Ocean-based Muography

Hiroyuki Tanaka

Detection of the seafloor deformation (a few mm/yr)

Currently the ocean bottom pressure gauge (OBPG) is a unique solution

The OBPG has been applied to

A. monitoring a submarine volcano

Chadwick Jr., W.W. *et al*. *J. Volcanol. Geoth. Res.* (2006).

B. detecting a seismic vertical displacement of the seafloor and

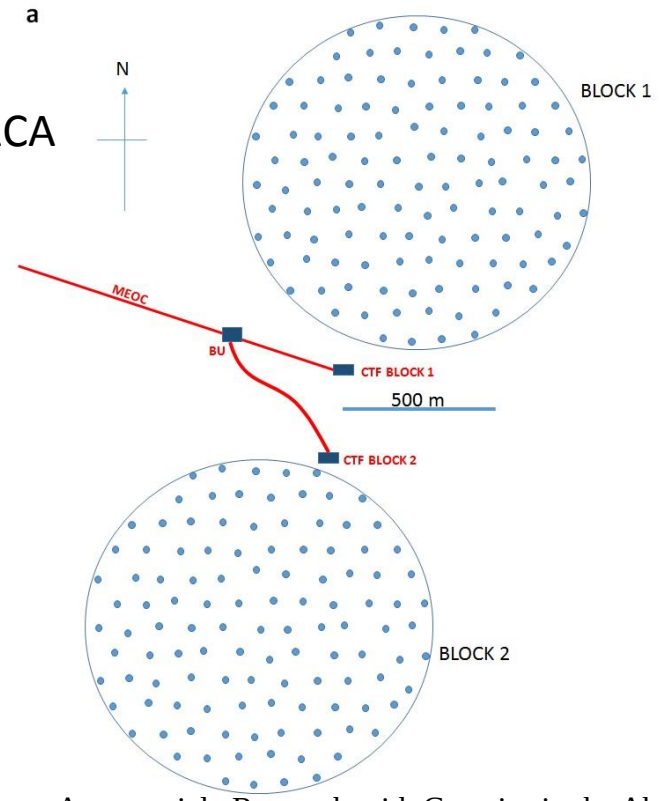
Ito, Y. *et al*. *Geophys. Res. Lett.* (2011)

C. tsunami wave propagation

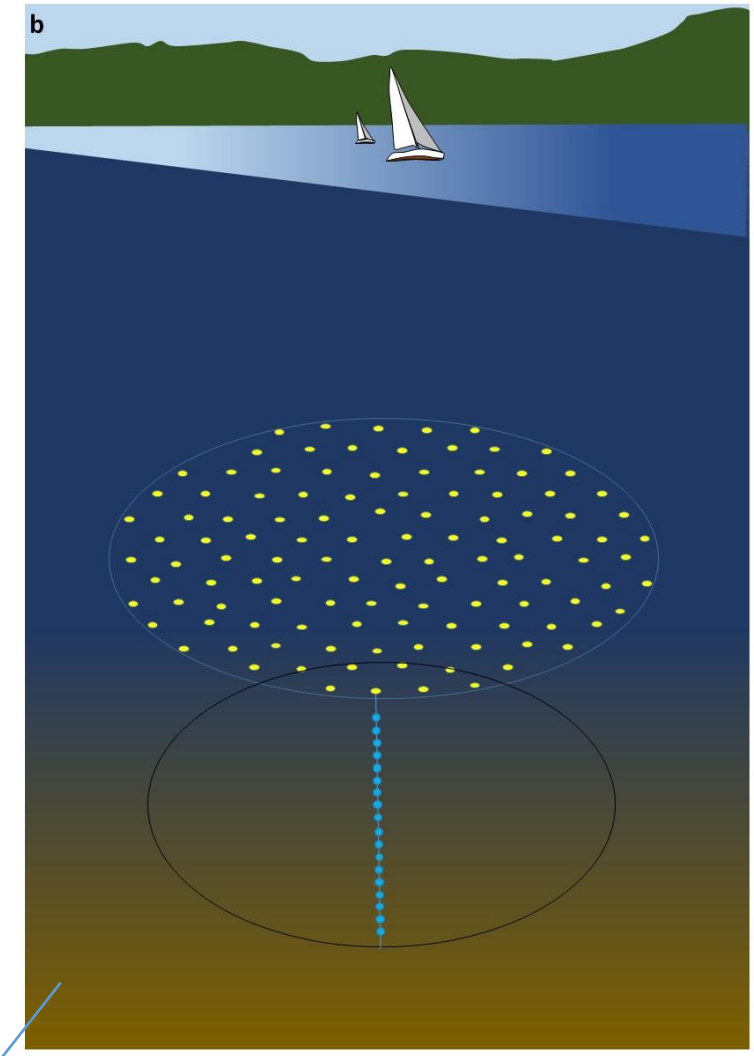
Maeda, T. *et al. Earth Planets Space* (2011)

Uplift and subsidence of the seafloor with an accuracy of up to a few mm (however) over a short time period (seconds to days)

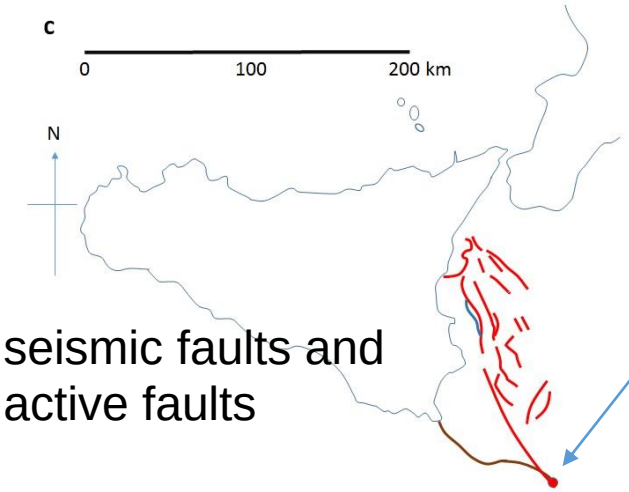
Chadwick Jr., W.W. *et al*. *J. Volcanol. Geoth. Res.* (2006).



Astroparticle Research with Cosmics in the Abyss



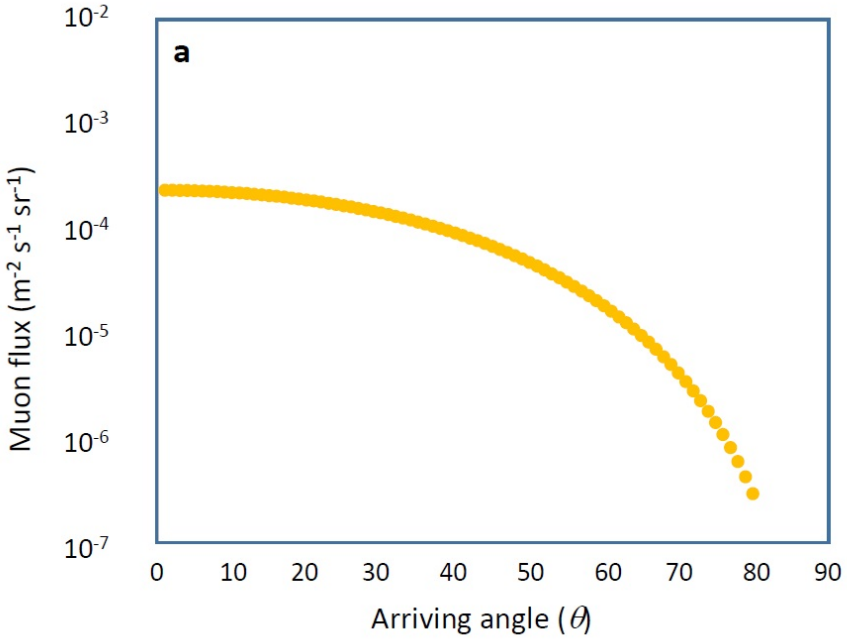
2888-3500 m below sea level

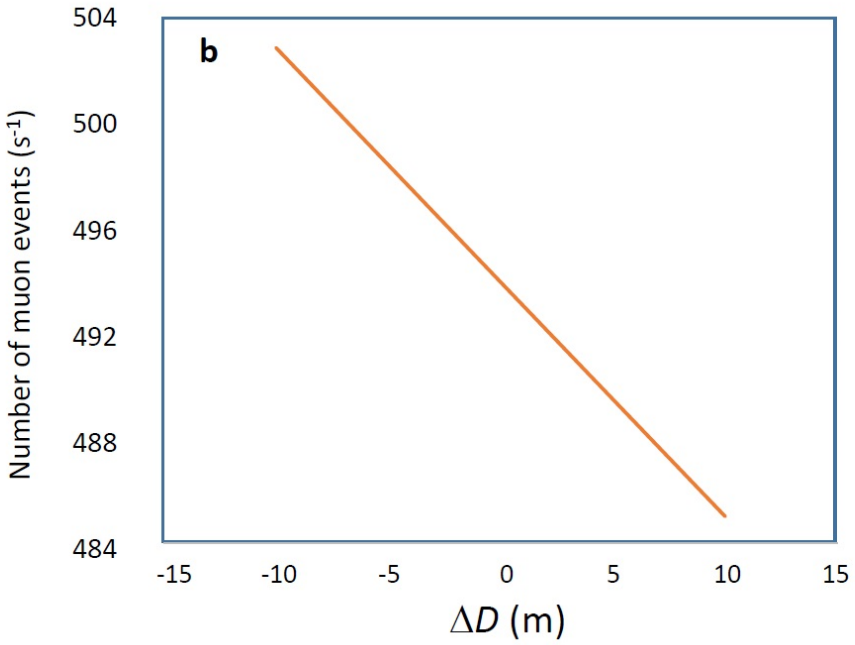


seismic faults and active faults

Uplift rates in southern Calabria and eastern Sicily were significantly high at a rate of more than 2 mm/yr between late Pleistocene and Holocene Antonioli, F. *et al. Tectonophysics* (2006)

Muon event rate at ARCA





seawater density: 1.02 gcm^{-3}

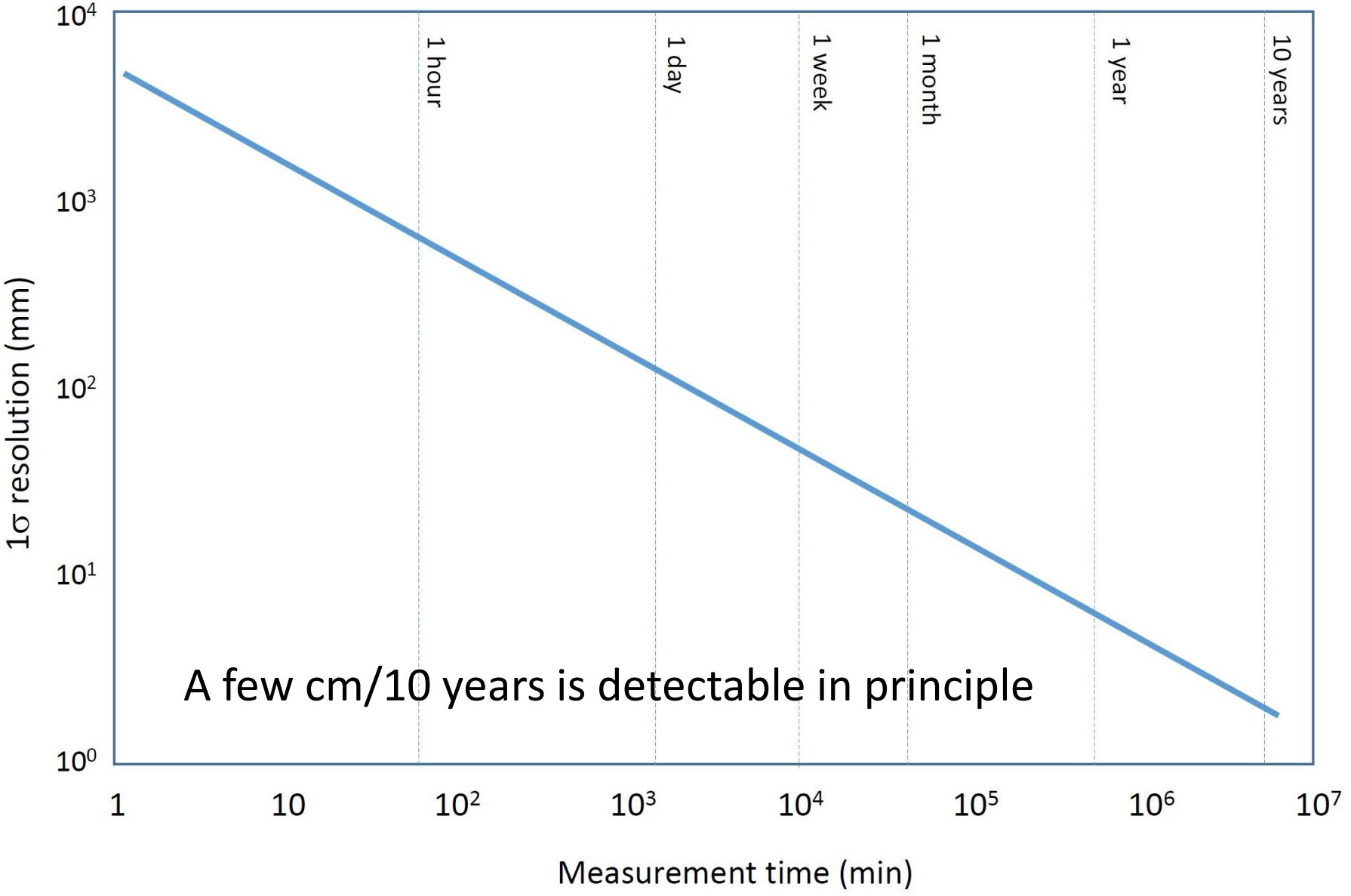
$I = 366.73\ E^{-1.976}$ L3 *Phys. Lett. B* (2004)

CSDA range Groom et al. 2012

present modeling, CORSIKA, MUPAGE, and ANTARES
0.71, 0.72, 0.81, and 0.90 x 10^{-3} s^{-1} m^{-2} @ 2350 m bsl

Reduction factor of 1.6$\pm$0.1, 1.7, 1.7, and 1.7 (2050 m to 2350 m)

Aguilar, J.A. *et al*. *Astropart. Phys.* (2010).


10^4
10^3
10^2
10^1
10^0
1σ resolution (mm)
1 hour
1 day
1 week
1 month
1 year
10 years
A few cm/10 years is detectable in principle
1
10
10^2
10^3
10^4
10^5
10^6
10^7
Measurement time (min)