

Local Surveys at the Fundamental Station Wettzell

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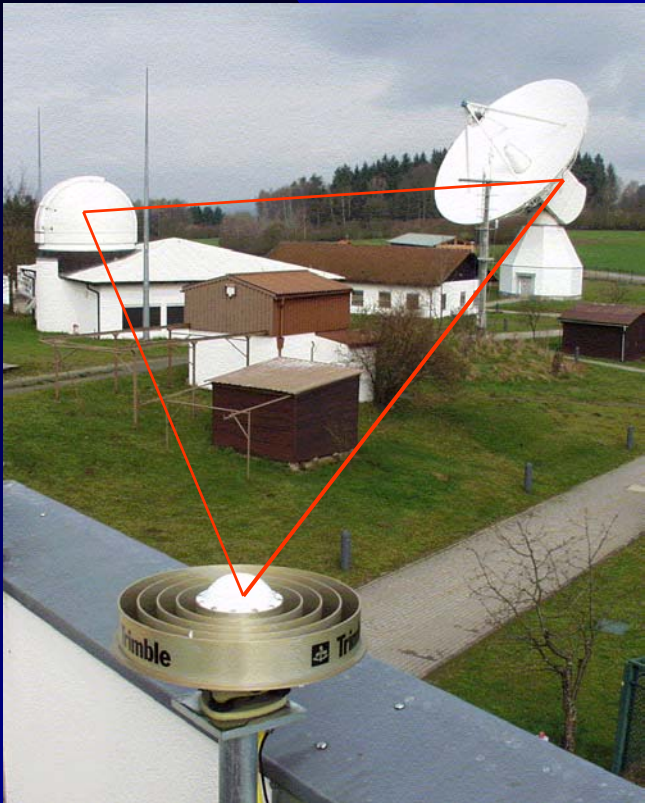
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Objectives of Local Survey



- Determination of the local ties between the reference points of the measuring systems (VLBI, SLR, GPS, DORIS etc.) employing classical survey techniques
- Reference to survey markers with connections to the national survey
- Detection of local movements and instabilities
- Inclusion of new measuring systems

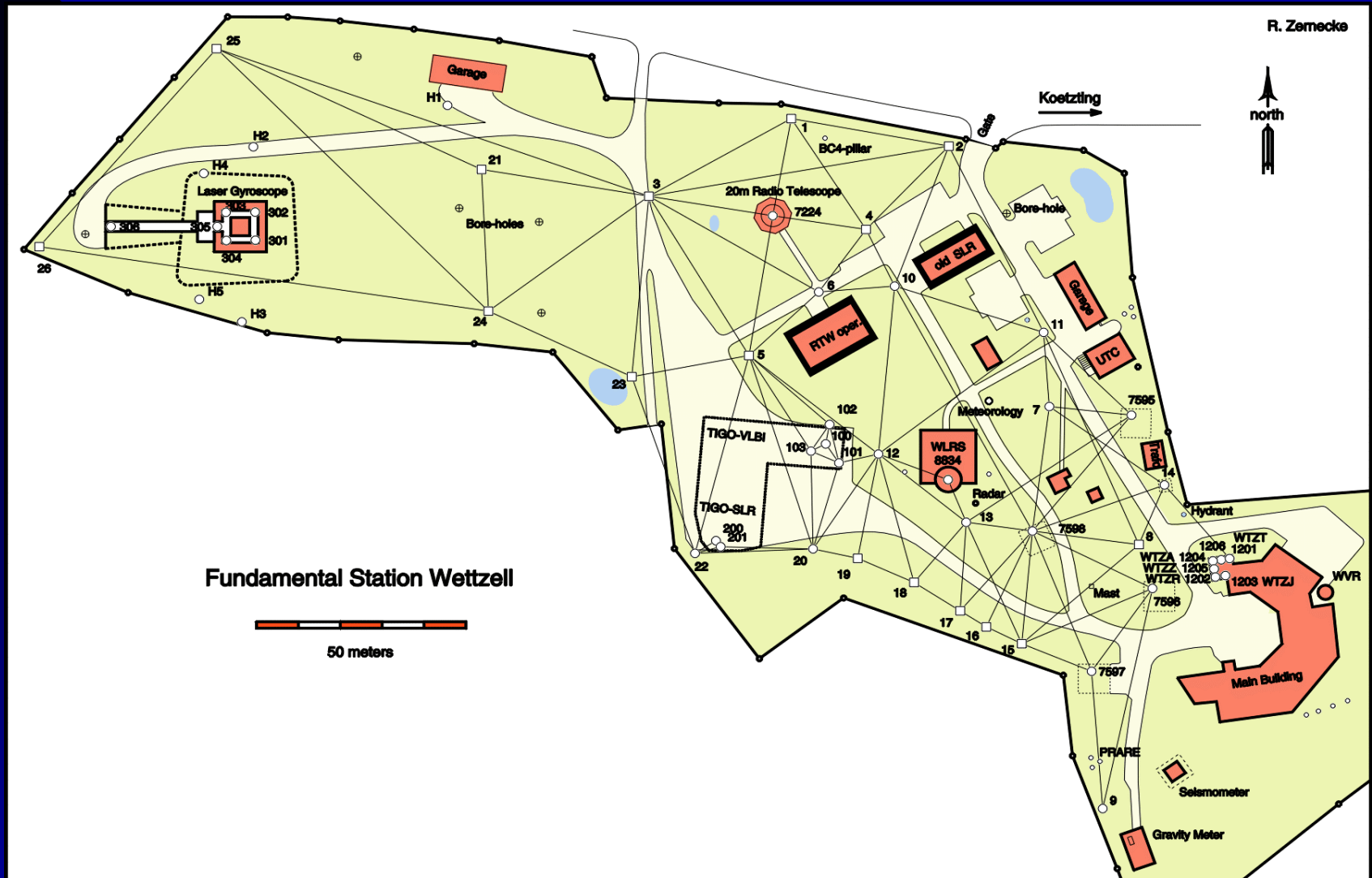
Areas of Problems

- Establishment of Local Survey Network(s)
 - ◆ Design of the network
 - ◆ Observations (directions, distances, heights, gravity...)
- Monumentation and groundmarkers
- Access to the reference points of the space geodetic measuring systems
- Orientation of the local network
- Data Analysis
 - ◆ Data reduction
 - 2 dimensional coordinates + height
 - Solution Vector
 - Variance Covariance Matrix
 - Transformation into TRF
- Data Archiving and Documentation

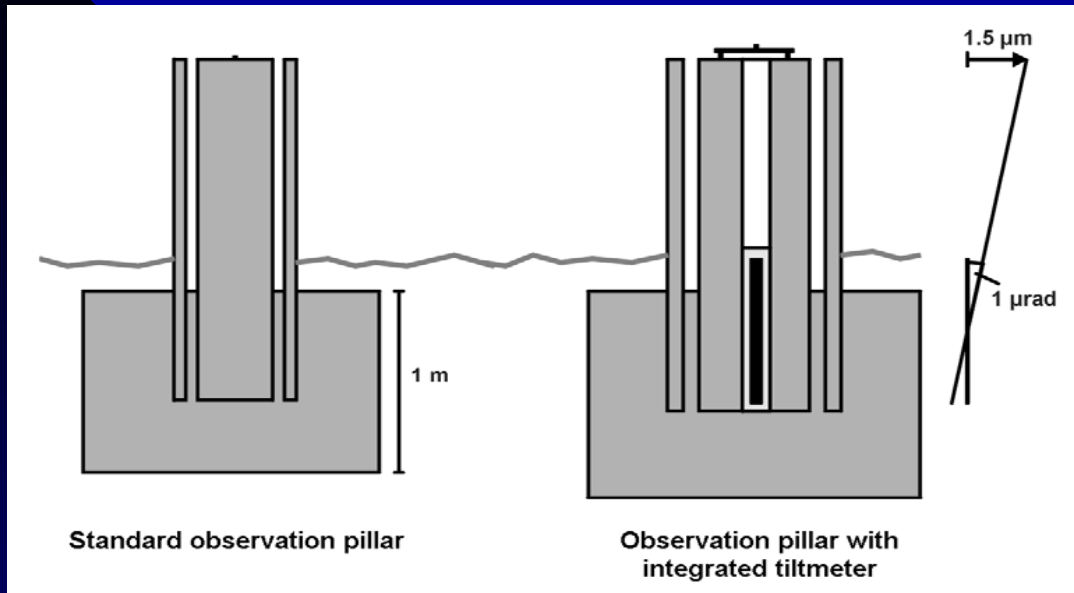
Local Network FS-Wettzell (History)

- 1976 Seeger, Billich
- 1981 Beetz, Billich, Richter, Soltau
- 1985 Kipar, Stichling
- 1991 Klesen
- 1993 Lang
- 1995 Fundheller, Neumann
- 1996 Lang
- 1997 Jocham
- 2000 Zerneck
- 2002 Fischer, Becker

Local Network FS-Wettzell



Monumentation

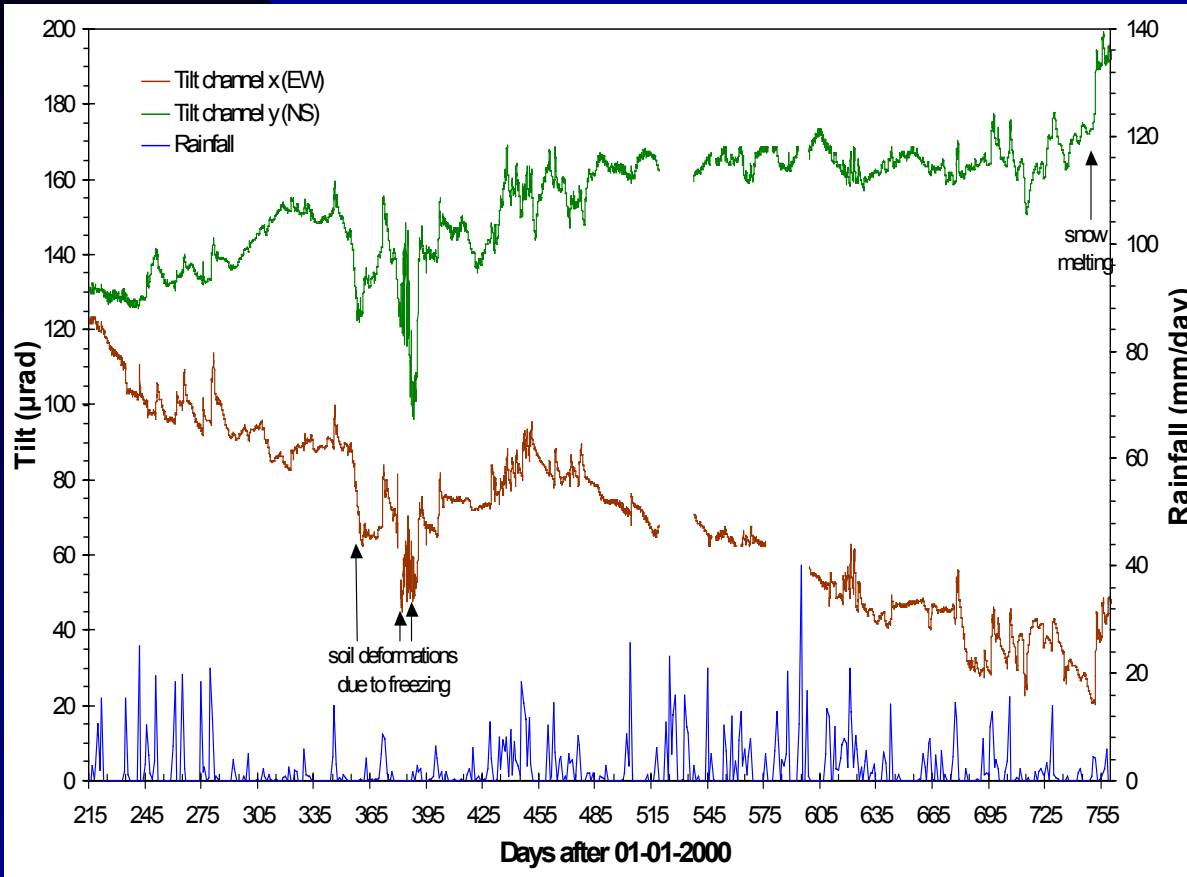


- Pillars with forced Centering
- Groundmarkers
- Levelling markers



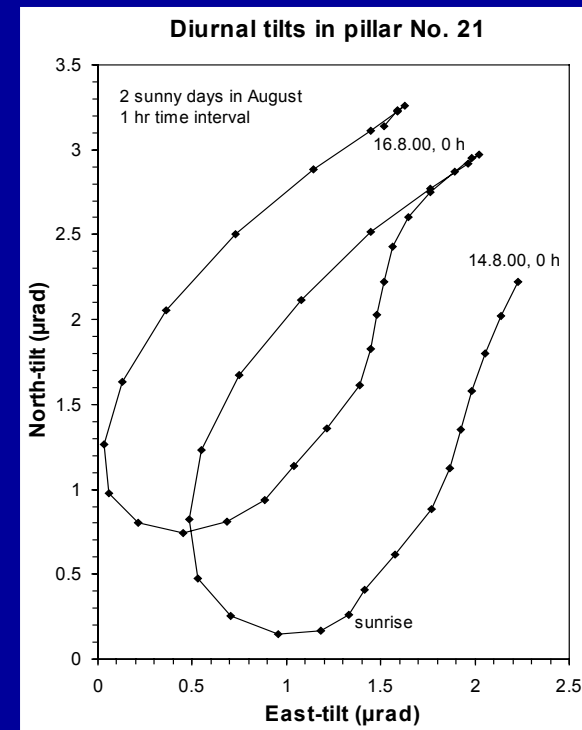
Monument Stability

observed with the integrated AGI borehole tiltmeter for 540 days
variations are within 200 μrad ($> 0.3\text{mm}$)

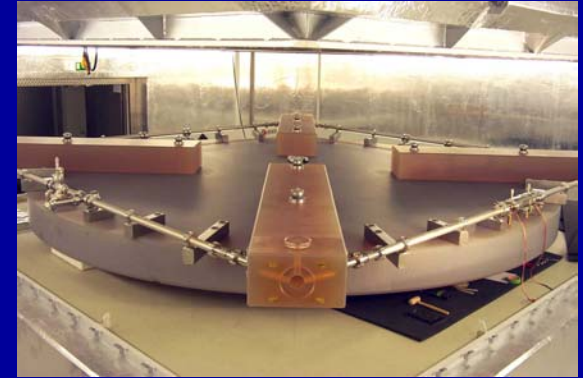


Long term stability

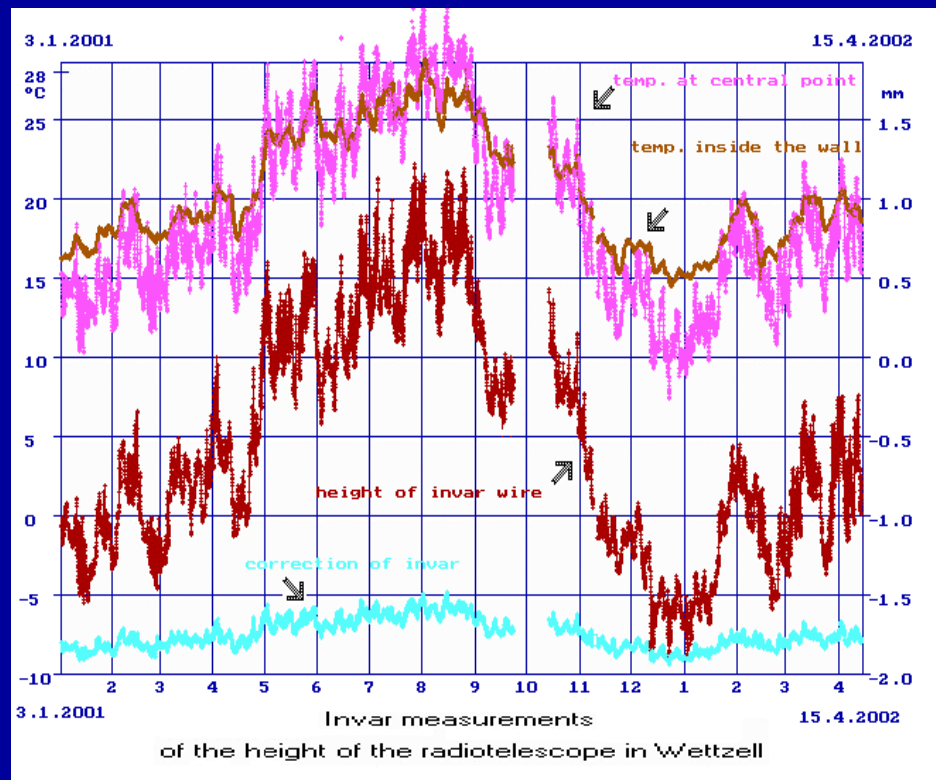
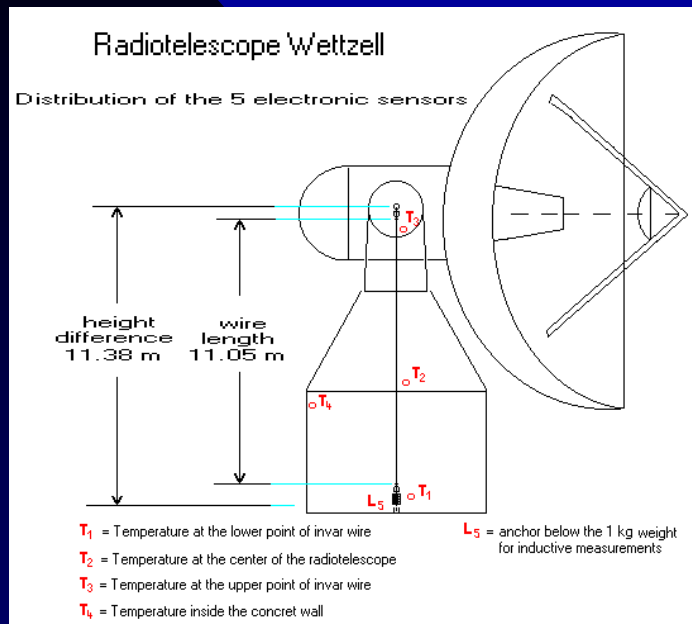
Short term stability



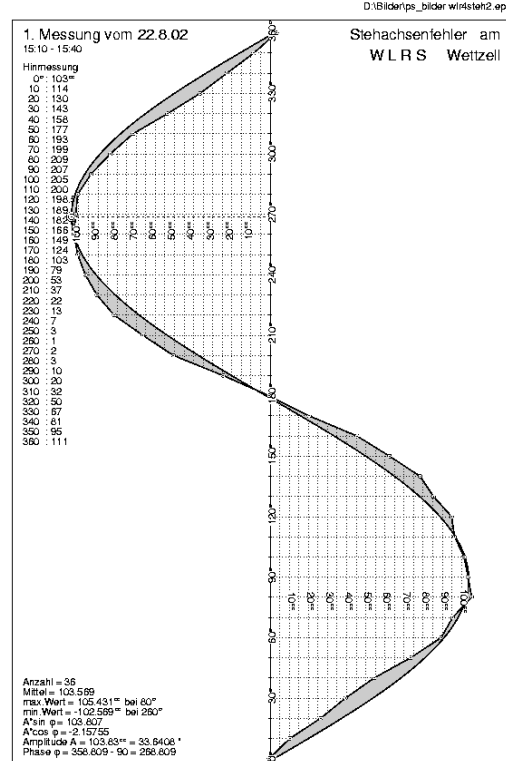
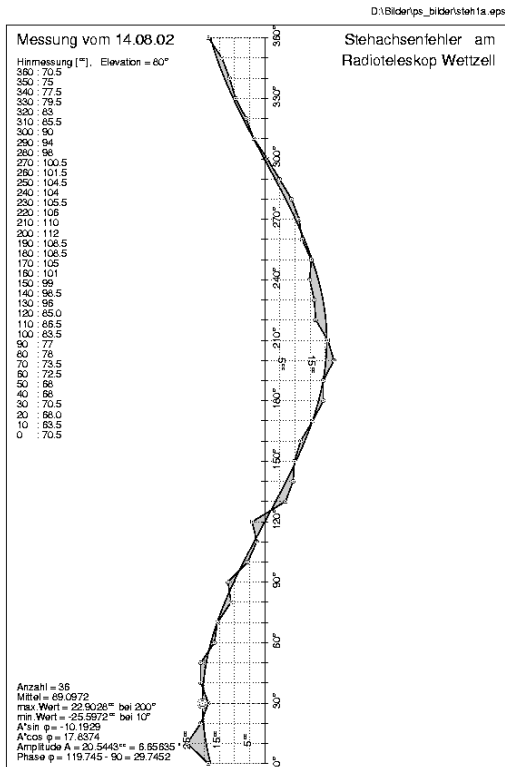
Access to the Reference Points



Variations with Time (e.g. RTW thermal expansion)



Tilt of Azimuth Axis RTW and WLRS



RTW

- ◆ Amplitude 6,65''
- ◆ Phase 29,74°

WLRS

- ◆ Amplitude 33,64''
- ◆ Phase 268,80°

Survey Tools (2002)



- Tachymeter: Leica TCA 2003
 - ◆ Directions 0.15 mgon
 - ◆ Distances 1mm + 1ppm
- Theodolite: Kern DKM 2AC
 - ◆ Directions 0.1mgon
- Distance: Mekometer (Leica)
 - ◆ Distances 0.2mm +0.2ppm
- Leveling: Leica DNA 03
 - ◆ Heights 0.3mm per km
- GPS-receiver
 - TRIMBLE SSI 4000
 - Ashtech Z12
 - AOA SNR8000
- Plumbline system (“Abloter”)

Adjustment of 2002 Observations

- Data Reduction Software
 - ◆ PANDA (Version 3.09)
 - Developed by GeoTec-Forschungsgesellschaft für Angewandte Geodätische Technologien
 - ◆ CREMER
 - Cremer Programmentwicklungs GmbH
- Used for
 - ◆ Adjustment of geodetic Networks
 - 1d Leveling
 - 2d Network
 - Transformations
 - Etc.

Adjustment: Leveling

Leveling (free network adjustment)

◆ Number of Observations:	317
◆ Number of Points	
✎ Total	115
✎ Datum Points	64
◆ Standard Deviations	
✎ Stand. Dev. Average	0.05mm
✎ Min.-max Stand. Dev.	0.02 ... 0.08mm

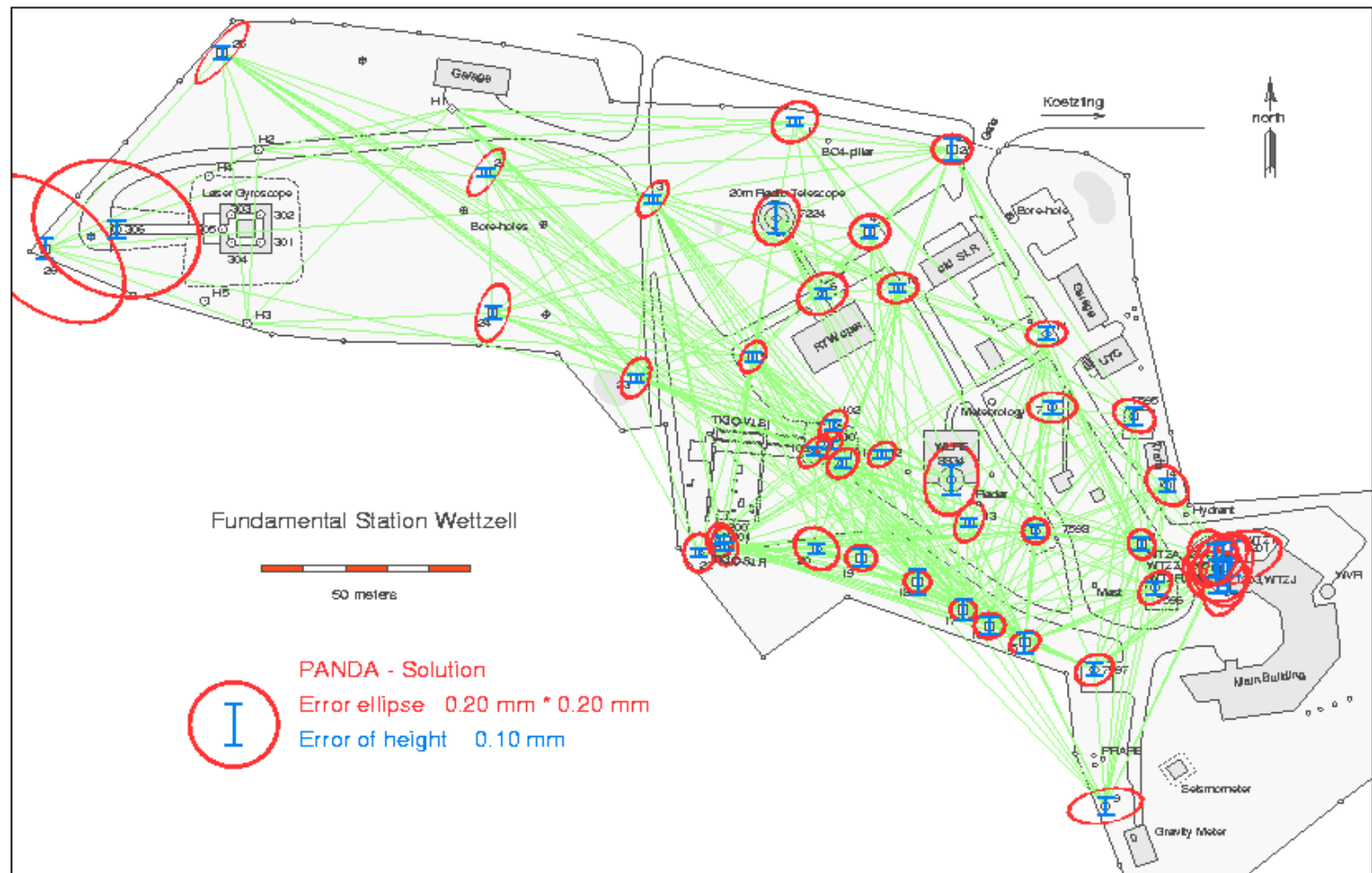
Adjustment: 2D Network (Gauss-Krüger Coordinates)

■	Number of Observations	972
◆	Directions	422
◆	Distances	550
■	Number of Network Points	
◆	Total	57
◆	Datum Points	30
■	Number of Unknowns	
◆	Coordinates (R: East, H: North)	114
◆	Orientation	39
■	Standard Deviations	
◆	Standard Deviation of Position (σ_s)	0.13... 0.23 mm
◆	Orientation Standard Deviation	0.08....0.25 mgon

Results of Adjustment 2002

(Error Ellipses-Positions, Error Bars-Heights)

R. Zernedke



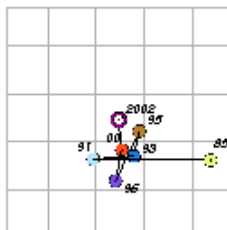
Comparison with Previous Results - Extract

Remaining differences in the coordinates after their transformation into epoch 2002

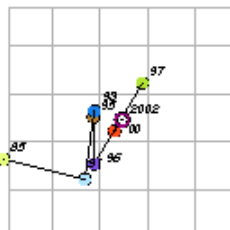
● 1985 Kipar
 ● 1991 Klesen
 ● 1993 Lang
 ● 1995 Fundh.
 ● 1996 Lang
 ● 1997 Jocham
 ● 2000 Zemecke
 ● 2002 Fischer

Scale: 1 mm

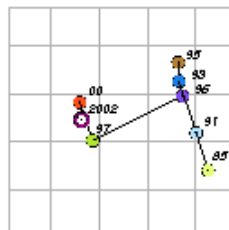
Pillar 001



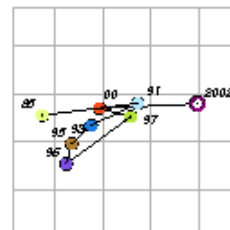
Pillar 003



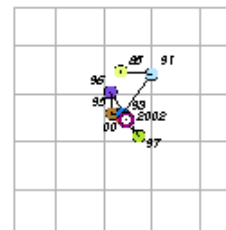
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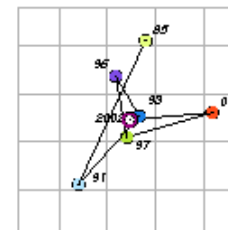
Point 006 under pavement



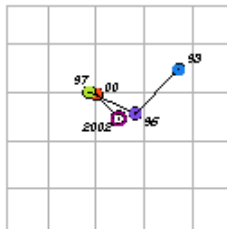
Pillar 008



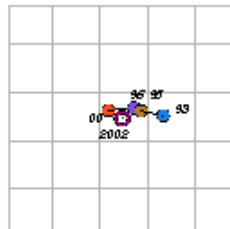
Point 009



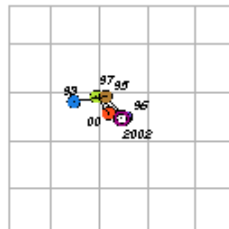
Point 010



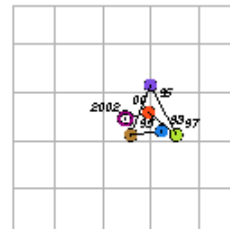
Point 011



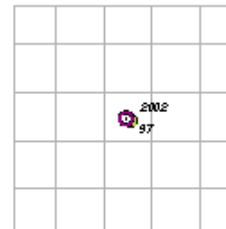
Point 012



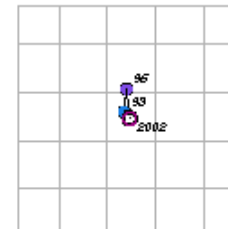
Point 013



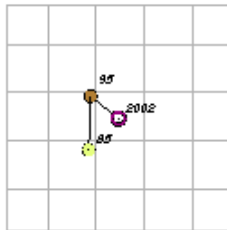
Point 100 TIGO-RT



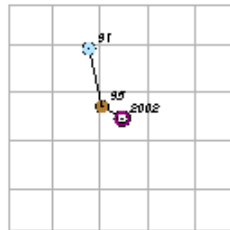
Point 1201 GPS



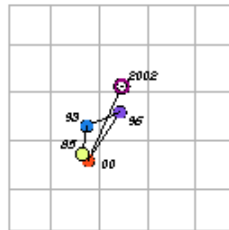
Point 7224 RTW



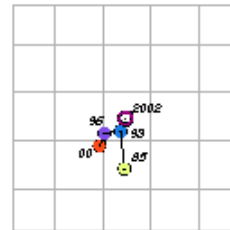
Point 8834 WLRS



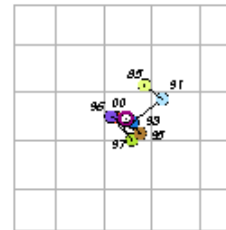
Pad 7595



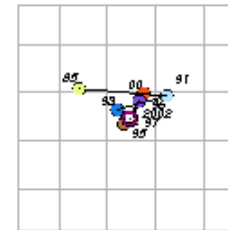
Pad 7596



Pad 7597



Pad 7598



Height changes in the years from 1985 until 2002

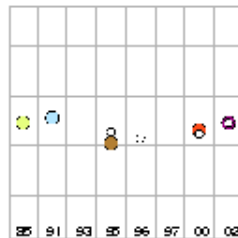
● 1985 Kipar ● 1991 Klesen ● 1993 Lang ● 1995 Fundh. ● 1996 Lang ● 1997 Jocham ● 2000 Zernecke ● 2002 Fischer

Scale: 1 mm

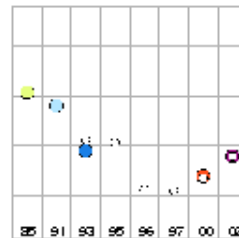
○ = Center of point

○ = Height mark

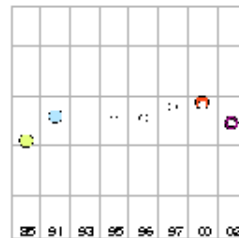
Pillar 001



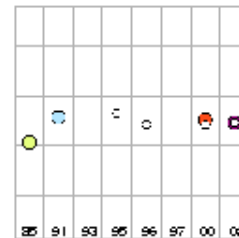
Pillar 002



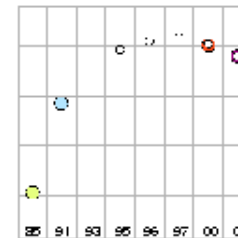
Pillar 003



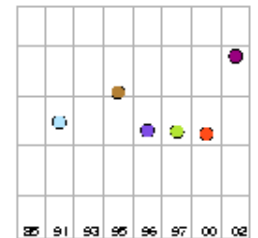
Pillar 004



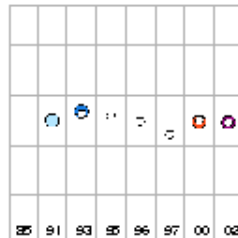
Pillar 005



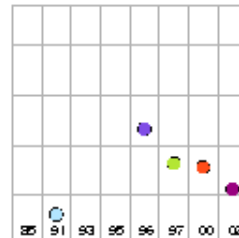
Point 006 under pavement



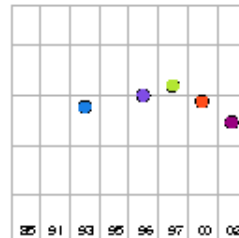
Pillar 008



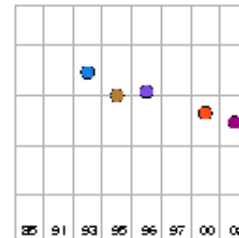
Point 009



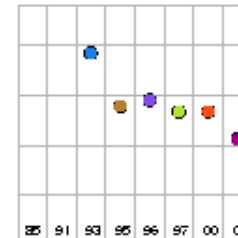
Point 010



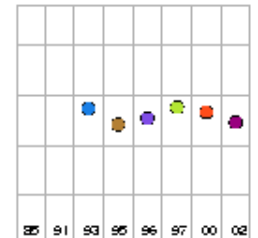
Point 011



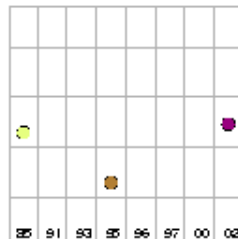
Point 012



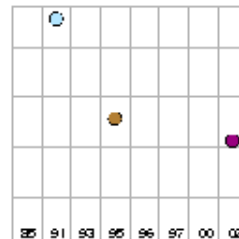
Point 013



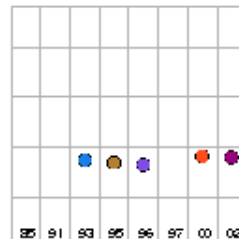
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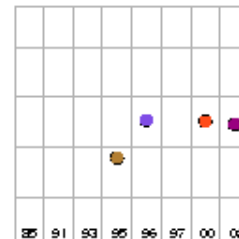
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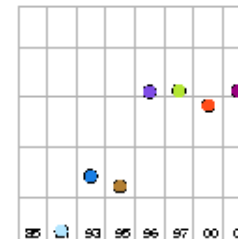
Pad 7595



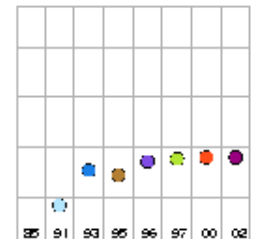
Pad 7596



Pad 7597



Pad 7598



Final Remarks

- Survey effort should not to be underestimated
- Resolution
 - ◆ Precision
 - Position 0.1 ... 0.4 mm
 - Vertical 0.02 ... 0.1mm
 - ◆ Repetition
 - Horizontal 1mm
 - Vertical 1mm
- Data archiving for further extensions and combinations
- Documentation