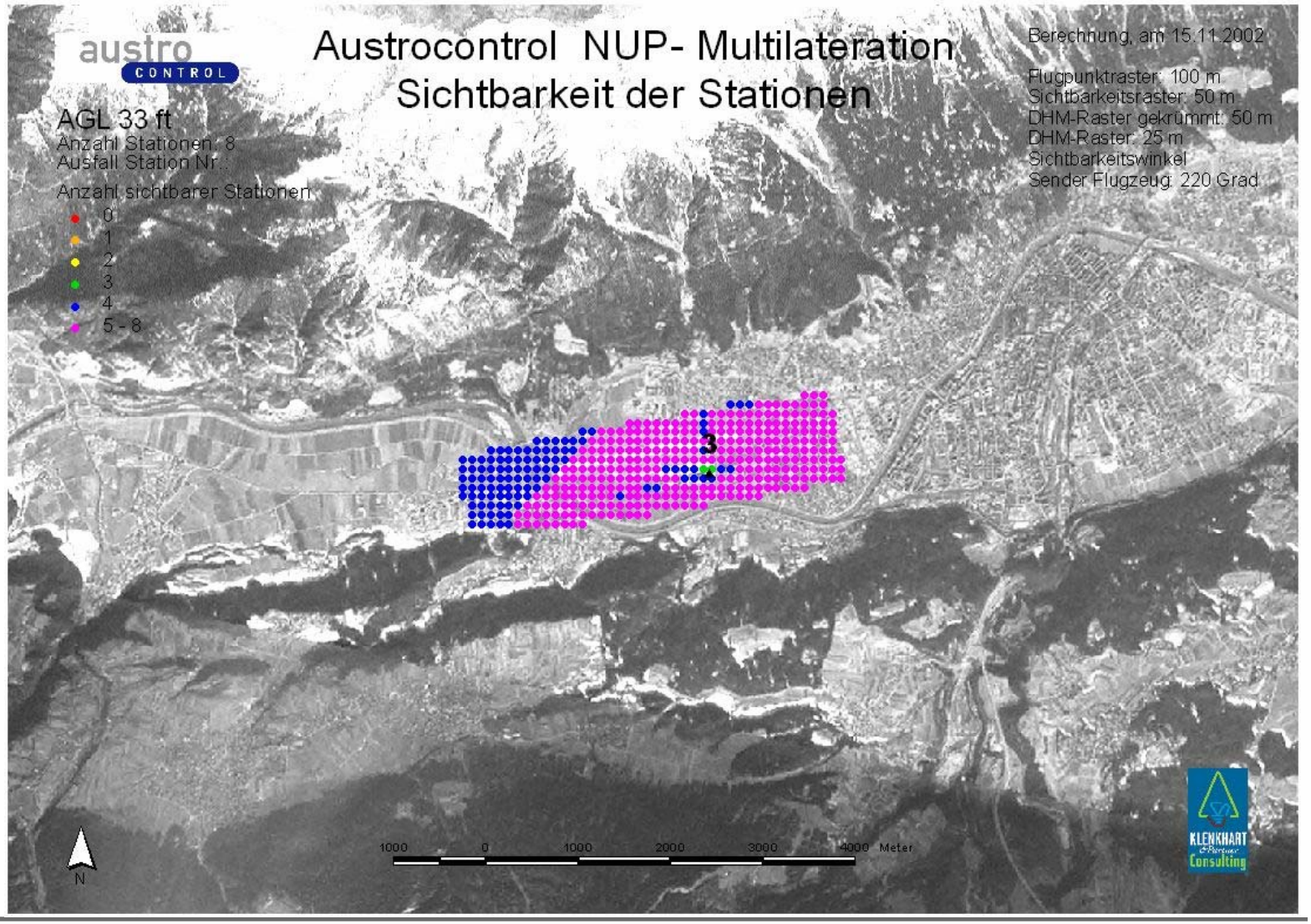
Multilateration Visibility of the Stations at 1,000 ft AGL



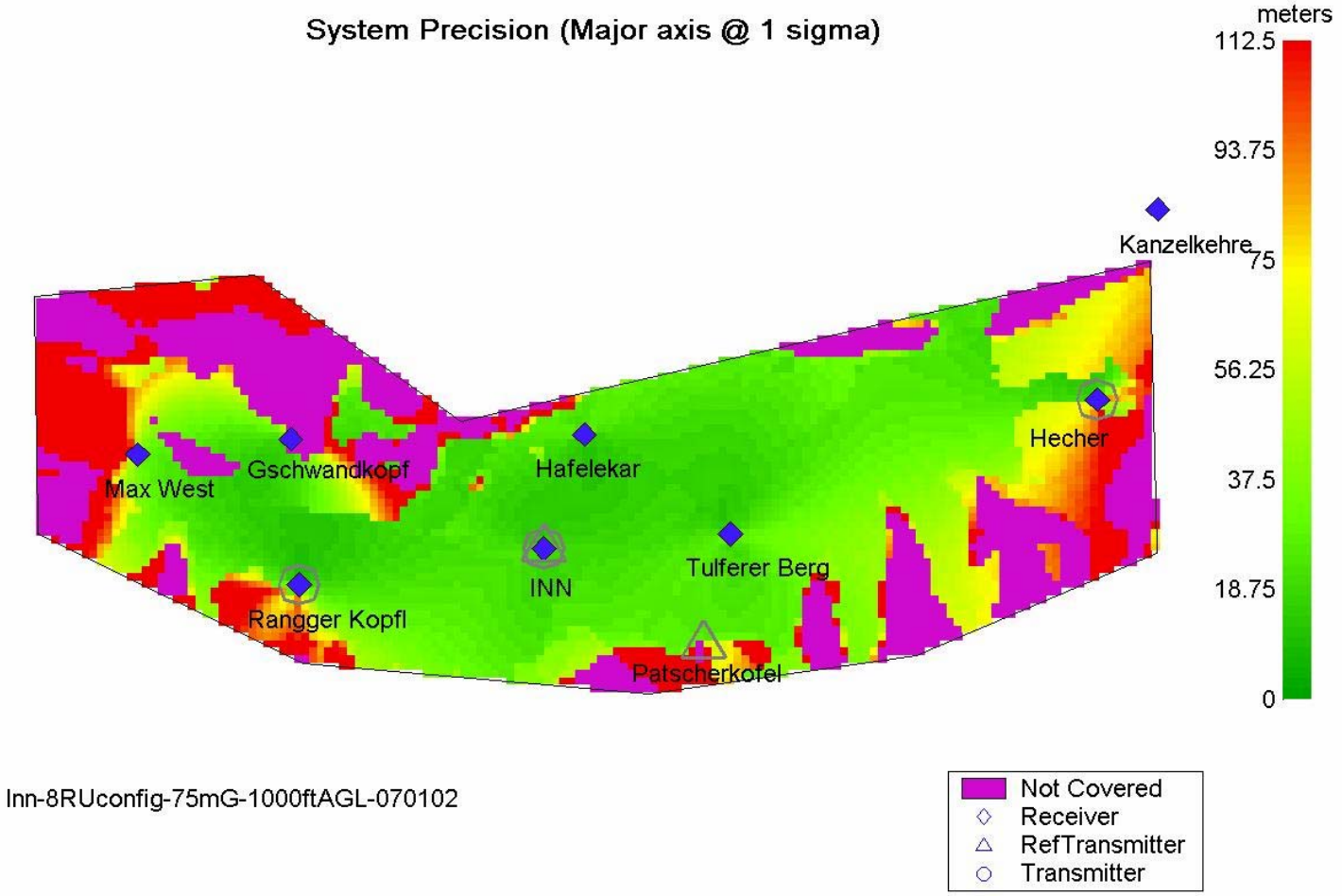
Multilateration Visibility of the Stations at 6,000 ft AGL



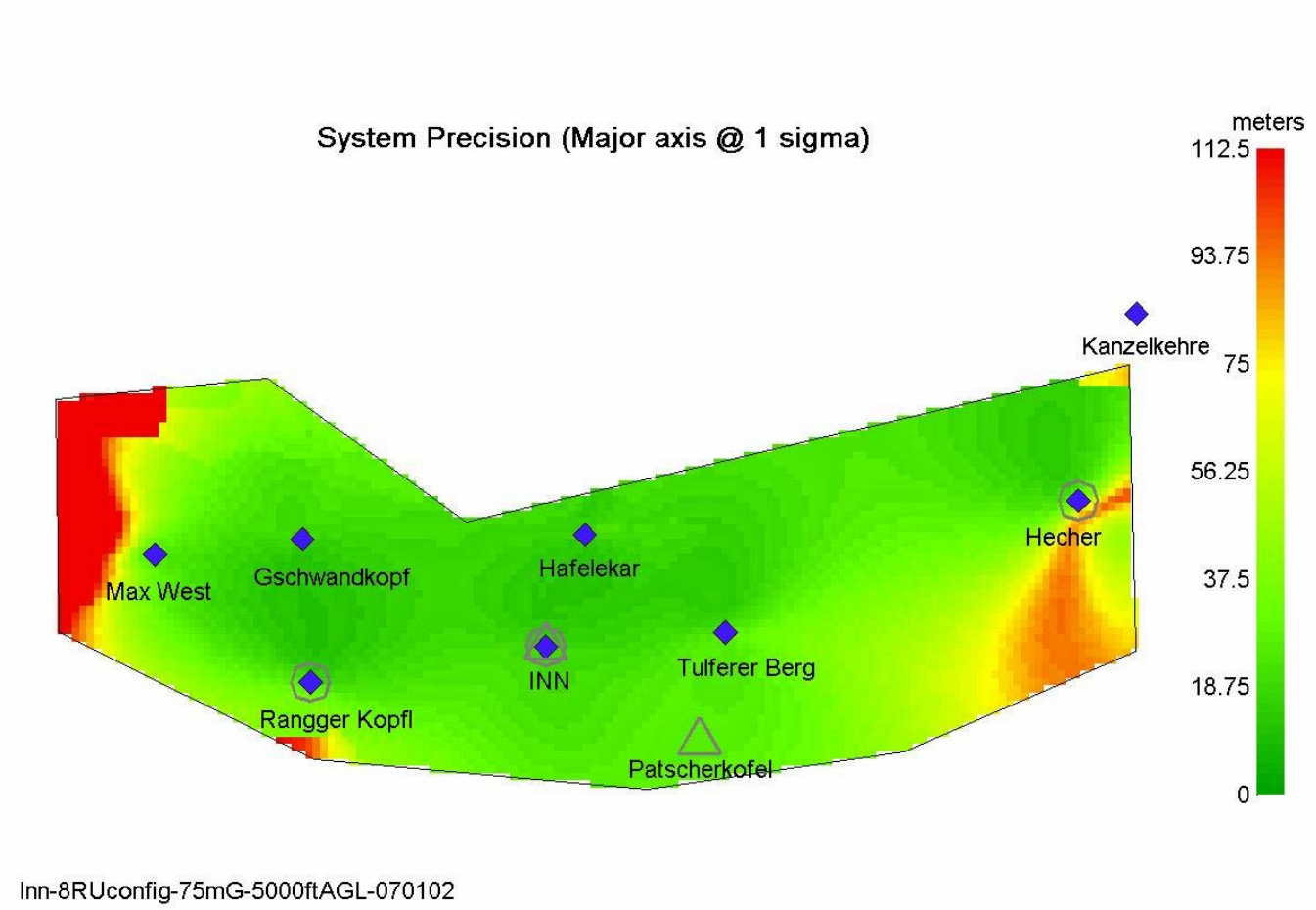
Multilateration Visibility of the Stations at 33 ft AGL



Coverage Analysis at 1,000 ft AGL



Coverage Analysis at 5,000 ft AGL



MDS Performance Examples

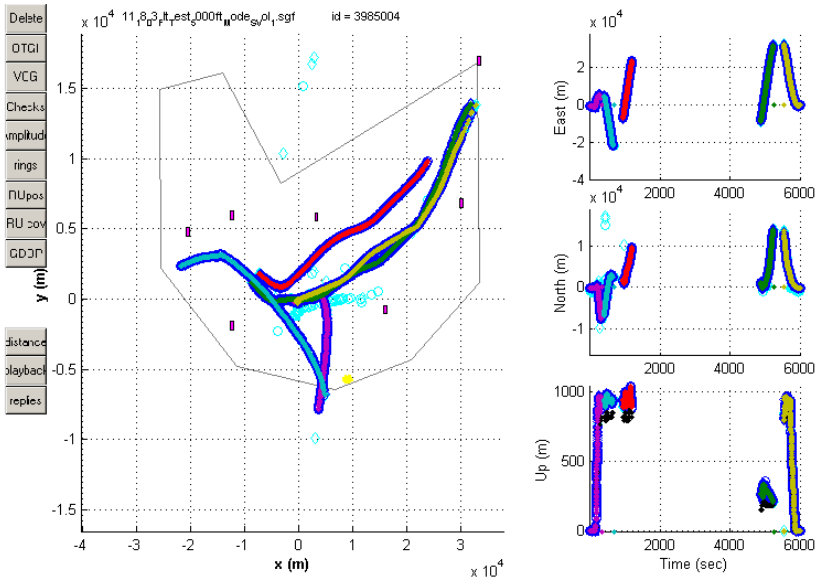
Test results November ’03 flight trials:

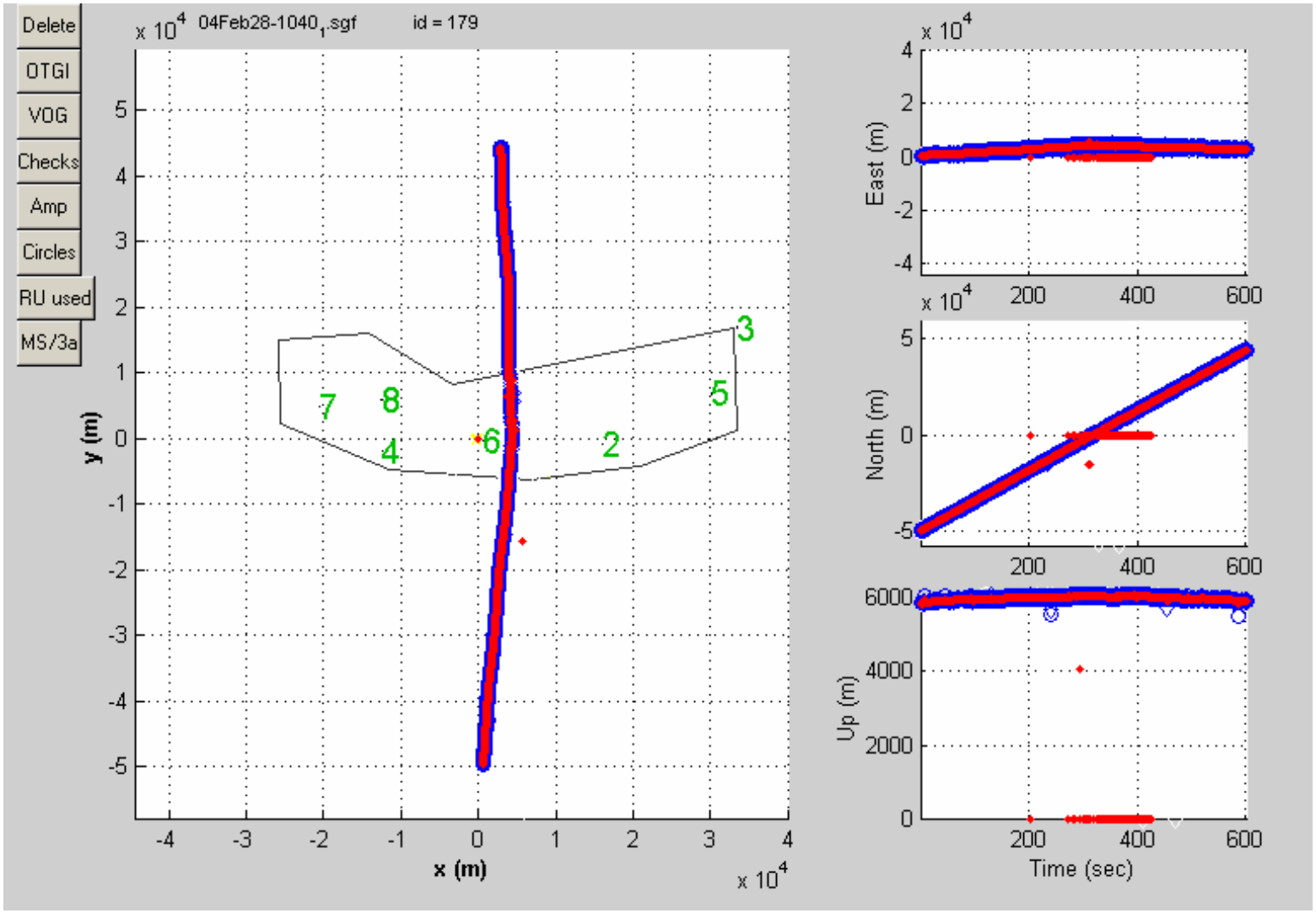
Flight program:

Preliminary results:

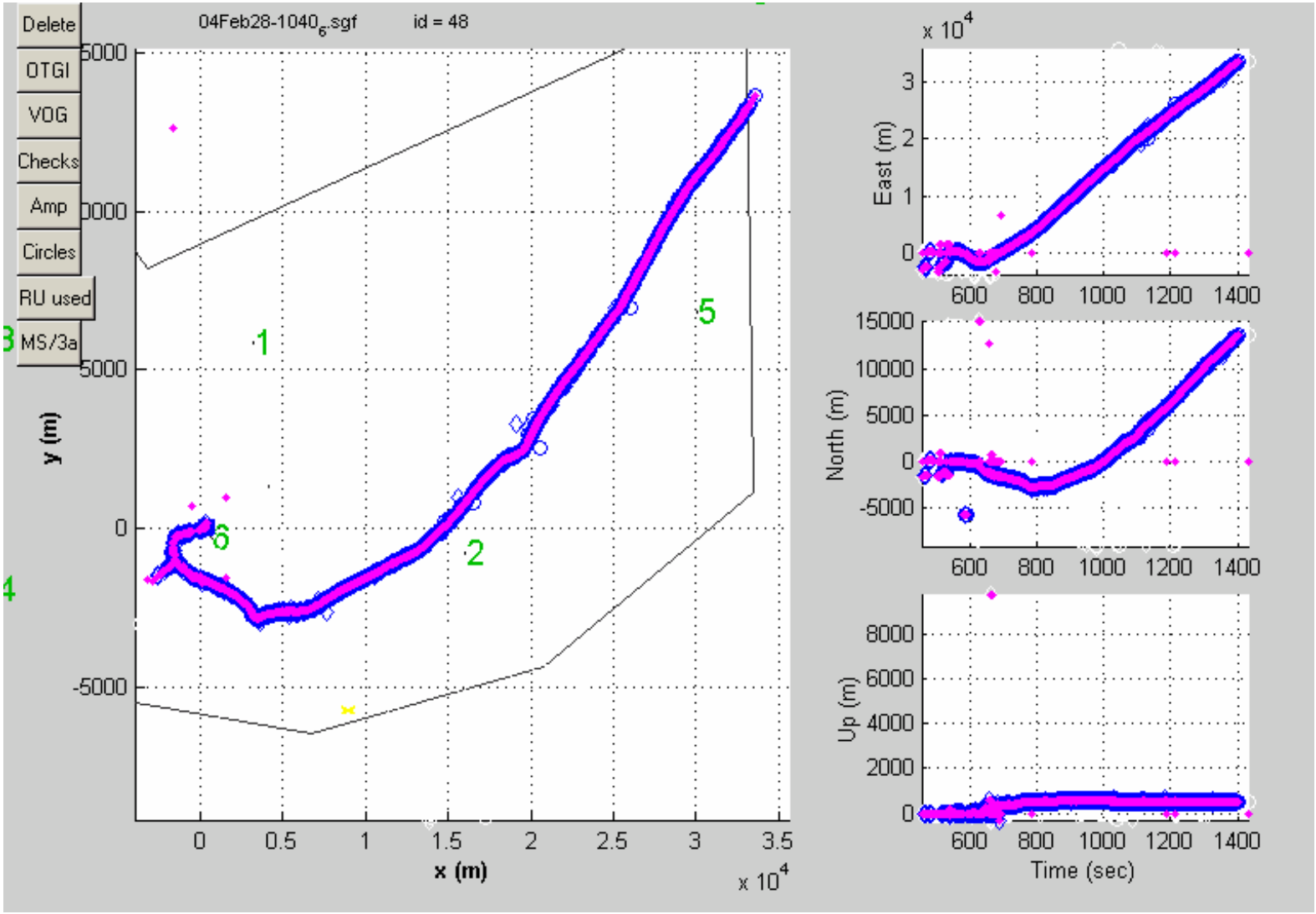
Error Thresh	Pos < Threshold		Track < Threshold	
10.0	232	14.46%	261	16.27%
20.0	794	49.50%	868	54.11%
50.0	1535	95.70%	1592	99.25%
70.0	1554	96.88%	1599	99.69%
100.0	1575	98.19%	1601	99.81%
1000.0	1604	100.00%	1604	100.00%

Number of Positions: 1604

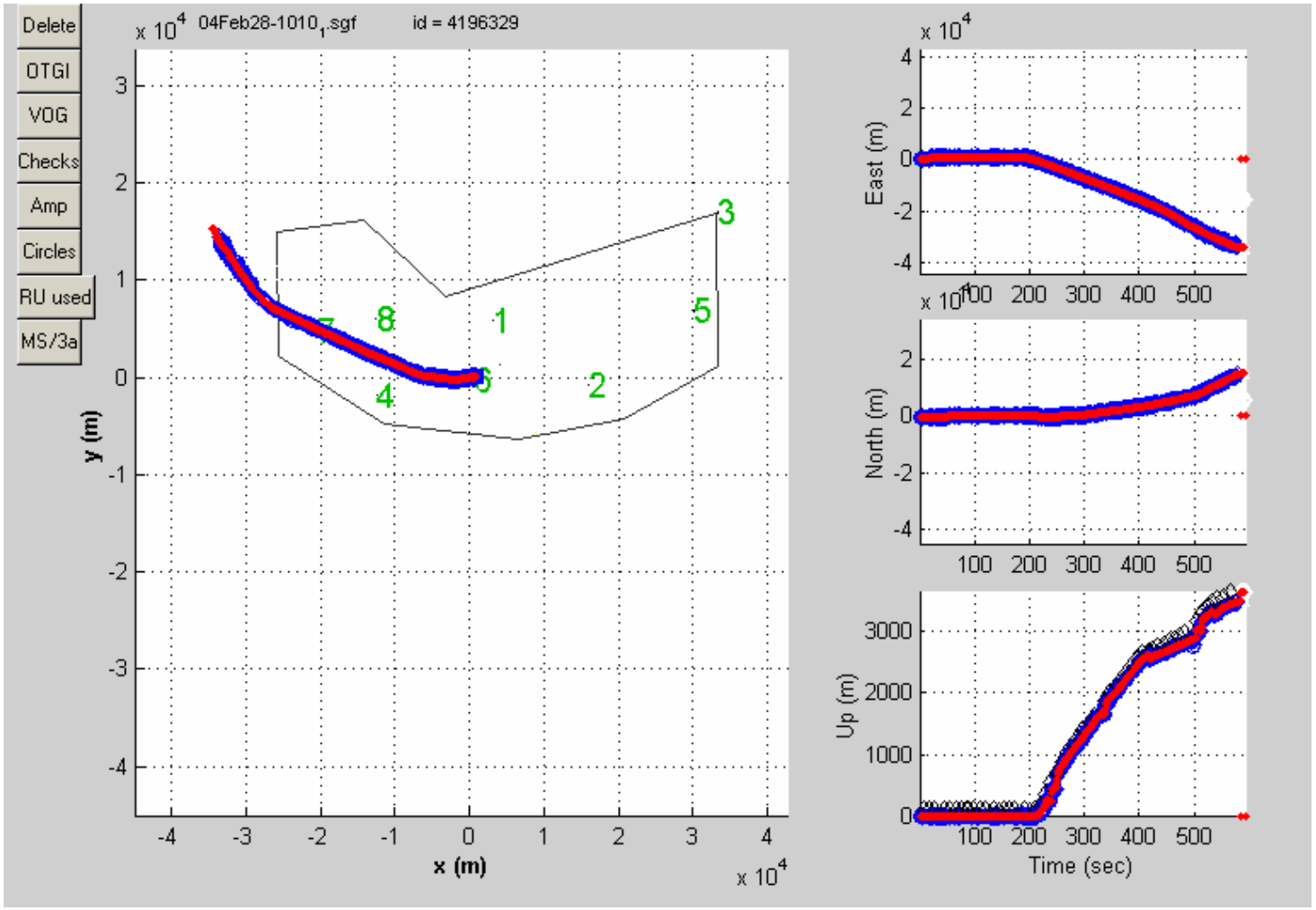




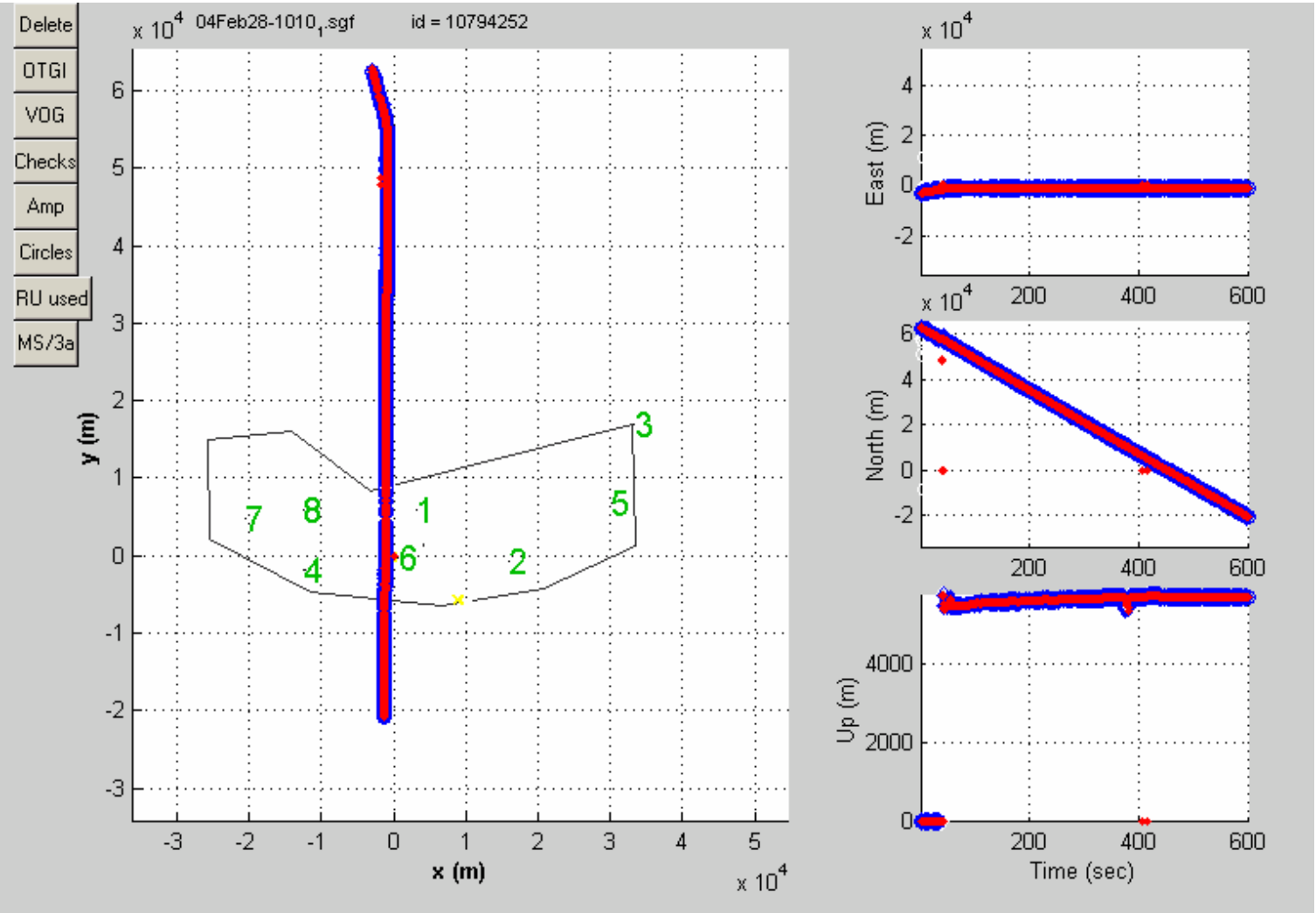
- This is another ATCRBS target track for an overflight target. This target passes over the required coverage volume at an altitude of more than 20,000 feet.



- This is a track of a very small private aircraft. The target takes off from the airport and continues to the east through the coverage volume. The target remains at a very low altitude – never exceeding 2,000 feet above ground. This target flew below the required coverage altitudes while departing to the east. At the eastern edge of the coverage area, the required coverage altitude is 4,600 feet above the airport ground height. This target was flying less than 2,000 feet above the airport ground level when it left the coverage volume.



- This Mode S target takes off from the airport and travels west through the required coverage area. The target is tracked well as it ascends to an altitude of approximately 12,000 feet as it passed beyond the required coverage area. Mode C and Mode A interrogations of this Mode S target were successful during this time.



- This Mode S target traverses the required coverage volume, but is at a much higher altitude than the targets of interest for the Innsbruck MDS system. This target passed over the coverage volume at an altitude of approximately 20,000 feet. While inside the required coverage boundaries, this target track is updated on average 1.55 times per second. Total time to cross the boundary is approximately 454 seconds. During this time, the track was updated 704 times.

VDL Mode 4 ADS-B Ground Station

VDL 4000/GSI

Fully redundant and SARP compliant for ATC, ATM & AO. Handles ADS-B, TIS-B, FIS-B, Gras 1, 2 & 4.

austro CONTROL

Sensis CORPORATION

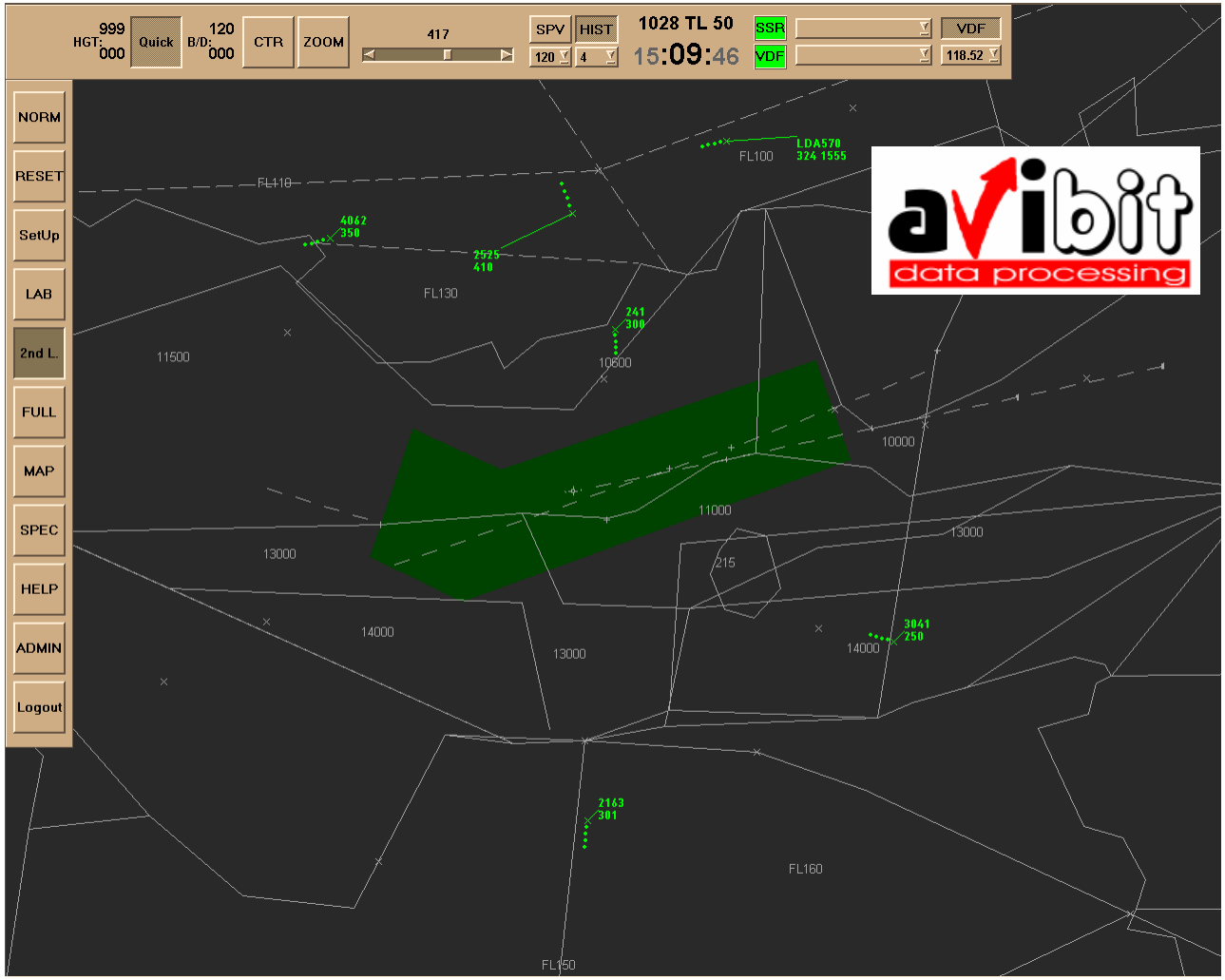
Vehicle Ground Based

VDL 4040/AO

Fully SARP compliant AO system with application software.

The Vehicle Kit is used in different kinds of vehicles at Innsbruck Airport. By utilizing this equipment real-time data exchange between databases and vehicles is supported.
The vehicle transponder communicates with the Ground Station via the digital data link VDL-Mode 4. The Ground Station is connected to the Innsbruck local surveillance system.

Air Situation Display – ASTOS Datafusion, Tracking and HMI



Outlook for WAM in Austria

- Additional projects scheduled within Austro Control following completion of Innsbruck SAT in May 2004.
  - Integration of WAM Sensors into the Surveillance Data Processing and Distribution System.
  - Expand WAM from Vienna Airport into the TMA.
  - Expand into the rest of Austria and CEATS Area with Partner ANSPs.
  - Expand WAM from Innsbruck Valley towards Munich together with DFS.
- Work with partners towards International Standardization of WAM.
- WAM and ADS-B technology are complementing each other in high density airspace and at airports.
- WAM reduces surveillance costs for Austro Control and provides improved accuracy and overall performance.