

Status of the Twin Telescope Wettzell - 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
	α , δ time series	0.5 mas	monthly	1 month	1 month
EOP	UT1-UTC	5 μ s	→ 7 d/w → continuous	10 min	near real time
	$d\phi$, $d\epsilon$	25-50 μ as	→ 7 d/w	1 day	near real time
	x_p , y_p	25-50 μ as	→ 7 d/w	10 min	near real time
	dx_p/dt dy_p/dt	8-10 μ 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 , ϕ	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**



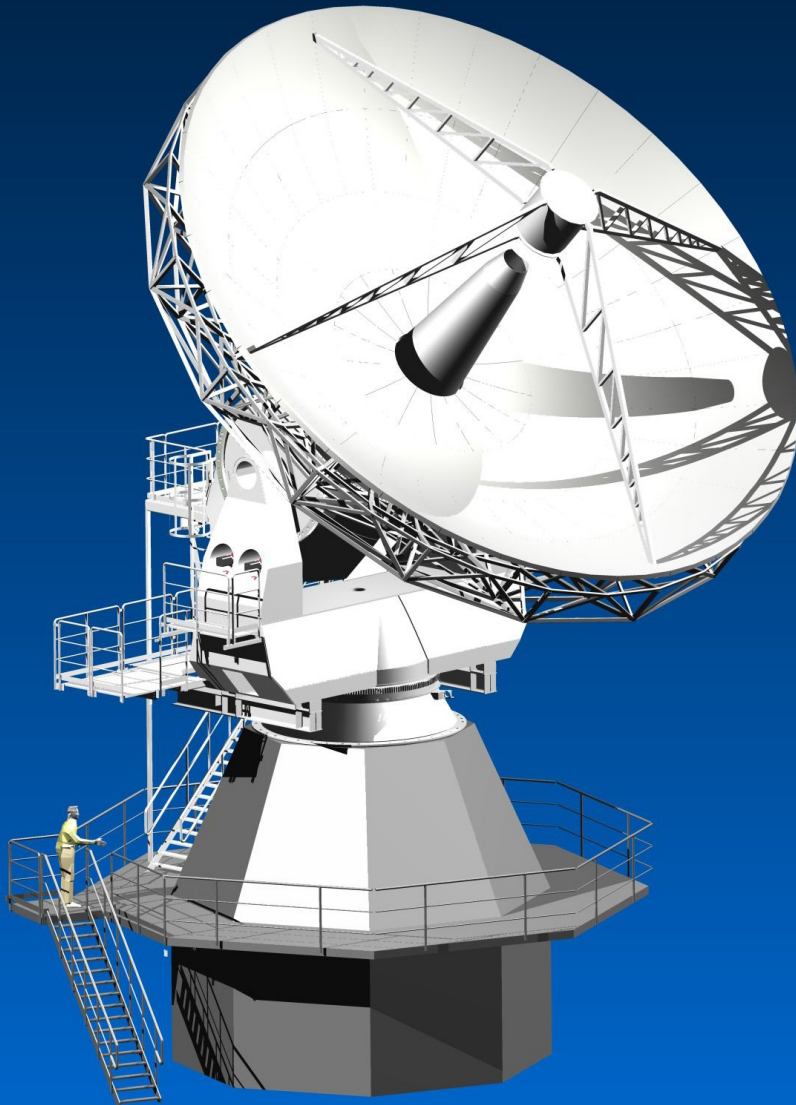
1983-2008 = 25 years
of geodetic VLBI



- 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



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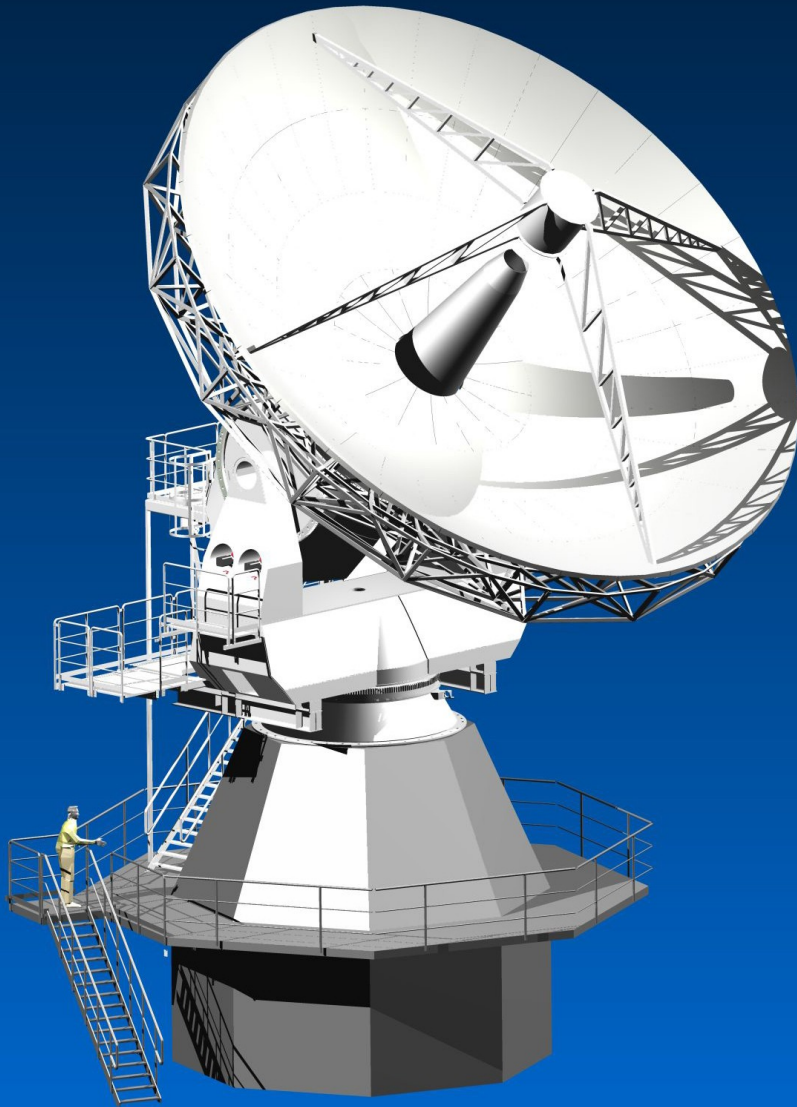


- Number of identical radio telescopes: 2
- Main reflector: 13.2m
- ALMA mount
- Optics: ring focus, axially-displaced ellipse reflector
- $f/D = \sim 0.29$
- Subreflector with hexapod mount
- Vel.: Az $12^\circ/s$, El $6^\circ/s$
- Acc.: Az/El $3^\circ/s^2$
- 27 bit Encoder: $0.3m^\circ$



Twin Telescope Wetzell as a Geodetic Monument

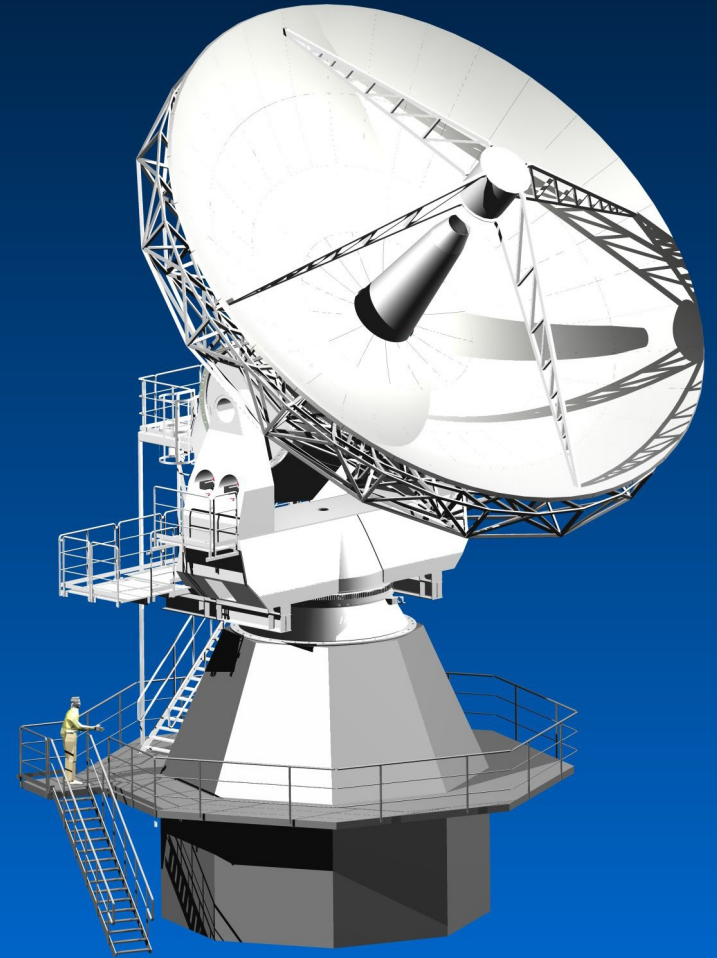
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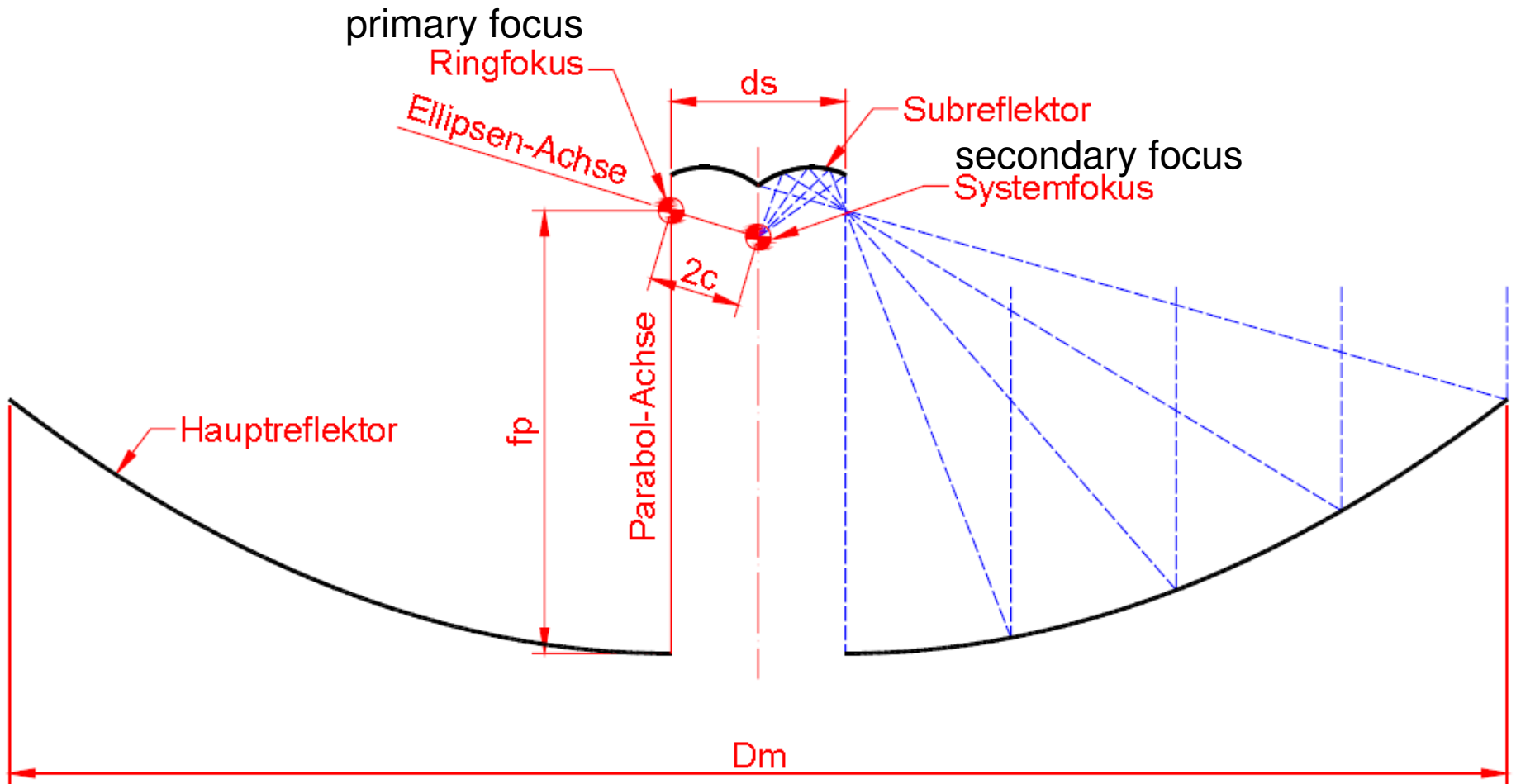
- Life time: >20 years
- 3D reference point: <1 mm (accessible and measurable with respect to a local survey network)
- Path length error: <0.3 mm (under all operations conditions)

TTW – two identical radio telescopes at one site

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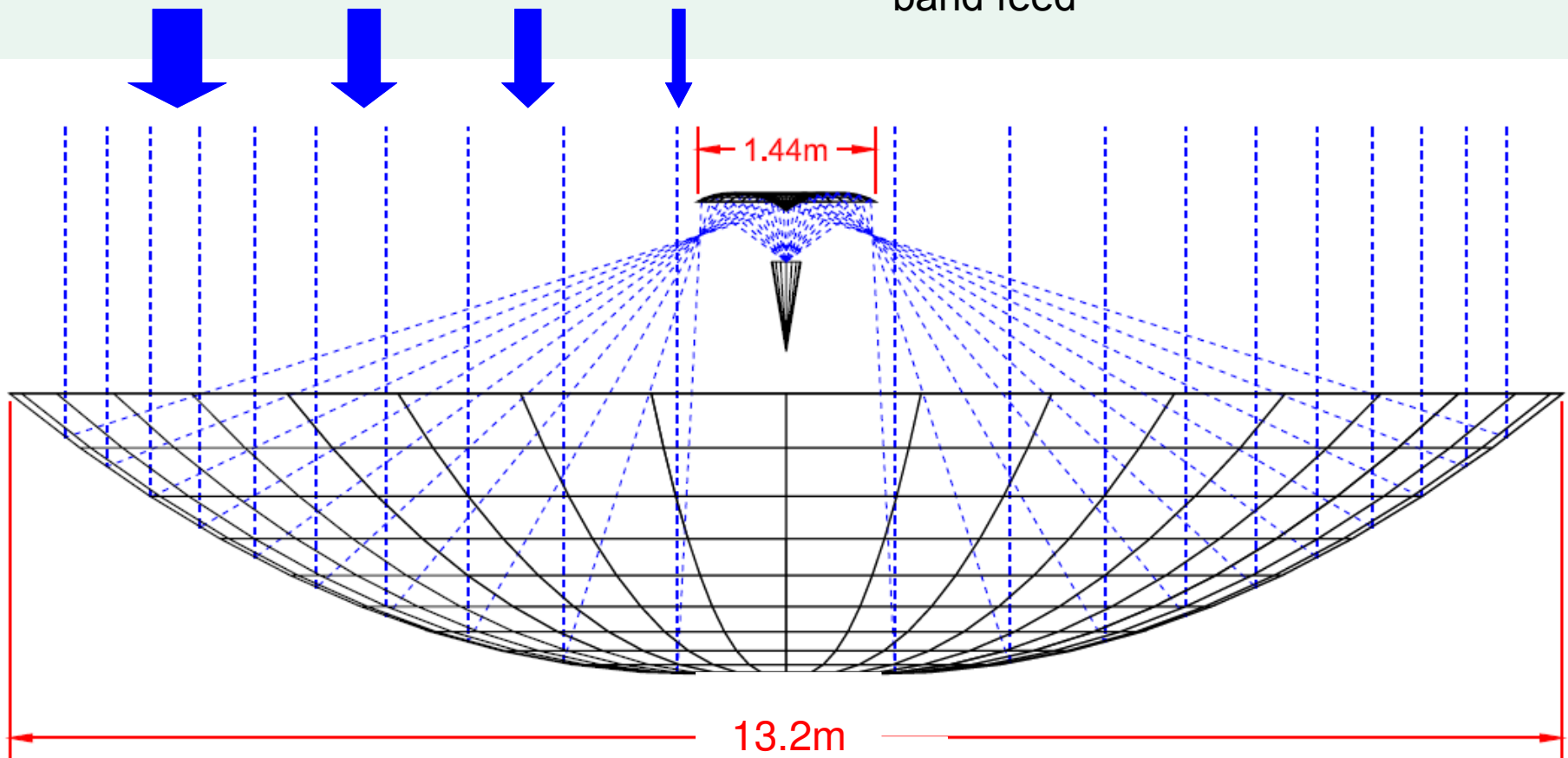


Ring Focus Design Axis Displaced Ellipse Reflector



Advantages of Ring Focus Design

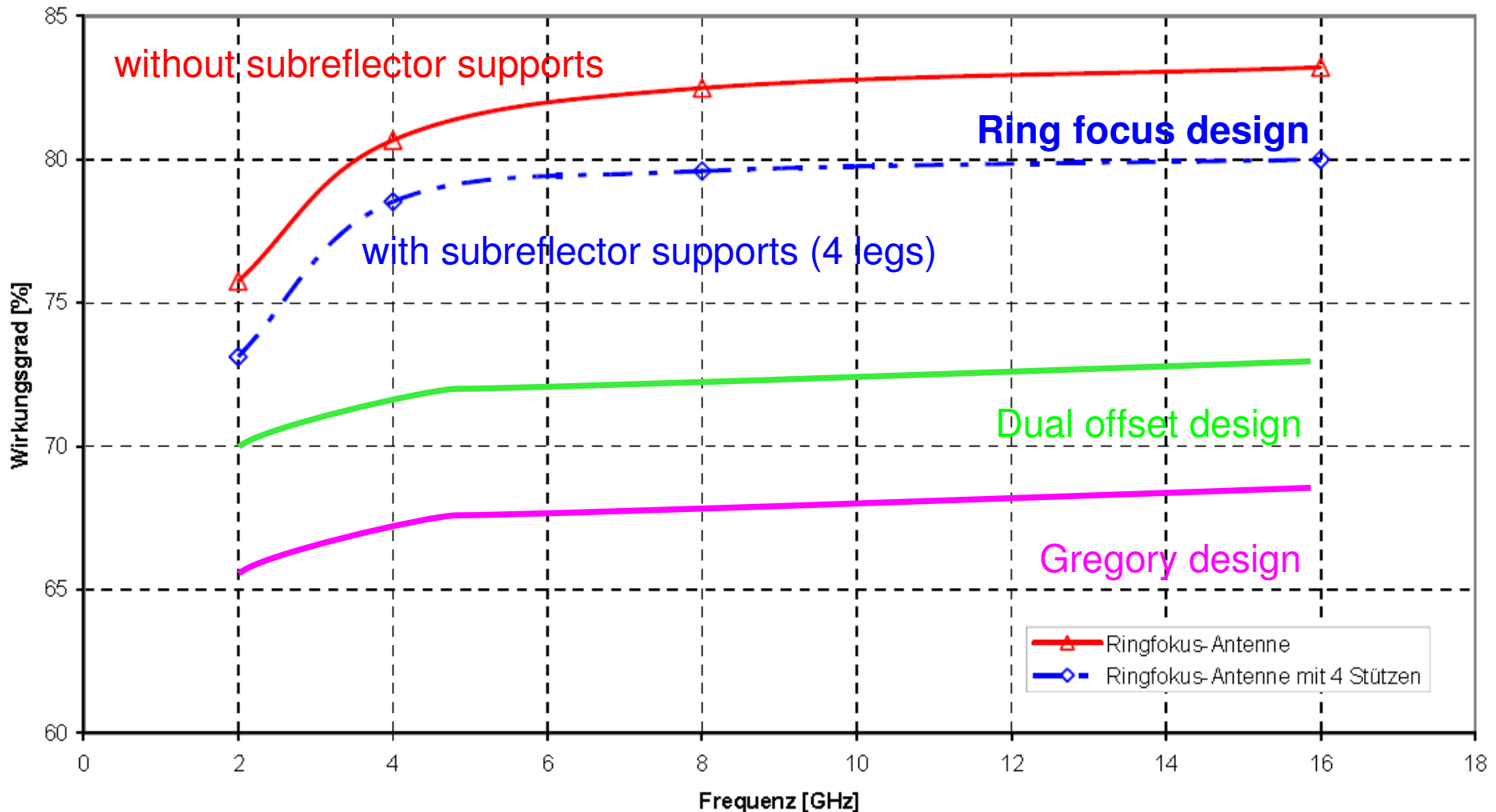
- Rays from main reflector rim illuminate the pointed vertex of the subreflector
- Rays from main reflector central area illuminate the subreflector rim
- Minimum reflection of energy towards the feed horn
- Feed horn can be positioned close to the subreflector as needed for wide-band feed

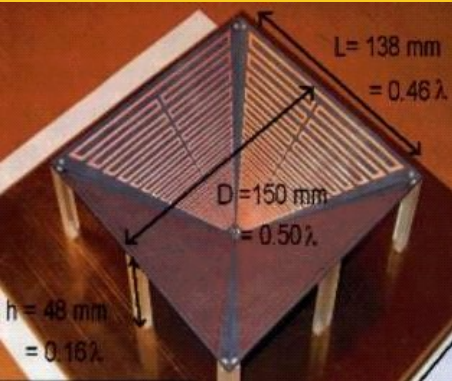


Area of illumination: $\sim 135\text{m}^2$

Expected Aperture Efficiency in comparison to concurrent designs

(Numbers for idealized Gauss Feed)





1.2-13GHz
+11dBi

- **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.



2-18 GHz
+6-13.5dBi

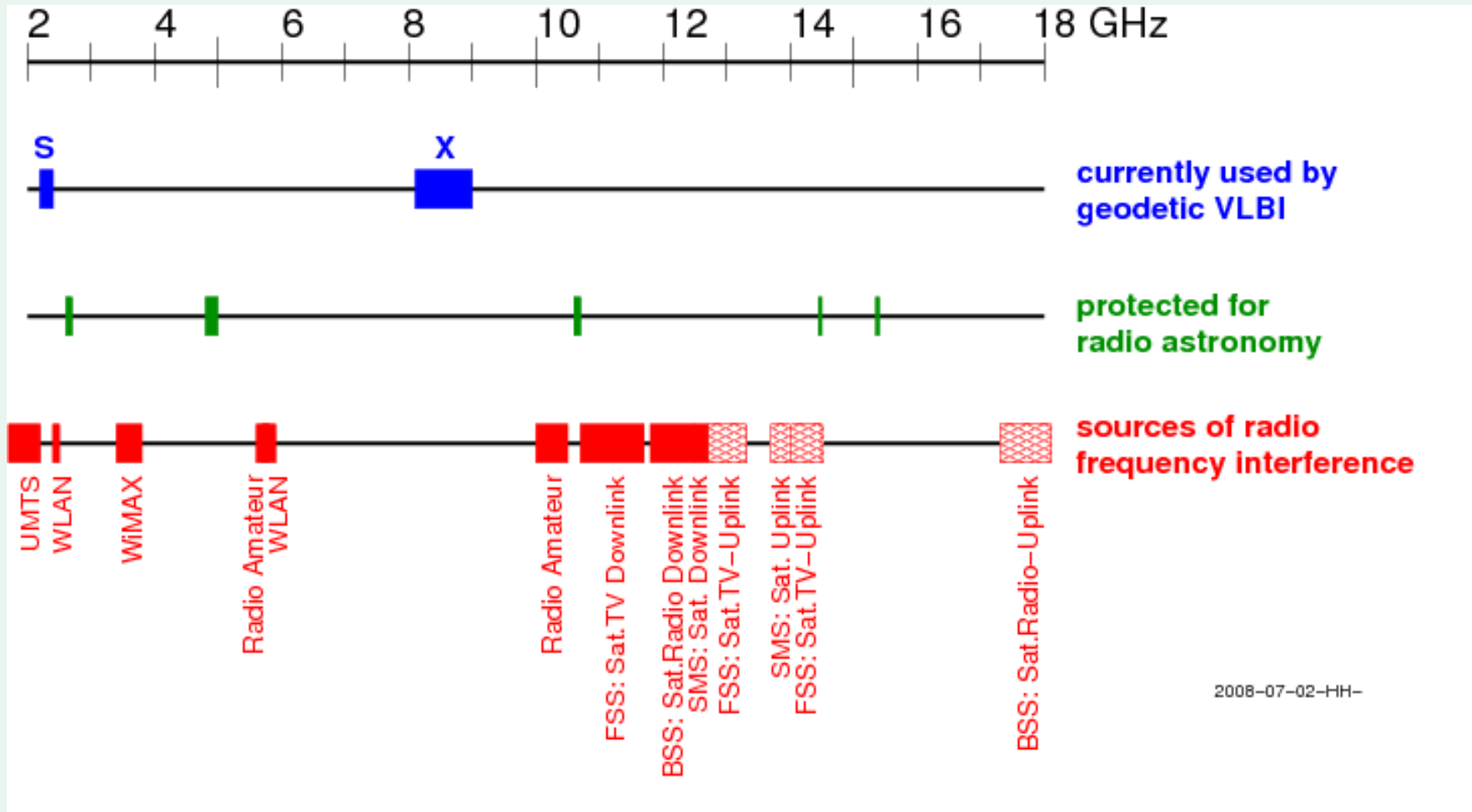
Quadriga Lindgren Feed



1-18 GHz
+6.5-7.5dBi

Log-Periodic Feed
Rhode&Schwarz

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**

The participants of the IVS VLBI2010 Workshop on Future Radio Frequencies and Feeds (FRFF), held in Wettzell/Höllenstein, Germany from March 18–20, 2009, make the following recommendations:

- The initial implementation of the VLBI2010 system needs to be capable of observing the broadband range of **2.2 to ~14 GHz**.
- The VLBI2010 system needs to be capable of **S/X operation**.
- The antenna should allow for a **possible future inclusion of Ka-band** (32 GHz) operation.
- The complete **end-to-end operation of the VLBI2010 system** should be demonstrated in a campaign in **early 2012**. As many antennas as possible should participate.
- A plan should be established for the transition from the legacy S/X system to the VLBI2010 broadband delay system. Such a **transition plan** can be beneficial for obtaining future funding and will support a timely changeover.

TTW-Time Schedule as proposed by BKG

today

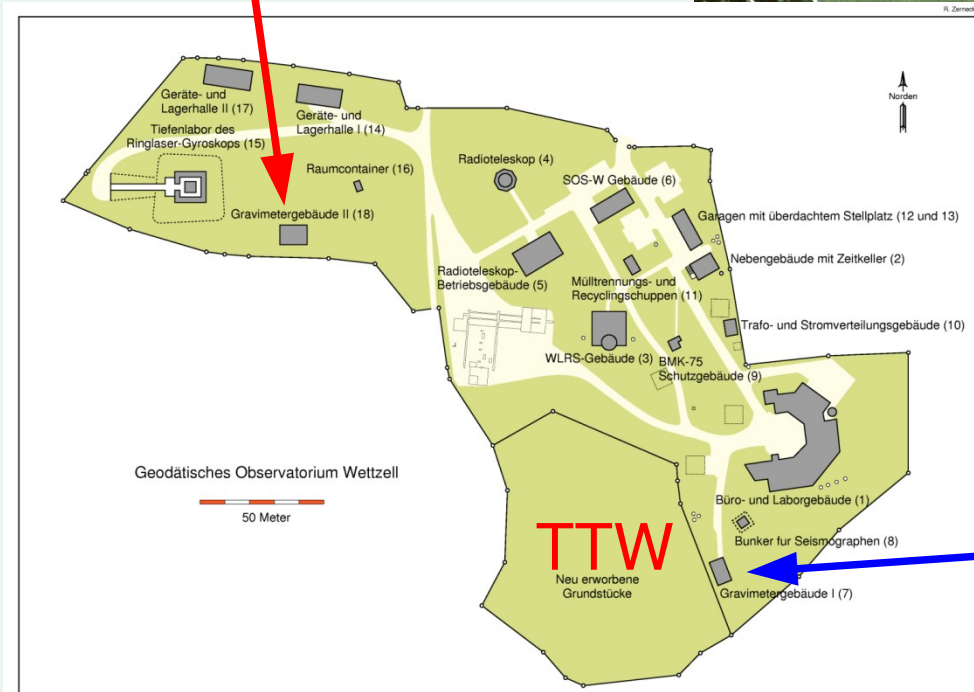
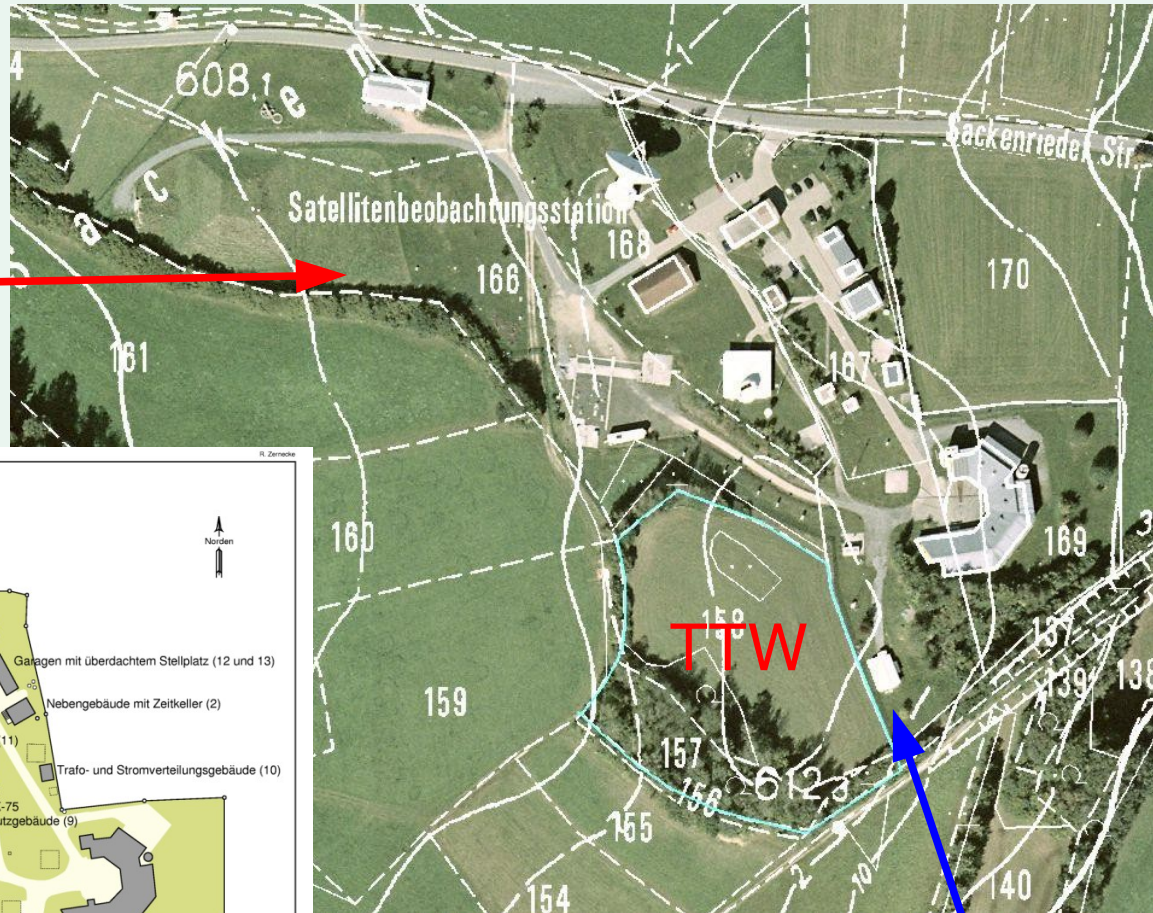


<i>Activity</i>	2006	2007	2008	2009	2010	2011
Projectmanagement	■	■	■	■	■	■
Site acquisition		■	■			
Twin-Telescope (this document)						
Call for bids		■	■			
Design			■	■		
Construction of parts				■	■	
Assembling at Wettzell						■
Buildings, foundations						
Planning			■	■		
Construction			■	■	■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

need for workshop

Property:

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



existent gravity
meter house

- 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

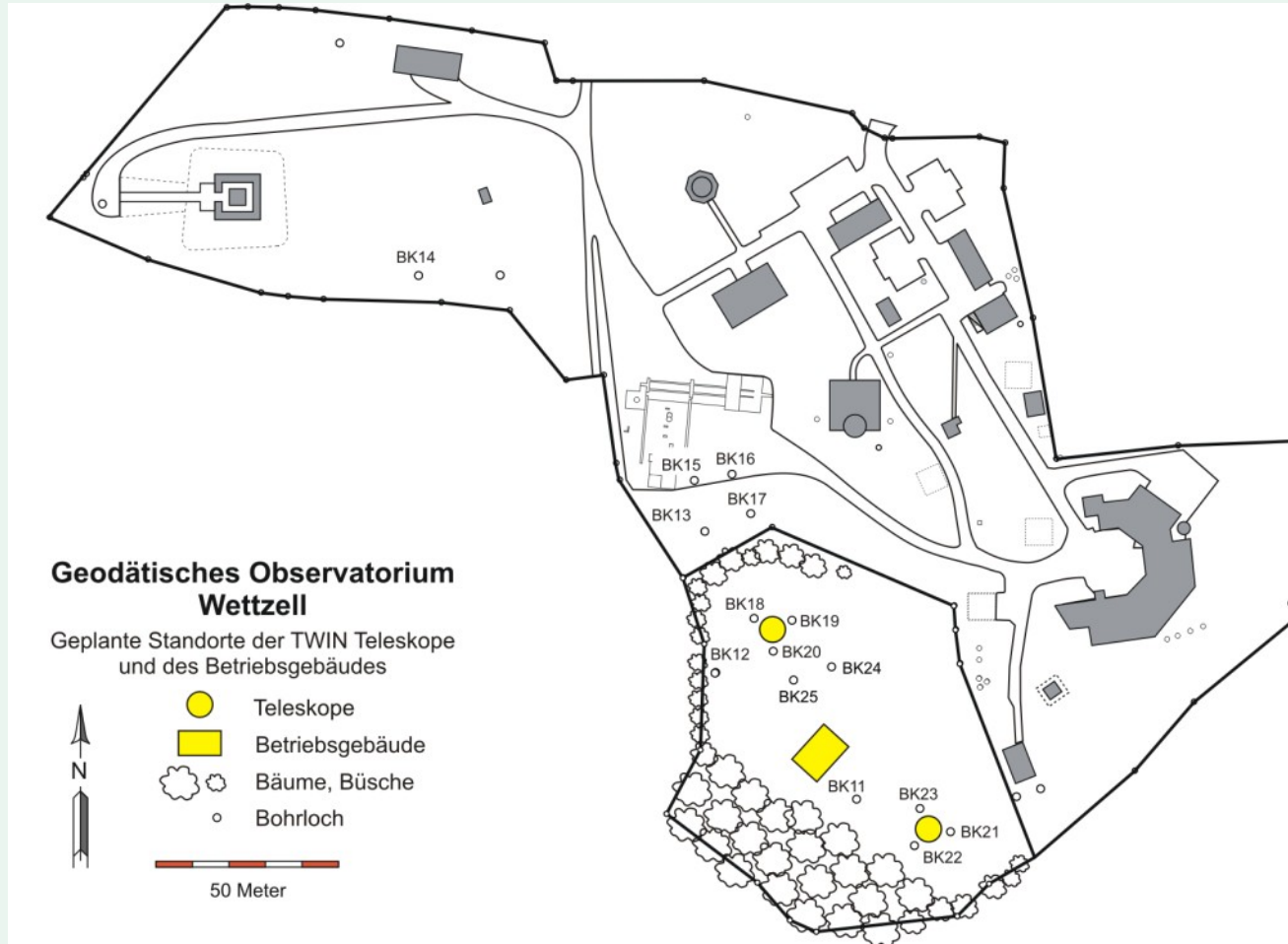


BK 22

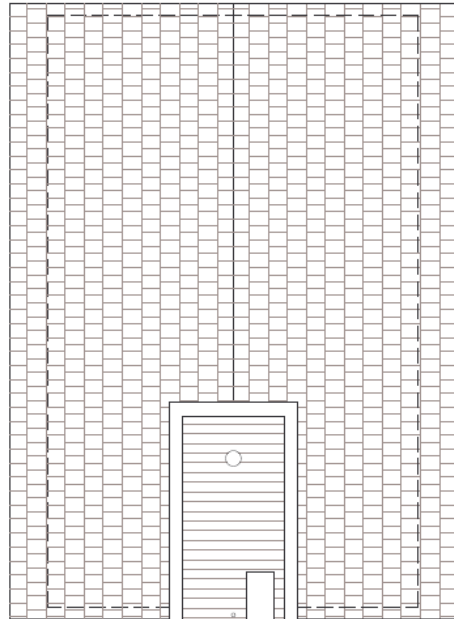


BK 23



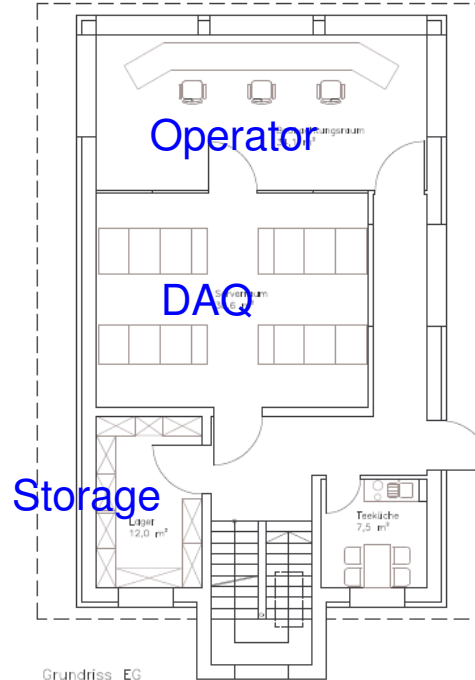


Roof

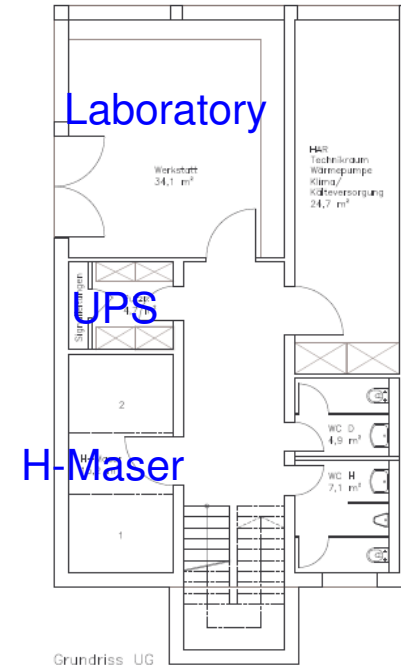


Platform for instruments

1st Floor



Basement



Variante B

Betriebsgebäude
Fundamentalstation Wettzell
Stand 15.09.2008

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)

TTW – two identical radio telescopes at one site

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