# The RING GPS network: a research geodetic infrastructure to study plate boundary deformation in the Central Mediterranean

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(* red people may not continue to work at INGV in the next future)

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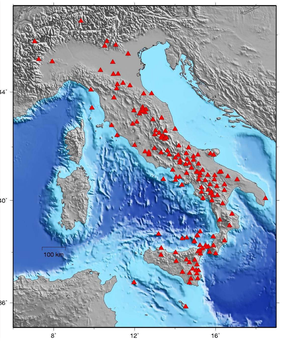
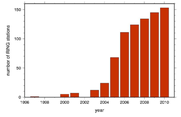
## The RING CGPS network infrastructure

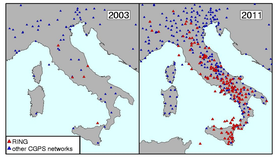


We present the INGV (Italian National Institute of Geophysics and Volcanology) geodetic research infrastructure and related facilities, dedicated to the observation and monitoring of current deformation of the plate boundary between Africa and Eurasia. The recent increase of continuous GPS (CGPS) stations in the Central Mediterranean plate boundary zone offers the opportunity to study in detail the present-day kinematics of this actively deforming region.

### RING growth from 2004 to 2011



For answering all the open questions related to this complex area, INGV deployed a permanent, integrated and real-time monitoring CGPS network (RING) all over Italy. The RING network (http://ring.gm.ingv.it) is now constituted by more than 150 stations.




### The RING CGPS network quality

#### Monument types

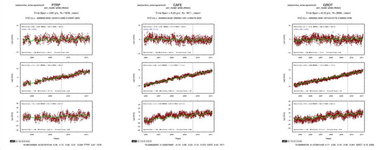
All stations have high quality GPS monuments and most of them are co-located with broadband or very broadband seismometers and strong motion sensors.

*Wyatt-Agnew short drilled braced (monument foundation = 1.5 m)*

*Deep reinforced concrete pillar (monument foundation = 8 m)*

*Steel rod on building (the Grottaminarda castle)*

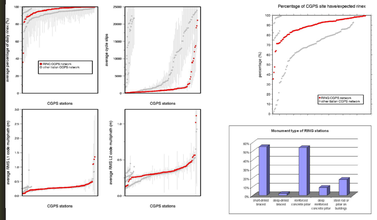
*Co-located CGPS and seismic station*

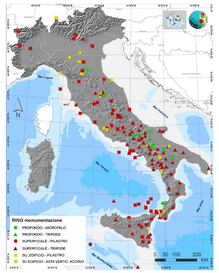


*Typical free field seismic and CGPS site*

### RING network with respect to other non-scientific Italian network

Efforts made on site and instrumentation selection result in good raw GPS data quality, with respect to commercial networks



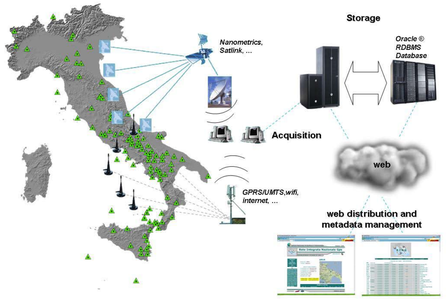


*RING by monument type*

## Data acquisition and management infrastructure

The RING CGPS sites acquire at 1Hz and 30s sampling rates (some of them acquire at 10 Hz) and are connected in real-time to the INGV acquisition centers located in Roma and Grottaminarda. Real-time GPS data are transmitted using different systems, such as satellite systems, Internet, GPRS/UMTS and wireless networks. The differentiation of data transmission type and the integration with seismic instruments makes this network one of the most innovative CGPS networks in Europe.

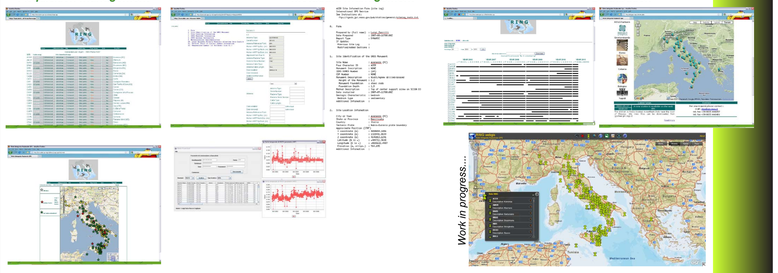
*RING by data transmission type*




### DB management Infrastructure

To manage data acquisition, storage, distribution and access we developed dedicated facilities including new softwares for data acquisition and a web-based collaborative environment for management of data and metadata.

*Acquisition management* *Metadata management* *Distribution*

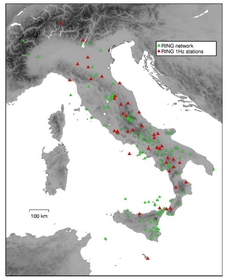



### Regional cadastral CGPS networks that contribute to RING Infrastructure

The INGV data acquisition centers acquire, archive and analyze most of the Italian CGPS stations managed by regional or national data providers (such as local Authorities and nation-wide industries), integrating more than 350 stations of the CGPS scientific and commercial networks existing in the Italian region.

*For red regions, 30s rinex from cadastral networks will be distributed through the RING web infrastructure*

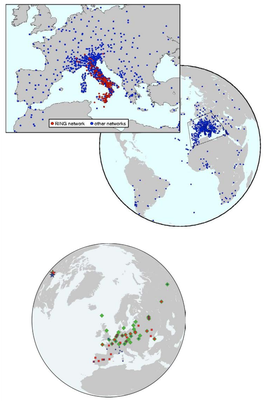
*Commercial and cadastral networks contributing to RING infrastructure*



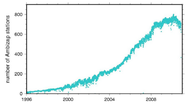

*1Hz transmitting RING stations contribute to RTK positioning of national and regional data providers*

## GPS data analyis infrastructure

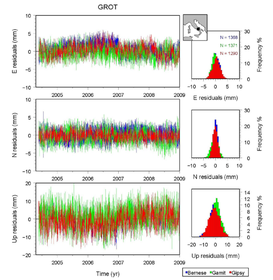
The GPS analysis is carried out with the three main geodetic-quality softwares used in the GPS scientific community: Bernese GAMIT an GIPSY-OASIS. The resulting daily solutions are aligned to the ITRF2005 reference frame. Stable plate reference frames are realized by minimizing the horizontal velocities at sites on the Eurasia and Nubia plates, respectively.



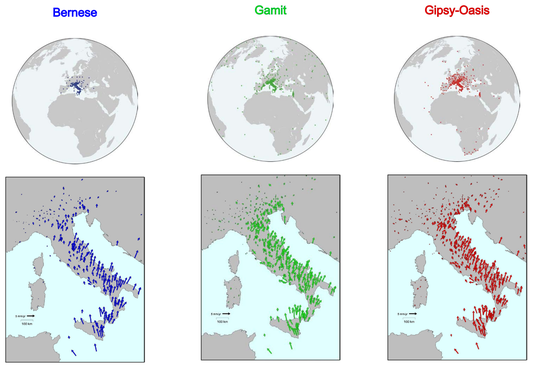
*Reference frame CGPS stations for the bernese (blue), Gamit (green) and Gipsy (red) solutions*

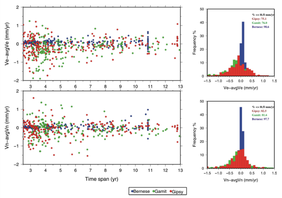


*cumulative number of analyzed CGPS at the INGV analysis centers*



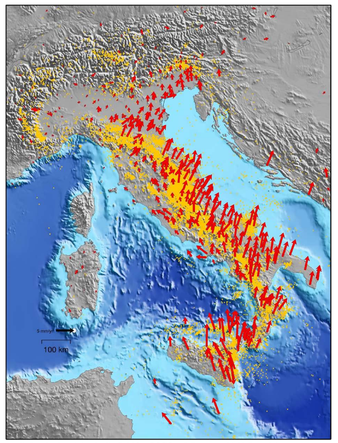

*residuals of GROT time series from Bernese, Gamit and Gipsy-Oasis solutions*



The different software-related solutions consistency RMS is within 0.3 mm/yr (Avallone et al., 2010). The solutions are then evaluated with regard to the numerous scientific motivations behind this presentation, ranging from the definition of strain distribution and microplate kinematics within the plate boundary, to the evaluation of tectonic strain accumulation on active faults.

## GPS data analyis results



*Italian horizontal velocity field for CGPS > 2.5 years old. Yellow dots represent crustal seismicity (data from http://side.rm.ingv.it)*

The RING network is strongly contributing to the definition of GPS velocity field in the Italian region, and now is able to furnish a newly and up to date view of this actively deforming part of the Nubia-Eurasia plate boundary. INGV is now aiming to make the RING (and integrated CGPS networks) data and related products publicly available for the scientific community. We believe that our network represents an important reality in the framework of the EPOS infrastructure and we strongly support the idea of an European research approach to data sharing among the scientific community. We will present (a) the current CGPS site distribution, (b) the technological description of the data acquisition, storage and distribution at INGV centers, (c) the results of CGPS data analysis, and (d) the planned data access for the scientific community.

### RING main references: http://ring.gm.ingv.it

*Avallone A., G. Selvaggi, E. D'Anastasio, N. D'Agostino, G. Pietrantonio, F. Riguzzi, E. Serpelloni, M. Anzidei, G. Casula, G. Cecere, C. D'Ambrosio, P. De Martino, R. Devoti, L. Falco, M. Mattia, M. Rossi, F. Obrizzo, U. Tammaro and L. Zarrilli (2010). The RING network: an improvement of the GPS velocity field in the Central Mediterranean area, Annals of Geophysics, 51 (2).*

*Cecere, G. (2007), La piattaforma tecnologica di gestione dati e informazioni della Rete Integrata Nazionale GPS (RING), Rapporti Tecnici INGV, n. 52.*

*D'Agostino, N., A. Avallone, D. Cheloni, E. D'Anastasio, S. Mantenuto & G. Selvaggi (2008), Active tectonics of the Adriatic region from GPS and earthquake slip vectors, J. Geophys. Res., 113, B12413, doi:10.1029/2008JB005860.*

*D'Ambrosio, C. (2007), Variazione costruttiva applicata a monumentazioni, del tipo "Short-Drilled Braced, per stazioni GPS permanenti, Rapporti Tecnici INGV, n. 46.*

*Devoti R., F Riguzzi, M. Cuffaro & C. Doglioni (2008), New GPS constraints on the kinematics of the Apennines subduction, Earth Planet. Sci. Lett. 273, 163-174.*

*Falco, L. (2008), Implementazione e gestione di una rete di monitoraggio GPS e sismica mediante tecnologie GPRS/EDGE/UMTS/HSDPA, Rapporti Tecnici INGV, n. 69.*

*Memmolo, A., C. D'Ambrosio, F. Minichiello, V. Cardinale, E. D'Anastasio, A. Avallone, L. Falco, N. D'Agostino, G. De Luca, F. Criscuoli, A. Castagnozzi, F. Migliari, L. Zarrilli, L. Abruzzese and G. Cecere (2010), La rete GPS permanente di pronto intervento: l'esperienza del terremoto de L'Aquila del 6 Aprile 2009, Rapporti Tecnici INGV, n. 162.*

*Minichiello, F., A. Memmolo and C. D'Ambrosio (2010), 4EVO: Sviluppo del tripode short-drilled-braced dell'INGV per le reti GPS permanenti, Rapporti Tecnici INGV, n. 149.*

*Selvaggi, G., Mattia M., Avallone A., D'Agostino N., Anzidei M., Cantarero M., Cardinale V., Castagnozzi A., Casula G., Cecere G., Cogliano R., Criscuoli F., D'Ambrosio C., D'Anastasio E., DE Martino P., DEL Mese S., Devoti R., Falco L., Galvani A., Giovani L., Hunstad I., Massucci A., Minichiello F., Memmolo A., Migliari F., Moschillo R., Obrizzo F., Pietrantonio G., Pignone M., Pulvirenti M., Rossi M., Riguzzi F., Serpelloni E., Tammaro U. & Zarrilli L. (2006), La Rete Integrata Nazionale GPS (RING) dell'INGV: un'infrastruttura aperta per la ricerca scientifica, X Conferenza ASITA, Bolzano, Atti Vol. II, 1749-1754.*

*Serpelloni, E., Perfetti, P. & Cavaliere A. (2009), Progettazione e realizzazione di un computer-cluster per l'analisi dati GPS con i software GAMIT e GOCA, Rapporti Tecnici INGV, N. 93, pp. 18.*

*Serpelloni, E., M. Anzidei, P. Baldi, G. Casula, & A. Galvani (2005), Crustal velocity and strain rate fields in Italy and surrounding regions: New results from the analysis of permanent and non-permanent GPS networks, Geophys. J. Int., 161, 861–880, doi:10.1111/j.1365-246X. 2006.06218.x.*