

# **Twin Telescope Wettzell**

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## **A VLBI2010 Project**

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# Primary Goals of IVS-WG2

## Product Specifications and Observing Programmes



IVS-Products  
requesting  
24h/7d  
observations

Category	Products	Accuracy	Frequency of solutions	Resolution	Timeliness
TRF	x, y, z time series (one solution per session)	2-5 mm	→ 7 d/w	1 day	1 day
	episodic events	2-5 mm	→ 7 d/w	< 1 day	near real time
	annual solution coordinates velocities (multi session)	1-2 mm 0.1-0.3 mm/y	yearly	-	1 month
CRF	radio source coordinates	0.25 mas for as many sources as possible	yearly		1 month
	$\alpha$ , $\delta$ time series	0.5 mas	monthly	1 month	1 month
EOP	UT1-UTC	5 $\mu$ s	→ 7 d/w continuous	10 min	near real time
	$d\phi$ , $d\epsilon$	25-50 $\mu$ as	→ 7 d/w	1 day	near real time
	$x_p$ , $y_p$	25-50 $\mu$ as	→ 7 d/w	10 min	near real time
	$dx_p/dt$ $dy_p/dt$	8-10 $\mu$ as/day	→ 7 d/w	10 min	-
geodynamical parameters	solid Earth tides $h$ , $l$	0.1%	1 y	1 y	1 month
	ocean loading $A$ , $\phi$	1%	1 y	1 y	1 month
	atmosphere loading	10%	1 y	1 y	1 month
physical parameters	tropospheric parameters	1-2 mm	→ 7 d/w	10 min	near real time
	zenith delay gradients	0.3-0.5 mm	→ 7 d/w	2 h	
	ionospheric mapping	0.5 TEC-units	→ 7 d/w	1 h	near real time
	light deflection parameter	0.1%	1 y	all sessions used	1 month

Table 1: Summary of primary goals of IVS Working Group 2

## Requirements (relevant to radio telescopes):

- 1 mm position and 1 mm/year velocity for position  
→ **construction!**
- Continuous observations of Earth orientation parameters  
→ **>1 radiotelescope per site!**
- Small, fast-moving antennas (30s slew-track cycle/source)  
→  **$\geq 6^\circ/\text{s}$**
- Reduced susceptibility to external interference  
→ **wideband 2-18? GHz**



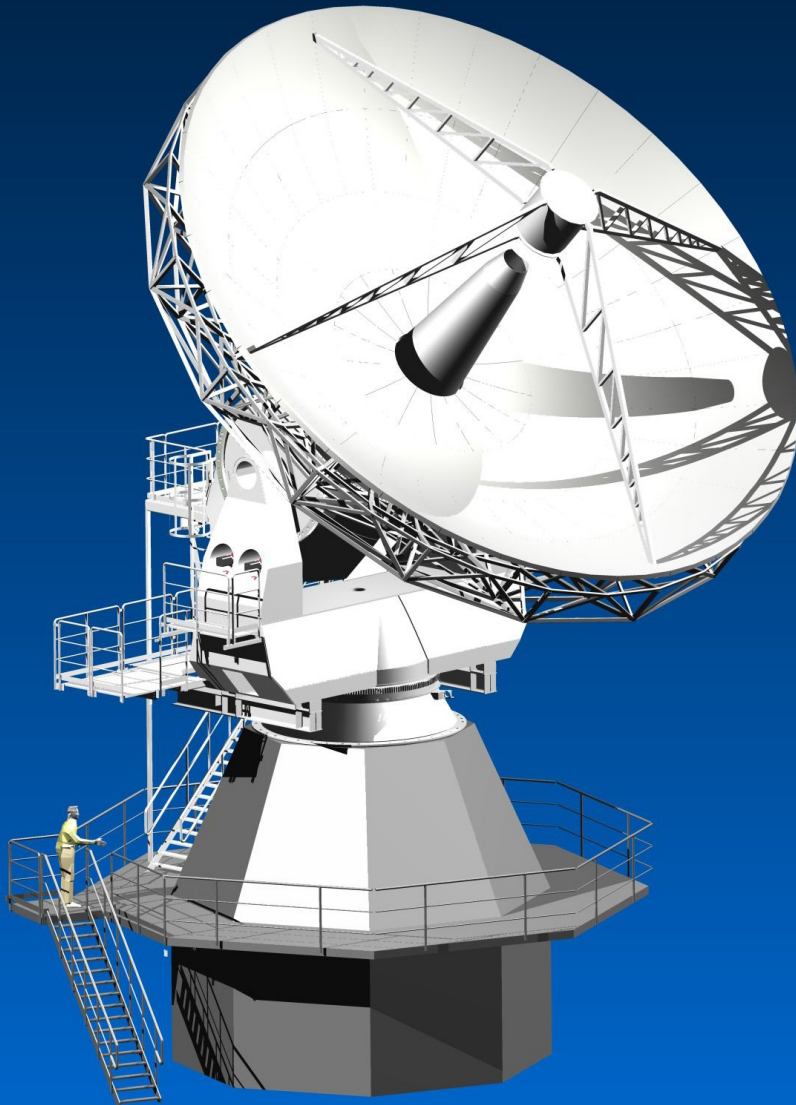
1983-2008 = 25 years  
of geodetic VLBI



- Midterm replacement of RTW necessary due to wear out
- TTW is to comply with the IVS VLBI2010 vision
- 2007: call for bidding, plot purchased
- 2007-12-28: contract signed with Vertex Antennentechnik GmbH
- 2008-12-04: Design Review



VERTEX ANTENNENTECHNIK GmbH



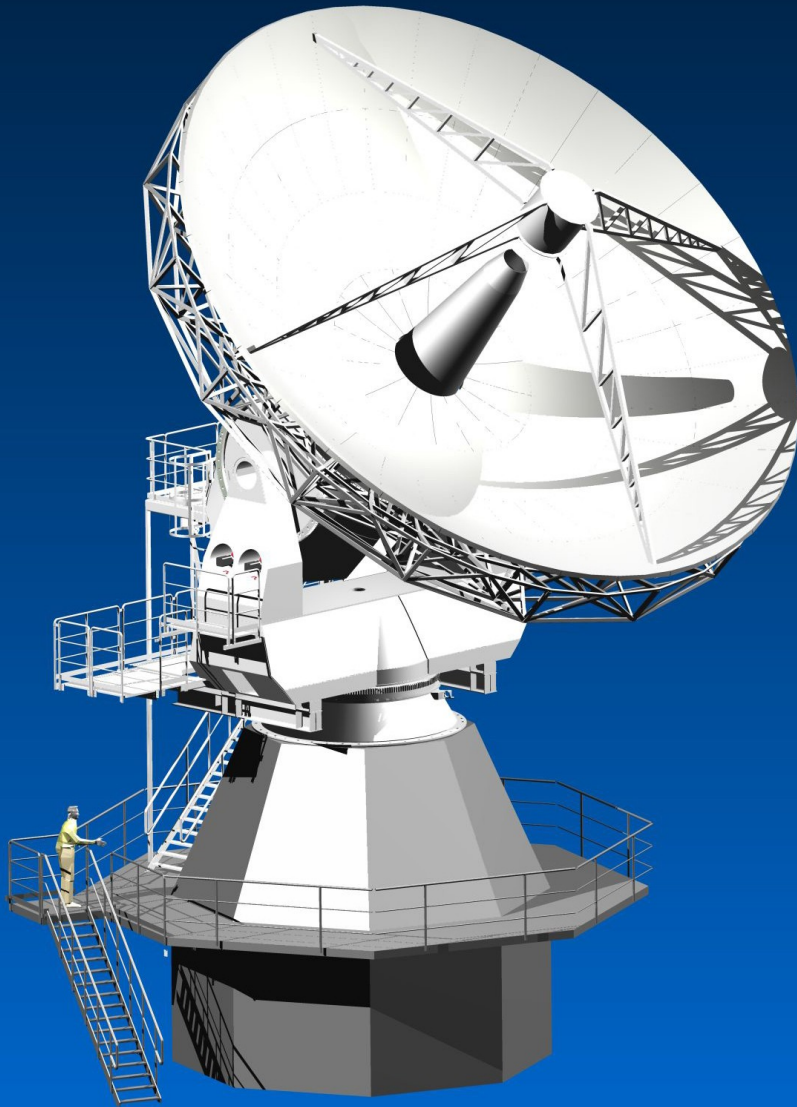
- Number of identical radio telescopes: 2
- Main reflector: 13.2m
- ALMA mount
- Optics: ring focus, axially-displaced ellipse reflector
- $f/D = \sim 0.29$
- Subreflector with hexapod mount
- Vel.: Az  $12^\circ/s$ , El  $6^\circ/s$
- Acc.: Az/El  $3^\circ/s^2$
- 27 bit Encoder:  $0.3m^\circ$





# Twin Telescope Wetzell as a Geodetic Monument

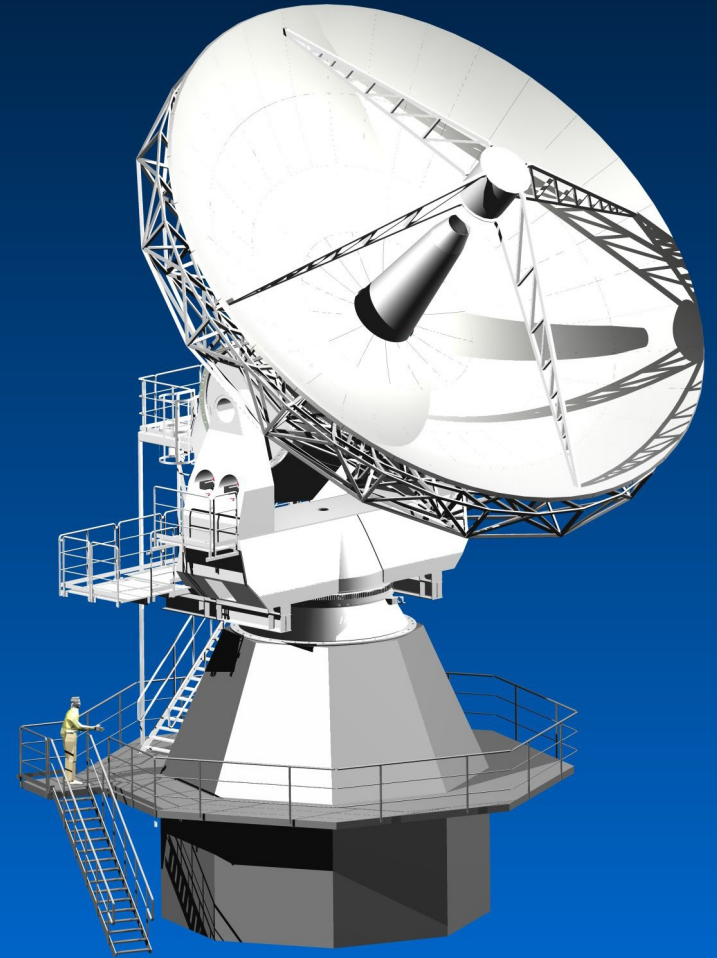
VERTEX ANTENNENTECHNIK GmbH



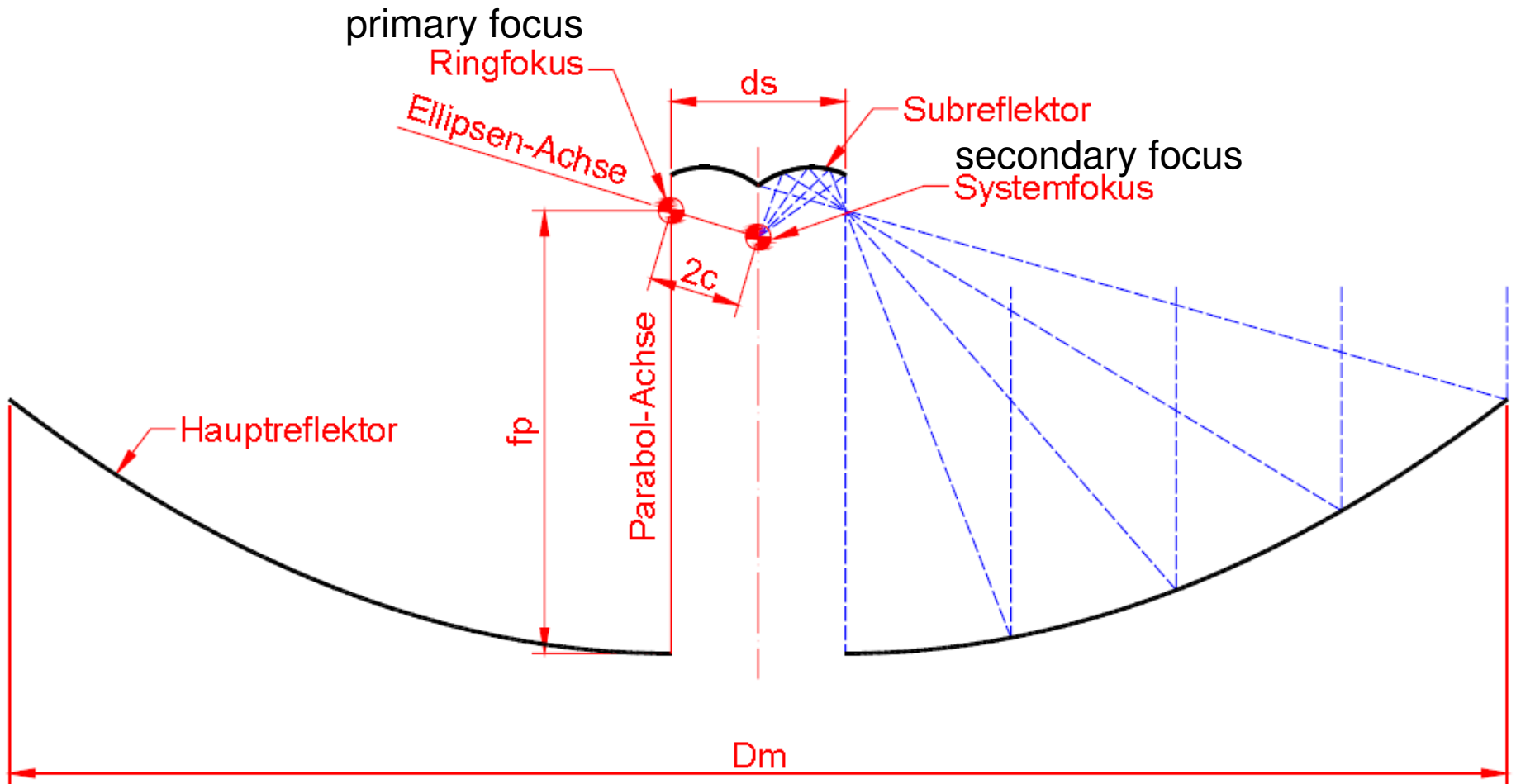
- Life time: >20 years
- 3D reference point: <1 mm (accessible and measurable with respect to a local survey network)
- Path length error: <0.3 mm (under all operations conditions)

# TTW – two identical radio telescopes at one site

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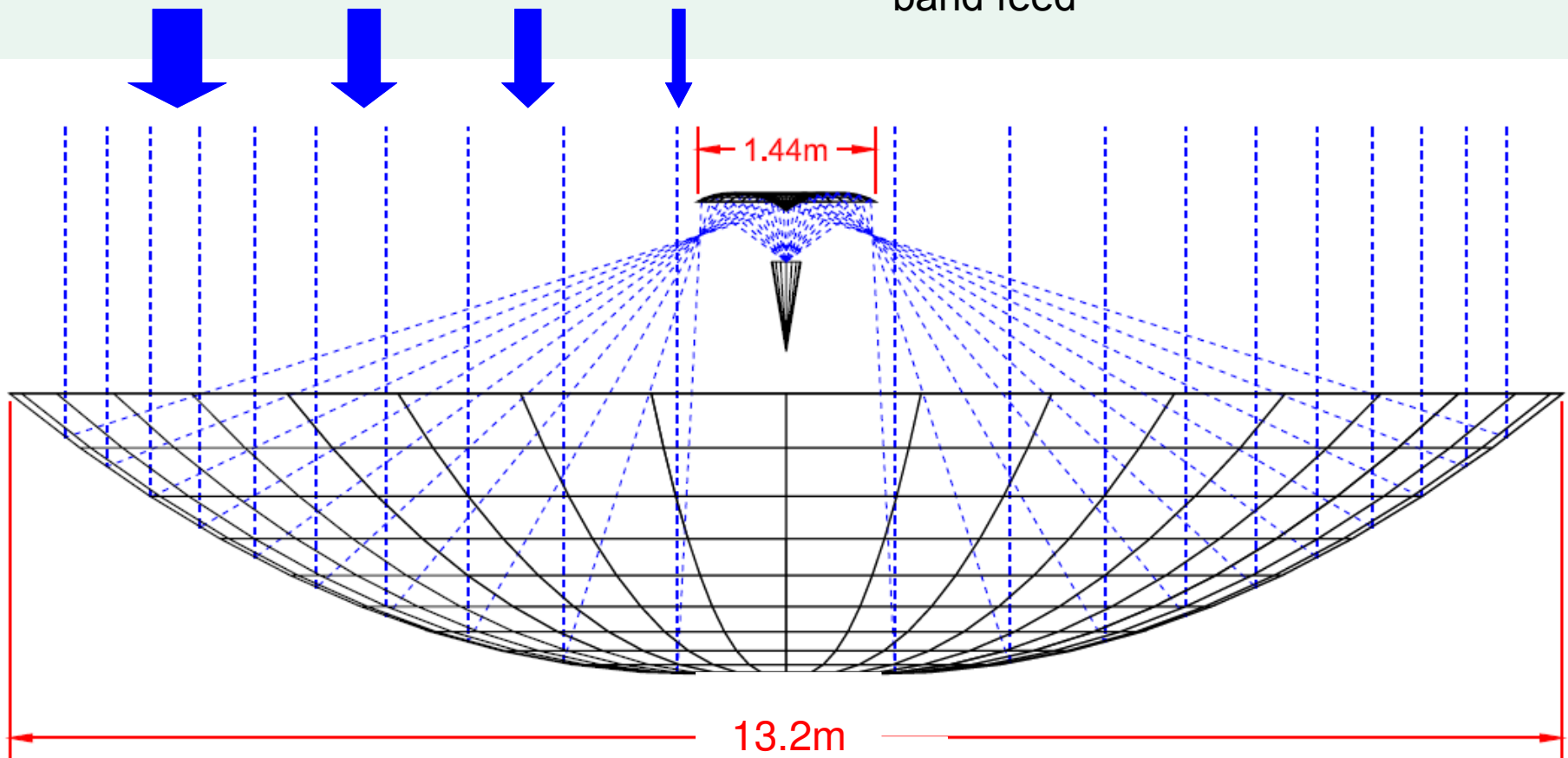
# Ring Focus Design Axis Displaced Ellipse Reflector





# Advantages of Ring Focus Design

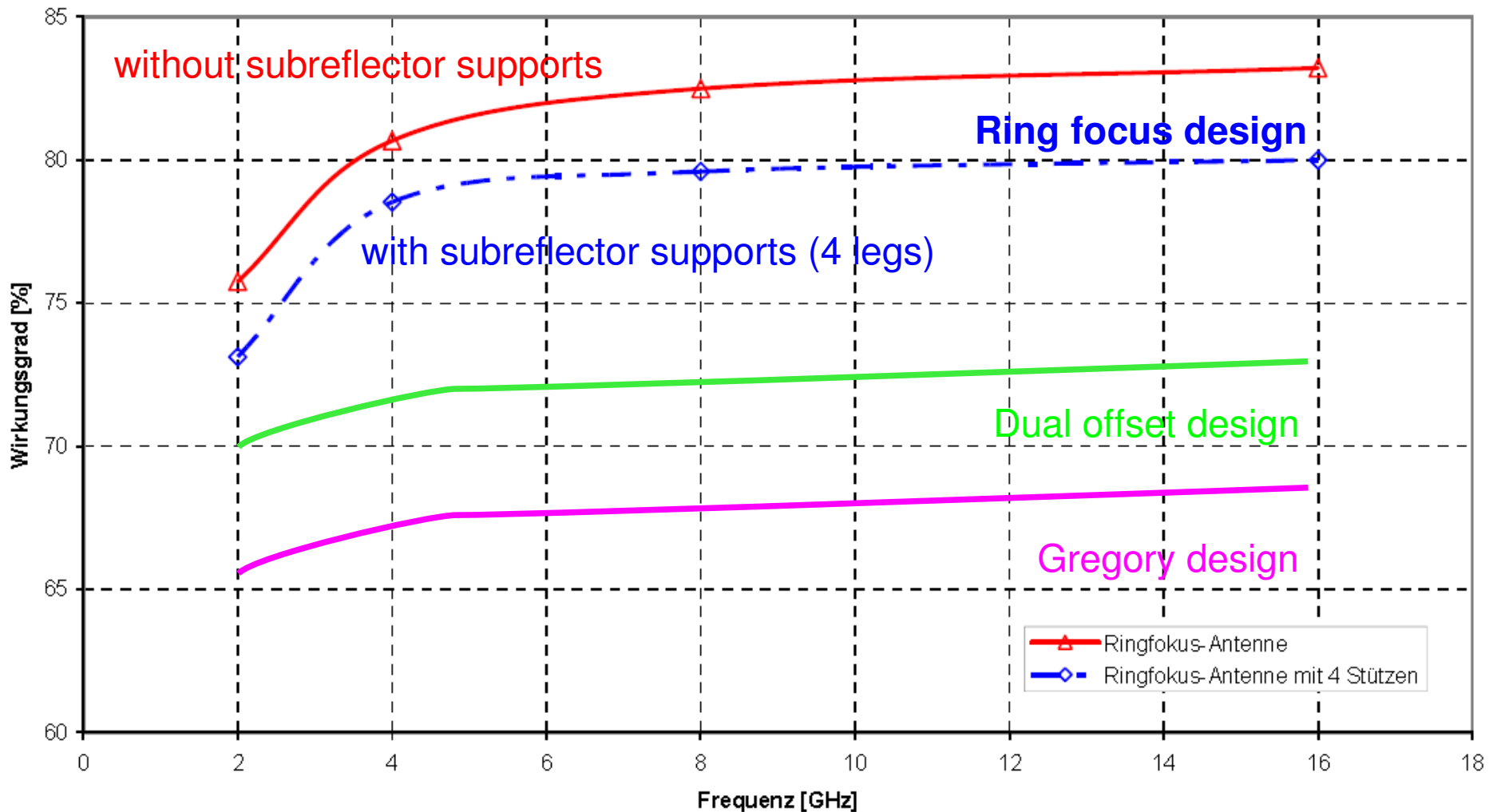
- Rays from main reflector rim illuminate the pointed vertex of the subreflector
- Rays from main reflector central area illuminate the subreflector rim
- Minimum reflection of energy towards the feed horn
- Feed horn can be positioned close to the subreflector as needed for wide-band feed

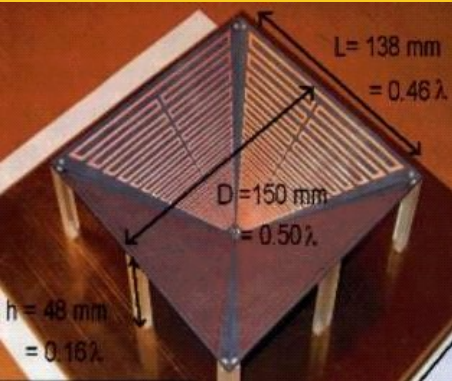


Area of illumination:  $\sim 135\text{m}^2$

# Expected Aperture Efficiency in comparison to concurrent designs

(Numbers for idealized Gauss Feed)





1.2-13GHz  
+11dBi

Kildal Eleven Feed



2-18 GHz  
+6-13.5dBi

Quadriga Lindgren Feed



1-18 GHz  
+6.5-7.5dBi

Log-Periodic Feed  
Rhode&Schwarz

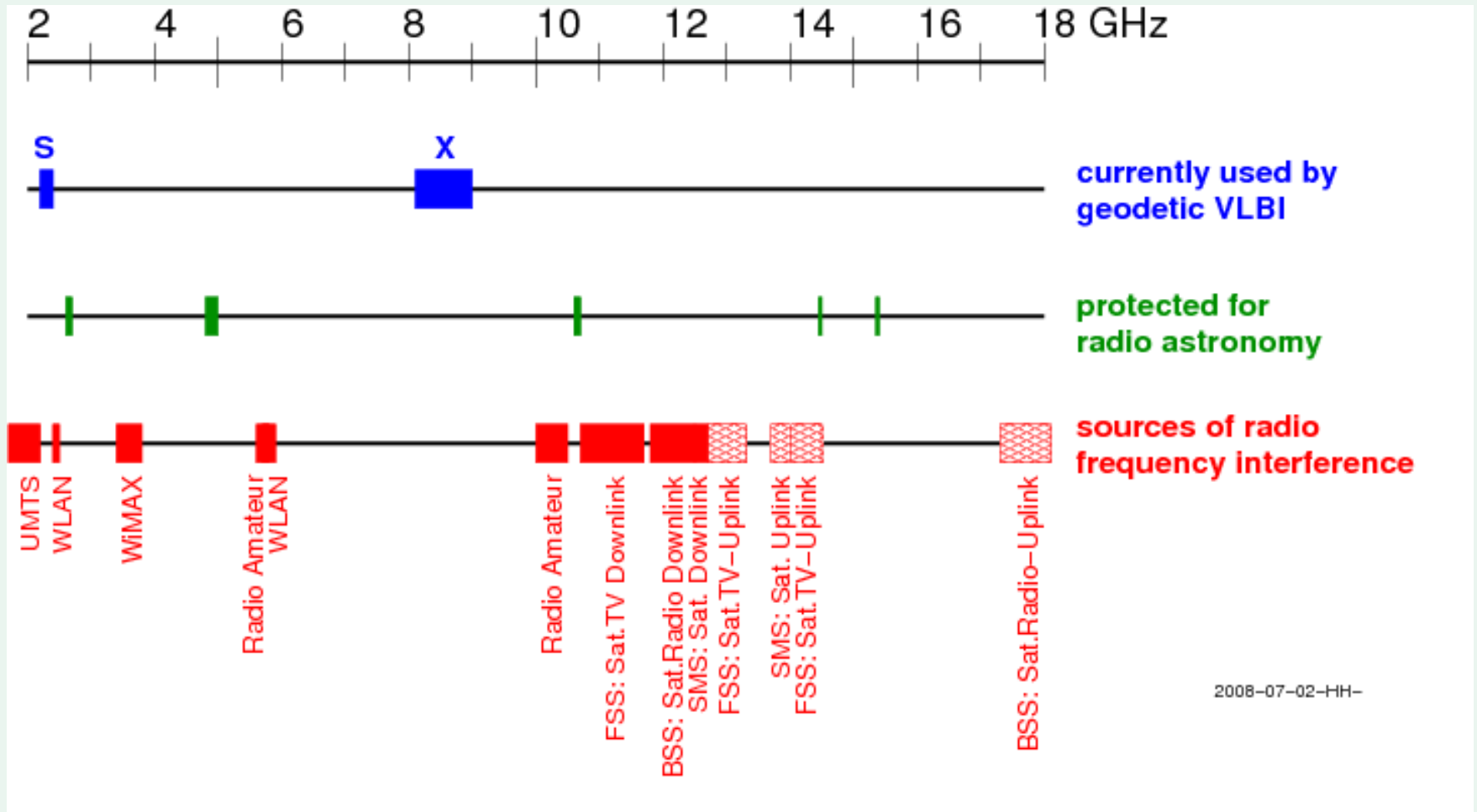
- **VLBI2010 feed still does not exist.**
- Ongoing developments and tests.

## What do they have in common?

- **Less efficient** than optimized S/X feeds
- Request **cooling** due to higher system temperature
- Half illumination angle:  $\geq 50^\circ$
- Is phase center frequency dependent?

**Conclusion:** Request for specific VLBI2010 feed development.

# Future Radio Frequencies in Geodetic VLBI?



**Wetzell**  
**March 18-20**  
**2009**



Meeting Place  
Landhotel Miethaner

### Units

- Broadband Delay
- Feeds
- Polarization
- Broadband Receiver Design
- Radio Frequency Interference
- Site Ties, Antenna Deformation, GNSS Orbits

### Structure for each unit

- Tutorial (40' + 20')
- Presentations
- Conclusion

### Projected outcome:

- Recommendation to the IVS-DB on **future radio frequencies**
- Recommendation to the IVS-DB on **future feed specifications**



# TTW-Time Schedule as proposed by BKG

today

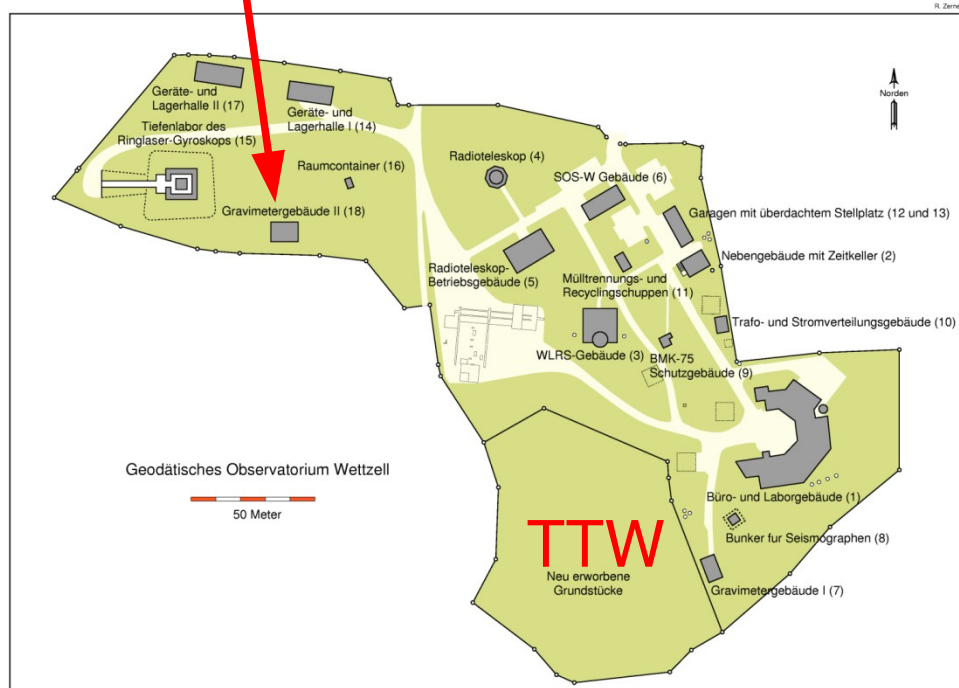
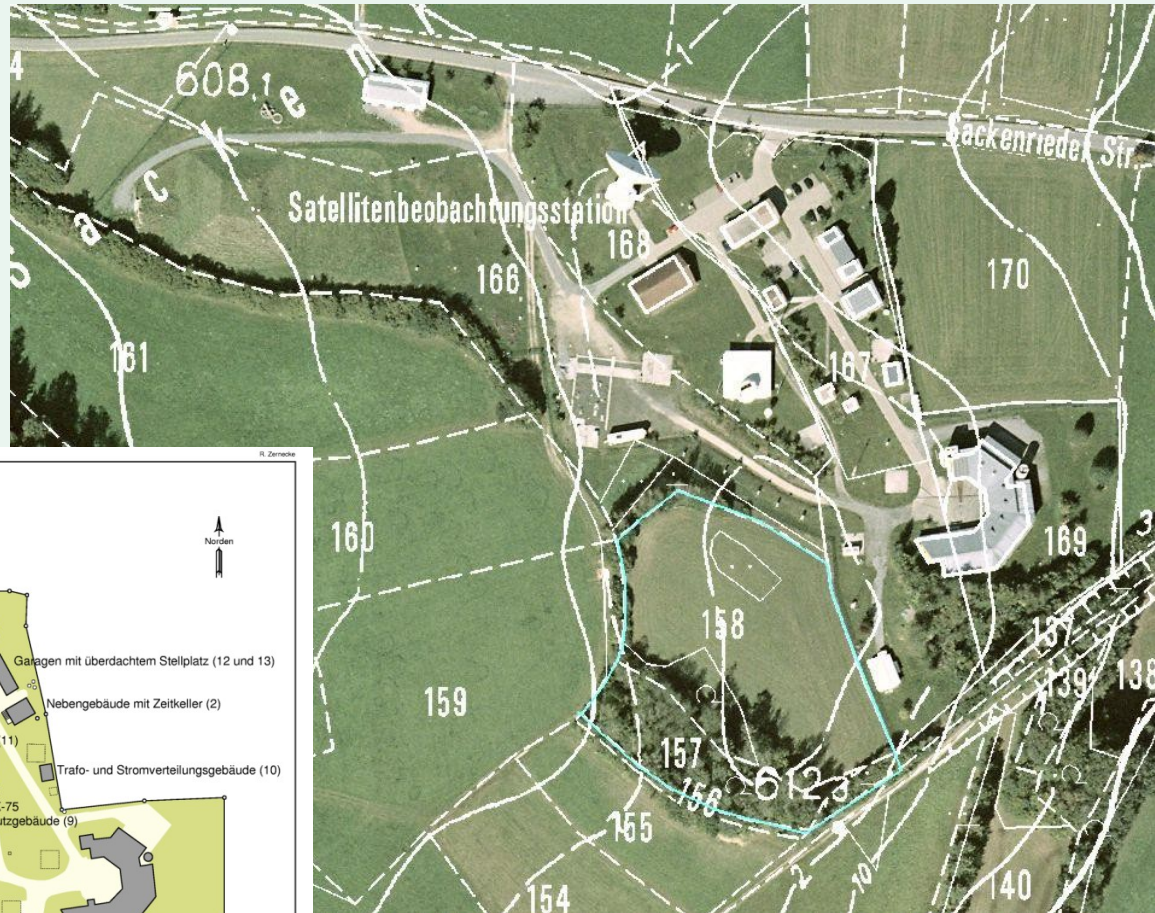


<i>Activity</i>	2006	2007	2008	2009	2010	2011
<b>Projectmanagement</b>	■	■	■	■	■	■
<b>Site acquisition</b>		■	■			
<b>Twin-Telescope (this document)</b>						
Call for bids		■	■			
Design			■	■		
Construction of parts				■	■	
Assembling at Wettzell						■
<b>Buildings, foundations</b>						
Planning			■	■		
Construction			■	■	■	
<b>HF-Components</b>						
Call for bids			■	■		
Construction, delivery				■	■	
<b>Data Acquisition</b>						
Call for bids				■	■	
Construction, delivery					■	■
<b>Acceptance, finalization</b>						■

need for workshop

## Property:

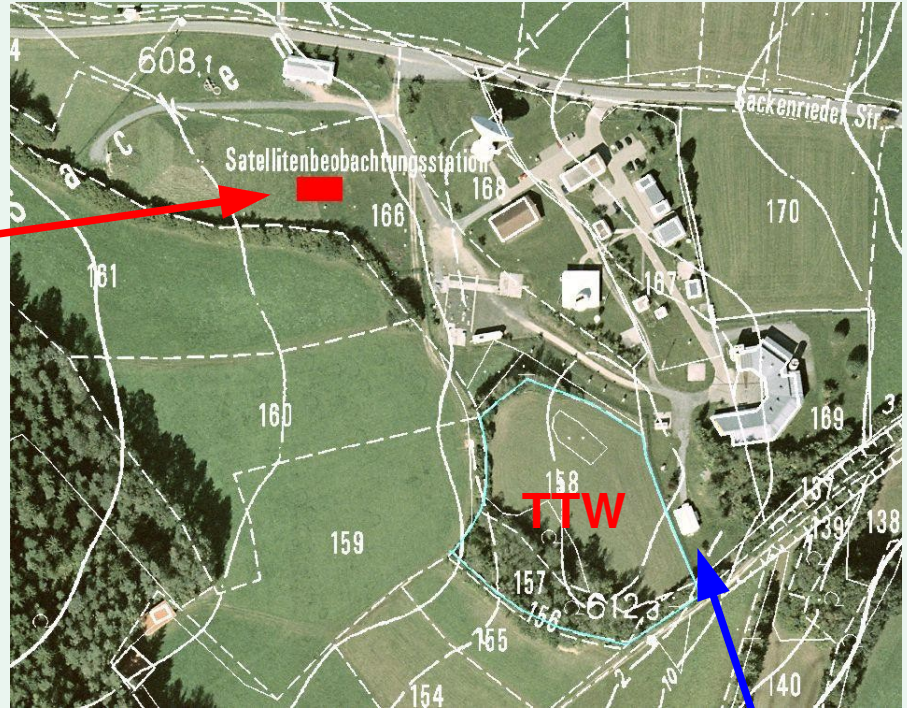
- purchase of No 158,157
- surveyed and registered
- new gravity meter house





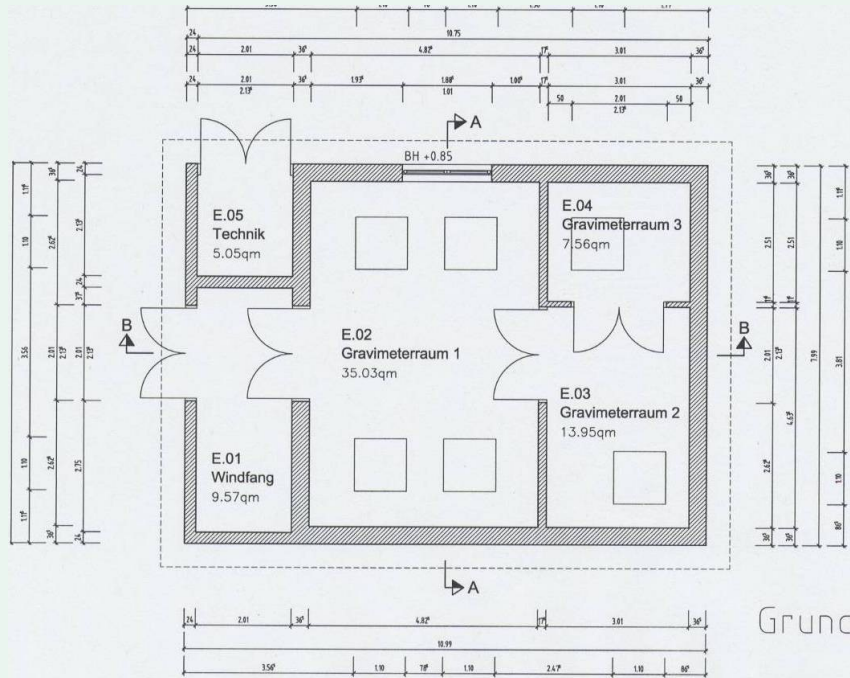
## Gravity Meter House

- To avoid possible interference of gravity measurements an **additional gravity meter house** needs to be constructed in a quiet zone.



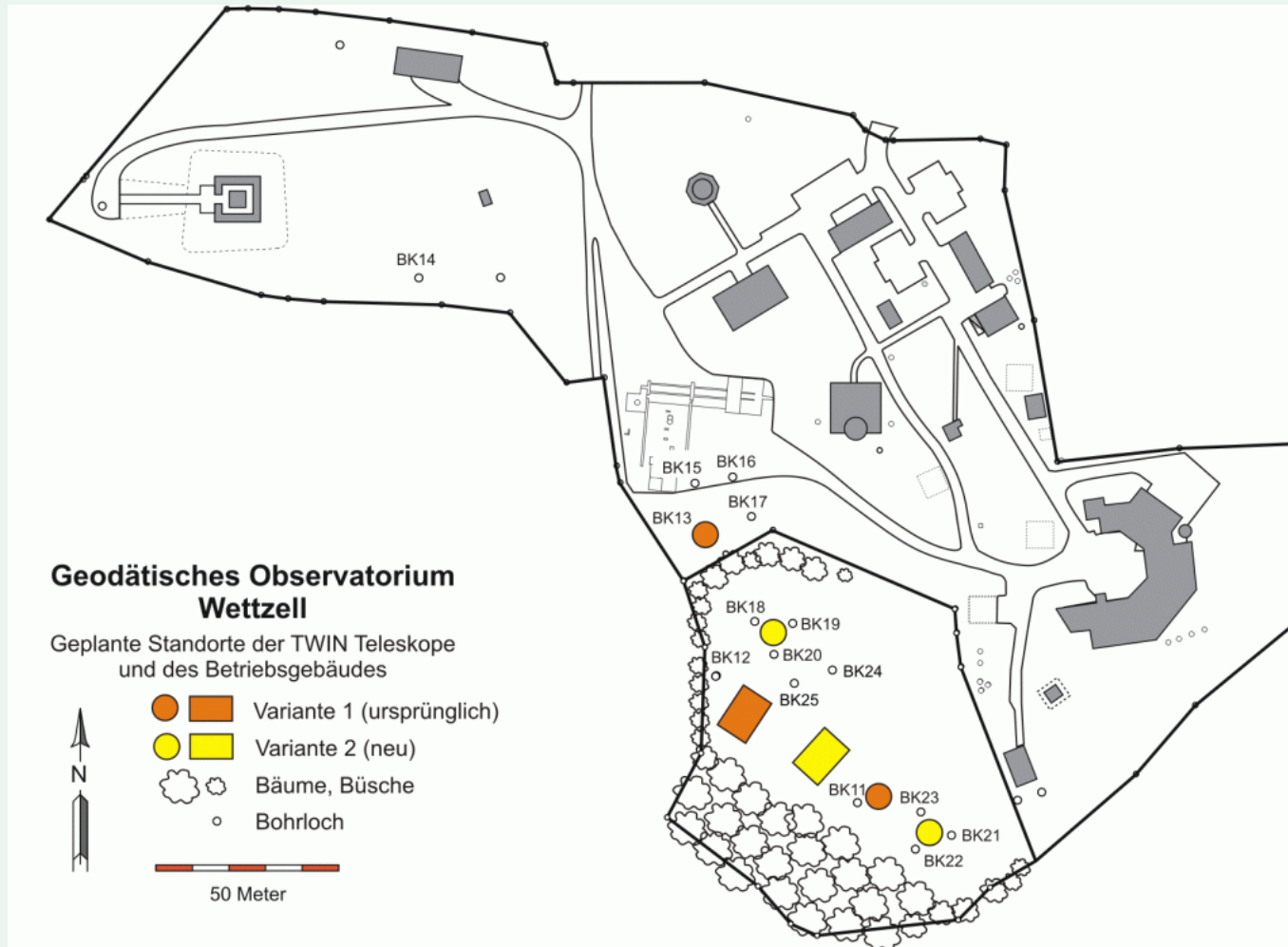
existing gravity meter house

currently under construction



# Exploration of TTW proposed Site Locations

Planned sites and locations of drillings for TTW fundamentation



- First Reconnaissance: 09.–13.06.2008 (Drillings BK 11- BK 14)
  - BK11 (Site 1 in SE): suitable
  - BK12 (Operationsbuilding): very suitable
  - BK13 (Site 2 in NW): not suitable
  - BK14 (Site of new Gravity Meter House): very suitable
- Second Reconnaissance: 08.–10.09.2008 (Drillings BK 15 - BK 17)
  - Results of drillings BK15, BK 16, BK 17 are similar to BK 13
  - Site 2 declared to be unsuitable
- Selection of alternative sites, shift of 20-40m to SE
- Final drillings: 23.10. – 6.11.2008 (BK 18 bis BK 25)
  - Site 1' (BK 21 - BK 23): very suitable
  - Site 2' (BK 18 - BK 20): suitable





# Drilling Results Site 2: not suitable underground

BK 13



BK 15



BK 16



100 cm





# Drilling Results Site 2': suitable rocky underground

BK 18



BK 19



BK 20







# Drilling Results Site 1': very suitable

BK 21

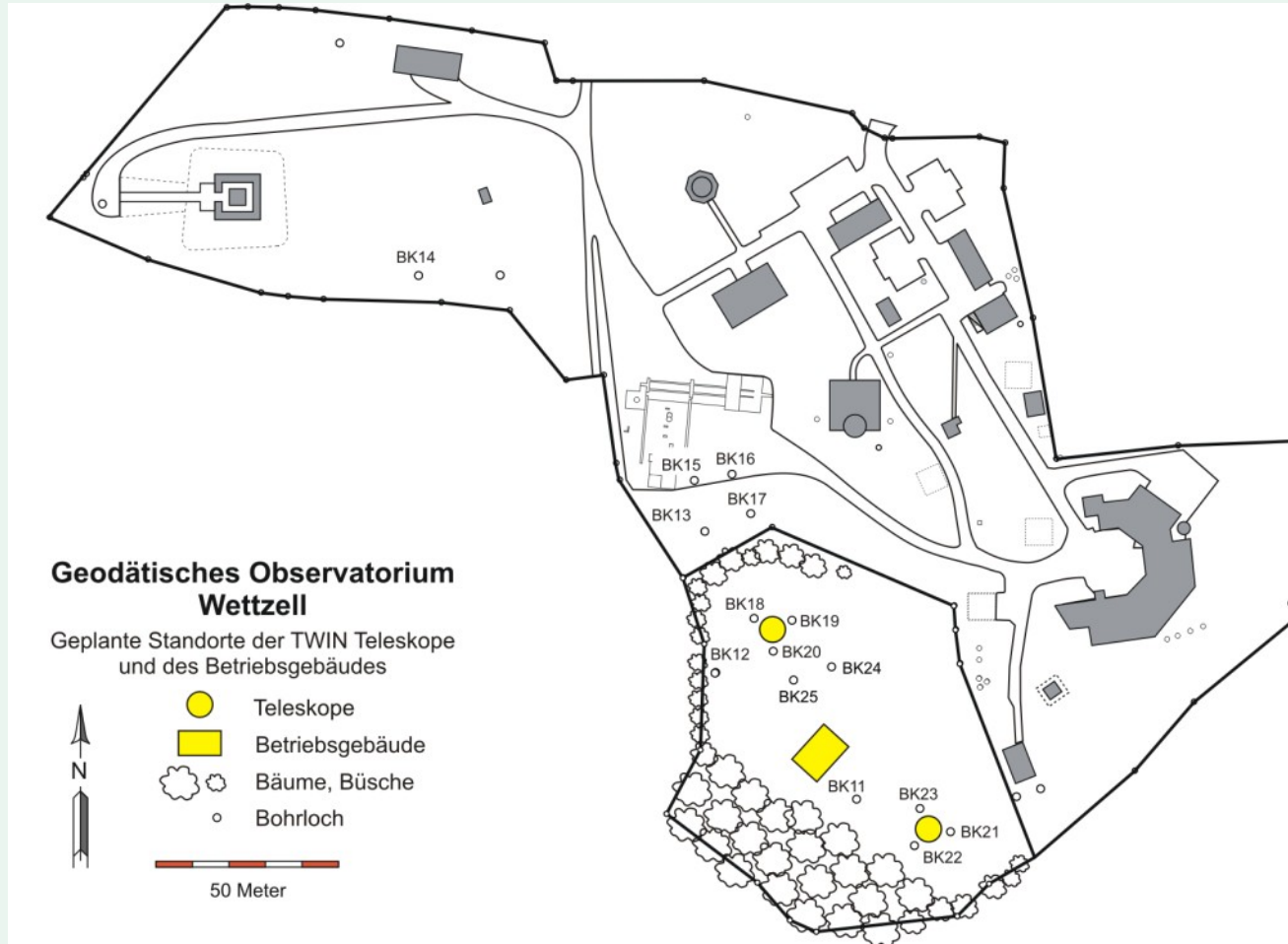


BK 22

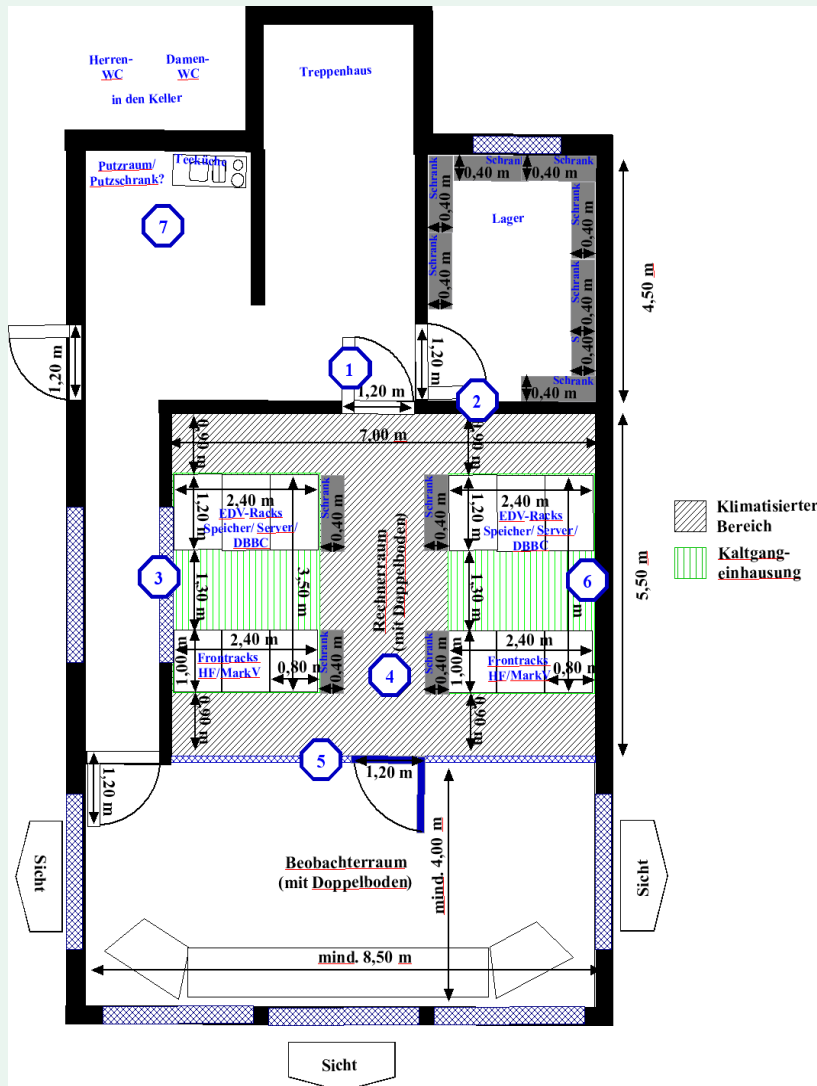


BK 23







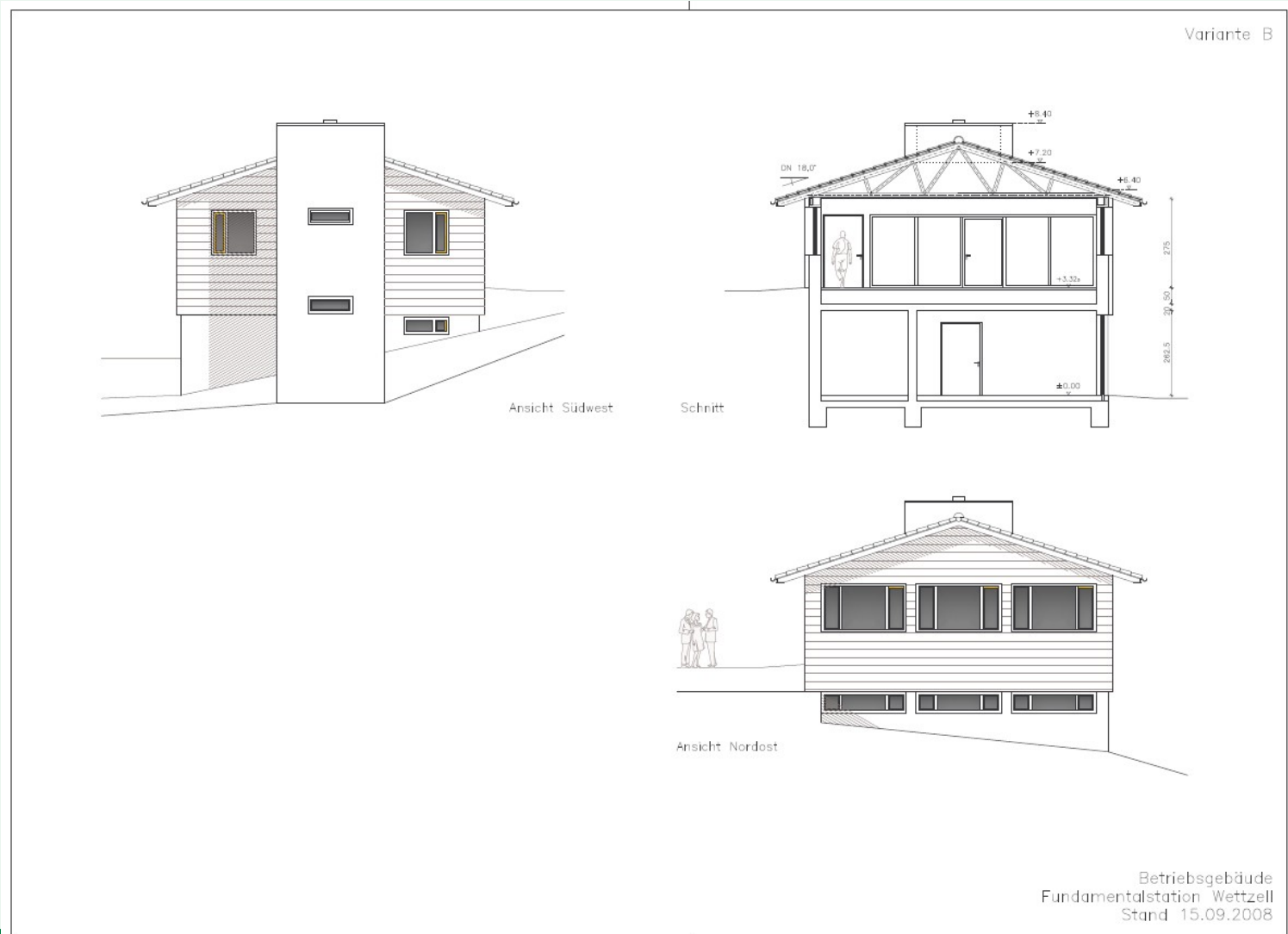


- 0) Erhalt des grundsätzlichen Vorschlags von Herrn Schütz (Änderungen wie Besprochen bei Meeting)
- 1) Rückwärtige Tür entsprechend architektonischer Gesichtspunkten platzieren, Öffnungsrichtung nach außen; Zugang zum Lager über diese rückwärtige Tür;
- 2) Evtl. Durchreiche einplanen, falls dies als sinnvoll erachtet wird
- 3) Anbringung einer Möglichkeit der natürlichen Beleuchtung des Rechnerraums, falls sinnvoll und machbar (energietechnisch etc.); Platzierung nach architektonischen Gesichtspunkten
- 4) Umdimensionierung des Rechnerraums mit der Möglichkeit zweier Kaltgangeinhausungen (falls benötigt, erspart die thermisch, hermetisch dichten Racks); Anordnung der Racks noch variabel; TWIN-Anordnung der Racks je Teleskop spiegelbildlich; Türen öffnen nach außen, um in den Räumen Platz zu sparen; Zusätzliche Lagerschränke im Rechnerraum für Akklimatisation der 8-Packfestplatten; Wärmelast nach aktuellen Abschätzungen 25KW;
- 5) Komplette Glasfront mit Glastüre zwischen Beobachter- und Rechnerraum; Tür nach architektonischen Gesichtspunkten; Öffnung nach außen; Geräusch- und Temperaturblockade; Verlängerung des Beobachterraums;
- 6) Zugangspunkt der Kabel zu den Teleskopen etc. im Doppelboden entsprechend vorsehen
- 7) Teeküche/Putzraum(Putzschrank) im oberen Stockwerk; evtl. mit Sitzgelegenheit; Damen und Herren-WC in den Keller (hygienisch besser)



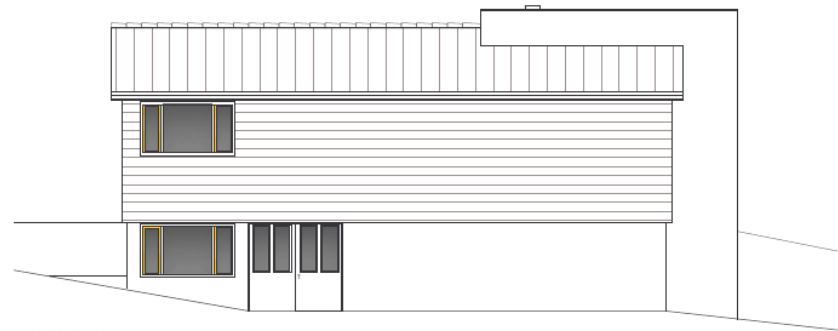


## Planing Staatliches Bauamt: rear and front view

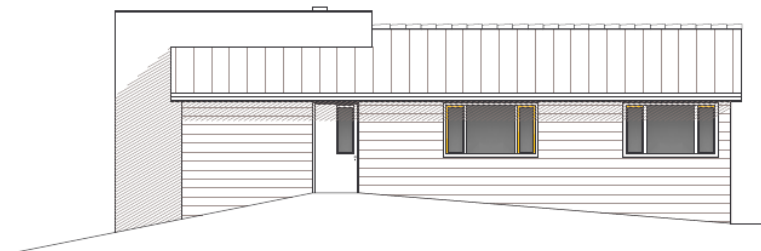


## Planing Staatliches Bauamt: Side views

Variante B



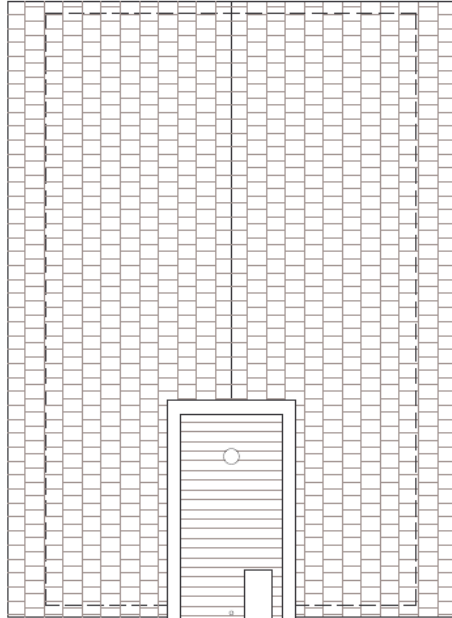
Ansicht Nordwest



Ansicht Südost

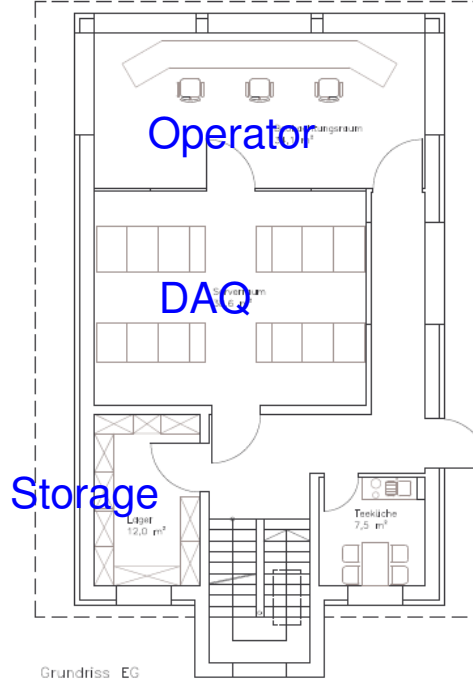
Betriebsgebäude  
Fundamentalstation Wettzell  
Stand 15.09.2008

## Roof

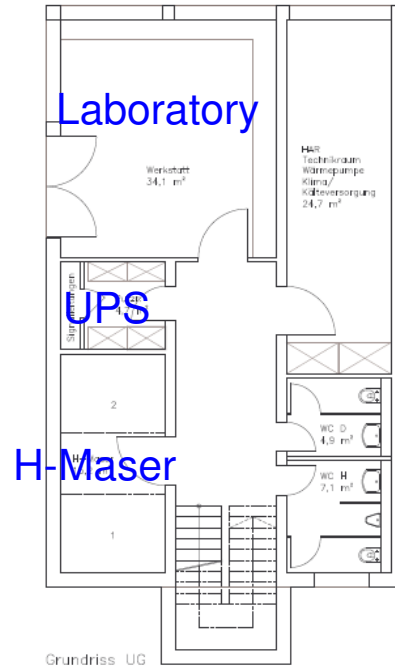


Platform for instruments

## 1<sup>st</sup> Floor



## Basement

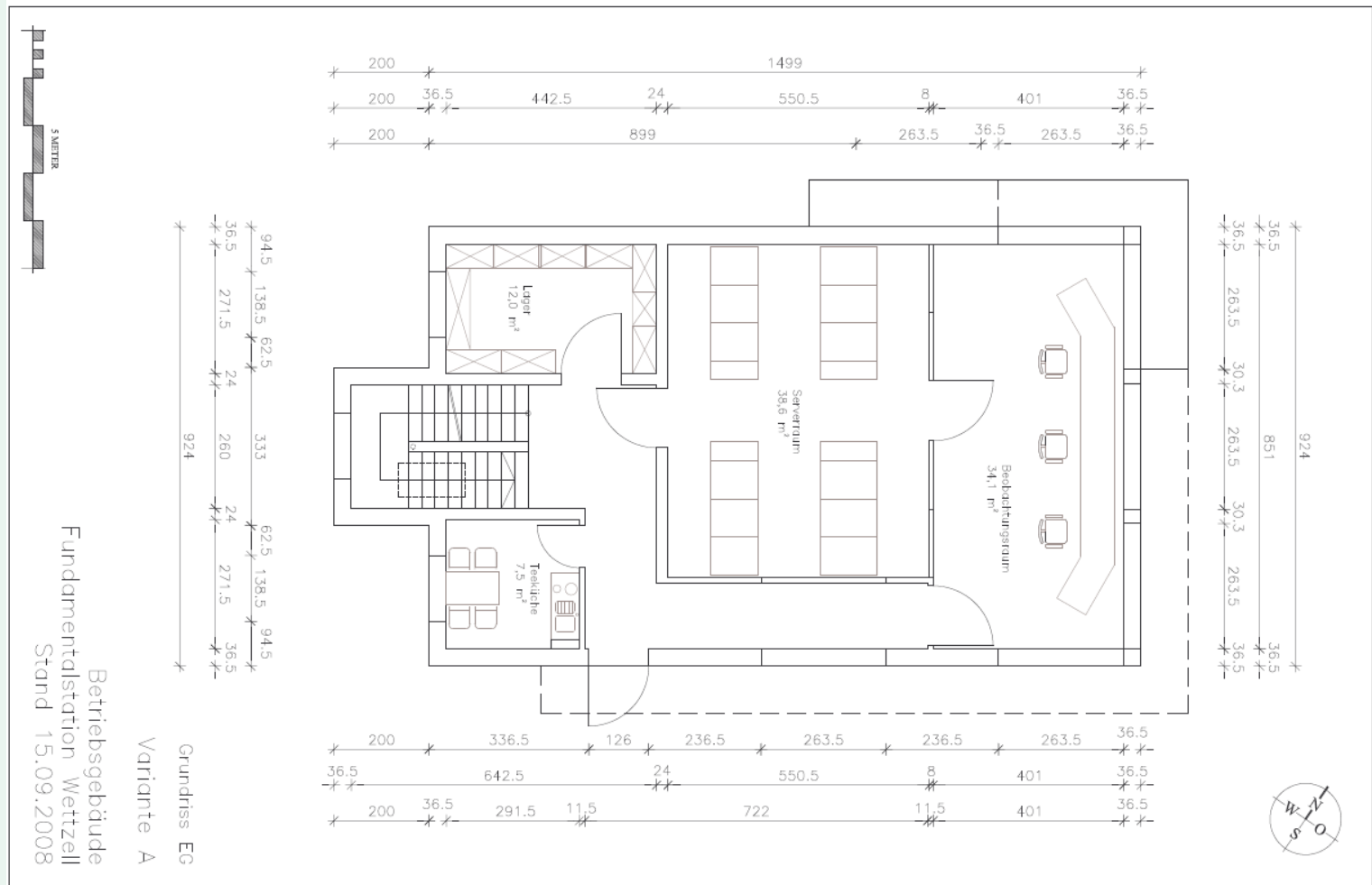


Variante B

Betriebsgebäude  
Fundamentalstation Wettzell  
Stand 15.09.2008

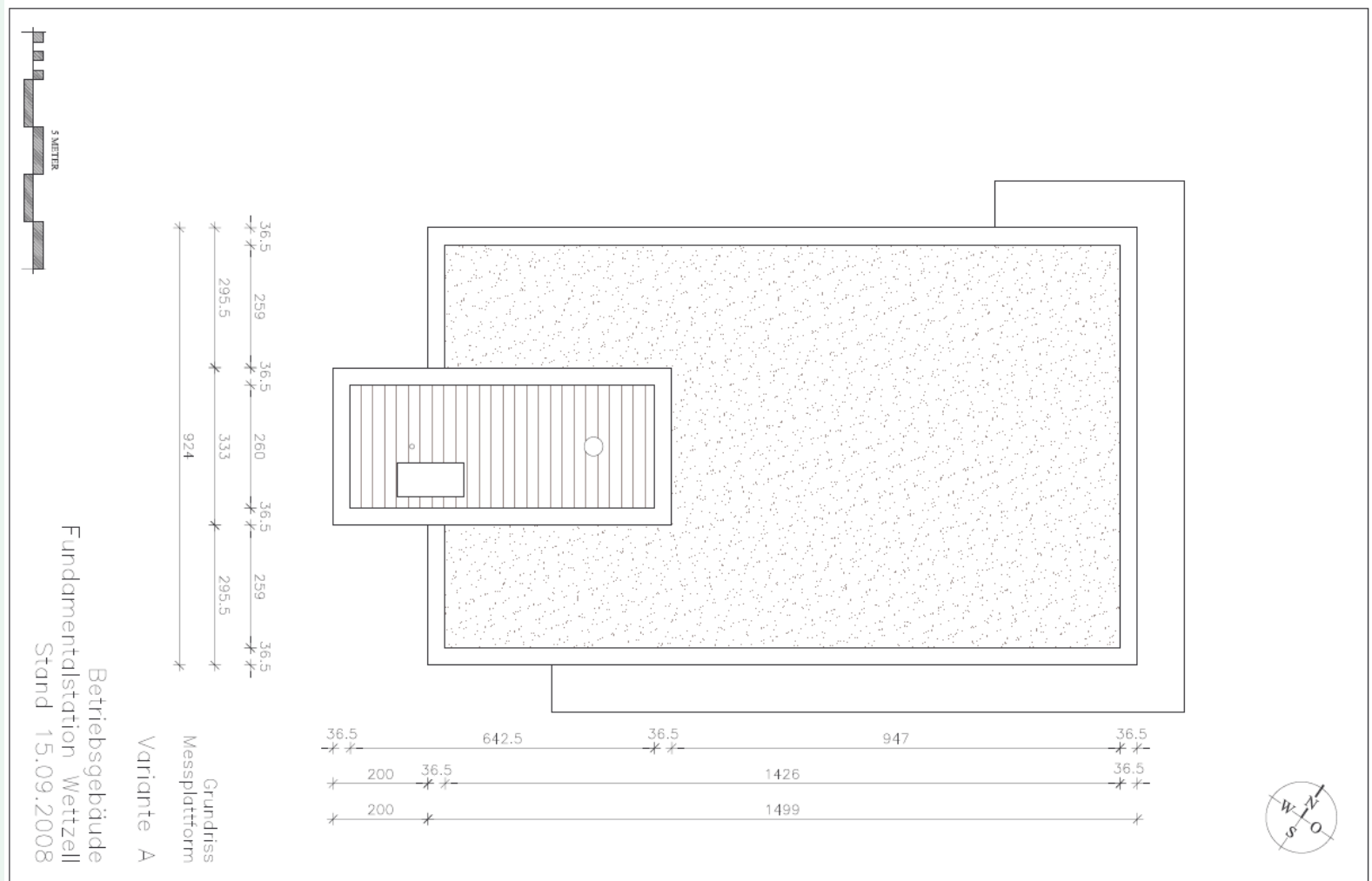


## Planing Staatliches Bauamt: 1<sup>st</sup> floor with VLBI control room and server room for 3 radio telescopes.





## Planing Staatliches Bauamt: Roof with platform for local surveys and sensors.



## Twin Telescope Wettzell

- Ongoing project 2008-2011
- Rigorous attempt to provide the instrumentation needed to realize the VLBI2010 vision of the IVS
- New optics for VLBI radio telescopes (ring focus)
- Fast moving ( $12^\circ/\text{s}$ ,  $6^\circ/\text{s}$ )
- Long lasting (geodetic monument, lifetime  $>20$  years)
- Extremely stiff construction ( $<0.3\text{mm}$  path length error)
- Wide band observation ready
- 24h/7d operation (twin concept)