

History of the Universe



Τώρα
(13.7 δισεκατ. χρόνια)

Δημιουργία αστέρων
(1 δισεκατ. χρόνια)

Δημιουργία Ατόμων
(380,000 χρόνια)

Δημιουργία πυρήνων
(180 δευτερόλεπτα)

Δημιουργία p,n
(10^{-10} seconds)

Διαφοροποίηση των Κουόρκς
(10^{-34} δευτερόλεπτα)

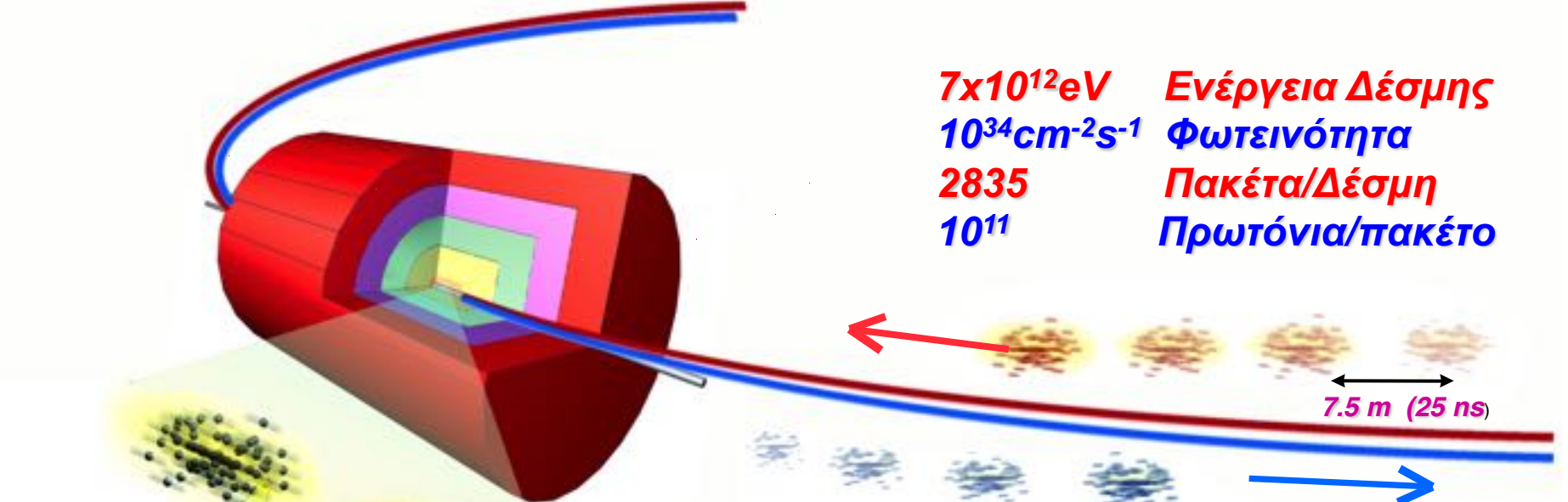
LHC
 4×10^{-12}
δευτερόλεπτα

ενημέρωση με τα πειραματικά (πριν το Big Bang)

The Large Hadron Collider



$7 \times 10^{12} \text{ eV}$ **Ενέργεια Δέσμης**
 $10^{34} \text{ cm}^{-2} \text{ s}^{-1}$ **Φωτεινότητα**
2835 **Πακέτα/Δέσμη**
 10^{11} **Πρωτόνια/πακέτο**



7 TeV Πρωτόνια Αντιπρωτόνια

Διασταύρωση Πακέτων $4 \times 10^7 \text{ Hz}$

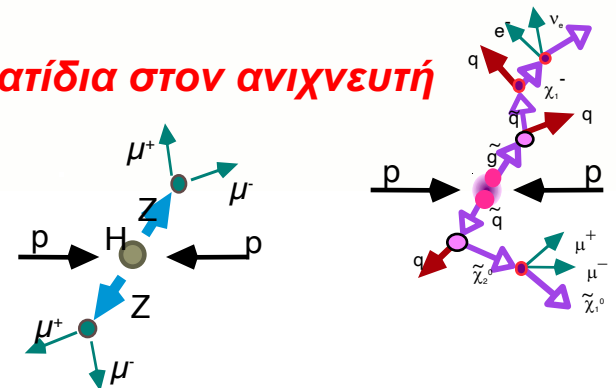
Συγκρούσεις Πρωτονίων 10^9 Hz

Συγκρούσεις Παρτονίων ~ 1600 σωματίδια στον ανιχνευτή

Παραγωγή Νέων Σωματιδίων 10^{-5} Hz
(Higgs, SUSY,)

Επιλογή 1 γεγονότος στα 10,000,000,000,000








Επιλογή 1 γεγονότος στα 10,000,000,000,000

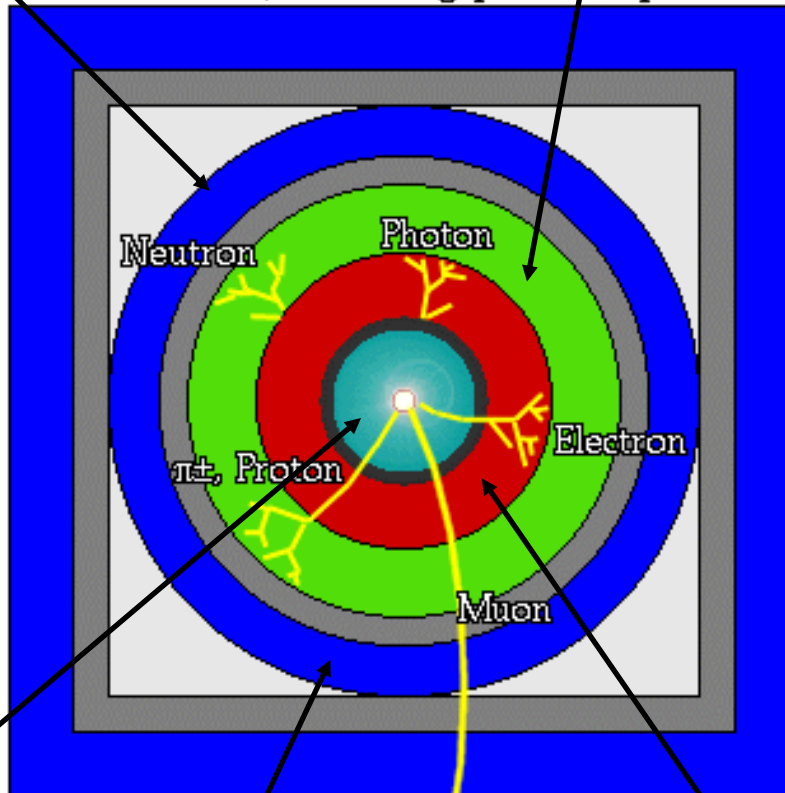


Fe ή άλλα βαριά μέταλλα

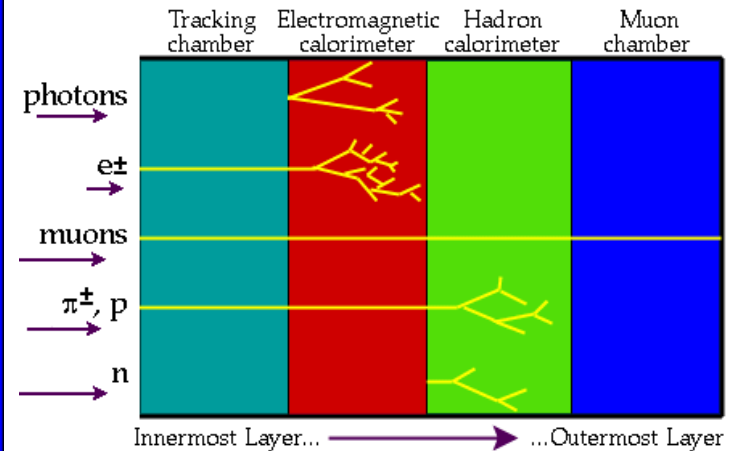
Βαριά υλικά π.χ. χαλκός

A detector cross-section, showing particle paths

-  Beam Pipe (center)
-  Tracking Chamber
-  Magnet Coil
-  E-M Calorimeter
-  Hadron Calorimeter
-  Magnetized Iron
-  Muon Chambers



Κάθε επίπεδο αναγνωρίζει και μετρά ή ξαναμετρά την ενέργεια σωματιδίων που δεν μετρήθηκαν στα προηγούμενα επίπεδα



Κανένα επίπεδο από μόνο του δεν μπορεί να αναγνωρίσει και να μετρήσει τις ενέργειες και τις ορμές όλων των σωματιδίων

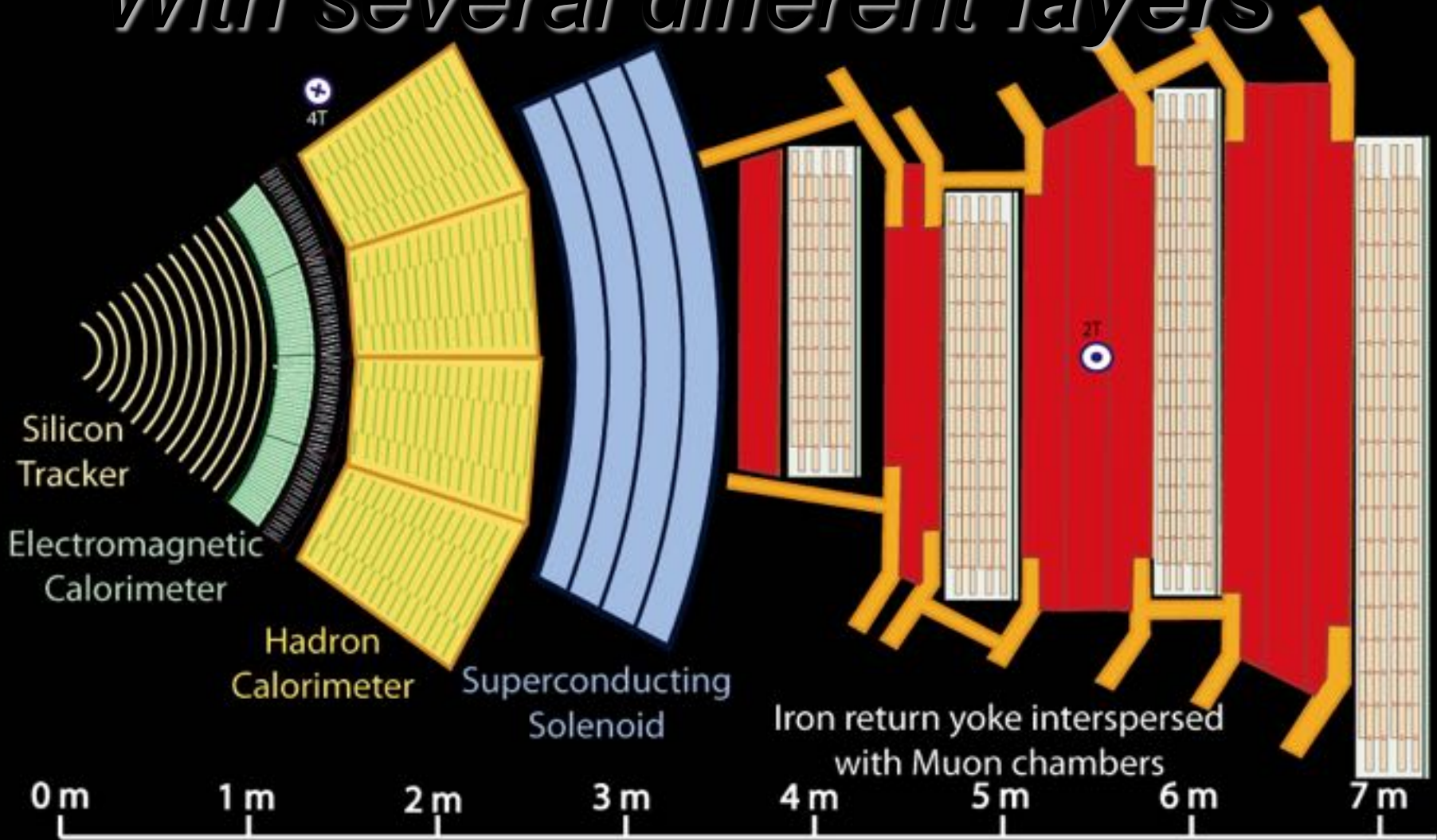
Ελαφρά υλικά

Ζώνη όπου μένουν Μόνο ν και μ

Υλικά με μεγάλο Z π.χ ενώσεις Pb

ενημέρωση μεταπτυχιακών

With several different layers



Key:

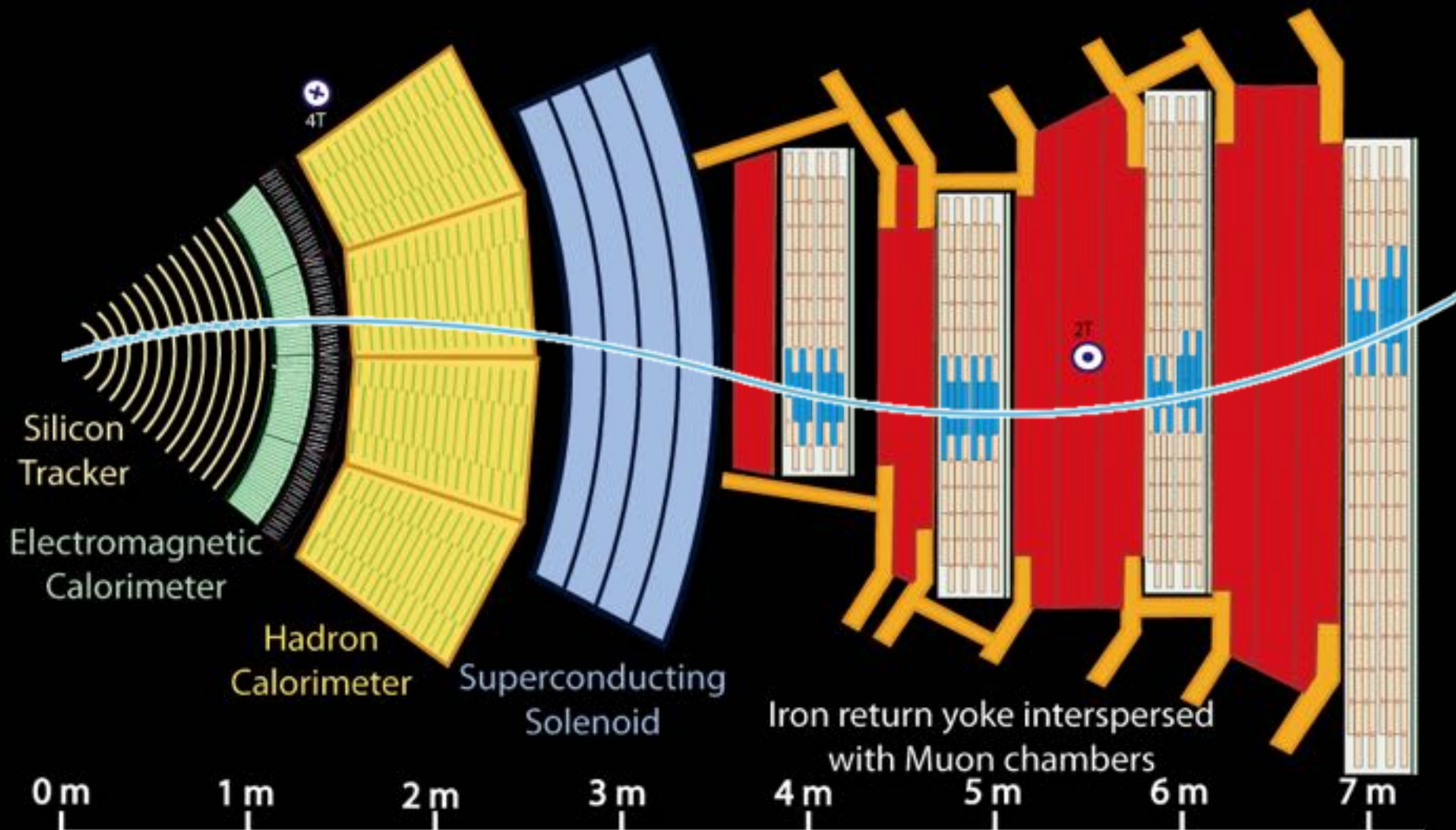
— Muon

— Electron

— Charged Hadron (e.g. Pion)

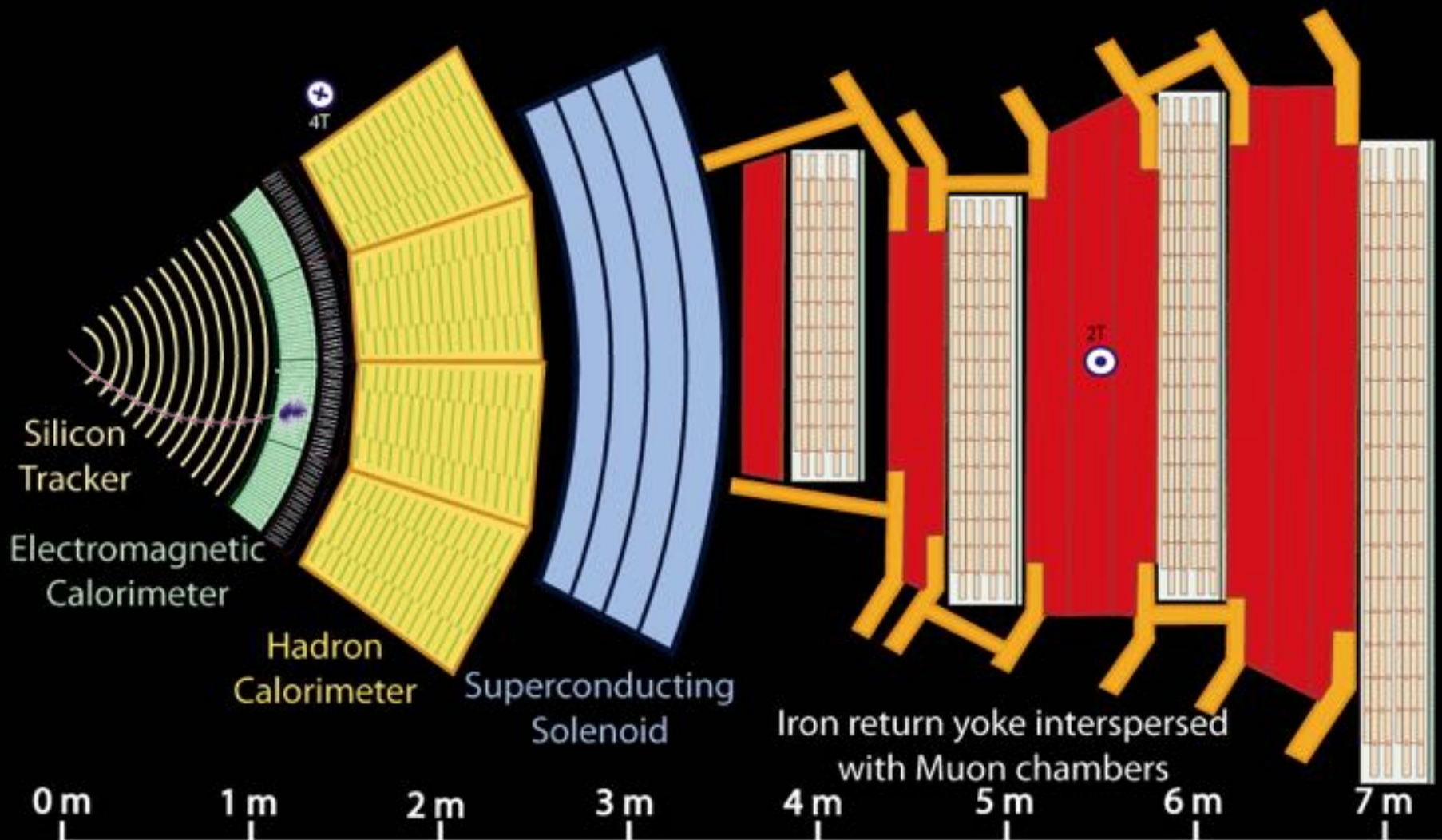
- - - Neutral Hadron (e.g. Neutron)

••••• Photon



Key:

- Muon
- Electron
- Charged Hadron (e.g. Pion)
- - - Neutral Hadron (e.g. Neutron)
- - - Photon



Key:

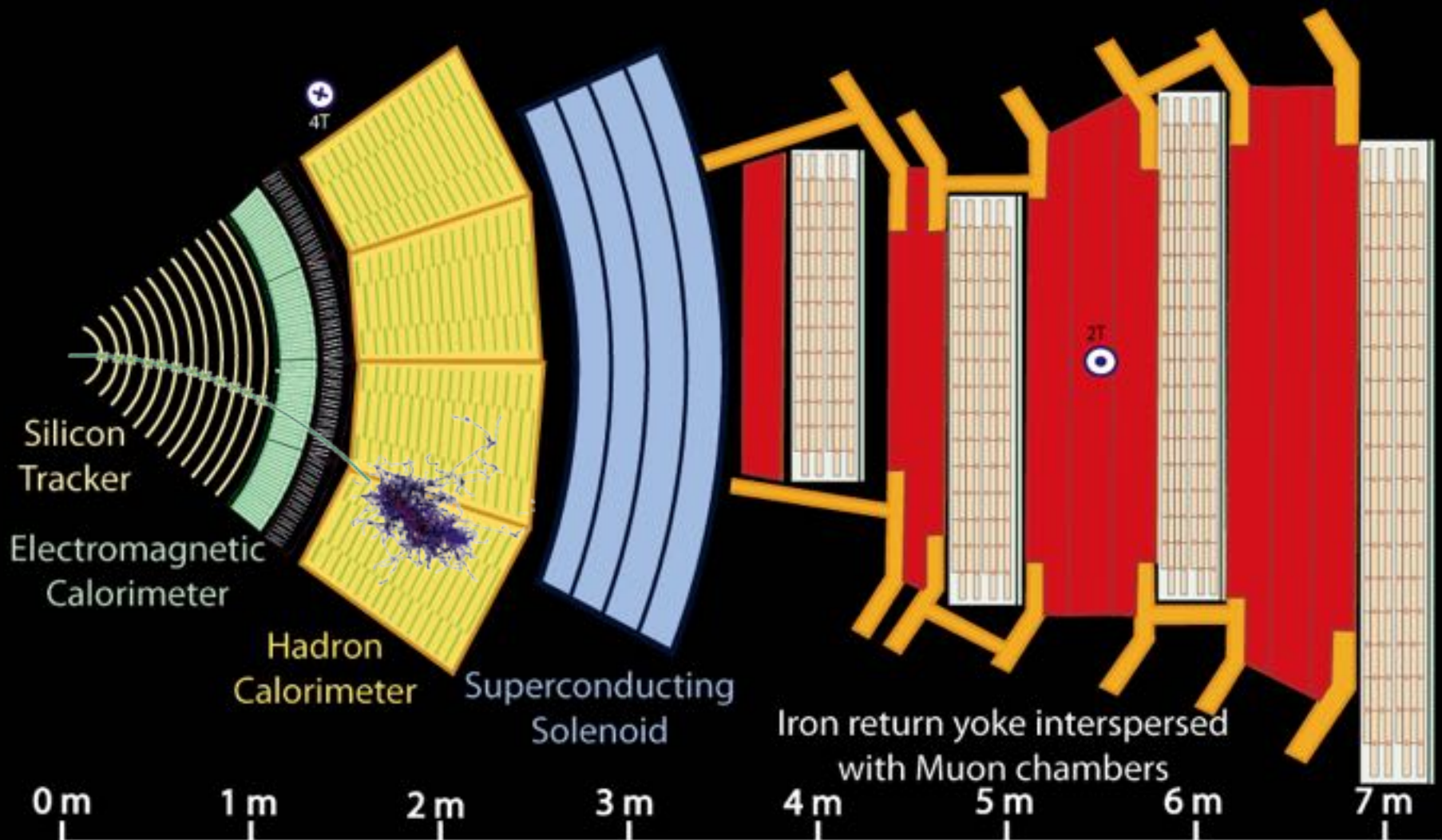
— Muon

— Electron

— Charged Hadron (e.g. Pion)

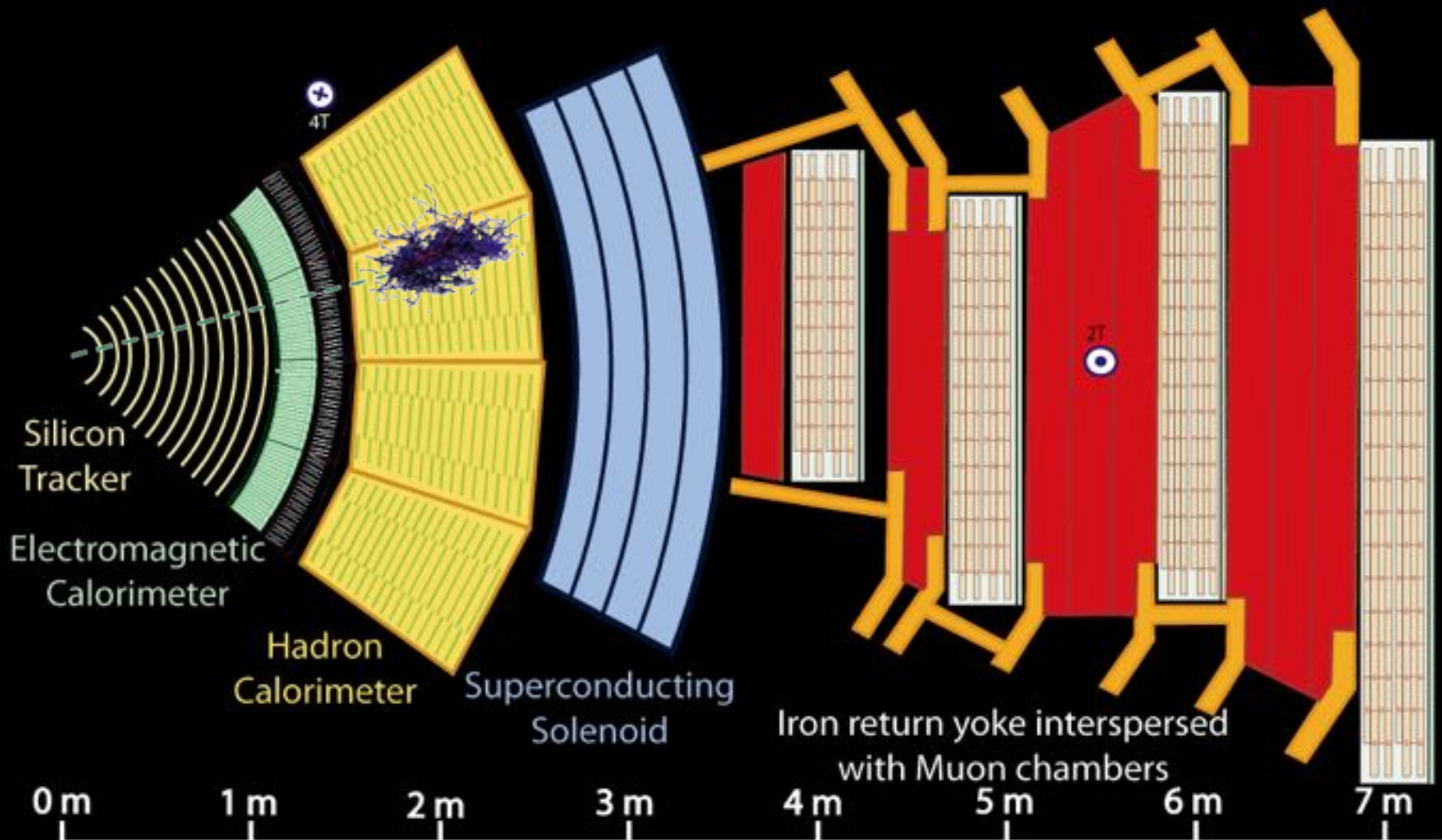
- - - Neutral Hadron (e.g. Neutron)

••••• Photon



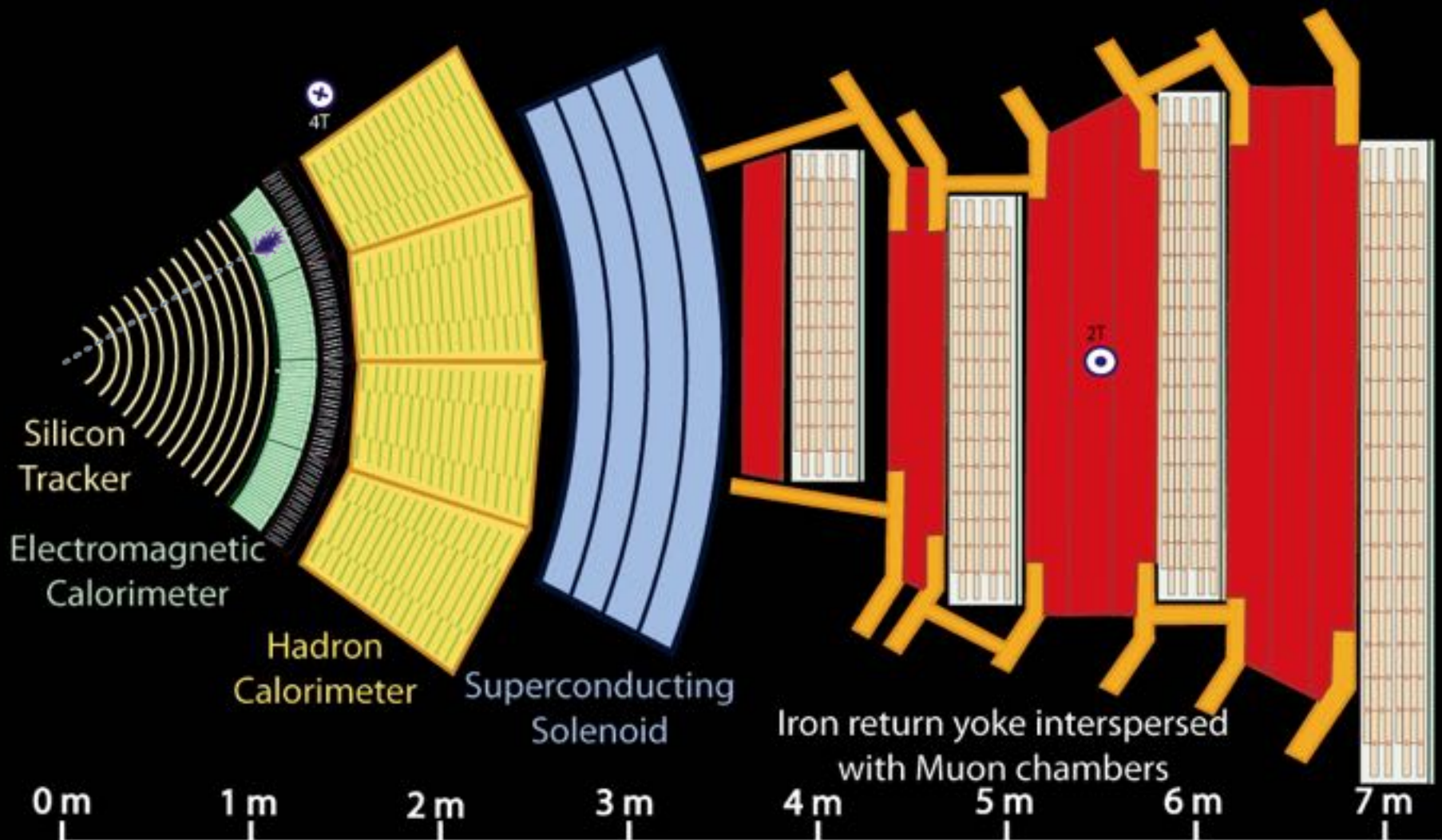
Key:

- Muon
- Electron
- Charged Hadron (e.g. Pion)
- - - Neutral Hadron (e.g. Neutron)
- Photon



Key:

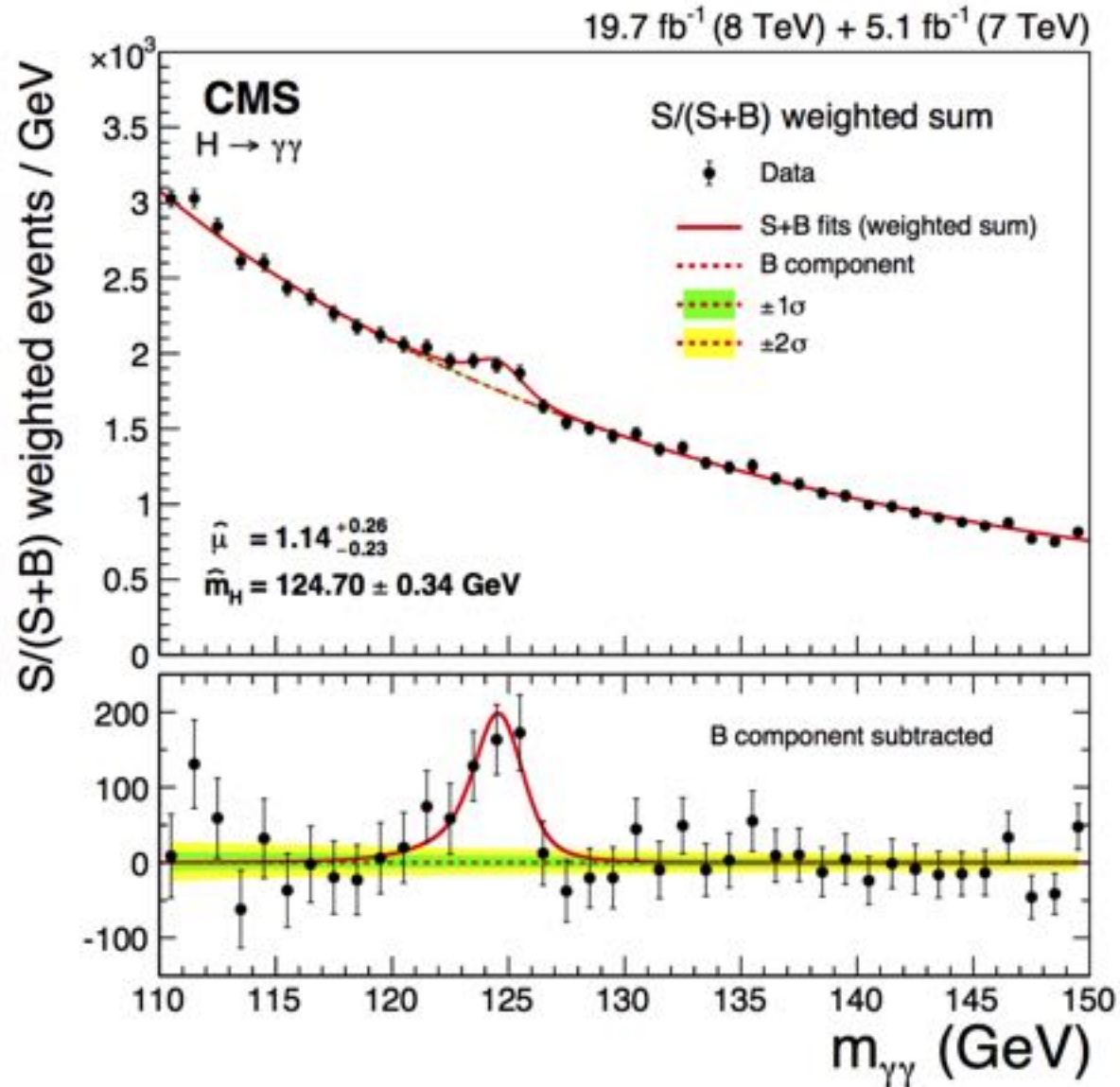
- Muon
- Electron
- Charged Hadron (e.g. Pion)
- - - Neutral Hadron (e.g. Neutron)
- Photon



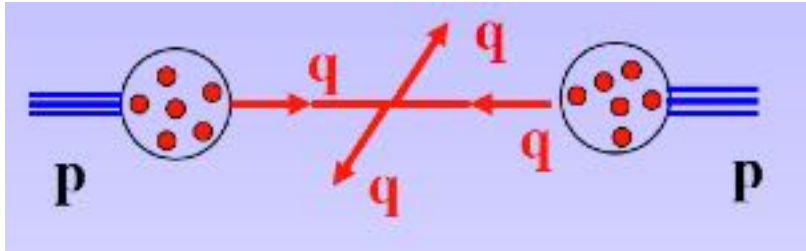
Key:

- Muon
- Electron
- Charged Hadron (e.g. Pion)
- - - Neutral Hadron (e.g. Neutron)
- ⋯ Photon

Higgs discovery by CMS : $H \rightarrow \gamma\gamma$ channel



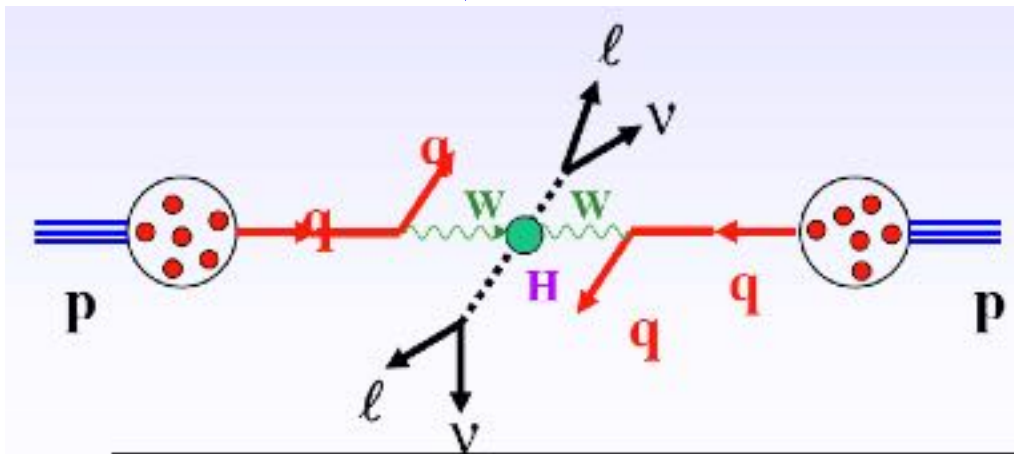
Σκεδάσεις κουόρκς



Δεν έχουμε λεπτόνια και φωτόνια στην αρχική κατάσταση

Αν παρατηρήσουμε λεπτόνια & φωτόνια με μεγάλη εγκάρσια ορμή => ενδιαφέρουσα φυσική

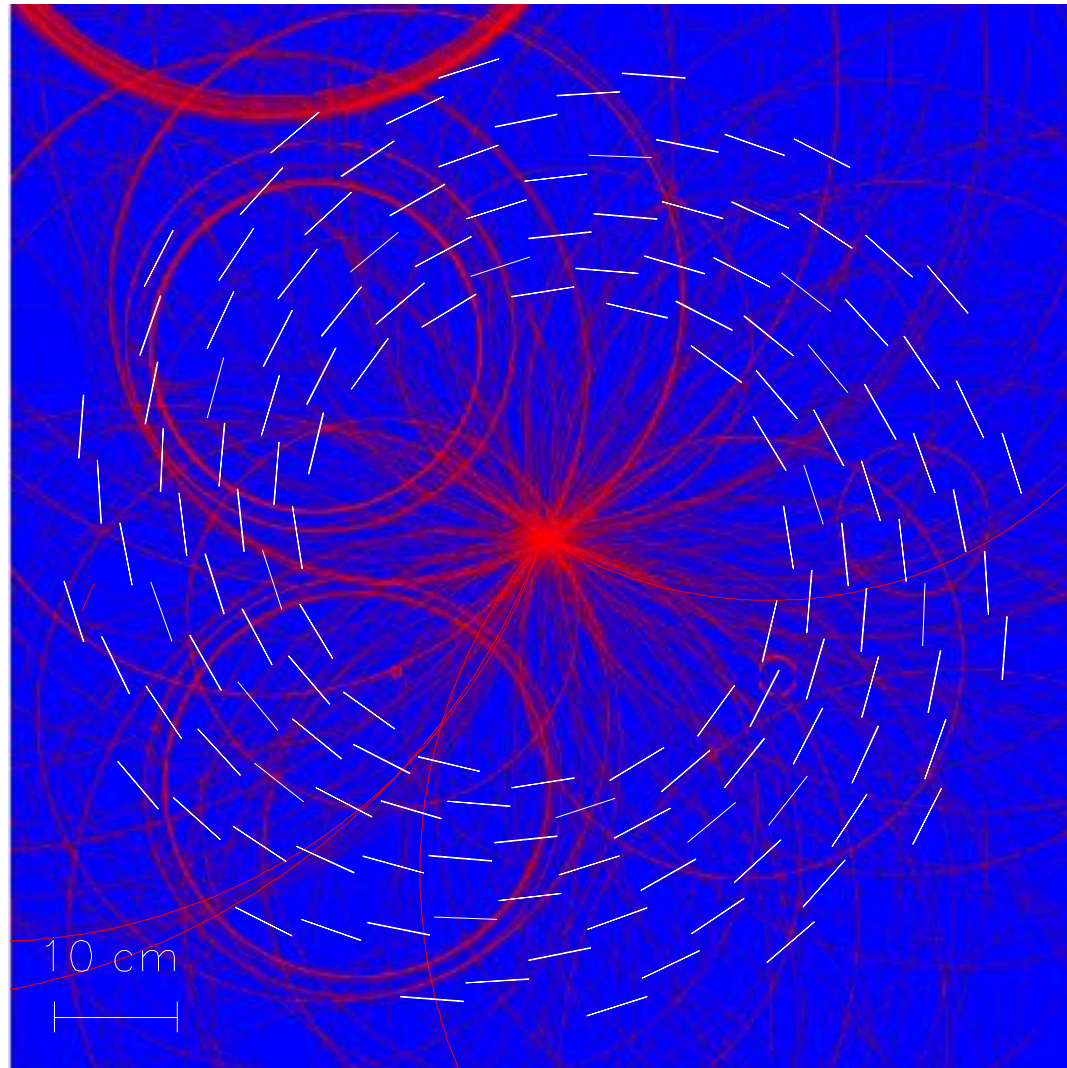
π.χ. παραγωγή Higgs



Σημαντικές ενδείξεις

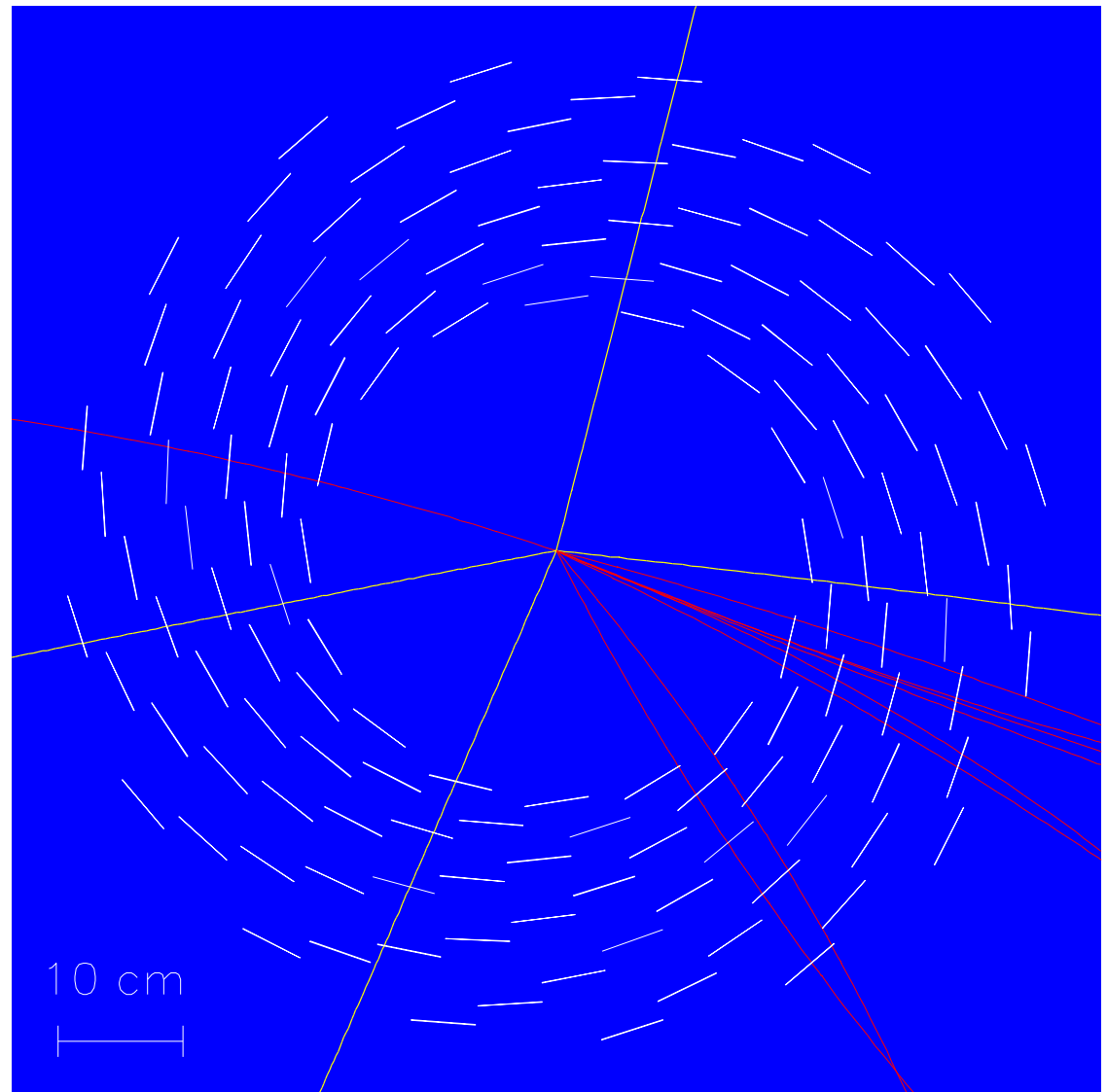
- Φωτόνια & λεπτόνια
- Ελλiptής εγκάρσια ορμή

Βρείτε 4 Ευθείες Τροχιές



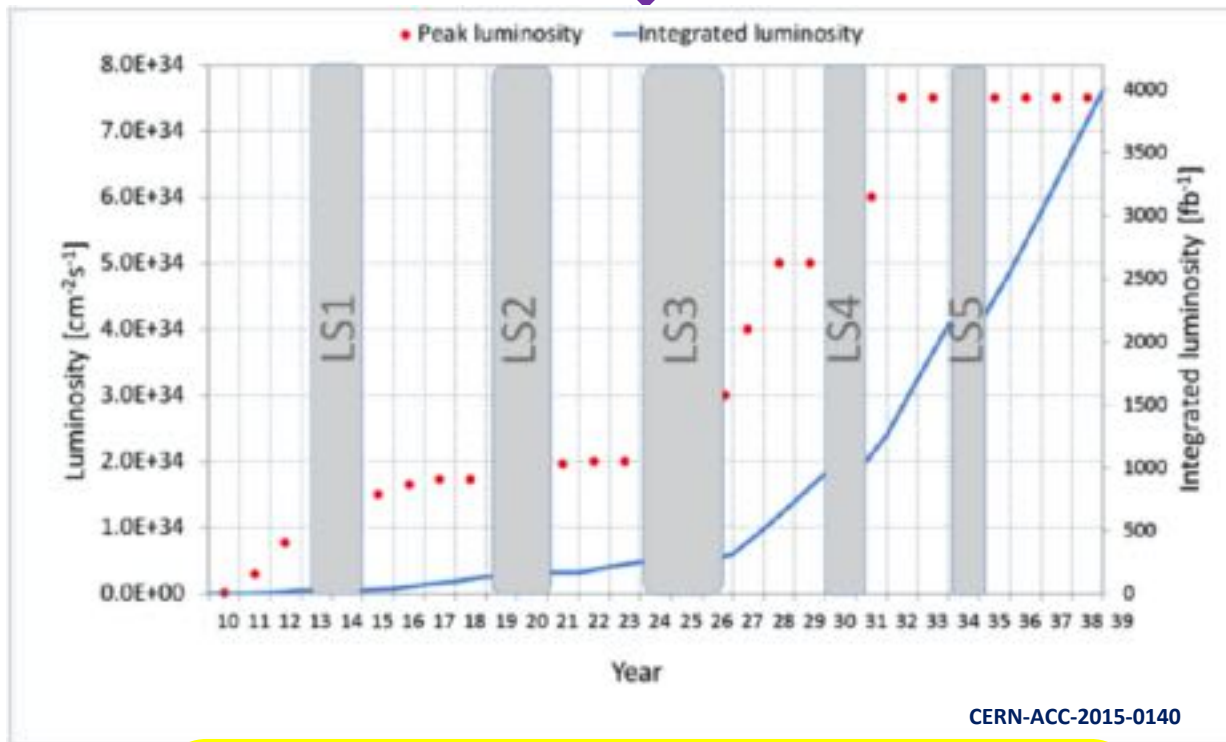
ενημέρωση μεταπτυχιακών

**Θέτουμε ένα όριο
στην εγκάρσια ορμή των
σωματιδίων $p_T > 20 \text{ GeV}$**





Forecast for LHC and HL-LHC Operation



The goal for HI-LHC:

- Peak Luminosity : $5.0 (7.5) \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$
- Integrated Luminosity over 10 years: 3000 fb^{-1}
- PU: 150-200

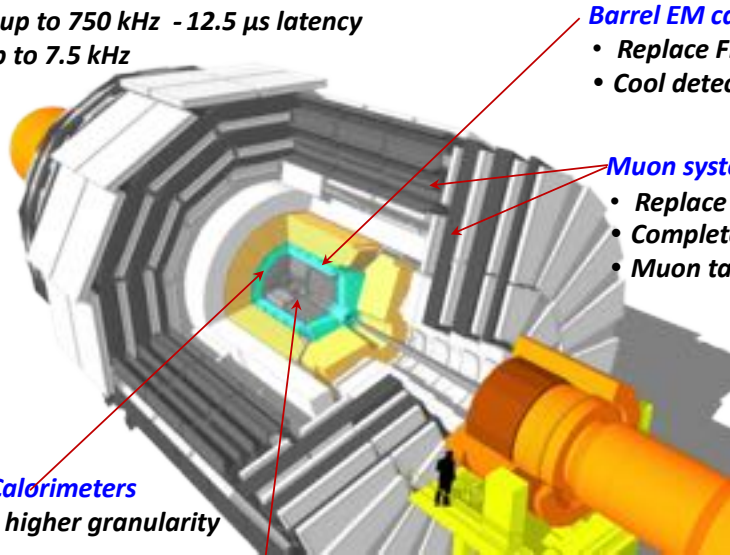


CMS DETECTORS PHASE 2 UPGRADES



Trigger/DAQ

- L1 with track up to 750 kHz - 12.5 μ s latency
- HLT output up to 7.5 kHz



Barrel EM calorimeter

- Replace FE electronics
- Cool detector APDs

Muon systems

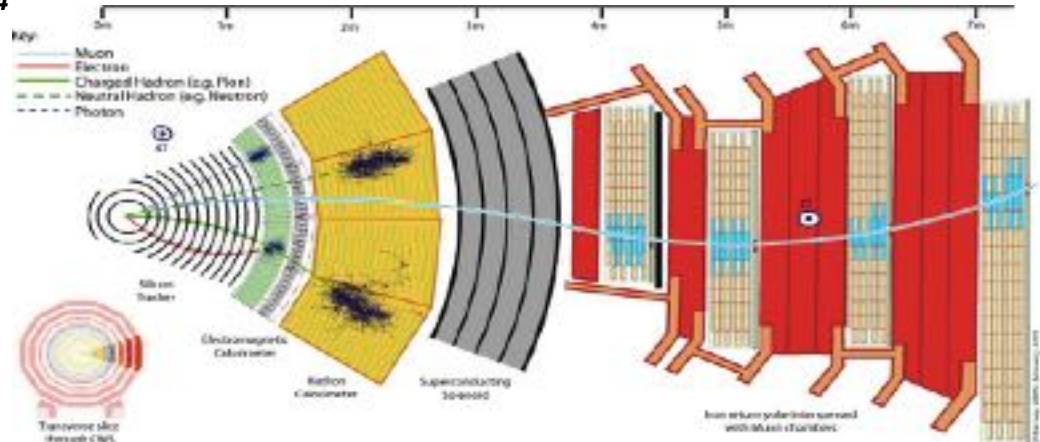
- Replace DT & CSC FE electronics
- Complete RPC coverage
- Muon tagging $2.4 < \eta < 3$

Replace Endcap Calorimeters

- Rad. Tolerant - higher granularity

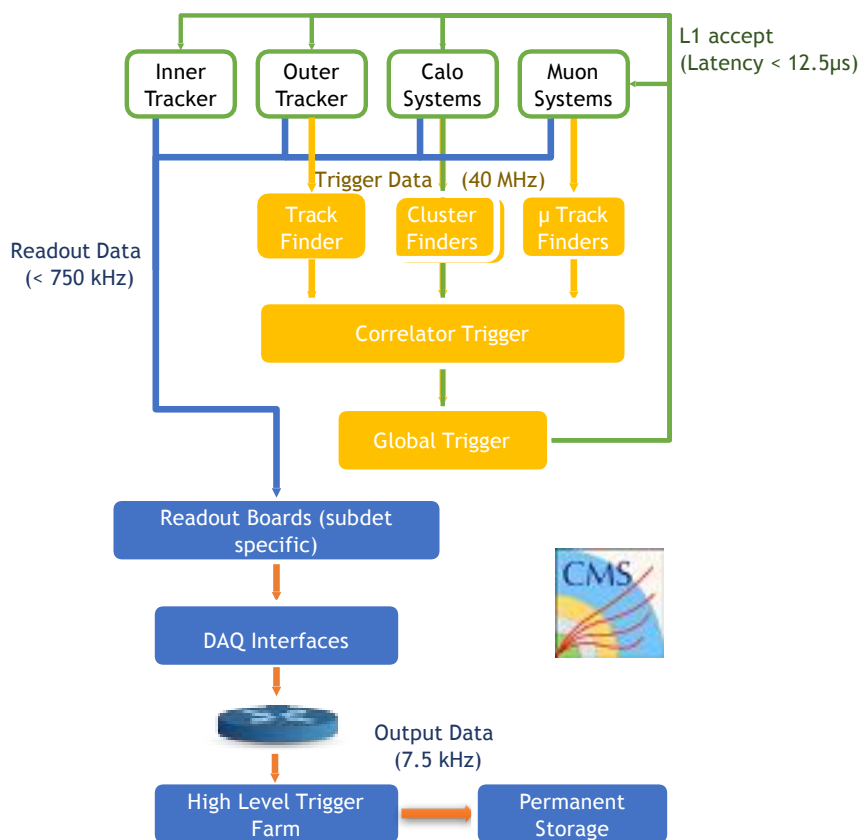
Replace Tracker

- High granularity – less material- b eff- p_T resolution
- Selective readout of outer tracker at 40 MHz for L1 trigger
- Extend η coverage to 4

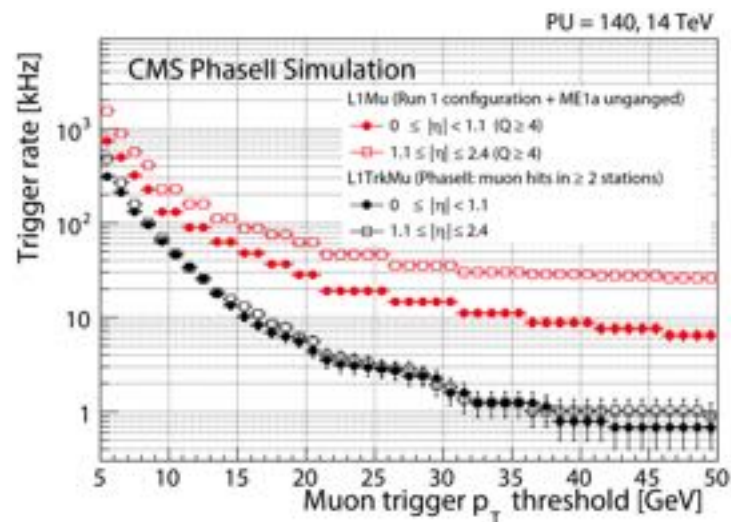
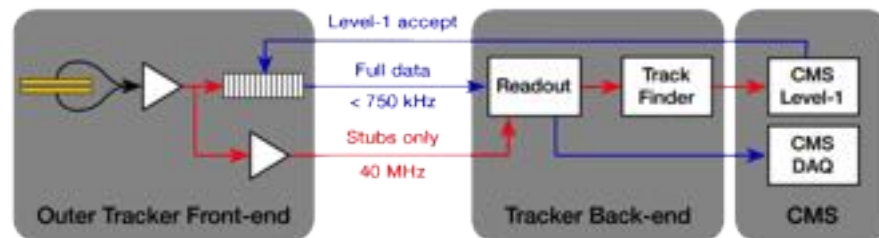


L1 Trigger in CMS Phase II

Global CMS Phase II Trigger Architecture

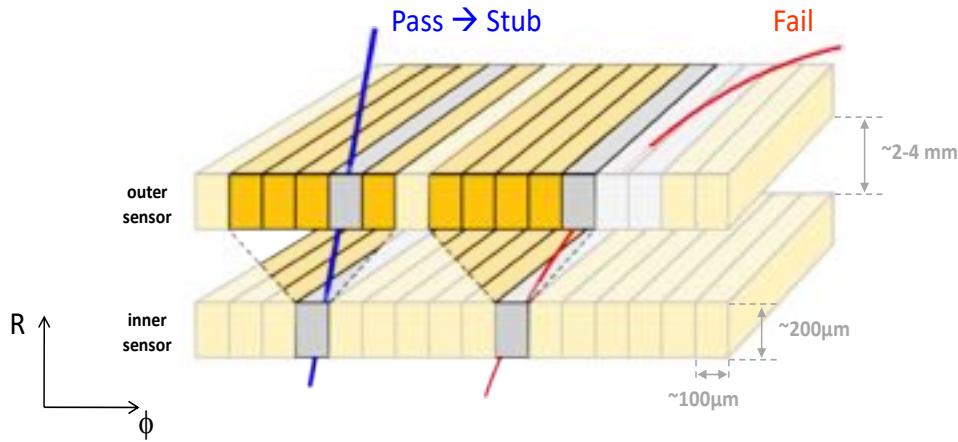


CMS Phase II Tracker L1

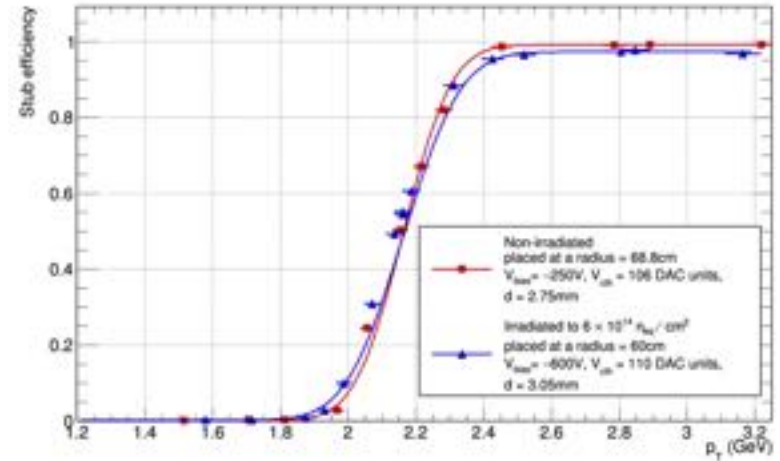


The current stand-alone muon trigger system occasionally assigns a high transverse momentum to low p_T muons.

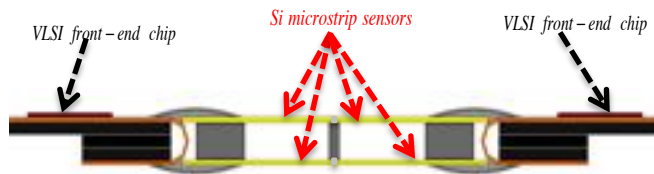
Provide Tracker Info to L1



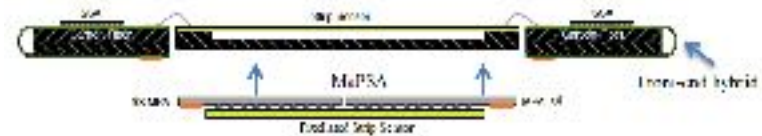
120 GeV/c pions



2S module



PS module



High- P_T tracks (**stubs**) can be identified if cluster centre in top layer lies within a search window in $R-\phi$ (rows)

- P_T cut is given by: module radius (z), sensor separation and correlation window



Physics Analysis

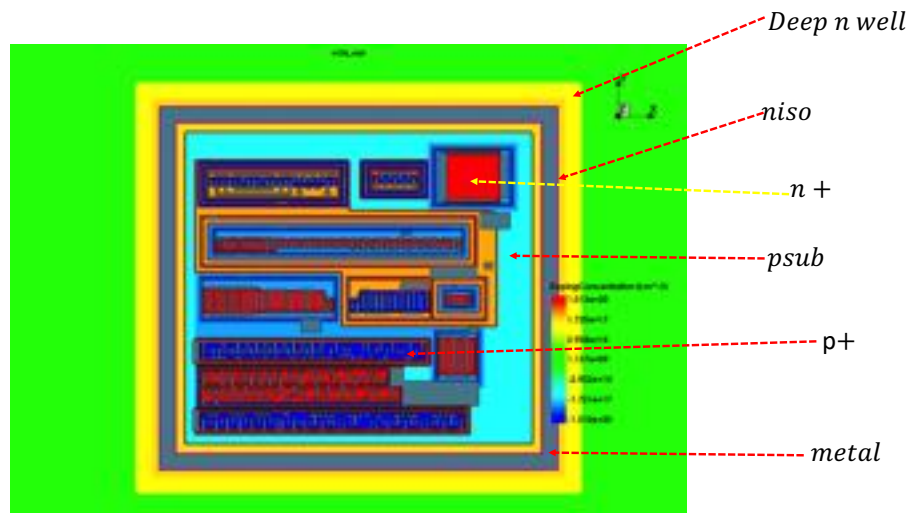
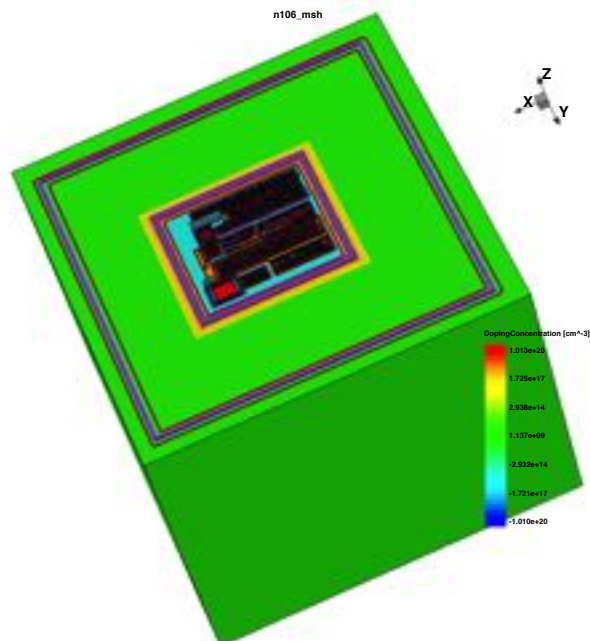
G. Daskalakis, G. Anagnostou , Aris Kyriakis

Phase II upgrade of the CMS Silicon Tracker (D.Loukas, A.Kyriakis)

- ***Simulations***
- ***Electronics***
- ***Sensors***
- ***Beam Tests***
- ***Irradiations***



3D Simulation of CMOS sensors



Presentations & Publications in 2019:

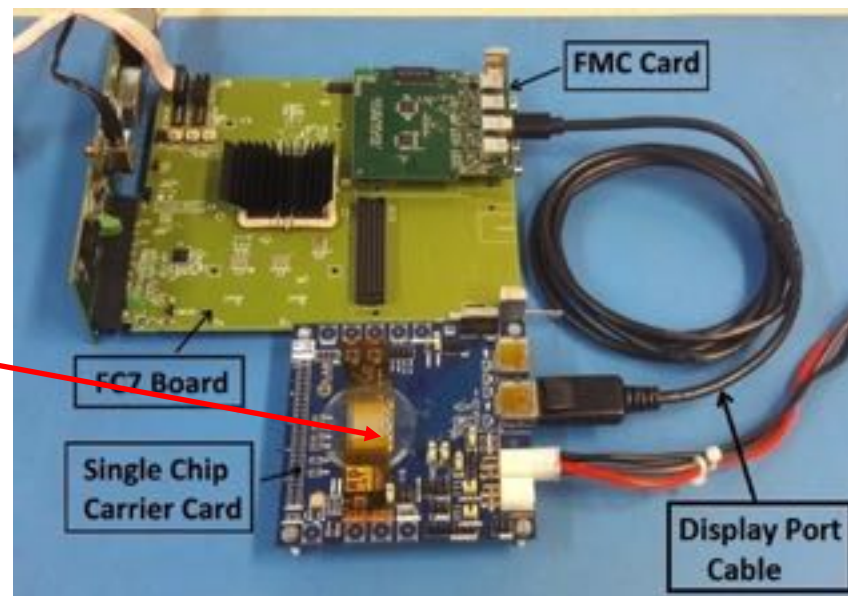
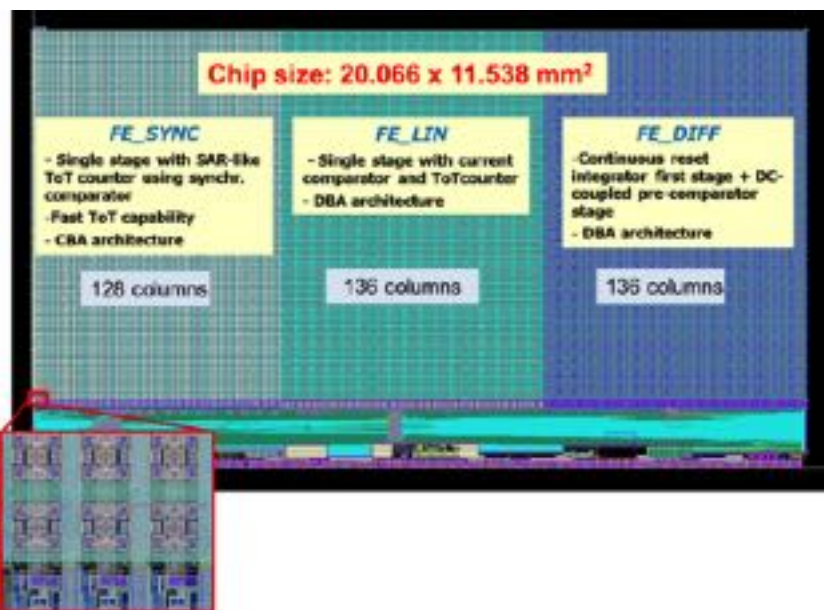
- D.Loukas, "TCAD Simulation of the HVCMOS sensor for the MIDAS personal active dosimeter", 34th RD50 Workshop 12-14 June 2019, Lancaster University
- C.P. Lambropoulos et al., "MIDAS: A miniature device for real-time determination of the identity and the energy of particles in space", submitted to *Space Weather*
- C.Potiriadis et al., "Miniature Neutron Spectrometer for Space", Submitted to *JINST*
- C.P. Lambropoulos et al., "The MIDAS dosimeter/particle monitor of charged particles and neutrons for space environment", submitted to *Radiation Measurements*



Electronics Test System

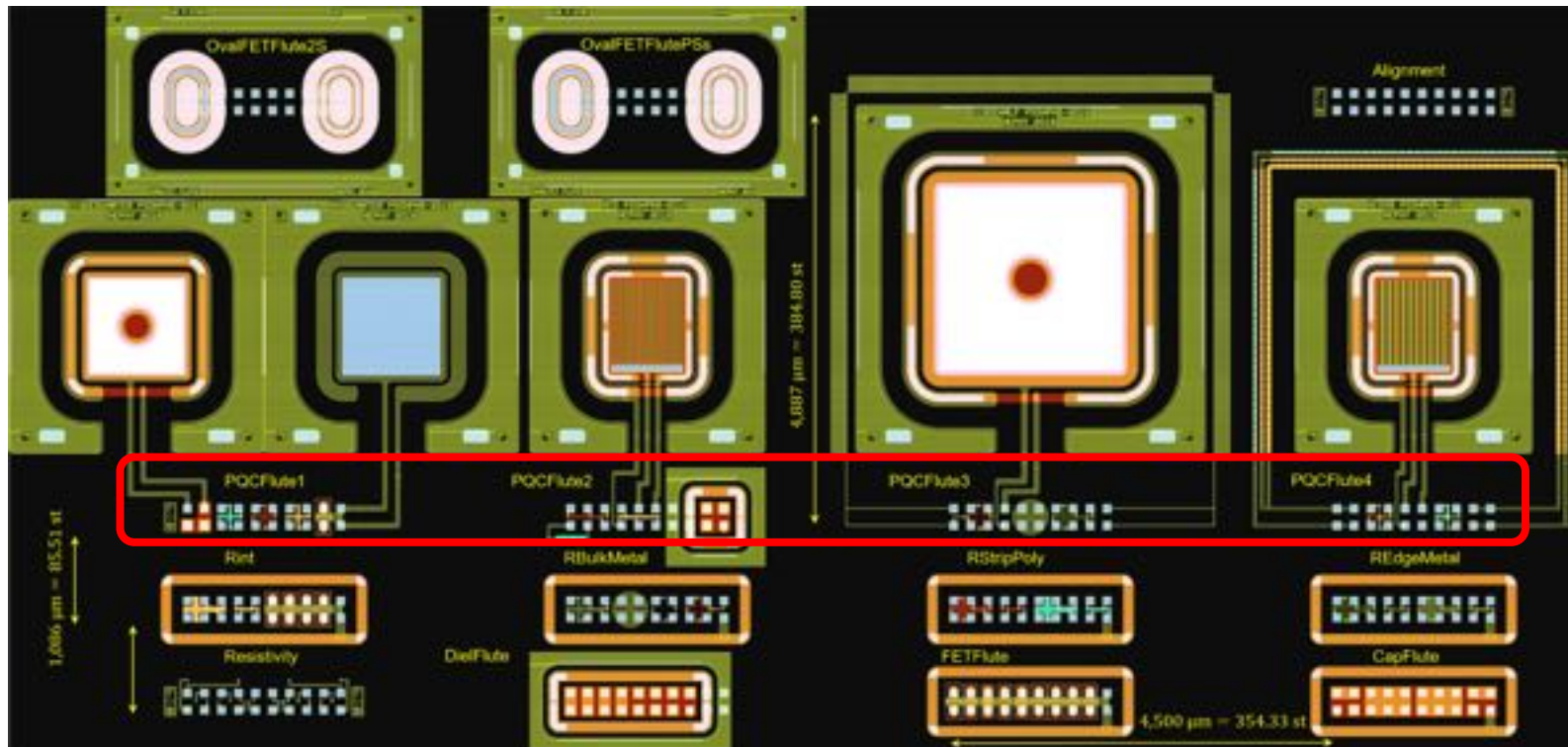
DEMOKRITOS is contributing to the development of the firmware for the Inner Tracker μ DTC, which is the CMS DAQ testing and development platform for the RD53A chip.

RD53 chip



Test Bench system at Demokritos

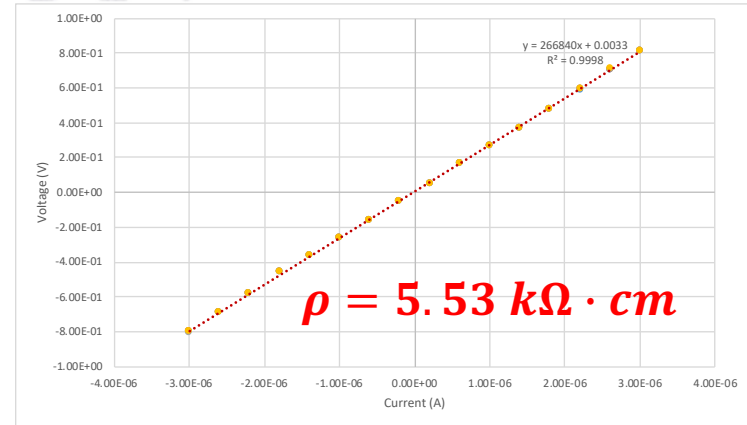
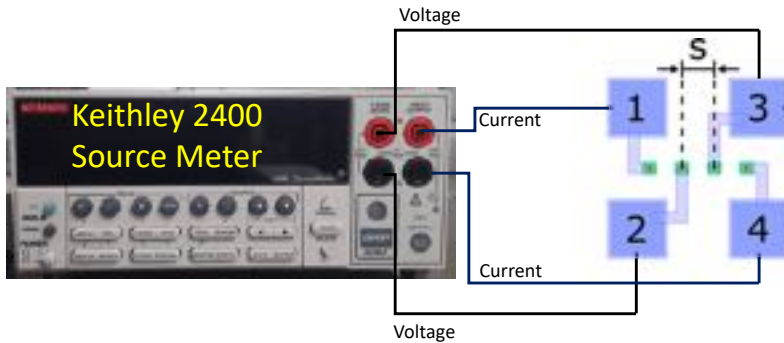
Process Quality Test Structures



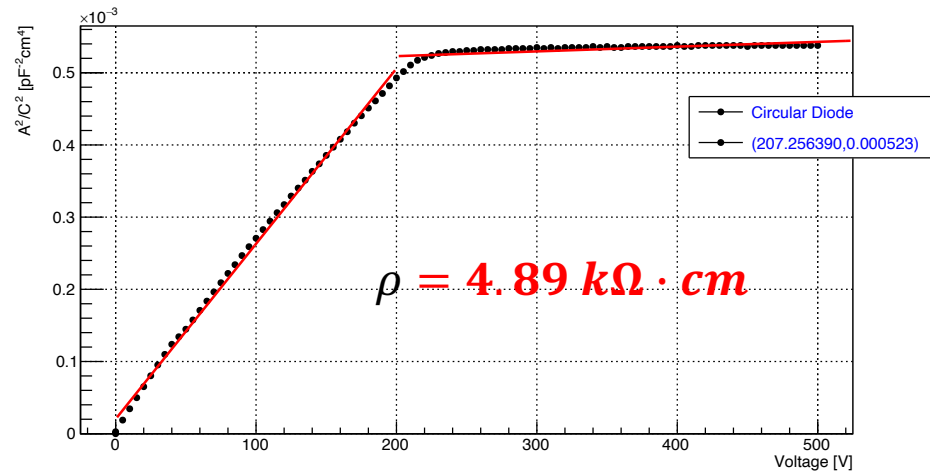
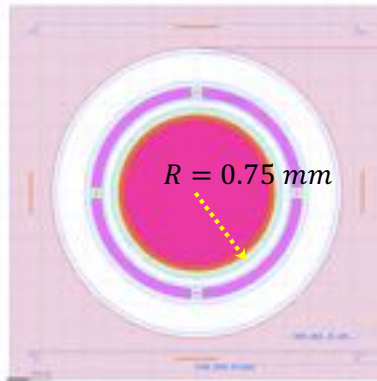
Plan to measure the 4 PQC flutes – Measurement time a few hours → throughput 2/day

4-Point Resistivity Measurements

(Infineon VE711408_08_16)



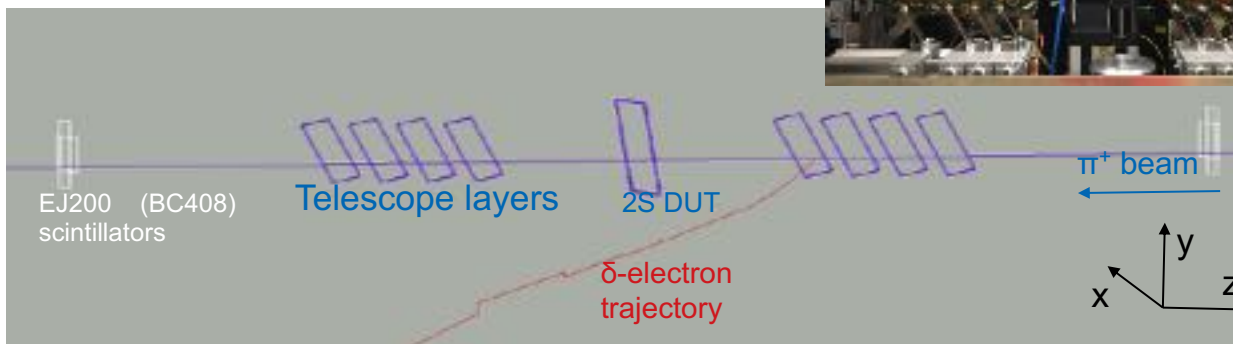
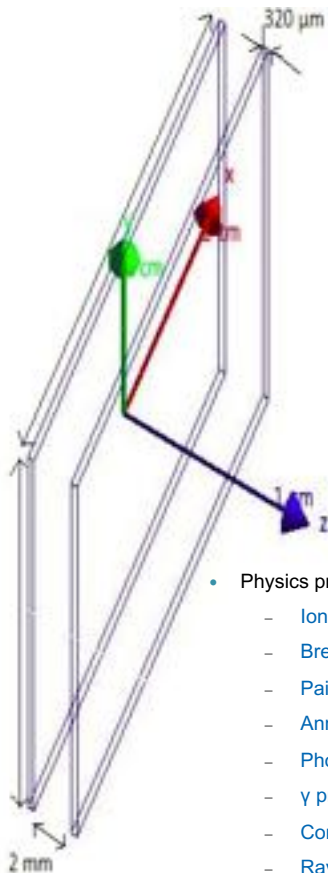
Round Diode: $2R = 1.5 \text{ mm}$





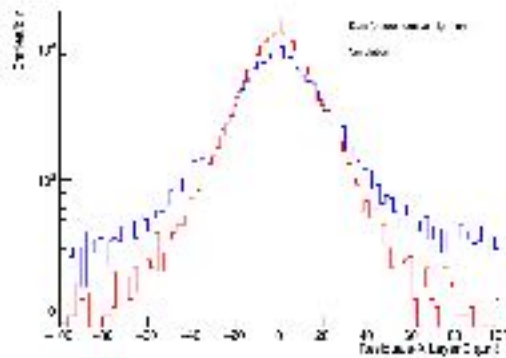
The CHROMIE Telescope

Based of Phase I Pixel modules
Rate : 40 MHz

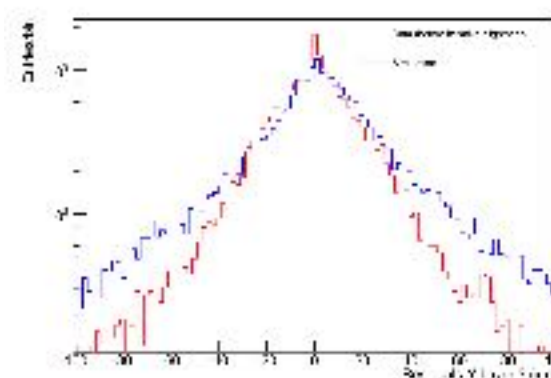


- Physics processes:
 - Ionizations
 - Bremsstrahlung
 - Pair production
 - Annihilation
 - Photoelectric effect
 - γ production
 - Compton scattering
 - Rayleigh scattering
 - Klein-Nishina model for the differential cross section

X residuals

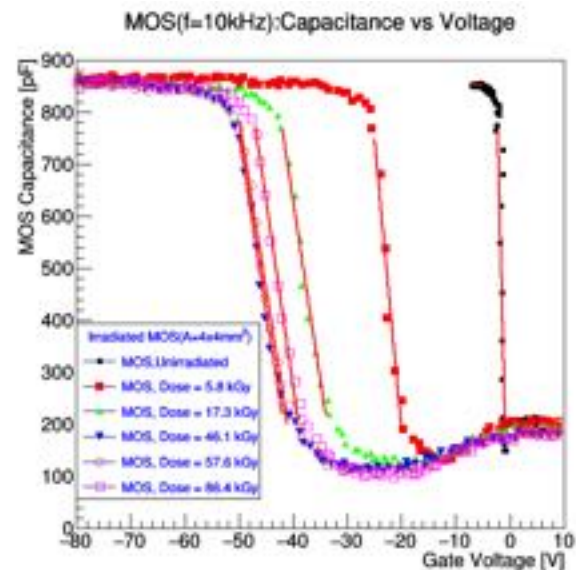
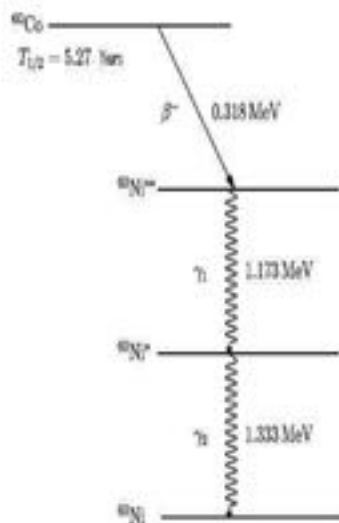


Y residuals

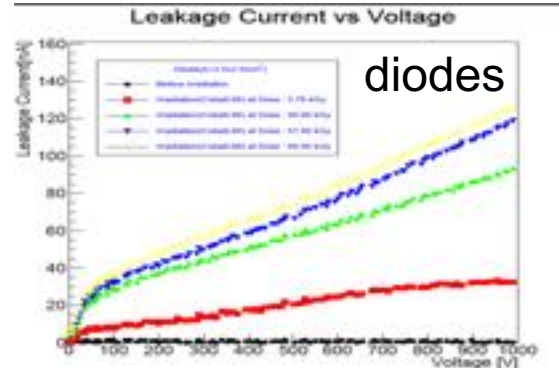




MOS and Diode irradiation studies for Phase 2 CMS Tracker Upgrade



^{60}Co source: Picker therapy unit 30 TBq (March 2012)
 horizontal orientation (~11 TBq October 2019) Greek
 Atomic Energy Commission (GAEC),



Details in Aris talk



DETECTOR INSTRUMENTATION
LABORATORY

Laboratory (80 m²) with temperature and humidity control



Probe Station : Carl Suss PA 150

Climatic Chamber (recently installed)



Wire Bonding (Delvotec 5430)
(Proposal for a new fully automated machine under evaluation by GSRT)