

RAP



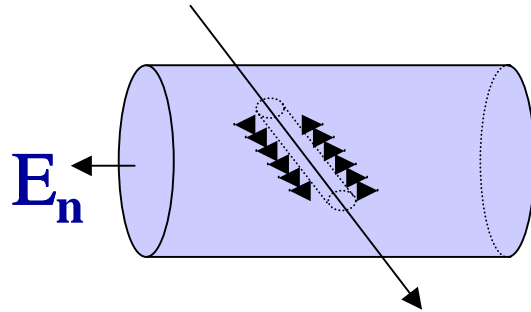
RAP: Thermoacoustic Detection at the DAΦNE Beam Test Facility



RAP Collaboration: S. Bertolucci, E. Coccia, S. D'Antonio, A. Fauth, A. de Waard, G. Delle Monache, D. Di Gioacchino, V. Fafone, G. Frossati, C. Ligi, A. Marini, G. Mazzitelli, G. Modestino, G. Pizzella, L. Quintieri, G. Raffone, F. Ronga, P. Tripodi, P. Valente

A handwritten signature in black ink, appearing to be 'EA'.

5th Amaldi Conference Tirrenia (Pisa), Italy 6-11 July 2003



The energy deposited by a particle is converted in a local increase of temperature

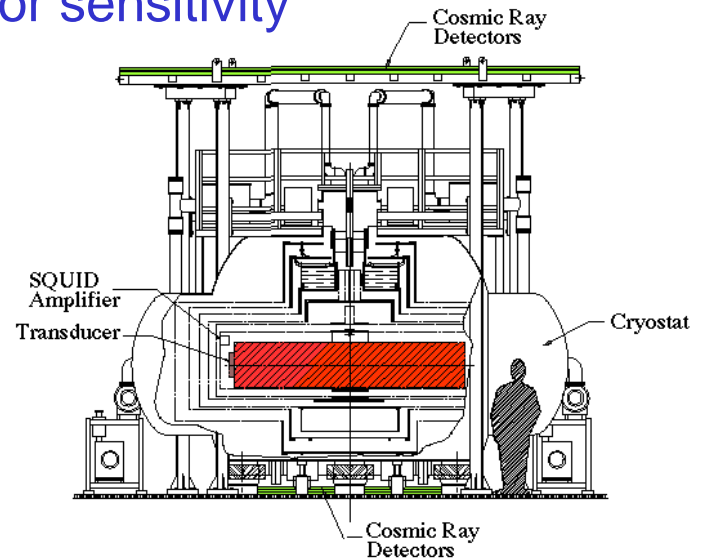
$$\delta T = \delta E / (\rho C V); \delta p = \gamma \cdot \delta E / V;$$

$$\gamma = \alpha Y / (\rho C) \quad \gamma = \text{Grüneisen constant}$$

$$E_n \propto \gamma^2 \cdot (dE/dx)^2 \cdot F_n^2$$

The Thermo Acoustic Model predicts very small signal for present resonant gravitational wave detector sensitivity

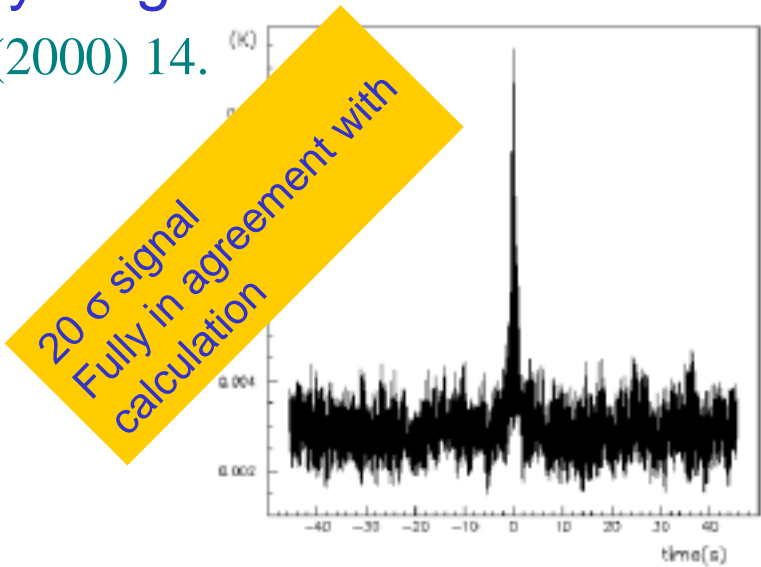
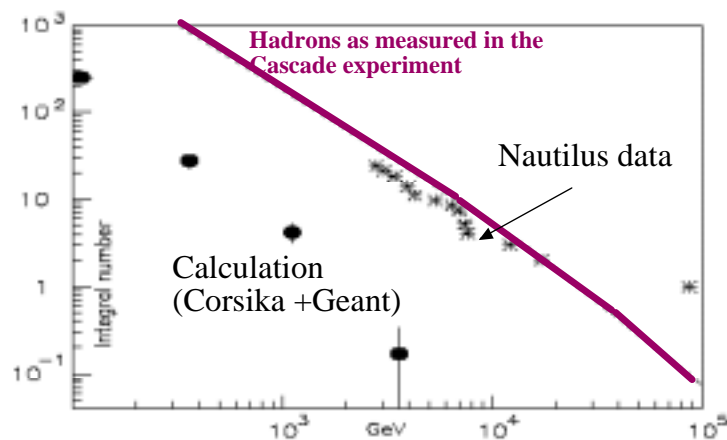
1992 NAUTILUS was equipped with a cosmic ray veto system
 Nucl.Instrum.Meth.A355:624-631,1995



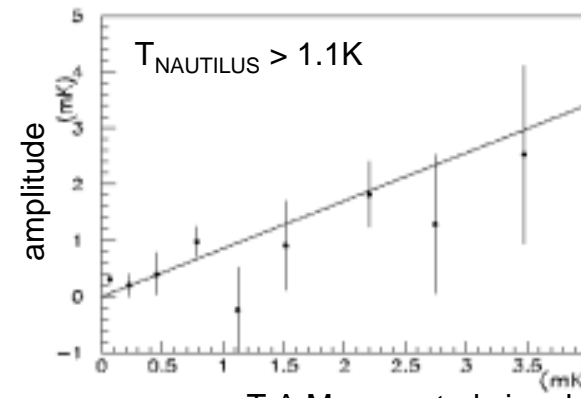
RAP Physical Motivation (con't)

1999 first measurement of cosmic rays signature in the NAUTILUS antenna, Phys. Rev. Lett. **84** (2000) 14.

2000 anomalous signal detected, Phys. Lett. **B499** (2001) 16.



2001 dependence from NAUTILUS thermodynamic temperature, Phys. Lett. **B540** (2002) 179.



End of 2001 RAP Proposal, LNF-01-027(IR)



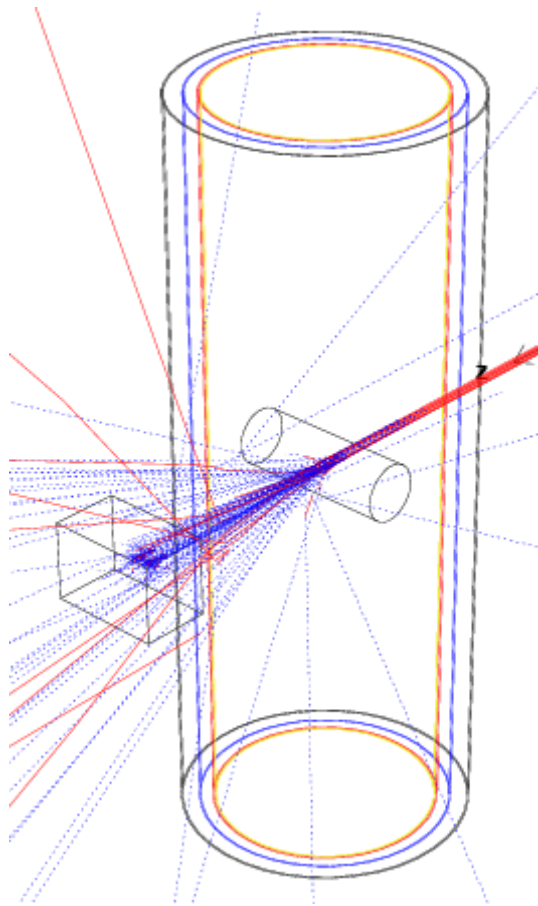
T.A.M. expected signal Induced by measured shower

thermal and mechanical

energy lose

Geometric factor

$$E_n \propto \gamma^2 \cdot (dE/dx)^2 \cdot F_n^2$$



GEANT simulation

In order to understand:

γ enhancement of Grüneisen factor in super-conducting state

(dE/dx) enhancement of energy conversion in super-conducting state

(dE/dx) exotic component of cosmic rays (nuclearites, monopoles)

The thermo-acoustic model has been proven effective at room temperature by previous experiments

Rev.Sci.Instrum.71:1345-1354, 2000 and pervious papers

$$\gamma = \alpha Y / (\rho C)$$

Mechanical and thermal properties of the detector are contained in the Grüneisen parameter, assumed almost constant with the temperature.

The extrapolated value at zero Kelvin from measurements done at 4 K, give: $\gamma = 1.6$

γ (actually α) can not be directly measured at temperatures below T_c . Recent evaluation based on critical magnetic field $H_c(P, T)$ measurements and specific heat give a different value of the Grüneisen parameter in the super-conducting state. In particular at $T = T_c$:

$$\gamma_s = -10.7 \pm 0.8$$

A. Marini, under publication



RAP DAΦNE Beam Test Facility

e^- / e^+ $n_{\text{average}} = 1 - 10^{10}$ particles

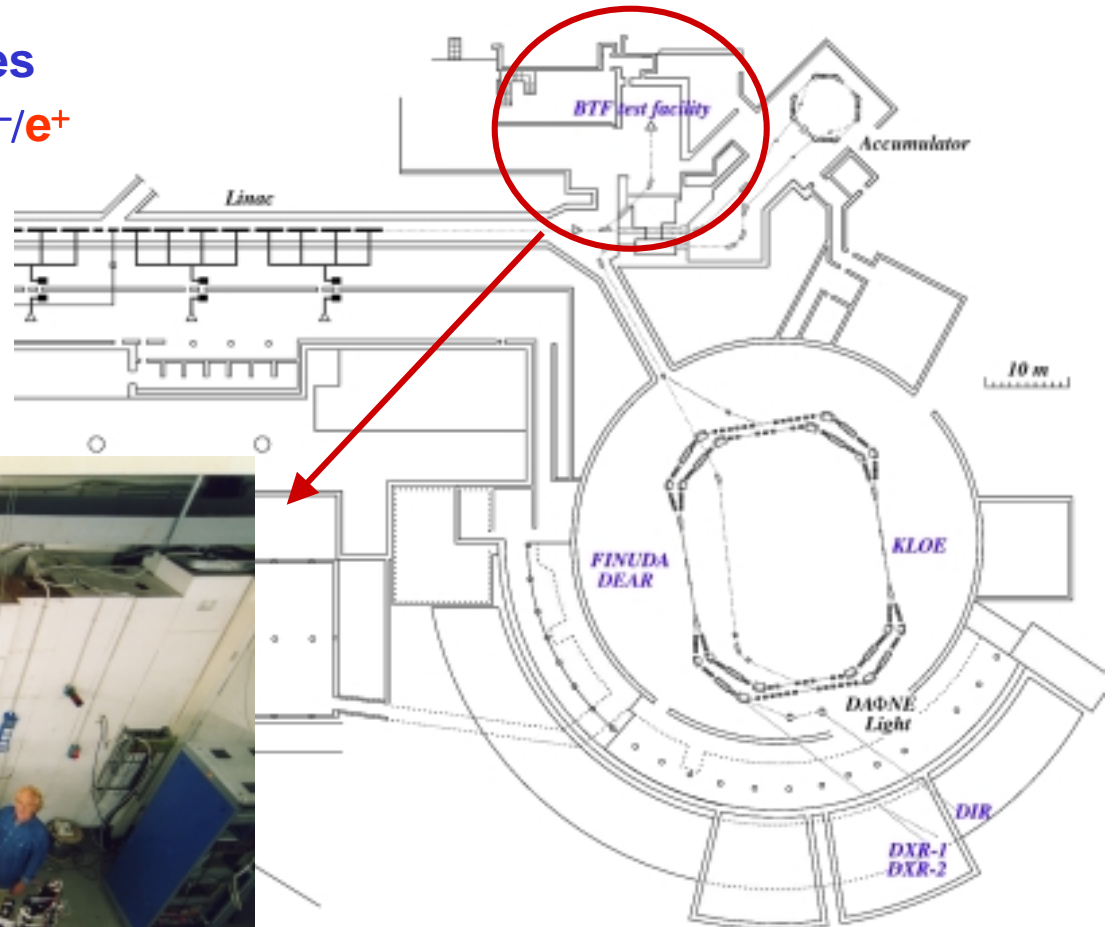
Energy: 20–800 MeV e^-/e^+

Repetition rate: 50 Hz

Pulse Duration: 1–10 ns

1% energy selection

100 m² Experimental Hall



RAP

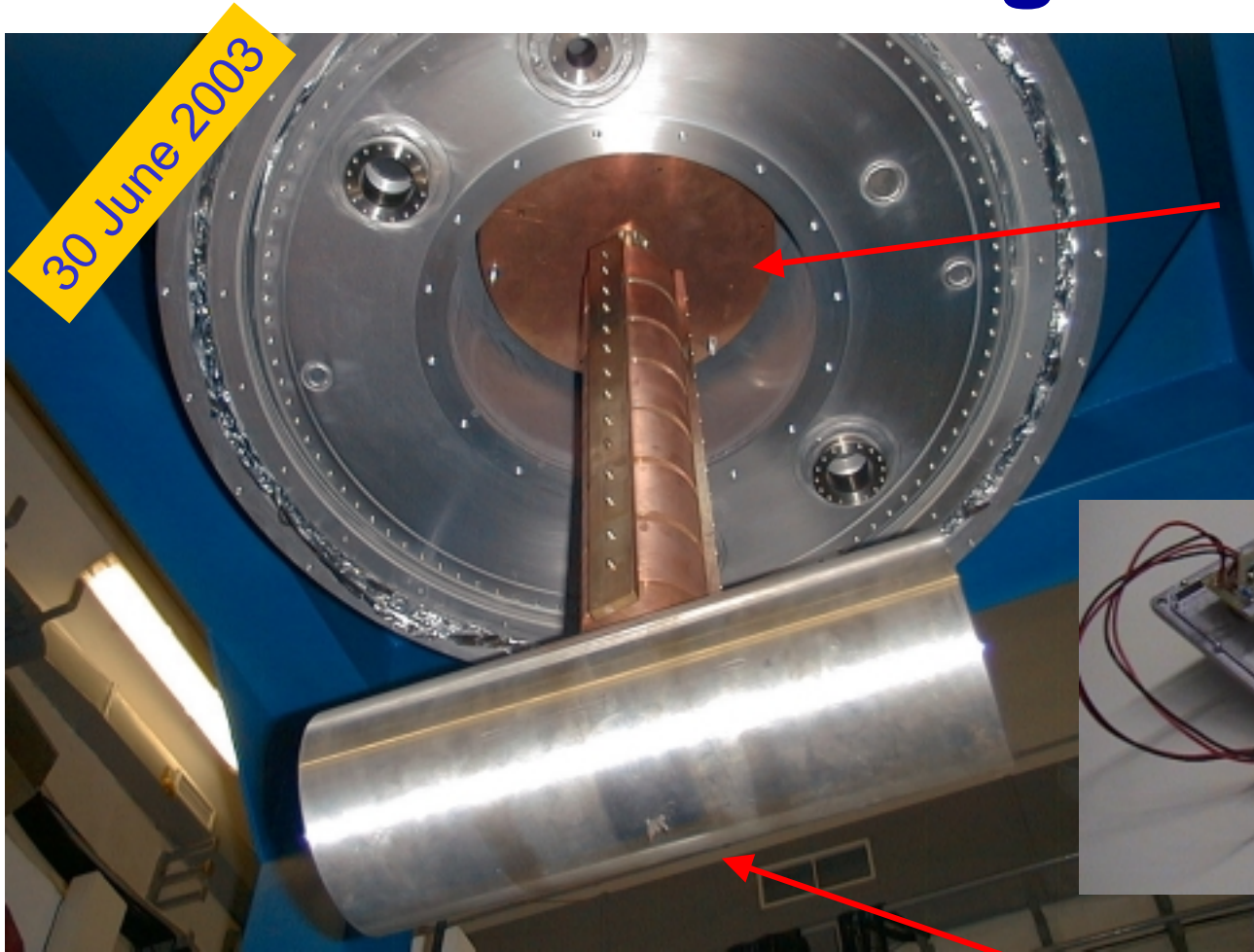
RAP Installation @ BTF



18 June 2003

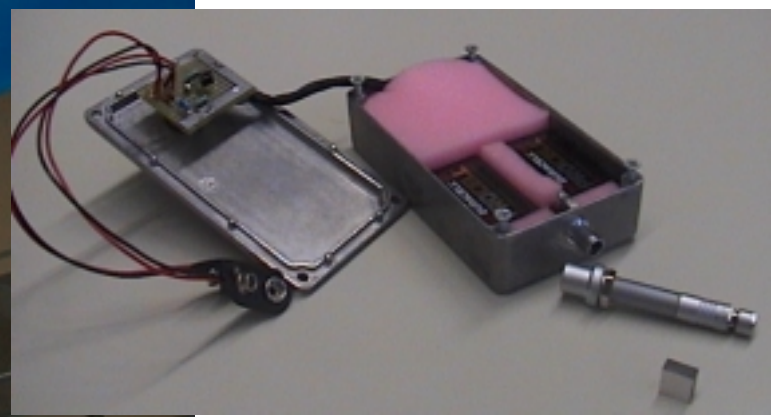


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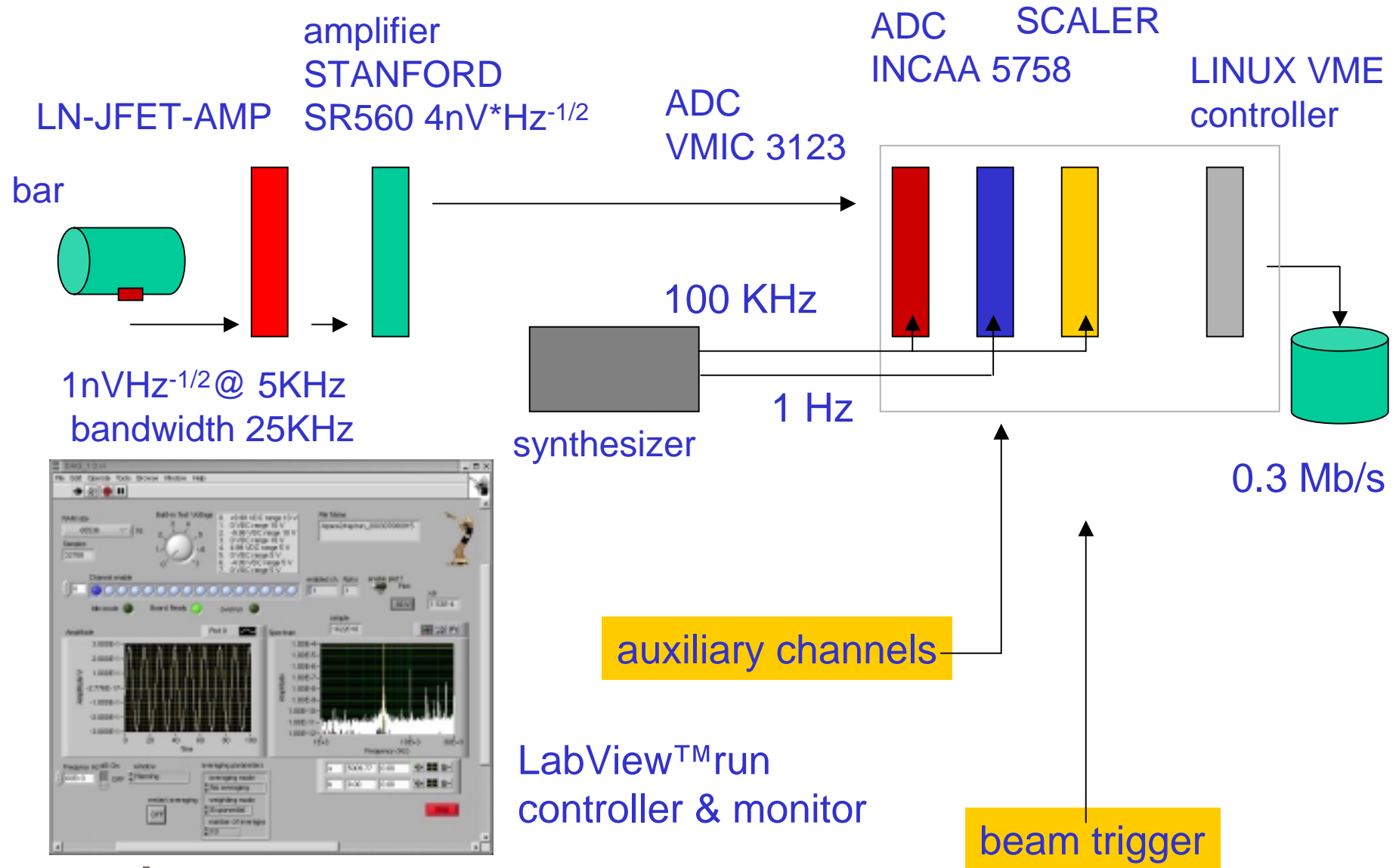
7 OFCH copper masses
1 OFCH copper tube
Attenuation: -200db@5KHz

Al 5056 bar, 50x18 cm

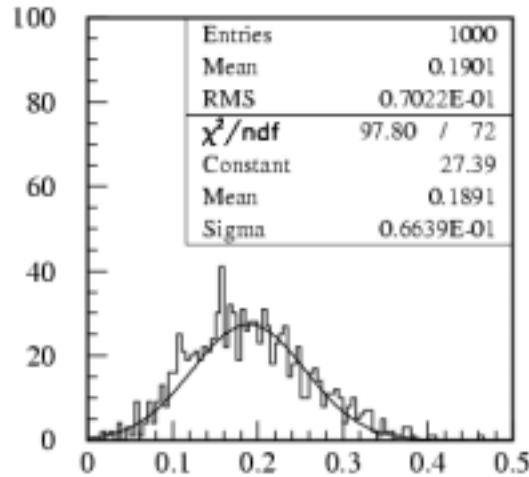


Read-out:
piezo-electric ceramic
JFET amplifier
 $1\text{nVHz}^{-1/2}$ @ 5KHz
bandwidth 25KHz

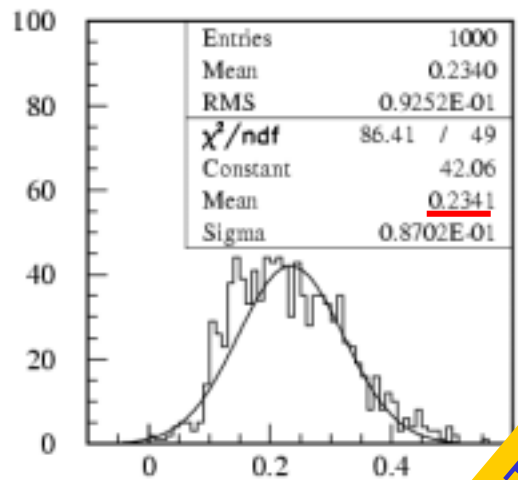
operating temperature 100 mK



EA



ΔE in bar, 1000 x 510 MeV, 50.0 cm



ΔE in bar, 1000 x 750 MeV, 50.0 cm

GEANT simulation

$$\gamma = 1.6$$

$$E_1(K) = 4 \cdot 10^{-13} \cdot N_e^2 \cdot (dE/MeV)^2$$

noise temperature = 0.5 K

SNR (energy) = 100 →

$N_e = 4 \cdot 10^4$ electrons @ 750 MeV

SNR (energy) = 100 →

$N_e = 10^6$ electrons @ 750 MeV

at room temperature

- **Phase 1:** installation and test of full apparatus at room temperature, suspension, electronics, DAQ, mechanical structure ready (**done**)
first measurement at room temperature (coming soon...)
- **Phase 2:** cryogenic test, and low temperature measurement in non super-conducting state (September 2003)
- **Phase 3:** dilution refrigerator installation
measurement in super-conducting state (2004)



The 6th Amaldi Conference will end the history

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<http://www.Inf.infn.it/esperimenti/rap/>



The screenshot shows a Netscape browser window displaying the RAP website. The browser title is "RAP - Netscape". The address bar shows "LNF Home Page" and "RAP". The website content includes:

- Logos for INFN (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Frascati), RAP, and DAFNE BTf.
- Section: **Rivelazione Acustica di Particelle**
- Text: Search for thermo-acoustic effects on a cryogenic target by a particle beam at the [DAFNE BTf](#)
- Section: **Documents**
 - [RAP articles and notes](#)
 - [RAP presentations](#)
 - [Interesting papers](#)
- Section: **Photos**
 - [RAP photographs!](#)
- Section: **People**
 - [RAP Mailing list](#)
 - [RAP Web](#)
 - [News!](#)
 - [Private](#) 

There are two images on the right side of the page: a photograph of a large blue cryogenic target and a schematic diagram of a particle beam hitting a cylindrical target, with a small cartoon figure of a person standing next to it.

The browser status bar at the bottom shows "Document: Done (0,792 secs)".

