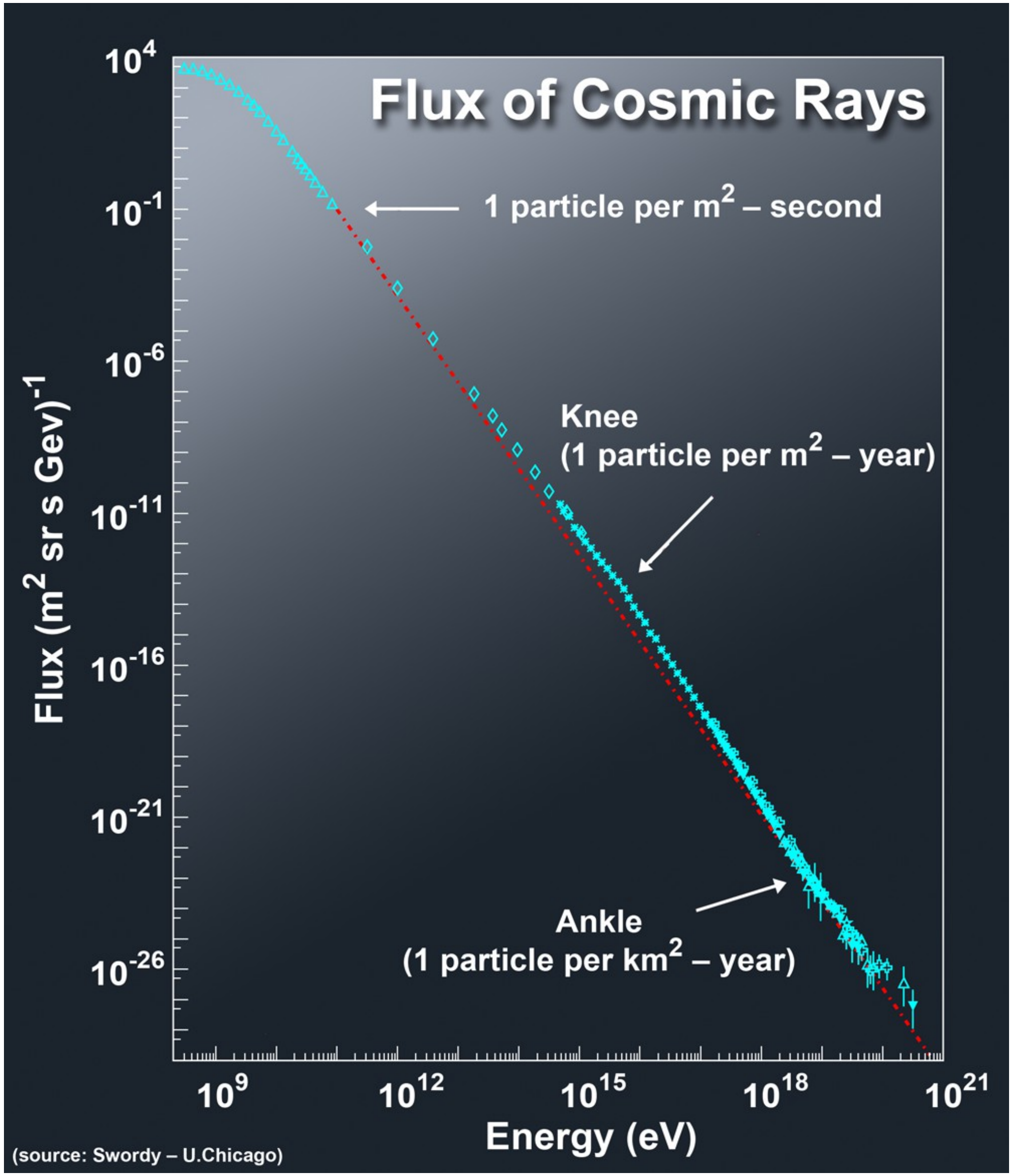
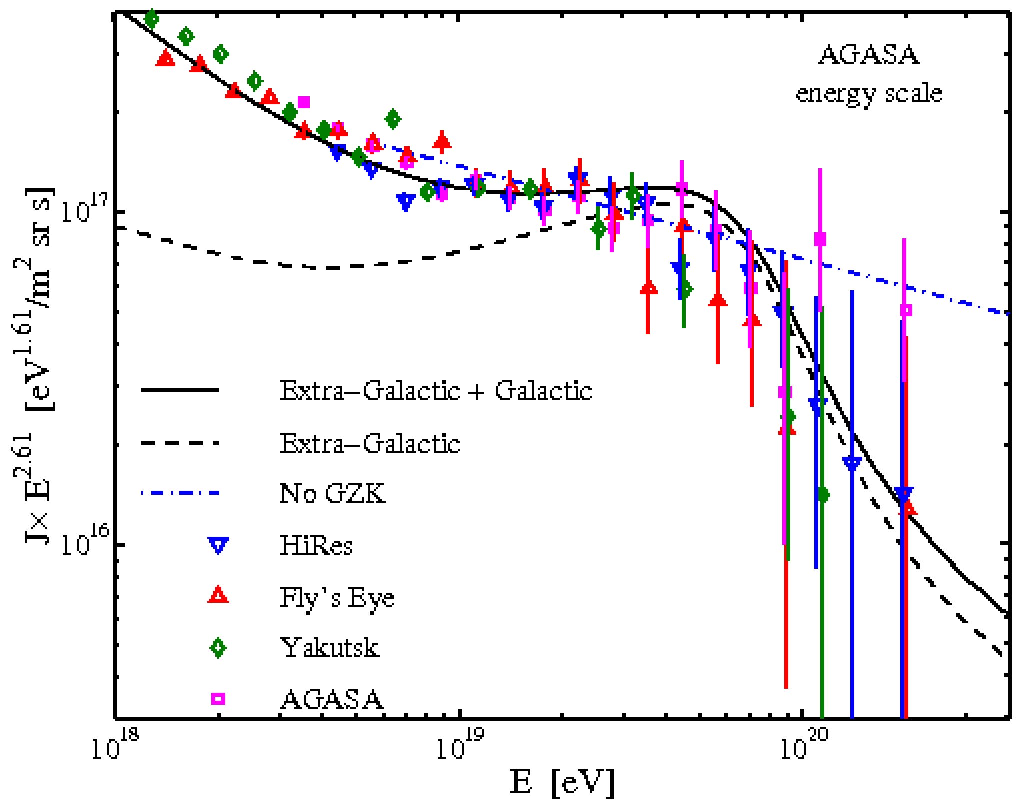


Kozmikus sugárzás spektruma



UHECR spectrum

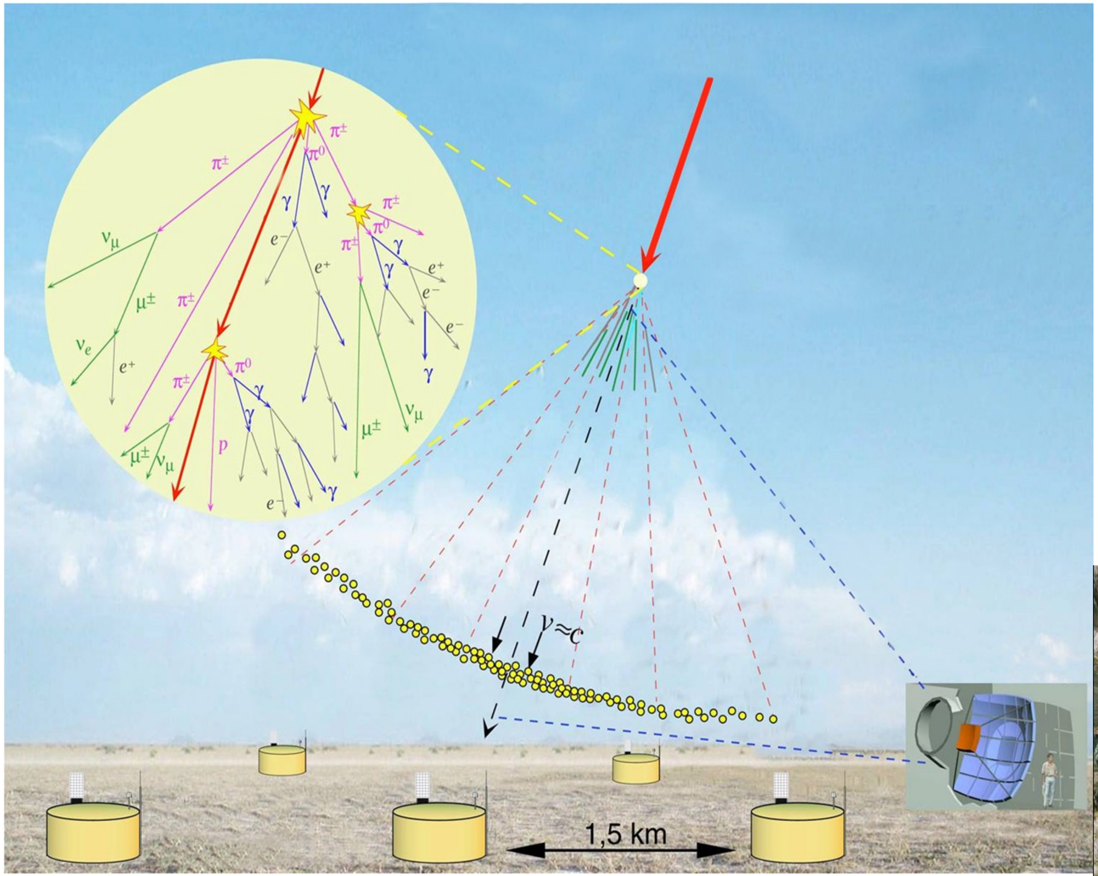
Források:

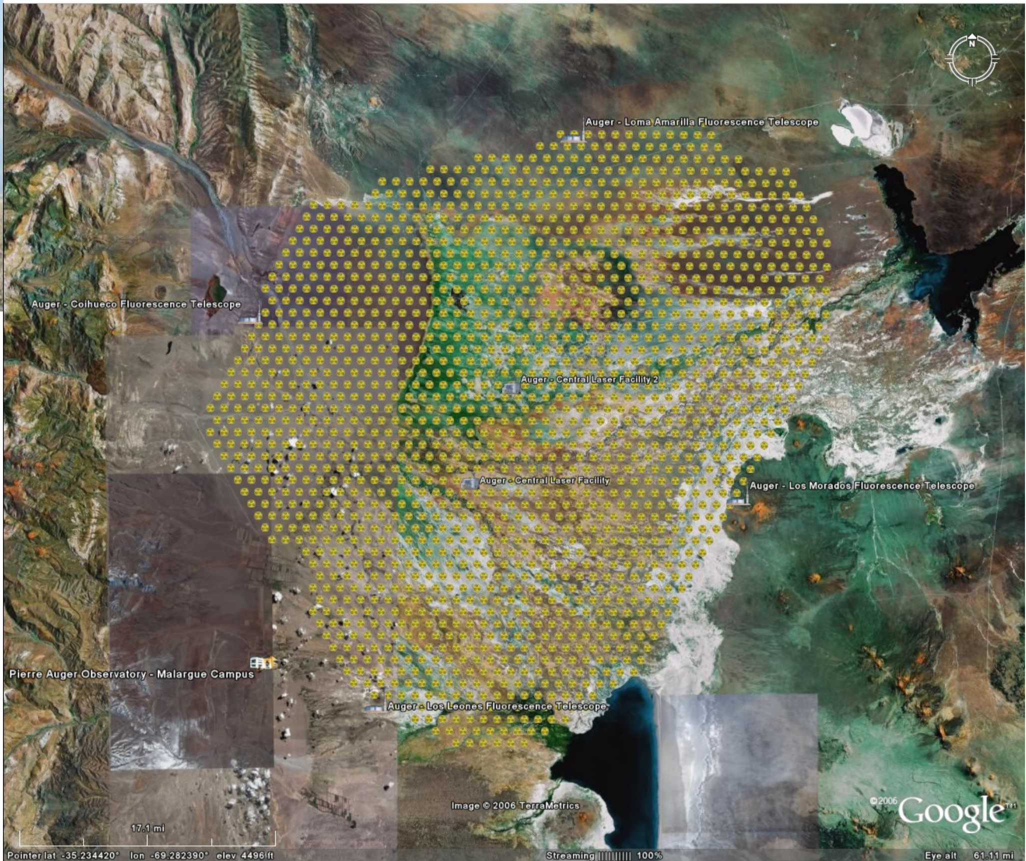
AGN – gyenge korreláció, nem meggyőző

Jól korrelál anyagsűrűséggel

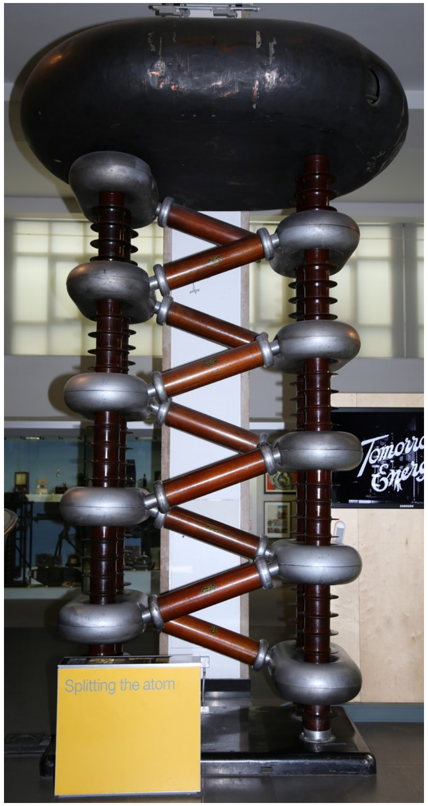
GRB? Nehéz igazolni...

Pierre Auger observatory

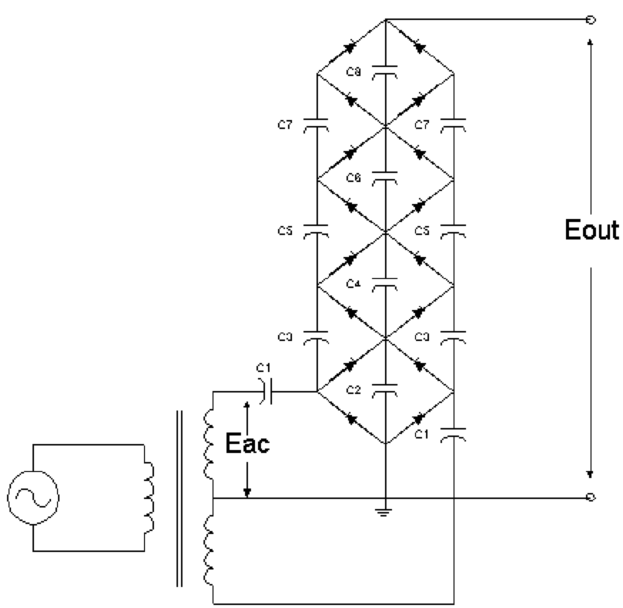


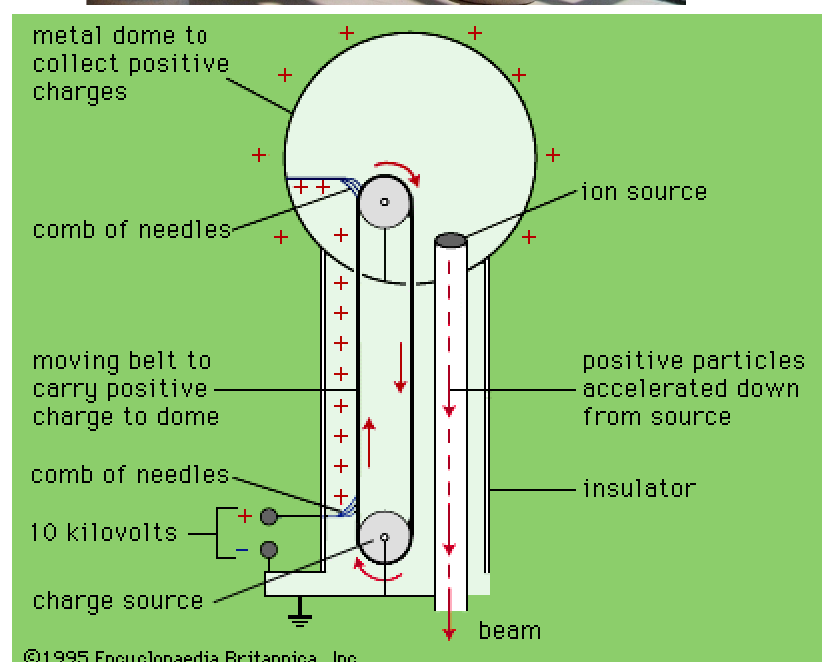


Cockroft-Walton generátor

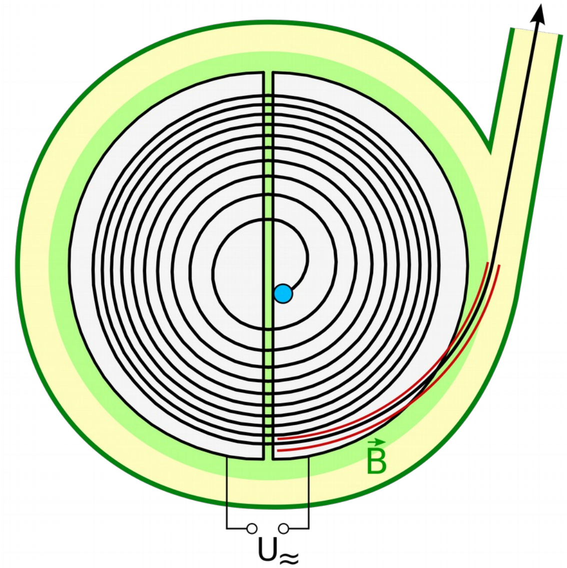


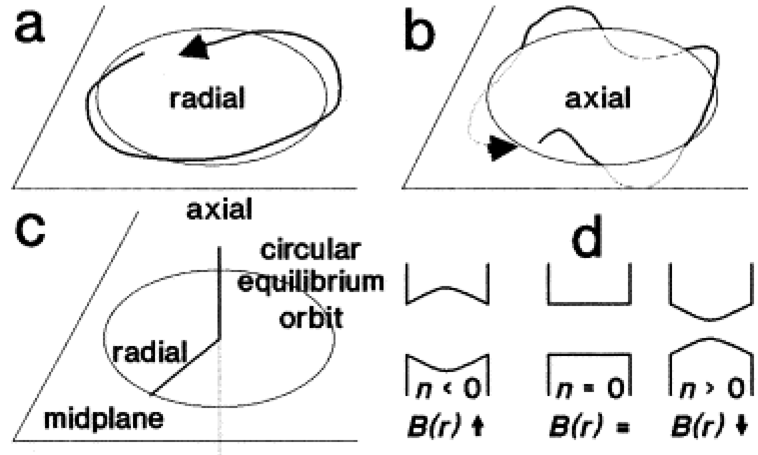
Van de Graaff generátor



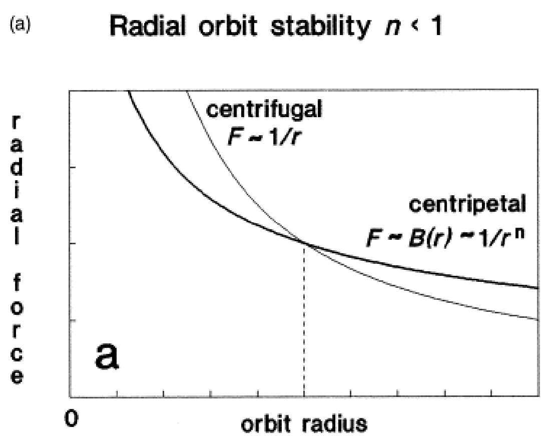


Ciklotron



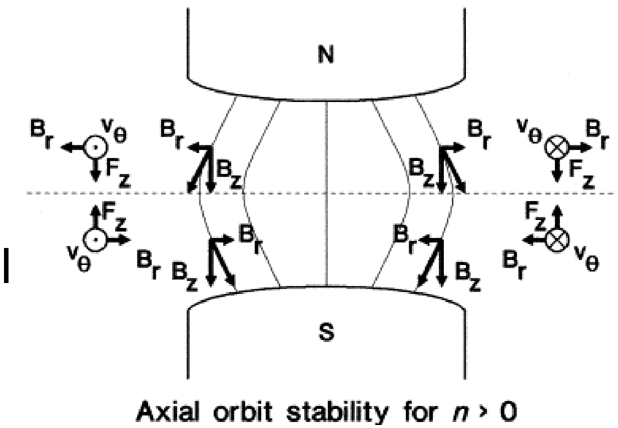


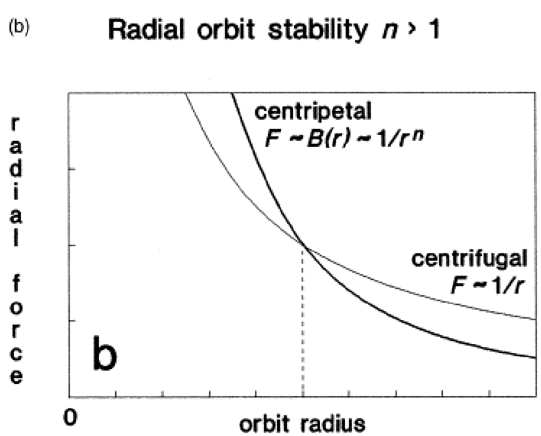
n: field index



Radiálisan stabil

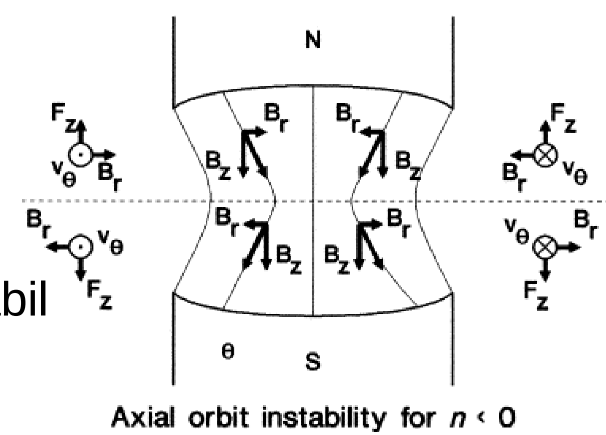
Axiálisan stabil (fókuszál)





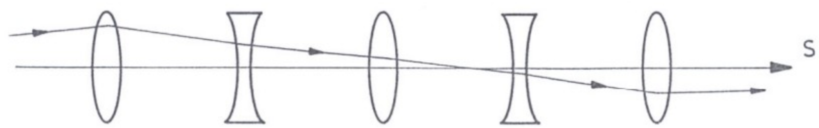
Radiálisan instabil

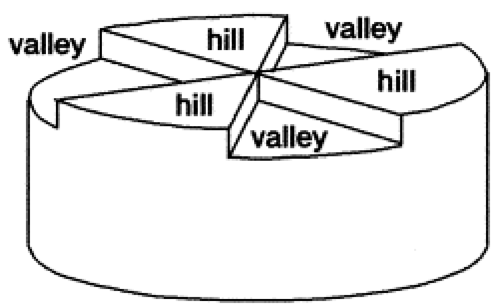
Axiálisan instabil (defókuszál)

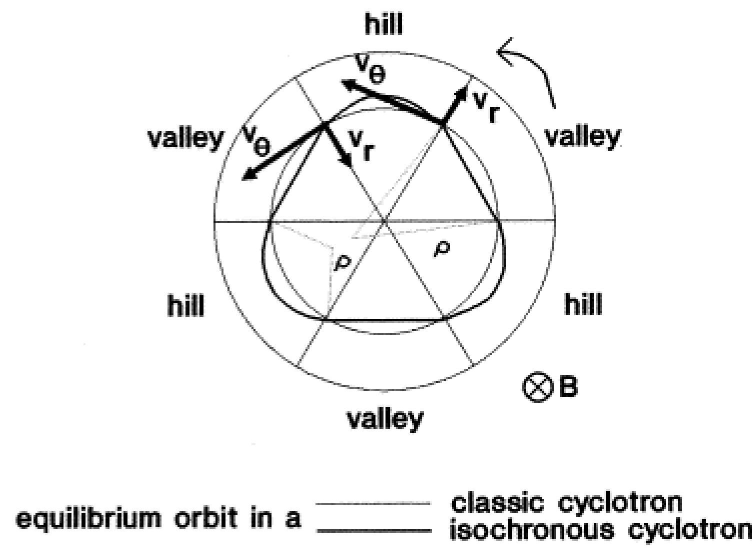


Izokron ciklotron

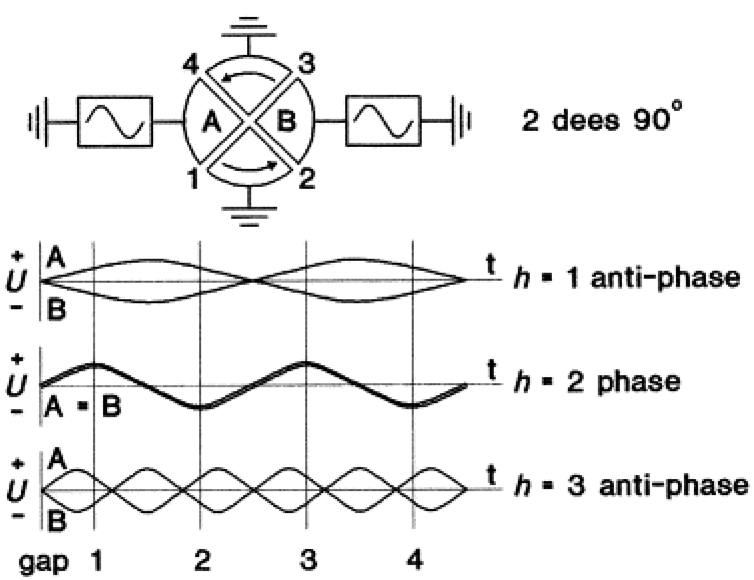
Erős fókuszálás







Relativisztikus tömegnövekedés kompenzálásához n<0 kell: izokron ciklotronban megoldható!



Two-dee cyclotron

$$\omega_E = h\,\omega_{ion} = h\,\frac{e\,B}{m}$$

Betatron

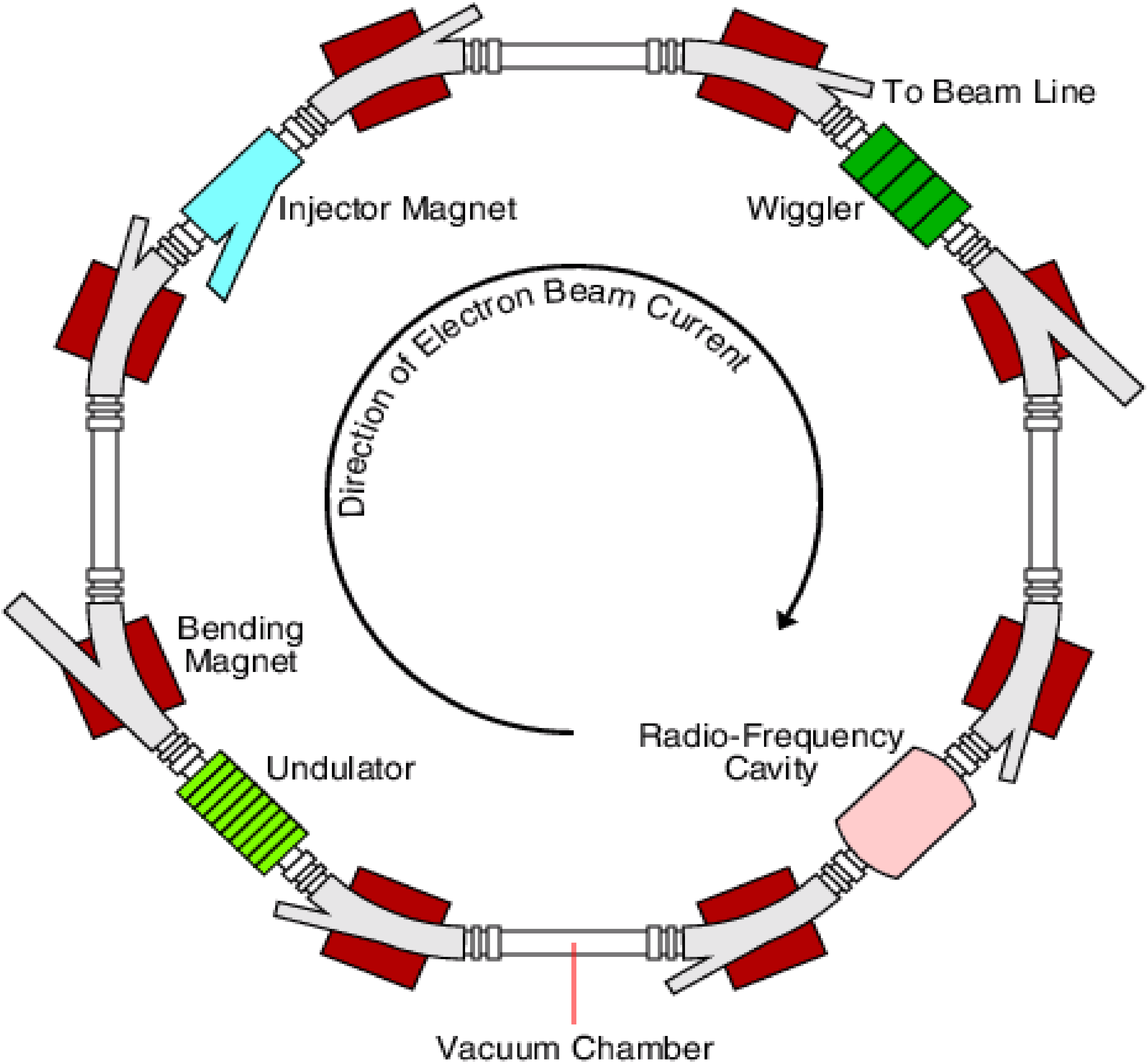
Indukciós gyorsító elve: R. Widerøe (1923)

Widerøe feltétel: $$B_0 = \frac{1}{2}\frac{\Phi_0}{\pi r_0^{\,2}}$$

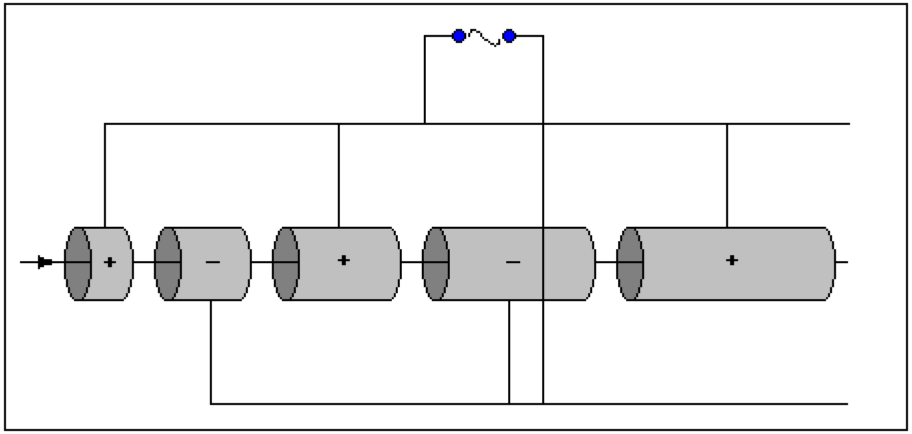
Kivitelezés: D. Kerst (1940)

Képen: 1942, 6 MeV

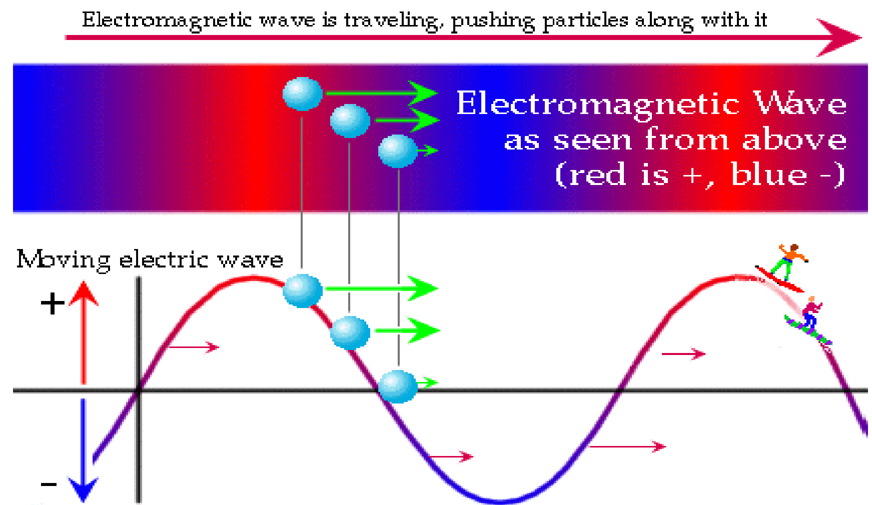
Szinkrotron



Lineáris gyorsító

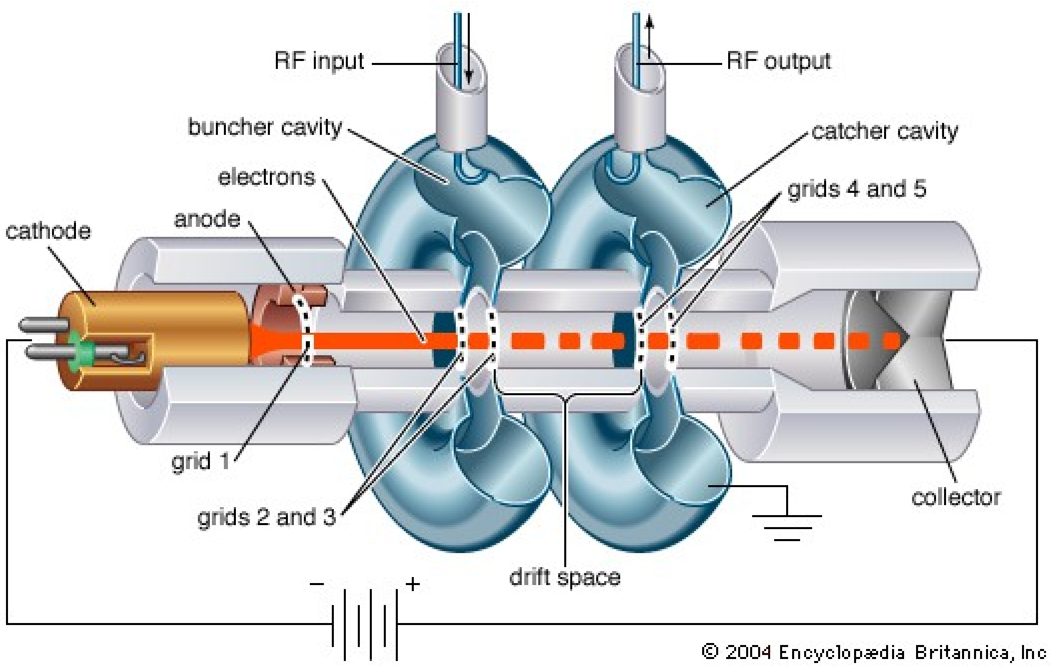


Simplified version of the Luis Alvarez linear accelerator.

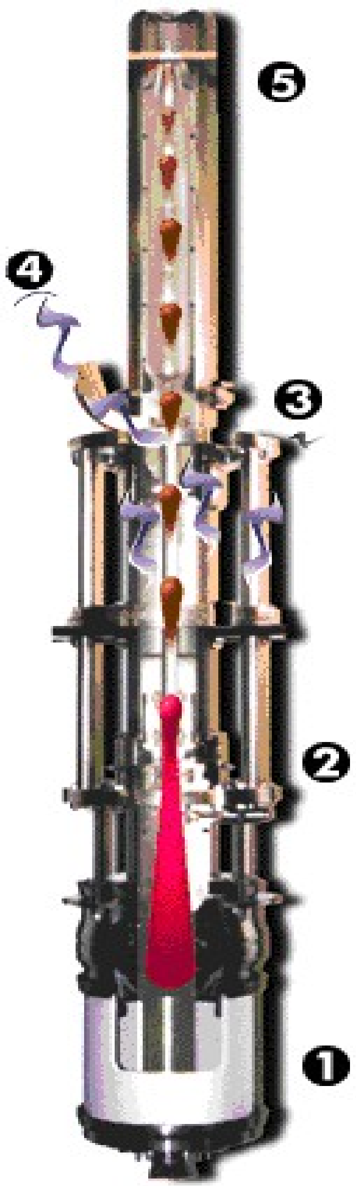


Positively charged particles ( ) close to the crest of the E-M wave experience the most force forward; those closer to the center experience less of a force. The result is that the particles tend to move together with the wave.

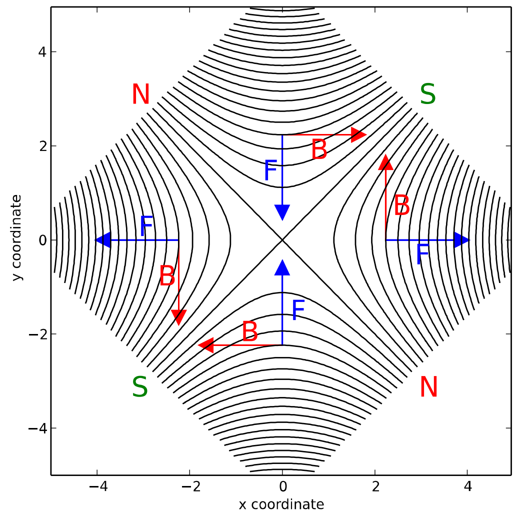
Nagy teljesítményű RF tér: klystron

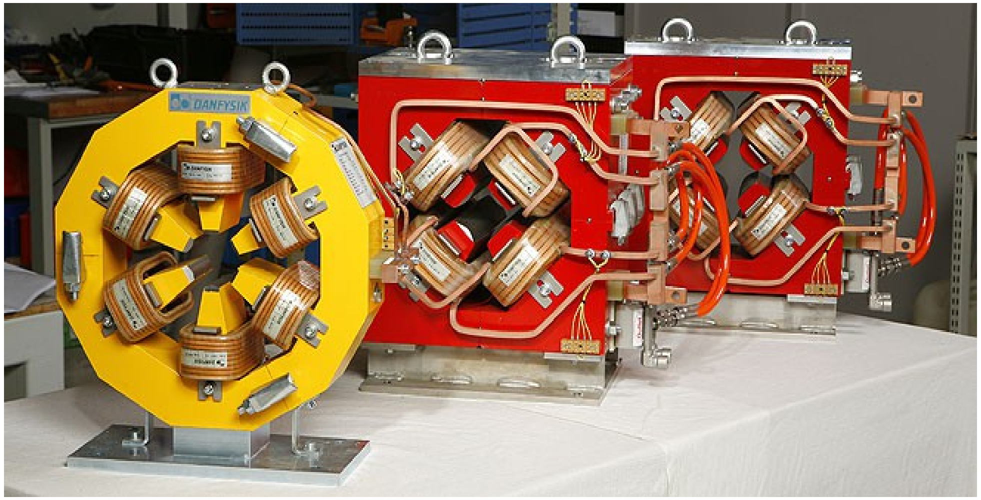


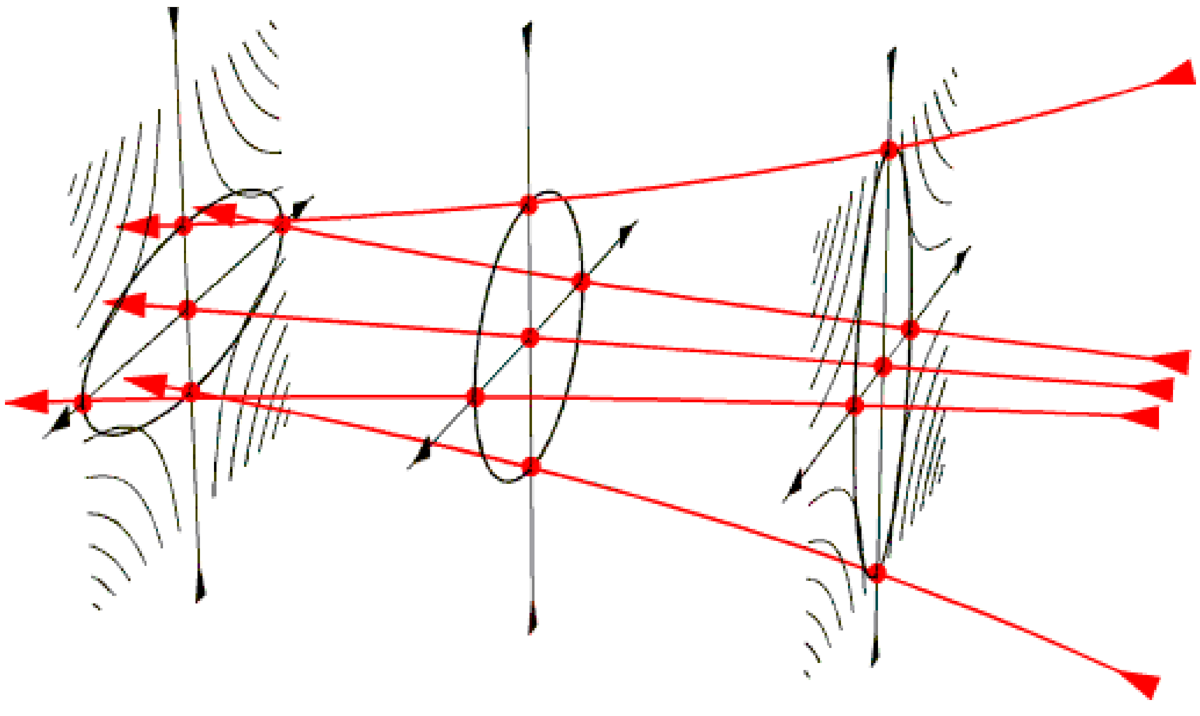
A klystron működése



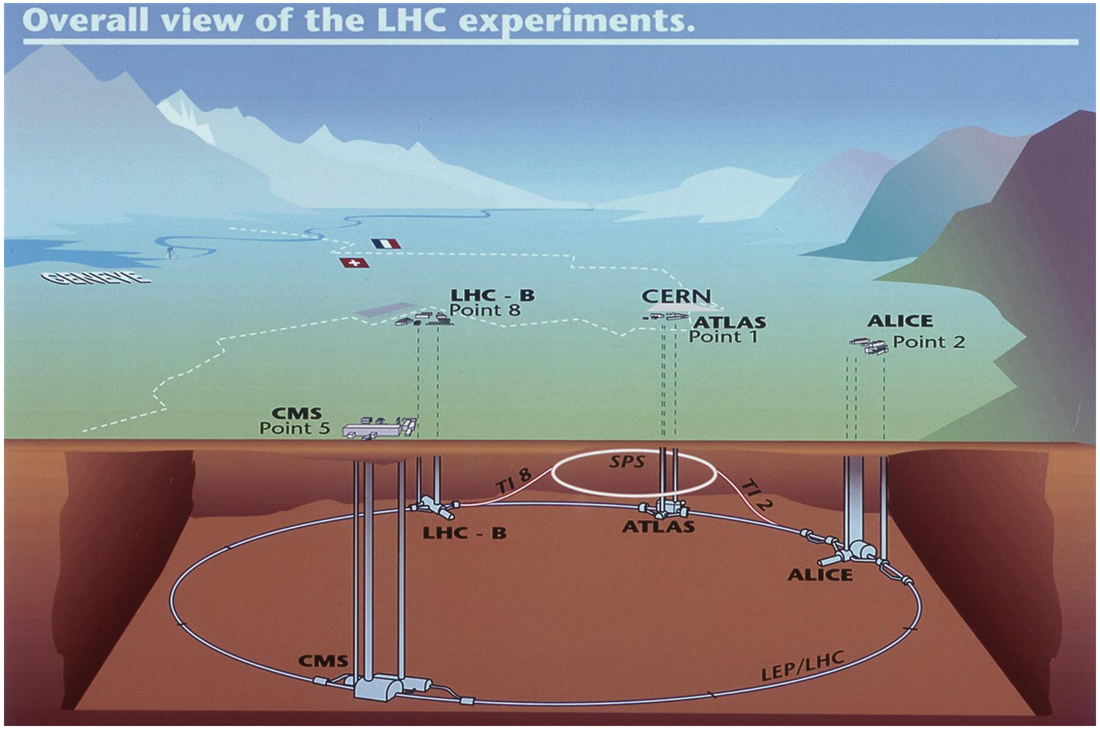
Fókuszálás: kvadrupól mágnes



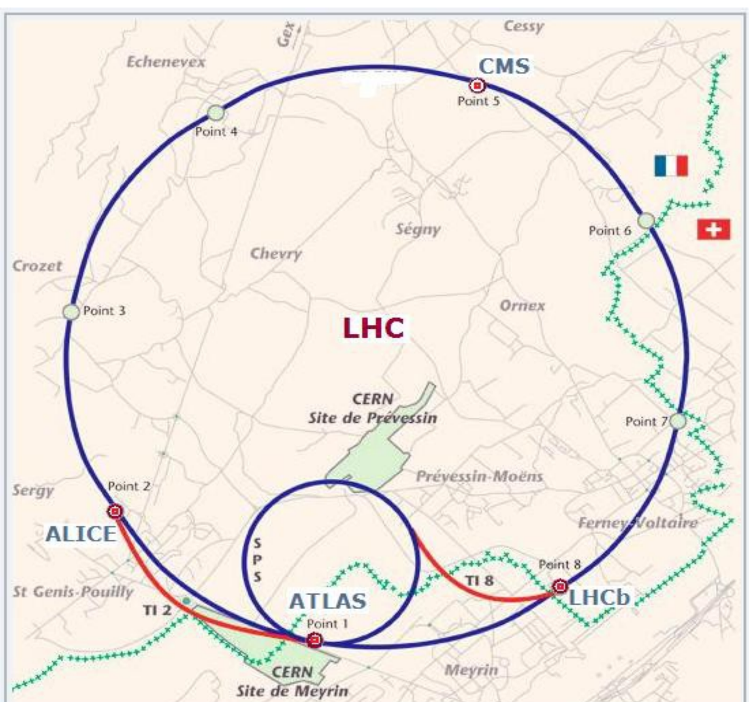




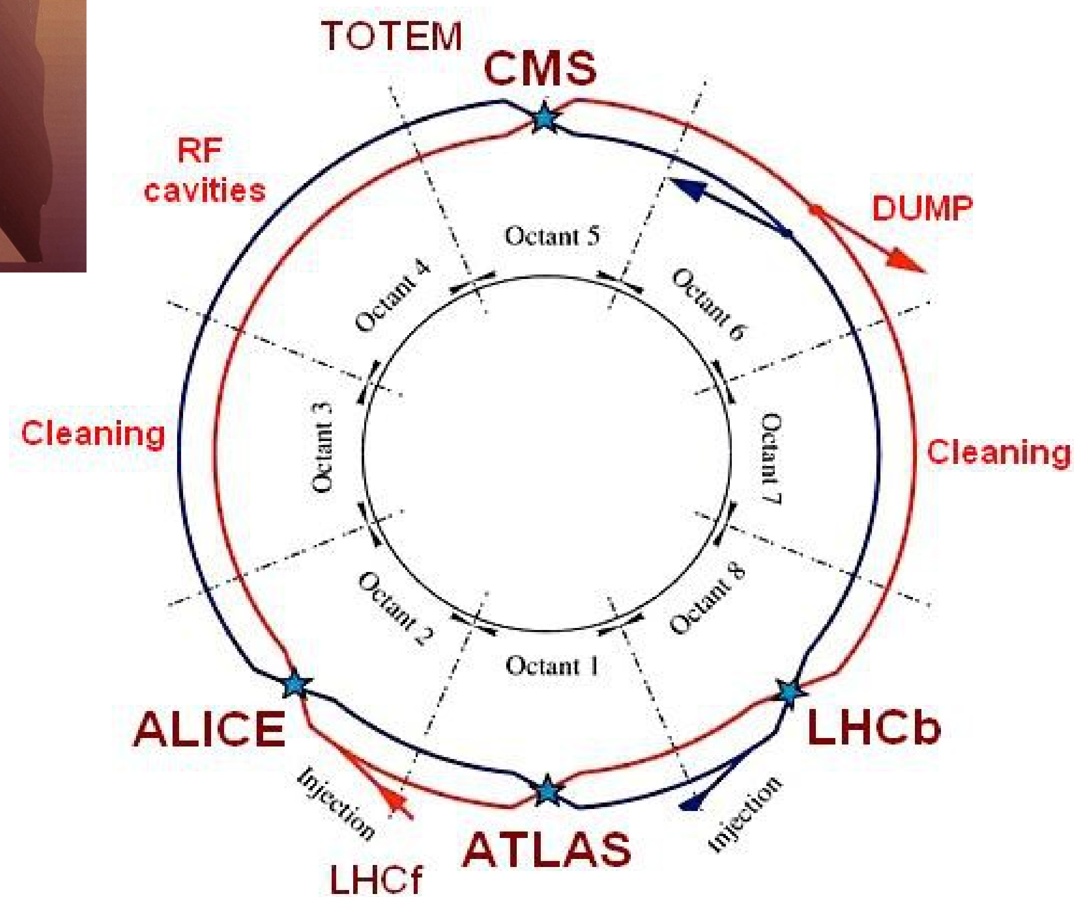
LHC



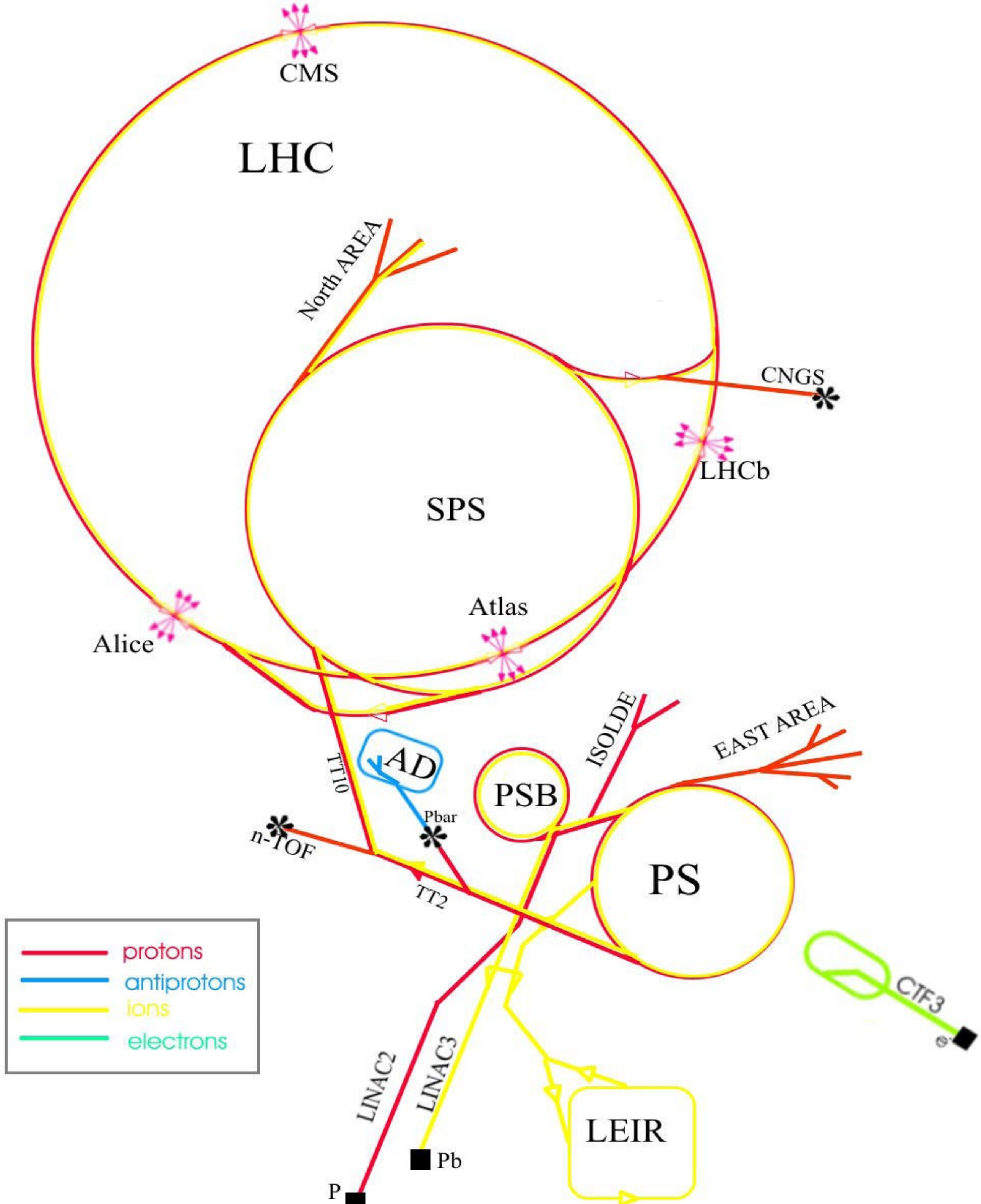
Overall view of the LHC experiments.
LHC - B
Point 8
CERN
ATLAS
Point 1
ALICE
Point 2
CMS
Point 5
SPS
TI 8
TI 2
LHC - B
ATLAS
ALICE
CMS
LEP/LHC



Cessy
Gex
Echenevex
CMS
Point 5
Point 4
Point 6
Ségny
Chevry
Crozet
Point 3
Ornex
LHC
CERN
Site de Prévessin
Point 7
Prévessin-Moëns
Sergy
Point 2
ALICE
Ferney-Voltaire
S P S
Point 8
TI 8
LHCb
ATLAS
Point 1
St Genis-Pouilly
TI 2
CERN
Site de Meyrin
Meyrin



TOTEM
CMS
RF
cavities
DUMP
Octant 5
Octant 4
Octant 6
Cleaning
Octant 3
Octant 7
Cleaning
Octant 2
Octant 8
Octant 1
ALICE
LHCb
Injection
Injection
ATLAS
LHCf

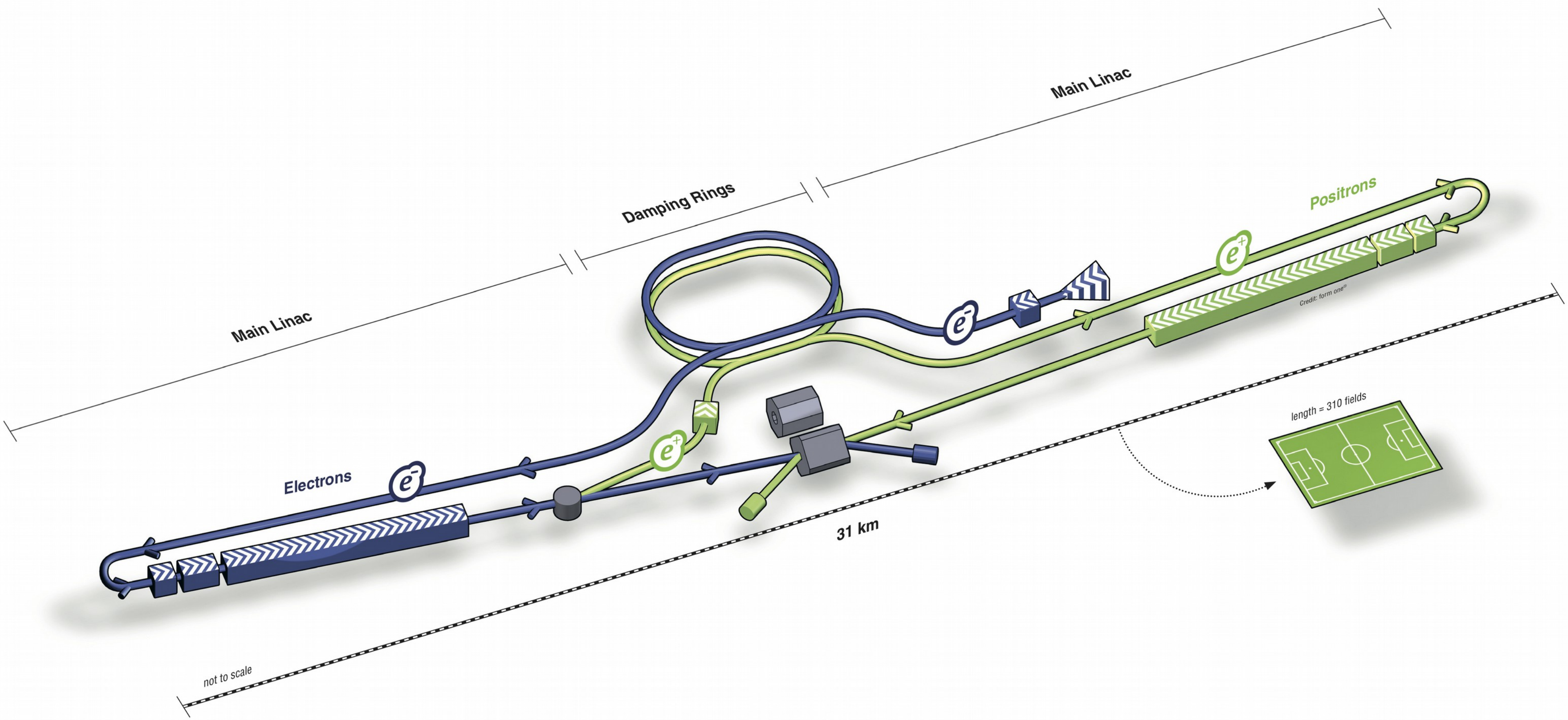

CMS
LHC
North AREA
CNGS
LHCb
SPS
Atlas
Alice
ISOLDE
EAST AREA
TT10
AD
PSB
Pbar
n-TOF
PS
TT2
protons
antiprotons
ions
electrons
CTF3
e-
LINAC2
LINAC3
LEIR
Pb
P

pp ütközés az LHC-ban (ATLAS)

Nehézion ütközés az LHC-ban (ATLAS)

LHC és a Big Bang

International Linear Collider (ILC)



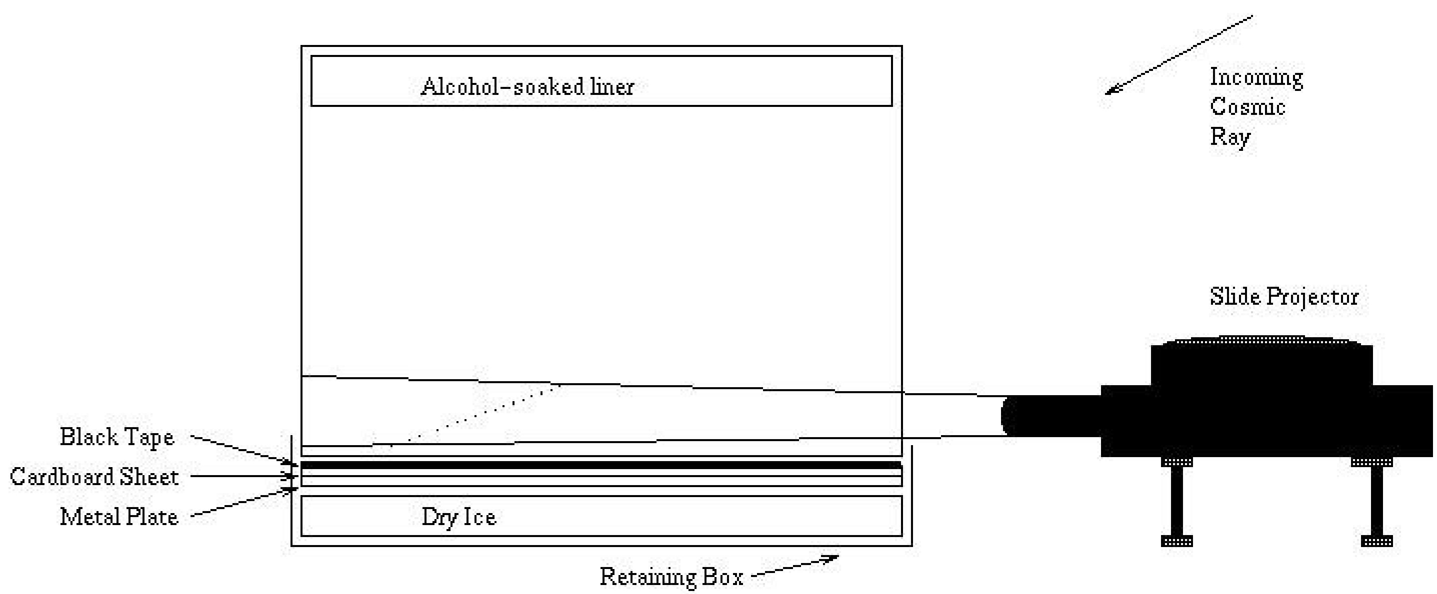
Elektron-pozitron ütköztető

Célok: Higgs-bozon tulajdonságok precíziós mérése
Szuperszimmetrikus részecskék
Extra dimenziók (TeV méretben)
Legkorábban 2026-ban indulhat, költség 20-25 G$
Kezdeti energia: 250+250 GeV, upgrade után 500+500 GeV
2 nagy detektor

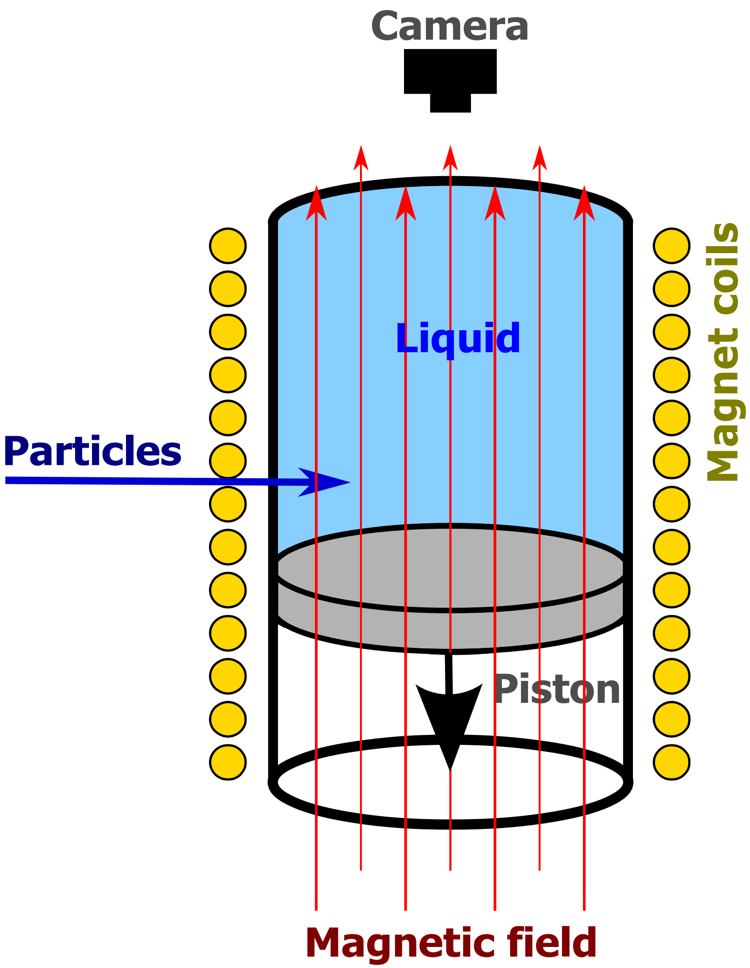
Detektorok


S. Harris
"QUARKS. NEUTRINOS. MESONS. ALL THOSE DAMN PARTICLES
YOU CAN'T SEE. THAT'S WHAT DROVE ME TO DRINK.
BUT NOW I CAN SEE THEM!"

Wilson-féle ködkamra

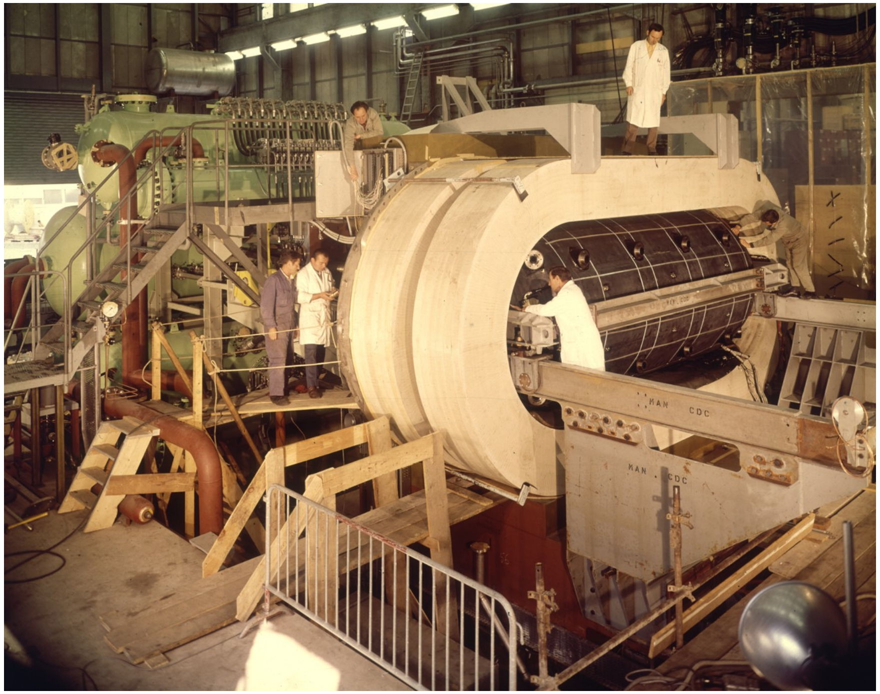


Buborék kamra

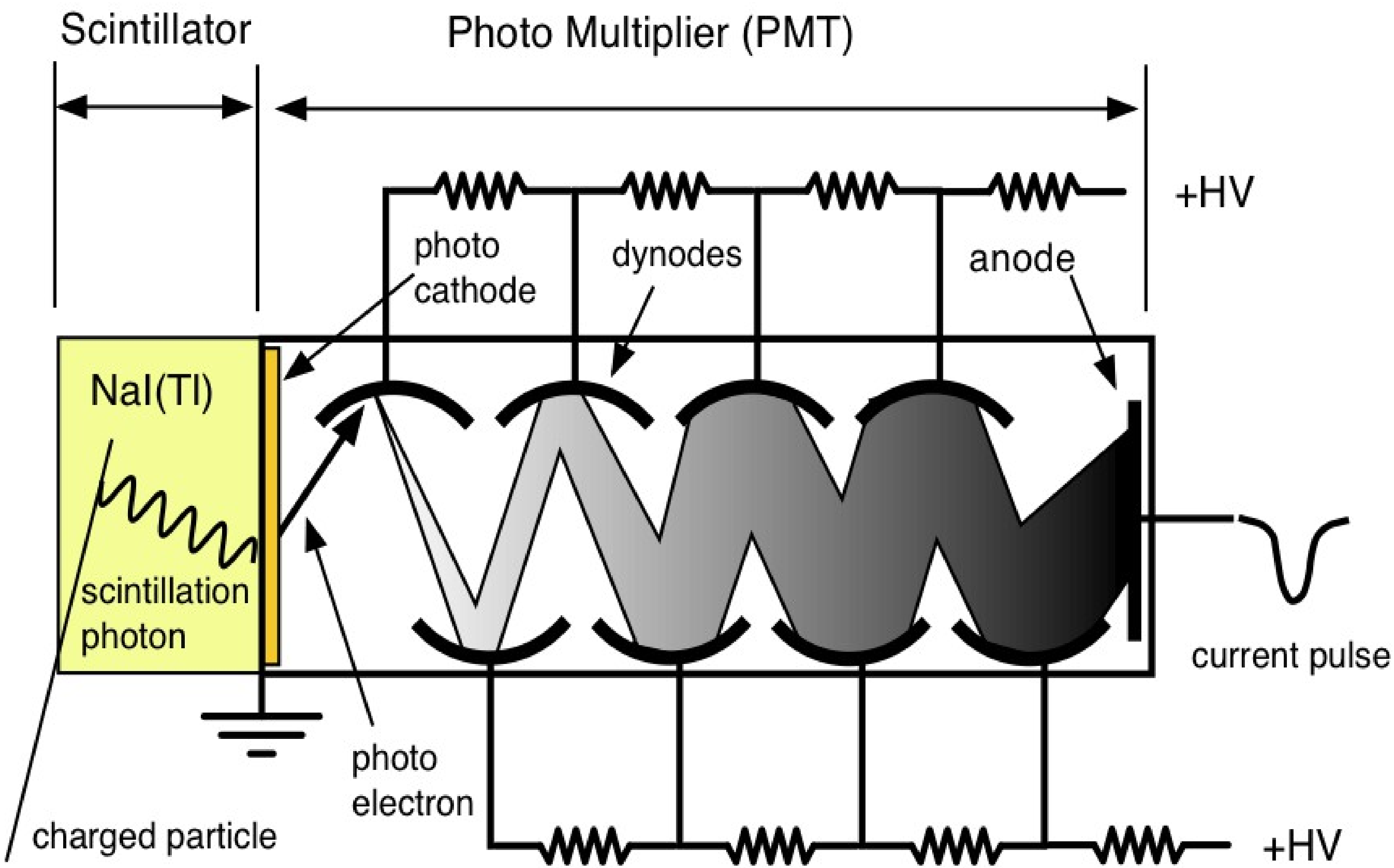


FNAL

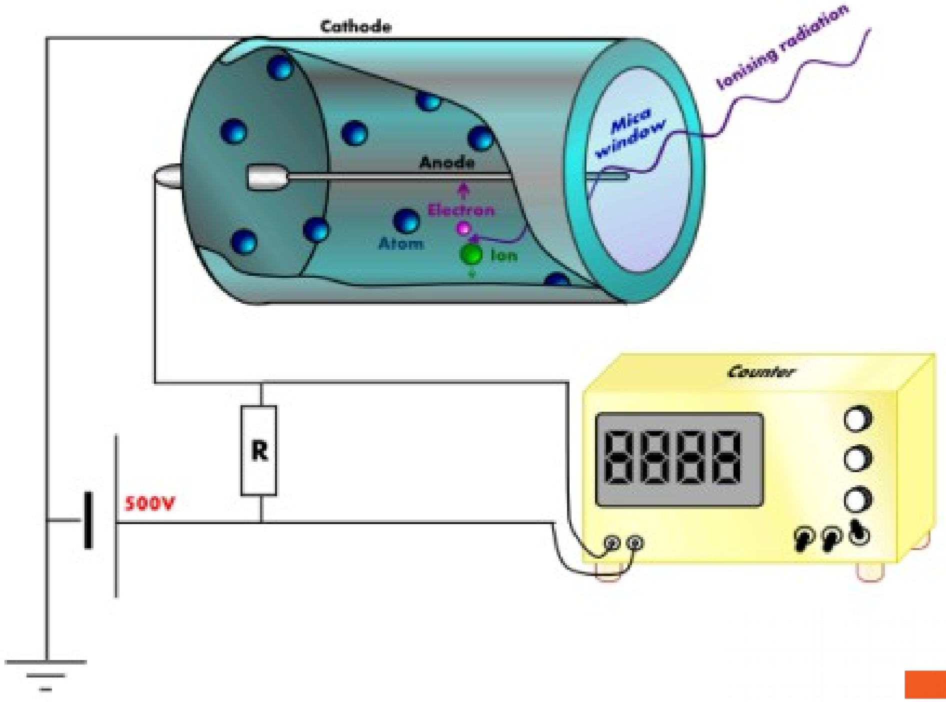
Gargamelle

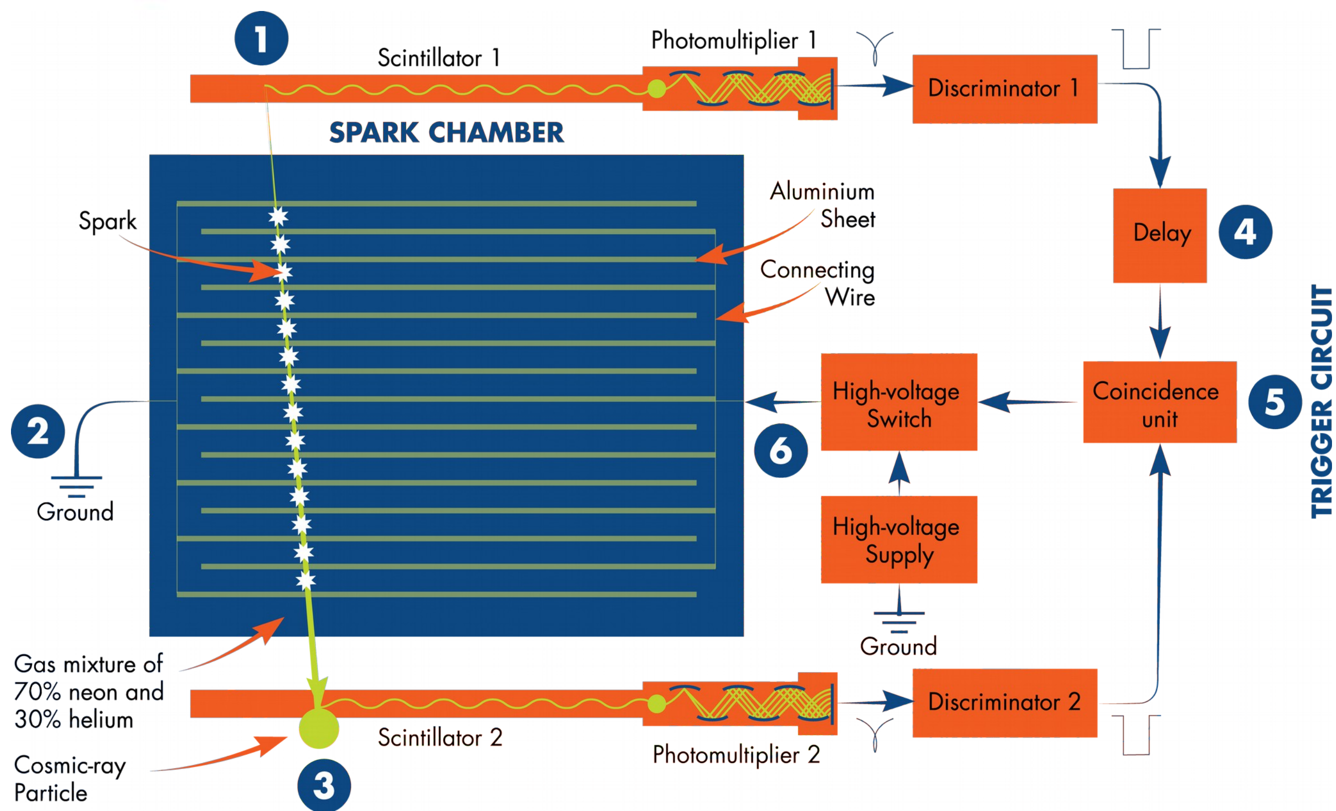


Szcintillációs számláló, photomultiplier

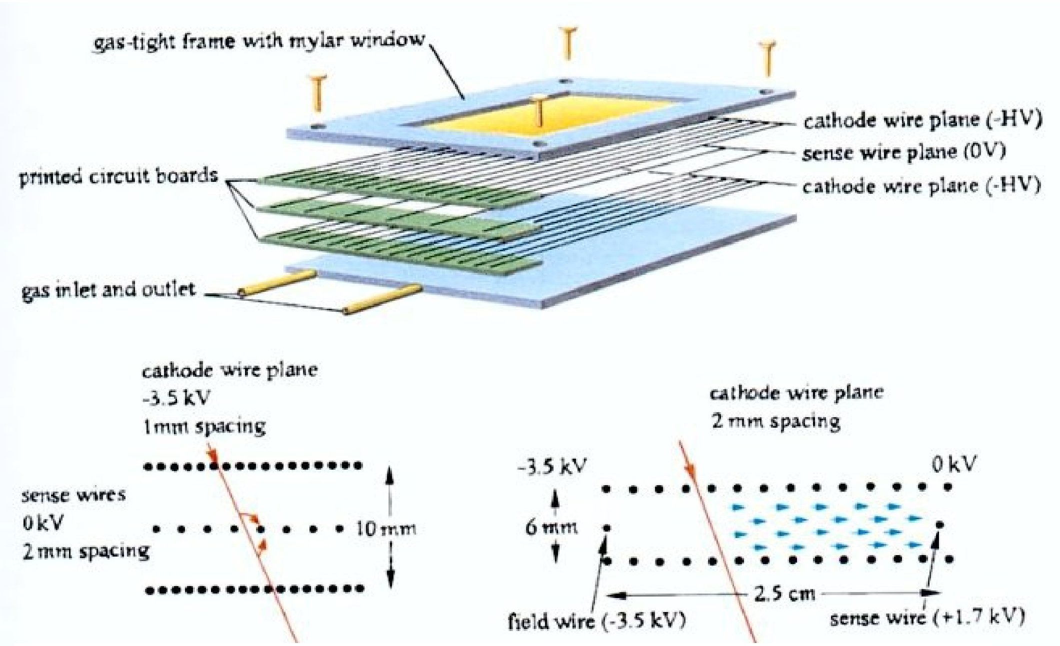


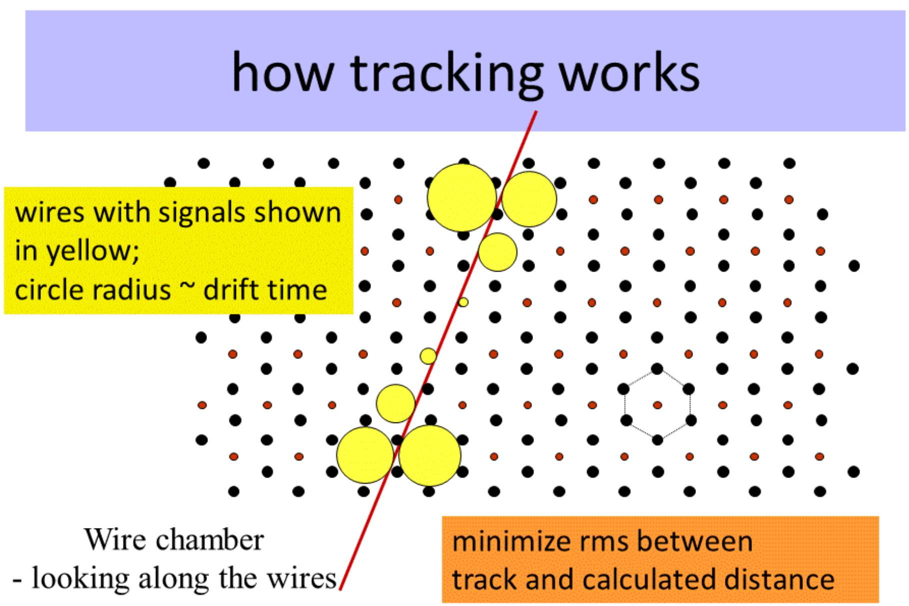
Geiger-Müller számláló, szikrakamra





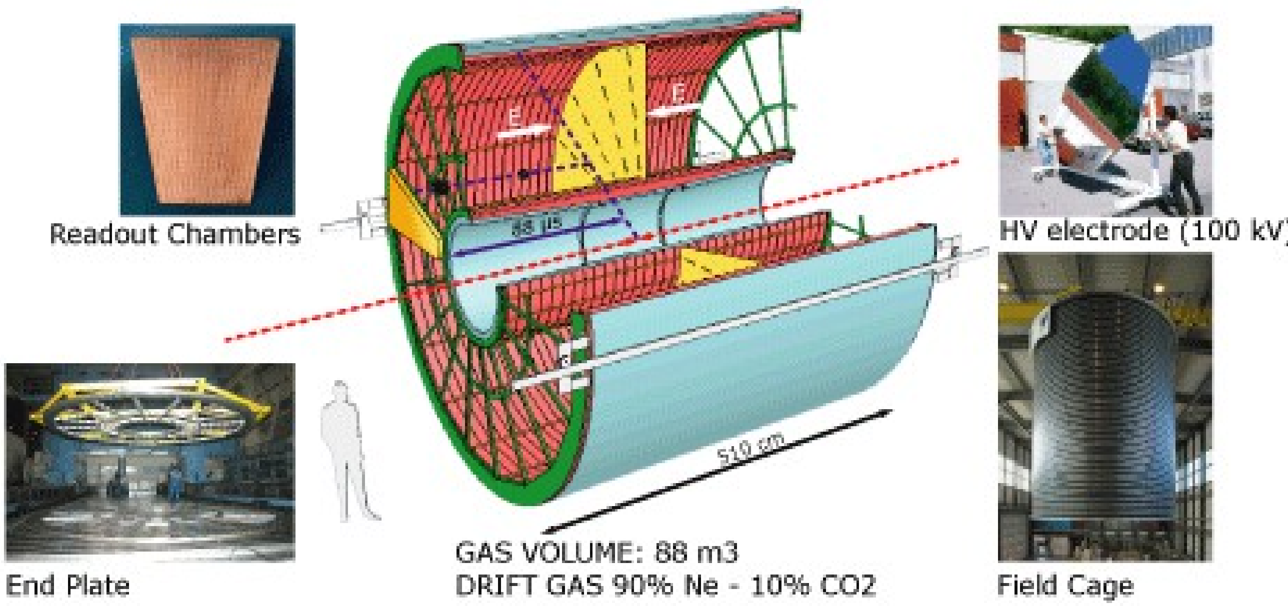
Proporcionális kamra

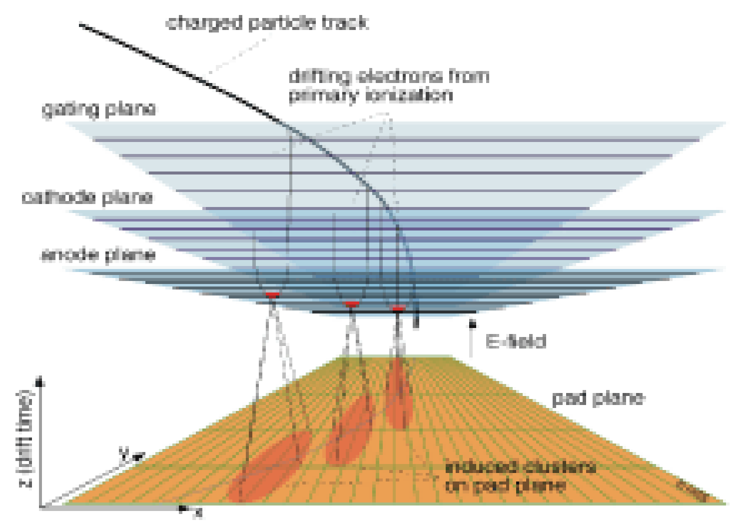


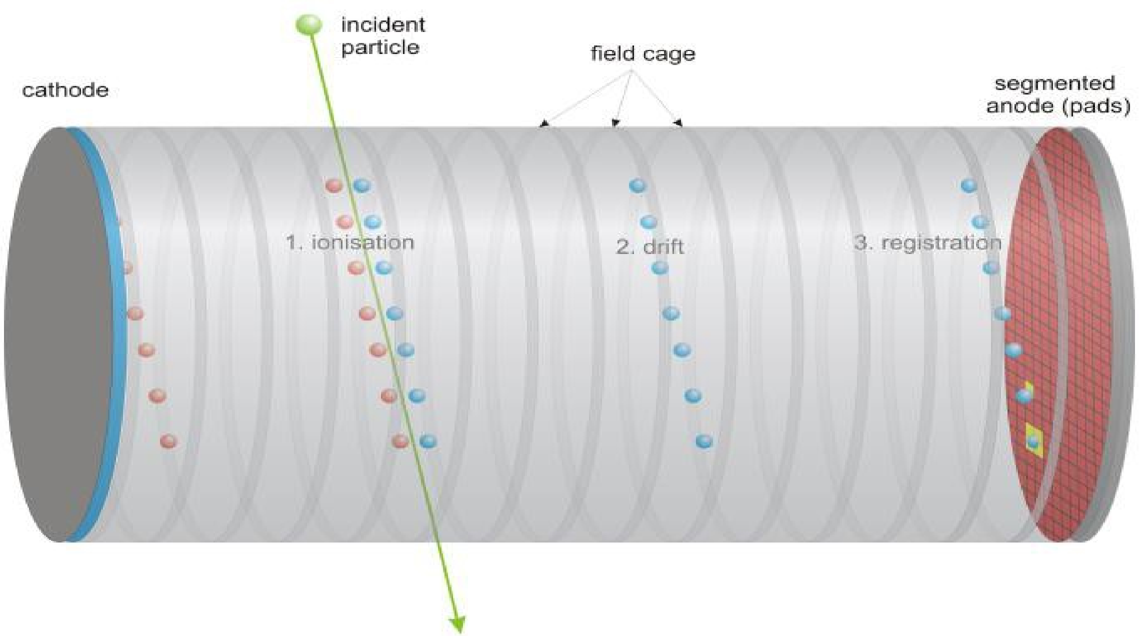


Time projection chamber

CERN ALICE

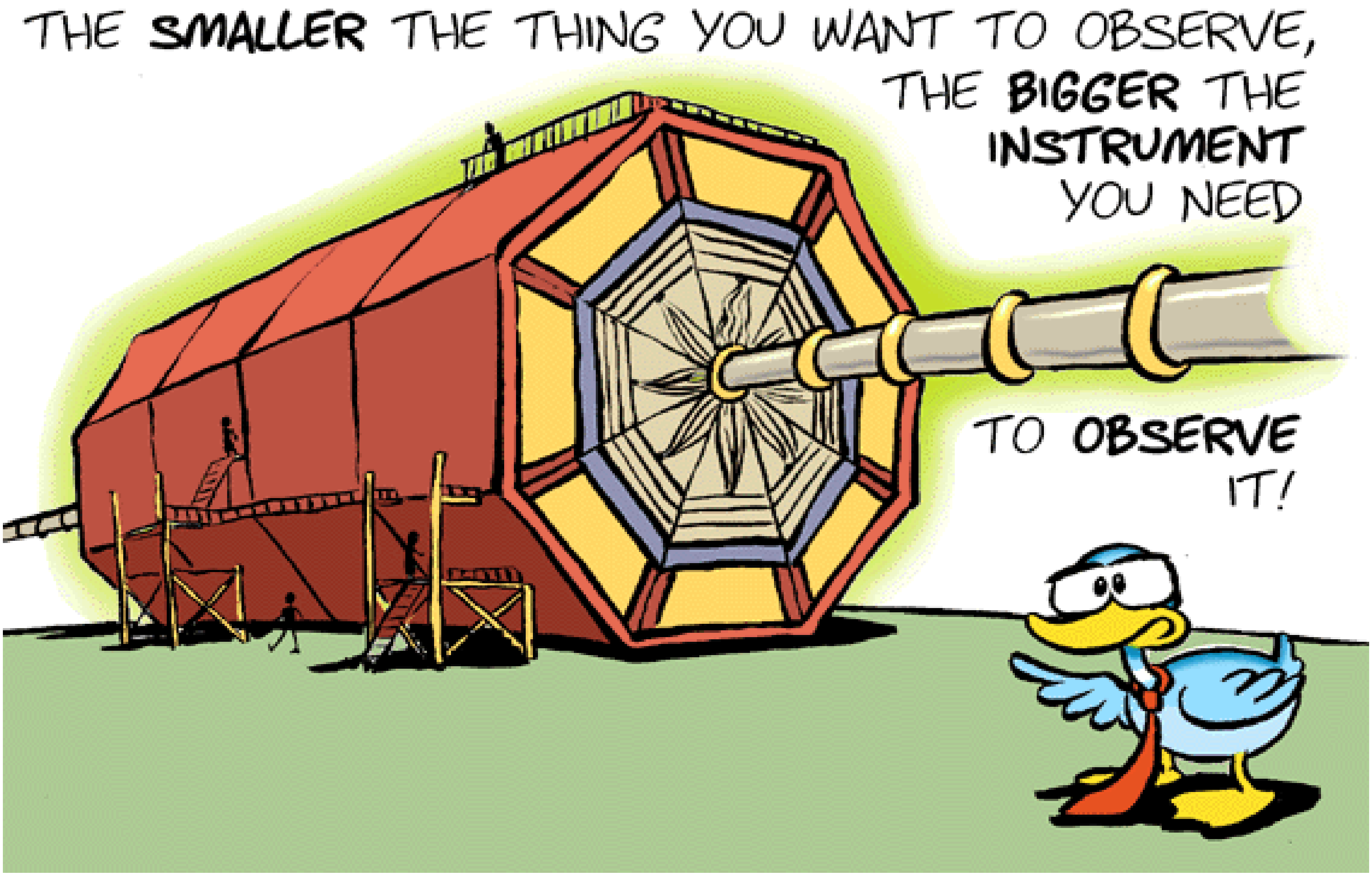




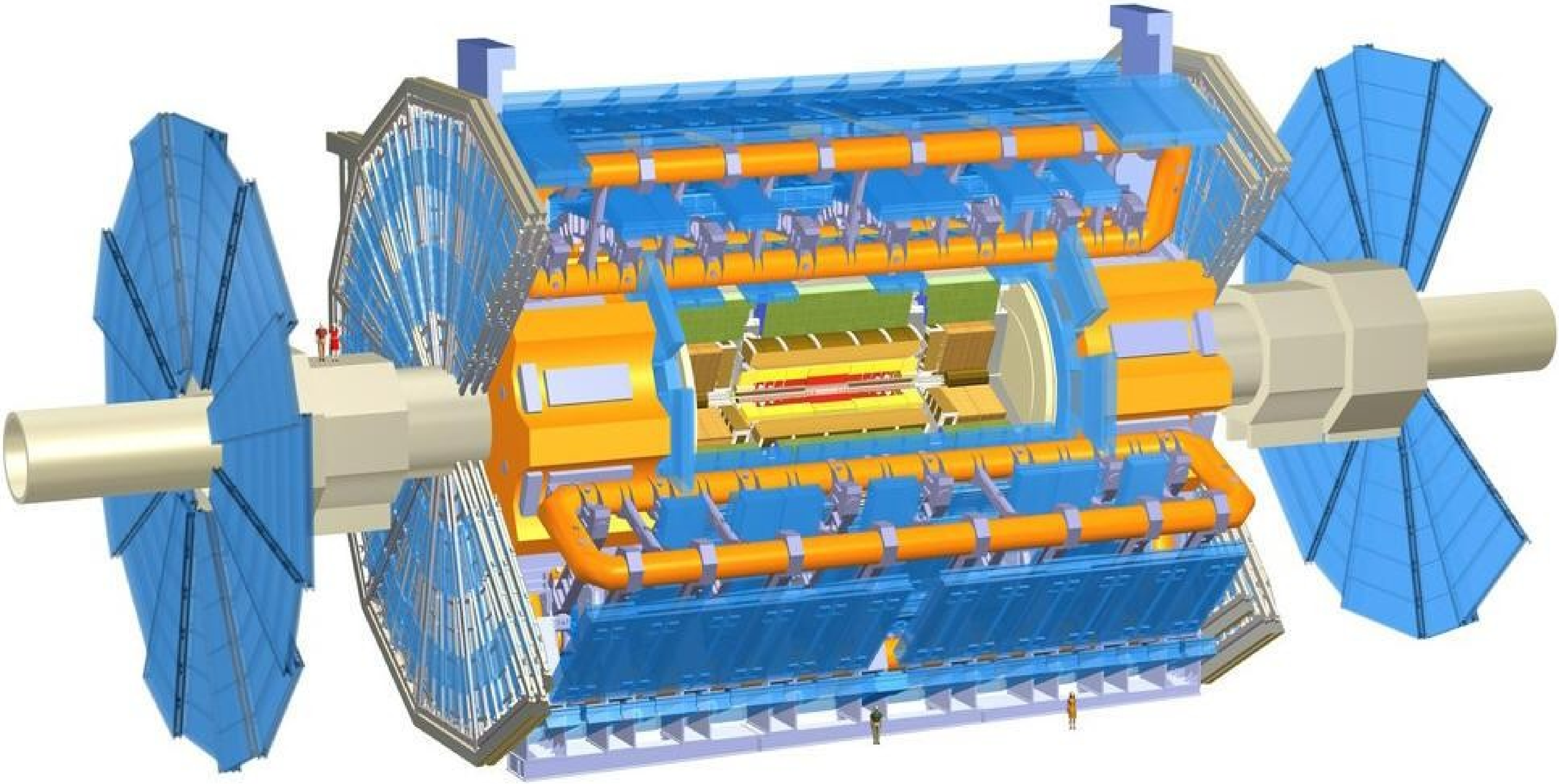


Nagyszámú trajektória 3D
rekonstrukciója
+ dE/dx (részecske azonosítás)

Egy igazi detektor: LHC ATLAS

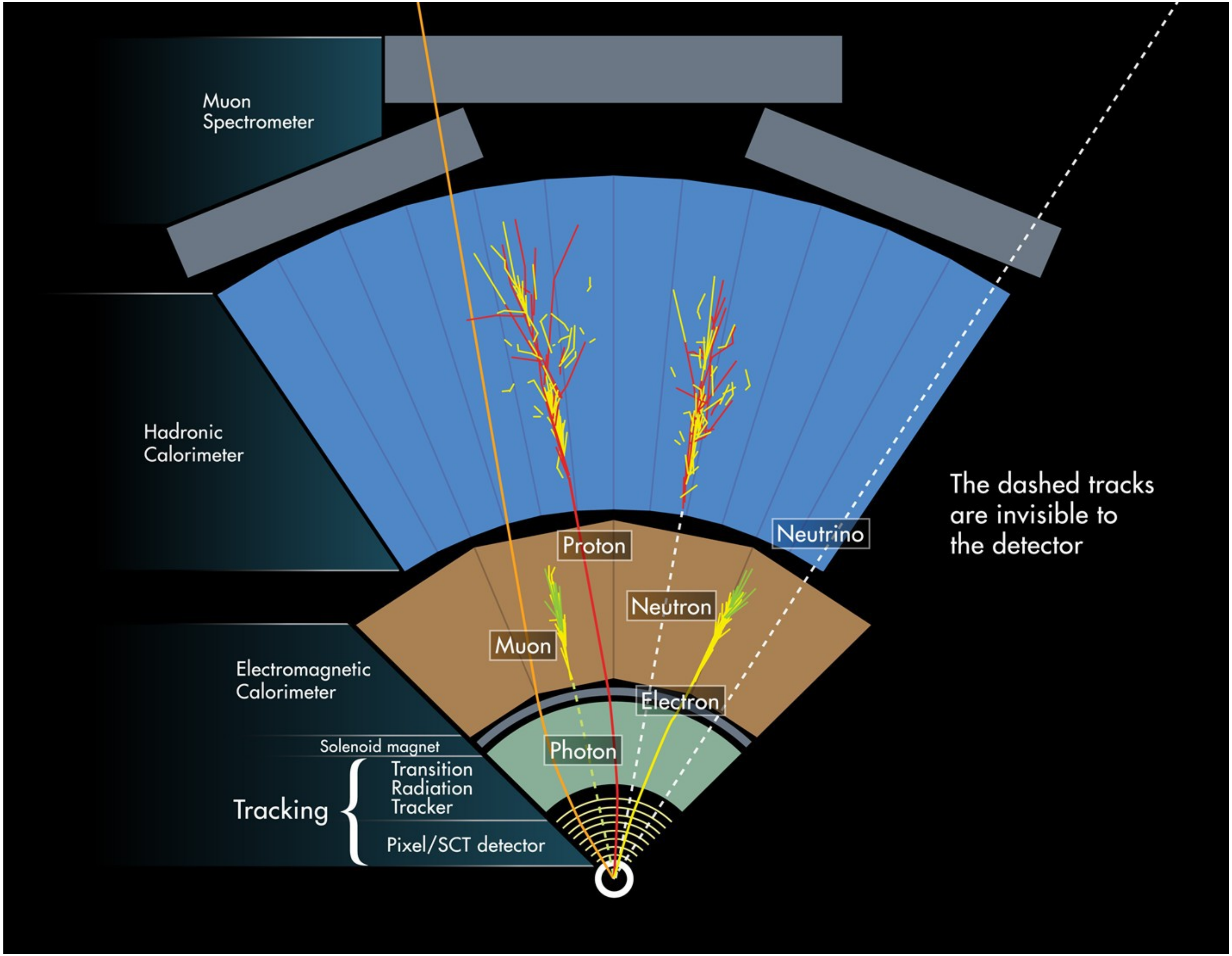


CERN ATLAS



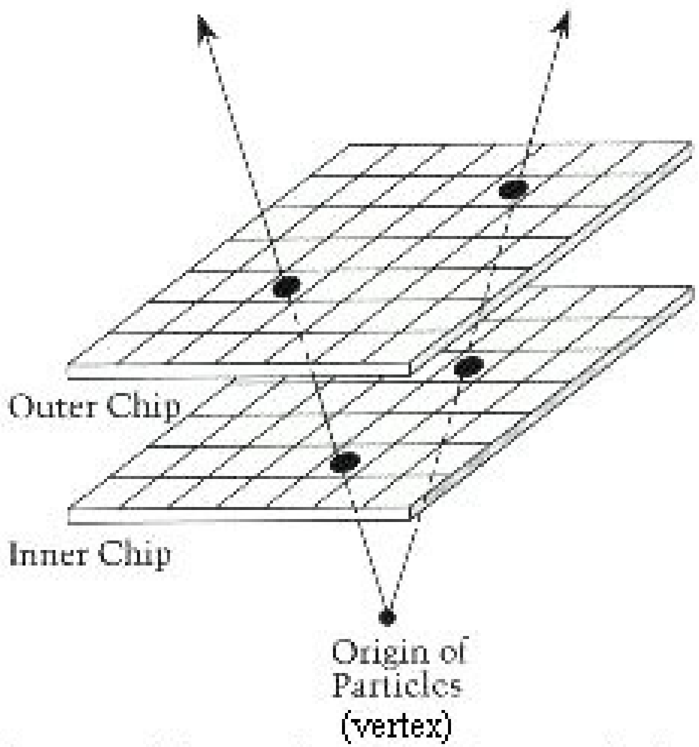
A Toroidal LHC Apparatus (ATLAS): 45 méter hosszú, 25 méter átmérőjű, 7000 tonna.
Kollaboráció: mintegy 3,000 fizikus, 175 intézet, 38 ország.
Higgs-keresés, CP-sértés, W tömeg mérés, top kvark mérése, szuperszimmetria keresés.

ATLAS részecskeazonosítás



Belső szolenoid 2 Tesla: 400 MeV alatti részecskék át se jutnak!
Külső szupravezetőtoroid: 2-8 Tesla (hadron kalori + muon kamrák, 1.6 GJ energia)

Vertex detektor



Two particle tracks leave charges in the two layers of the vertex detector.

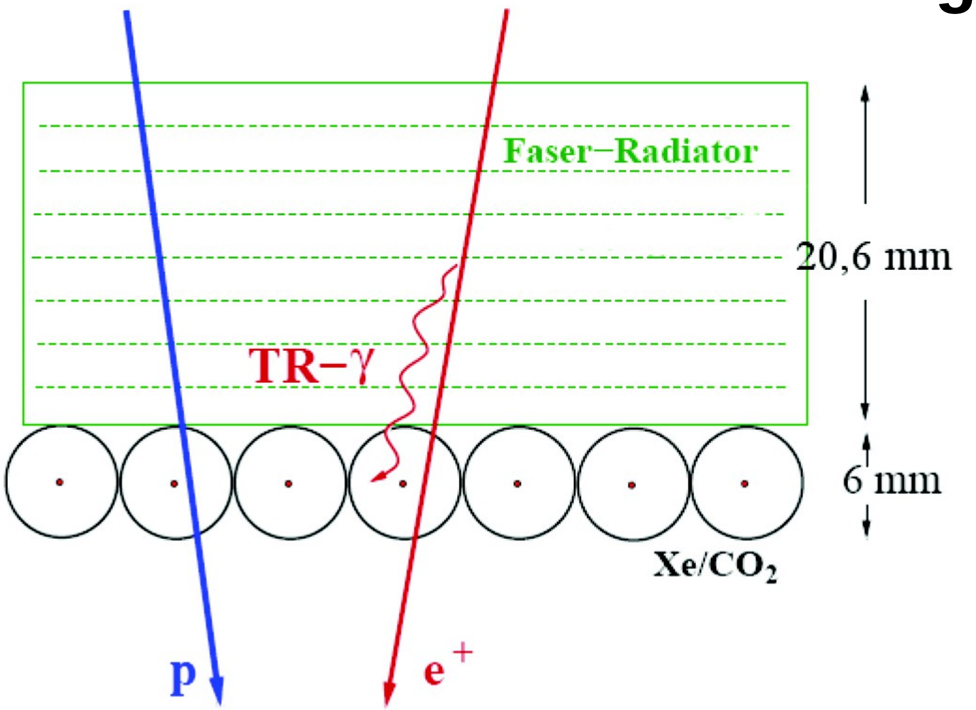
Atlas: 61 m^2 csík, 6300000 csatorna
2 m^2 pixel, 80000000 csatorna

Az összes kiolvasási csatorna fele!

ATLAS:
silicon pixel detectors
- barrel 3 layers (including 1 removable) 4, 10, 13 cm
- 5 disks on each end-cup side from 11 – 20 cm
- pixel size 50x400 μm^2

silicon strip detectors - quasi-double-sided
- barrel 4 layers 30, 38, 45, 52 cm
- 9 wheels on each end-cup side
- strip pitch 80 μm, 12 cm length
- stereo angle 40 mrad

Átmeneti sugárzás detektor



Transition radiator tracker

Számottevő jel: γ≥1000

5 GeV elektron/pozitron nyomot hagy

5 GeV proton gyakorlatilag nem

Pozitron/proton megkülönböztetés

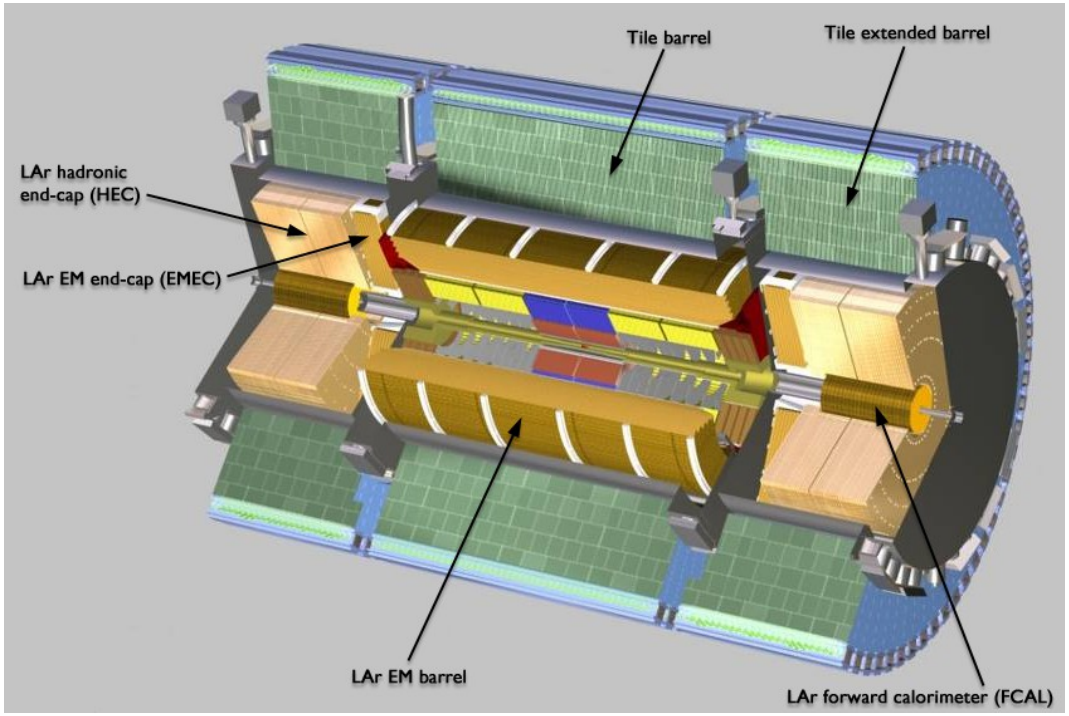
Gyapjú radiátor: kb. 100 átmenet

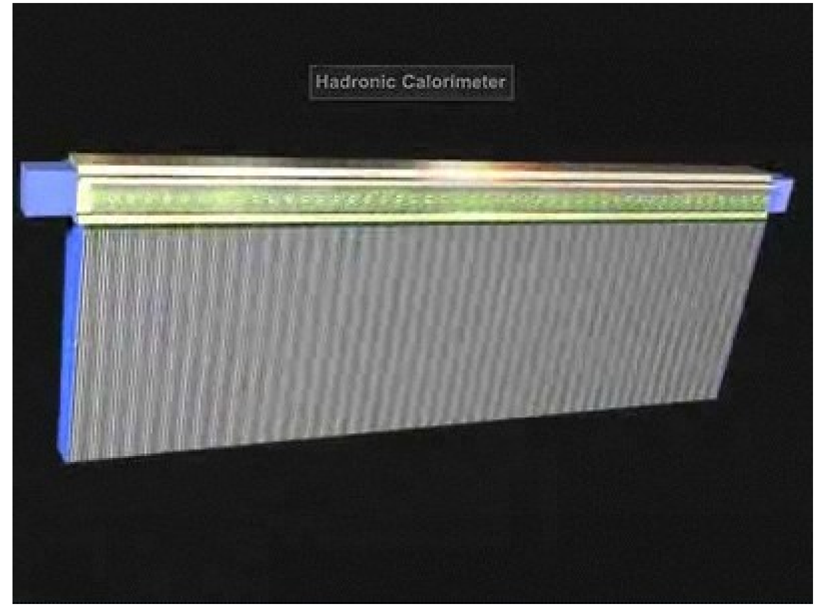
Röntgen sugárzás:
drift csövekkel detektálva

Összesen 298000 cső

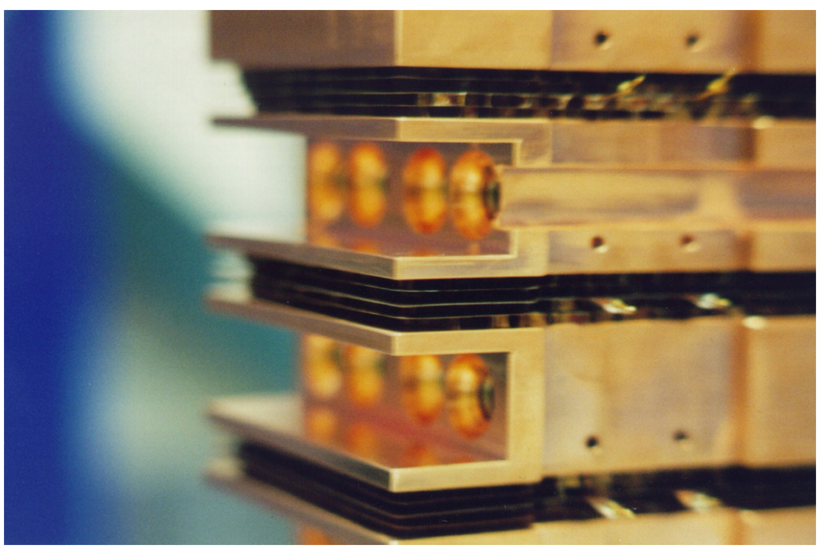
200 mikrométer pontosság

ATLAS kaloriméter



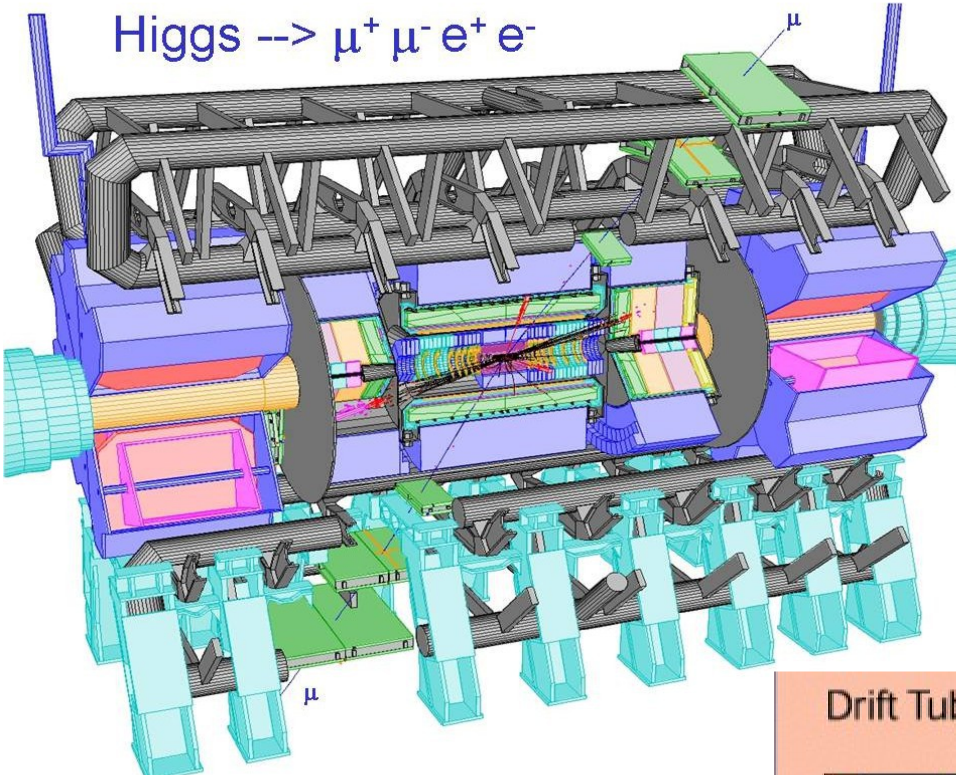


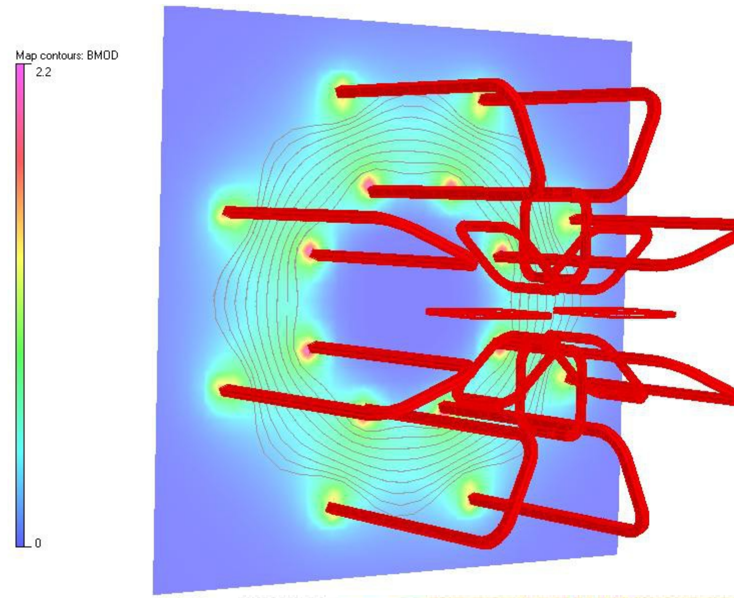
Hadron kaloriméter:
Acél abszorber, szcintillátorok

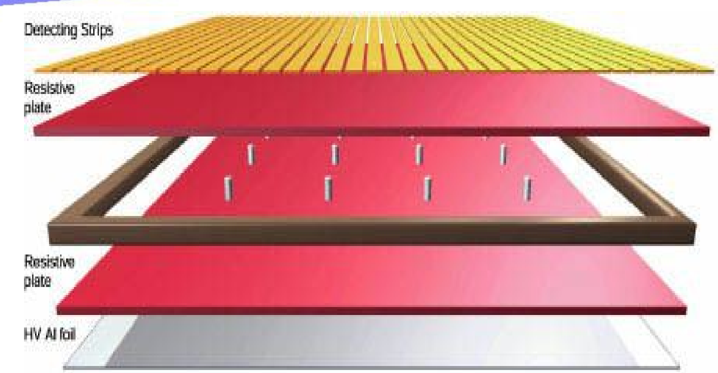


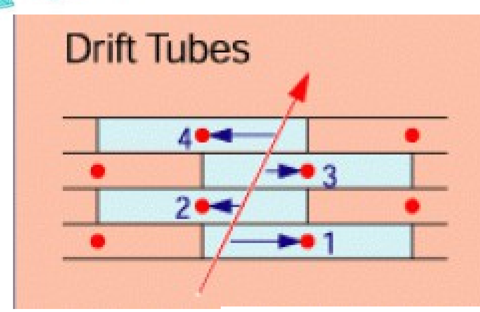
Elektromágneses kaloriméter
Elnyelők: ólom, rozsdamentes acél
Mintavétel: folyékony argon

ATLAS müon spektrométer





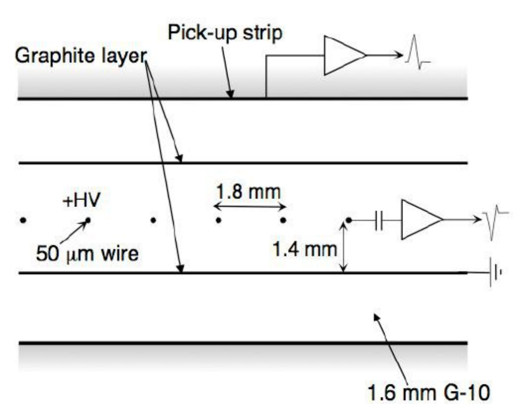


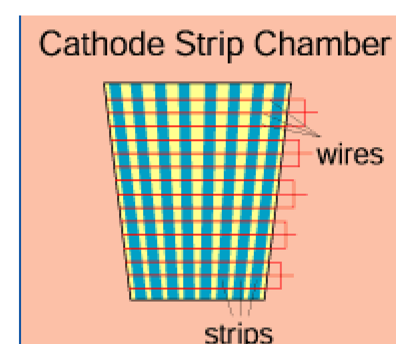


Többféle detektor elem

Monitored Drift Tubes Chambers (barrel)
Cathode Strip Chambers (CSC,6 réteg,endcap)
3 pont → pálya rekonstrukció, p mérés

Thin Gap Chambers (endcap)
Resistive Plate Chambers (barrel)
Trigger (gyors reakció, p becslés)





Adatfeldolgozás

25 MB/esemény, 40 millió esemény/sec

→ 1 petabyte/sec !!!!

Triggerek: eseményválogatás

Első szint: detektoron belüli elektronika → 100000/sec
Második/harmadik szint: detektor melletti klaszter

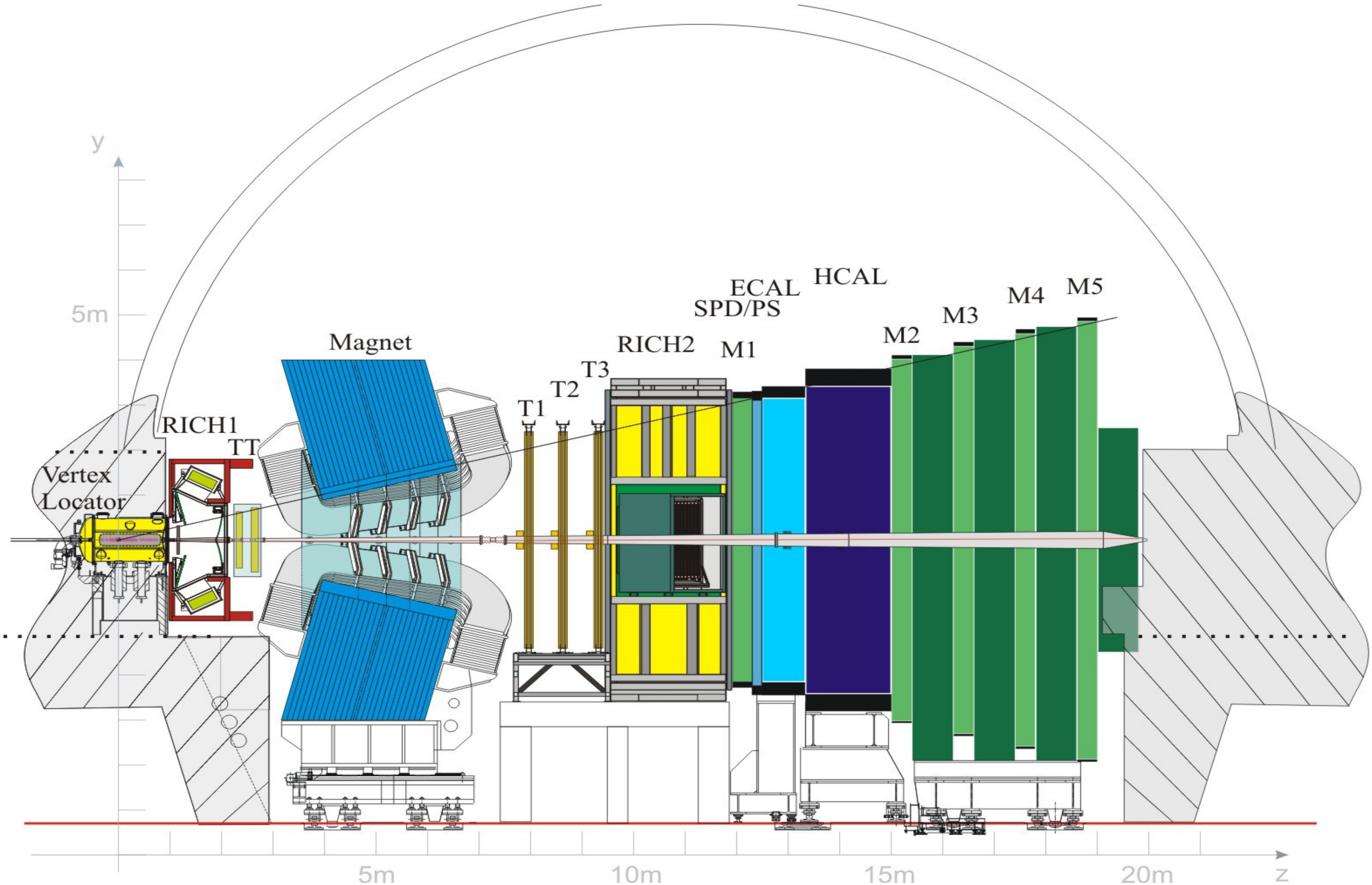
Marad: pár száz/sec

Tömörítés után kb 100 MB/sec

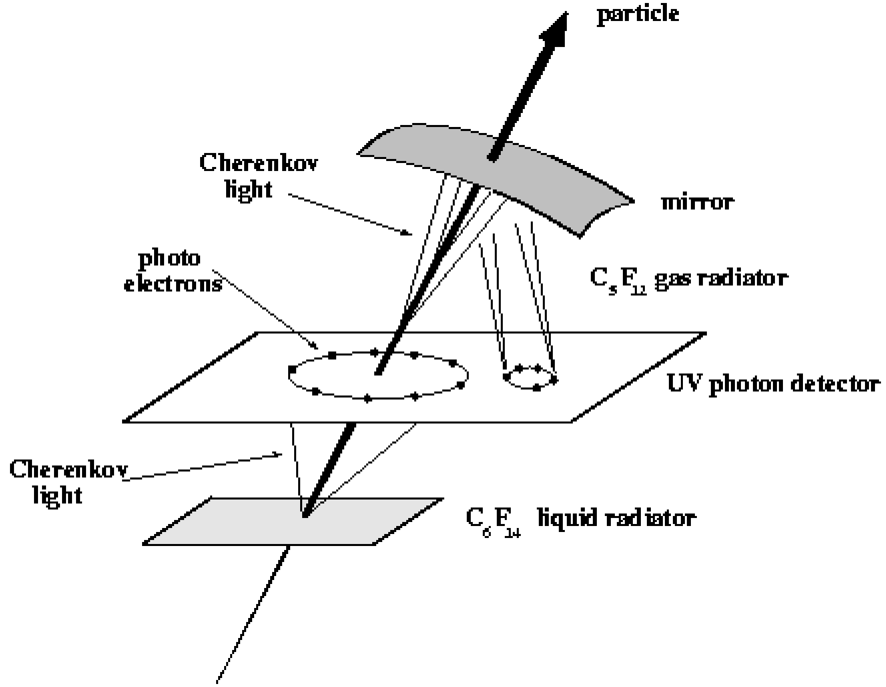
Esemény rekonstrukció: offline

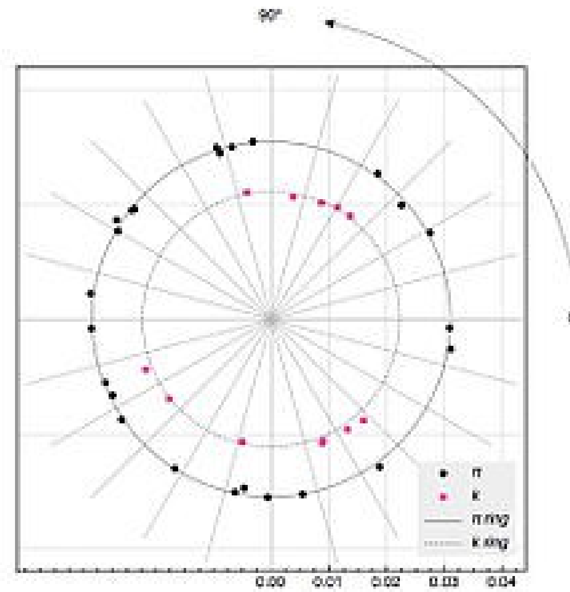
Grid számítóközpontok

LHCb kísérlet

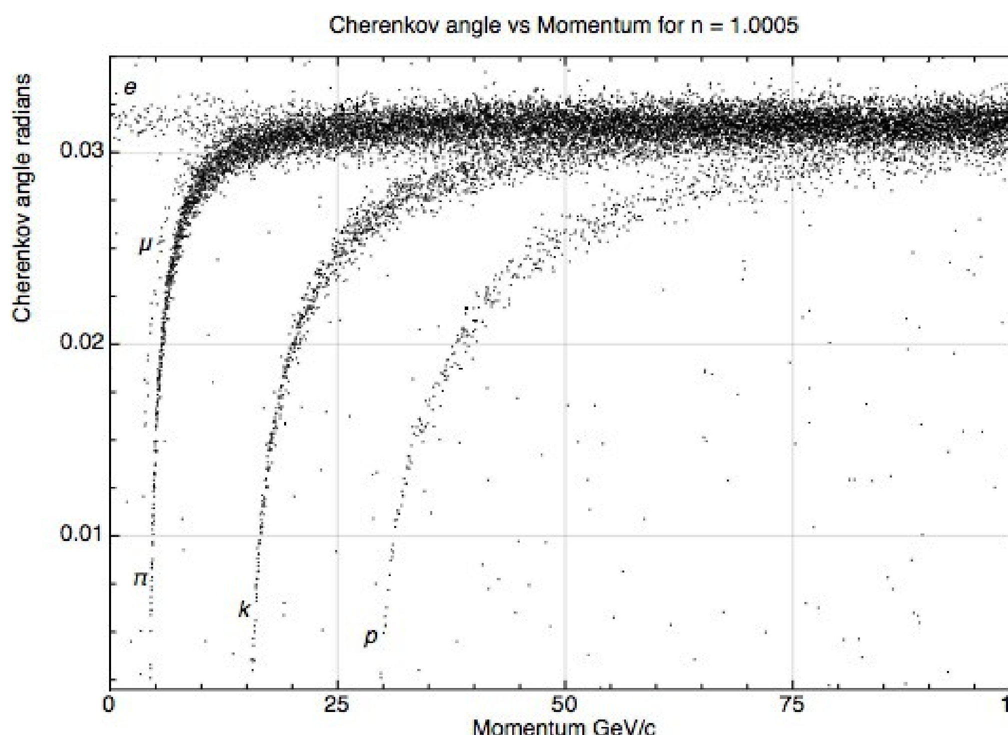


RICH = Ring Imaging Cherenkov detector





(p=22 GeV/c)



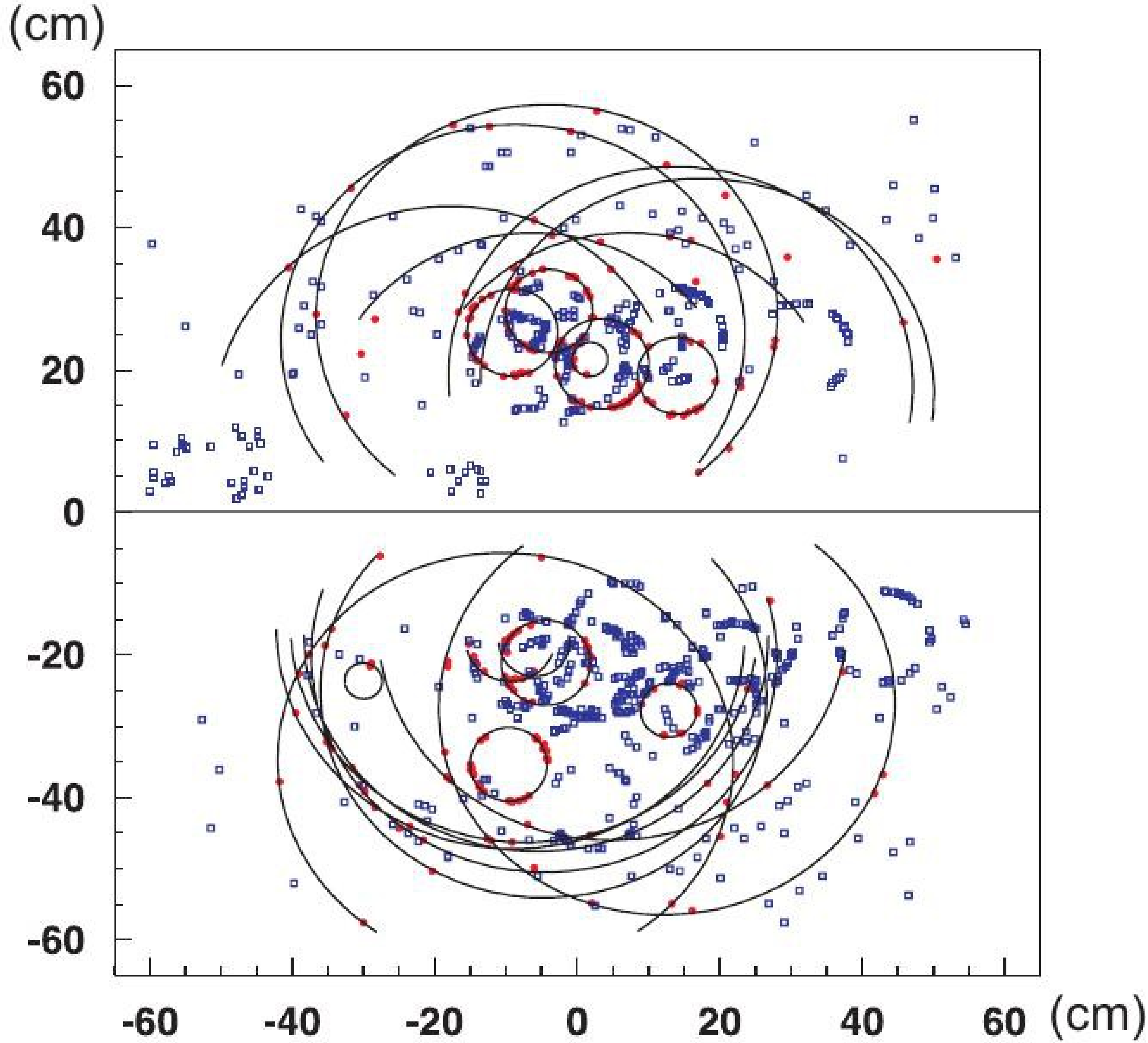
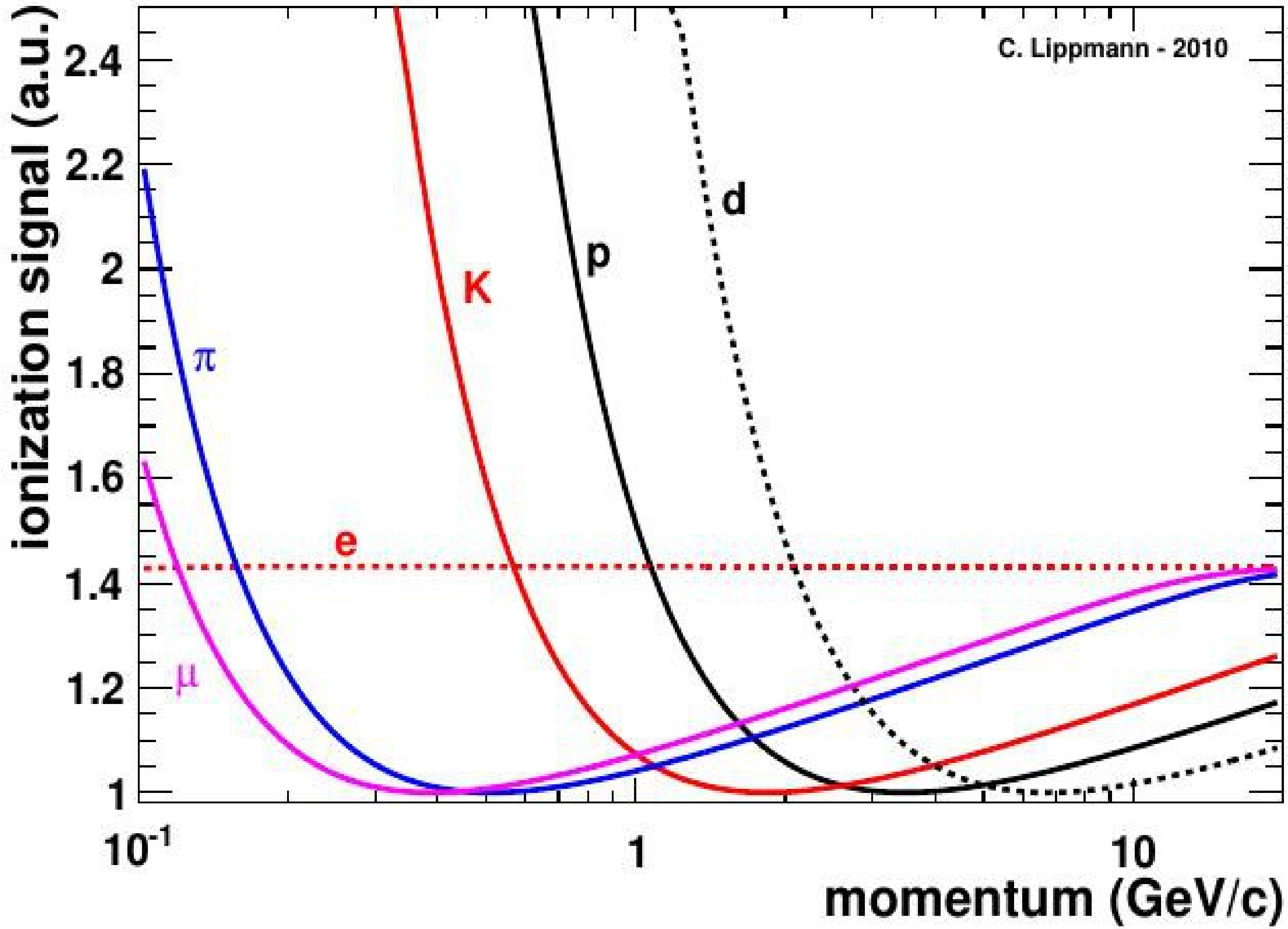


Figure 26: Typical, simulated LHCb event in the RICH1 detector [18]. The data from the two photodetector planes are drawn in the upper and lower halves.

Azonosítás ionizációval

$$\left\langle \frac{\mathrm{d}E}{\mathrm{d}x} \right\rangle \propto \frac{z^2}{\beta^2} \left(\log \frac{\sqrt{2 m_e c^2 E_{cut}}\, \beta\gamma}{I} - \frac{\beta^2}{2} - \frac{\delta}{2} \right)$$



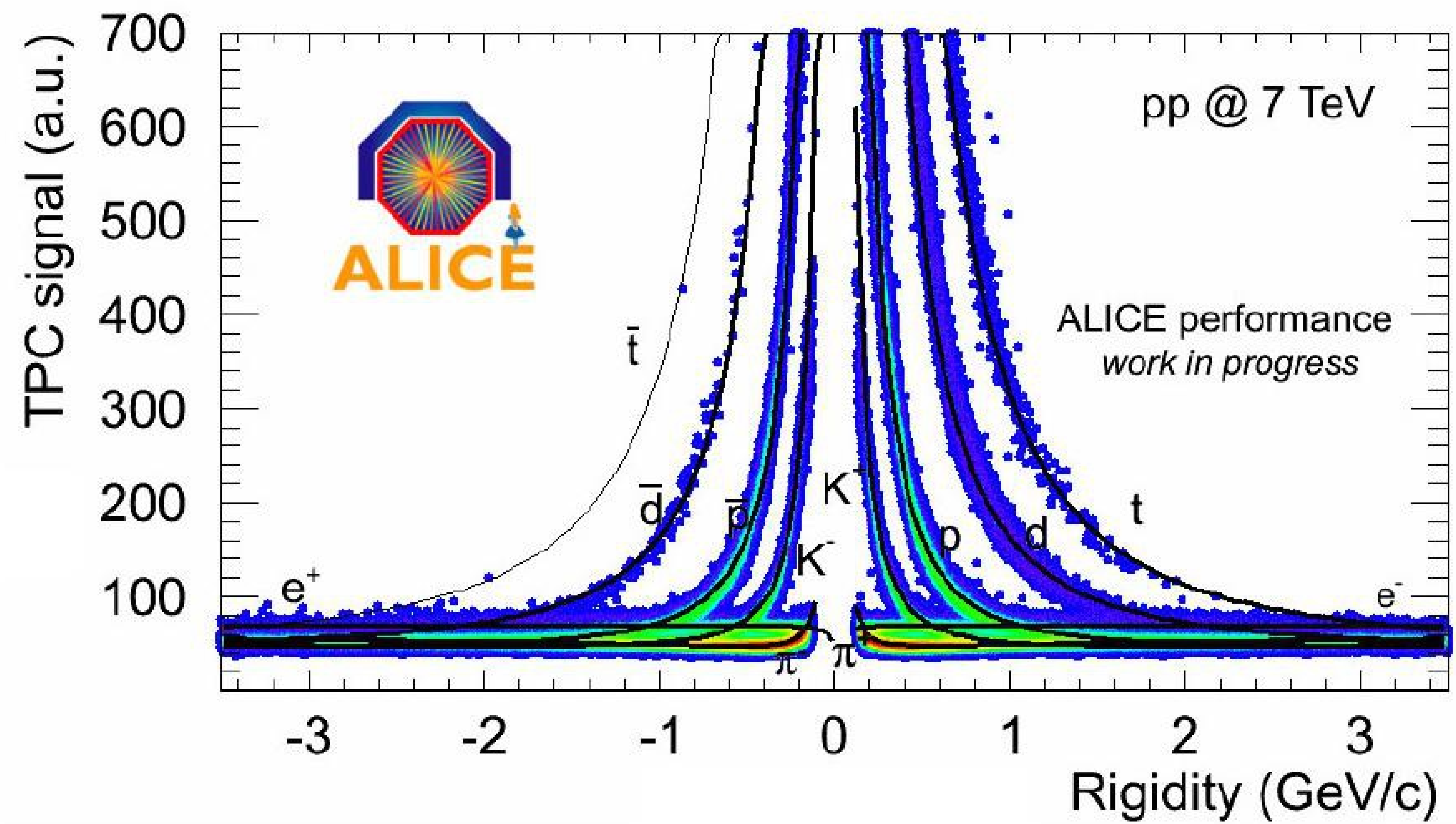


Figure 13: Measured ionization signals of charged particles as a function of the track rigidity (particle momentum divided by charge number). 11×10^6 events from a data sample recorded with $\sqrt{s}=7\,\mathrm{TeV}$ p–p collisions provided by the LHC were analysed. The lines correspond to a parameterization of the Bethe-Bloch curve as described in Ref. [20]. Also heavier nuclei like deuterons and tritium and their anti-particles are found.

TOF=Time-of-flight

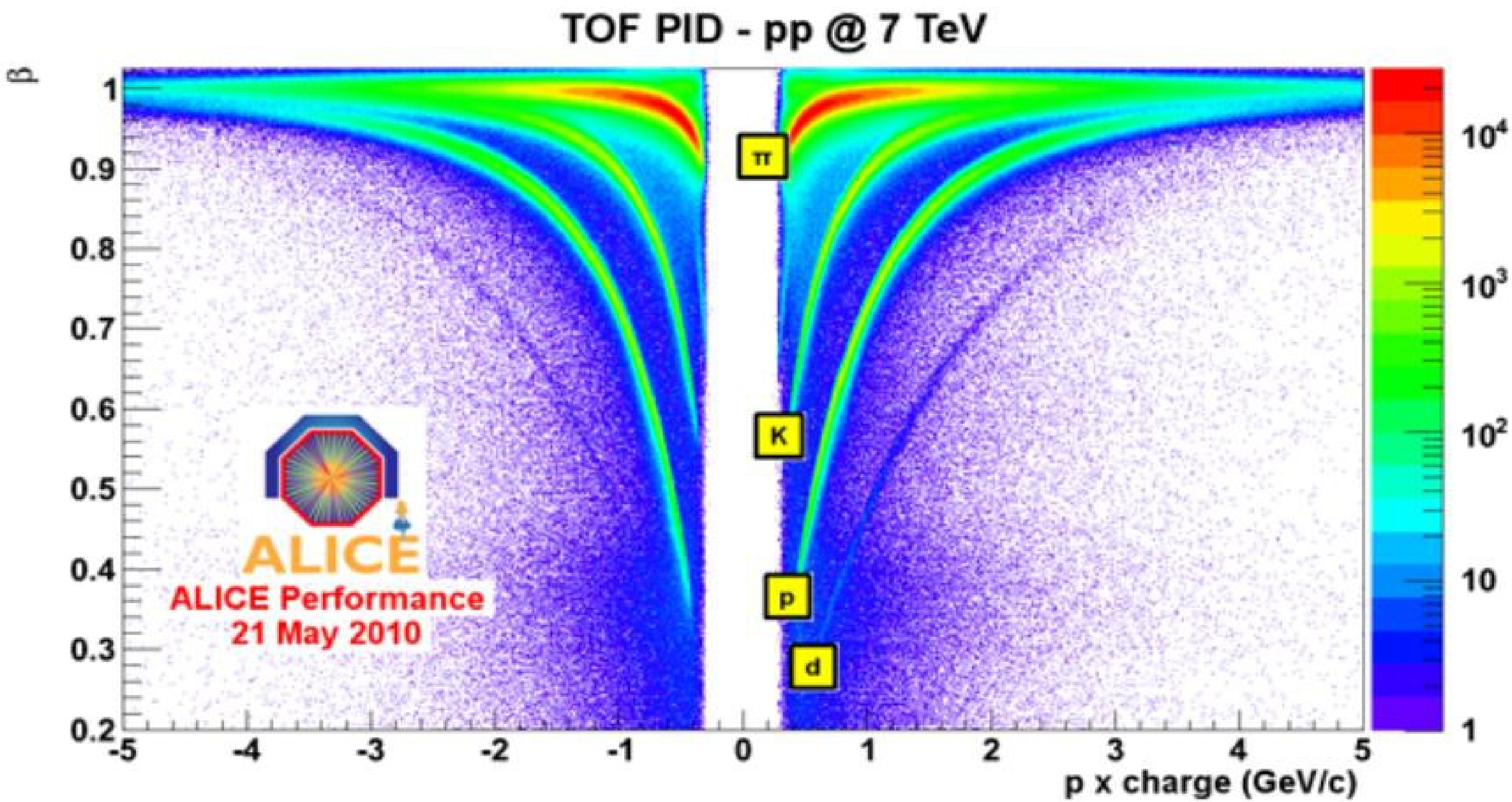
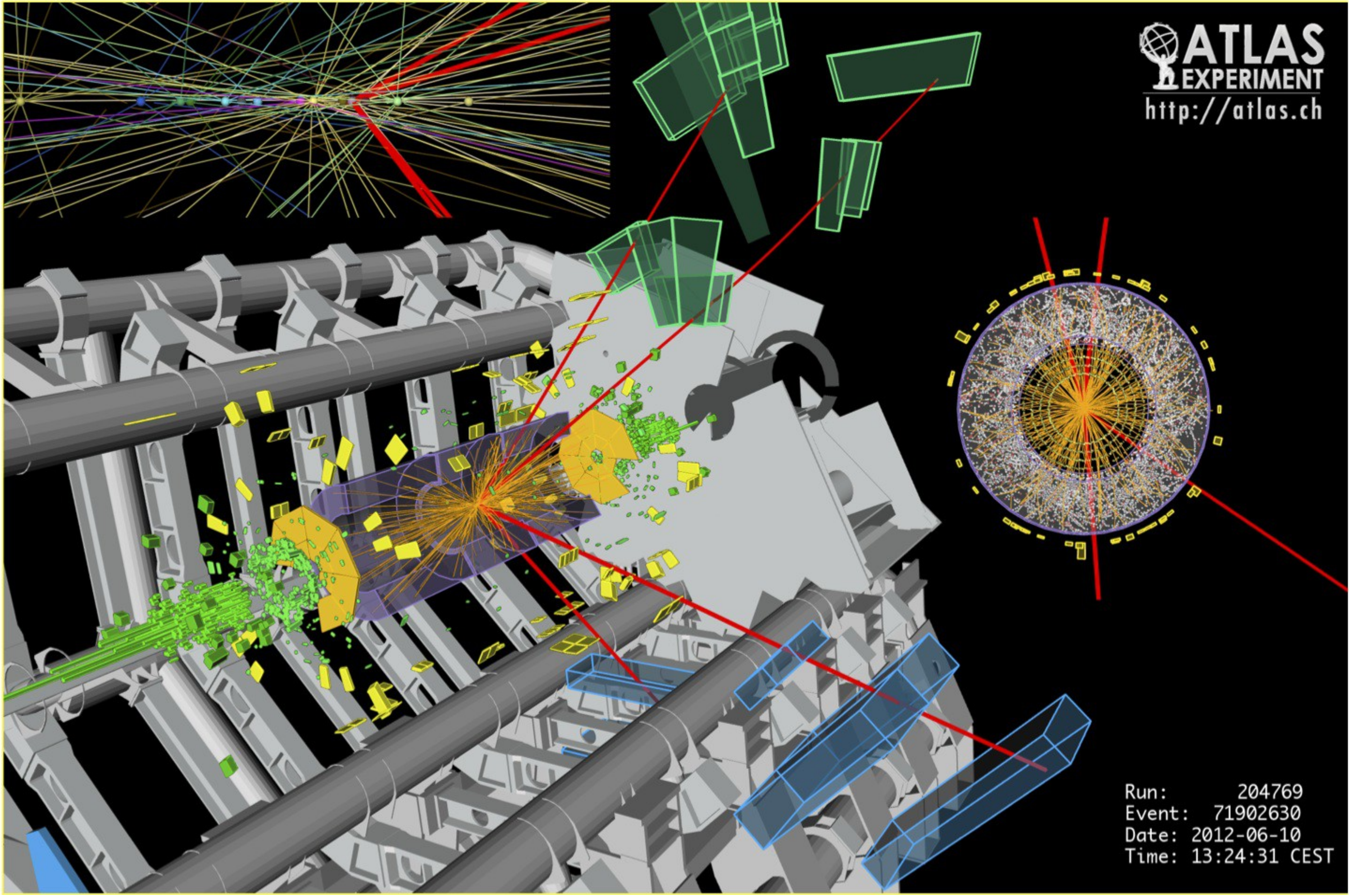


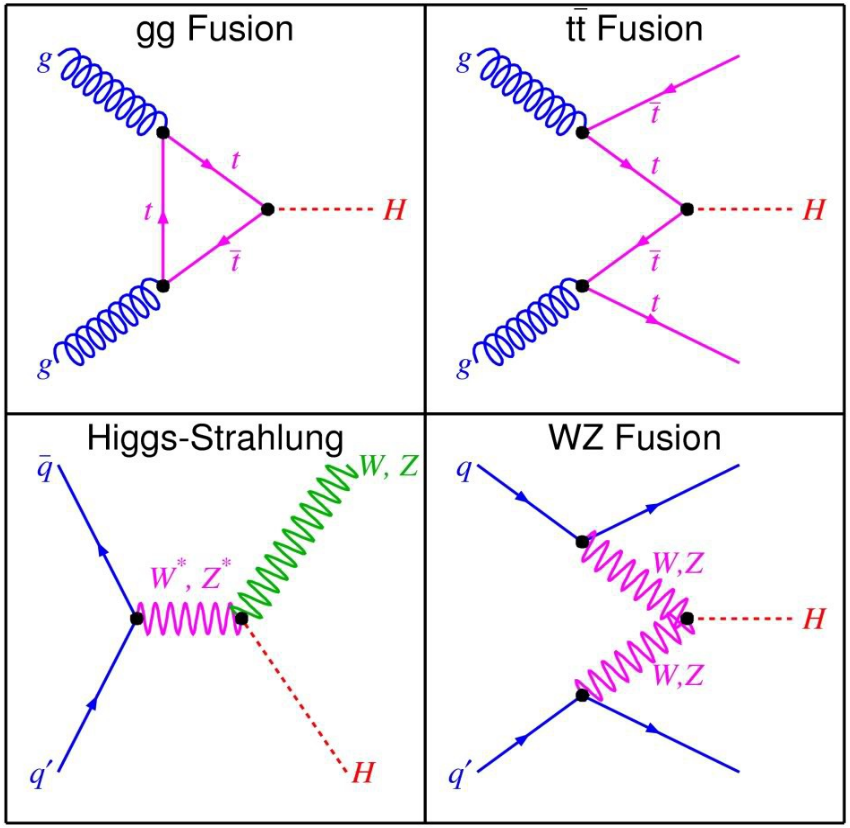
Figure 18: Velocity $\beta = v/c$ as measured with the ALICE TOF detector as a function of the particle momentum p multiplied with the particle charge number Z for a data sample taken with $\sqrt{s} = 7\,\text{TeV}$ collisions provided by the LHC in the year 2010. No data is available for momenta $\lesssim$300 MeV/c, since these particles do not reach the detector due to the curvature of their tracks in the magnetic field.

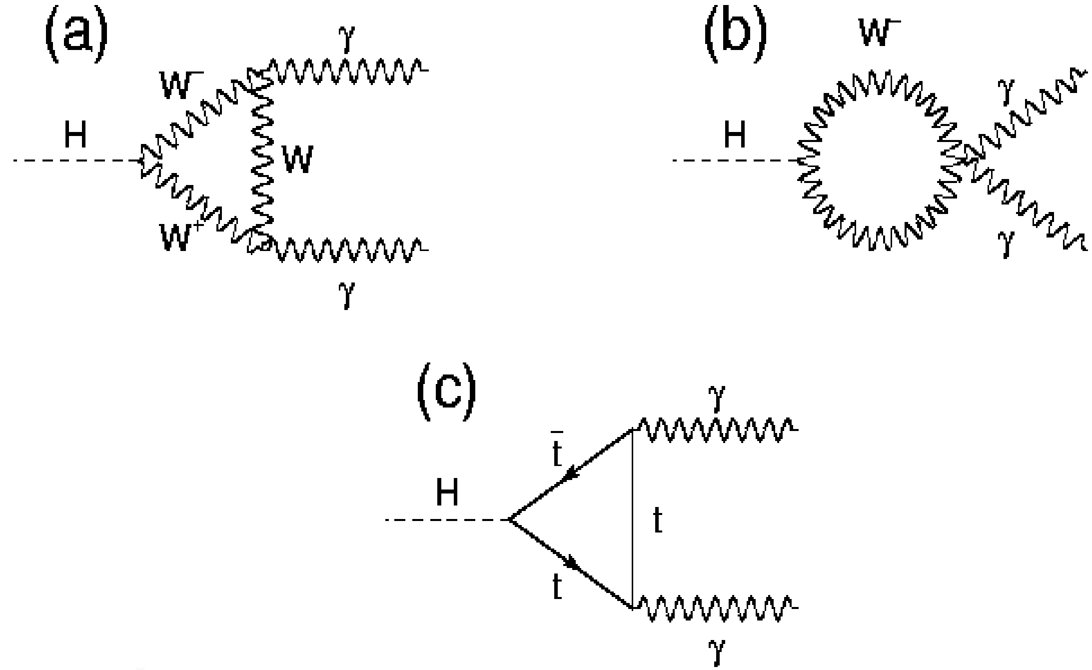
4-müon Higgs jelölt

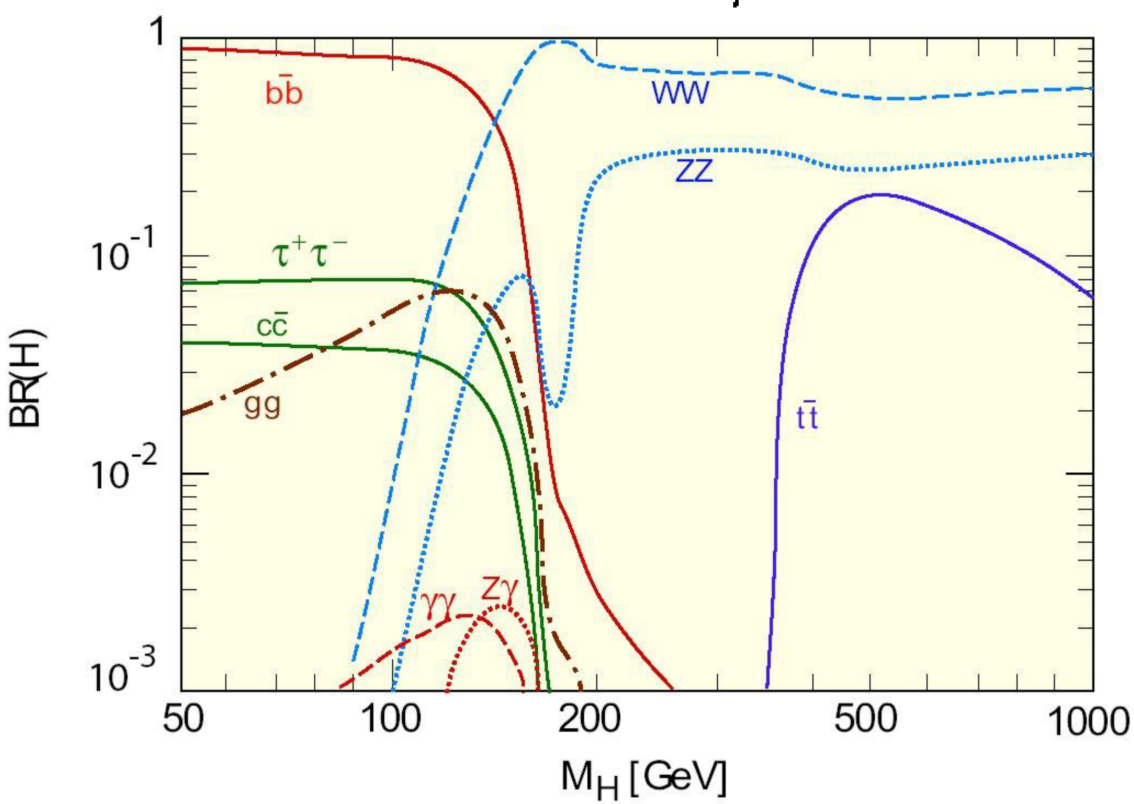


$$H \rightarrow 2\,Z \rightarrow 2\,\mu^{+} + 2\,\mu^{-}$$

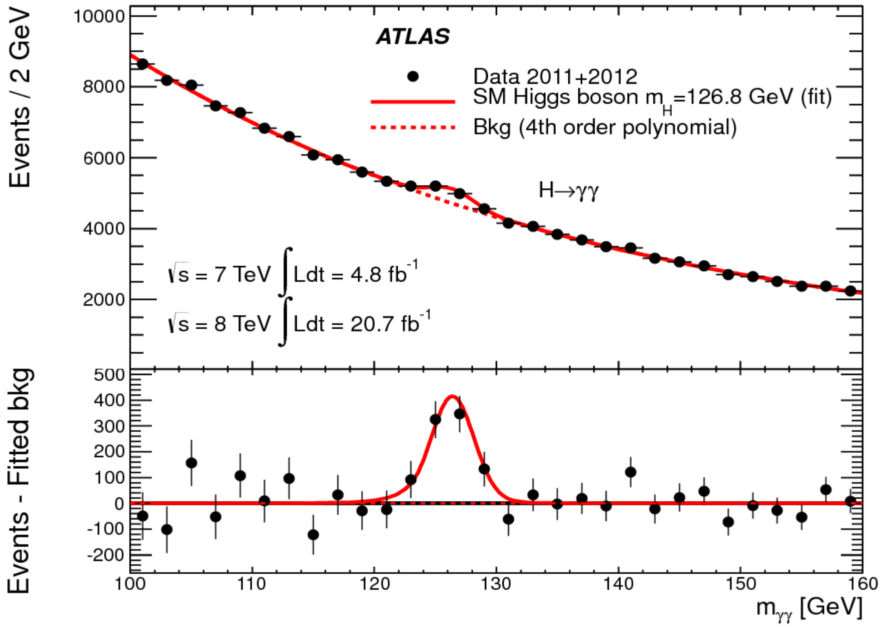
Higgs keltés és bomlás

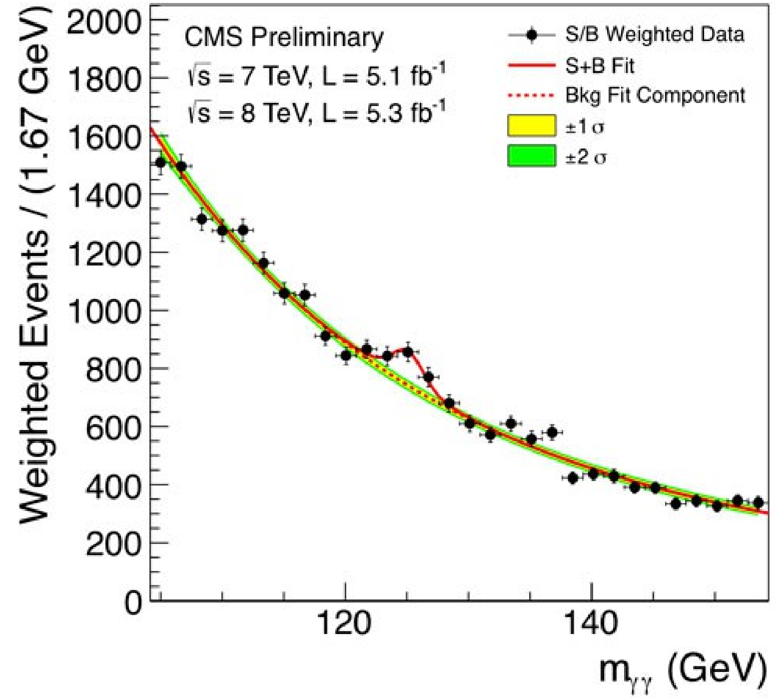






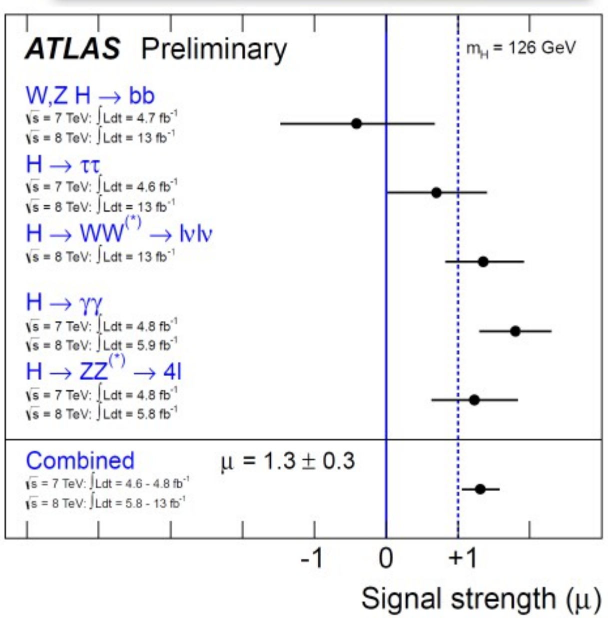
Higgs szignál

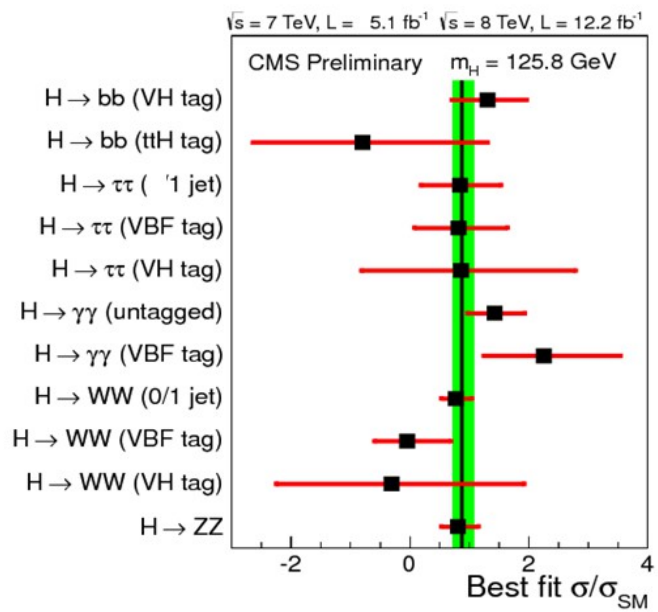




Best–fit Higgs mass m_H :
126.0 ± 0.4 (stat) ± 0.4 (syst) GeV

- M=125.8 ±0.4 (stat) ± 0.4 (syst) GeV





- σ/σ_{SM}=0.88±0.21


EUREKA! WE FOUND the GOD PARTICLE !!!
#@$! DANDRUFF!


WE FOUND THE 'GOD' PARTICLE: AND HE'S PRETTY UNHAPPY.
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