Overview on calorimetry R&D for FACTOR (Messina/Trieste/Udine approach)

(V. Bonvicini *et al*.)

A. Penzo (June 4, 2008)

Trieste-Udine R&D

- Traditionally Ts/Ud R&D → **Photodetectors**
- Traditionally Ts/Ud R&D → **Si Devices**

Tracking + Calorimetry

- SiPM and compensating Calorimetry
  - Perfect match

An Italian landscape

Active Groups/Collaborations

Worldwide:

- CALICE (ILC):
  - > 10’000 SiPM tested
- CMS (LHC):
  - HCAL Upgrade
- FNAL: T2K, SiDET (ILC)

In Italy:

DASIPM, Del Guerra et al., (Pisa, Bari, Bologna, Perugia,Trento)
medical application PET),space physics

P-ILC: Frascati, Roma1

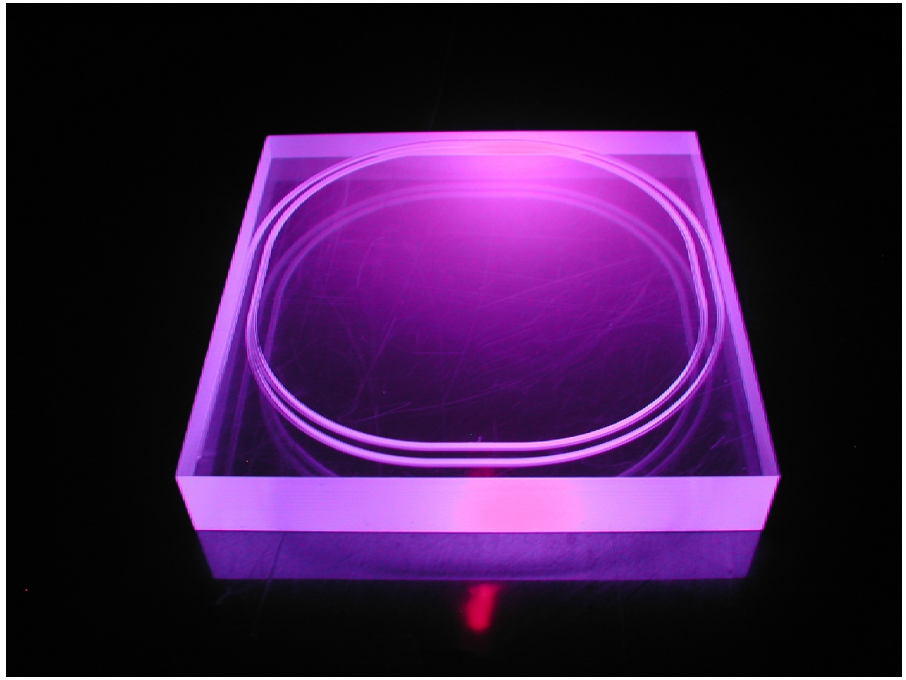
FACTOR (W. Bonvicini et al.: Trieste/Udine, Messina+IRST)

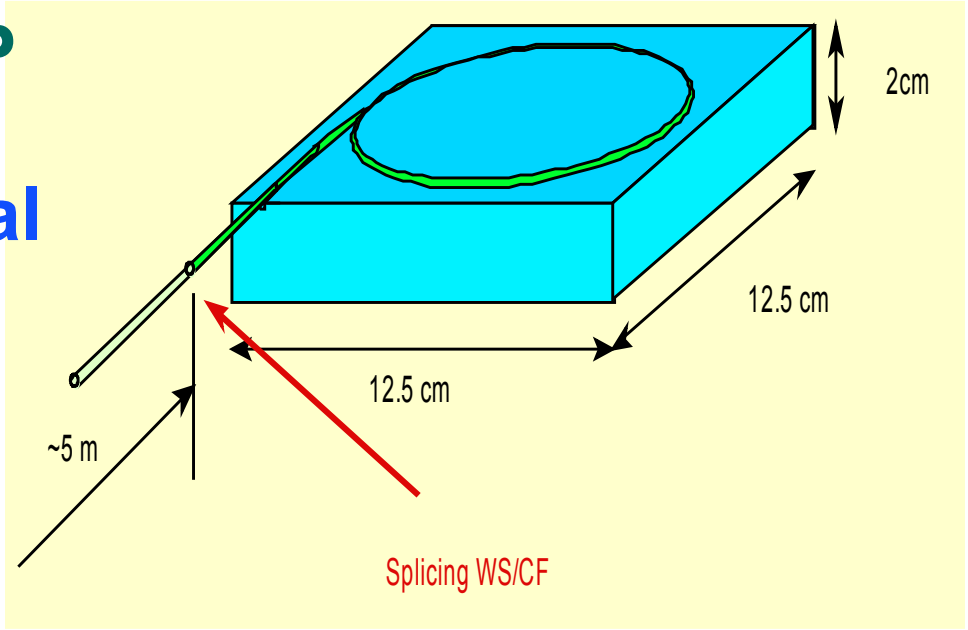
INFN activities on/with SiPM

- **Sources of SiPM**
  - SiPM R&D at IRST-Trento
- **FACTOR R&D Project (Ts/Ud, Me + …)**
  - First round prototype devices and tests (Trieste/Udine, Frascati, CERN, FNAL)
- **Possible implications:**
  - DREAM phase 2, 4th Concept
  - ILC polarimetry

Tiles used for Ts/Ud tests

- **Dubna scintillator + keyhole/double-spiral groove + 3M super-reflector**
- **Kuraray fiber achieved 37 pe/MIP without optical glue, 44 pe/MIP with glue.**
- **Lose x3-4 along optical path to PMT (attenuation+splice+ connector)**





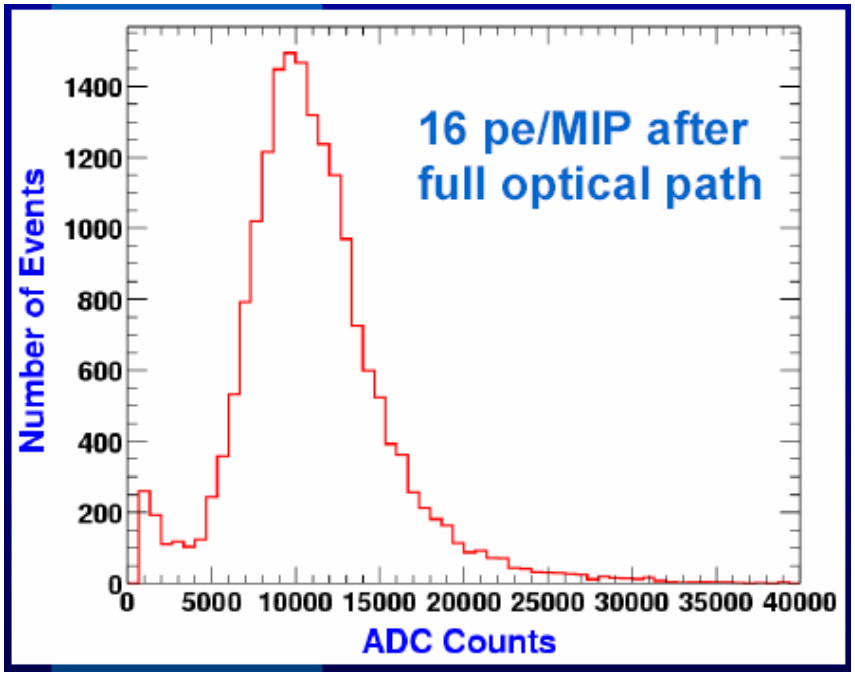
Performance (MIP)

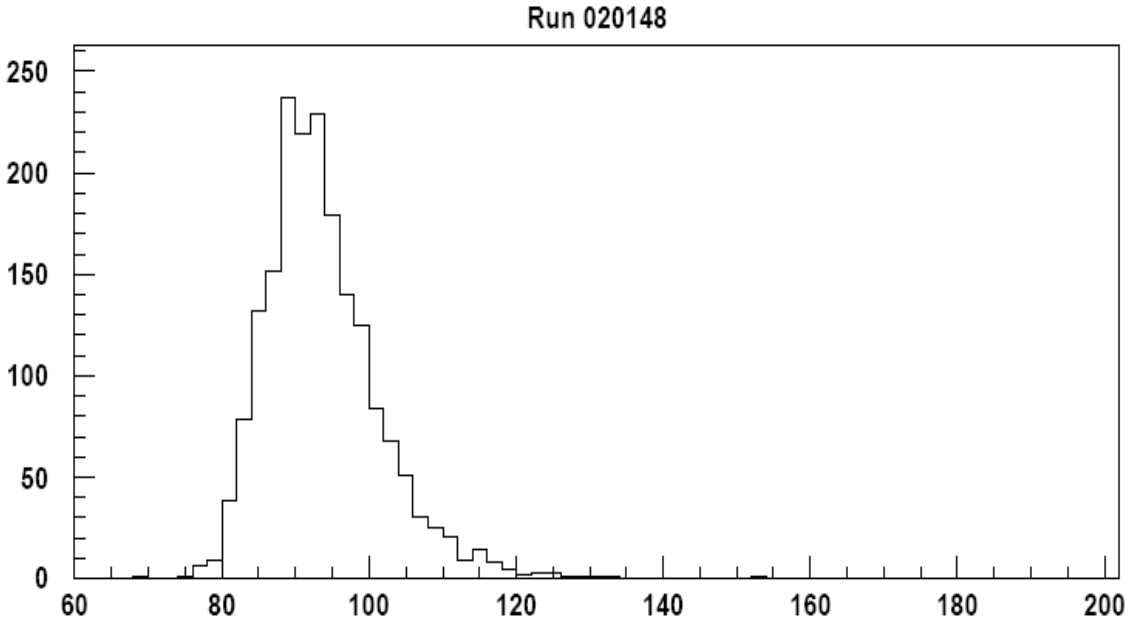
with

PMT

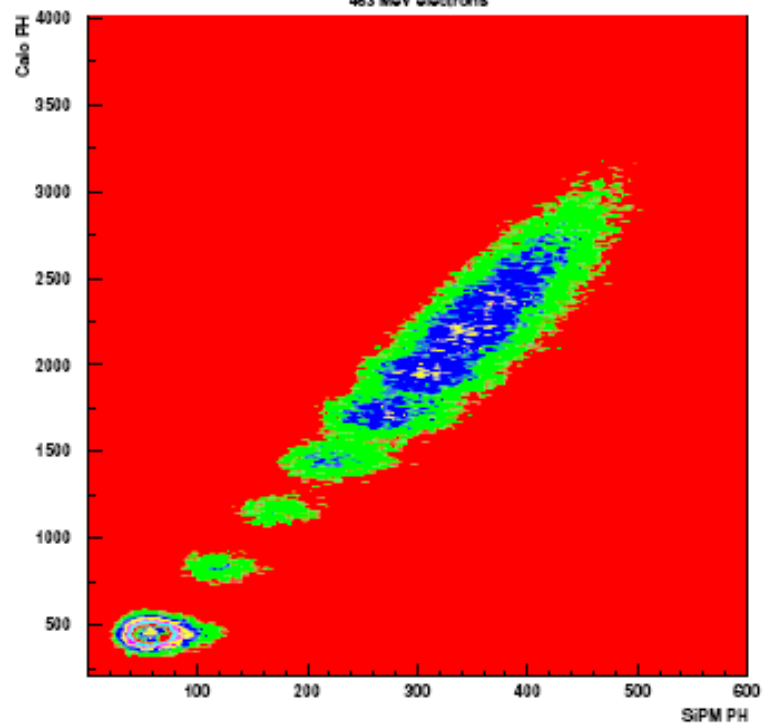
and

SiPM





Test beam at LNF

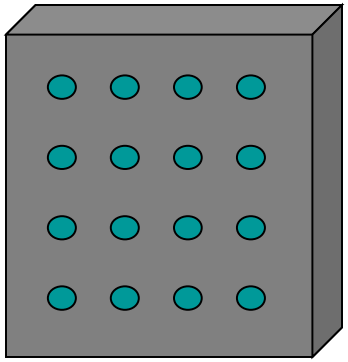


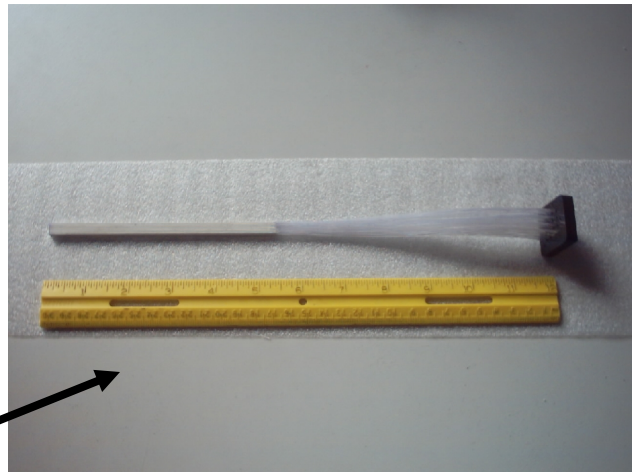
Tile +SiPM amplitude vs Cherenkov Mult. Counter

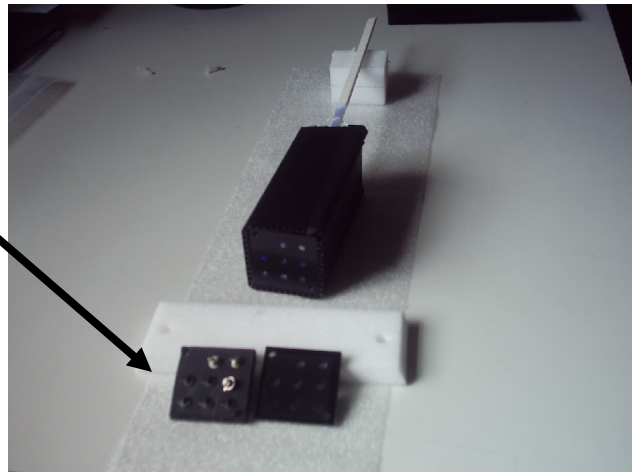
- Eric Vallazza, Michela Prest

Tracking application study: Fiber Hodoscope

[5 layers of 0.5 mm diameter Fibers]



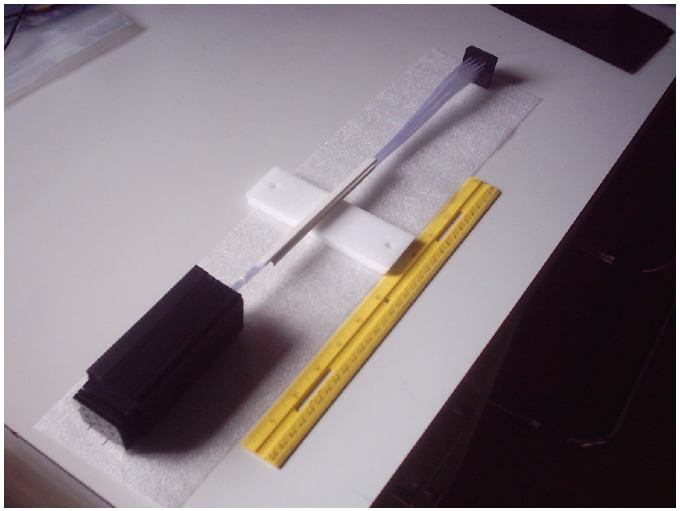




- **Fiber Array** mapped via a **Template** on a16 channel multi-anode photomultiplier H6568
- A second **Fiber Array** equipped with **SiPM** (8 channels, each corresponding to 2 of the adjacent channels of MAPMT)

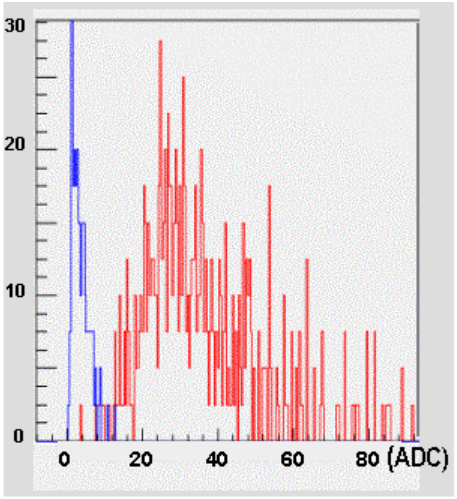
The 2 hodoscopes are accurately superimposed and aligned in a PS test beam (T11)

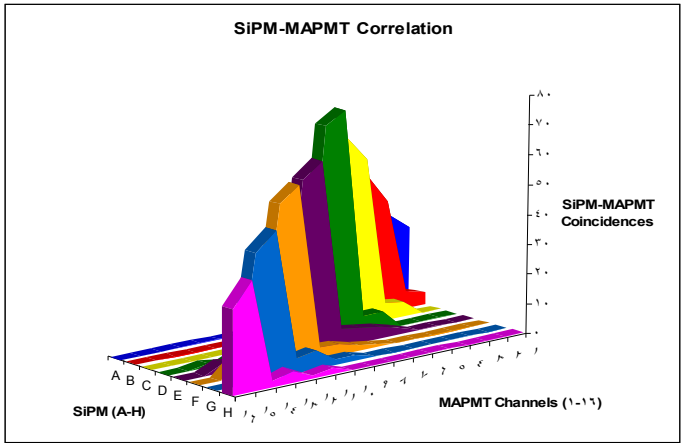
Test beam results at PS



10x10 cm^2 hodoscope

- The amplitude distribution for one SiPM, gives the spectrum (red) of the signals (coincidence with the MAPMT), and the pedestal (blue). The S/N ratio corresponds to about 5.
- The 2-dim. plot represents the correlation of the SiPM channels (A-H) with the MAPMT (1-16).





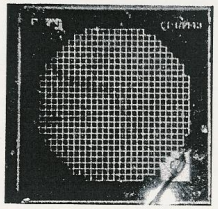
First prototypes for initial tests

- **10 SiPM (1mm²) purchased from SiLite**

SiLite Inc.

2348 Dawns Pass
Knoxville, TN 37919
Phone: 865-406-4845
Email: efremenko@gmail.com

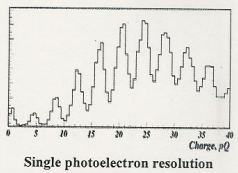
1mm Square, Silicon Photo Diode (SPM)



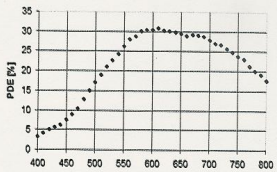
Micro photo

Specifications

Parameter	Description	Unit
Spectral Response	400-800	nm
Peak Sensitivity Wavelength	600	nm
Maximum photon detection efficiency	30	%
Operation voltage	~ 40	V
Mode of operation	Limited Geiger	
Gain	$1.6 * 10^6$	
Time jitter	50	ps
Number of pixels	556	
Effective aria	1	mm
Geometrical efficiency	70%	
Noise at room temperature	1	MHz
Excess noise factor for $G=10^6$	< 20%	
Single Ph.e separation	up to 15th	
Operation temperature	-40^0 to 40^0	C
Storage temperature	-40^0 to 40^0	C



Single photoelectron resolution



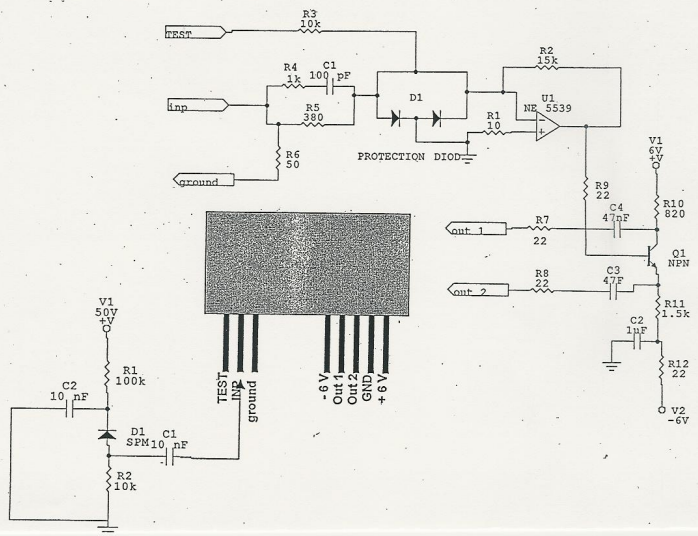
Quantum Efficiency

All performance figures are indicative.
Signal amplifier diagrams and biasing circuits are available.
CAUTION: Light sensitive part is not enclosed - DO NOT TOUCH THE SENSOR TO AVOID PERMANENT DAMAGE

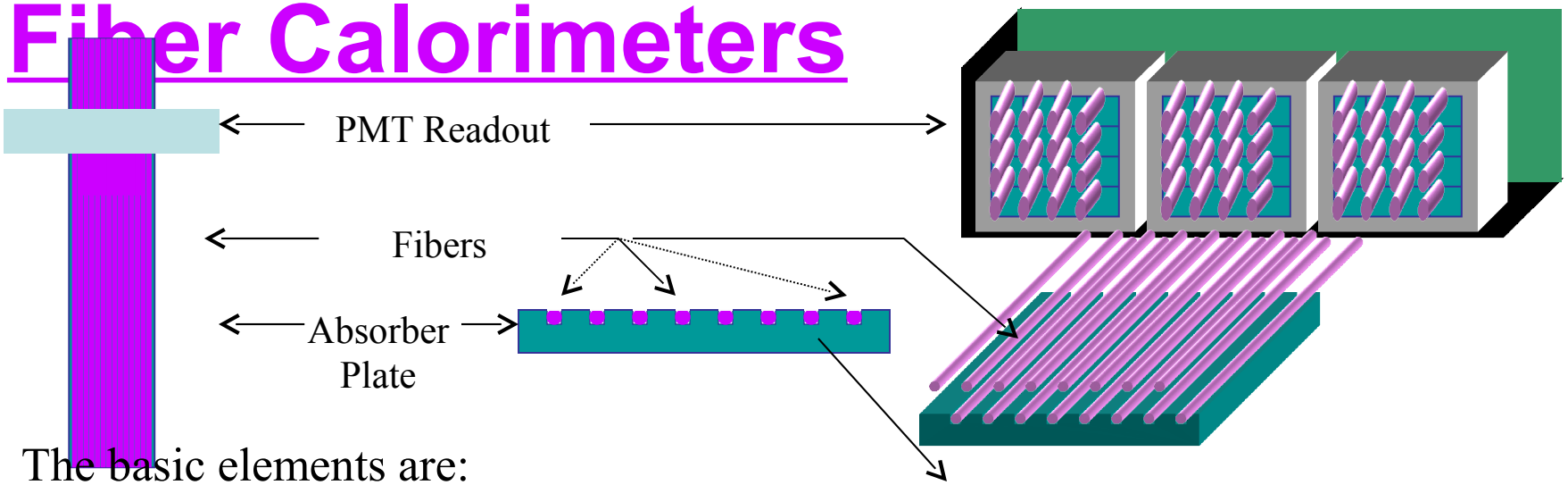
SiLite Inc.

Item	Description	Unit price	Units	Total
1	SPM diode	60.00	10	600.00
	Comments:			
	Shipping and handling	25.00		25.00
	Total invoice			**625.00**

Amplifier for SPM.



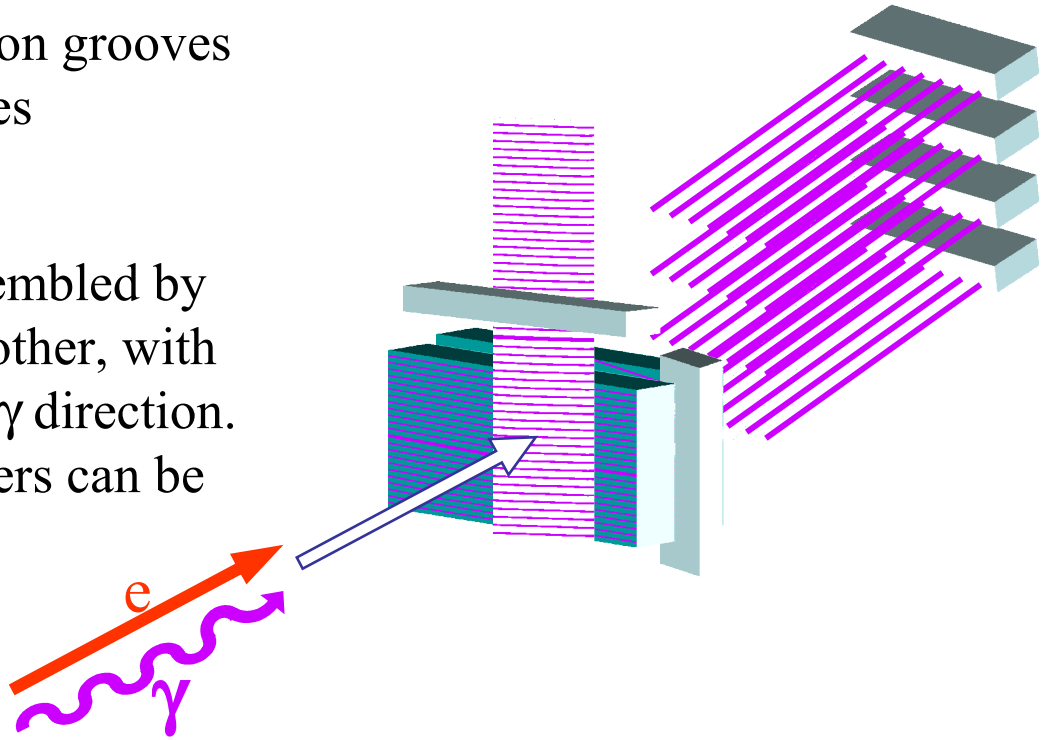
Fiber Calorimeters



The basic elements are:

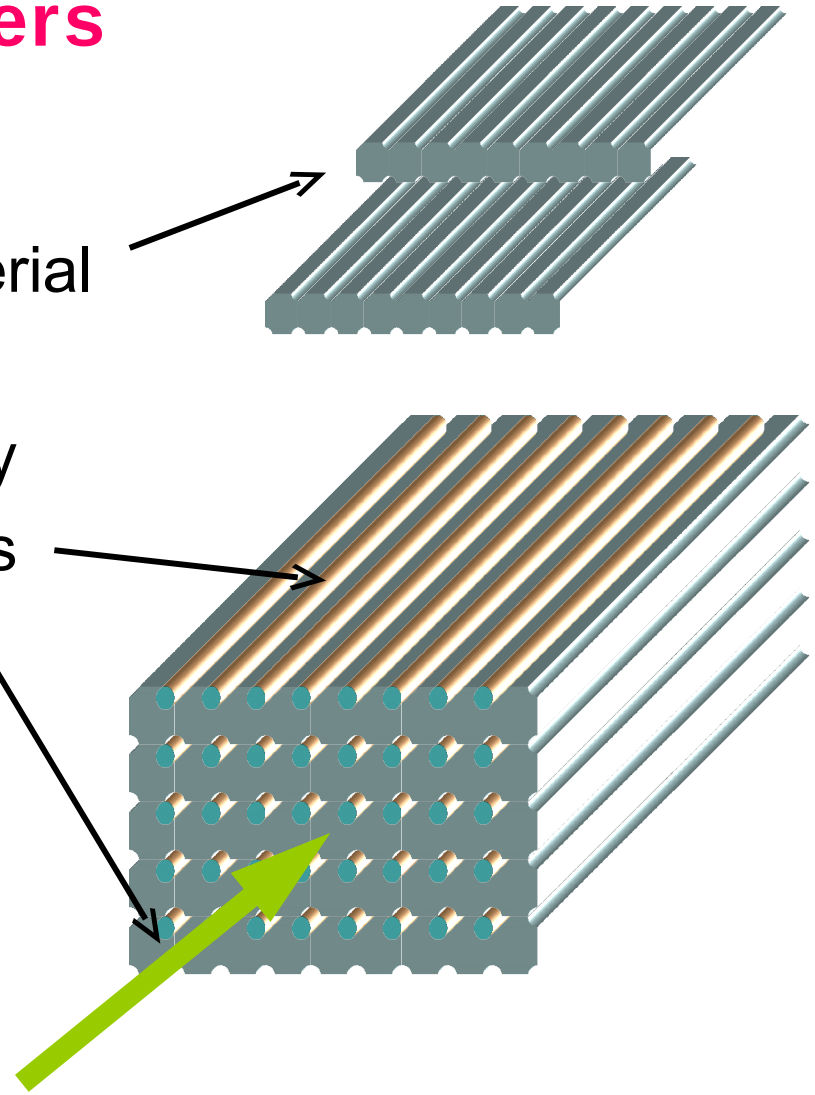
a) absorber plates with precision grooves
b) fibers inserted in the grooves
c) PMT reading out the fibers

Calorimeter modules are assembled by stacking plates on top of each other, with fibers running parallel to the e/γ direction. Few planes with transverse fibers can be used as pre-shower elements.

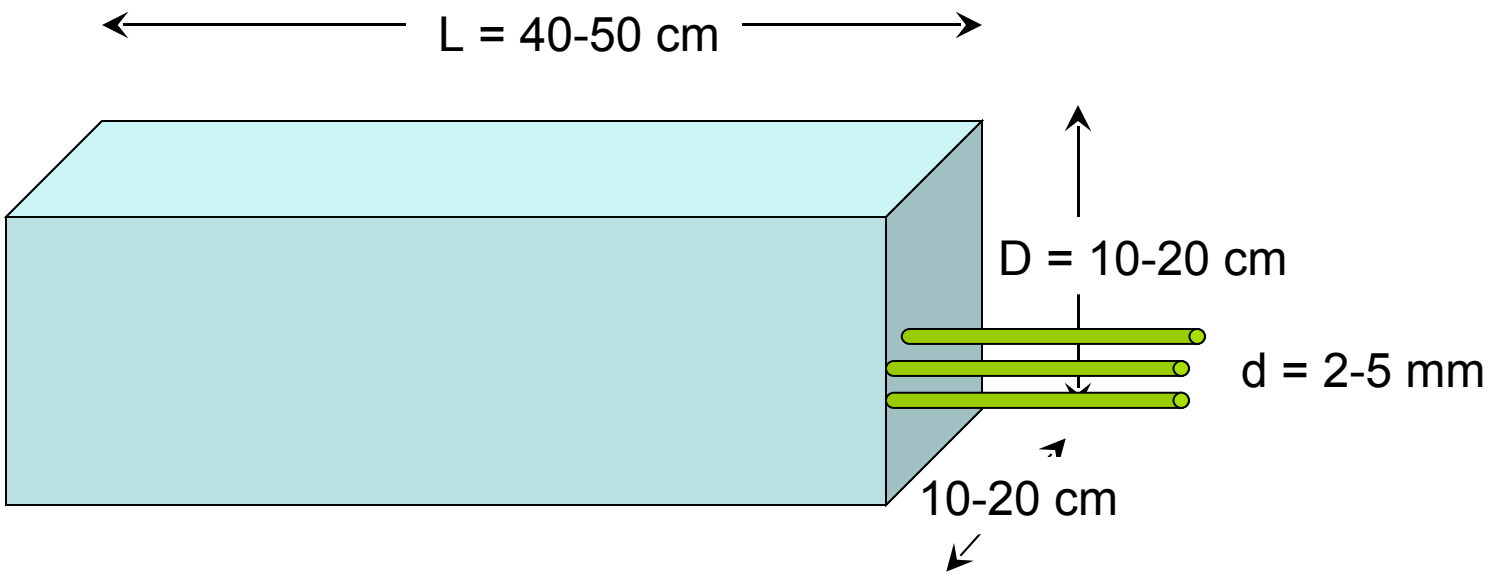


(Quartz) Fiber Calorimeters

- Grooved plates of absorber material
- Plates stacked to form a matrix
- Plates welded together for rigidity
- Quartz Fibers inserted in grooves
- Fibers along incoming particles
- Fibers read-out on opposite side
- Cherenkov light signal
- Main response to EM particles
- High granularity
- Fast response



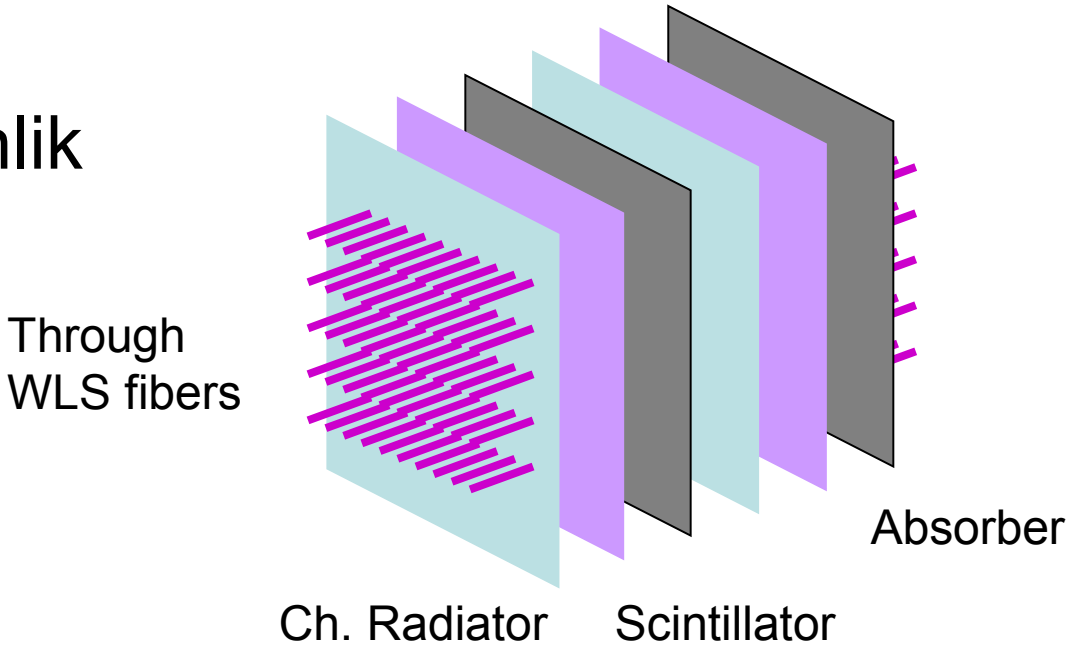
General size and shape (generic EM prototype)



- Pb matrix with long. grooves for fibers
- L = 20-30 Xo; D = 3-4 R_M
- d = 2-5 mm

Generic prototypes

- Composite Shashlik



- Crystal arrays

PbWO : ≈ 50 elements array +PMTs

Leadglass + Scitillator slabs

- Liquid scintillator