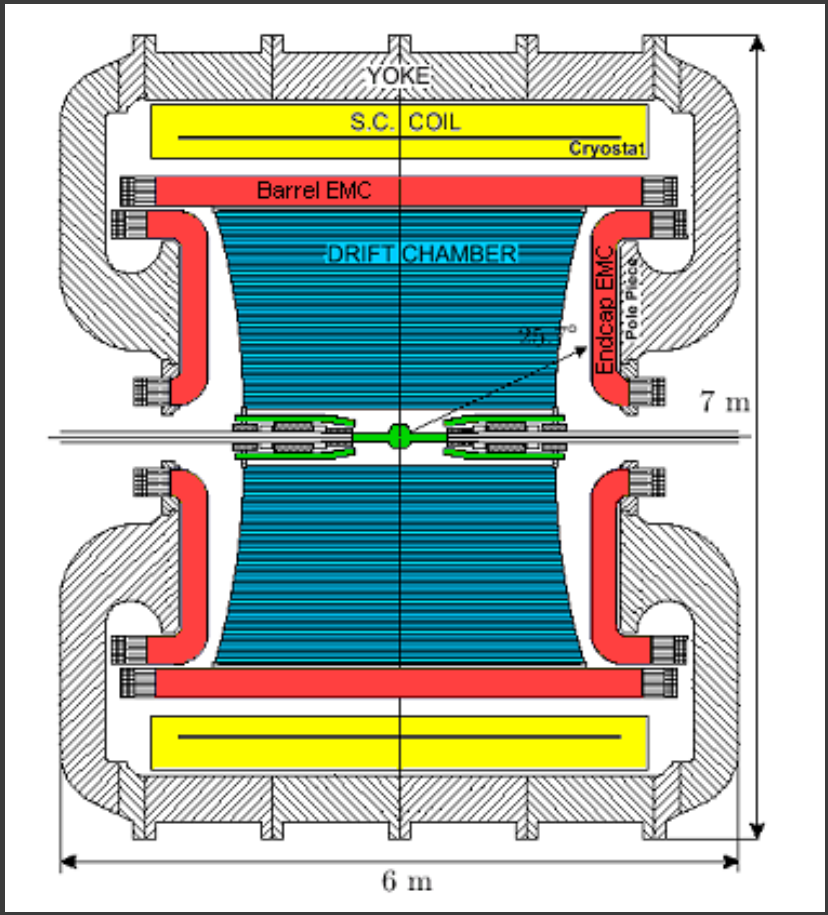
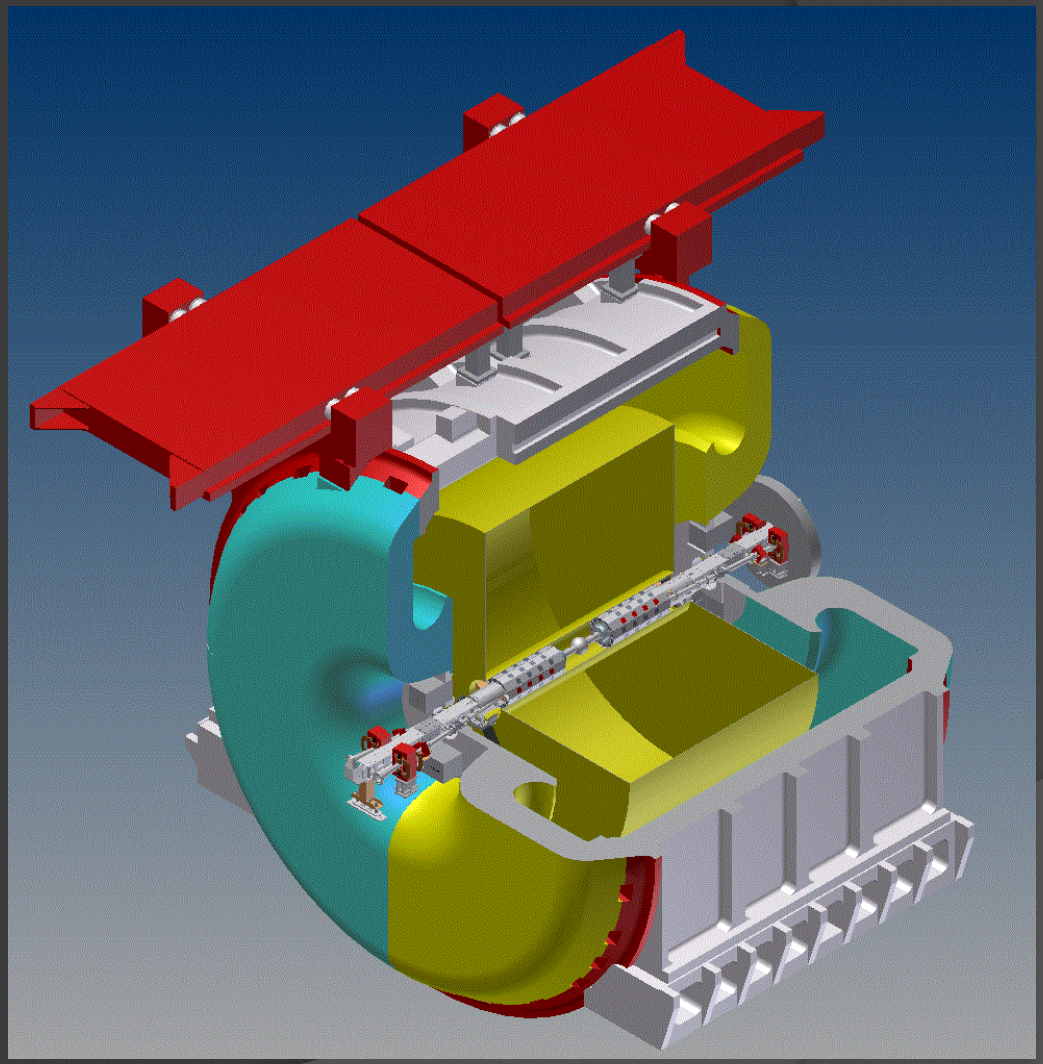
Danilo Domenici

IL TRACCIATORE INTERNO DI KLOE-2

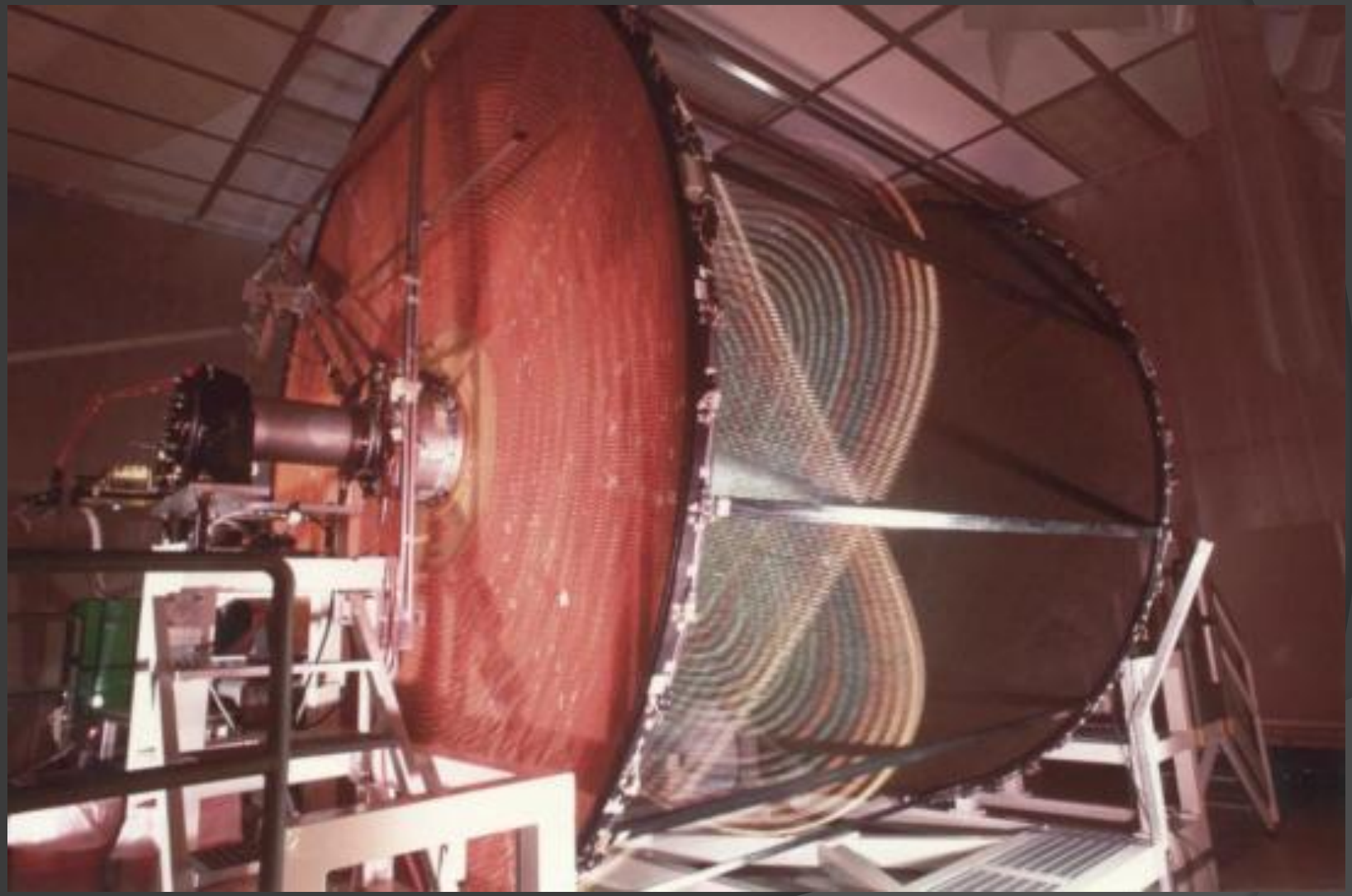
LNF Test Labs 2014

Il rivelatore KLOE

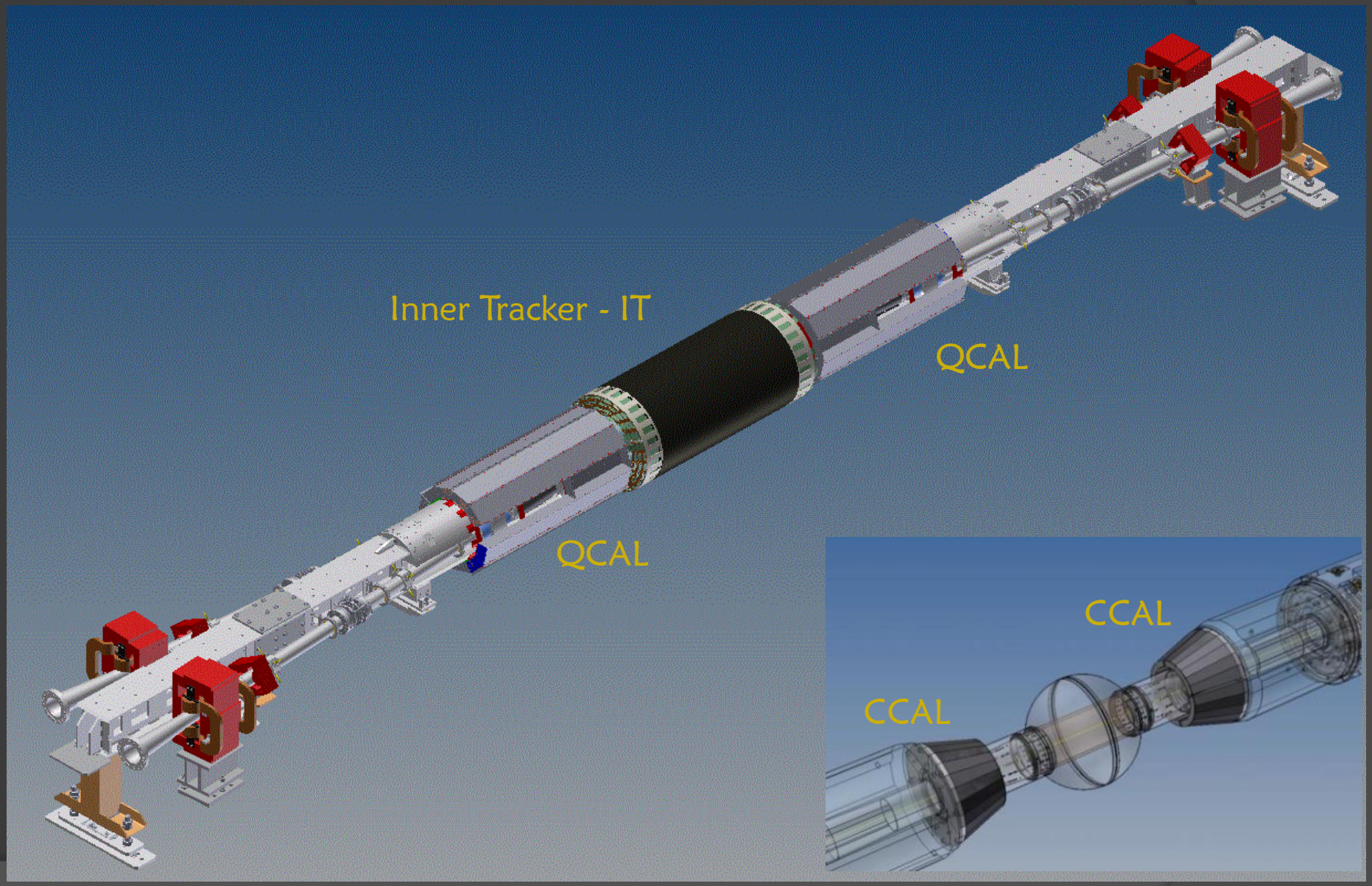




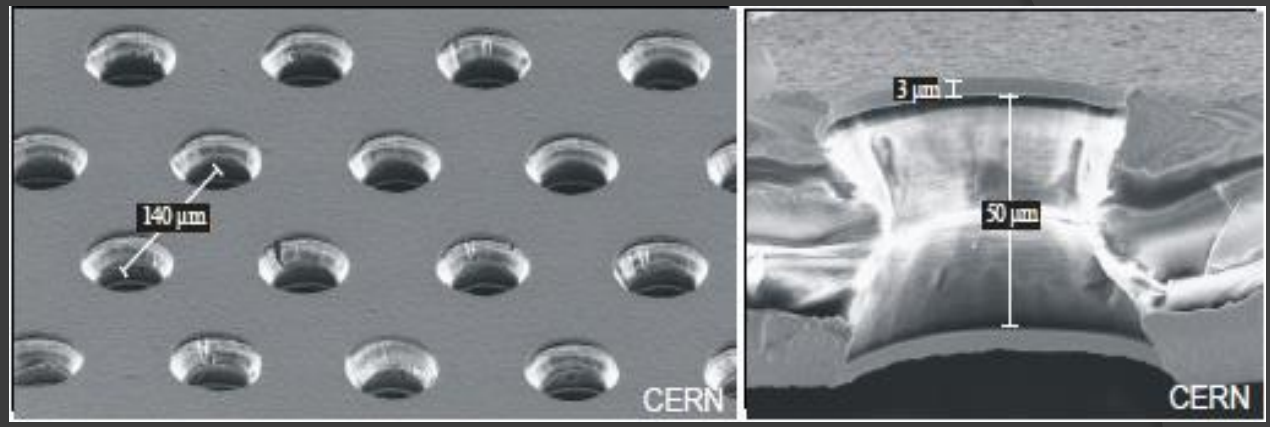
La Camera a Deriva



I nuovi rivelatori di KLOE-2

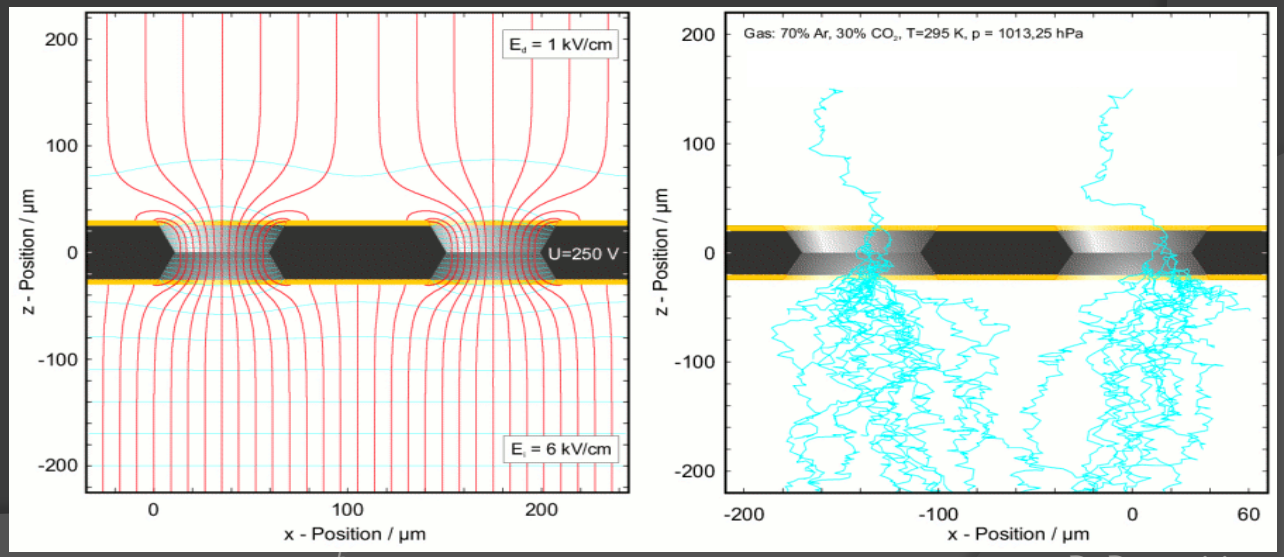


GEM: Gas Electron Multiplier

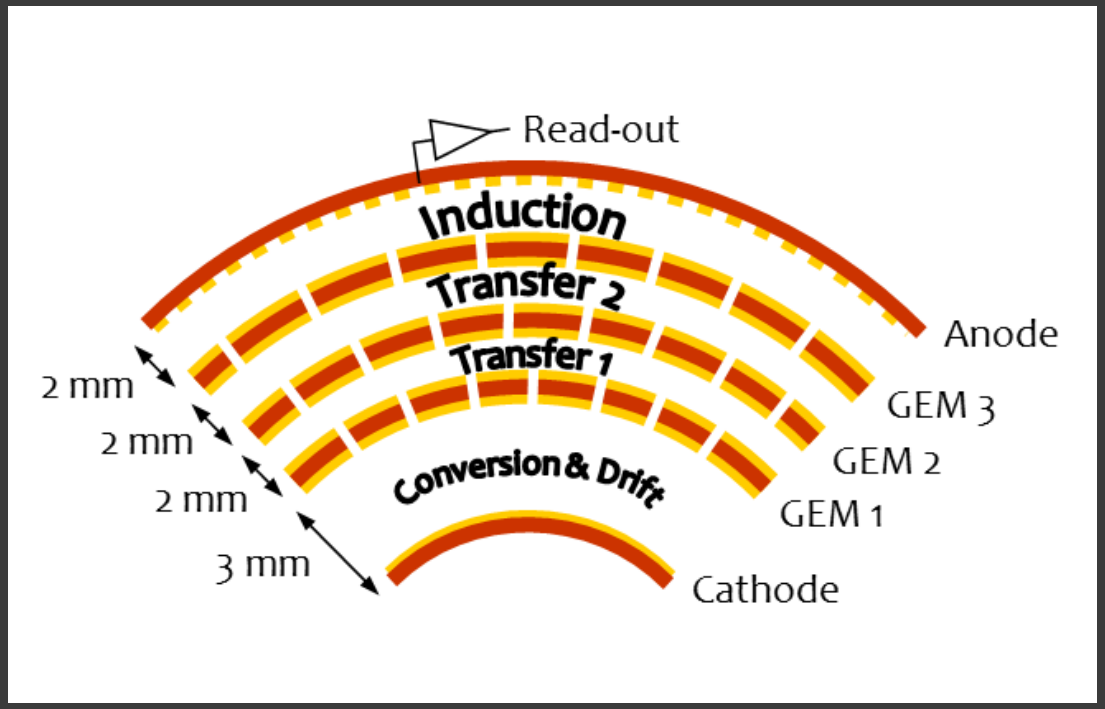


Un foglio sottile (50 µm) di Kapton con le facce ricoperte di Rame viene perforato con una matrice di micro-fori (diametro 70 µm) usando tecniche litografiche

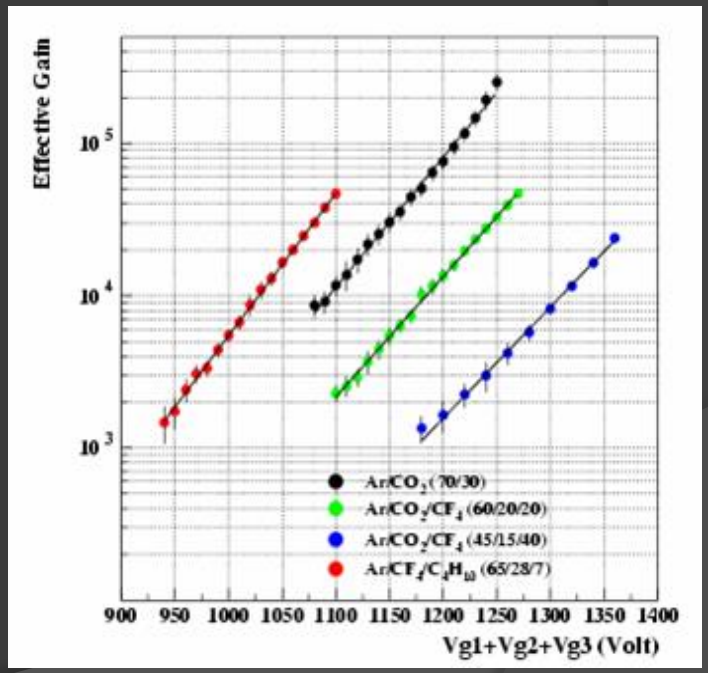
Applicando una tensione tra le facce (400 V) si crea un campo elettrico nei fori (100 kV/cm) che induce una moltiplicazione degli elettroni di ionizzazione



GEM: Gas Electron Multiplier



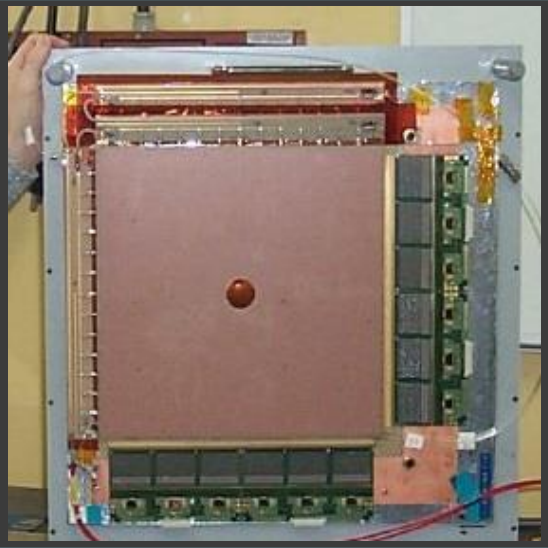
Guadagno tipico 10^4
Per 30 e- primari prodotti da una MIP si ottiene un segnale di 50 fC

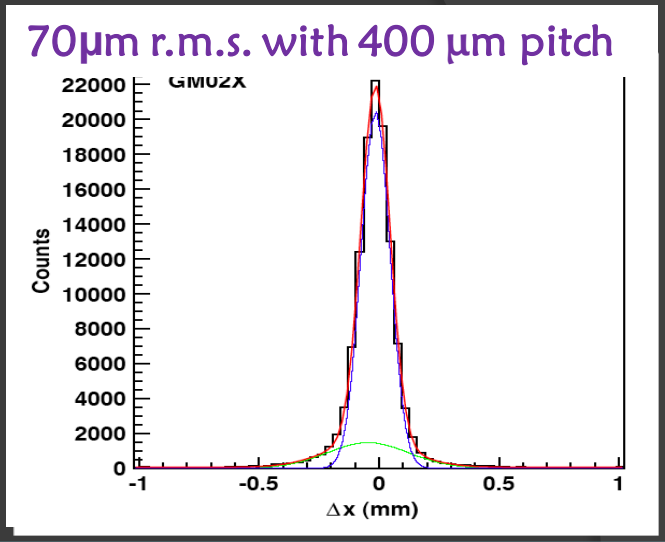


Un rivelatore a tripla-GEM è costituito da Catodo, 3 GEM in cascata
e l'Anodo di readout in un volume attivo di gas (es. Ar/CO_2)

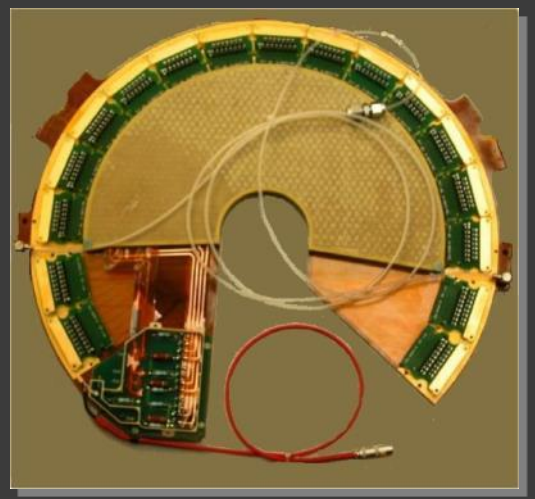
GEM applications in HEP: present

COMPASS 2001
(first use of GEM in large HEP experiment)
22 31x31 cm^2 triple-GEMs
analog XY strips readout with APV25





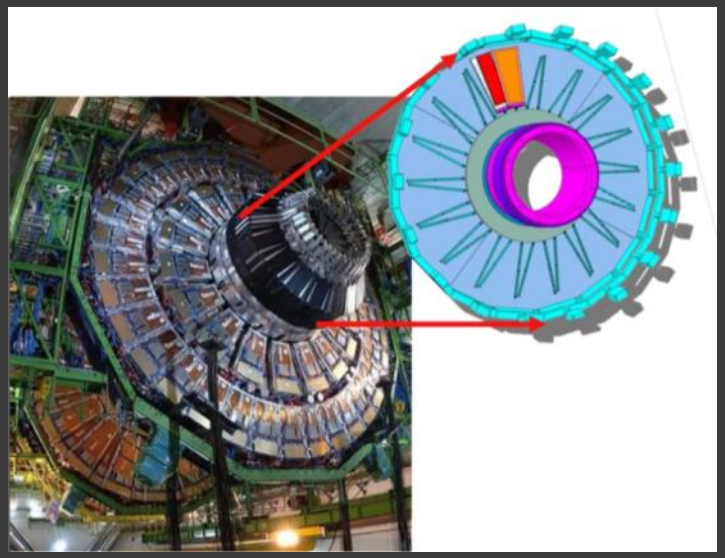
LHCb 2006
24 20x24 cm^2 triple-GEMs
digital pad readout
with CARIOCA-GEM

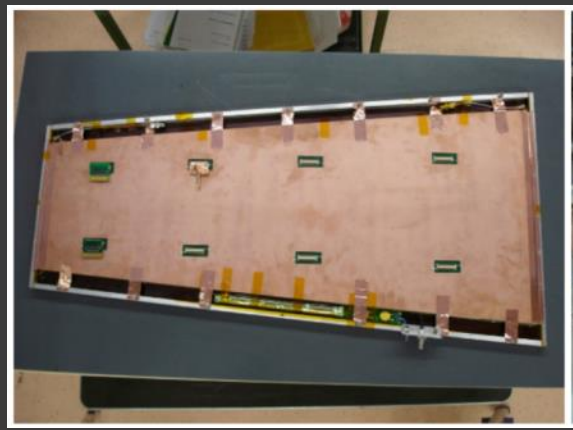


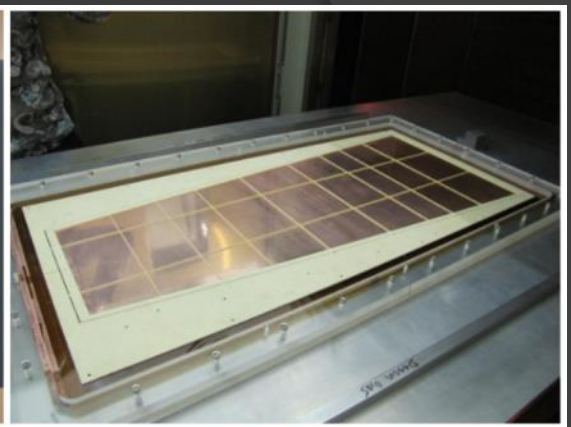
TOTEM 2006
40 ø15 cm triple-GEMs
digital rφ strips
readout with VFAT

KLOE 2013
4 Cylindrical triple-GEMs (ø 13 ÷ 20 cm)
digital XV strips readout with GASTONE

GEM applications in HEP: LHC upgrades





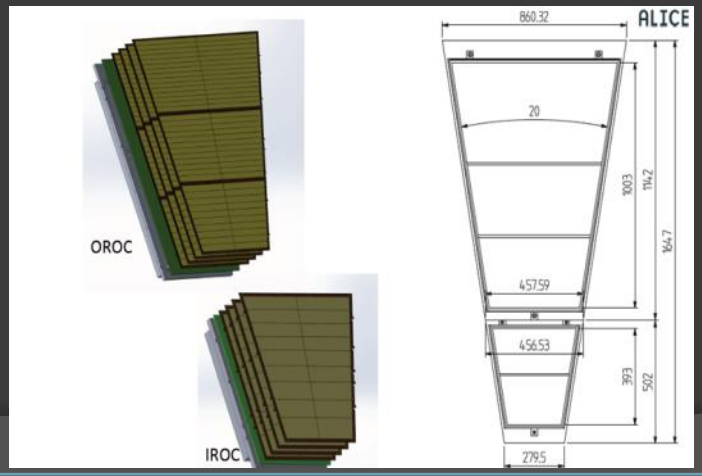


CMS Muon System upgrade

2 demonstrators will be installed by end 2016
Full GE1/1 station instrumented in LS2 (if approved)

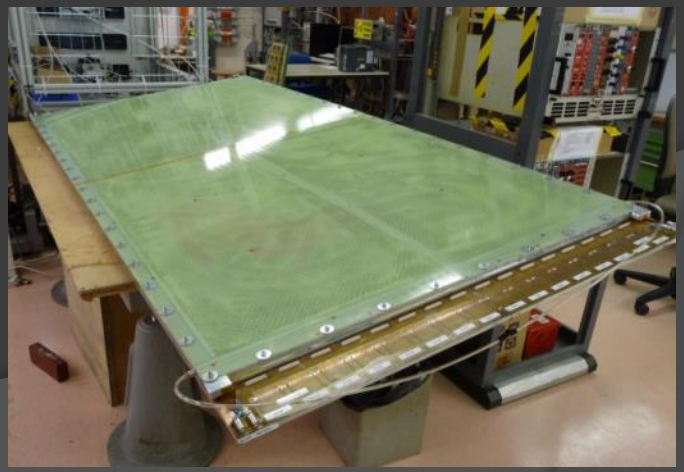
ALICE TPC upgrade

replace MWPC with MPGD
(GEM or MM to be decided)

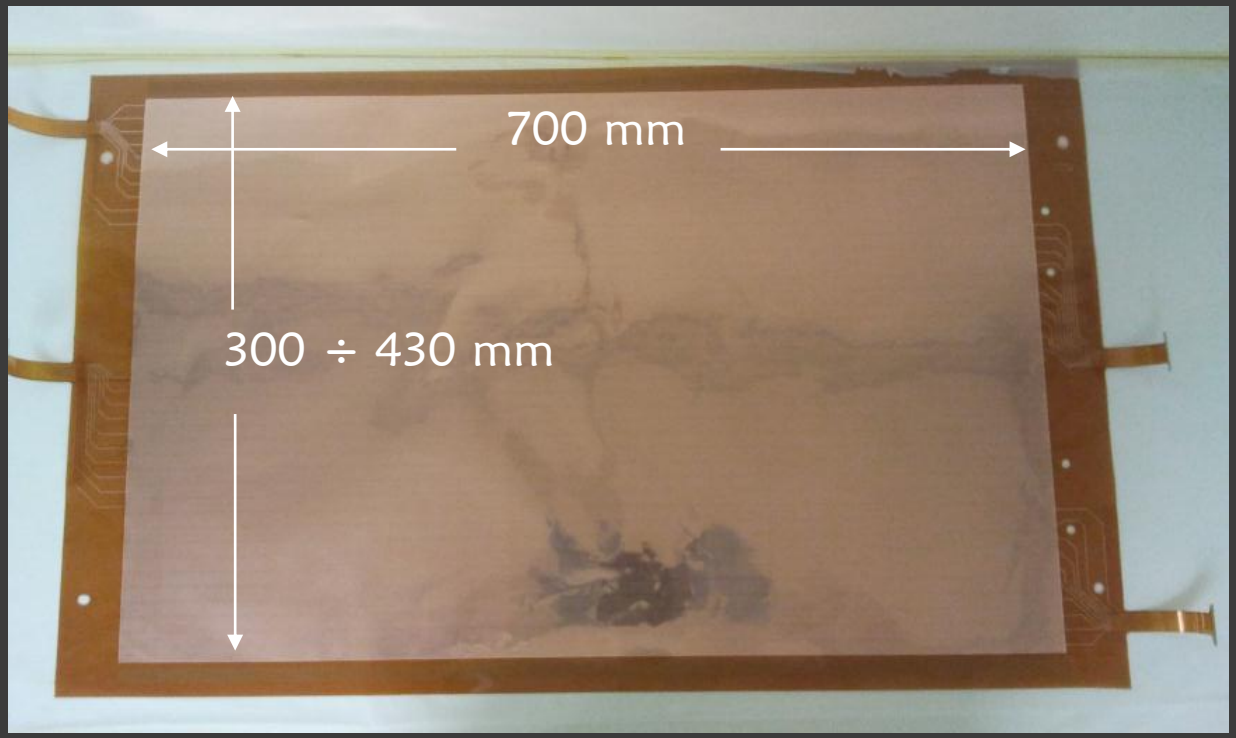


ATLAS Muon System upgrade

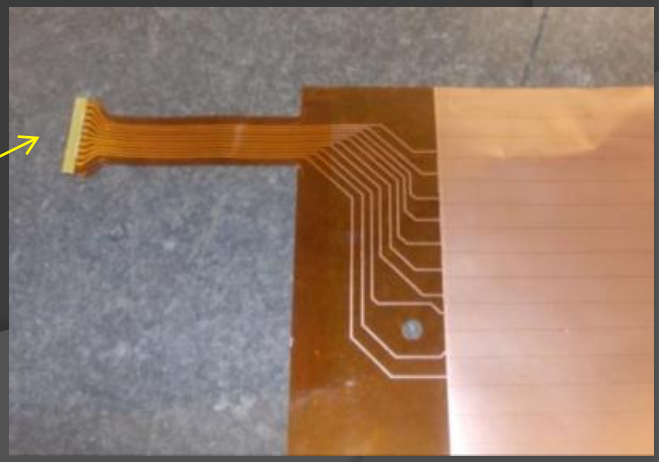
1280 m^2 of MicroMega will be installed in LS2
digital (and analog in future) redout with VMM



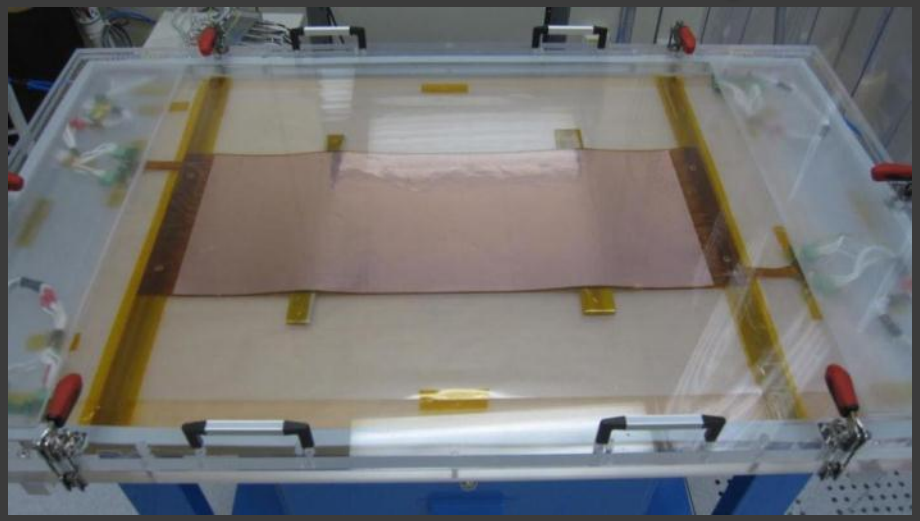
Disegno del foglio GEM di KLOE



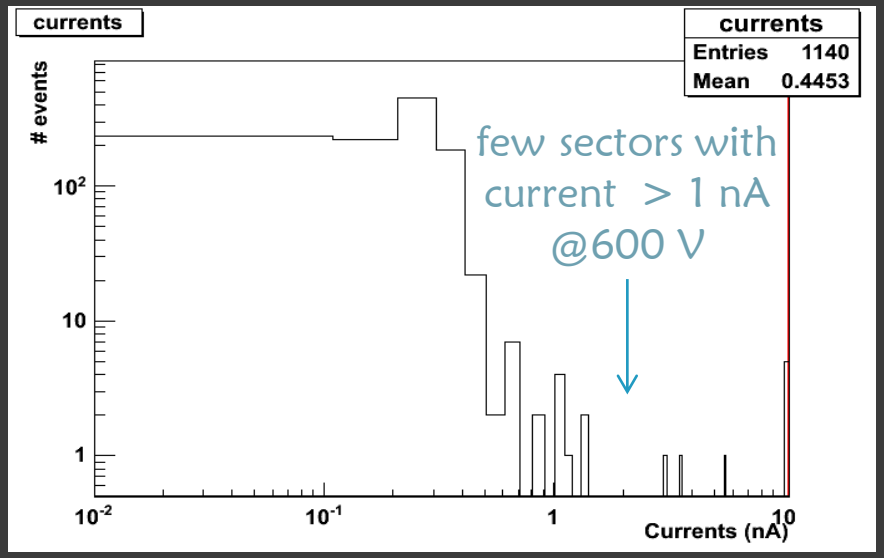
- Prodotto al laboratorio CERN-TE-MPE-EM
- Il lato top è diviso in 40 settori
- Connessioni HV raggruppate in 4 codine

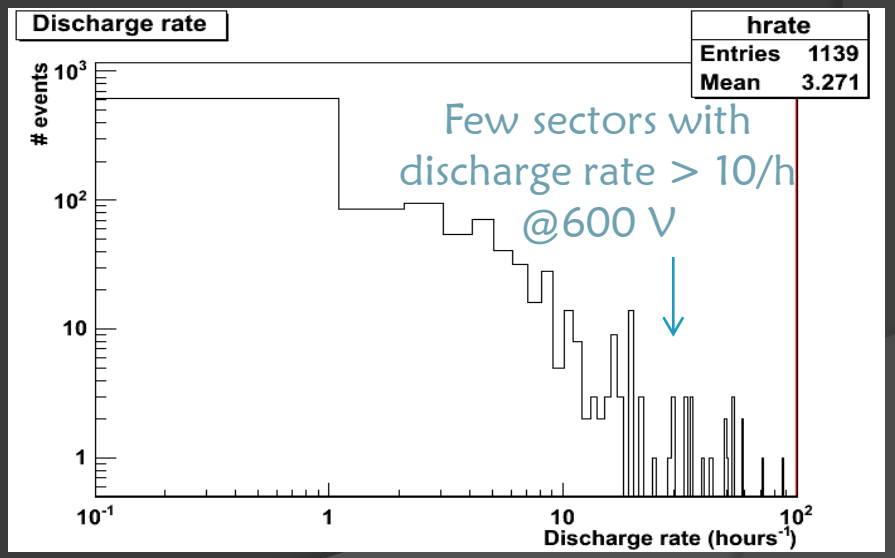


Test di qualità dei fogli



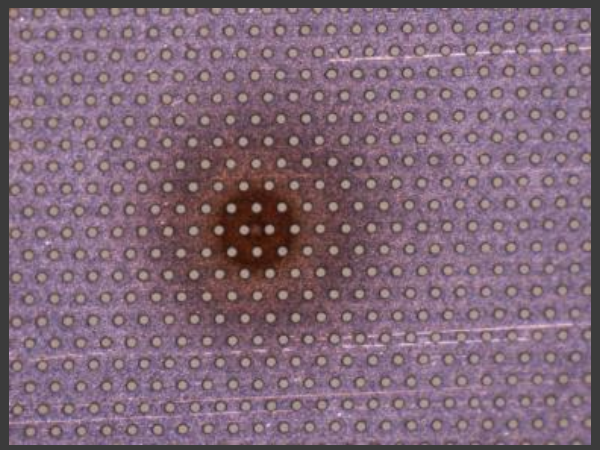
- Box in plexiglass a N_2 per ridurre RH sotto il 10%
- Ogni settore deve avere currente < 1nA @ 600V
- Rate di scarica misurato in un periodo di 1h

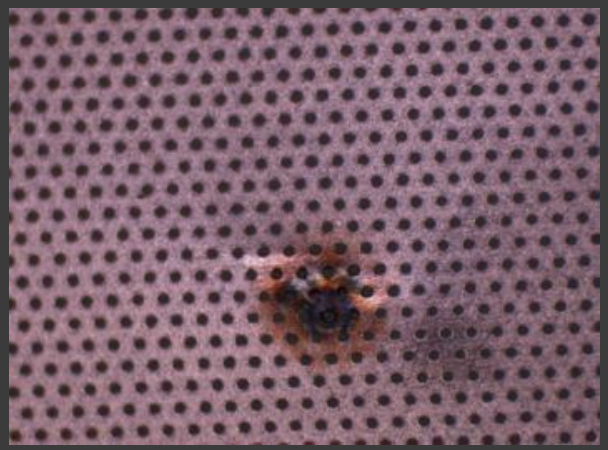


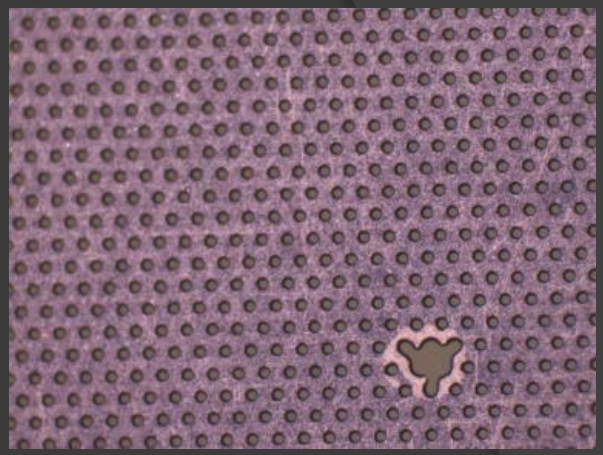


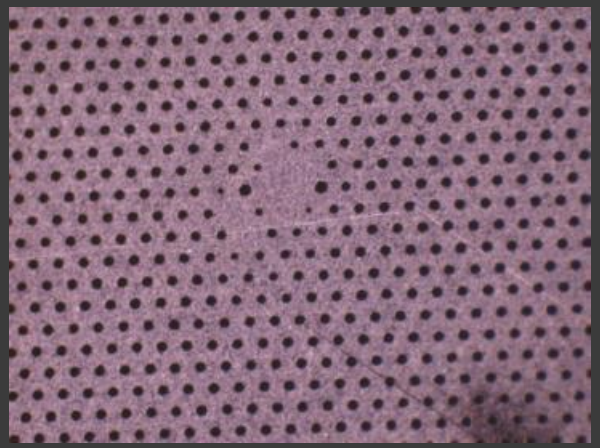
Final yield: 76% (12 bad foils over 50)

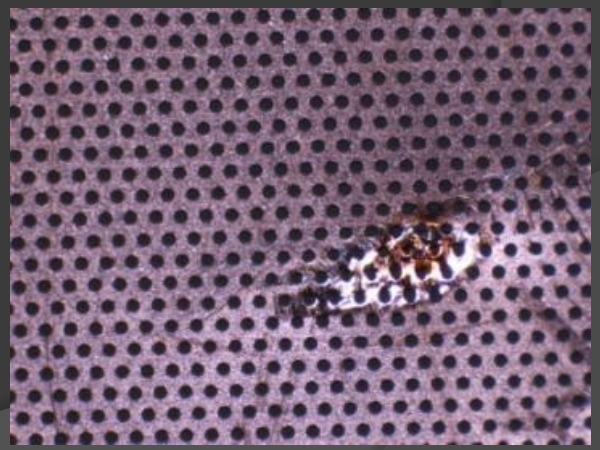
GEM al microscopio









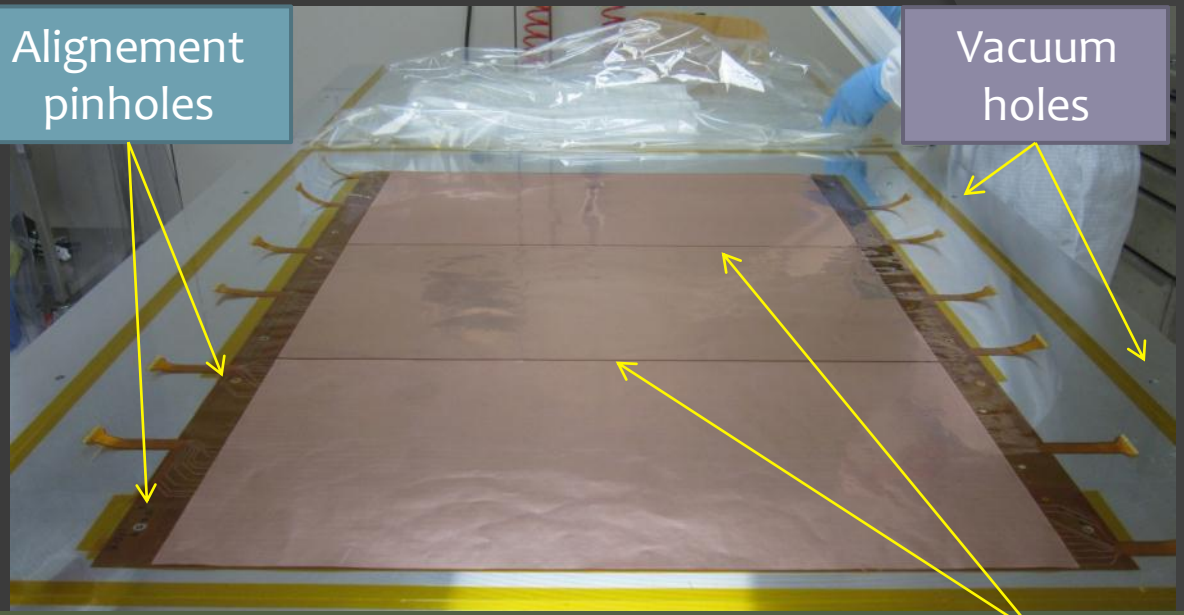


Realizzazione di una GEM cilindrica

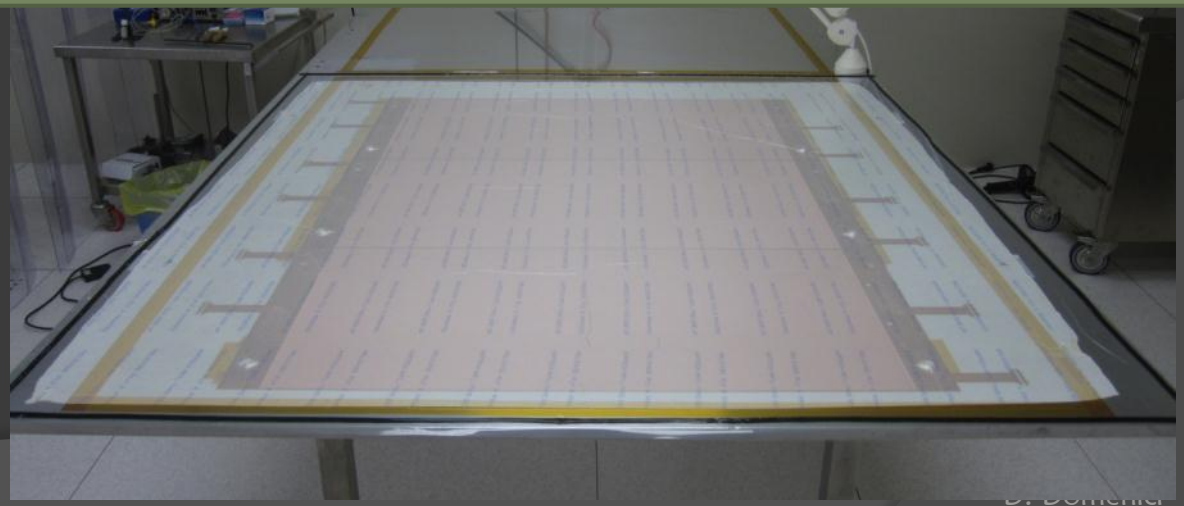
Epoxy glue (Araldite 2011) is distributed by hand on a 2 mm wide line

Alignement pinholes

Vacuum holes



3 GEM foils are spliced together with a 3 mm overlap and closed in a vacuum bag (0.9 bar)

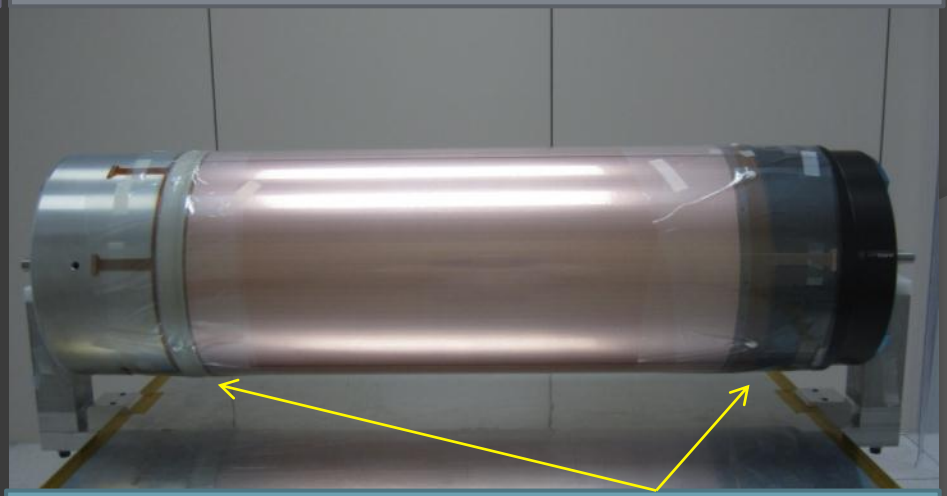


Realizzazione di una GEM cilindrica

GEM is protected with a Mylar sheet and wrapped on the cylindrical mold

Transpirant tissue (PeelPly from RiBa) is placed around to distribute vacuum

Vacuum bag envelope

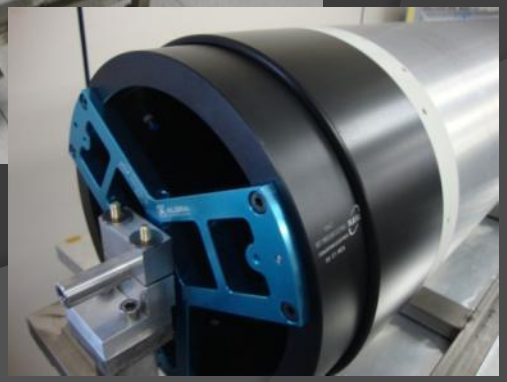


Final cylindrical GEM with internal and external rings

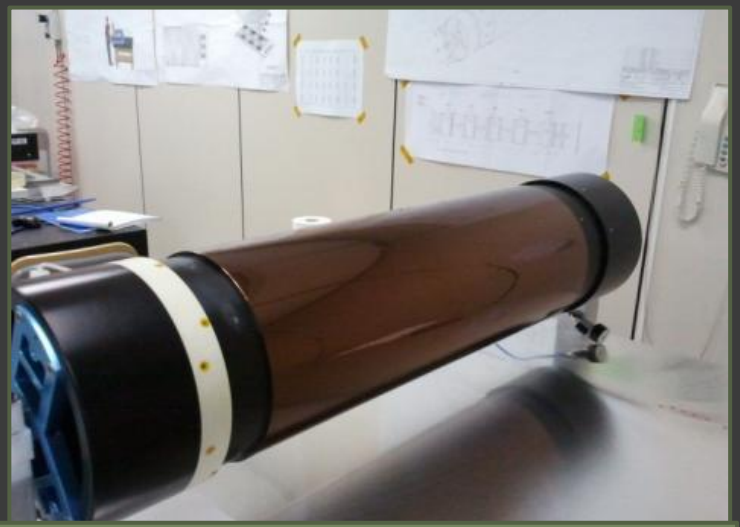
Stampi clindrici e anelli di supporto

Aluminum/Teflon molds from ALGRA

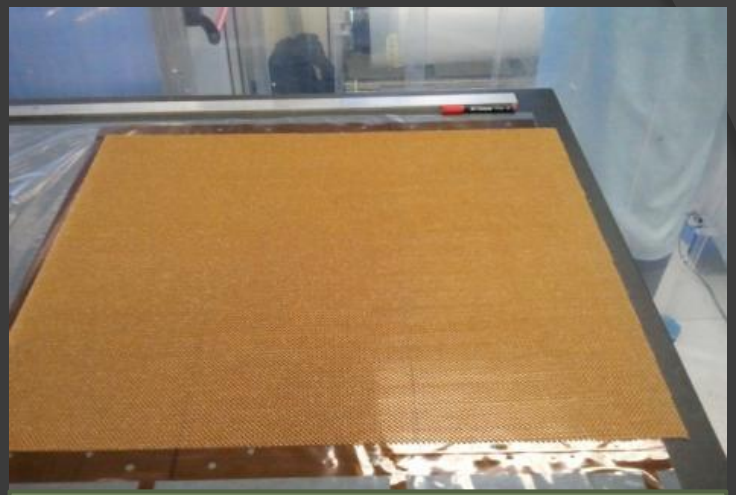
Durostone
Fiberglass/Epoxy
rings from RESARM



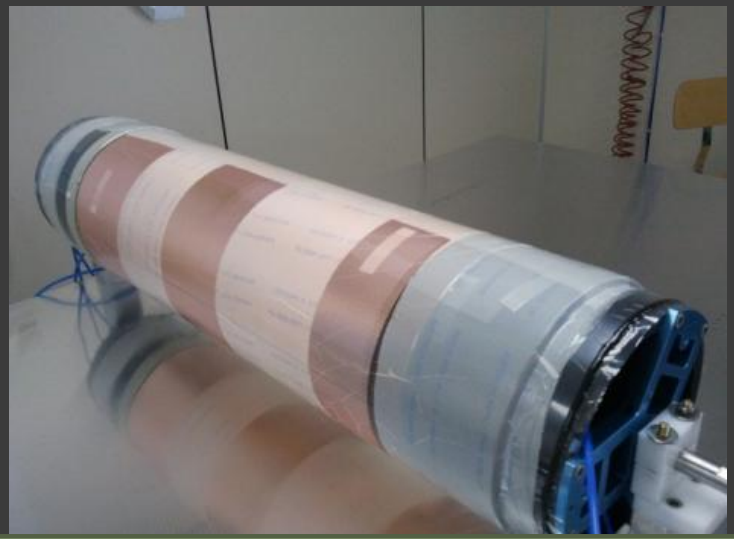
Realizzazione del Catodo cilindrico



Inner layer is glues on the mold



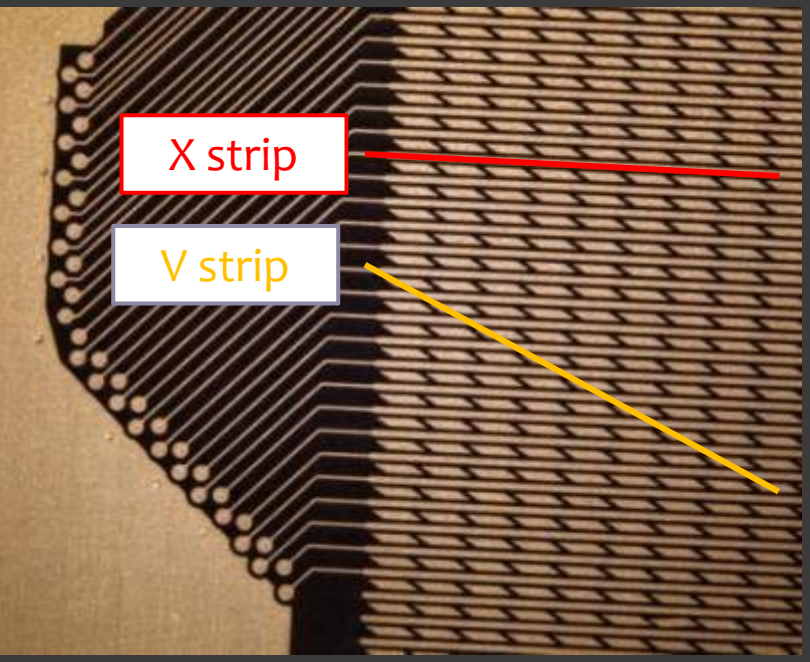
Nomex honeycomb is glued on the cathode foil



Cathode is rolled on the mold and glued in a vacuum bag

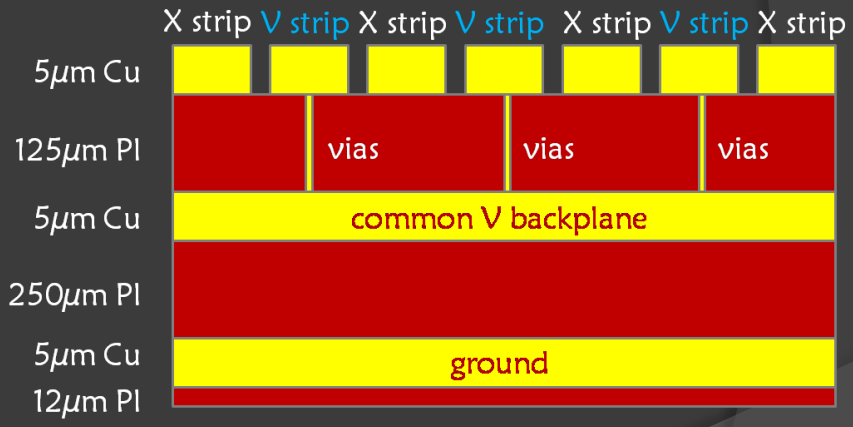
Cathode is ready

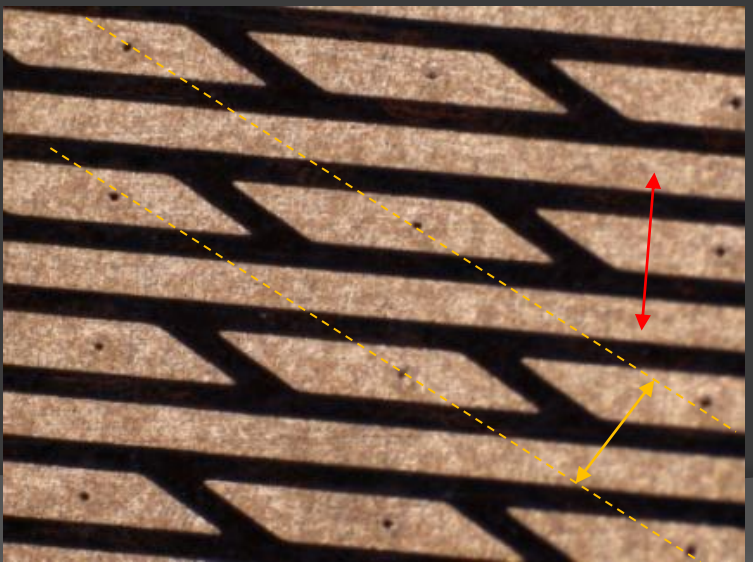
Anodo di readout



Readout plane is realized at CERN TE-MPE-EM
It is a kapton/copper multilayer flexible circuit
Provides 2-dimensional readout with XV strips on the same plane

- X are realized as longitudinal strips
- V are realized by connection of pad through conductive holes and a common backplane
- Pitch is 650 μm for both

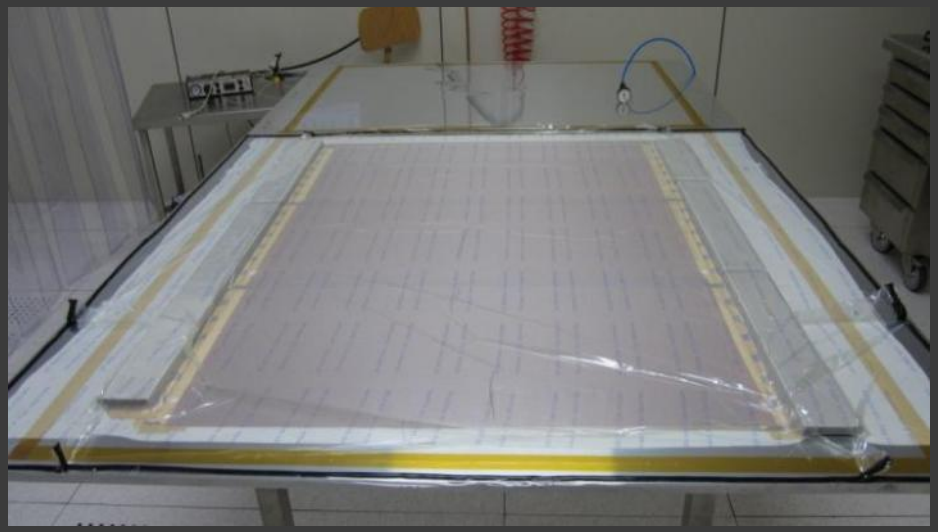




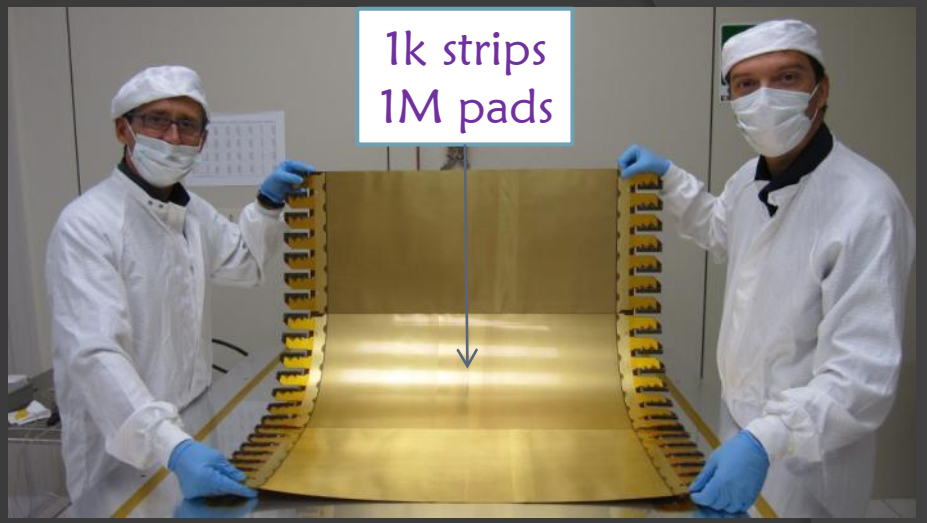
X pitch 650μm → X res 190μm

V pitch 650μm → Y res 350μm

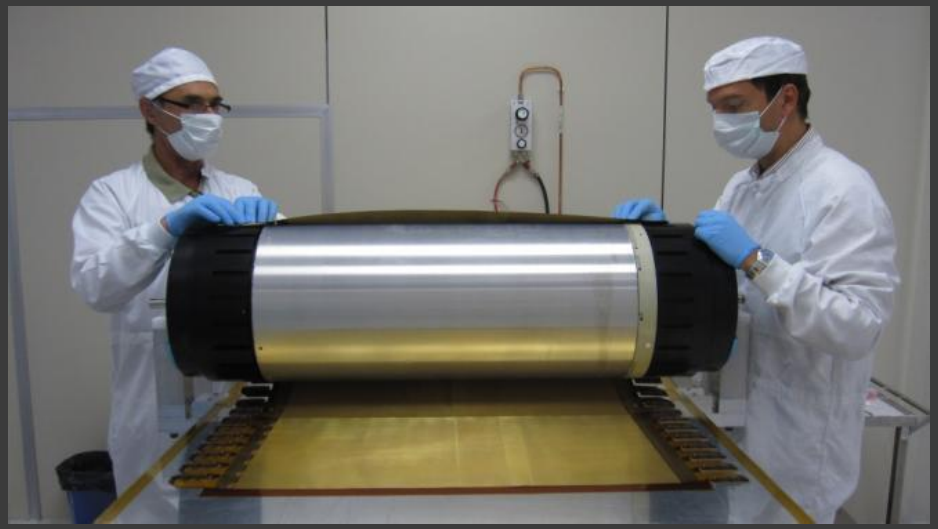
Realizzazione del Catodo cilindrico



Incollaggio planare sotto vuoto



Foglio finale lungo ~ 1 m



Avvolgimento sullo stampo cilindrico

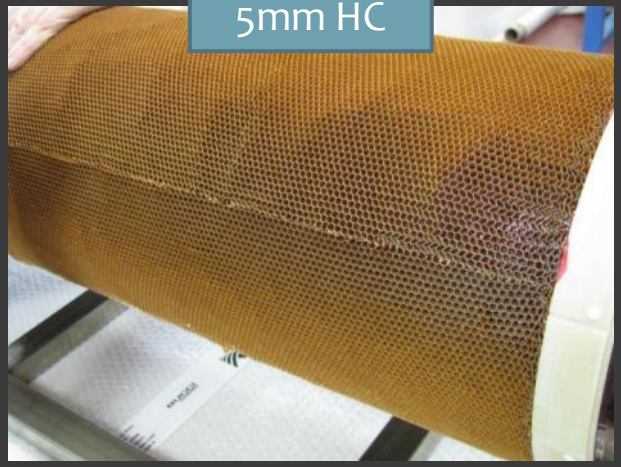
Incollaggio finale sotto vuoto

Laminazione del readout in CF

- The readout is shielded with a very ligth Carbon fiber composite structure realized by RiBa Composites, Faenza, IT
- The shield is composed by a sandwich of two 90 μm thick carbon foils prepreg with epoxy spaced by a 5 mm thick Nomex honeycomb

first 90μm CF skin

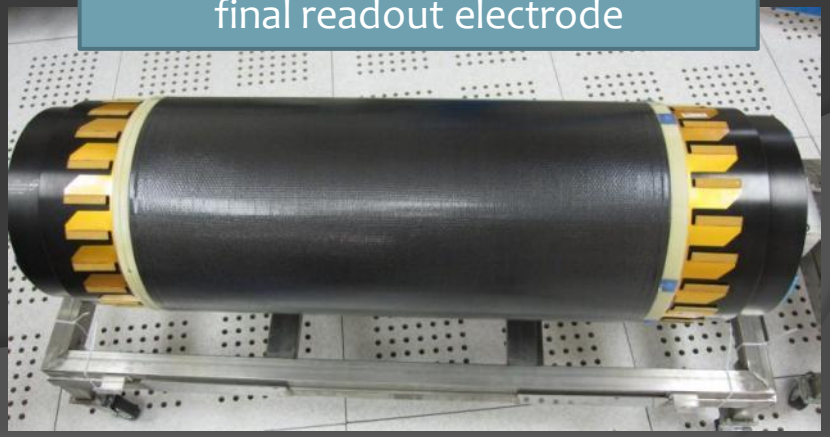
5mm HC



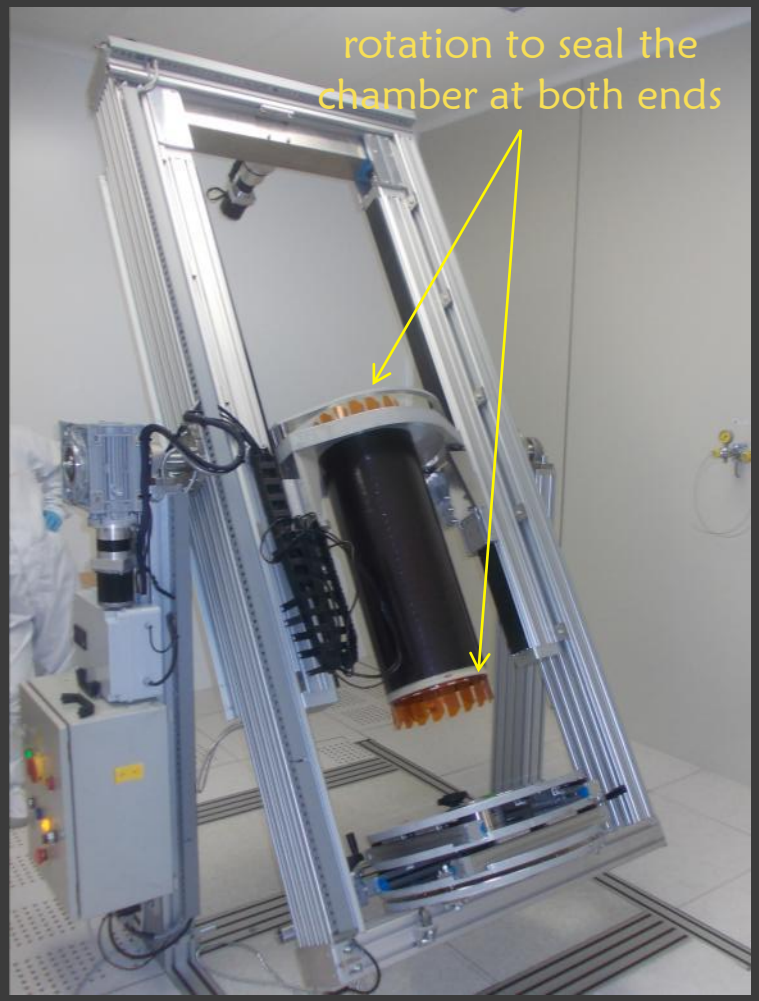
second 90μm CF skin

curing 24h in autoclave

final readout electrode

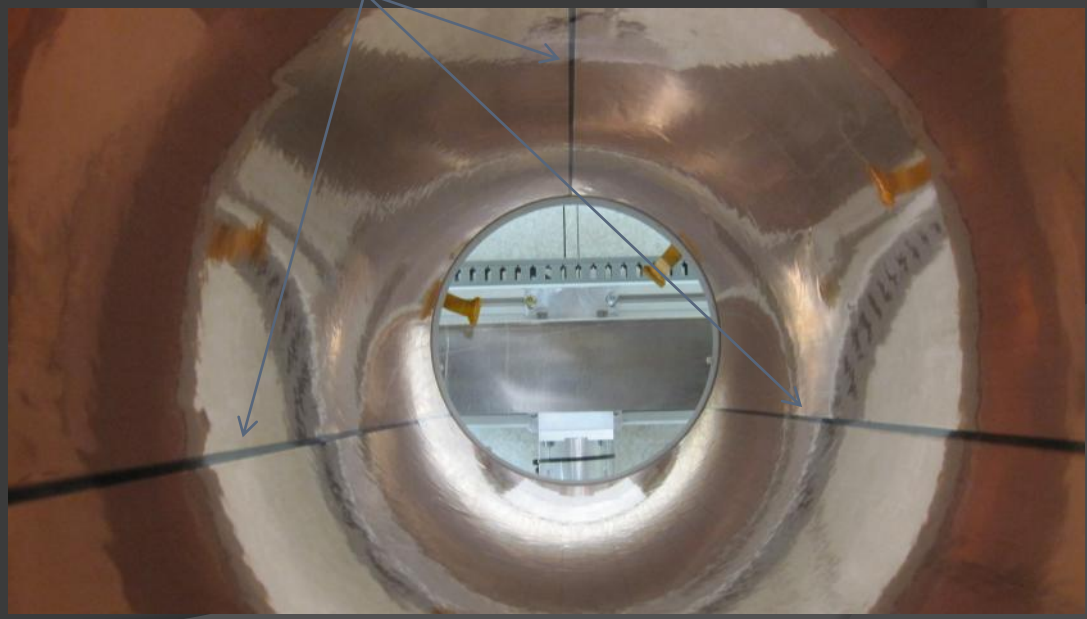


Assemblaggio di una tripla-GEM



A Vertical Insertion Machine has been built to assembly the 5 electrodes of a Cylindrical-GEM

3 glued overlap zones

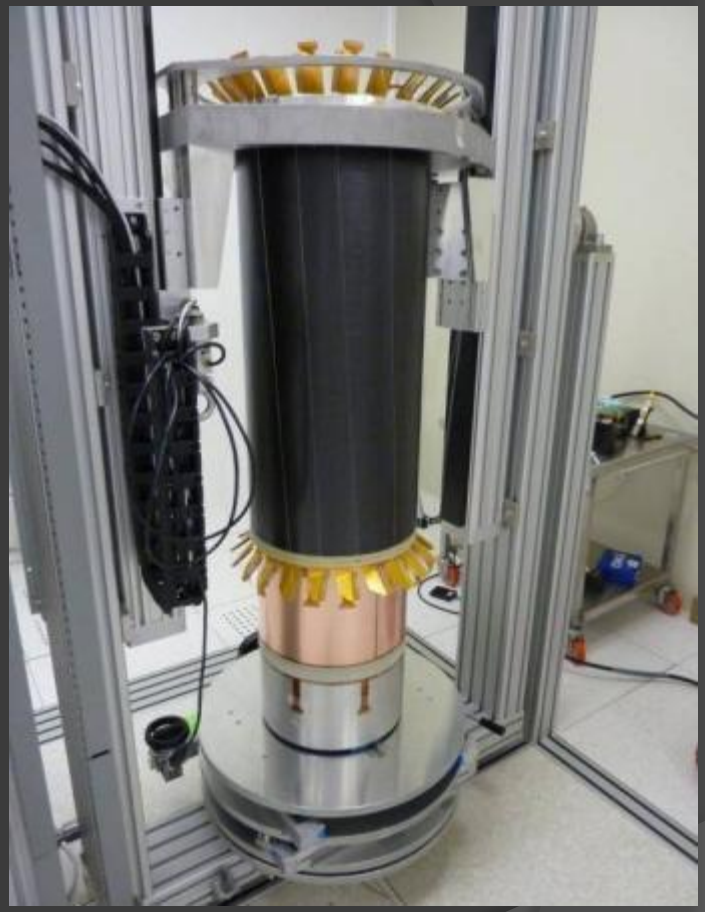


vertical movement precision: 100μm/1.5m

Assemblaggio di una tripla-GEM

The GEM is fixed at the bottom of the insertion machine with its mold. Redout is fixed to the top

Both electrodes are axially aligned with precision of 0.1mm/1.5m



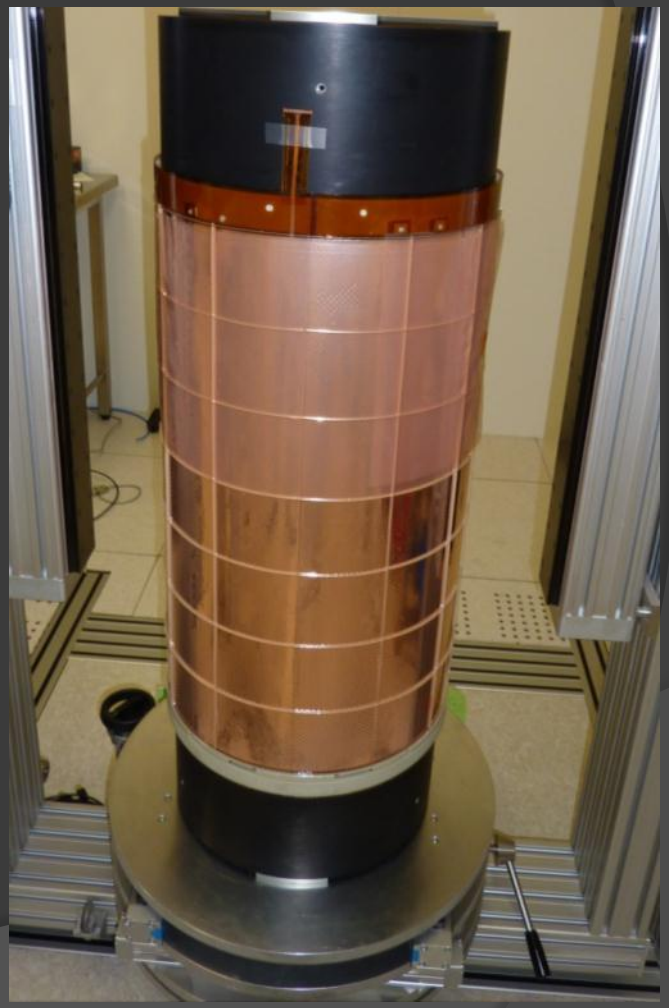
Readout is moved down around the GEM. Eventually the mold is extracted. Procedure is repeated for all electrodes

Griglia spaziatrice in PEEK

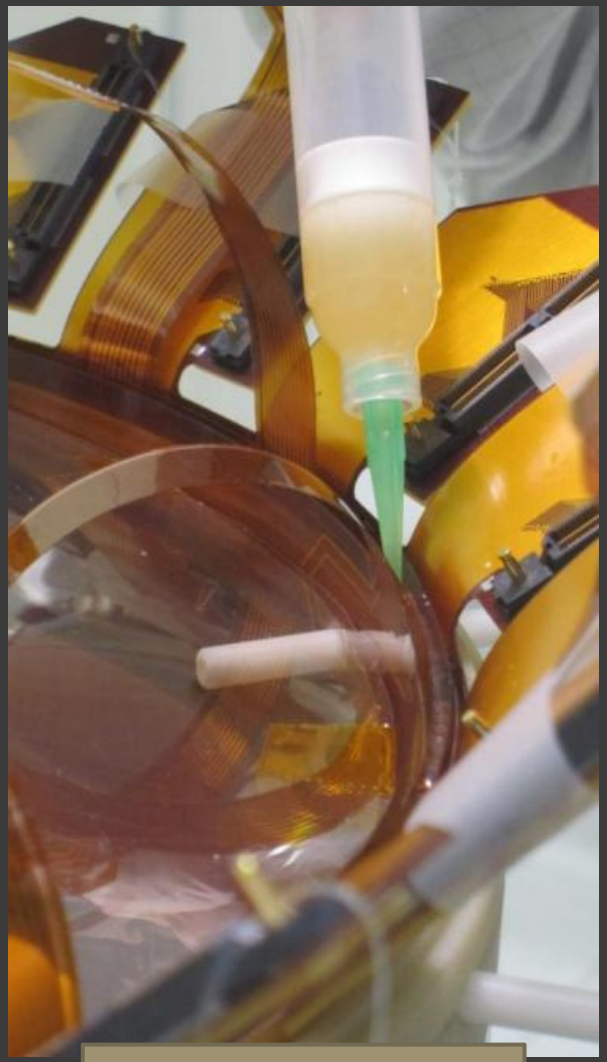
- To avoid possible relaxation of the gaps due e.g. to thermal expansion of the foils, we fix a spacing grid on the GEMs (only for Layers 3 and 4)
- It is realized by assembling 8 rings and 12 rods of 300 μm thick PEEK

PEEK grid assembled

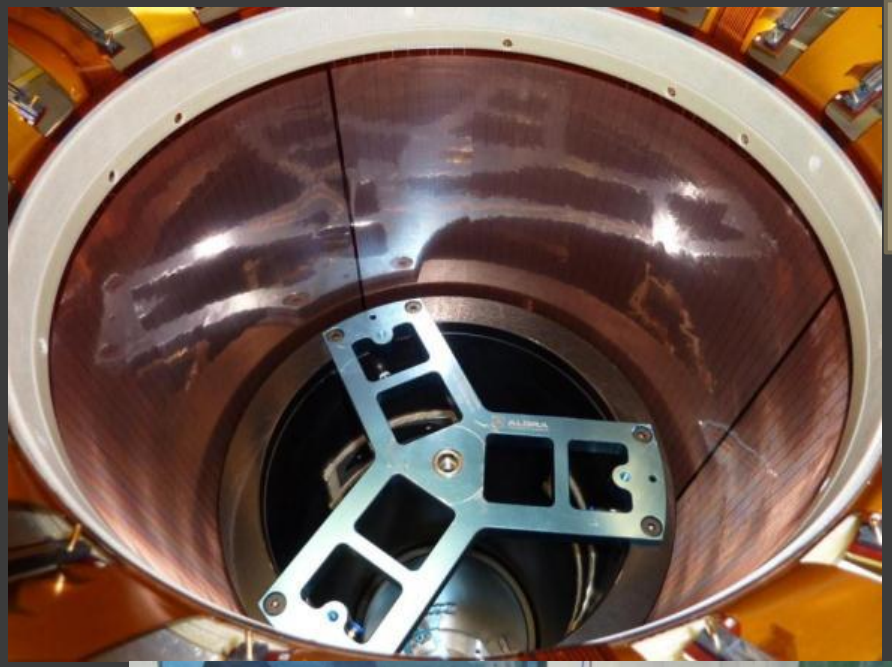
grid fixed on the GEM



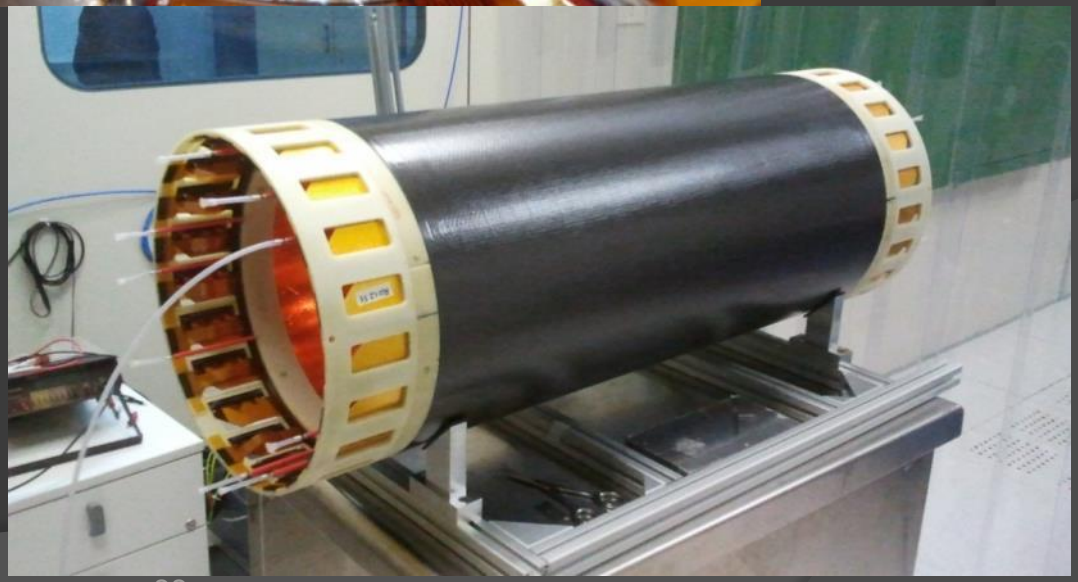
Dettagli dell'assemblaggio



Detector is sealed by an epoxy flow



Internal GEM surface with the anular FR4 flange



Cylindrical-GEM Inner Tracker

4 cylindrical-GEM detectors

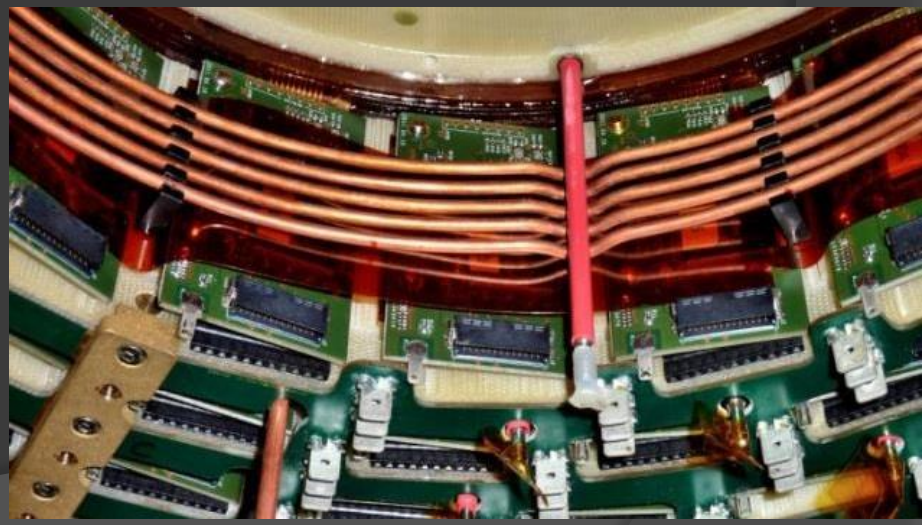
41 cm | 36 cm | 31 cm | 26 cm

IT FEE: Gastone Chip

Technology	0.35 CMOS - no radhard
Sensitivity (pF)	20 mV/fC
Z_{IN}	400 Ω (low frequency)
C_{DET}	1 – 50 pF
Peaking time	90 – 200 ns (1-50 pF)
Noise (erms)	800 e^- + 40 e^-/pF
Channels/chip	64
Readout	LVDS/Serial
Power consum.	≈ 0.6 mA/ch

128 channels
GASTONE Board

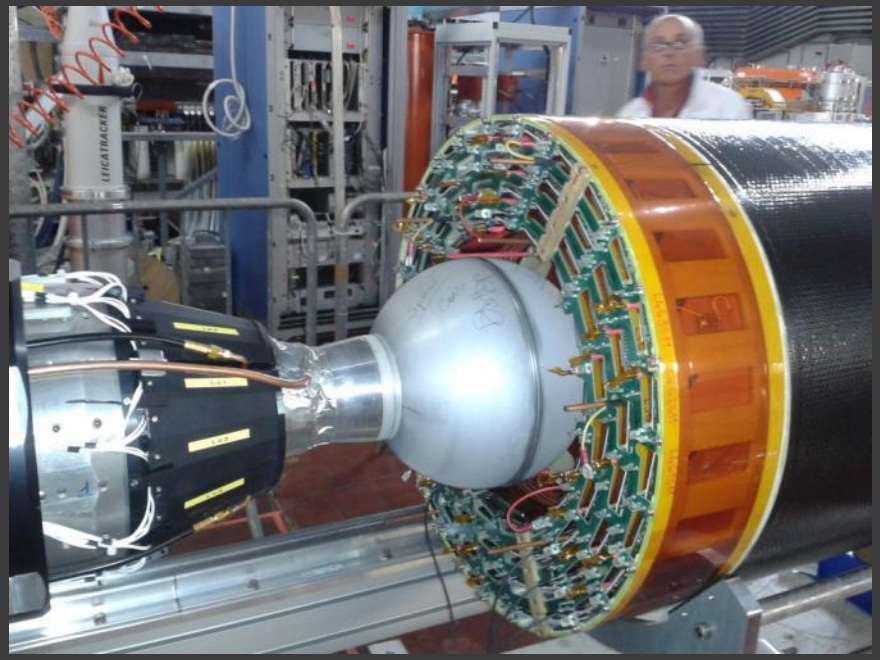
- Mixed analog-digital circuit
- Low input equivalent noise, low power consumption and high integrated chip
- 4 blocks:
  1. charge sensitive preamplifier
  2. shaper
  3. leading-edge discriminator
  4. monostable



Il tracciatore assemblato

3.14
2013

Montaggio sulla Beam-pipe

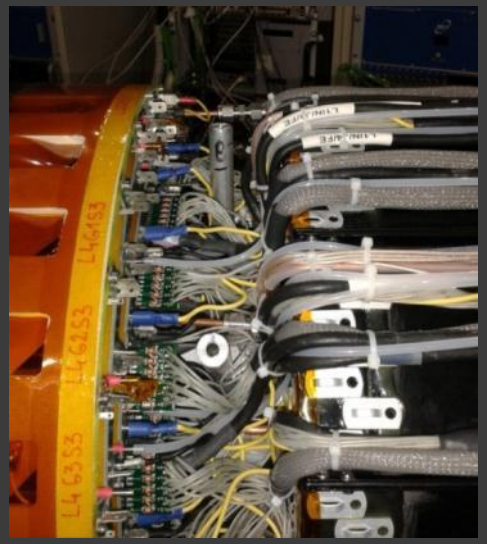


La nuova IR di DAFNE

Cablaggio dell'IT

Each IT side has:

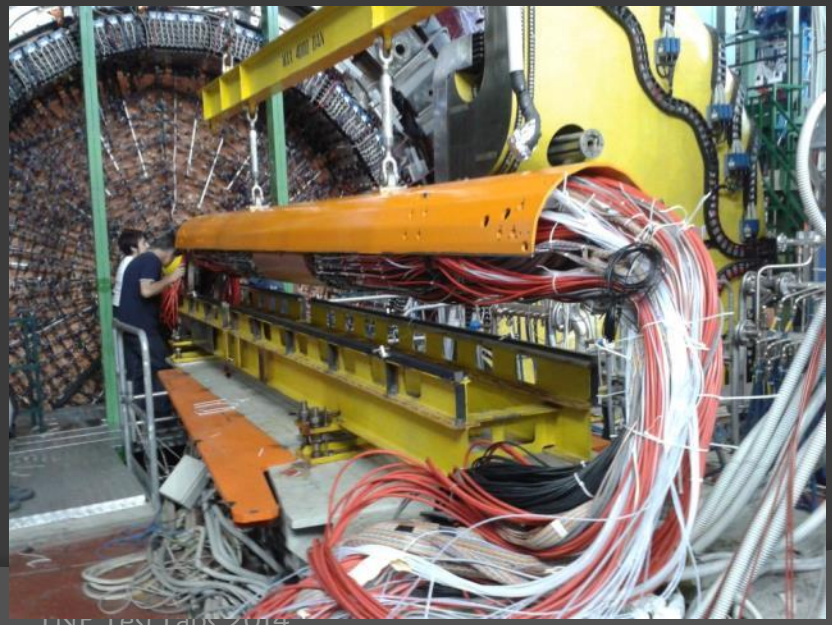
- 90 readout cables
- 69 HV cables
- 36 gas tubes
- 8 cooling tubes
- 6 temp. probes cables

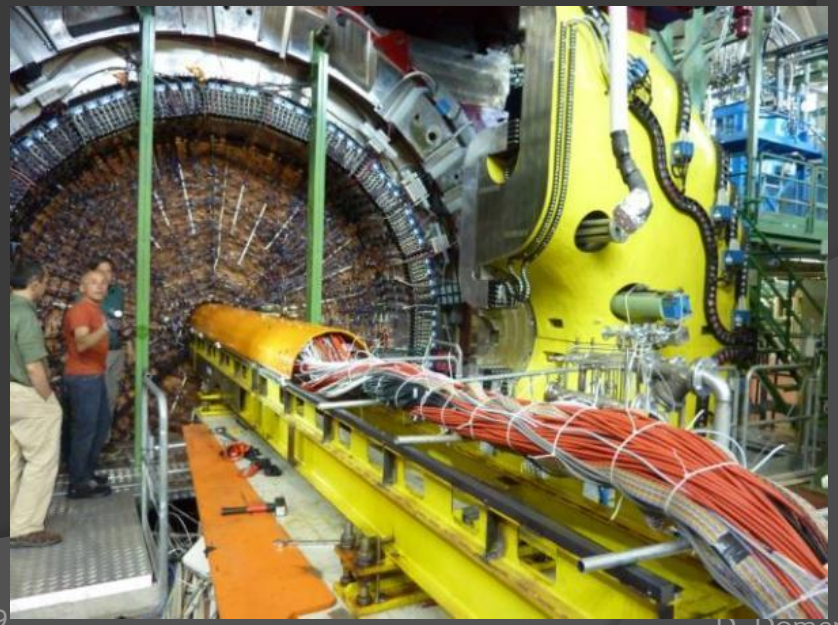


Detail of connectors zone

IT cabled and shielded

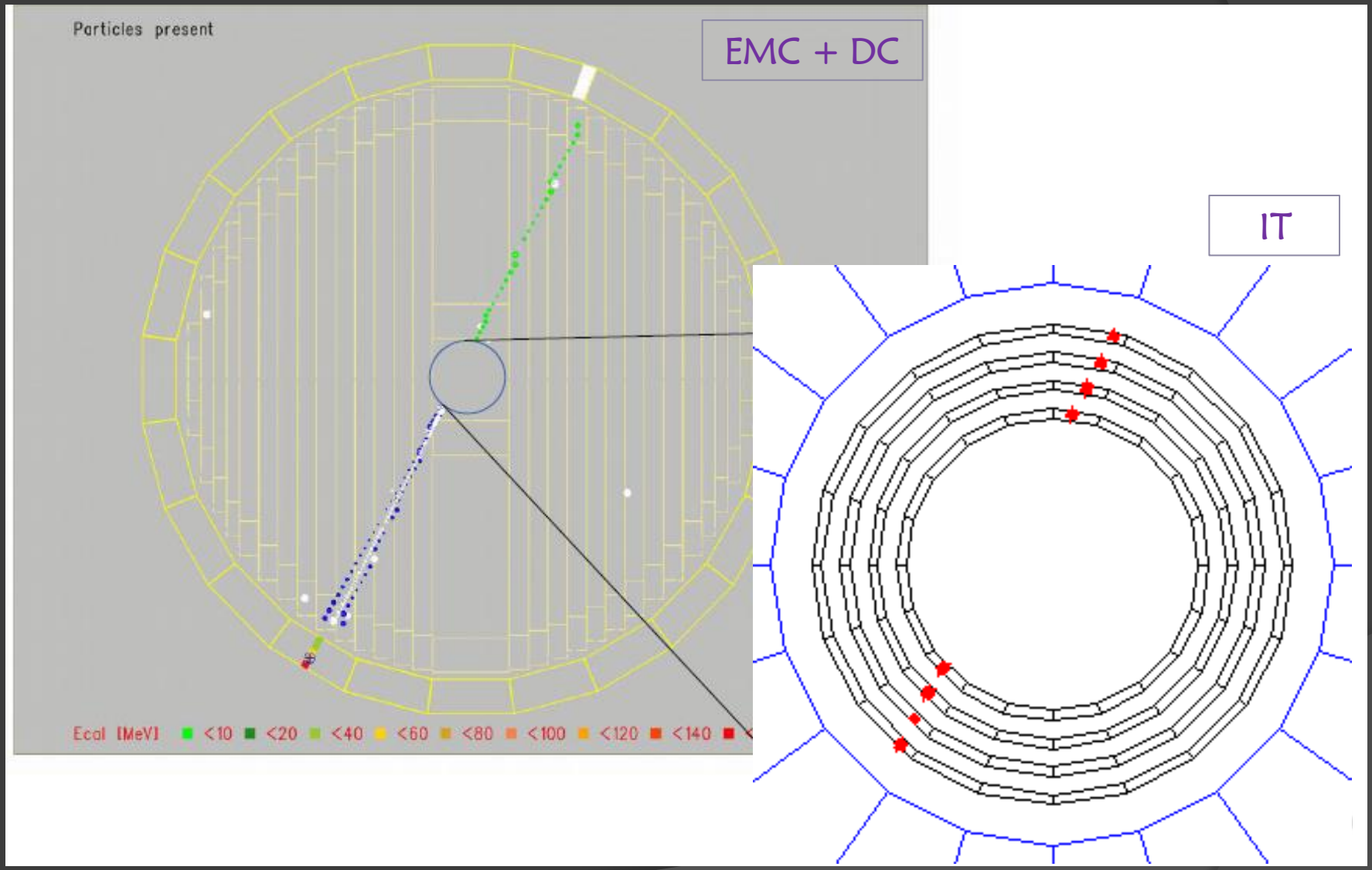
Inserimento in KLOE



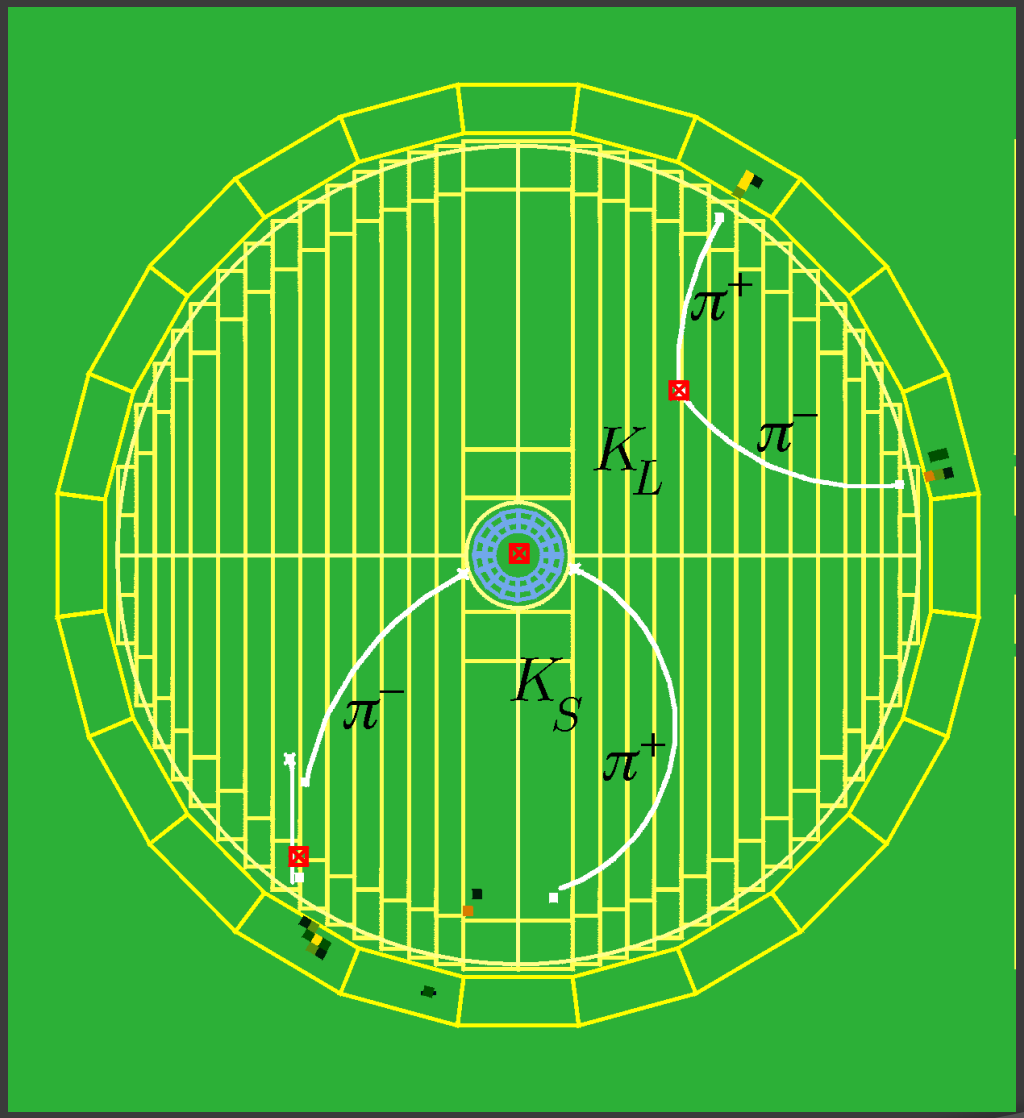


Inserimento in KLOE

Un raggio cosmico in KLOE



Tracciamento in KLOE-2



$e^+e^- \rightarrow \Phi \rightarrow K_L K_S$

$K_L \rightarrow \pi^+\pi^-$

$K_S \rightarrow \pi^+\pi^-$

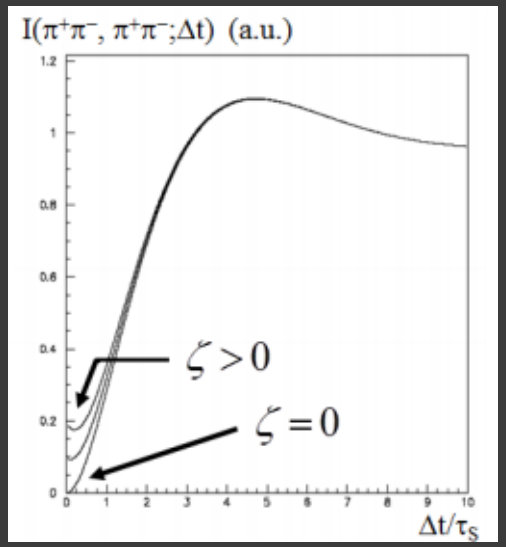
Drift Chamber
$\sigma_{r\varphi} \sim 200$ μm - $\sigma_z \sim 2000$ μm
Inner Tracker
$\sigma_{r\varphi} \sim 200$ μm - $\sigma_z \sim 370$ μm
$K_S \rightarrow \pi^+\pi^-$ Vertex Resolution
2 mm $\approx c\tau_S/3$

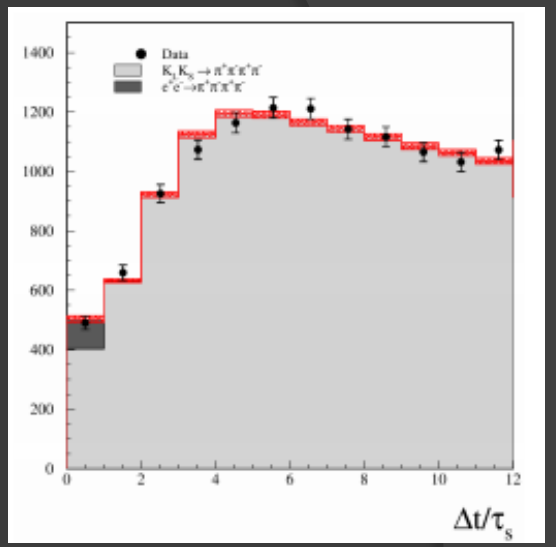
Obiettivi di Fisica

Test della simmetria CPT

$e^+e^- \rightarrow \Phi \rightarrow K_L K_S$
$K_L \rightarrow \pi^+\pi^-$
$K_S \rightarrow \pi^+\pi^-$

4 tracce cariche
provenienti dall'IP





Ricerca di Materia Oscura

$e^+e^- \rightarrow \Phi \rightarrow \eta U$
$\eta \rightarrow \pi^+\pi^-\pi^0$
$U \rightarrow e^+e^-$

4 tracce cariche
provenienti dall'IP