# The Austrian radom family
# Expected differences for the EPN and IGS reprocessing

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## 1. Introduction

Austria started a network of GPS permanent stations in 1992. While the oldest station GRAZ was already used by research with Doppler satellites the construction and position of it was decided to be kept. For the new sites at that time a common design was made to the needs of a mountainous country with continental climate. Apart from the ground constructions the antenna protection by radoms was an important issue. The main points of request to a radom should be

- Protect the antenna against rain, snowfall, ice coverage and weathering,
- Protect the antenna against damage by humans and animals,
- Protect the antenna against storms until 250 km/h,
- Do not reduce the power of the incoming signals,
- Do not change the phase centre(s) of the antenna with the radom.

At that time there were no industrial products which fulfilled the requests. Fortunately, the Laser group of the Space Research Institute of the Austrian Academy of Sciences made a proposal to manufacture a new type of radoms with their electronic knowledge and their experiences from being hobby pilots. A radom was constructed therefore, consisting of a sort of plastics and resin used for sail airplanes and protected by a certain varnish. It consists of a cylindrical part plus a hemisphere where the common phase centre was placed into the focus of the hemisphere. The dimensions were designed for choke ring antennas. The radom was checked and be found adequate, not changing the height position by more than five millimeters. The type was named for the IGS antenna/receiver table as 'GRAZ' (Figure 1, left), even the station GRAZ was not equipped with a radom. After some years (1995) the site PFAN has to be equipped with an antenna with groundplane, but the antenna didn't fit into the radom. Therefore a radom of bigger dimensions was built and put at the station (again Figure 1, left). Unfortunately the name GRAZ was kept because the behavior seemed to be the same. With the increasing number of stations of the Federal Office of Metrology and Surveying a type 'BEVA' was created by shortening the cylindrical part of the radom (Figure 1, right). Originally this type was also named GRAZ but it was corrected very quickly. Because all sites with BEVA type are national and not international ones the type was not introduced into the IGS table. The first problems of changing positions have been detected by using antennas of the TRIMBLE Zephyr type (Stangl, Titz 2006). Large offsets of centimeters were seen caused by the combination radom+antenna. After the change from relative to absolute calibrations it became necessary together with the problems mentioned before that the combination radom + antenna for each site should be calibrated, also for historical combinations. The older Allen Osborne antennas were excluded from the calibrations, but from field measurements it is known that their relative calibration is very close to that without a radom (type 'NONE'). A couple of combinations were sent to Geo++ beginning of 2007. Due to robot problems, results came back beginning of 2008 and were applied to the stations. At the same time the ambiguous handling of the radom type GRAZ in the past was intensively discussed in the technical working groups of IGS and EUREF. To have a clear situation for the future and to have definitions available that allows users to distinguish between the radom types, three new radom

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names (OLGA, PFAN and BEVA) have been created to separate the old radom type GRAZ into the three available variants of the austrian radom family. The name GRAZ war removed from the antenna/radom table an will not be used any more in the future. The historical situation has been cleared by editing the sitelogs of the affected stations so that the correct information is available for a future reprocessing of the networks. Due to other reasons (reference change) no international site is presently (autumn 2008) affected by the calibration change. This paper shows examples for the EPN sites how positions will change by applying the calibration values to the actual combinations.

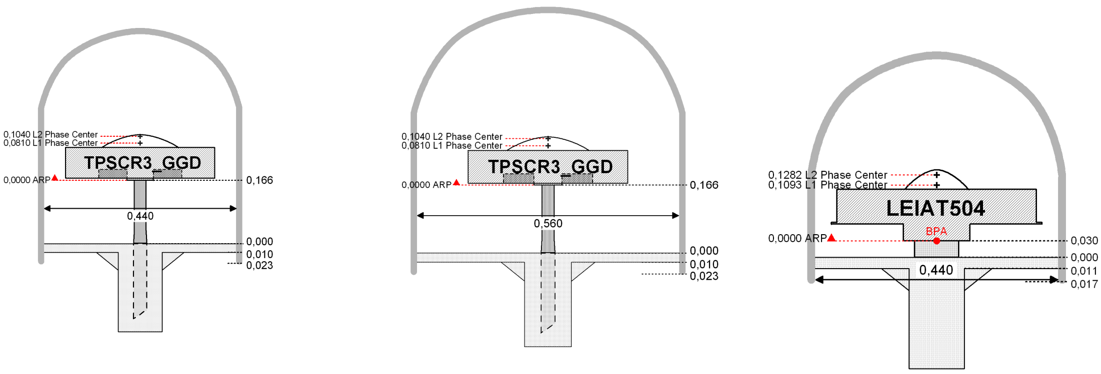


Figure 1: Austrian radom types, left former GRAZ now OLGA, centre PFAN, right BEVA, and the different positions of a typical choke ring antenna within them.

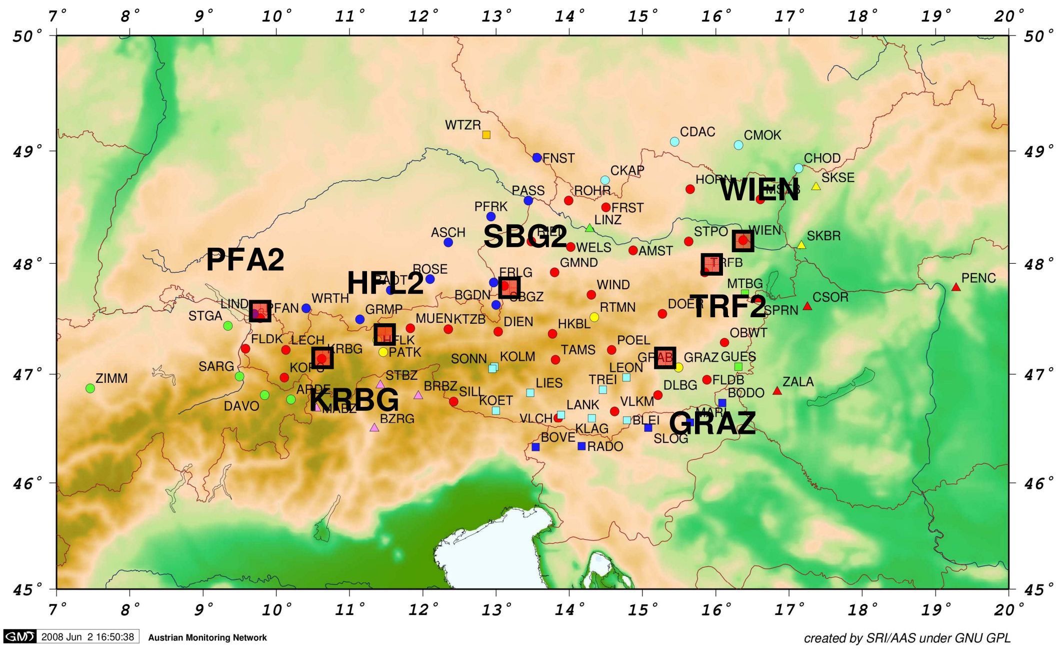


Figure 2: Selected sites (EPN and non-EPN) for testing the calibration effects.

## 2. Testbed, Configurations and Results

Figure 2 is showing the testbed consisting of the five EPN sites GRAZ, HFL2, PFA2, SBG2 and TRF2 together with two national sites KRBG and WIEN. The actual configurations of the test GPS week 1476 are given below:

**GRAZ antenna type TRM29659.00 radom type NONE – Reference**
**HFL2 antenna type TRM29659.00 radom type OLGA – type calibration**
**KRBG antenna type TRM41249.00 radom type BEVA – individual calibration**
**PFA2 antenna type TPSCR3_GGD radom type PFAN – individual calibration**
**SBG2 antenna type TPSCR3_GGD radom type OLGA – type calibration**
**TRF2 antenna type TPSCR3_GGD radom type OLGA – individual calibration**
**WIEN antenna type LEIAT504 radom type BEVA – type calibration**

All combinations are tested against the results with the former 'calibrations' where always the radom type NONE was chosen. Only GRAZ remains unchanged because it has really no radom. From the daily results the weekly solutions were computed to smooth the daily variations of several millimetres. For the computations the Bernese Software 5.0 was used. Due to copyright constraints by Geo++, calibration values may not be published. The largest parts of the calibration values, the phase centre offsets, show variations below 10 mm, with LEICA and TOPCON being on the high side.

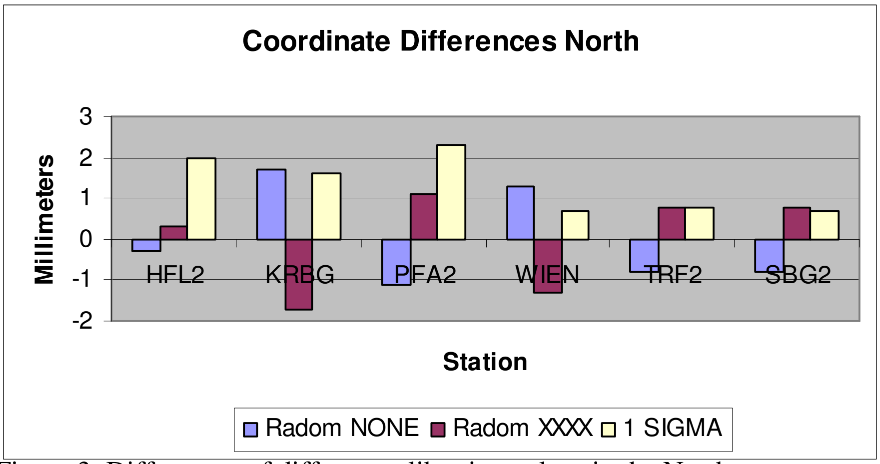


Figure 3: Differences of different calibration values in the North component.

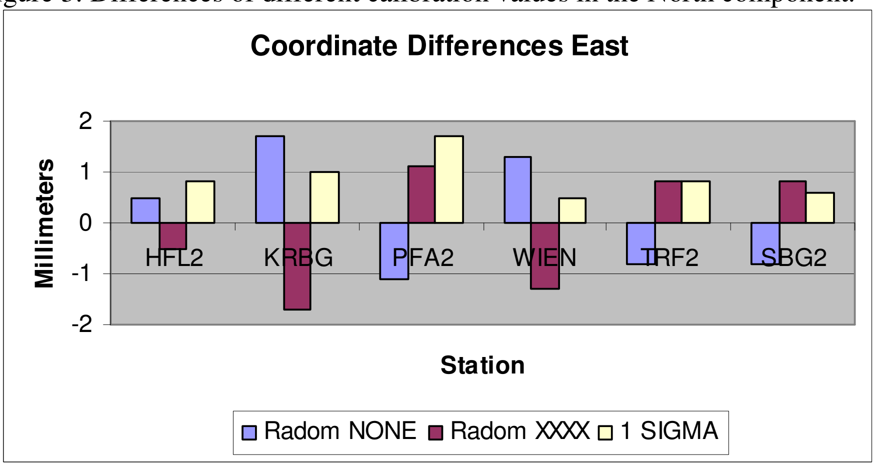


Figure 4: Differences of different calibration values in the East component.

Figures 3 to 5 show the differences due to different calibration values in the three components North, East and Up. For comparison the 1 sigma values of the residuals of seven daily results are plotted. They reflect the daily variations of the coordinates, typically about ±1 mm for the horizontal components and up to ±5 mm for the vertical ones. The sigma values are not changed by the different calibration models. As expected the absolute values in the horizontal components are quite small and not significant at the 2 sigma level. One can see a pattern common to the antenna type, e.g. for the three TOPCONs at PFA2, SBG2 and TRF2. Generally the Up component is much more influenced by the change of calibration values. However, except two sites, SBG2 and TRF2, all the changes are not significant at the 2 sigma level. Both significant sites show the same difference of about 18 mm and are equipped with TOPCON antennas and the same radom type.

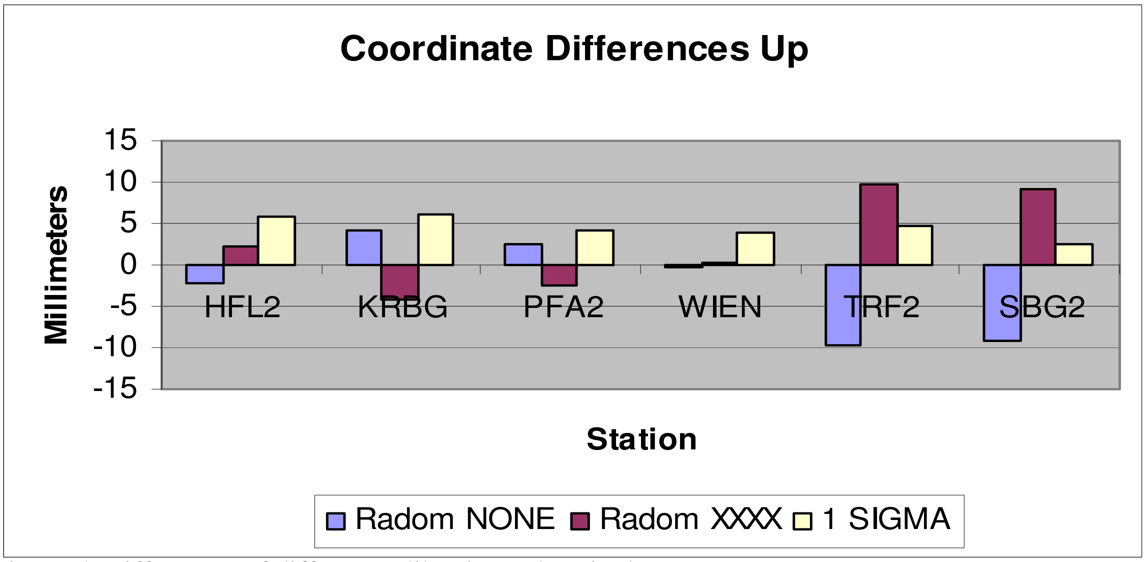

Figure 5: Differences of different calibration values in the Up component.

## 3. Discussion and Conclusions

The first question arises why the TOPCON antenna at PFA2 has a different pattern as at SBG2 and TRF2. Looking at the new calibration values the combination at PFA2 shows that the offsets are very close to those of type NONE whereas the OLGA type differs by more than seven millimetres. The azimuth and elevation variations have not such a big influence to explain the remaining 10 millimetres at SBG2 and TRF2. One reason could be that the NONE type values were simply transformed from relative calibration to absolute one without a new calibration. Additionally the antenna with radom type CONE was transformed. Before the switch to absolute calibrations a change in GOPE (Pecny, Prague) caused an offset of 16 mm in height by exchanging the Ashtech ASH701946.3 by TPSCR3_GGD CONE (EPN CB timeseries). After switching to absolute calibrations the station MTBG (Mattersburg, former IGEX station) the transition from JPSREGANT_DD_E to TPSCR3_GGD CONE caused an offset of 10 mm. However, all other newly calibrated values are very similar regardless of radom types, like CONE, PFAN and SCIT, individually calibrated or transformed. The OLGA type on the other side fits very well at other sites and should not have such differences in general. As it turned out after the results the second reason might be the removal of the original cone because the cone did not fit under the radom. It is likely therefore that the large up differences are combined from two sources, one coming from the calibration difference and one from the removal of the original cone in advance. Unfortunately the hypothesis cannot be proved yet due to lack of spares of those antennas. For all other sites and antenna+radom type combinations the differences are so small that a potential reprocessing of the IGS and EPN networks will not change too much when the old or the new calibrations are used.

## 4. Literature

G. Stangl, H. Titz, Antenna Tests at Vienna 2002-2005, EUREF Publication No. 15, Mitteilungen des Bundesamtes für Kartographie und Geodäsie, Band 38, Frankfurt am Main 2006, pp. 68-72, and http://www.euref-iag.net/symposia/Symposium2005-Vienna.html (Presentation).

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