ORCA (Antarctic Cosmic Ray Observatory: 2018 latitudinal survey)

J.J. Blanco[1], O. García Población[1], J. I. García Tejedor[1], C. T. Steigies[3] , J. Medina[1], M. Prieto[1], A. López-Comazzi[1], S. Ayuso[1], R. Gómez-Herrero[1], J. A. Garzón[2], D. García-Castro[2], P. Cabanelas[2], A. Gomis-Moreno[5], V. Villasante-Marcos[5], B. Heber[3], A. Morozova[4], G. Kornakov[6], T. Kurtukian[7], A. Blanco[8], L. Lopes[8], J.P. Saravia[8], H. Kruger[9], Du Toit Strauss[9], V. G. Yanke[10]

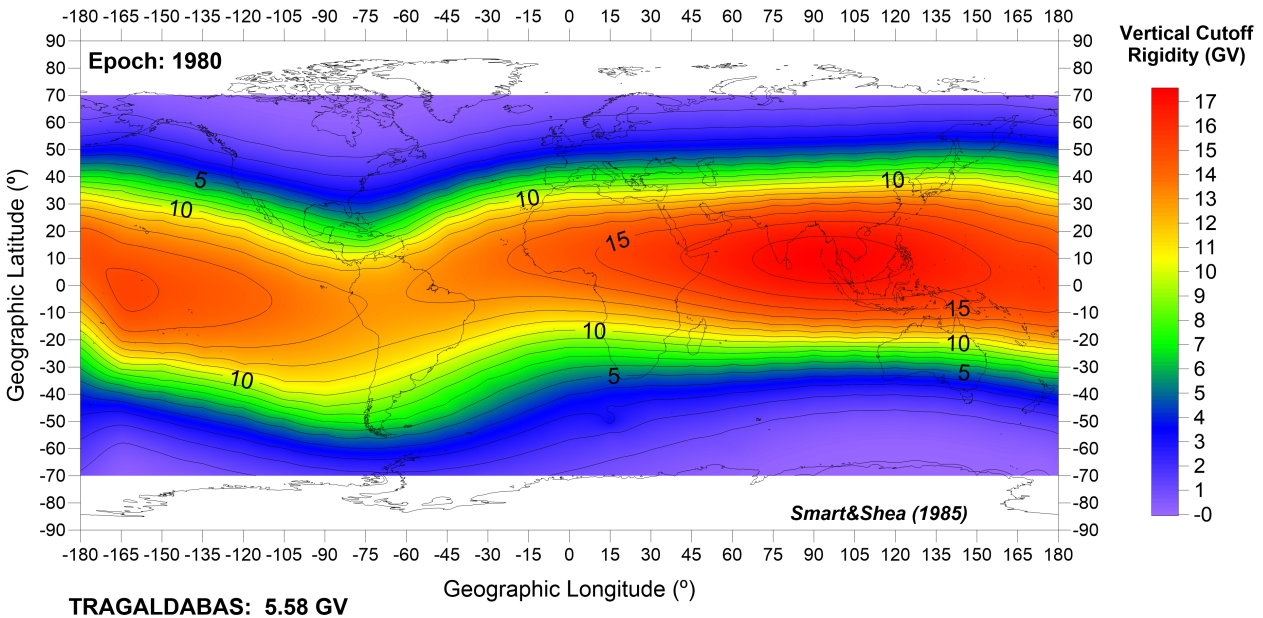
Co-authors and Institutes

J.J. Blanco[1], O. García Población[1], J. I. García Tejedor[1], C. T. Steigies[3] , J. Medina[1], M. Prieto[1], A. López-Comazzi[1], S. Ayuso[1], R. Gómez-Herrero[1], J. A. Garzón[2], D. García-Castro[2], P. Cabanelas[2], A. Gomis-Moreno[5], V. Villasante-Marcos[5], B. Heber[3], Anna Morozova[4], G. Kornakov[6], T. Kurtukian[7], A. Blanco[8], L. Lopes[8], J.P. Saravia[8], H. Kruger[9], Du Toit Strauss[9], V. G. Yanke[10].

[1]U. de Alcalá, Spain. [2]U. Santiago de Compostela, Spain. [3]IEAP, Christian Albrechts Universität zu Kiel, Germany. [4]CITEUC, Coimbra, Portugal. [5]Instituto Geográfico Nacional, Madrid, Spain.[6]TU-Darmstadt, Germany.[7]CEN-Bordeaux, France.[8]LIP-Coimbra, Portugal.[9]Center for Space Research, North-West University, South Africa. [10]Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation RAS (IZMIRAN), Moscow, Russia

1. Introduction
2. ORCA
3. Instruments
   - NEMO
   - MITO
   - TRISTAN
   - Minineutron monitor
4. Preliminary results
5. Conclusions

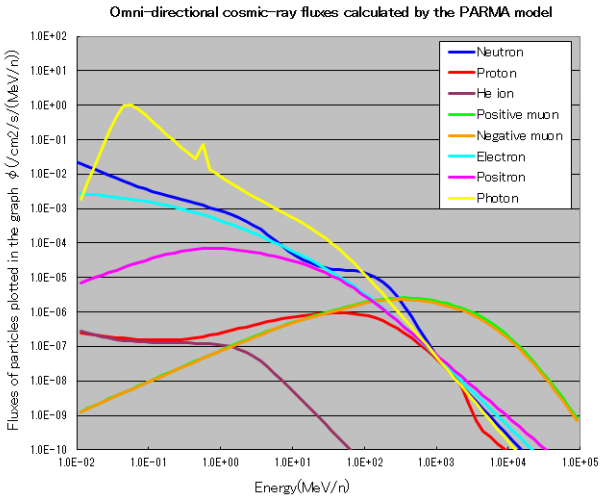
Smart & Shea (1985)



TRAGALDABAS: 5.58 GV

CaLMa: 6.71 GV

Sato (2015)



Latitudinal survey
check models
yield functions

multi-particle detector

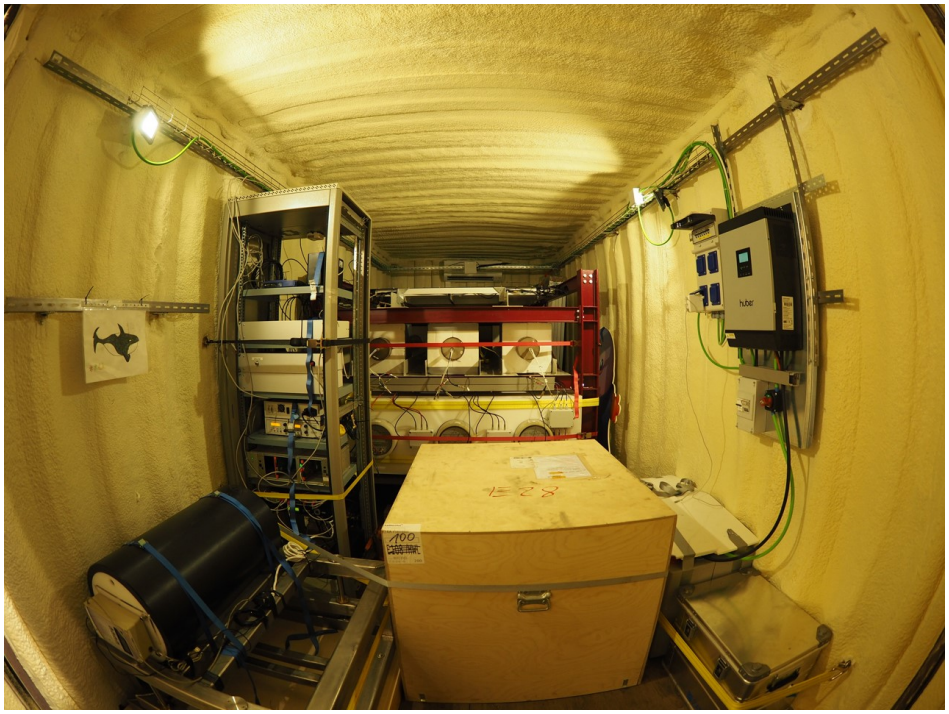
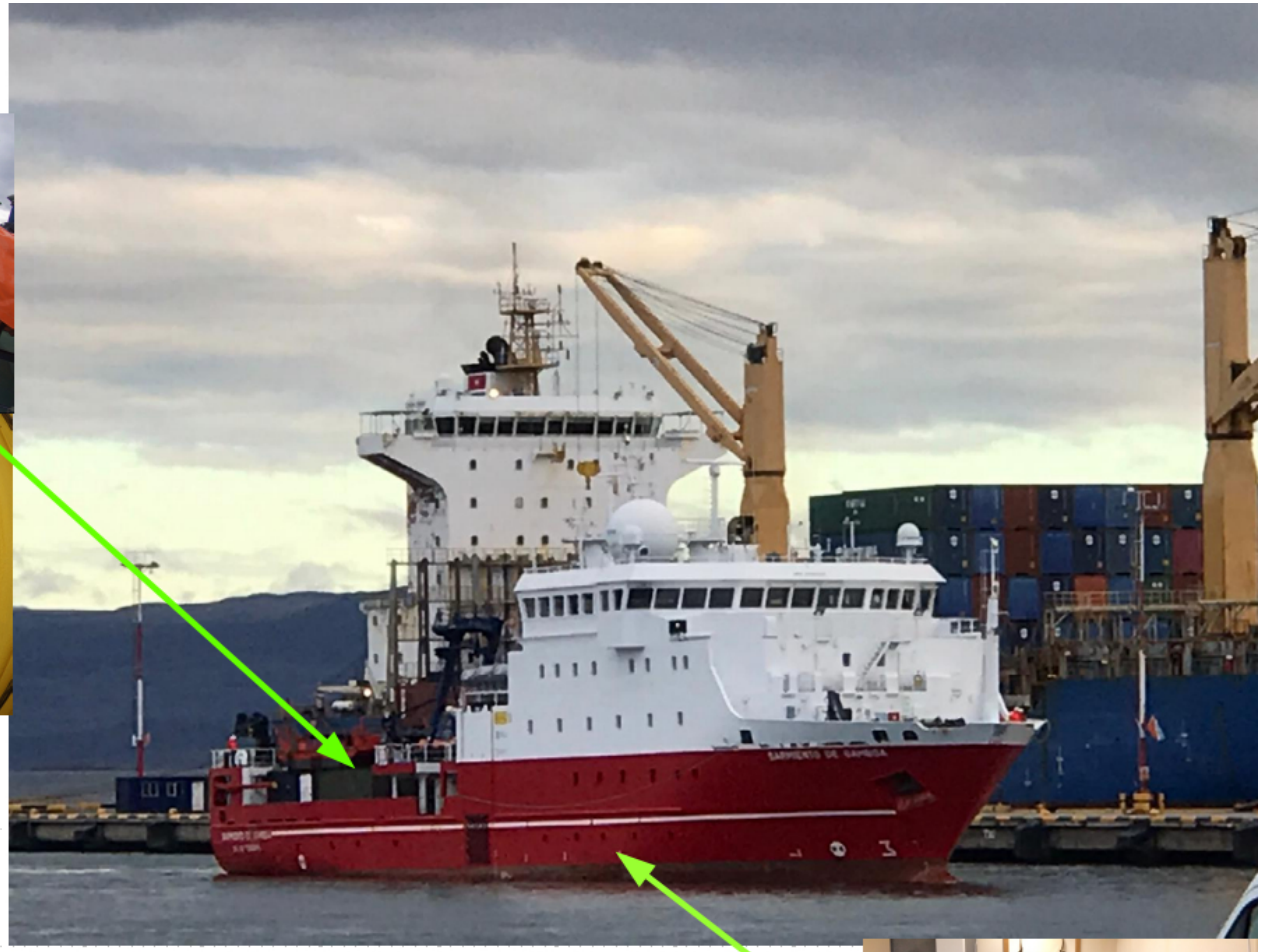


Figure: NEMO, MITO and mini neutron monitor in the container on Sarmiento de Gamboa′s deck.

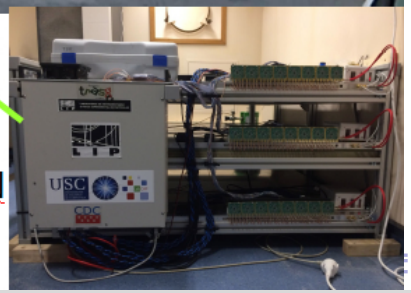
Figure: TRISTAN in the thermally controlled room under Sarmiento de Gamboa′s deck.

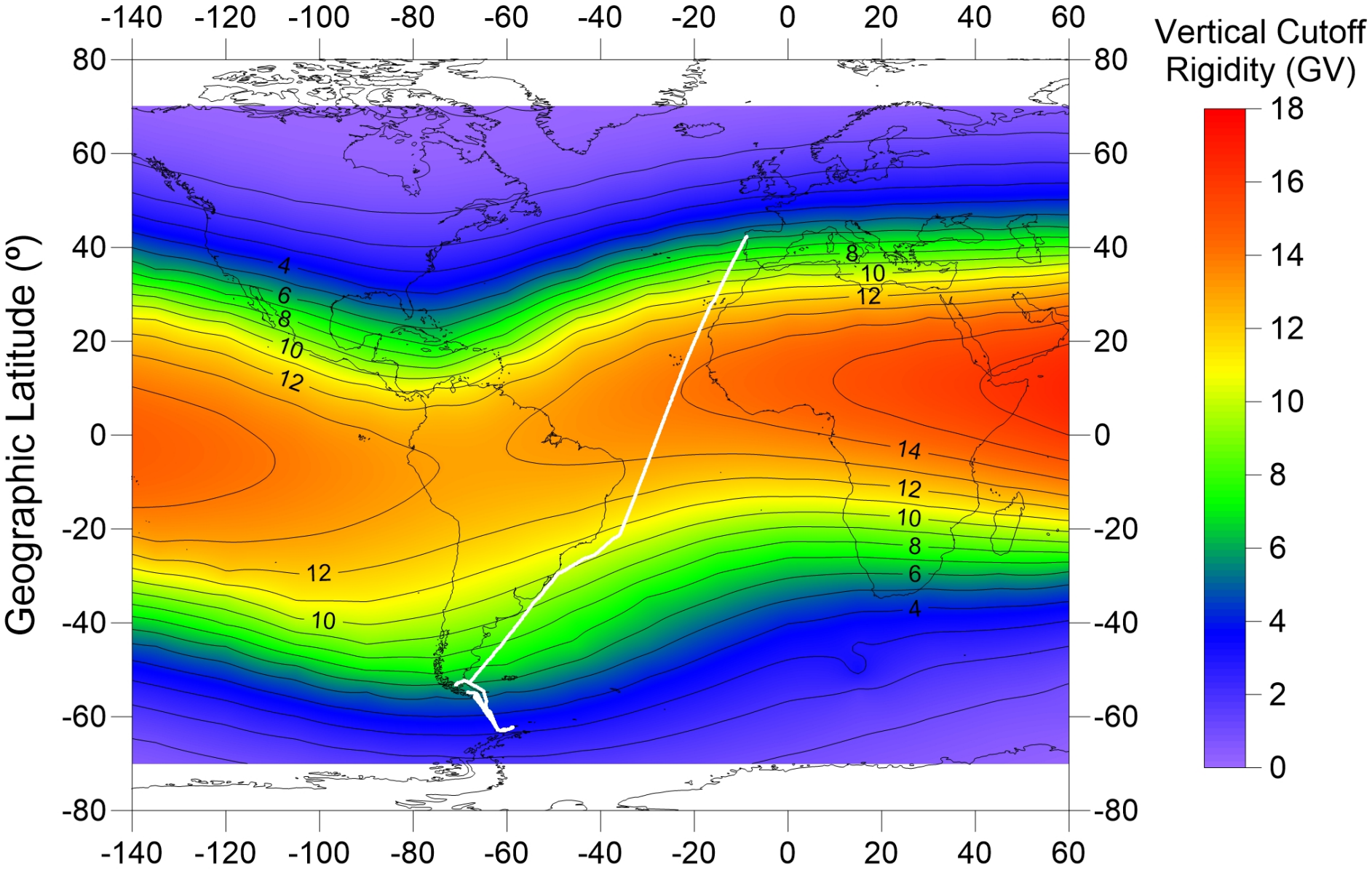
Nemo, MITO and mini-NM



Sarmiento de Gamboa

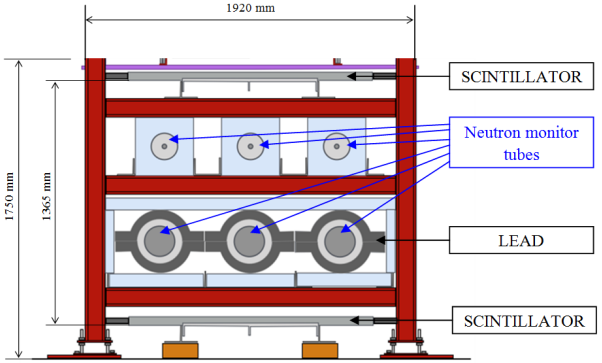
TRISTAN

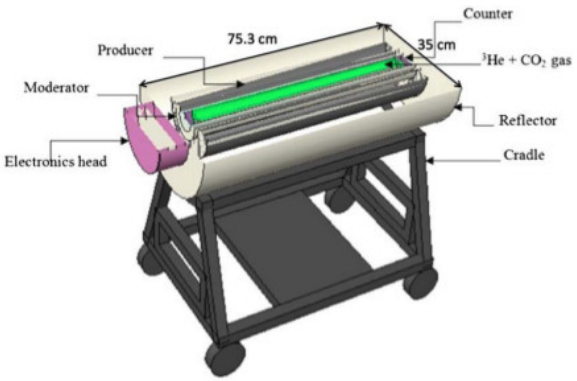


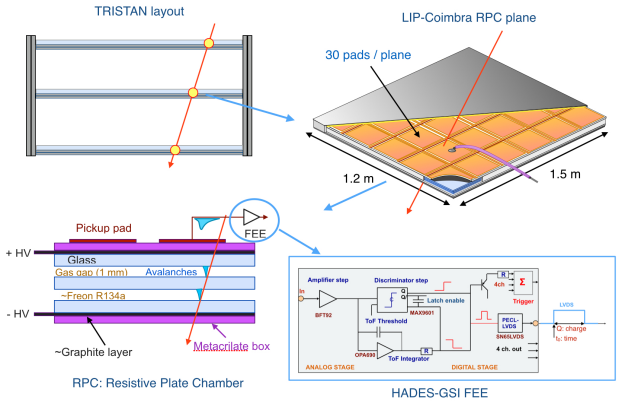

Vertical Cutoff Rigidity (GV)
Geographic Latitude (º)
-140 -120 -100 -80 -60 -40 -20 0 20 40 60
80 60 40 20 0 -20 -40 -60 -80
18 16 14 12 10 8 6 4 2 0
4 6 8 10 12
8 10 12
14 12 10 8 6 4
12 10

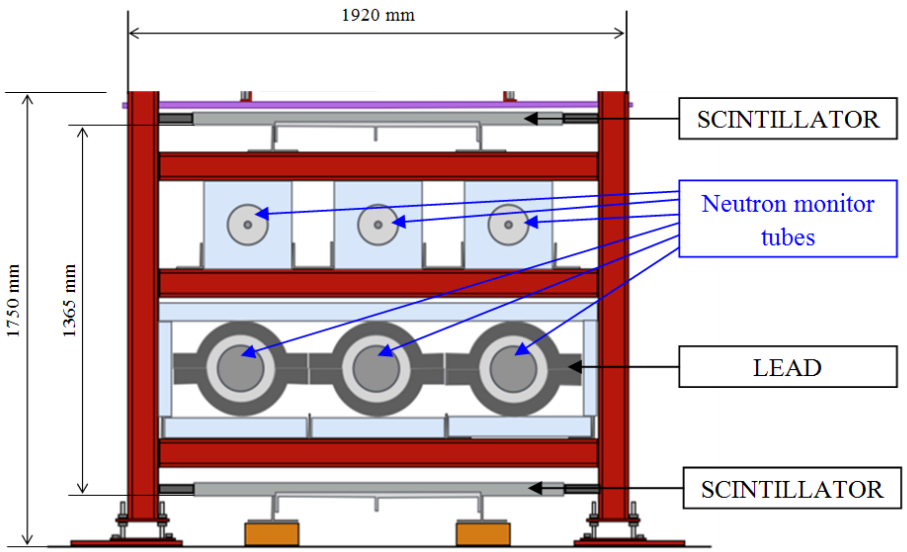
Sensor	Real Time	Directional information	Particle detection	Environmental corrections	Data survey	Trip
NEMO	Yes?	No	n	Yes: P	N42° to S62°	One way
MITO	No	Yes	μ	Yes: P/T/T_{lab}	N42° to S62°	One way
TRISTAN	No	Yes	μ , e-, γ	Yes: P/T/T_{lab}	N42° to S54°	Two-way
Mini-NM	No	No	n	Yes: P	N42° to S62°	One way
Vaisala	No	No	P, T, RH	No	N42° to S62°	One way

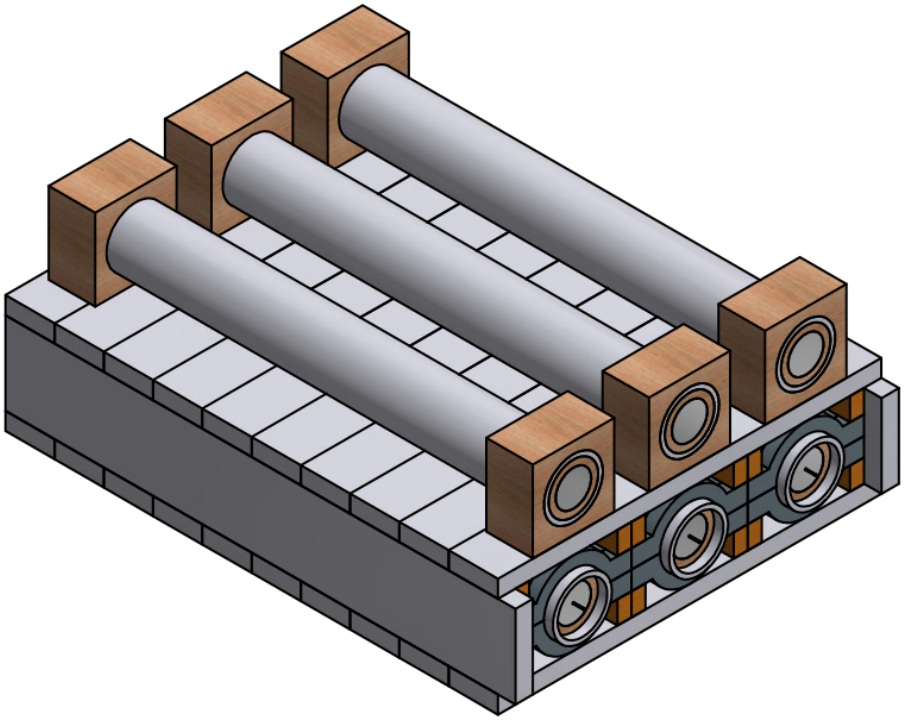
Table: ORCA sensors



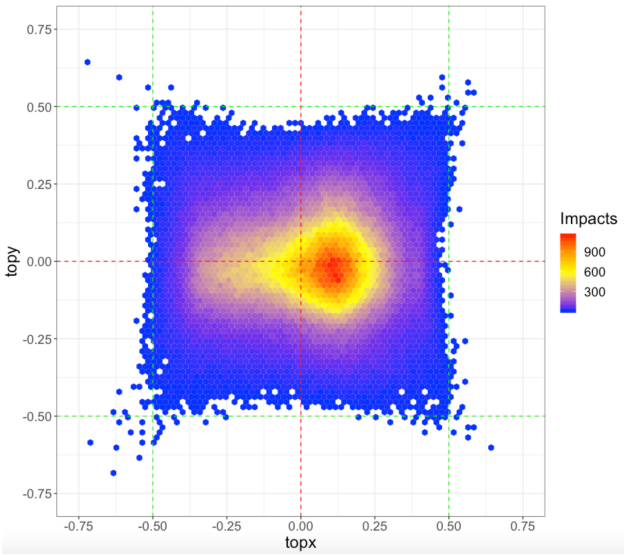




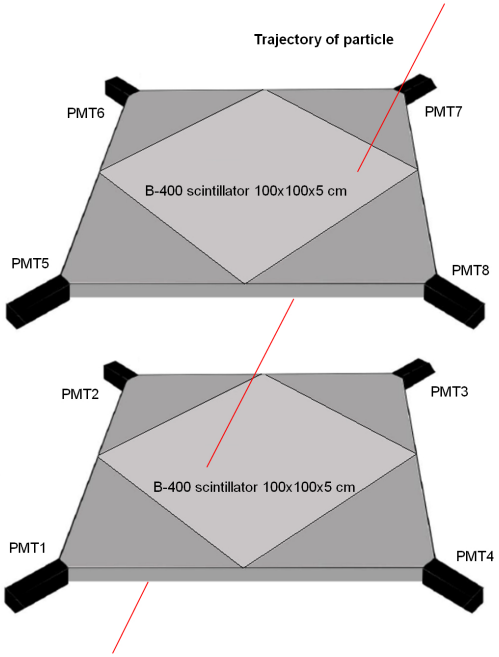




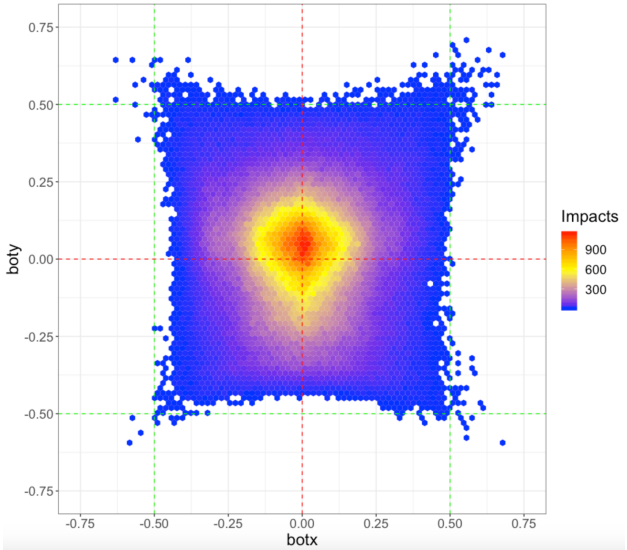
3NM64(ORCA)BP28 and 3BNM (ORCB)LND2061
neutrons
6 counters, 1min data



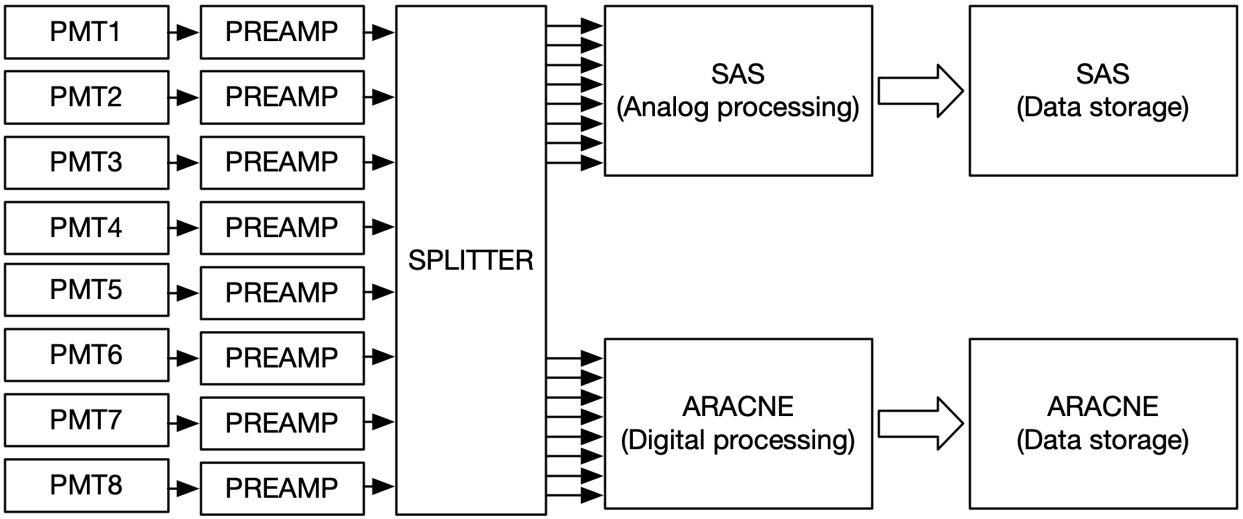
Coincidence channels: Top, Bottom , Coin8

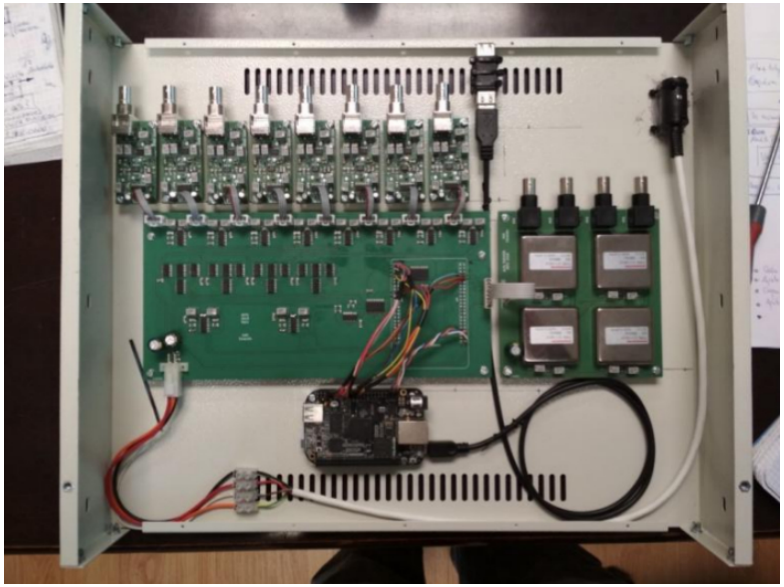


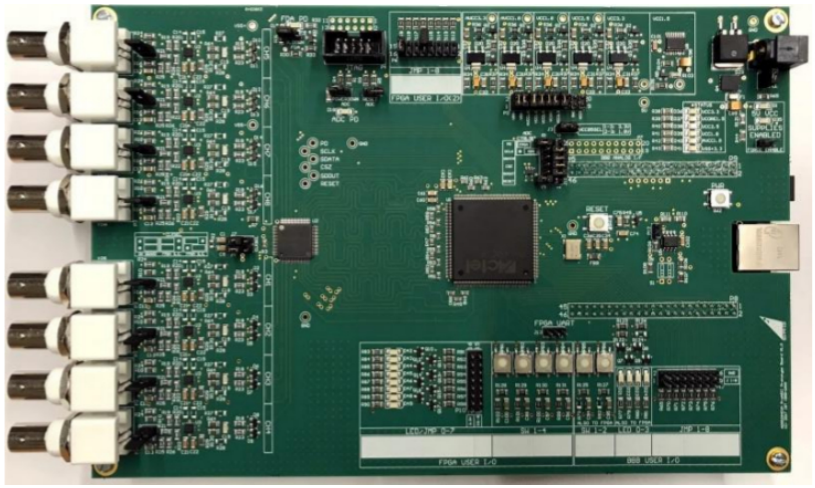
Particle trajectory

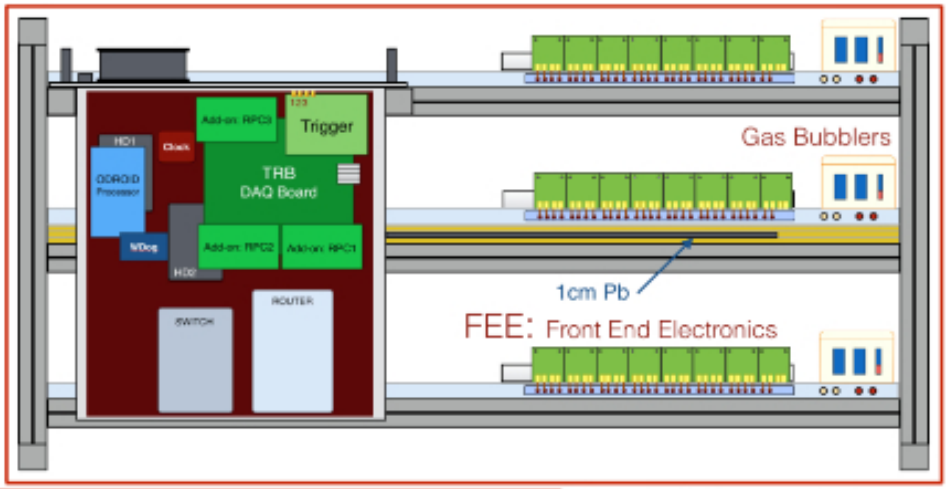


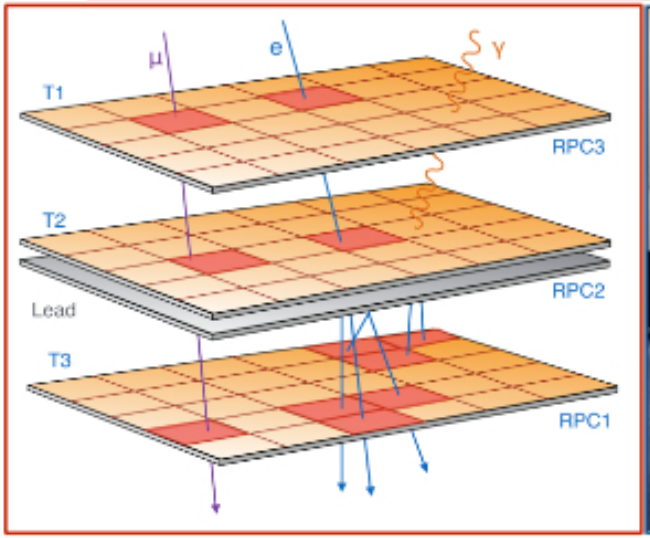
Impact point


PMT1
PMT2
PMT3
PMT4
PMT5
PMT6
PMT7
PMT8
PREAMP
SPLITTER
SAS
(Analog processing)
SAS
(Data storage)
ARACNE
(Digital processing)
ARACNE
(Data storage)



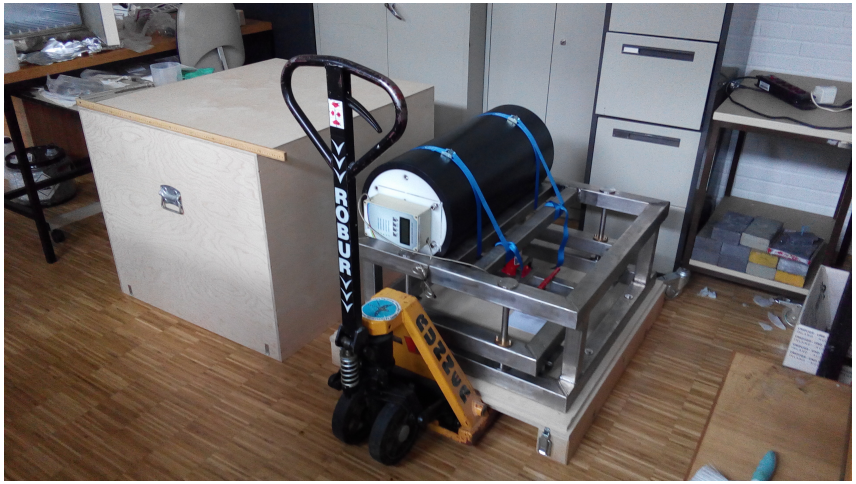


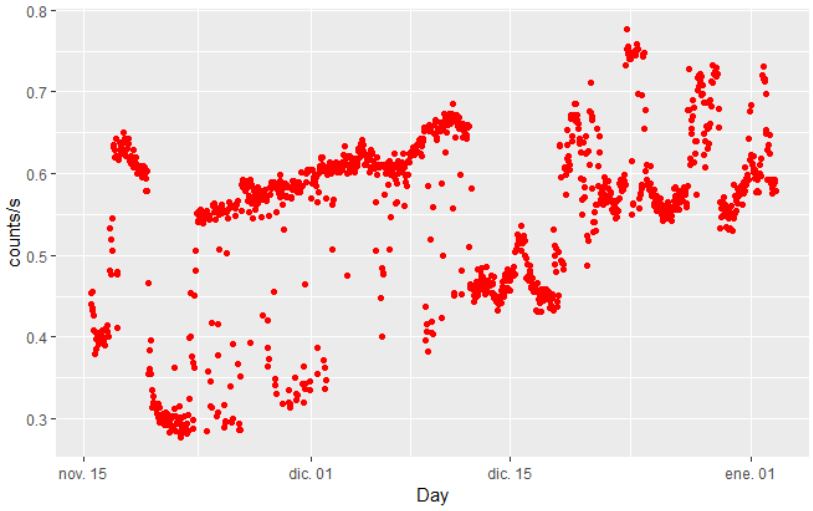




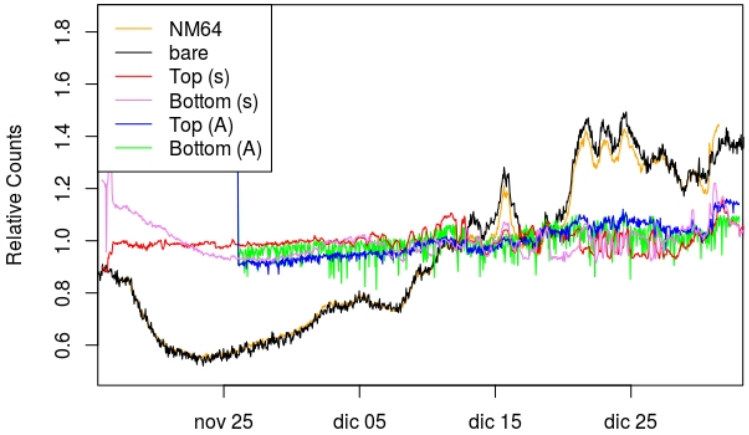
- TRISTAN is a multitrack detector
- 3 timing-RPC planes
- size: 1.50 x 1.20 m^2
- 90 read-out channels
- Performances

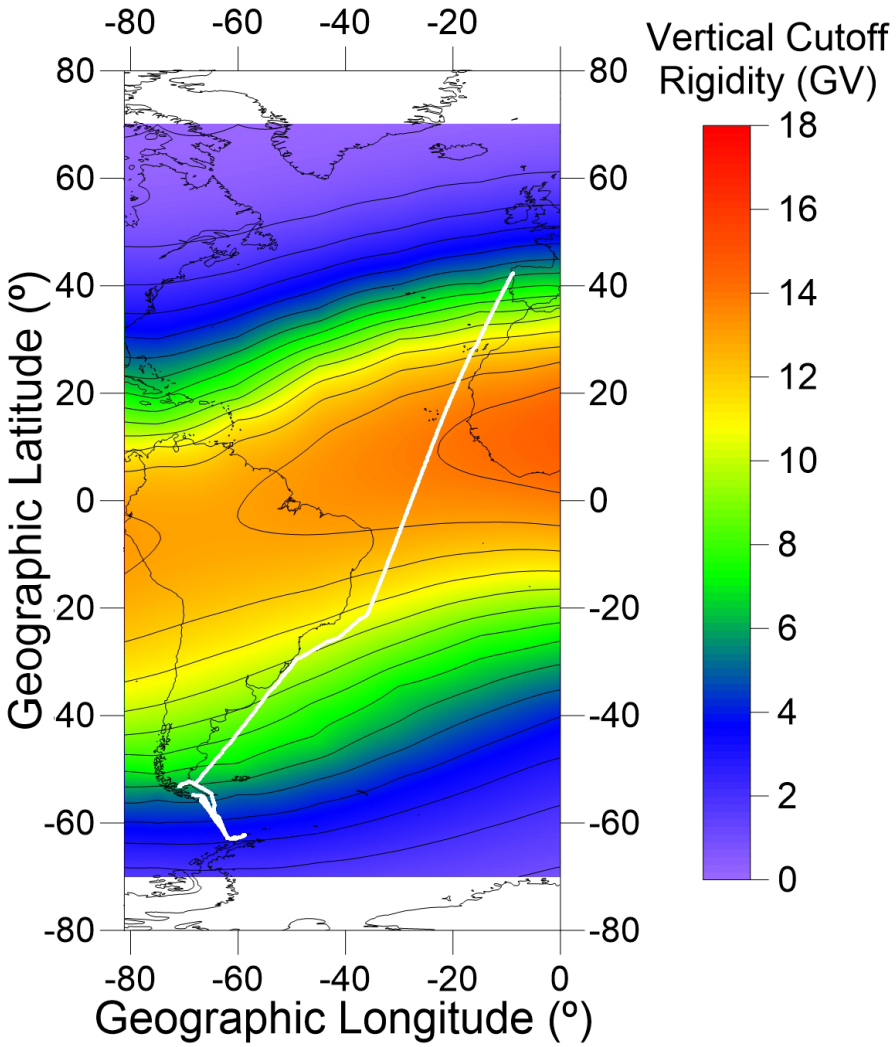
- $\sigma X = \sigma Y \sim 6.5cm$
- $\sigma\Omega = 0.1sr$
- $\sigma T = 0.3ns$
- Particle identification: μ, γ, e, p

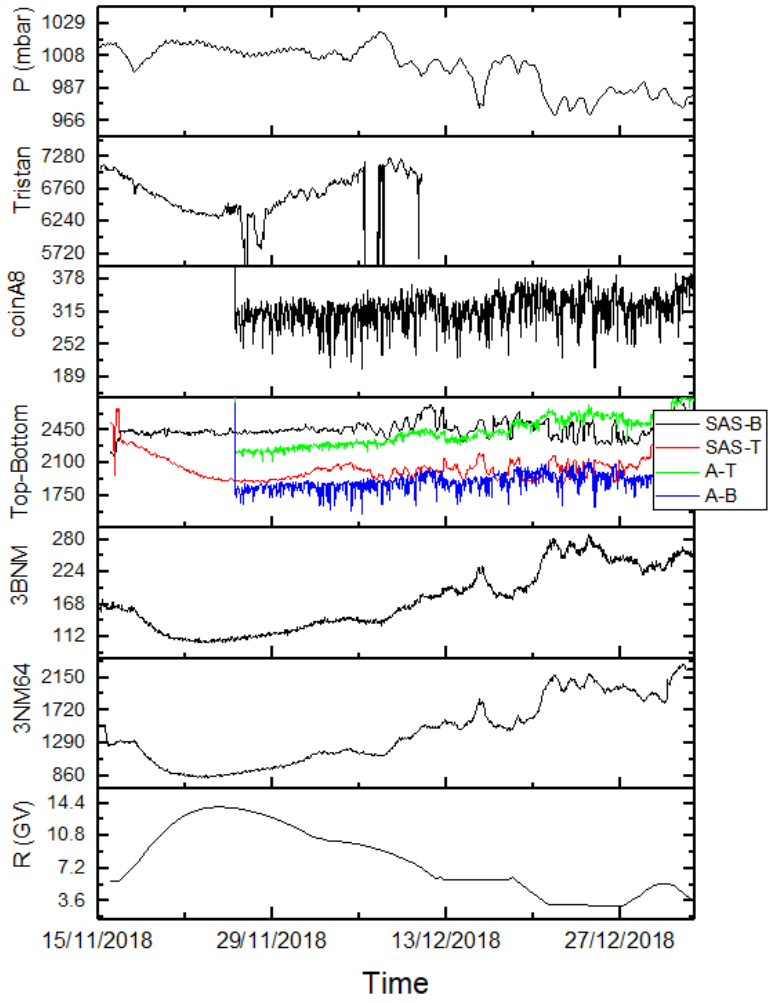


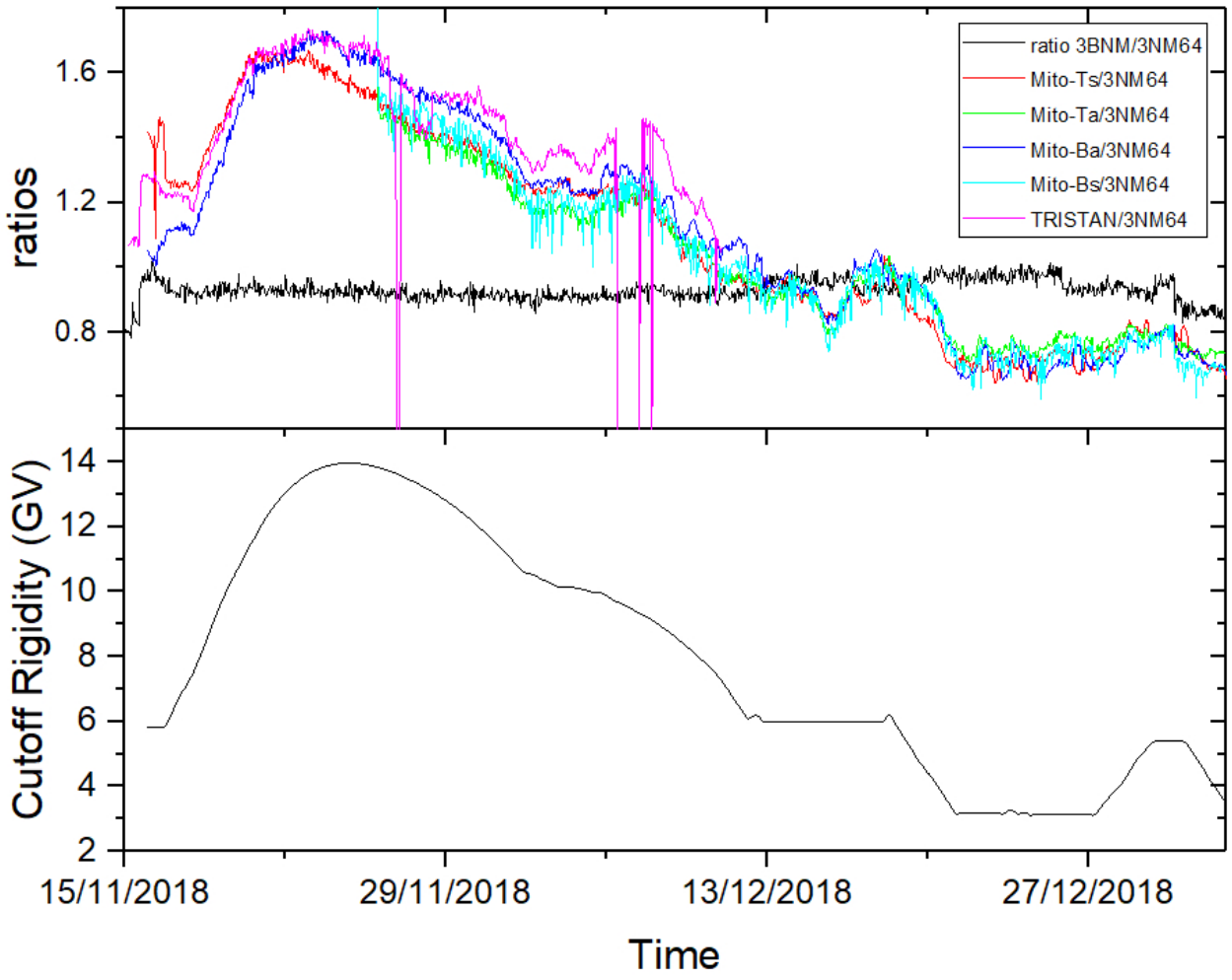


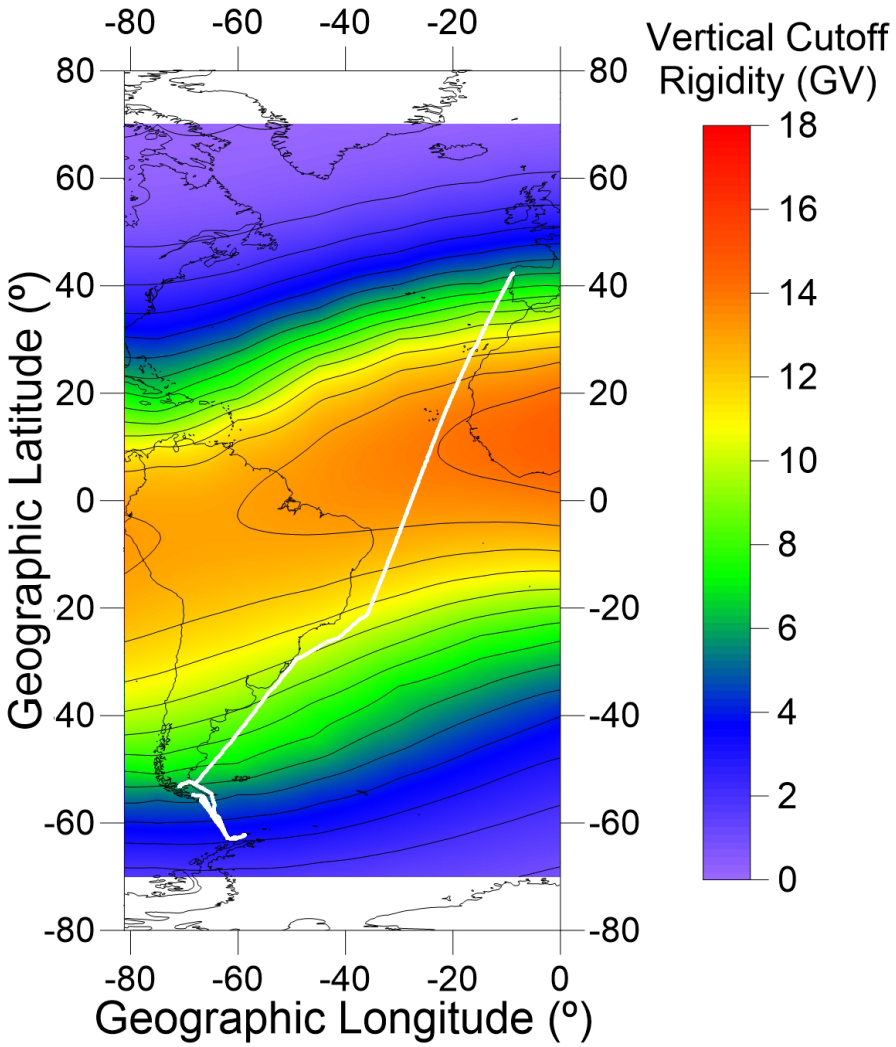
Something did not work!!

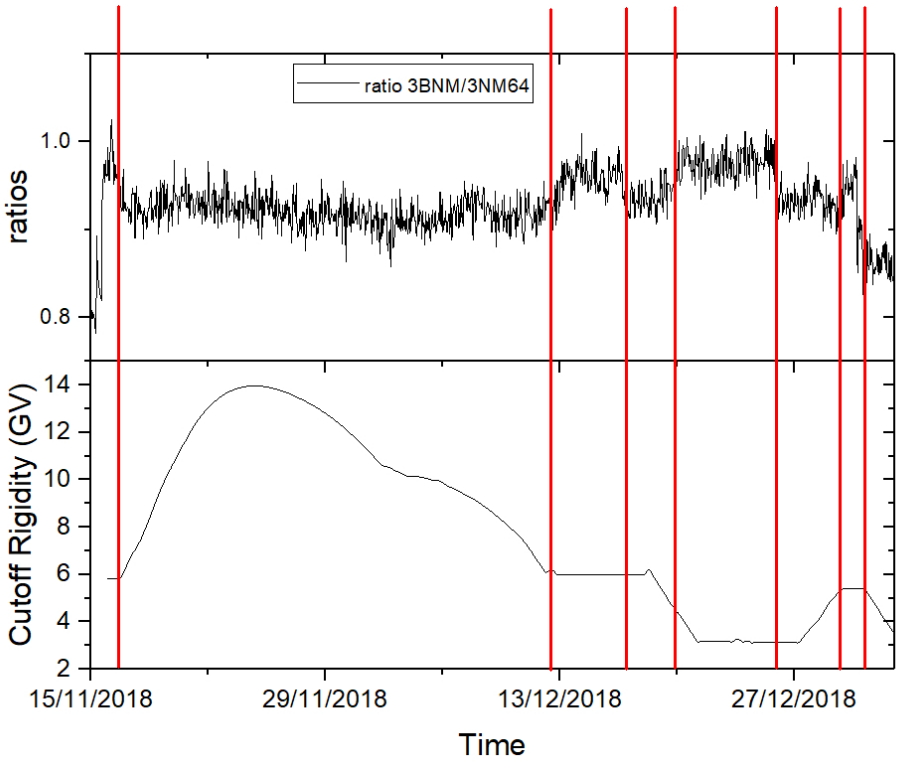


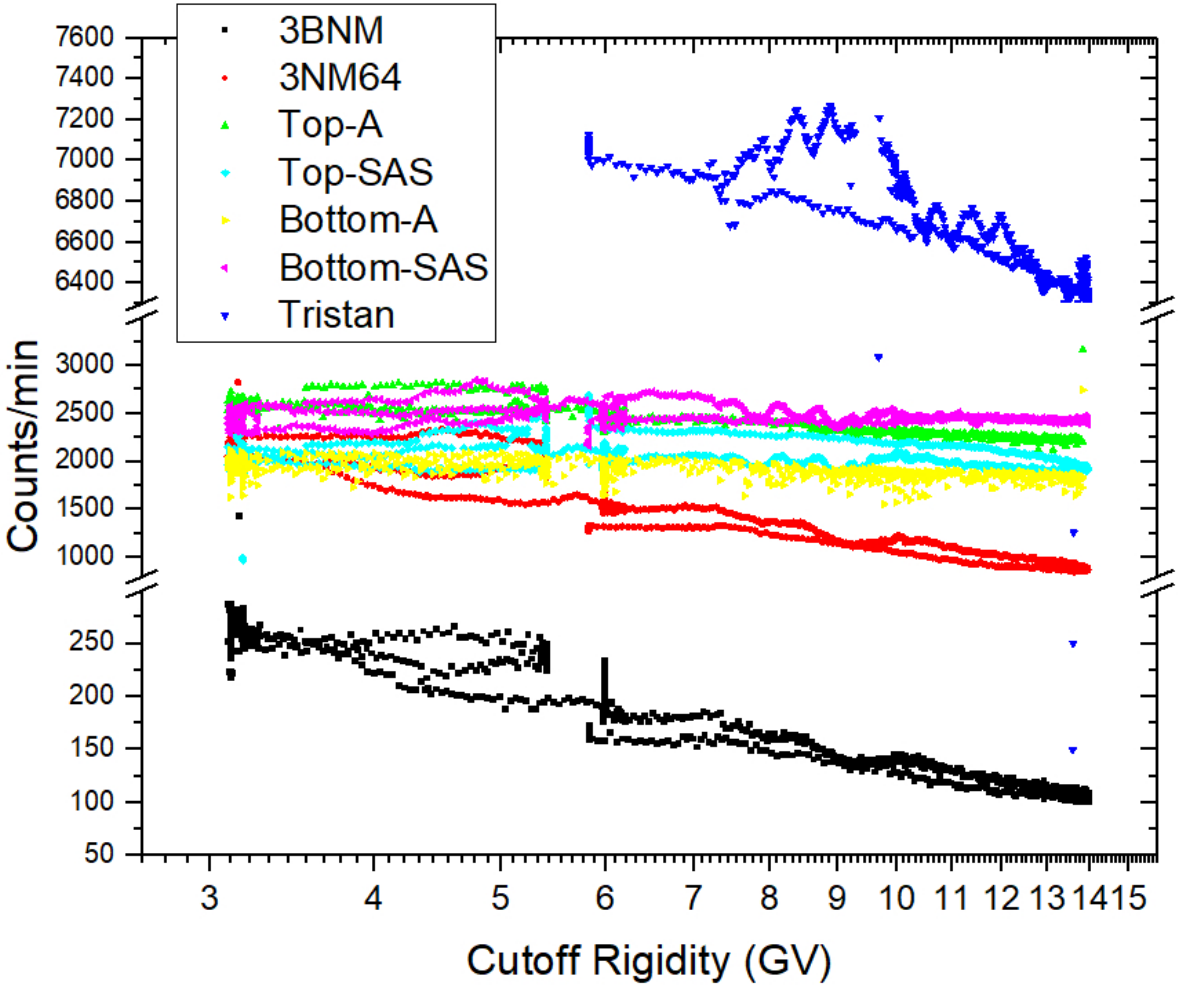

Vertical Cutoff Rigidity (GV)
18
16
14
12
10
8
6
4
2
0
Geographic Latitude (º)
Geographic Longitude (º)
-80
-60
-40
-20
0
80
60
40
20


P (mbar)
Tristan
coinA8
Top-Bottom
3BNM
3NM64
R (GV)
SAS-B
SAS-T
A-T
A-B
15/11/2018
29/11/2018
13/12/2018
27/12/2018
Time


ratio 3BNM/3NM64
Mito-Ts/3NM64
Mito-Ta/3NM64
Mito-Ba/3NM64
Mito-Bs/3NM64
TRISTAN/3NM64
ratios
1.6
1.2
0.8
Cutoff Rigidity (GV)
14
12
10
8
6
4
2
15/11/2018
29/11/2018
13/12/2018
27/12/2018
Time


Vertical Cutoff Rigidity (GV)
18
16
14
12
10
8
6
4
2
0
Geographic Latitude (º)
Geographic Longitude (º)
-80
-60
-40
-20
0
80
60
40
20
0
-20
-40
-60
-80


ratio 3BNM/3NM64
ratios
1.0
0.8
Cutoff Rigidity (GV)
14
12
10
8
6
4
2
15/11/2018
29/11/2018
13/12/2018
27/12/2018
Time



A very rough approach to the variation of countrates over rigidity ($counts \cdot min^{-1} \cdot GV^{-1}$):

-0.083 (NEMO: 3NM64)
-0.079 (NEMO: 3BNM)
-0.020 (MITO-Top (SAS))
-0.017 (MITO-Top (A))
-0.014 (TRISTAN)
-0.011 (MITO-Bottom(A))
-0.002 (MITO-Bottom(SAS))

Conclusions

- Preliminary results for the latitudinal scan performed by the Antarctic Cosmic Ray Observatory (ORCA).
- ORCA′s instruments measured, uninterruptedly, counting rates of neutrons and muons mainly, along a latitudinal survey from N42° to S62° in a trip of 48 days.
- The energy threshold of primary cosmic rays producing observable neutrons at sea level is lower than those producing muons.
- Nevertheless, both neutrons and muons show a rigidity dependence.
- The last result could confirm that the flux of primary cosmic rays with rigidities around 14 GV can contribute to the muon flux observed at sea level.

Thanks!

Have fun!!