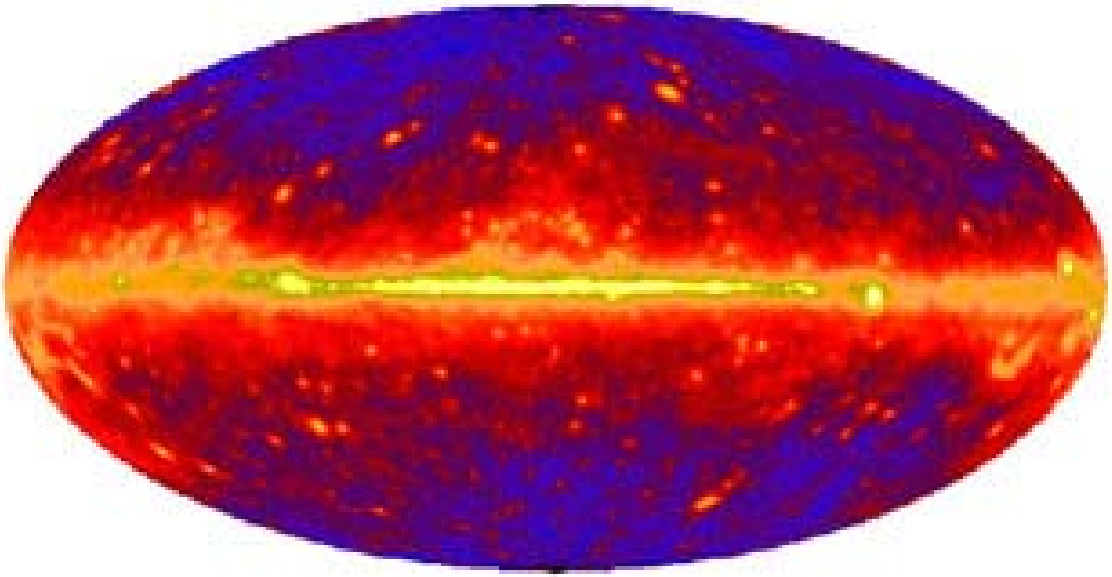
GLAST

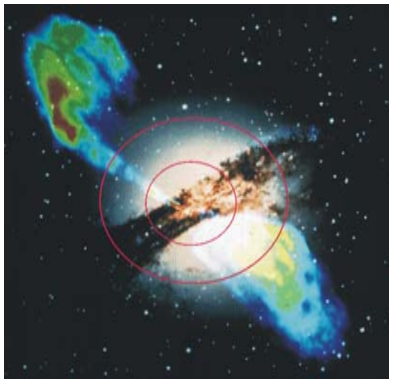
The Gamma Ray Large Area Space Telescope



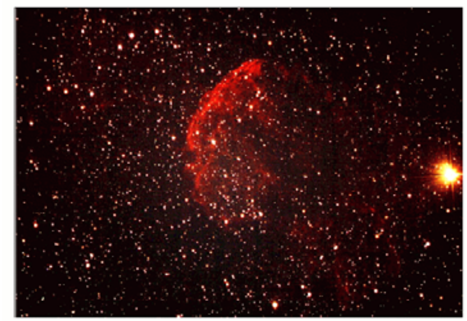
FRS meeting

CENBG

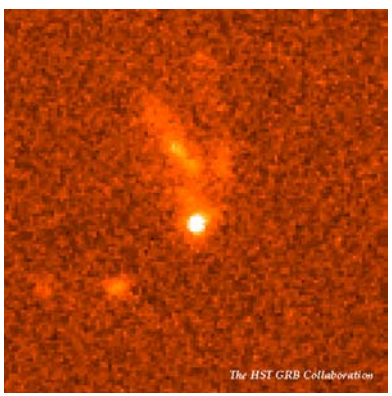
Science with GLAST



γ rays are produced in "non-thermal" processes by high-energy electrons or hadrons and thus probe the cosmic accelerator sites (shocks).
EGRET: about 270 sources, GLAST: over 9000 sources



- Active Galaxy Nuclei ("blazars")
- Gamma Ray Bursts
- Supernova Remnants
- Pulsars
- Microquasars?
- New class of objects?



LAT (Large Area Telescope)

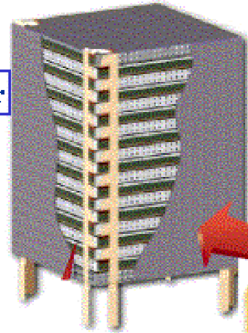
20 MeV-300 GeV

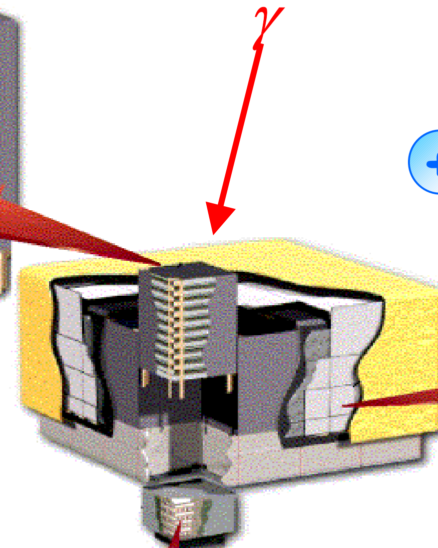
Si-Pb Tracker

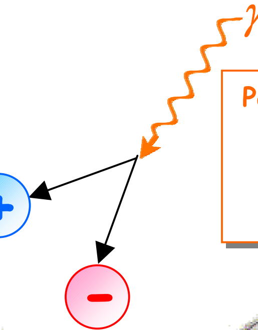
pitch = 201 μm

$12 \times 2.5\% \ X_0$

$+ \ 4 \times 25\% \ X_0$





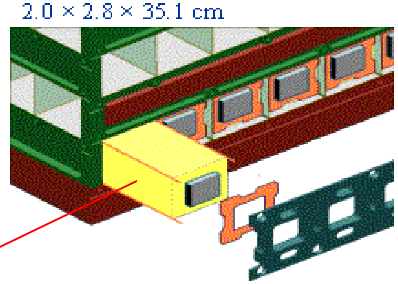


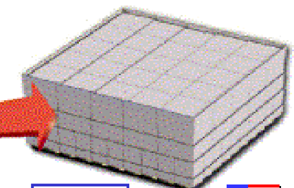
Pair conversion telescope
16 towers
- Veto
- Tracker
- Calorimetre

CsI Calorimeter

$8.6 \ X_0$ $\quad 8 \times 12$ bars

$2.0 \times 2.8 \times 35.1$ cm

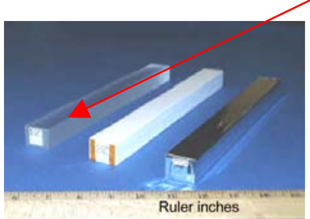


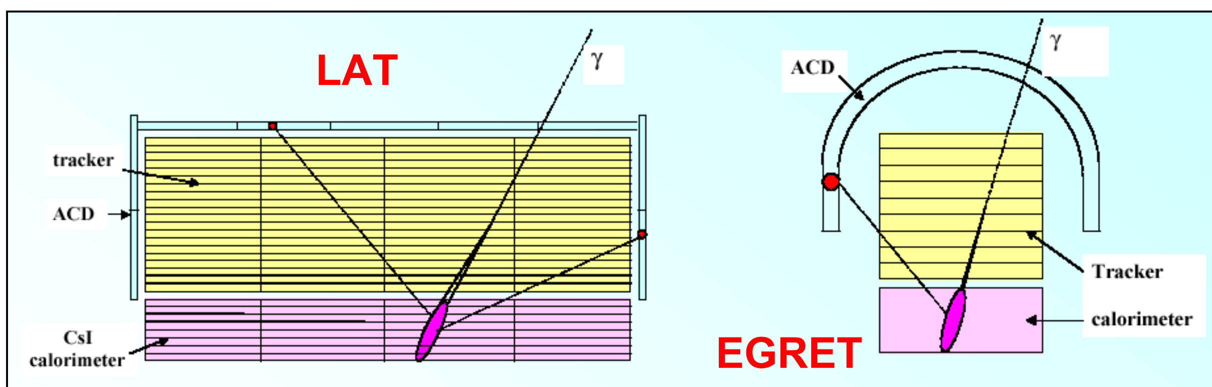


ACD

scintillator tiles

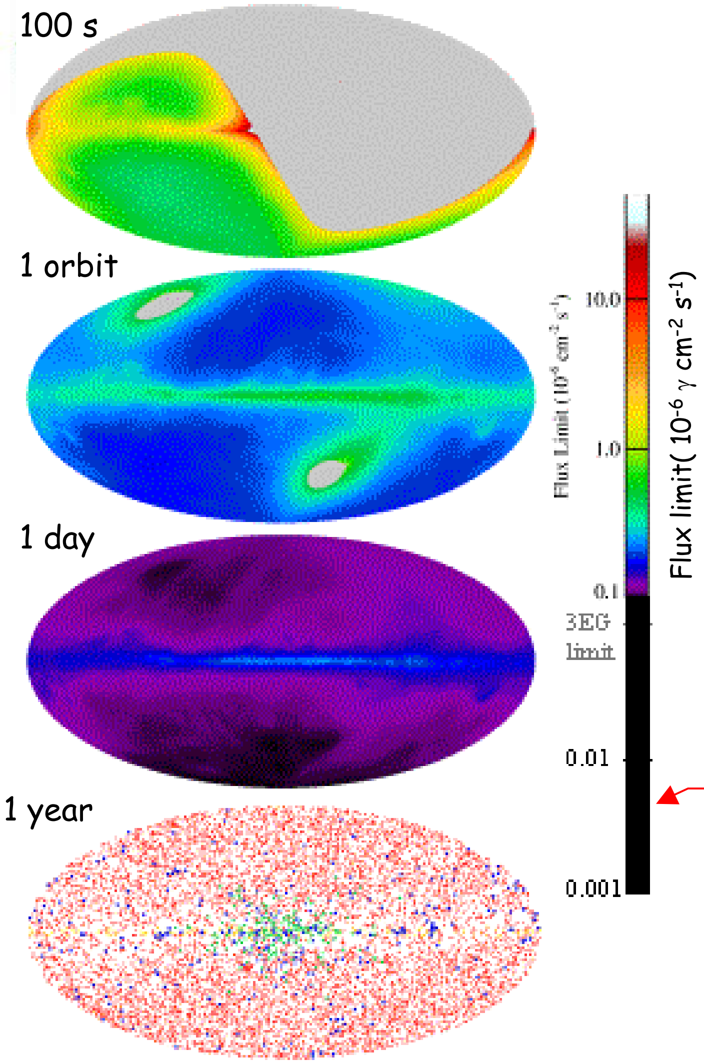
0.9997 efficiency





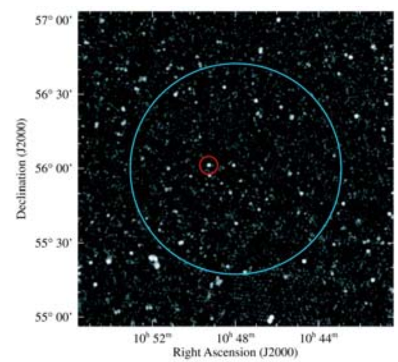
Orbit altitude:450 km
inclination: 28.5°

The LAT performance



	EGRET	GLAST
Detector technology	Spark chambers+ NaI calorimeter	Si-strips+ CsI calorimeter
Energy range	20 MeV-30 GeV	20 MeV-300 GeV
Energy resolution	10%	10%
Effective area	1500 cm^2	8000 cm^2
Deadtime per photon	100 ms	20μs
Field of view	0.5 sr	2.4 sr
Angular resolution (PSD)	5.8° at 100 MeV	3° at 100 MeV 0.2° > 10 GeV
Source location determination	5'-30'	30''-5'
Sensitivity (>100 MeV)	10^{-7} cm^{-2}s^{-1}	4 10^{-9} cm^{-2}s^{-1}
Power	160 W	650W
Orbit	350 km/ 28.5°	550 km/ 28.5°
Mass	1810 kg	3000 kg
Lifetime	1991-2000	2006-2011(16)

4 10^{-9} γ cm^{-2} s^{-1} for 1 year



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International Collaboration

Stanford University & Stanford Linear Accelerator Center
NASA Goddard Space Flight Center
Naval Research Laboratory
University of California at Santa Cruz
University of Washington

Commissariat à l' Energie Atomique: Département d' Astrophysique
Institut National de Physique Nucléaire et de Physique des Particules:
Ecole Polytechnique, CEN Bordeaux-Gradignan

Hiroshima University, University of Tokyo
Institute of Space and Astronautical Science
Institute for Cosmic-Ray Research

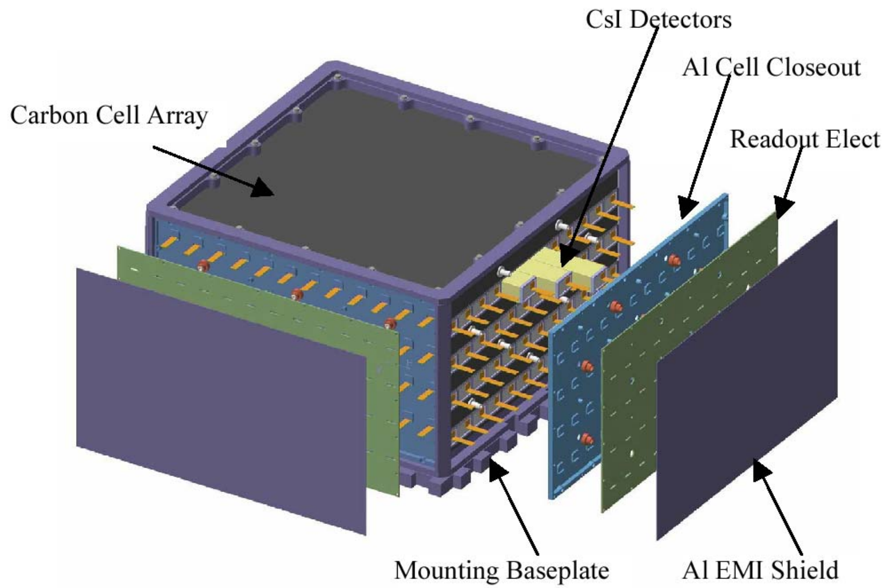
Institute Nazionale di Fisica Nucleare:Pisa,Trieste,Bari, Udine,Perugia, Roma
Italian Space Agency

Royal Institute of Technology, Stockholm University

~ 100 scientists from 28 institutes

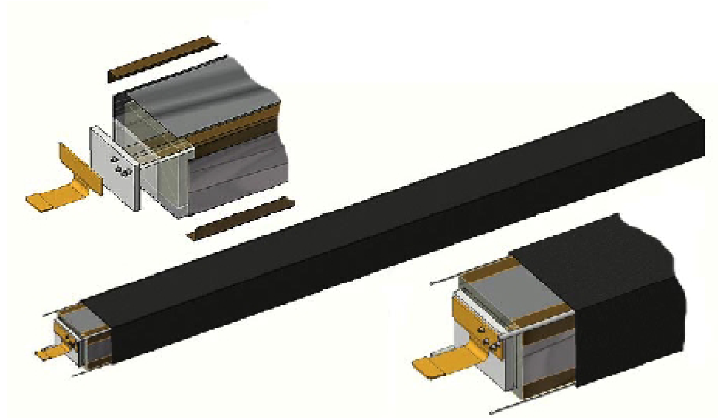
GLAST's calorimeter

Mass: 1492 kg
Consumption: 91 Watt



- 8 layers (8.5 R.L.) comprising 12 CsI crystal each, 96 crystals per tower
- layers are interlaced (x-y localisation)

GLAST's crystals



Length: 333 +0.0 -0.6 mm
Width: 26.7 +0.0 -0.4 mm
Thickness:19.9 +0.0 -0.4 mm (1.08 X0)
0.7 mm bevel at 45 deg.

Energy resolution (1.275 MeV) < 13% FWHM
Crystal-to-crystal dispersion < 10%
Light yield after 50 krad > 50% initial
Monotonous attenuation, 60 % overall.

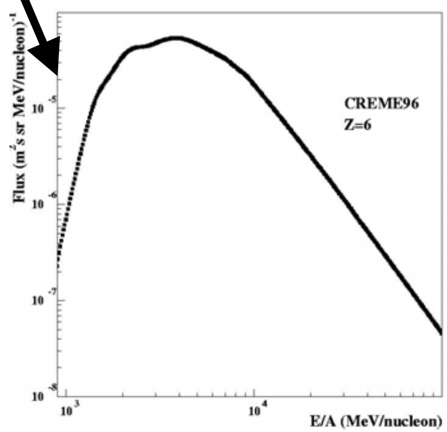
	Large Diode	Smal Diode
Active area (mm^2)	152	25
Capacitance (pf)	< 100	< 15
Dark current(nA) (25 deg, V=70 V)	< 10 nA	< 3 nA
Depletion voltage(V)	< 70	< 70
Photosensitivity (@ λ=540 nm)	> 0.33 A/W	> 0.33 A/W

Two PIN diodes at both ends → dynamic range from 2 MeV to 60 GeV

In-orbit calibration

Geomagnetic cutoff

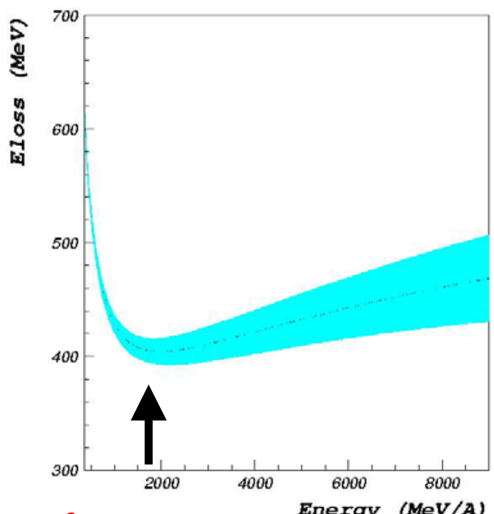
CR energy spectrum

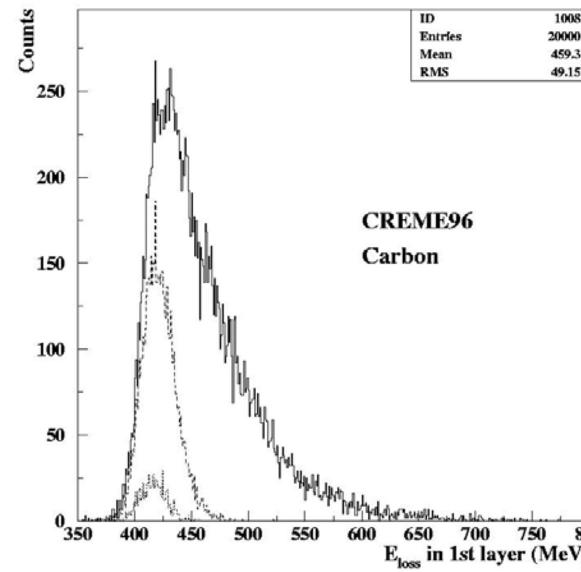


Use of the ionisation energy loss of cosmic-ray heavy ions

C, N, O, Mg, Si, Fe

E_{loss} (E)



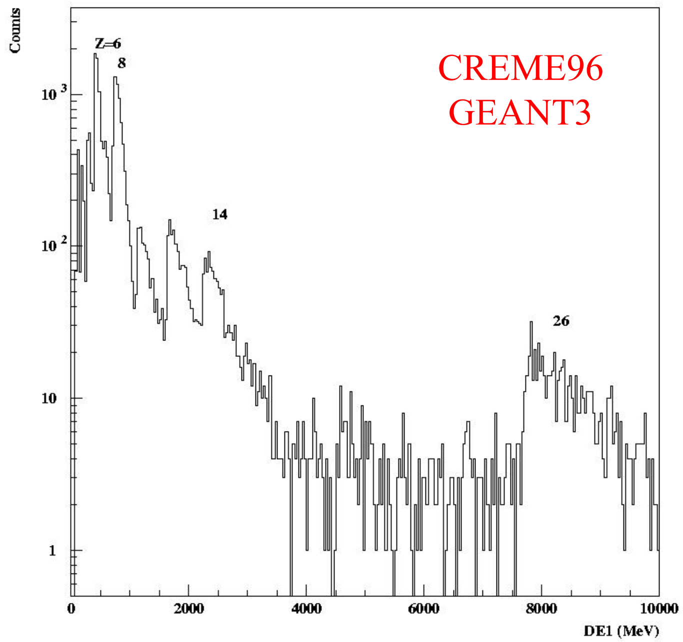


"minimum-ionisation" peak

minimum of ionisation

In-orbit calibration (2)

Simulated energy-loss distribution



We need to:

• know the CsI light function L(E,Z), non-linear because of quenching effects;

• test algorithms for rejecting reaction events (variation of Eloss between adjacent layers).

Quenching effects in CsI

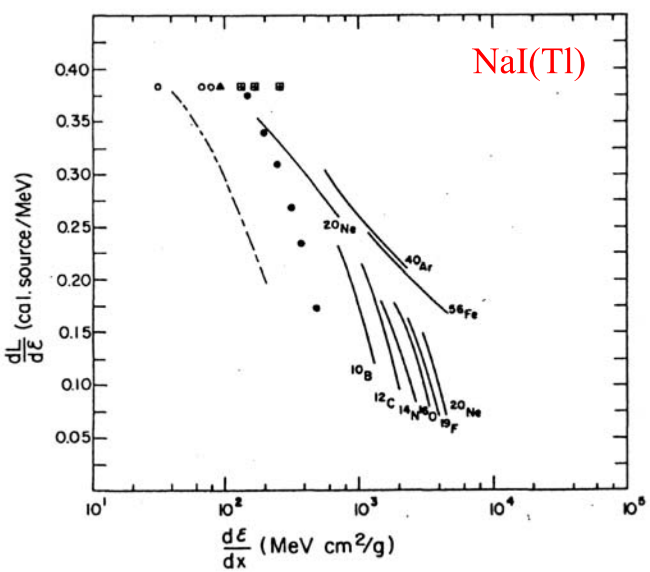
High ionisation density → non-radiative decay channel
("activation-depletion" hypothesis, exciton destruction at activator sites, recombination...)

Low energy: Birk's formula

$L(E) \propto E/(1+k_B\, dE/dx)$ k_B: quenching factor

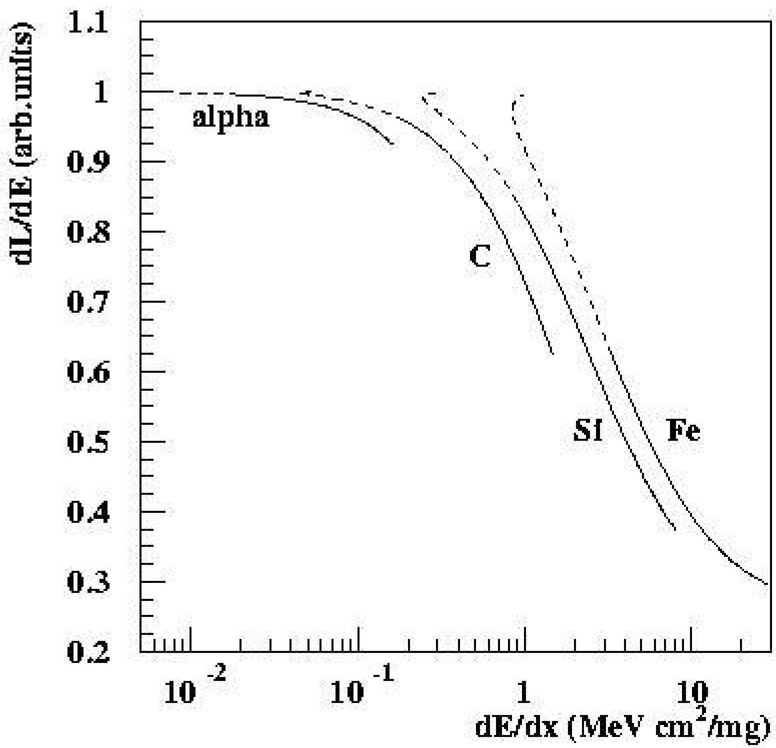
High energy:
at a given dE/dx, E is higher for greater Z → more δ electrons → less quenching

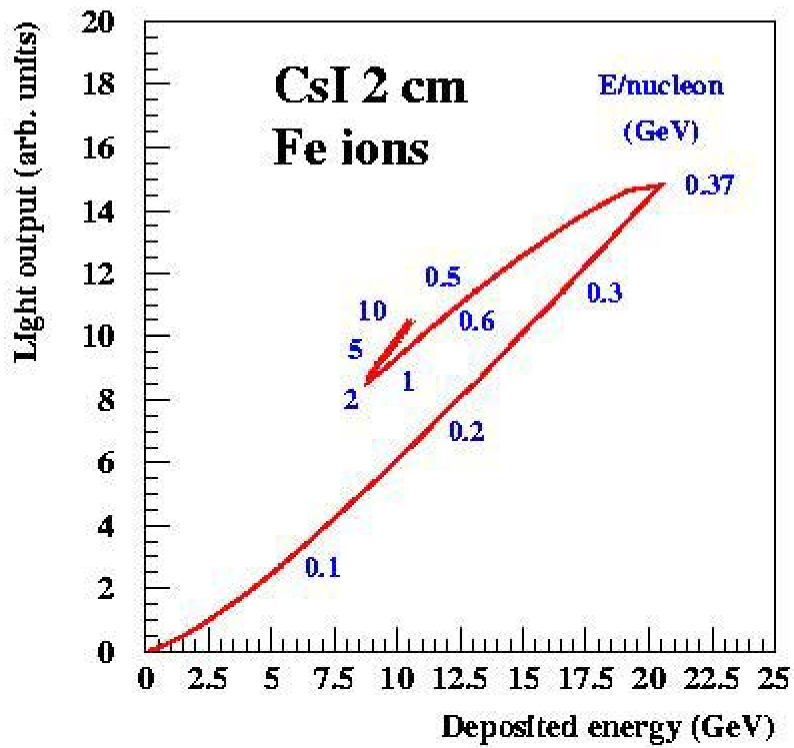
Very scarce data at high energy!



Salamon and Ahlen

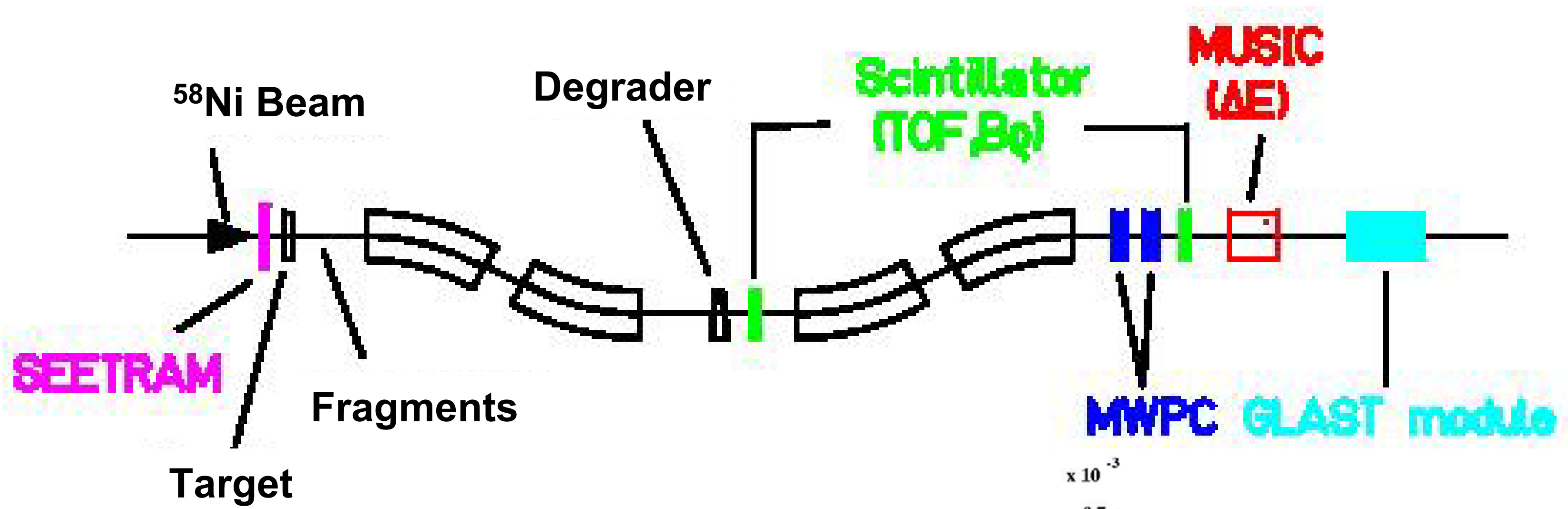
Examples of light functions



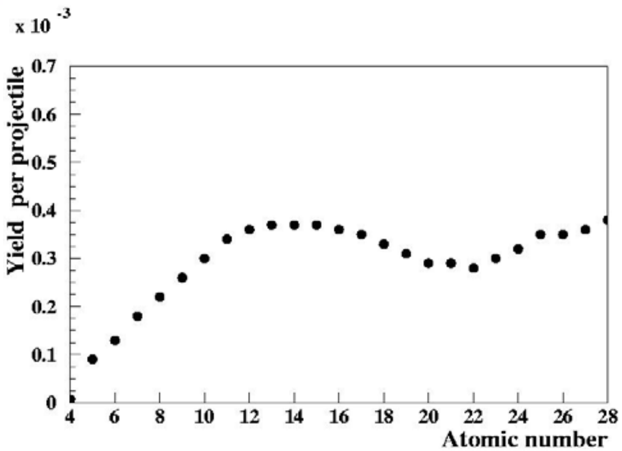


Function taken from Pârlog et al. (INDRA)
parameters adjusted from earlier GSI data

Experimental setup



One single beam: 1.7 GeV/nucleon ^{58}Ni



All fragments are produced simultaneously.
The energy is changed by varying the target thickness.
Great flexibility!

Experimental plan

10 shifts of ^{58}Ni in 2003

- calibration of the FRS with 900 MeV/nucleon ^{58}Ni
- 7 shifts: 7 energies between 100 and 1700 MeV/nucleon
  fragments with $4 \leq Z \leq 26$
  different angles: θ=0°, (θ, ϕ)=(30°,0°), (60°, 0°), (30°,30°)
- 3 shifts with degrader: C, Si, Fe