



# Case study of Poland

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## Outline

- Regulations of reference frames in Polish law
- Terrestrial Reference Frame
- Vertical Reference Frame
- National spatial reference system in Poland
- Gravimetric & Magnetism

# Regulations of reference frames in Polish law



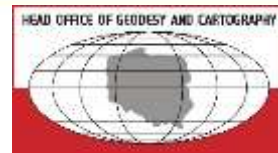
In 2012, the Regulation on the national spatial reference system was published. It is defining the reference system used in Poland:

- PL-ETRF2000 and PL-ETRF89 as a realization of ETRS89
- PL-KRON86-NH and PL-EVRF2007-NH – the second one as a realization of EVRS

coordinate systems and relations with reference system and frames I will show in later slides

But the way to implement these frames was (is) not easy...

# Regulations of reference frames in Polish law



According to Polish geodesy and cartography law Polish reference networks are divided into 3 classes for which two kind of authorities are responsible:

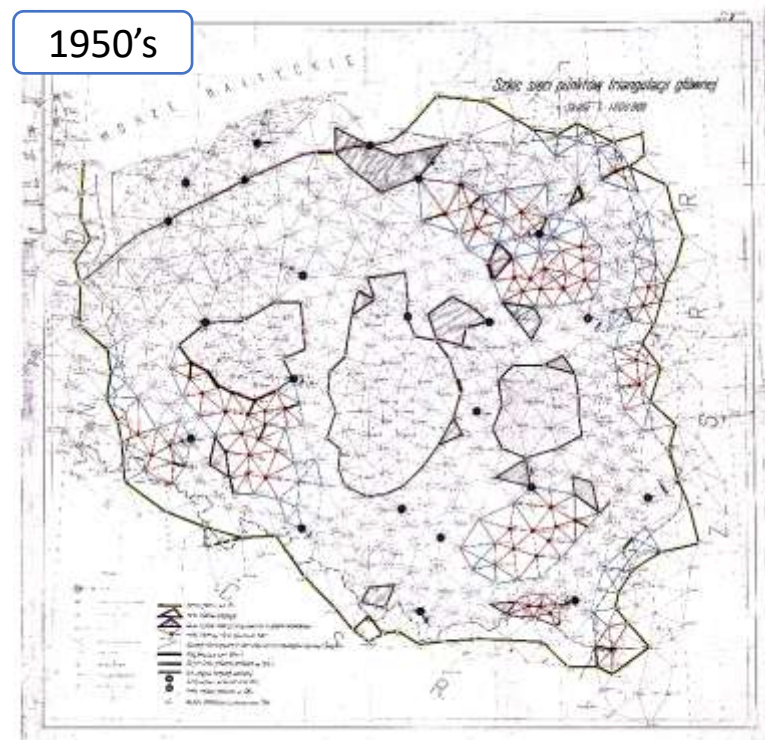
- Fundamental (earlier 1<sup>st</sup> class)
- Base (earlier 2<sup>nd</sup> class)
  - both classes form the basic geodetic network, which is under the responsibility of the Surveyor General of Poland
- Detailed (earlier 3<sup>rd</sup> class) – under the responsibility of the County Governor (by Surveyor of County) – 380 counties in Poland



# Terrestrial Reference Frame



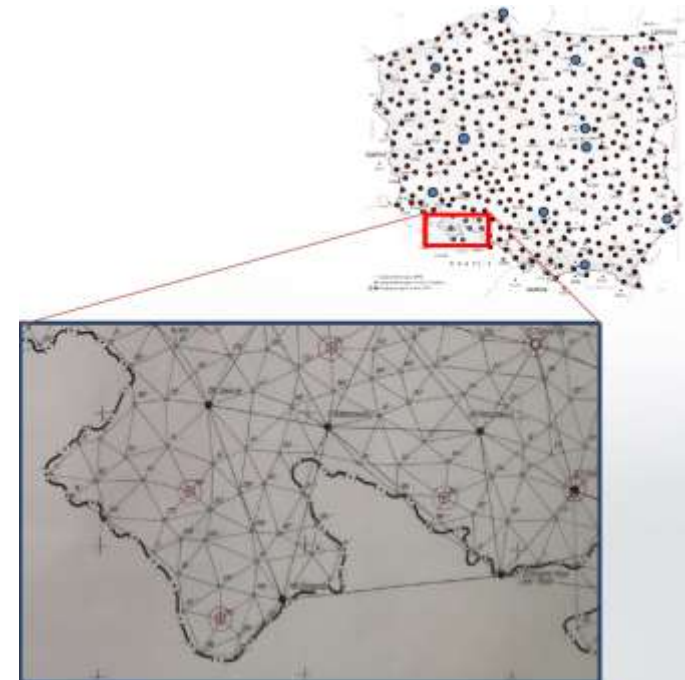
- After II World War territory of Poland was destroyed and boundaries was changed.
- In years 50's previous century unified astronomical-geodetic network was stabilized and measured (by triangulation).
- Control points of 1<sup>st</sup> class has been adjusted in USSR, in spatial reference to the Krassovsky's ellipsoid and the spatial position of control points in lower classes was computed in same reference and coordinate system (called 1965).



# Terrestrial Reference Frame



- In 90's the political system in Poland has been changed and also the strategy in geodesy.
- In 1992-1995 almost 400 control points from old 1<sup>st</sup> class was re-stabilized, measured by GPS and adjusted in ETRS89
  - 11 points was implemented into EUREF network and it became a "Zero order satellite network"
  - 359 points became a 1<sup>st</sup> order satellite network called POLREF
- The earlier triangulation observations were re-computed with coordinates referenced to the ETRS89 at epoch 1989.0
- From year 2000 the ETRF'89 frame has been introduced into use in Poland as the official spatial reference system
  - All basic control points has been adjusted in Polish coordinate system '1992' referenced to ETRS89 at epoch 1989.0 (in Polish regulation PL-ETRF89-1992)
  - Detailed control network at counties has been re-computed by 2010 in Polish coordinate system '2000' (in Polish regulation PL-ETRF89-2000)





# Terrestrial Reference Frame

- In 2008 the Multifunctional precise satellite positioning system ASG-EUPOS has started operational
- Between 2010 and 2012, a calibration campaign linking the ASG-EUPOS system stations with grounded control points of basic geodetic network was carried out:
  - ASG-EUPOS stations are stabilized as antennas for GNSS receivers, mostly at roof of buildings, with linked ground geodetic control point
  - All satellite geodetic control points was measured in GNSS campaign and adjusted to the nearest EPN stations with coordinates computed in ETRF2000 at epoch 2011.0
- The earlier triangulation observations were once again re-computed with coordinates referenced to the ETRS89, realization ETRF2000 at epoch 2011.0
- From year 2012 the spatial reference frame for satellite measurements is also the PL-ETRF2000, at epoch 2011.0





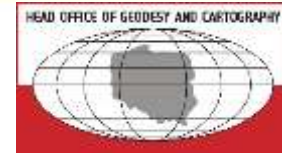
# Terrestrial Reference Frame

From 31 of July 2021:

- All ASG-EUPOS stations at territory of Poland are control points of fundamental class of the basic horizontal geodetic network (107 control points)
  - Transferring reference frame at territory of Poland
- Triangulation points, points of satellite network (EUREF-POL, POLREF, EUVN, EUVN-DA) are control points of base class of the basic horizontal geodetic network (about 6 700 points)
  - Realization of reference frame at territory of Poland
- In future:
  - Installation and starting operational new ASG-EUPOS Stations
  - New measurement campaign – similar to campaign from 2010-2012







# Vertical Reference Frame

1<sup>ST</sup> CLASS  
 VERTICAL  
 GEODETIC  
 NETWORK

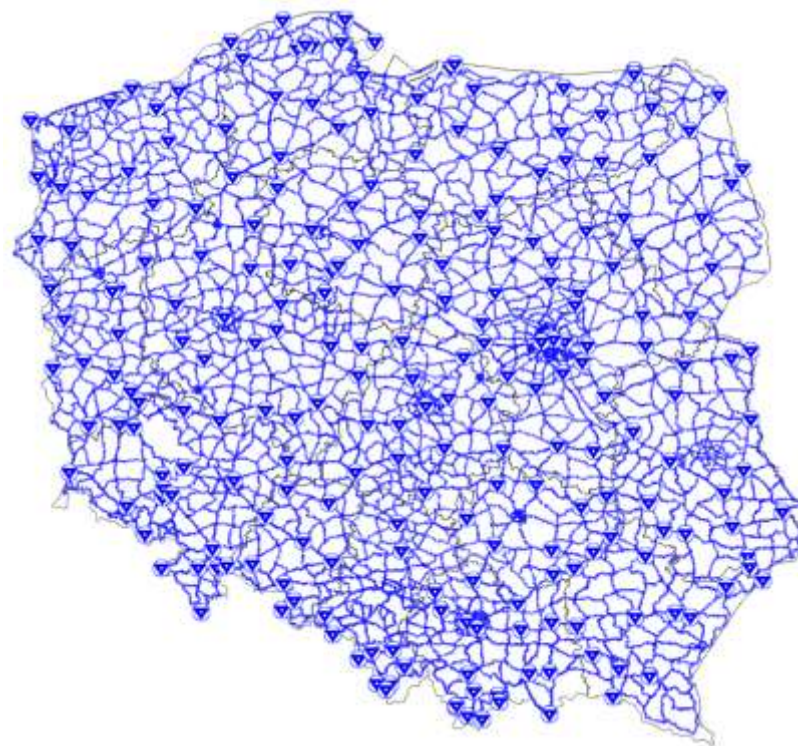


	1 <sup>st</sup> campaign	2 <sup>nd</sup> campaign	3 <sup>rd</sup> campaign	4 <sup>th</sup> campaign
Year of measurements	1926-1937	1947-1955	1974-1982	1999-2001
Length of lines	10 046 km	5 778 km	17 015 km	17 516 km
No. Polygons/Lines	36 / 121	23 / 116	135 / 371	158 / 382
Height system /level	Orthometric /Amsterdam	Normal /Kronstadt	Normal /Kronstadt/Amsterdam	Normal /Kronstadt/Amsterdam
Gravimetric system	Postdam	Postdam	IGSN71	International
Accuracy	± 1.04 mm/√km	± 0.78 mm/√km	± 0.91 mm/√km	± 0.91 mm/√km
Name of frame	Amsterdam	Kronsztad60	Kronsztad86/ EVRF2000	PL-KRON86-NH/ PL-EVRF2007-NH

# Vertical Reference Frame

From 31 of July 2021:

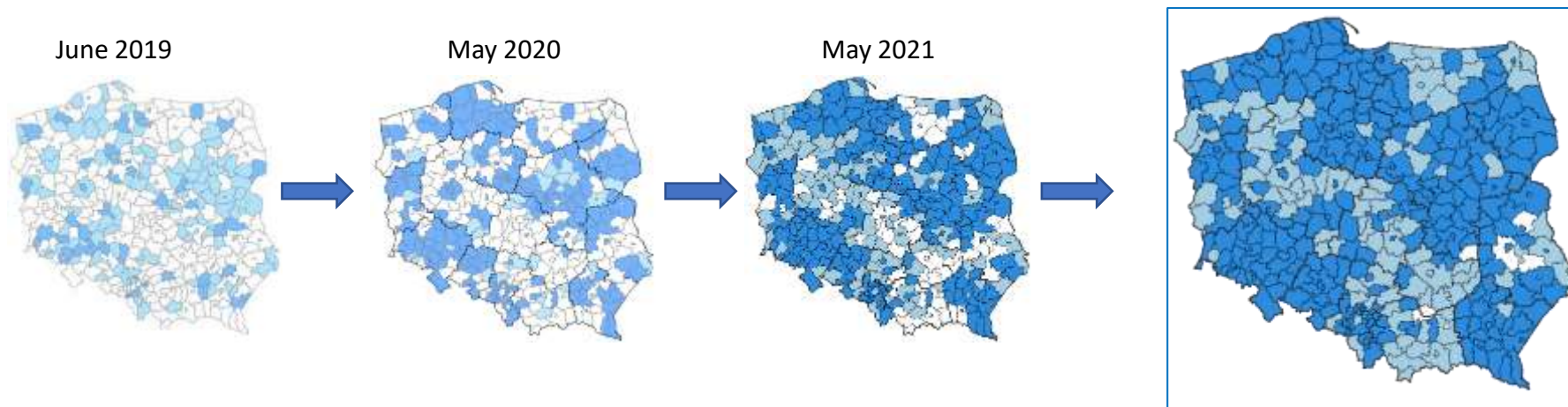
- Nodal points of 1<sup>st</sup> class UELN network are the fundamental class of the basic vertical geodetic network – adjusted in EUREF sub commission in part of European levelling network (243 control points)
  - Transferring reference frame at territory of Poland
- Points in lines of 1<sup>st</sup> and 2<sup>nd</sup> class of the then levelling network are control points of base class of the basic vertical geodetic network (almost 42 000 control points)
  - Realization of reference frame at territory of Poland
- In 2014 the heights of basic vertical geodetic network in vertical reference frame PL-EVRF2007-NH were published to use





# Vertical Reference Frame

- From that year all counties are implementing the PL-EVRF2007-NH frame at their area in detailed vertical geodetic network



PL-EVRF2007-NH implementation status	September 2022	
	Number of Counties	%
Not implemented (white)	7	1,84 %
Implementation in progress (light blue)	99	26,05 %
Implemented in County (blue)	<b>274</b>	<b>72,11 %</b>

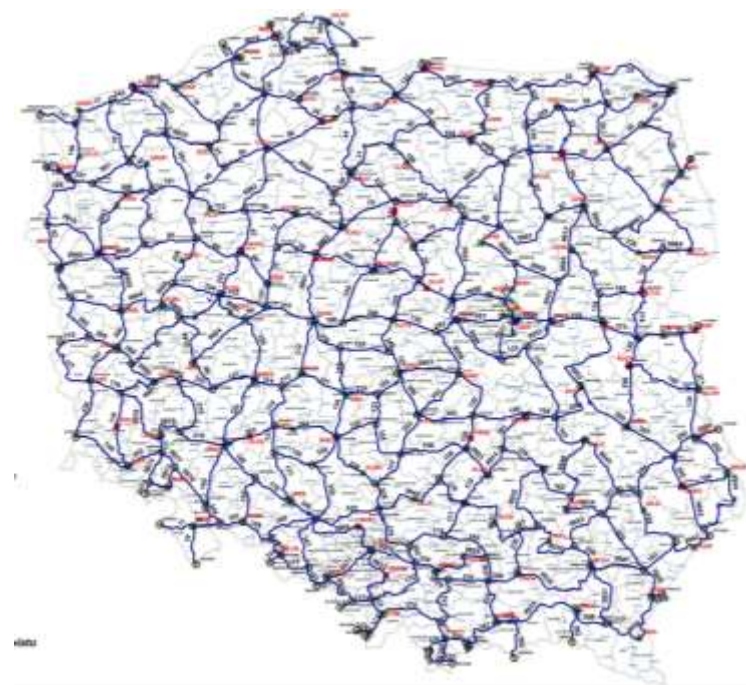


# Vertical Reference Frame



In future:

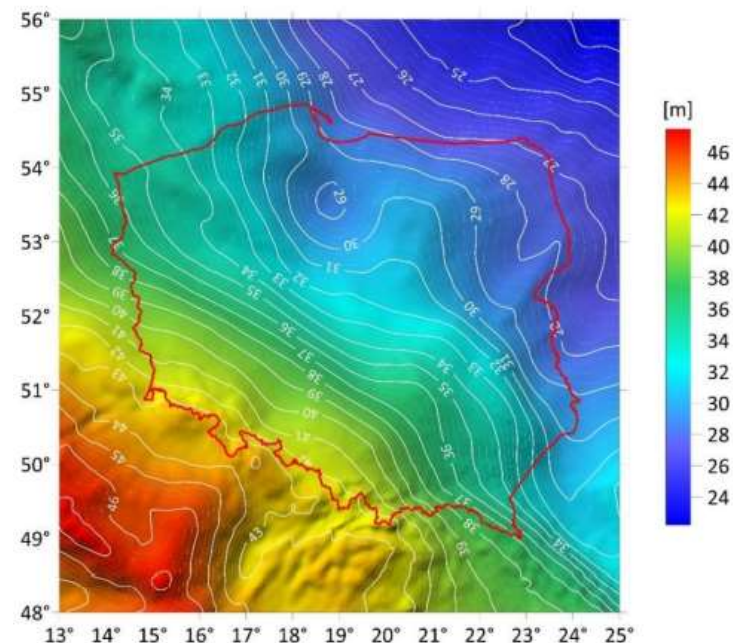
- In July of 2022 has started the 5<sup>th</sup> measurement campaign at levelling network in Poland
  - First the detailed project which must contains:
    - Used techniques – **geometrical and satellite levelling**
    - Technique and points to gravimetrical measurements to tidal and height system corrections
    - Linking with fundamental class of the horizontal geodetic network to preparing a new quasi-geoid model (ground points of the ASG-EUPOS stations have benchmarks)
    - Decrease number of basic control points to about 12 000
  - In 2024-2025 planned levelling measures



# Quasi-geoid model

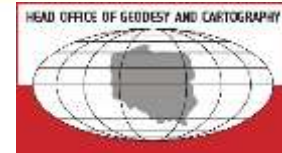
## Model PL-geoid2021:

- Computed by prof. Marek Trojanowicz and MSc. Magdalena Owczarek-Wesołowska from Wrocław University of Environmental and Life Sciences at the competition announced by Surveyor General of Poland in June 2021.
- computed for the area  $48^{\circ}\text{N} < \text{lat} < 56^{\circ}\text{N}$  and  $13^{\circ}\text{E} < \text{lon} < 25^{\circ}\text{E}$ , with a resolution of  $0.01^{\circ} \times 0.01^{\circ}$  by using the GGI method
  - The provided height anomalies are the difference of geodetic heights in the PL-ETRF2000-GRS80h datum and normal heights in the PL-EVRF2007-NH datum.
  - The reference ellipsoid for this model is GRS80.
  - The standard deviation of the heights difference at the GPS/leveling points is 1.9 cm.
- From 04.04.2022, the PL-geoid2021 model was introduced as valid for the territory of Poland.



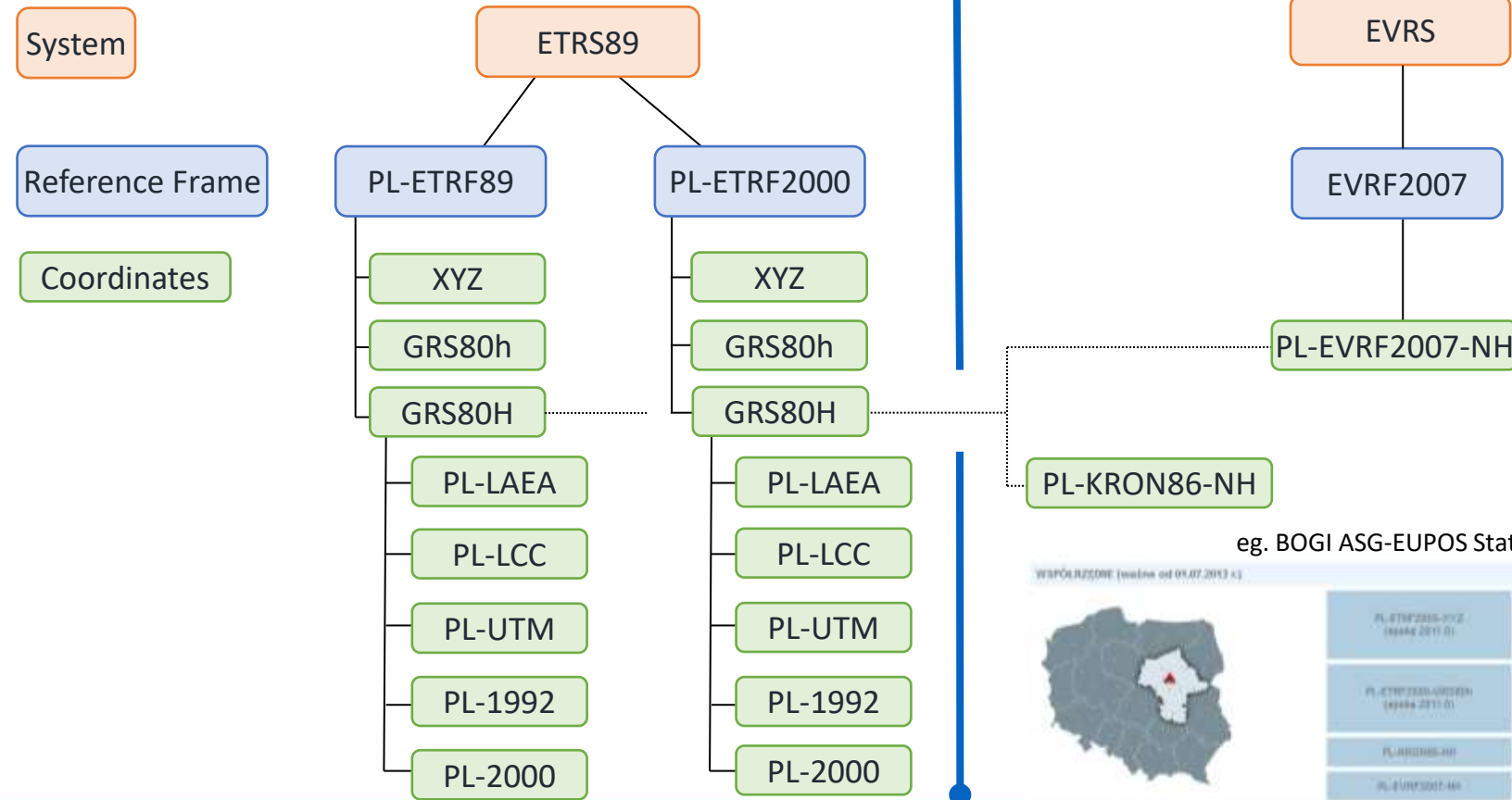
[https://www.isgeoid.polimi.it/Geoid/Europe/Poland/Poland\\_2021.html](https://www.isgeoid.polimi.it/Geoid/Europe/Poland/Poland_2021.html)

# National spatial reference system in Poland



Spatial/horizontal coordinates

Heights



eg. BOGI ASG-EUPOS Station

PL-ETRF2000-XYZ (16444 2011 0)	X = 3633015.66 m Y = 1307453.9157 m Z = 9035286.9028 m
PL-ETRF2000-GRS80H (16444 2011 0)	ψ = 52 22 29.963504 (1'') λ = 21 52 00.757060 (1'') h = 100.814 m
PL-GRS80H-NH	h = 100.15 m
PL-EVRF2007-NH	h = 100.323 m

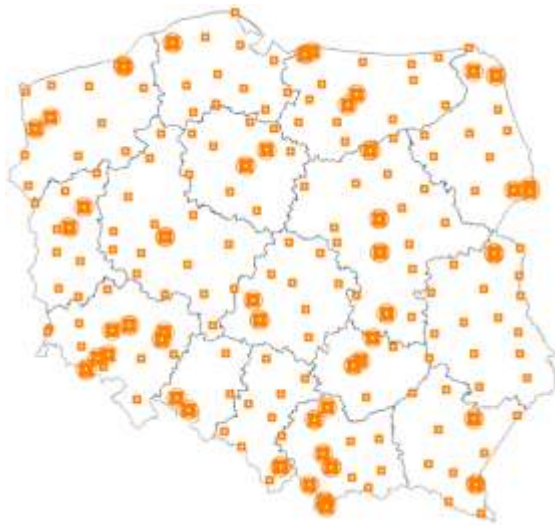




# Gravimetric & Magnetism

## Gravimetric network

- Measured with absolute gravity technique
  - Fundamental class measured by FG5 (WUT) - 27 points
  - Base class measured by A10 (IGiK) – 169 points
- Last measurement campaign in 2013-2015
- Next campaign planned in 2024-2026



## Magnetism network

- Fundamental class consist of points with measured magnetic field intensity, magnetic declination and inclination
- Base class consist of points only with measured magnetic declination
- Last measurement campaign in 2021



# National spatial reference system in Poland



INFORMATION ABOUT CONTROL POINTS OF BASIC GEODETIC NETWORKS IS AVAILABLE AT POLISH GEOPORTAL SITE:

<https://mapy.geoportal.gov.pl>

And in WMS/WFS services:

- <http://mapy.geoportal.gov.pl/wss/service/PZGIK/PodstawowaOsnowaGeodezyjnaPozioma>
- <http://mapy.geoportal.gov.pl/wss/service/PZGIK/PodstawowaOsnowaGeodezyjnaWysokosciowa>
- <http://mapy.geoportal.gov.pl/wss/service/PZGIK/OsnowaGrawimetryczna>
- <http://mapy.geoportal.gov.pl/wss/service/PZGIK/OsnowaMagnetyczna>



*Thank You for attention...*