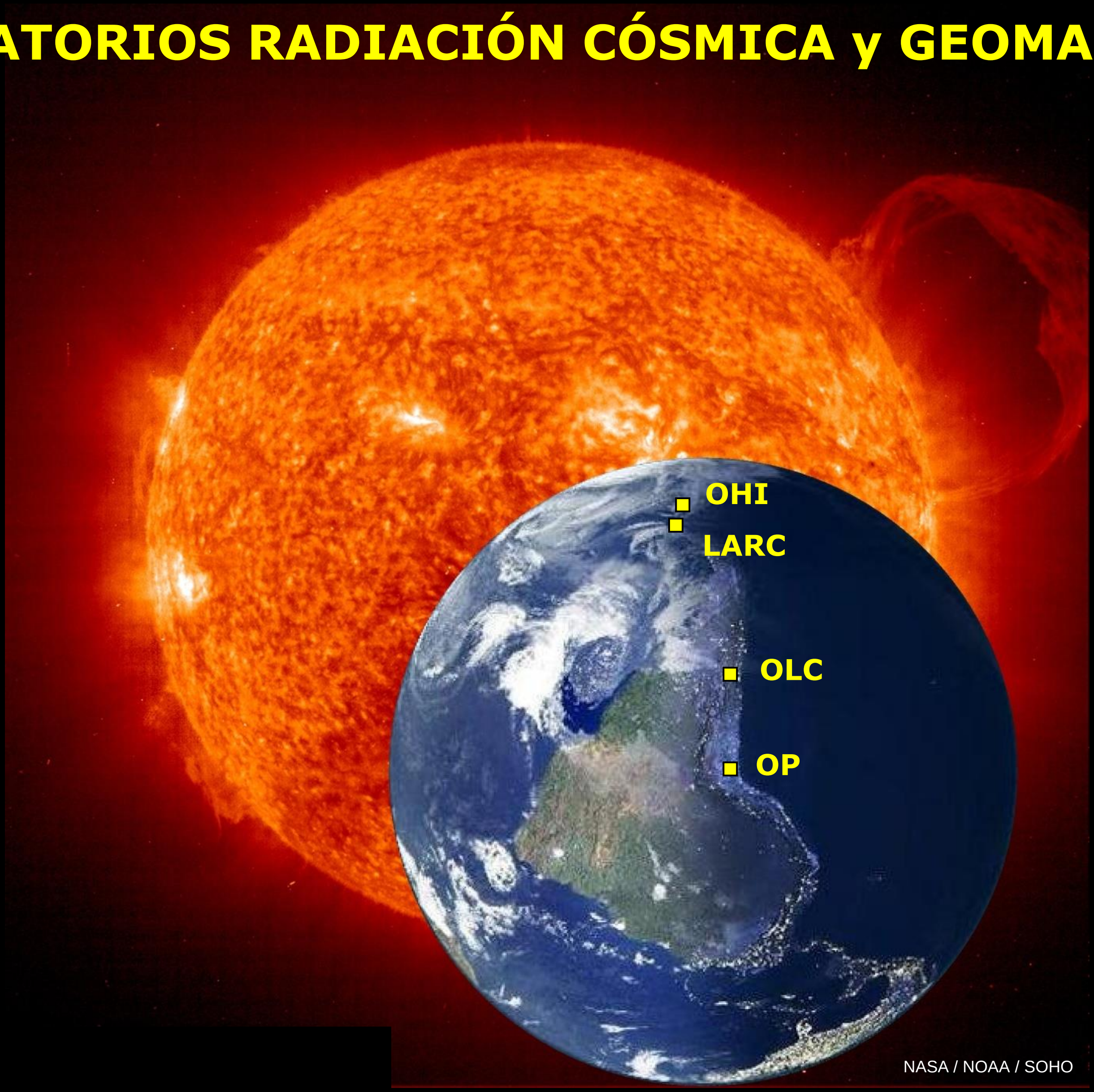
REPÚBLICA de CHILE

OBSERVATORIOS RADIACIÓN CÓSMICA y GEOMAGNETISMO



Consorcio Física Sol – Espacio interplanetario – Tierra - Atmósfera

About Geomagnetism, Cosmic Rays, Tectonic plates and Earthquake research in the . South Pacific Region coast of Chile

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Presentation in SAMA-IMAG meeting: D. Gálvez and E. G. Cordaro

We have presented the main characteristics of cosmic radiation observatories and magnetometers Chilean network in the Southern Hemisphere. We give their locations, the atmospheric-depth, the types of detectors, andthe geomagnetic rigidity cut. This network allows us to explore and study the dynamics of the inner Earth, its magnetic field, as well as the immediate environment outside the space and its relations with the different phases of solar activity and anisotropy of cosmic rays.

OBSERVATORIOS RADIACIÓN CÓSMICA y GEOMAGNETISMO

- **LARC** – Antártica. King George Island. Base E. Frei. 1991.
- **OHI** – Península Antártica. Base O'Higgins. 2004.
- **OLC** – Los Cerrillos. Santiago de Chile. 1948.
- **OP** – Putre. XV Región Arica y Parinacota. 2003.

LARC: Observatorio Antártico Radiación Cósmica y Geo magnetismo.

en Base Antártica “Pdte. E. Frei” Fuerza Aérea de Chile

Monitores de neutrón

6NM64-BF3-CL

3NM64-He3-CL

3NM64-He3-IT

UChile/Inach/FACH

Colaboración Chile-Italia.

Magnetómetro Themis Fluxgate

Colaboración UChile – UCLA - USA

Coordenadas geográficas: 62.20 S   301.03 E

Corte de rigidez geomagnético: 2.71 [GeV] (IGRF 2010)

Altitud: 40 m.s.n.m.

OHI: Estación geomagnética

en Base Antártica “Gral. B. O’Higgins” del Ejército de Chile.

Magnetómetro SMALL Fluxgate

Colaboración UChile – UCLA - USA

Coordenadas geográficas: 63.32 S 302.09 E

Corte de rigidez geomagnético: 2.45 [GeV] (IGRF 2010)

Altitud: 13 m.s.n.m.

In two of these observatories of *Putre* (OP) and of *Los Cerrillos* (OLC), we have measured the values of the South Atlantic magnetic anomaly. Also we have made the spatiotemporal comparison with the same variables in Antarctica Observatory (LARC).The magnetometer arrays SAMBA and the equipment installed in all Chilean Cosmic Ray Observatories cover more than 5.101 km of the Southern Cone. We have used the model of IGRF11/2010 geomagnetic stations and have calculated the trajectories and the geomagnetic rigidity for particles incident vertically from a height of 20 km. Each measurement is indicated with a discrimination pitch of 0.01 GeV.

OLC: Observatorio Radiación Cósmica y G eo magnetismo Los Cerrillos en Planta IDIEM. Depto. Física. FCFM Universidad de Chile

Monitor de neutrones

6NM64-BF3

UChile/IFSI/CNR URoma3

Colaboración Chile-Italia.

Telescopio Multidireccional

de muones. 7 canales.

UChile.

Magnetómetro Themis Fluxgate

Colaboración UChile – UCLA - USA

Coordenadas geográficas: 33.49 S   289.28 E

Corte de rigidez geomagnético: 9.53 [GeV] (IGRF 2010)

Altitud: 570 m.s.n.m.

OP: Observatorio Radiación Cósmica y Geo magnetismo Putre en Centro Internacional Estudios Andinos - INCAS UChile

Monitor de neutrones

3NM-IGY-He3

Telescopio Unidireccional

de muones. 3 canales.

UChile.

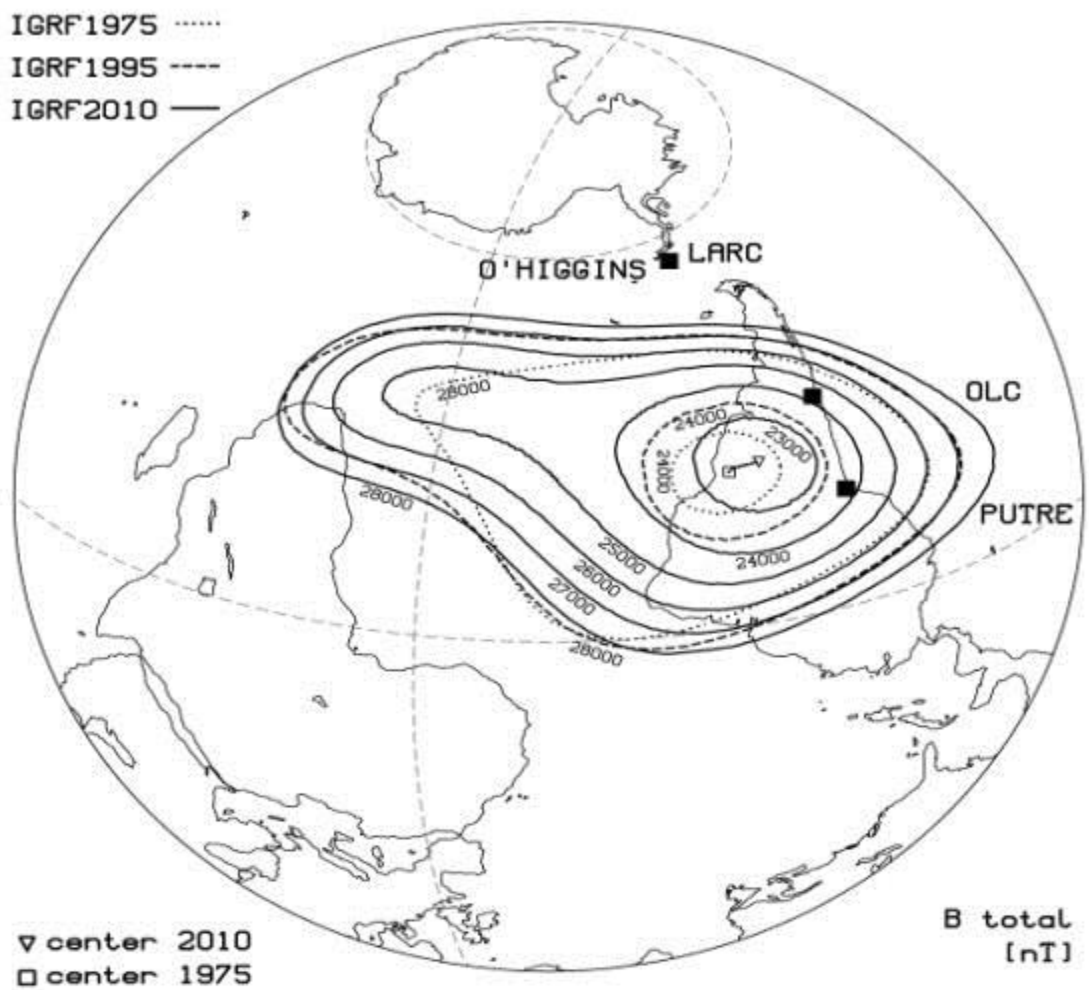
Magnetómetro SMALL Fluxgate

Colaboración UChile – UCLA - USA

Coordenadas geográficas: 18.19 S 290.44 E

Corte de rigidez geomagnético: 11.73 [GeV] (IGRF 2010)

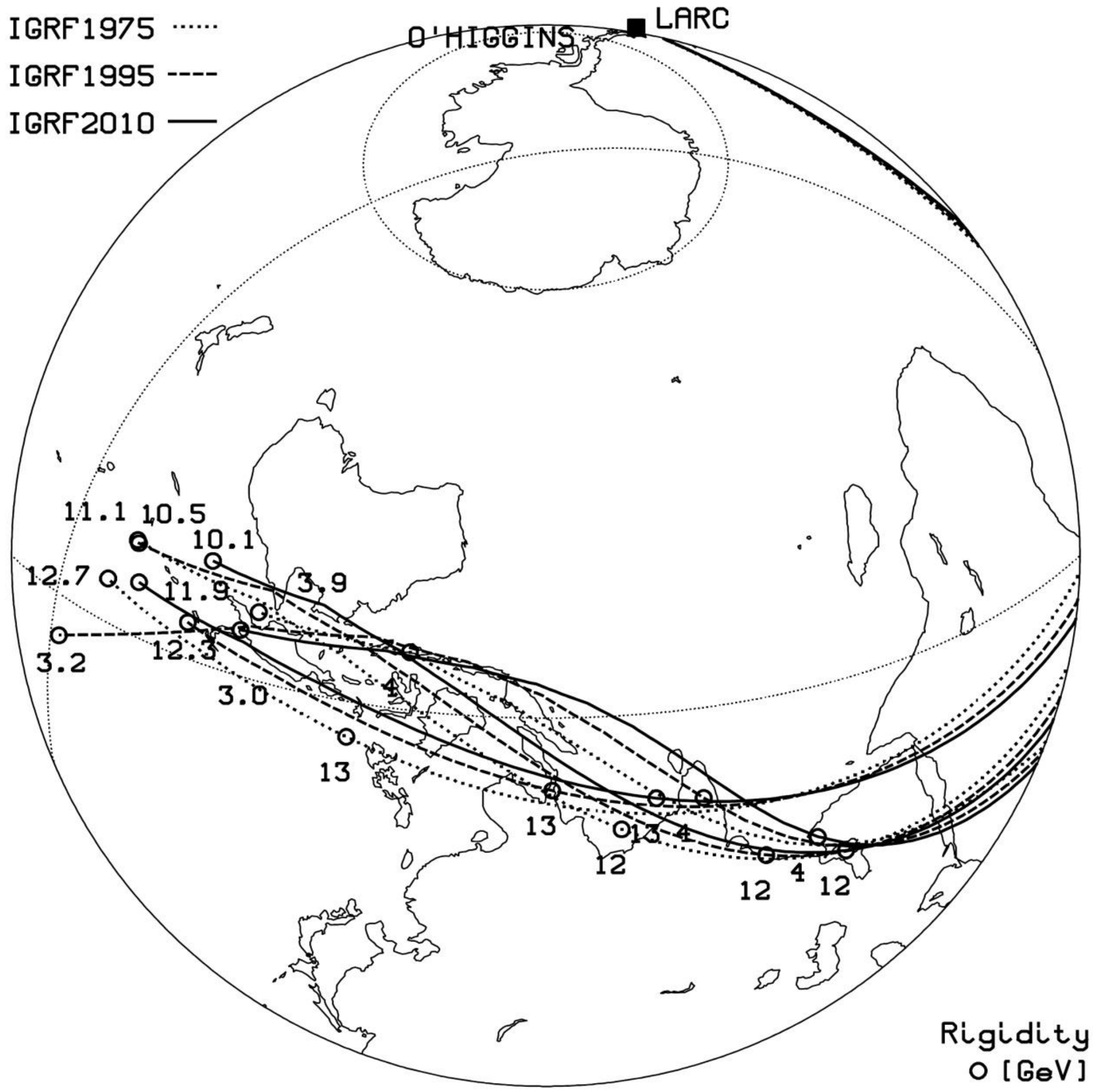
Altitud: 3598 m.s.n.m.



Map of the variability of geomagnetic field intensity of SAMA.

Combining of model of Shea and Smart, Ge3eant4/Magnetocosmic applications(REF 15)and the model of Tsyganenk and Usmanov for external magnetospheric (Ref 26) (over a grid of geographical coordinates from 18º to 80º South latitude and from 65º to 75 º west longitude for a period 1955 to 2010)we have obtained a map of the variability of geomagnetic field intensity of SAMA. Also, we have monitored the asymptotic arrival directions of particles and the secular variation of magnetic field intensity.

Correlations between geomagnetic jerk and the magnetic field have made with the data of the observatories of OP, of OLC, of LARC and the O'Higgins Station which is located in the Eastern Pacific Ocean sector in the southern hemisphere. The values obtained in OP and OLC magnetometers between 2003 and 2012are consistent with the theoretical values obtained for Atlantic Magnetic Anomaly. The values derived from the rate of change of the geomagnetic rigidity cut along the Hemisphere match with some specific locations of plate tectonic sand their unions in Pacific sector.



Direcciones asintóticas de ingreso de partículas a Observatorios R.C y Mag en sector del mar Pacifico en costas de Chile y valores del Corte de Rigidez.

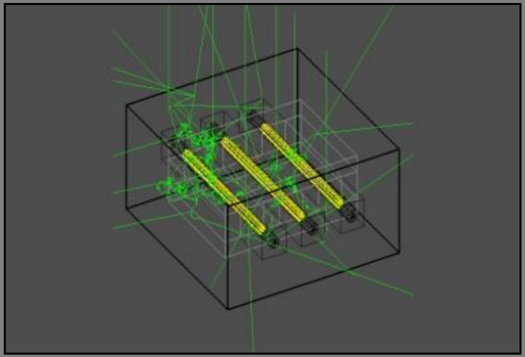
Monitored the asymptotic arrival directions of particles, that arrived to Putre, Los Cerrillos and Antarctic Observatories and magnetospheric O´Higgins Base

Metodología de investigación y desarrollo (I+D)
Ingeniería diseño y gestión.
Física Sol-Tierra   Radiación cósmica solar y galáctica.

Diseño, simulación y construcción de prototipos.

Pruebas de funcionalidad.

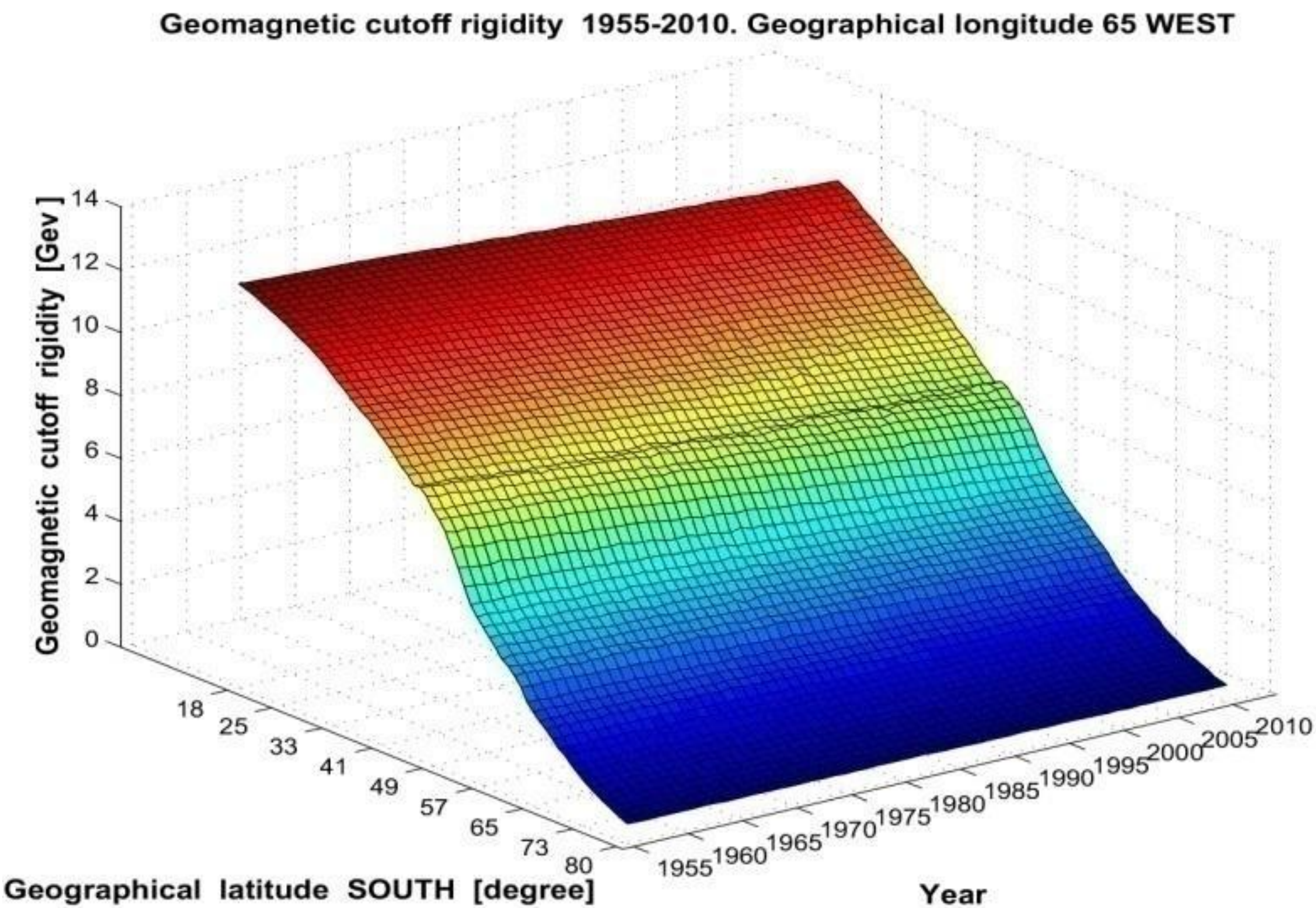
Diseño del sistema de adquisición de datos.



Calibración con observatorios de referencia. Mediciones terrestres, marítimas y en altura. Geomagnéticas y de radiación.

Puesta en marcha y operación continua.

Acceso a redes de comunicación en tiempo real.



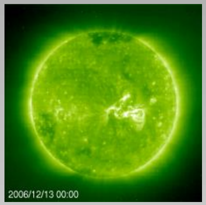
The values are derived from the geomagnetic rigidity cut along party hemisphere delivering some places with specific variation in the tectonic plate of sand from their unions in the Pacific sector.

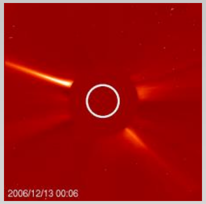
Correlations between geomagnetic jerk and the magnetic field have made with the data of the observatories of OP, of OLC, of LARC and the O'Higgins Station which is located in the Eastern Pacific Ocean sector in the southern hemisphere. The values obtained in OP and OLC magnetometers between 2003 and 2012are consistent with the theoretical values obtained for Atlantic Magnetic Anomaly. The values derived from the rate of change of the geomagnetic rigidity cut along the Hemisphere match with some specific locations of plate tectonic sand their unions in Pacific sector.

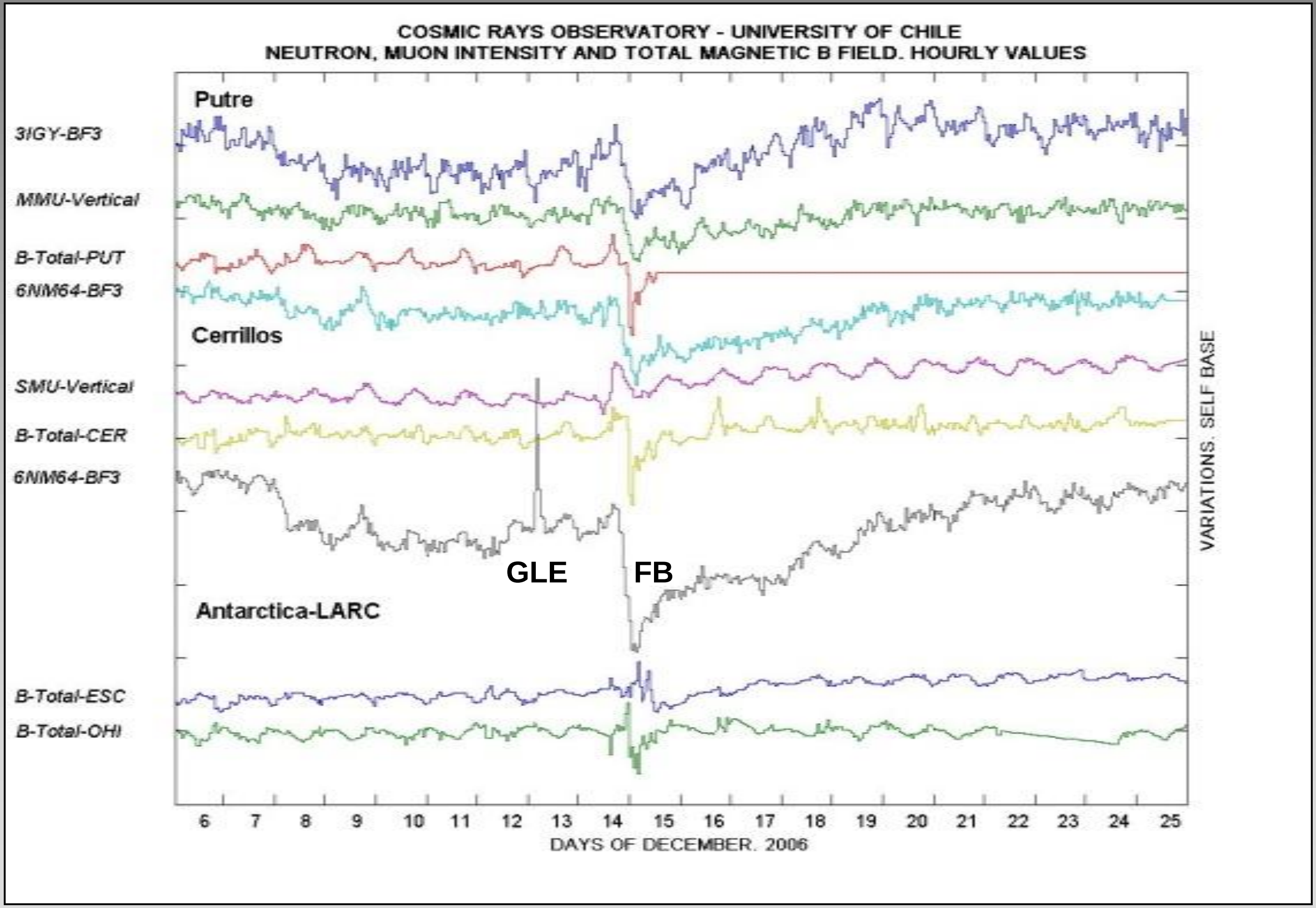
Moreover, we have presented a plot of the first and second derivative of the magnetic field on these locations. These derivatives are entirely consistent with the movement of tectonic plates. We have found that the changes of more than 5% in the Z component of the magnetic field, and it may indicate the existence of earthquakes with depths between 20 and 65 km. Finally, we have included a preliminary analysis of the magnetic field and their corresponding derivatives in the day of the last big earthquake (27.2. 2010).

Metodología de investigación y desarrollo (I+D)
Gestión de productos.
Física Sol-Tierra   Radiación cósmica solar, galáctica, Campo Magnético.

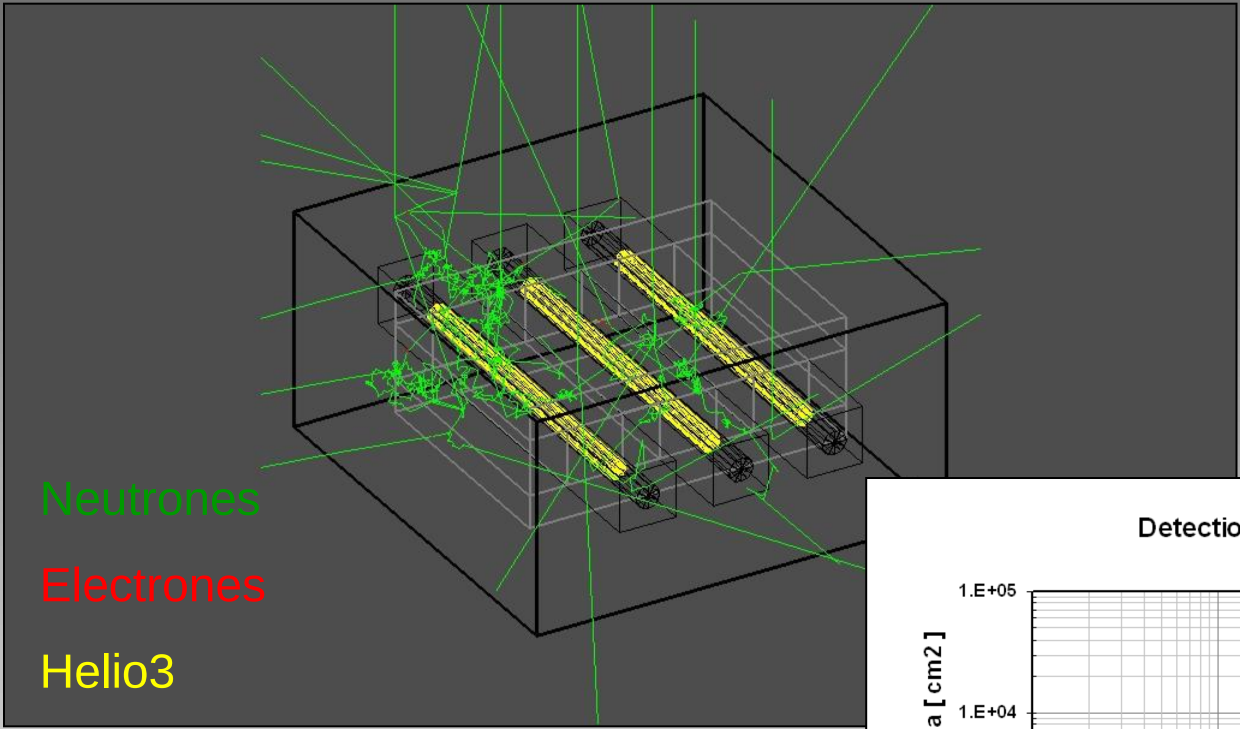
Evento de inyección de protones solares GLE, decrecimiento Forbush, Campo Magnetico. Medido en tiempo real desde Putre a la Antártica.Diciembre 2006.

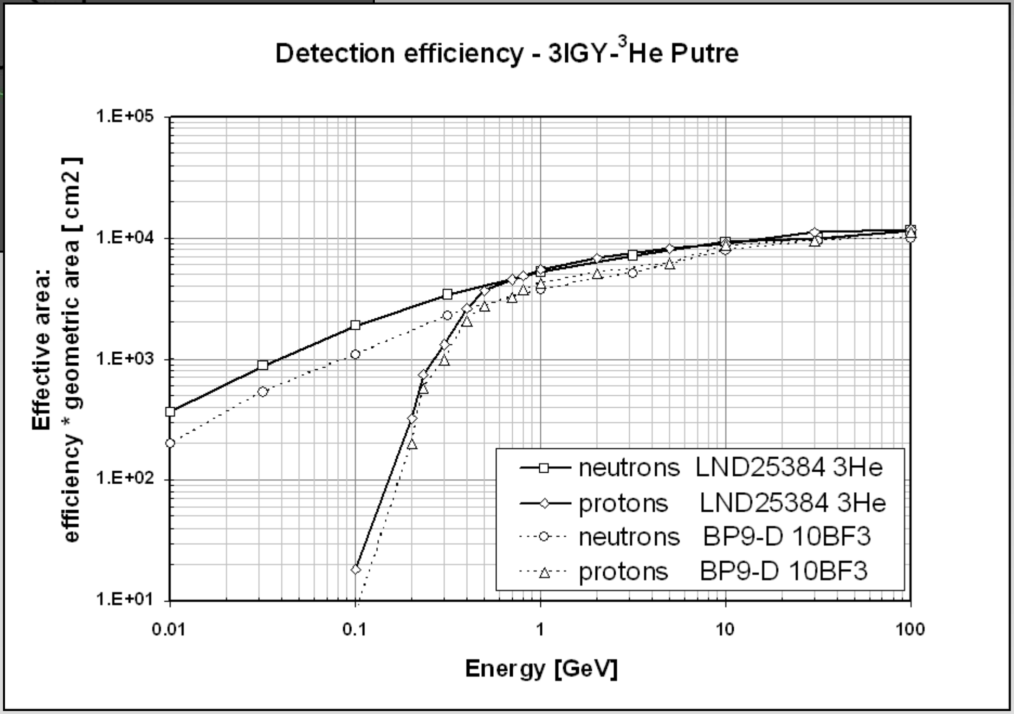






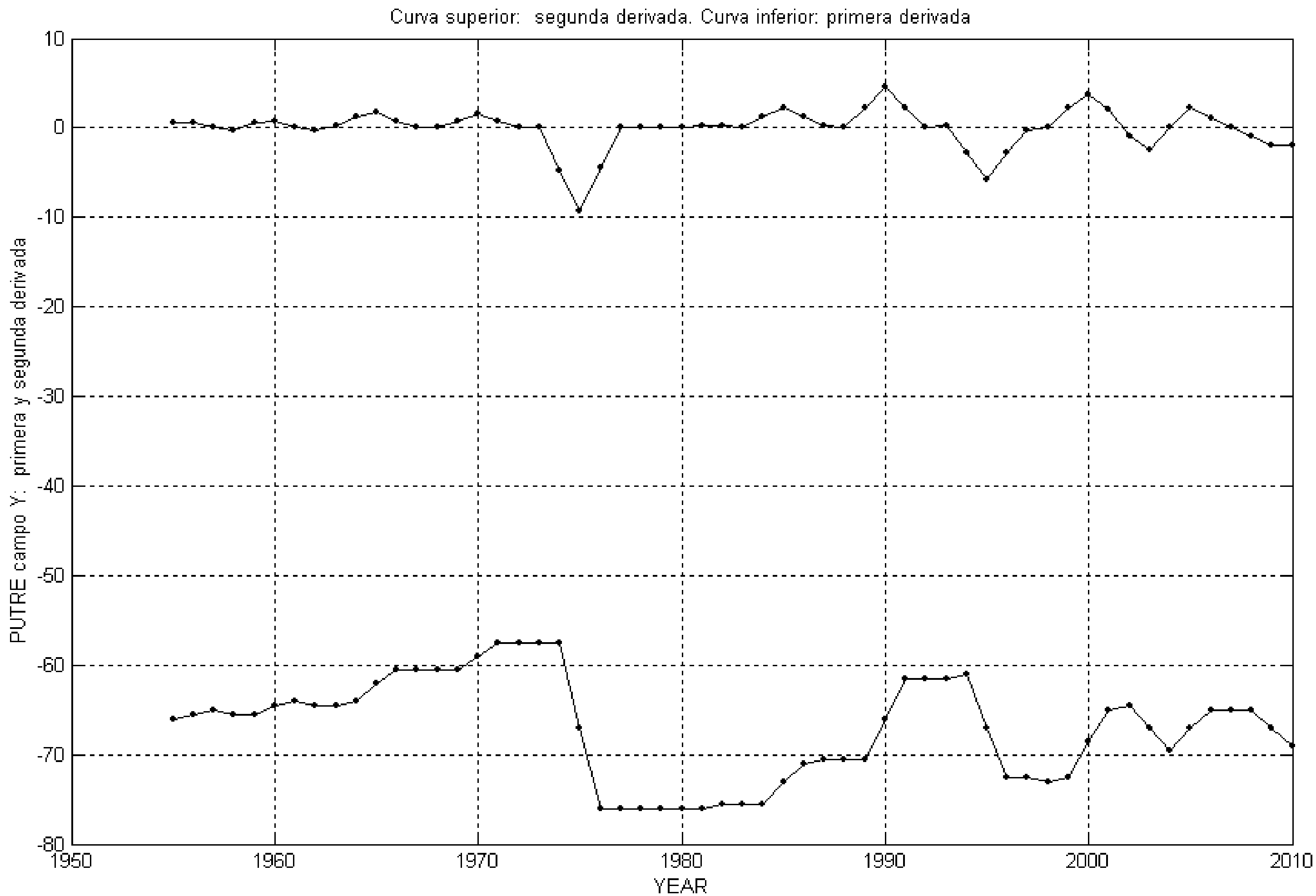
Modelo de simulación de partículas de alta energía y decaimiento radiactivo GEANT4, para monitor de neutrones 3NM-IGY-He3. Diseño calculado para maximizar la eficiencia en detección.





Referencia:

Cordaro, E.G., Olivares, E., Galvez, D., Salazar-Aravena, D., Laroze, D., “New 3He Neutron Monitor for Chilean Cosmic-Ray Observatories from the Altiplanic Zone to the Antarctic Zone”. Advances in Space Research 49 (2012),1670-1683



Plot of the first and second derivative of the magnetic field Y component in PUTRE Observatory from 1950 to 2010.

Etapa de construcción y puesta en marcha. Monitor de neutrones Helio3. Flux meter LARC y OLC.

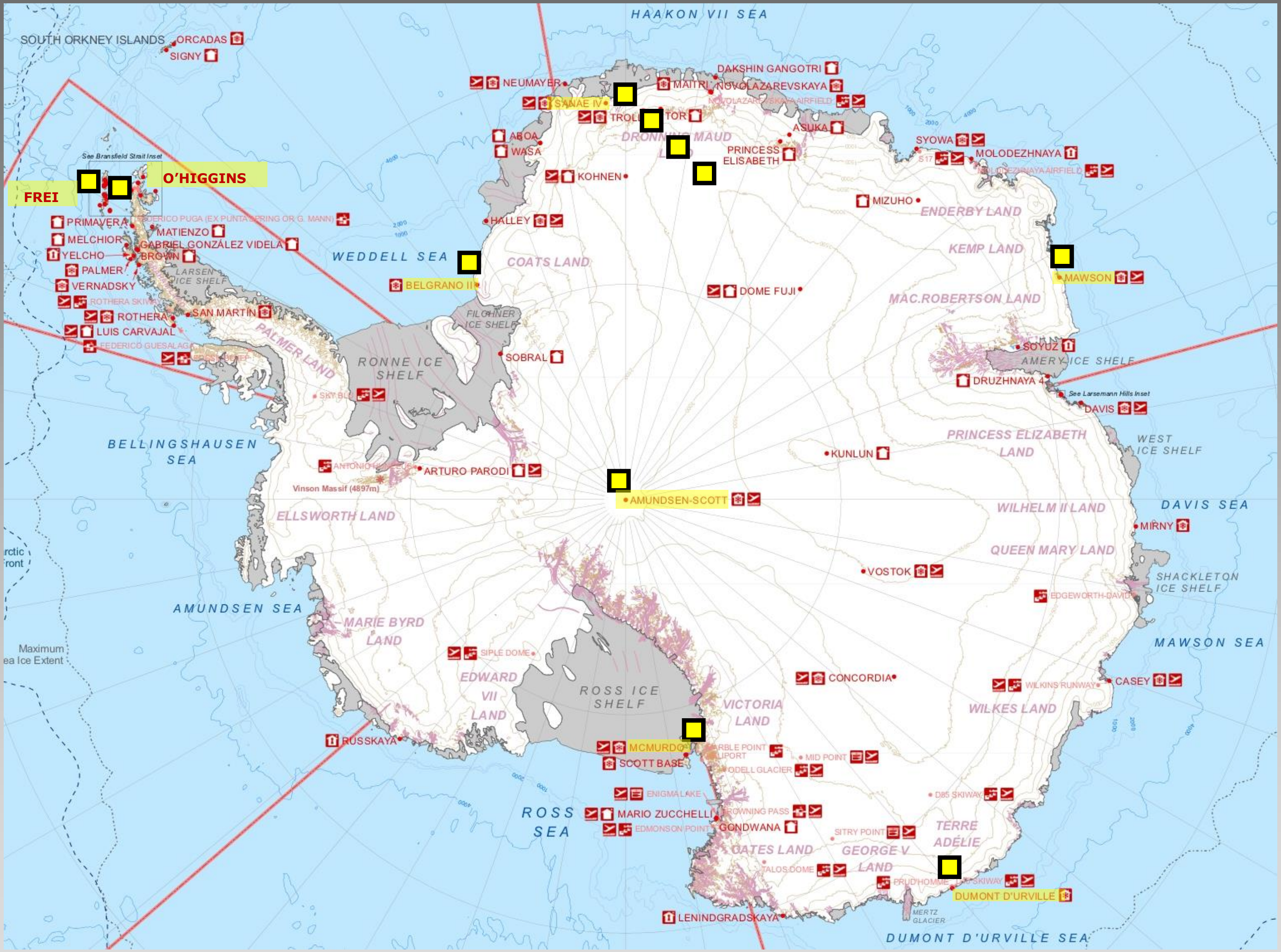
References.

Ref. 7: Cordaro. E.G., Laroze. D., Olivares. E.F., Galvez, D., Salazar. D. New 3He neutron monitor for Chilean cosmic rays observatories from Altiplanic zone to Antarctic zone. Advances in Space Research. 2012

Ref. 15: Smart and Shea to calculate the magnetic field using IGRF 1975 to 2010, and we used a Geant4/Magnetocosmics application [9] for the inner/external magnetospheric model.

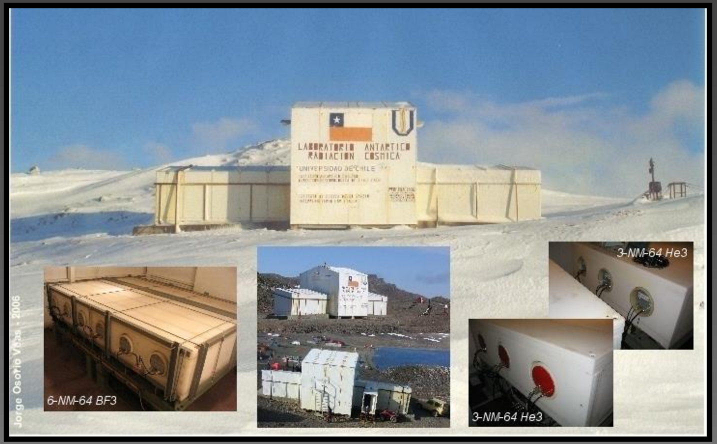
Ref. 26: (TSYGANENKO, N. A. and A. V. USMANOV, Determination of the magnetospheric current system parameters and development of experimental geomagnetic field models based on data from IMP and HEOS satellites, Planet. Space Sci.,30,985,1982.) External magnetic field

Mapa de estaciones antárticas. Monitores física Sol-Tierra y Magnetómetros (cuadro rojo solo magnetómetros)



Referencia: Council of Managers of National Antarctic Programs (COMNAP) 2011

Mapa de estaciones antárticas. Monitores física Sol-Tierra y Magnetómetros



Frei. Chile. 6NM64-BF3, 3NM64-He3, 3NM64-He3

O'Higgins. Chile. Magnetómetro