Physics Beyond Standard Model

- Standard Model
- Neutrino Search
- Big Bang Dark Matter
- Big Bang Dark Energy
- Quantum entanglement (量子纠缠)
- SUBSTRUCTURE of Fundamental PARTICLES ?

J. Ulbricht ETHZ Lecture USTC 2017

INTRODUCTION

Two NEW particles describe ALL FP's

Experiments to test the size of FP's via direct contact term.

Classical theoretical approach to calculate the size of FP's

Substructure of FUNDAMENTAL PARTICLE

Spinning superconducting electrovacuum soliton

Calculation of a wave function using the substructure of FP, via the E-field of a non point like Electron with the Gross-Pitaevskii equation.

Some time ago I discussed in detail a Classical theoretical approach to
calculate the size of FP's.

In this lecture I like to discuss out of the 5 approaches to study the problem two attempts :

A) Two NEW particles describe ALL FP's

B) Experiments to test the size of FP's via direct contact term.

In a later seminar in the institute I will discuss:

C) Spinning superconducting electrovacuum soliton

D) Calculation of a wave function using the substructure of FP, via the E-field of
a non point like Electron with the Gross-Pitaevskii equation.

A) Two NEW particles describe ALL FUNDAMENTAL PARTICLES

To introduce these NEW PARICLE it is first necessary to discuss a possible micro structure of Fundamental Particles. For this reason a

Empirical Toy Model Ansatz about a Microstructure of Fundamental Particles

ETAMFP-model

will be discussed first.

Eine Idee die nicht zuerst absurd erscheint taugt nichts. A.E.

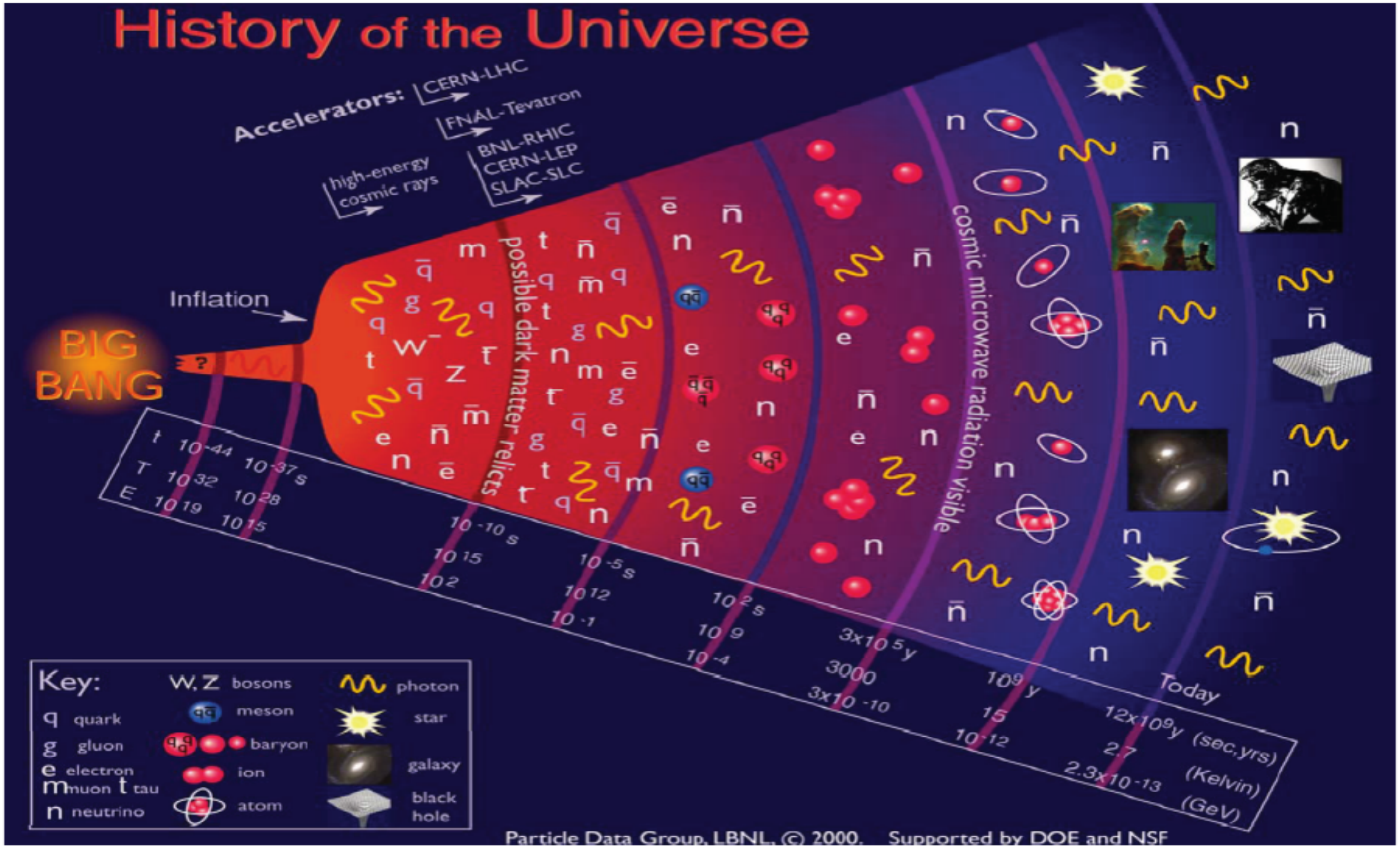
An idea which does not look in the first view absurd isn't much good. A.E.

The history of micro structure of Fundamental Particles extents from J. Michell 1783 with the introduction of Black Holes. Followed by many authors introducing Monopols, Skyrmions, charged scalar fields, Sphalerons, Dilatons, Solitons and until today the search for not point-like behaviour of Fundamental Particles.

The basic idea of the ETAMFP - model

To test the point character of a FP it is necessary to decrease the test size λ to zero. The size λ is direct inverse proportional to the test energy E_{CM} like $\lambda \sim f(1/E_{CM})$ This request leads to infinite high test energies.

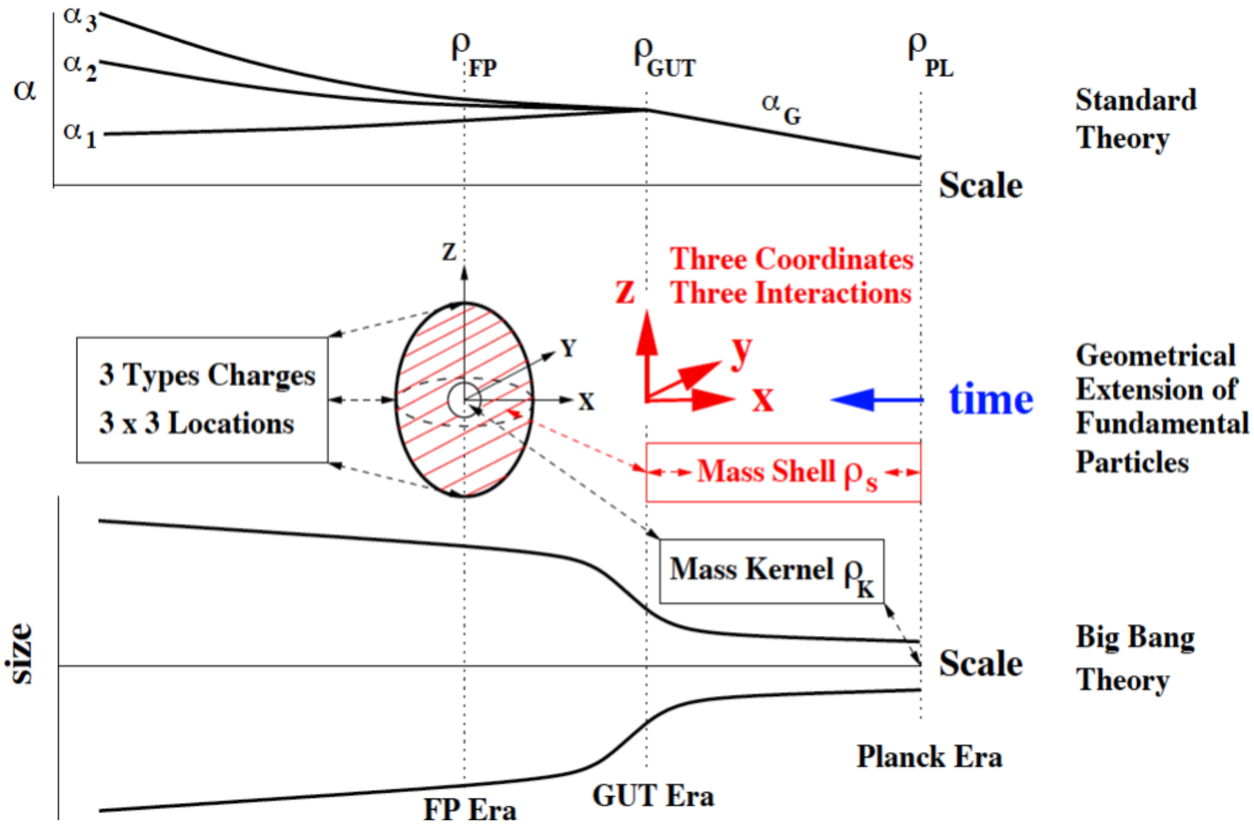
Such an experiment will after the running coupling constant of the Standard theory (SM) and the Big Bang (BBM) model change dramatically the physical conditions of the experiment.



If time reverse invariance hold until infinite test energy, it is possible to read the microstructure direct from the time development of the SM and BBM model.

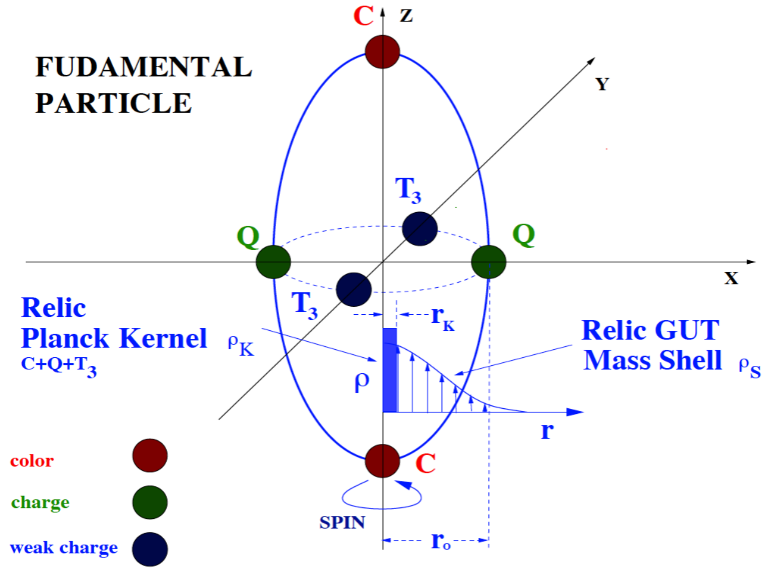
The geometrical approach I

The ETAMFP-model of a fundamental particle assumes that the particle contains every energy state a cross of its radius which the universe passed through during its evolution.



FP’s stabilize in the FP Era, the internal structure is for this reason a RESIDUEL of the time development of the SM and Big Bang model.

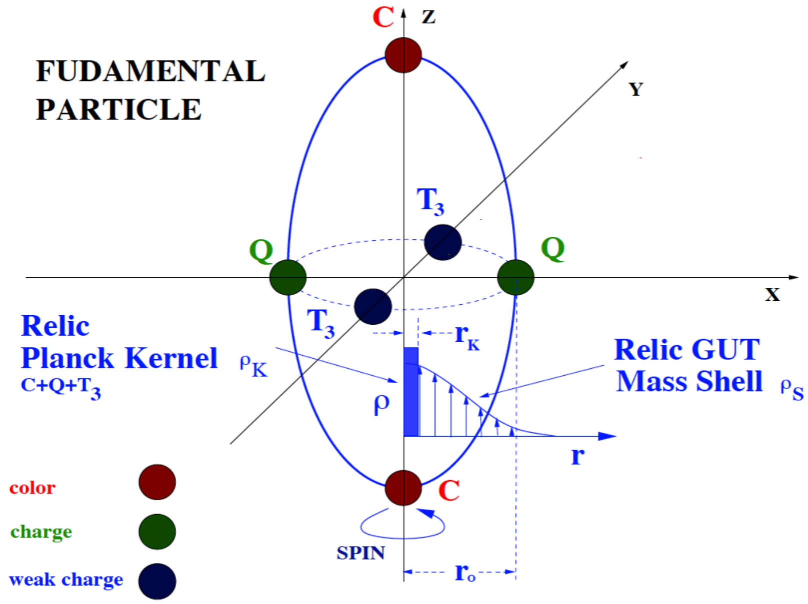
The geometrical approach II



If a spectator initiates the measurement from the Big Bang time t = 0 to the Planck scale he enters an era he will measure a quantized energy mass condensate, originated from a volume explosion with a density ρ_{PL}. In this mass-time dominated condensate the charges colour, electric and weak are already existing. The constituents of the condensate at a distance below $r < 10^{-33} cm$ are in direct contact not able to form an interaction similar to the field theory in the SM model. The statistical distribution volume explosion does not introduce a total quantized spin different from zero.

Next the Spectator will cross the domain boundary of the Planck scale at $Q = 10^{19} GeV$ at a distance from the centre of $r = 10^{-33} cm$ and enters the era to the GUT scale. This era is dominated by only one interaction forming a mass shell enclosing the mass kernel of the Planck Era. A structure of two particles interacting via gauge particle would be possible. If the total spin of universe would be zero these particles describing the mass shell could carry a spin. (e.g. spin 1/2 and spin 1 adding to spin zero). The mass shell could circle the Planck kernel.

The geometrical approach III



Next the spectator will cross the domain wall of the GUT Era at $Q = 10^{15} GeV$ at a mass density ρ_{GUT}. At the Grand unification scale in the time development of the universe the three interactions strong, electro magnetic and weak accompanied by the three types of charges strong, electro magnetic and weak get dominant. For the spectator who is concentrated on the particle like aggregates with spin axis, which are carried on from the quantum fluctuations of the Planck Era to this scale, three possible geometrical locations appear to place charges on one coordinate axis. In total 3 x 3 = 9 positions are open.

With increasing time after Big Bang the universe follows in the SM model the conditions of the running coupling constants and undergoes in the BBM model the inflation. The universe is big enough to host all FP's, gauge particles and hypothetical particles already existing before the GUT scale. All these particles would be in the ETAMFP model the outcome of primordial quantum fluctuations already in the Planck Era. The size of the universe decouple from the size of the FP's and they will get stable.

6 links between STANDARD and Big Bang Theory

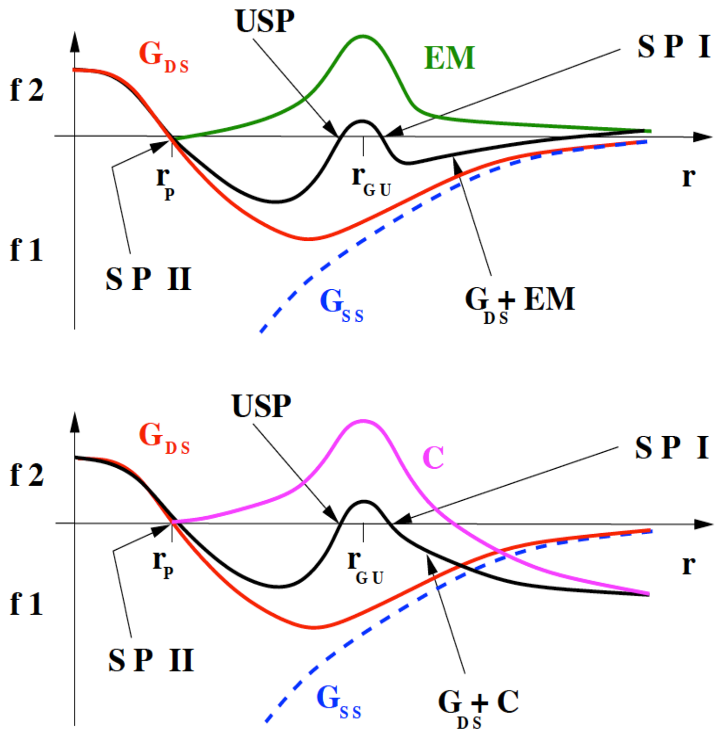
For this discussion it is usefully the spectator moves from the time today to the tome t = 0.

- First at scales for smaller as the Grand unification scale $E < E_G$ the three interactions strong, electromagnetic and weak are separated from each other, embedded in the space e.g. described by the Cartesian coordinates x, y and z. But in total exist four coordinates and four interactions. The last possible coordinate is the time and the last interaction the gravity.
- Second at the Grand unification scale where the gravitation is not negligible any more and next at the Planck Scale where the gravitation get dominant a complete geometrical extended three dimensional FP does not exist because the scale is to high or the test distance to small. This implements that the inner part of the FP is dominated by the gravitation and the structure is prevailing one dimensional. The three dimensional test distance is below $10^{-33} cm$ the time would be a good candidate for the last dimension.
- Third the mass-energy equivalence $E = m \times c^2$ which follows from the relativistic symmetries of space time, points to the time as connection to the gravity.
- Fourth the uncertainty principle $\Delta E \times \Delta t \sim \bar{h}$ together with the energy mass equivalent links time and gravitation.

- Sixthly the local isotropy of space-time leads in the SM via Noether-Theorem to the angular momentum conservation and to the spin of the FP’s. The mass of the FP’s in the ETAMFP model is a relic of time t=0 to the Planck time as Planck kernel followed the time to the GUT scale as mass shell. It is unlikely that the statistical equal distributed volume explosion in the Planck Era generates a spin. This could be the reason the universe has spin zero. But between Planck and GUT scale the size of the universe seems big enough to form particles which direct interact with each other. In such a case two spin 1/2 and one spin 1 particles which add to a total spin zero $2 \times \frac{\vec{1}}{2} + \vec{1} = \vec{0}$ could exist.

Forces and Stability

From experiment it is known that e.g in the case of the electron with a mean life time of $\tau > 4.6 \times 10^{26}\, y$ extreme stable distance dependences of the forces acting in the FP's must lead to such highly stable conditions. It is for this reason interesting to develop a general scenario of a possible radius dependence of the known four forces what could lead to such extreme highly stable conditions.



G_{SS} = Schwarzschild
G_{DS} = De Sitter

SP I and SP II are stable positions for charges EM and C at a radius r.

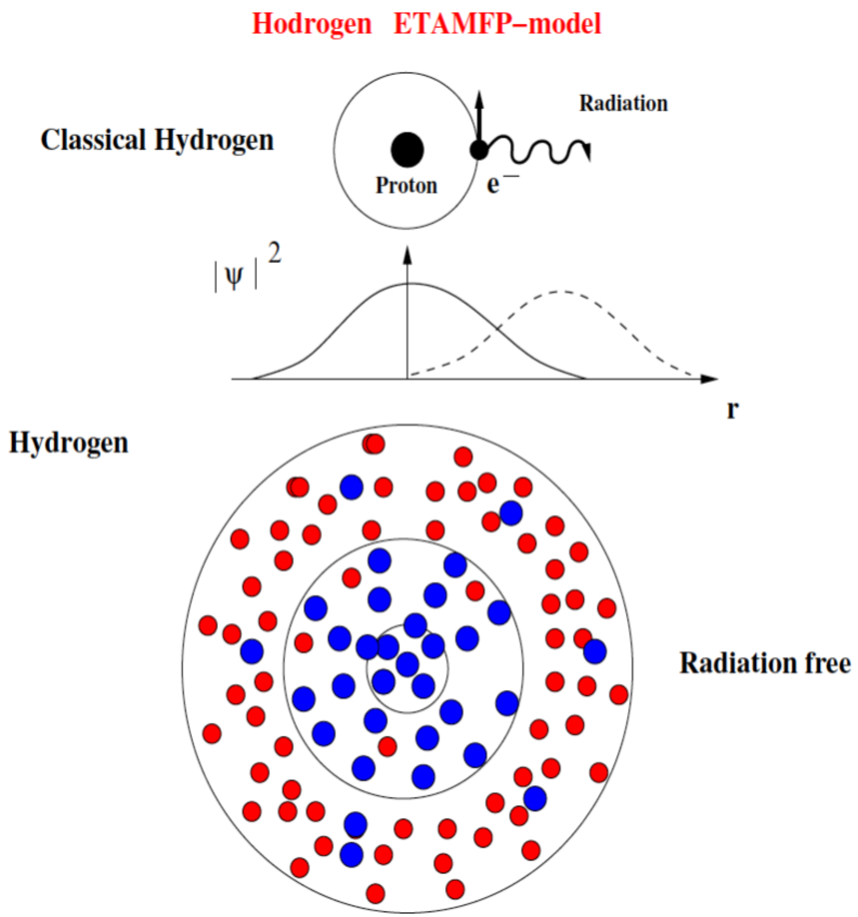
The flashing vacuum

For the electron with a life time of $\tau > 4.6 \times 10^{26}\,yr$ a radiation free path must exist (N.Bohr 1913).

Statistical fluctuations between ON shell and OFF shell.

Vacuum opens the possibility to introduce a microscopic picture for the probability function. $|\Psi|^2$ of Hydrogen or ETAMFP-electron.

The charge in the ETAMFP electron oscillates between ON shell and OFF shell (vacuum) and circle in this manner radiation free the centre.



Scheme for Extended Fermions and Bosons

- In the Standard Model are e.g. the parameters mass, spin, magnetic moment, electric dipole moment of the fundamental particles measured or calculated under the assumption the particles are mathematical points.

  As consequence the fermions with a finite rest mass would have in the centre an infinite density and with a Schwarzschild radius of about $R_s = 2 \times G \times m / c^2 \sim 10^{-55} cm$ behave like Black Holes.

- The ETAMFP model of extended Fundamental Particle would permit to avoid this difficulty and opens the possibility to describe the discussed parameters of the fundamental particles in a microscopic picture.

Three building block of microscopic picture

- Three plus one interactions : STRONG, EM, EW and (Gravitation)

- Three CHARGES: COLOUR C -----> R G B
  ELECTRIC Q -----> 0 ; 1/3 ; 2/3
  WEAK T3 ---→ 0; 1/2 ; 1

- Plus pseudo CHARGE MASS:

$$F_Q = \frac{1}{4\pi\varepsilon}\frac{Q_1 Q_2}{r^2}$$

$$F_M = \frac{1}{4\pi\mu}\frac{p_1 p_2}{r^2}$$

$$\rightarrow F_G = G\frac{m_1 m_2}{r^2}$$

- Three FAMILIES of fundamental particles

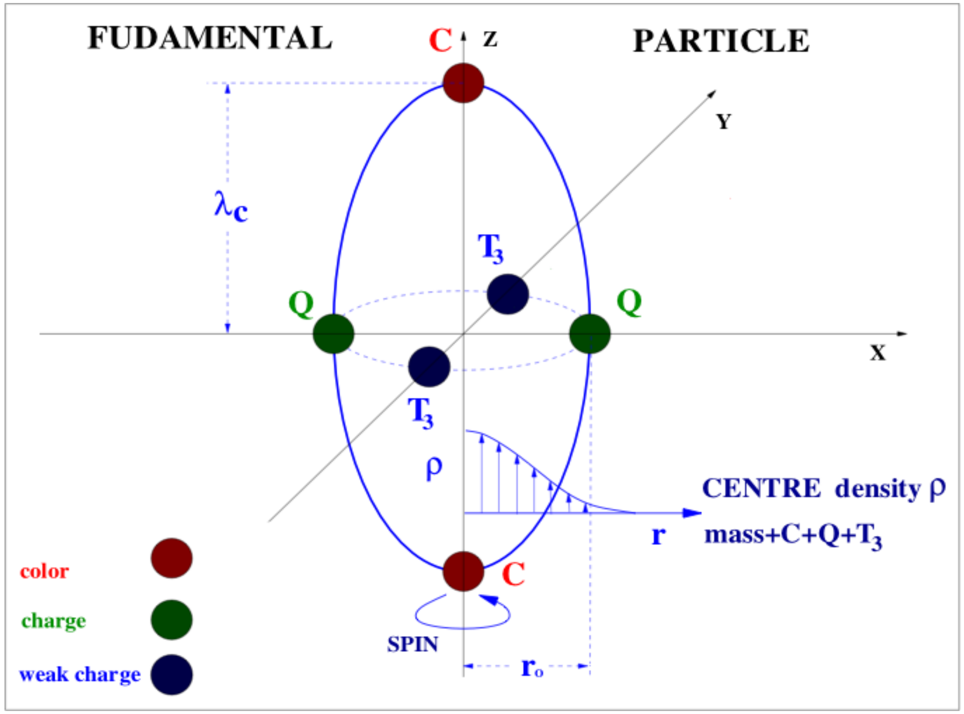
- Three quarks form one proton/neutron

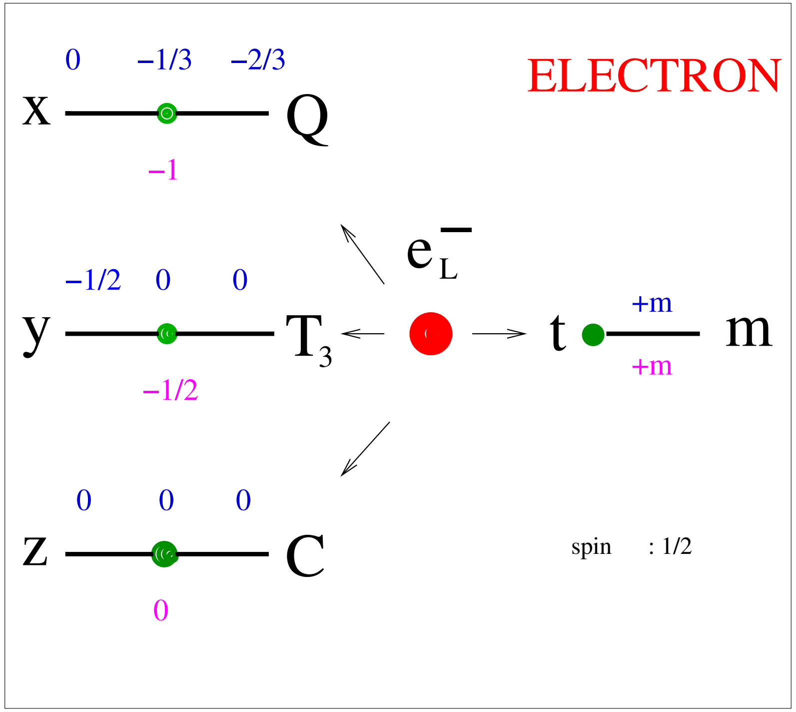
The introduction of TWO NEW Particles

PARTICLE A → Charge ± 2/3 Spin 1/2

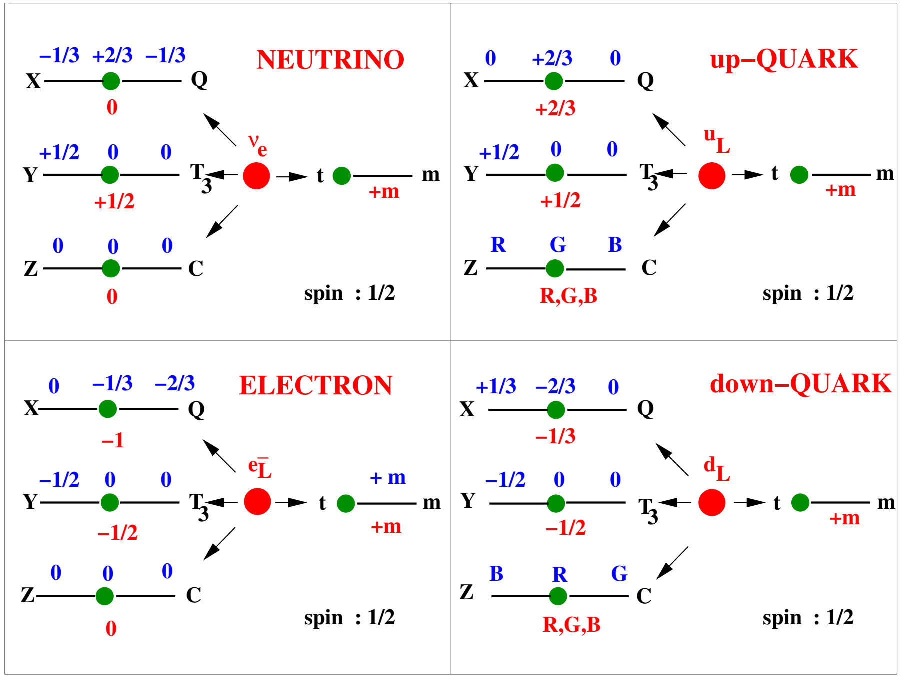
PARTICLE B → Charge ± 1/3 Spin 0

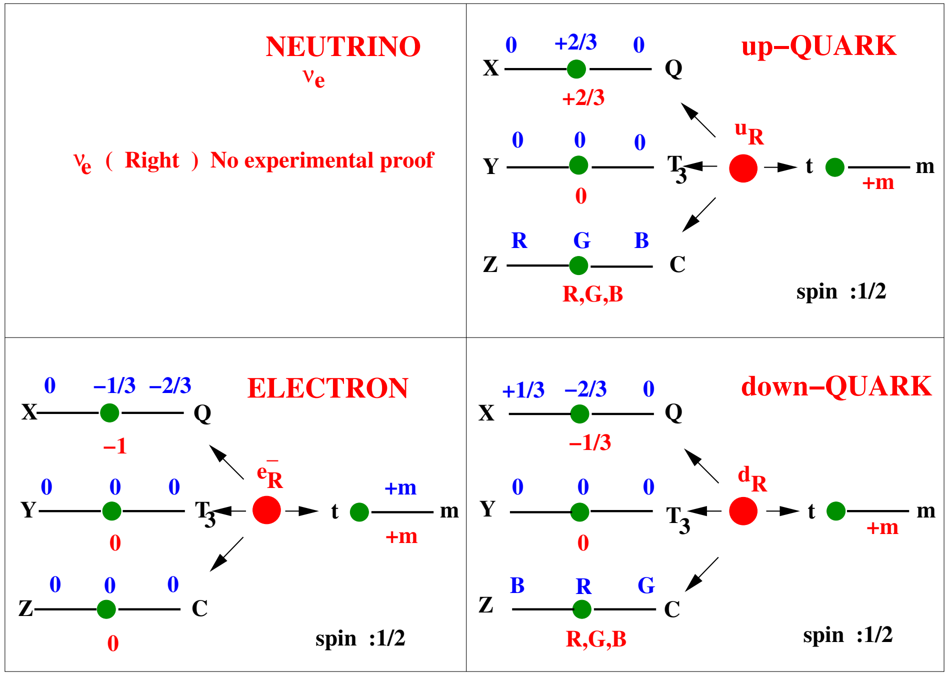
Scheme of the General Principle





Scheme of lightest left and right handed FERMIONS



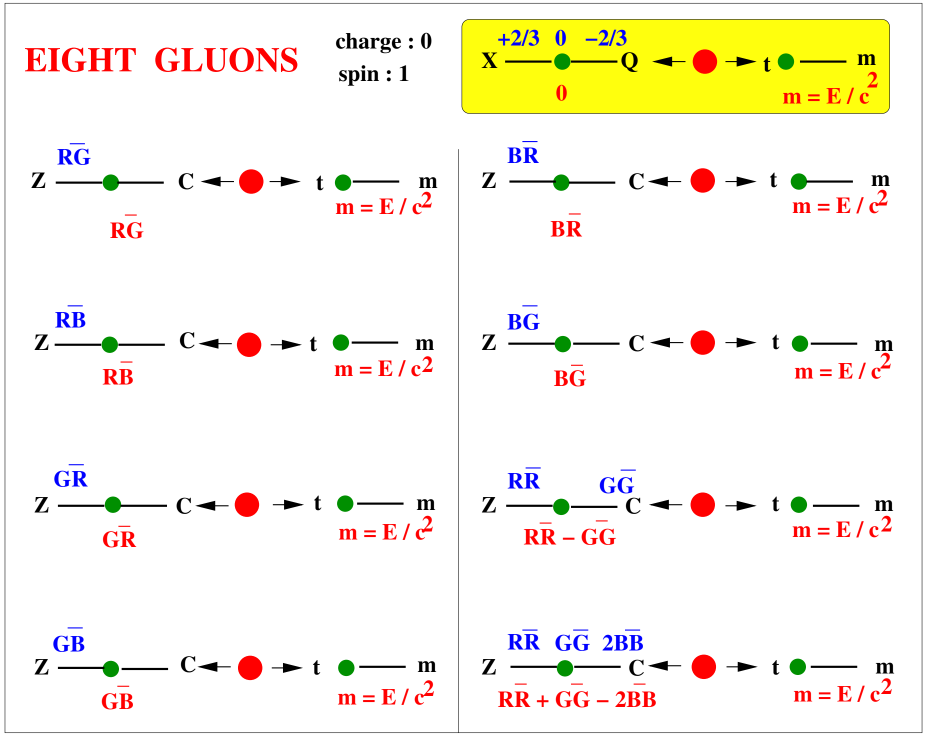


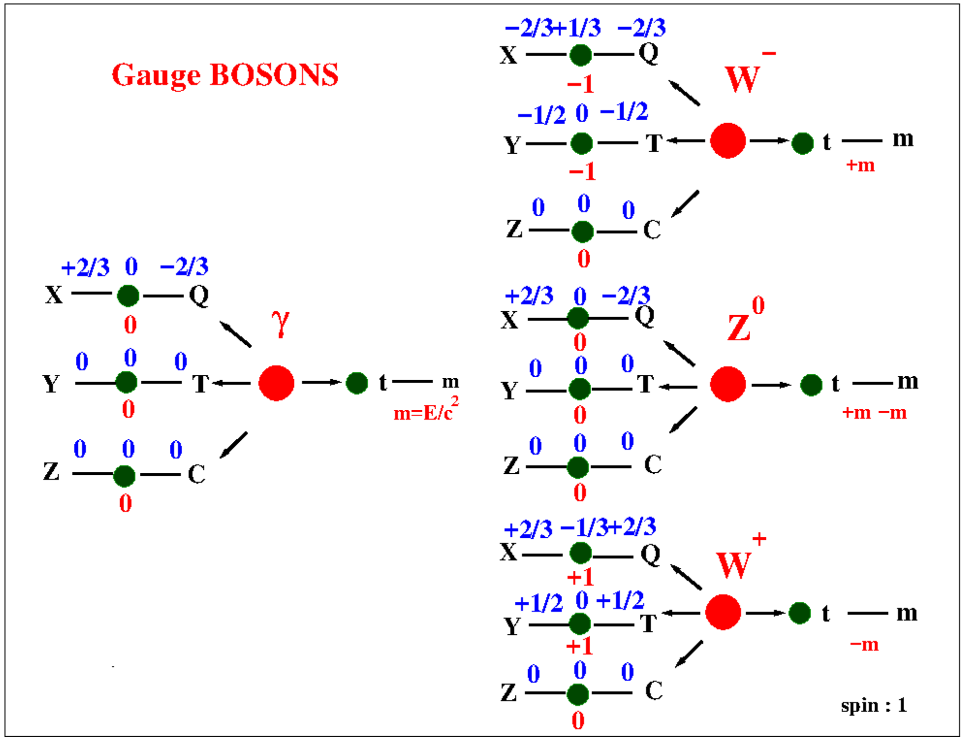
The SCHEME requests:

- Electron carries magnetic moment and electric dipole moment.Weak moments are possible.
- The up quark carries a magnetic moment.Weak magnetic moment is possible.18 colour combinations are possible.(RRR,GGG etc)
- The down quark could carry a magnetic and / or Weak magnetic moment. 18 colour combinations are possible.(RRR,GGG etc)

The QUARKS are the ONLY particles where all possible free positions for CHARGES are occupied. The QUARKS have a confined structure.

Scheme of the bosons





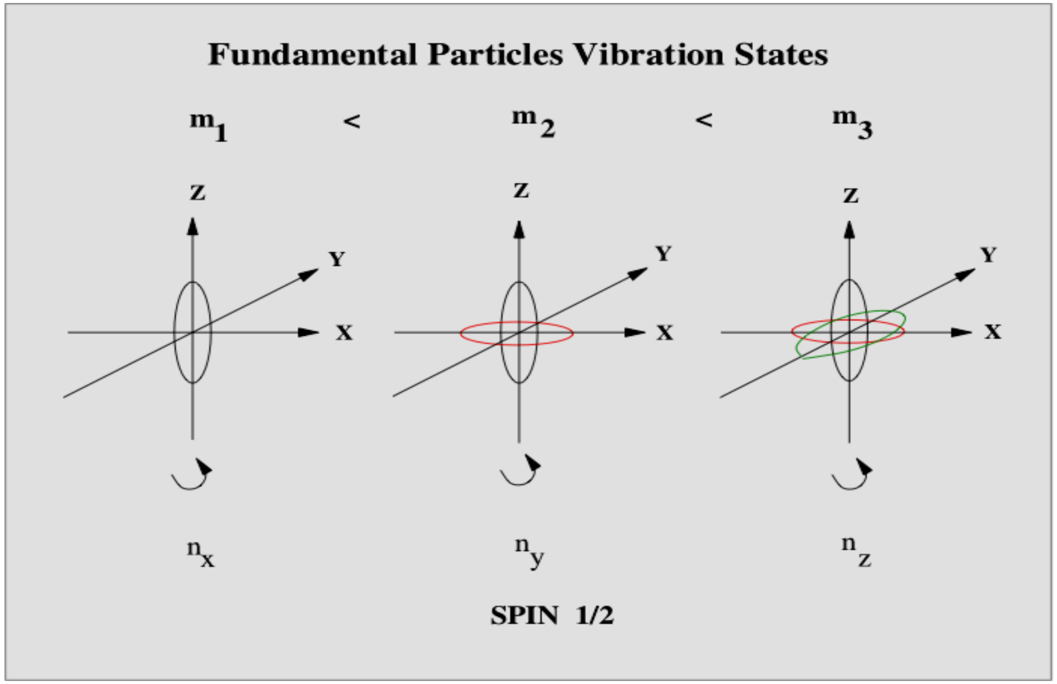
The SCHEME requests:

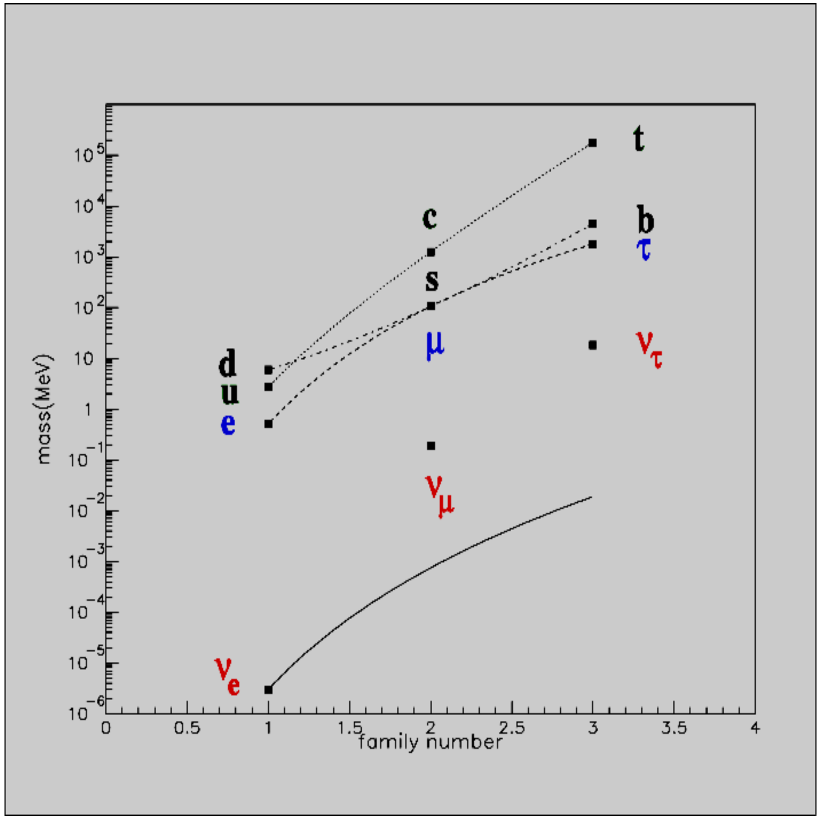
- Colour and anti-colour are located at one point.
- Eight gluons match on the z-axis.
- The bosons gamma and Z are only distinguished in the mass.

The Higgs is very simple. It would be composed of particle B Charge + 1/3 ; -1/3 Spin 0

The combination red/anti-red, green/anti-green,blue/anti-blue generates a confined structure.

The first three vibration states of fermions





$$E = \hbar\omega_o(n_x + n_y + n_z + 1/2)$$

$$E(k_i;Q) = (A + B|Q| + CQ^2 + D|Q|^3)(k_i)^{f(Q,k_i)}$$

$$f(Q,k_i) = \left[R + |Q|V(k_i - 1) + |Q|(|Q| - 1)\left\{S(|Q| - 1/3) + W(|Q| - 1/3)(k_i - 1) + T(|Q| - 2/3) + Z(|Q| - 2/3)(k_i - 1)\right\}\right]$$

$$2 - Parameters \rightarrow CARGE = Q - and - FAMILYnumber = k_i = (1,2,3)$$

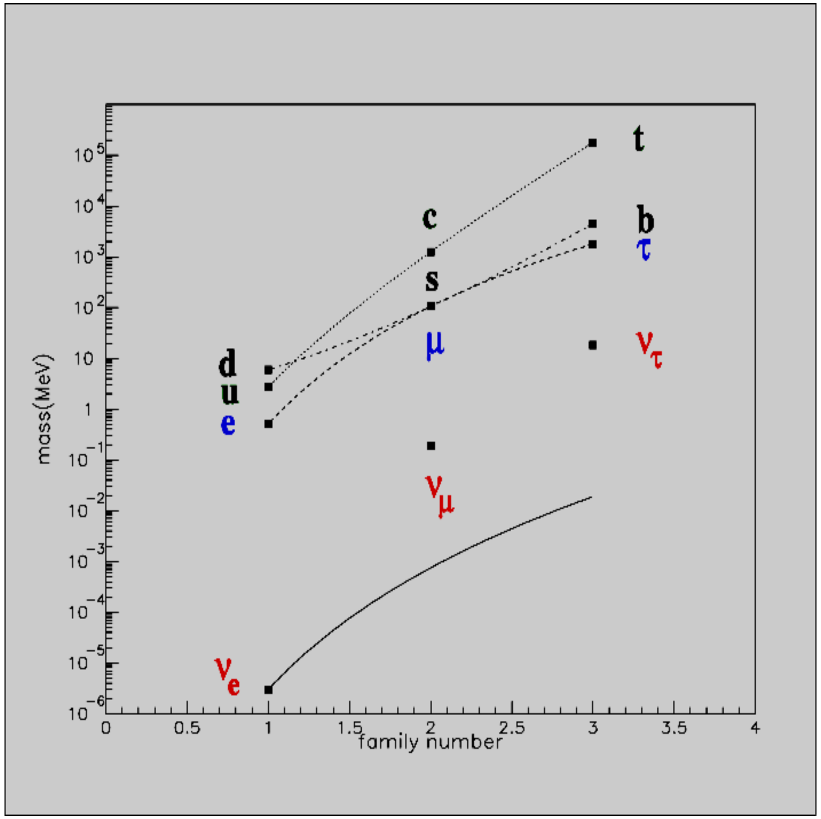
Constants $A < 3\times10^{-6}\,MeV$ B=42.1 MeV,C=-87.8 MeV,D=46.2 MeV,R=7.96,V=-0,27,S=5.25,W=-19.38,T=-77.34 and Z=26.82

Pseudo CHARGE MASS - Time - Dimension 4 - Flavour

The Pseudo CHARGE MASS defines the quantum numbers: Charm C , Strageness S, Topness T and Bottomness B’ and the related quantum numbers: Baryon B and Lepton L.

With the Hypercharge Y = (B + S + C + B’ + T) also the Isospin Y = 2 (Q - I_3) is defined.

Compared to the three coordinates x, y, z is the time, axis an absolute positive vector related to the development of the temperature of the universe. This temperature or energy can generate different masses.



Flavour in particle physics

Flavour quantum numbers

- Isospin: **I** or I_3
- Charm: C
- Strangeness: S
- Topness: T
- Bottomness: B'

Related quantum numbers

- Baryon number: B
- Lepton number: L
- Weak isospin: **T** or T_3
- Electric charge: Q
- X-charge: X

Combinations

- Hypercharge: Y
  - $Y = (B + S + C + B' + T)$
  - $Y = 2\,(Q - I_3)$
- Weak hypercharge: Y_W
  - $Y_W = 2\,(Q - T_3)$
  - $X + 2Y_W = 5\,(B - L)$

Flavour mixing

- CKM matrix
- PMNS matrix
- Flavour complementarity

V·T·E

Wikipedia

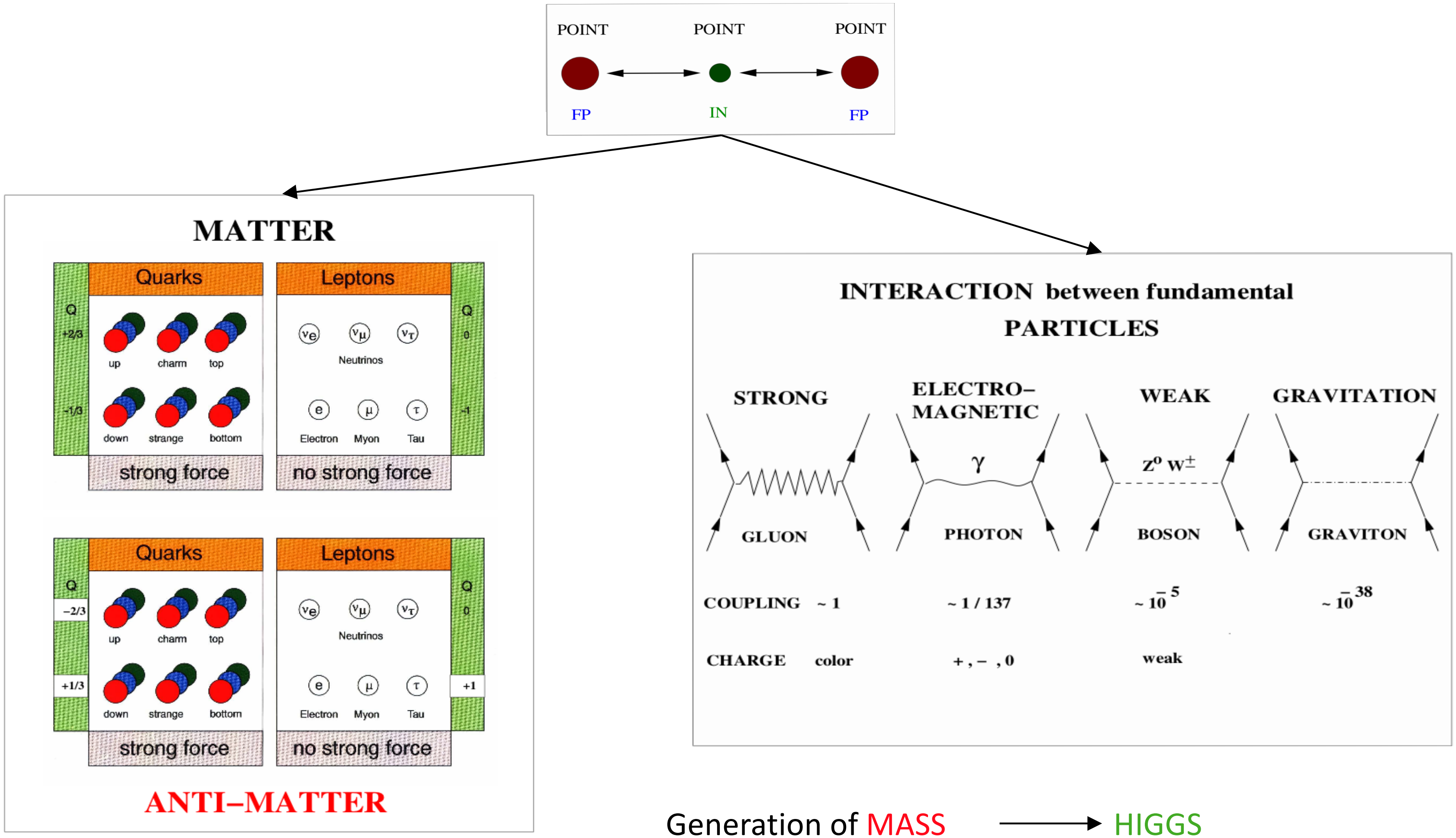
Conclusion of the new PATTERN

The introduction of the TWO new PARTICLES A and B allow to construct the light 20 FUNDAMENTAL PARTICLES with the PARTICLE A and B. A reduction of a factor 10.

The 8 heavy fermions are described also by these two particles. The are distinguished only be the mass from the light fermions. A possible vibration state would further reduce 8 parameters to two.

B) Experiments to test the size of FP's via direct contact term.

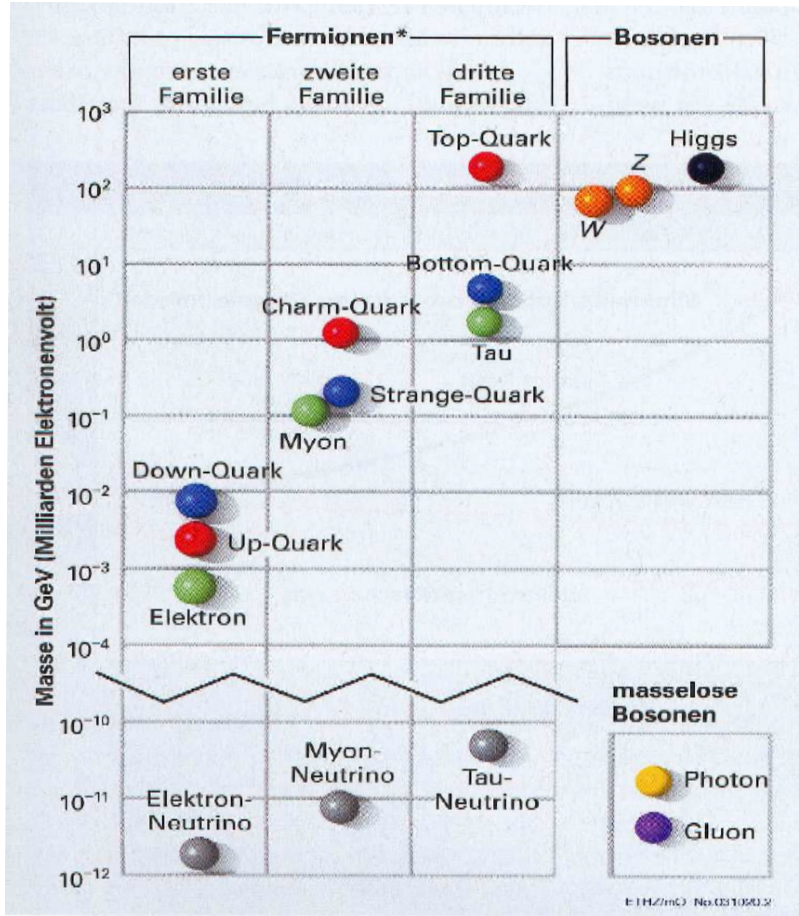
Reminder Standard Model



Generation of MASS $\longrightarrow$ HIGGS

Energy Spectrum Fundamental Particles

In Standard Model
point particles

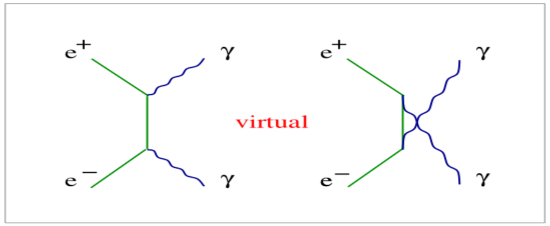


Electromagnetic Interaction

- In the case of electromagnetic interaction the process

$$e^+e^- \longrightarrow \gamma\gamma(\gamma)$$

is ideal to test the QED because it is in the initial and final state not interfered by the Z^0 decay.



- the Lagrangian for the electromagnetic interaction in QED is

$$L_{\text{int}} = -e\bar{\psi}\gamma^{\mu}\psi A_{\mu}$$

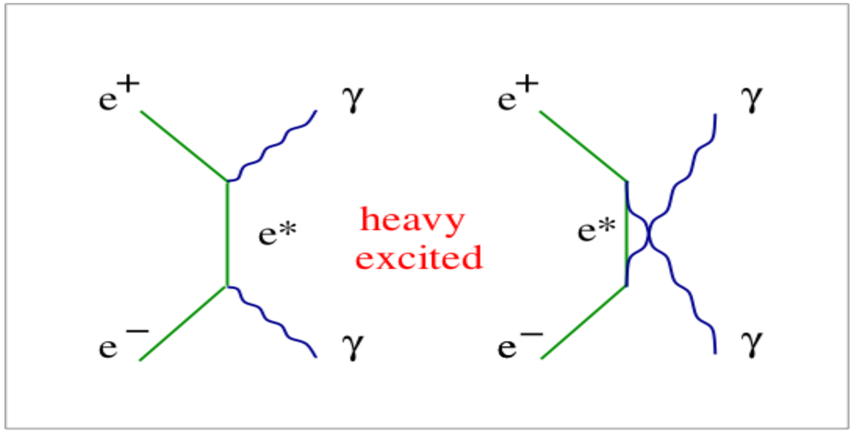
- the Born level cross section

$$\frac{d\sigma^0}{d\Omega} = \frac{\alpha^2}{s}\frac{1+\cos^2\Theta}{1-\cos^2\Theta}$$

- the third order cross section

$$\boxed{\left(\frac{d\sigma}{d\Omega}\right)_{\alpha^3} = \left(\frac{d\sigma^0}{d\sigma}\right)_{\alpha^2}(1+\delta_{virt}+\delta_{sb}+\delta_{hb})}$$

Heavy excited electron with mass m*



$$L_{excited} = \frac{e\lambda}{2m_{e^*}} \bar{\psi}_{e*} \sigma_{\mu\nu} \psi_e F^{\mu\nu}$$

λ is the coupling constant, $F^{\mu\nu}$ the electromagnetic field tensor, Ψ_{e*} and ψ_e are the wave functions of the heavy electron and electron respectively

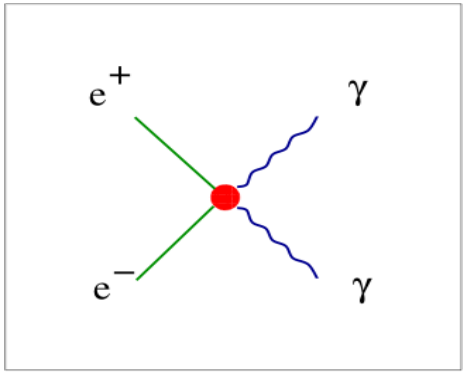
$$\frac{d\sigma}{d\Omega} = \left(\frac{d\sigma}{d\Omega}\right)_{O(\alpha^3)} (1+\delta_{new})$$

$$\boxed{\delta_{new} \cong \pm \frac{s^2}{2}\left(\frac{1}{\Lambda_\pm^4}\right)(1-\cos^2\Theta)}$$

For $s/m_{e*}^2 << 1$ the mass of the excited electron is given by

$$\Lambda_+^2 = m_{e*}^2/\lambda$$

For NON-point like interaction



$$L_{contact} = i\bar{\psi}_e \gamma_\mu (D_\nu \psi_e)\left(\frac{\sqrt{4\pi}}{\Lambda_6^2} F^{\mu\nu} + \frac{\sqrt{4\pi}}{\tilde{\Lambda}_6^2} \tilde{F}^{\mu\nu}\right)$$

The effective Lagrangian chosen for our case has an operator dimension 6, the wave function of the electron is ψ_e the QED covariant derivative is D_ν ,the tilde on $\tilde{F}^{\mu\nu}$ and $\tilde{\Lambda}_6$ stands for dual.

$$\frac{d\sigma}{d\Omega} = \left(\frac{d\sigma}{d\Omega}\right)_{O(\alpha^3)} (1 + \delta_{new})$$

$$\boxed{\delta_{new} = \frac{s^2}{2\alpha}\left(\frac{1}{\Lambda_6^4} + \frac{1}{\tilde{\Lambda}_6^4}\right)(1 - \cos^2\Theta)}$$

For the fits it is taken $\Lambda_6 = \tilde{\Lambda}_6$

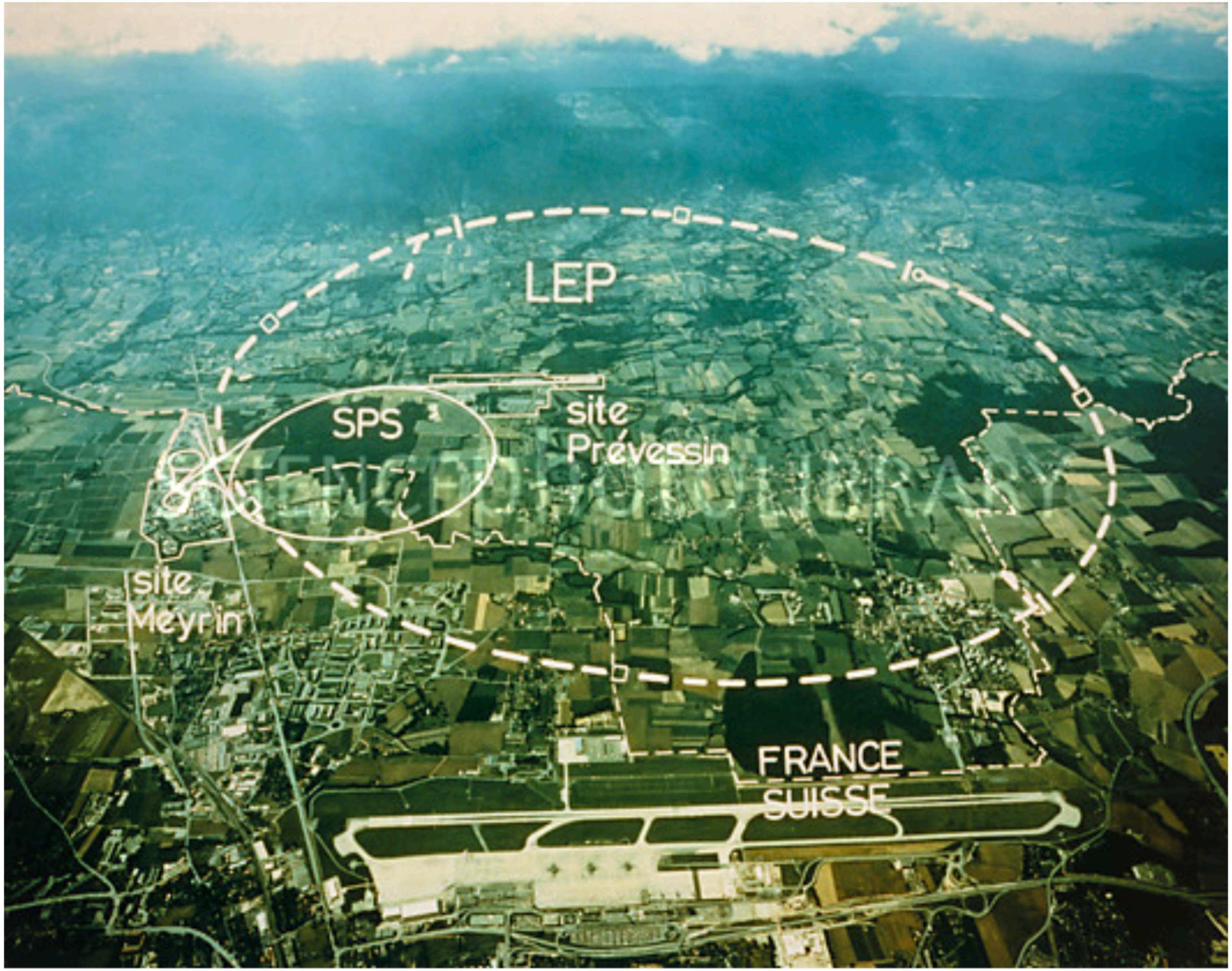
Λ_6 indicates the range of interaction r

$$\boxed{r = \hbar c / \Lambda_6}$$

Experiment to measur the $e^+ e^- \rightarrow \gamma\,\gamma\,(\gamma\,)$ reaction with the L3 Detector at LEP

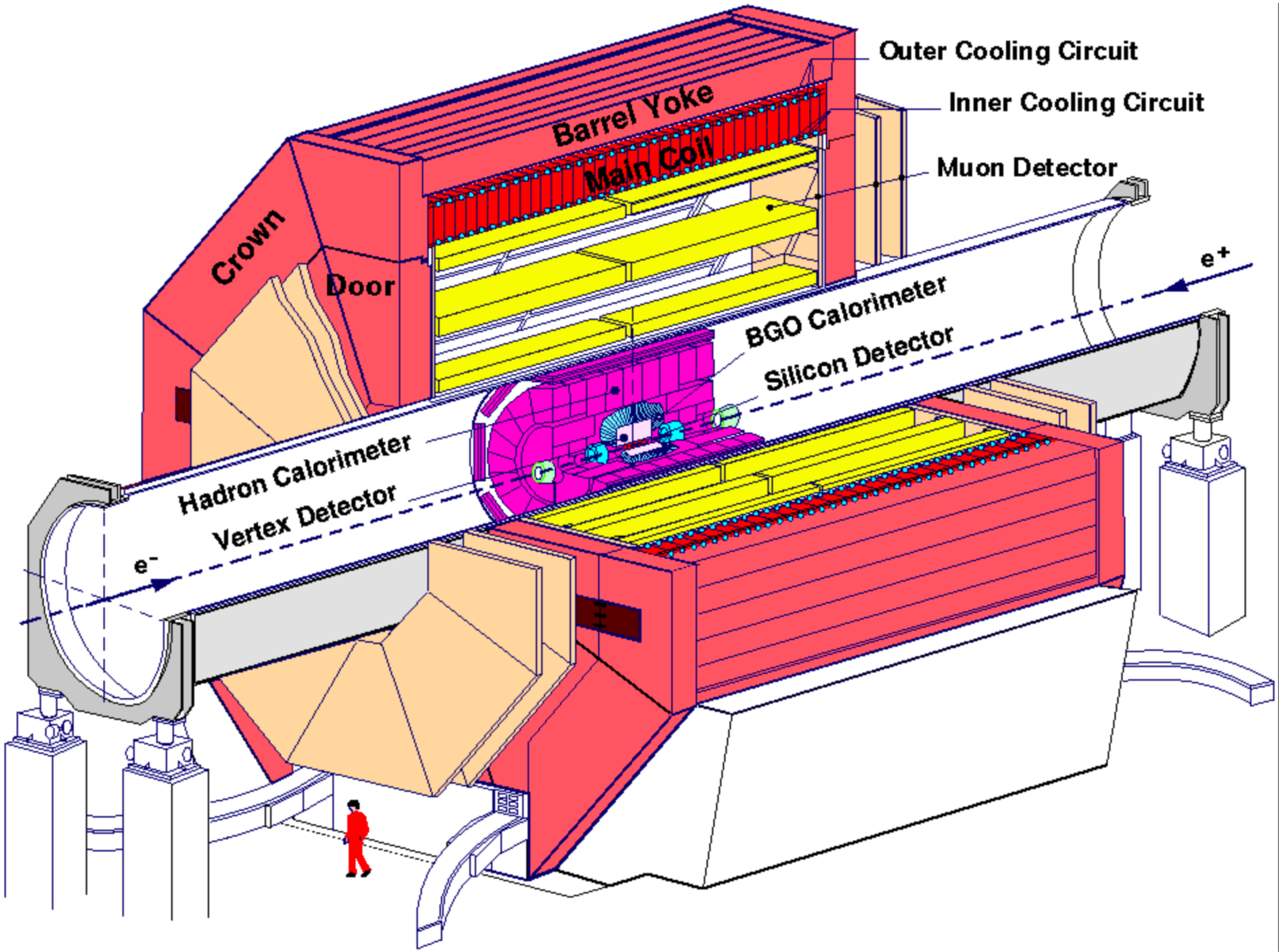
L3.web.cern.ch/l3/photos/l3views.html

The LARGE ELECTRON POSITRON COLLIDER (LEP)

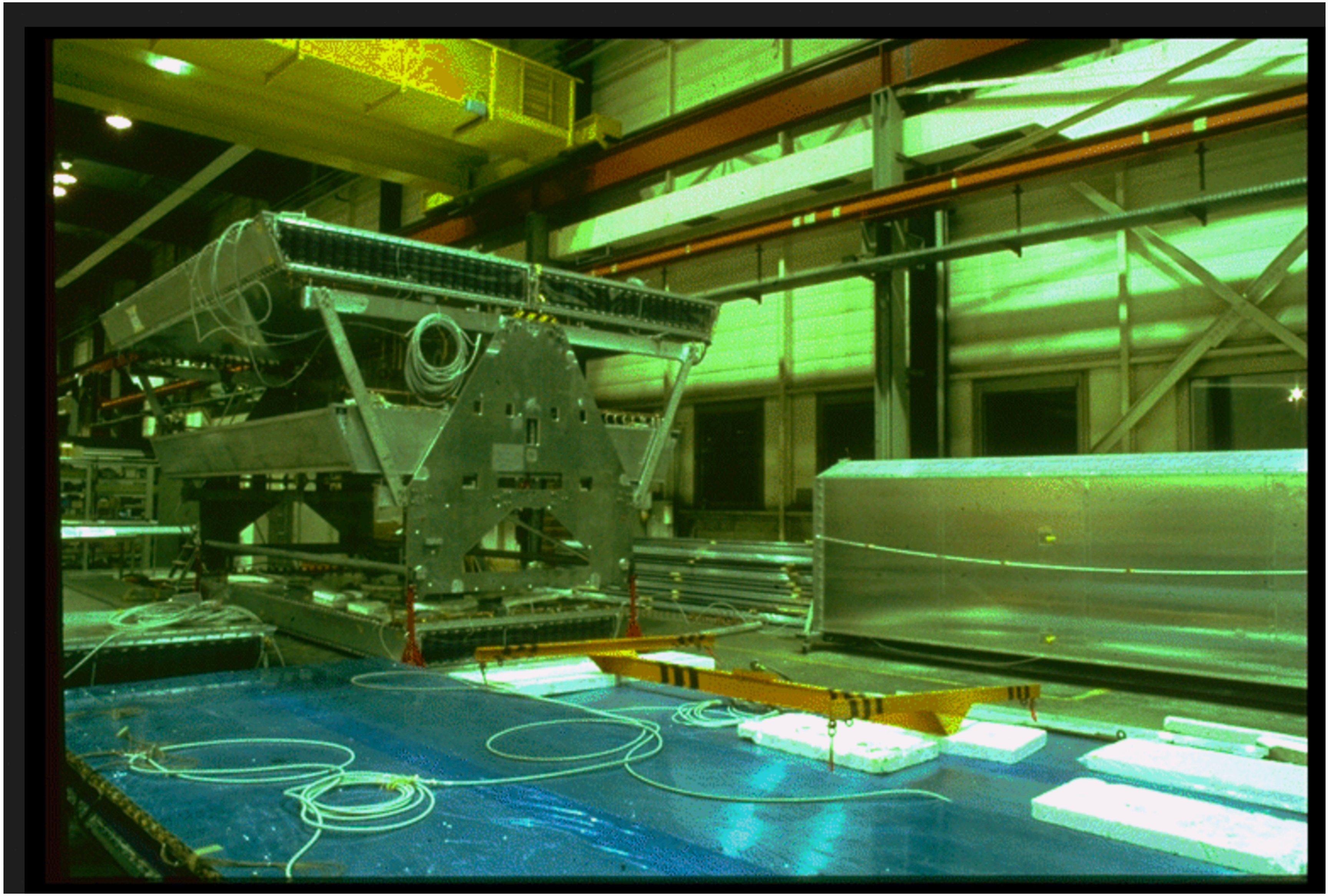


The LEP TUNNEL

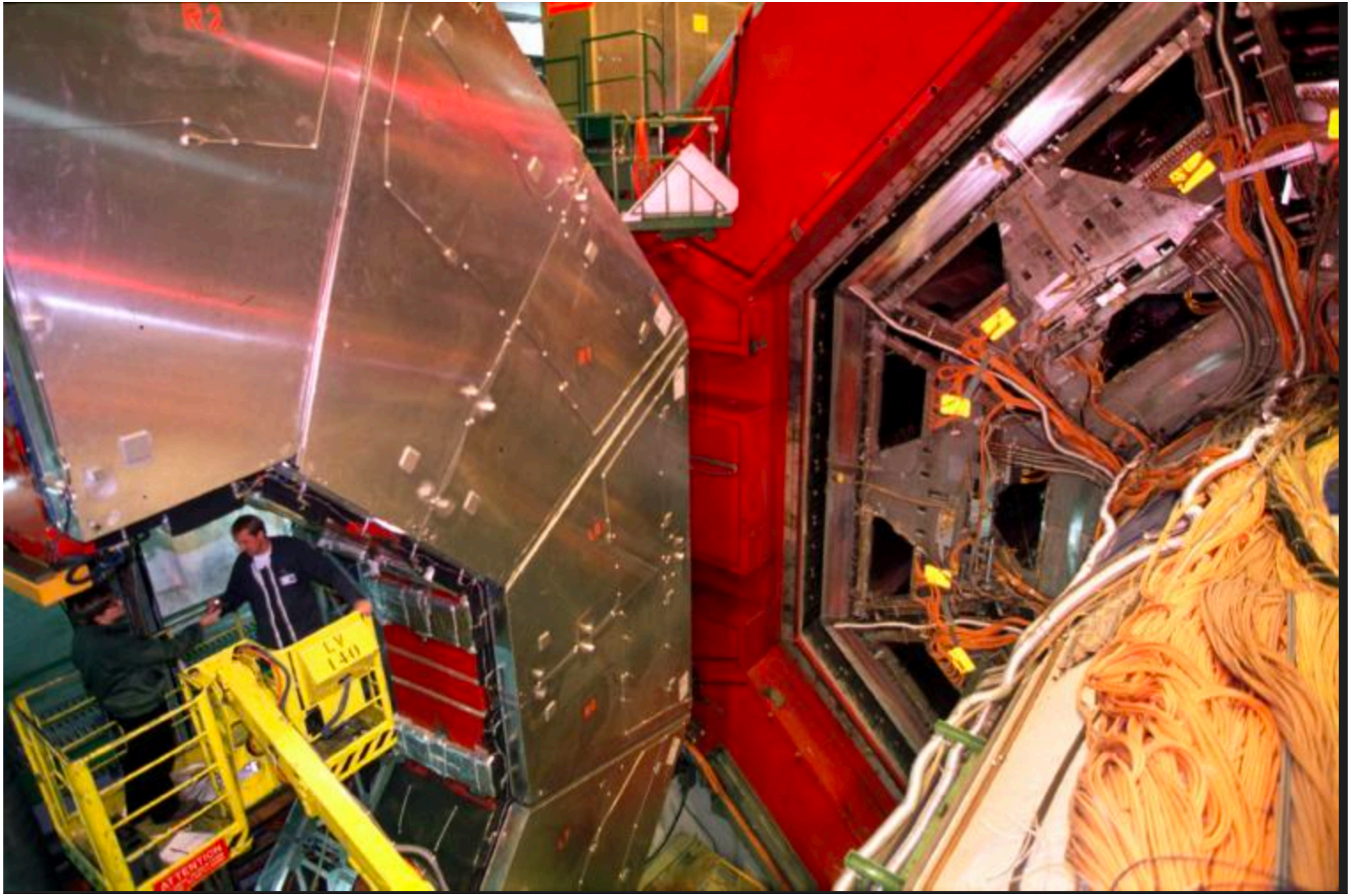
The L3 DETECTOR



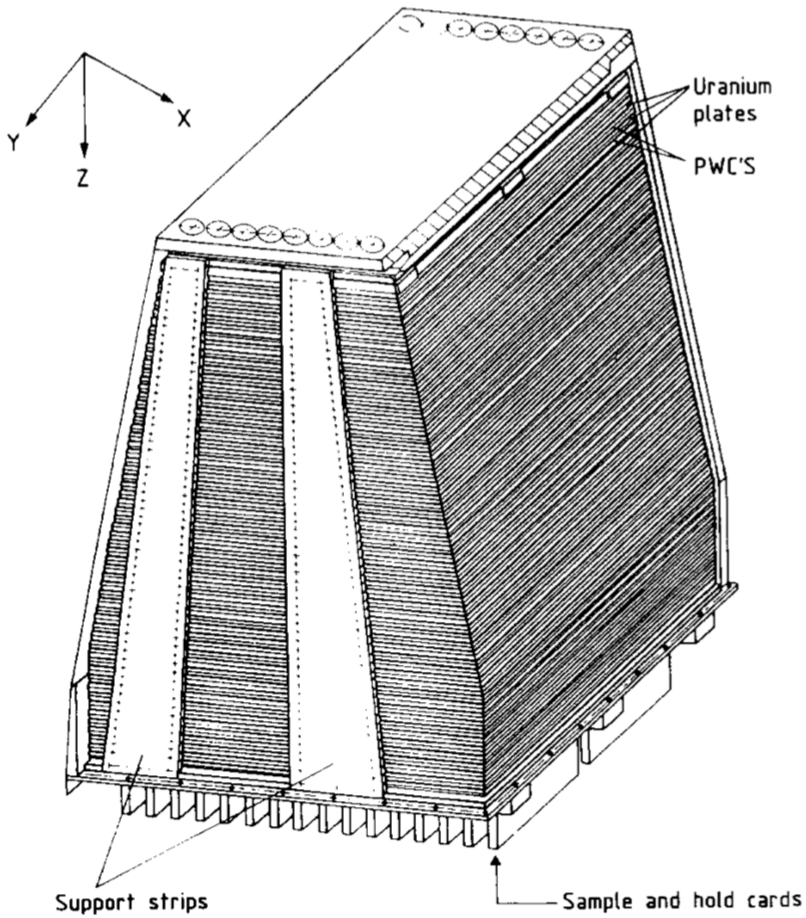
One Muon chamber octant

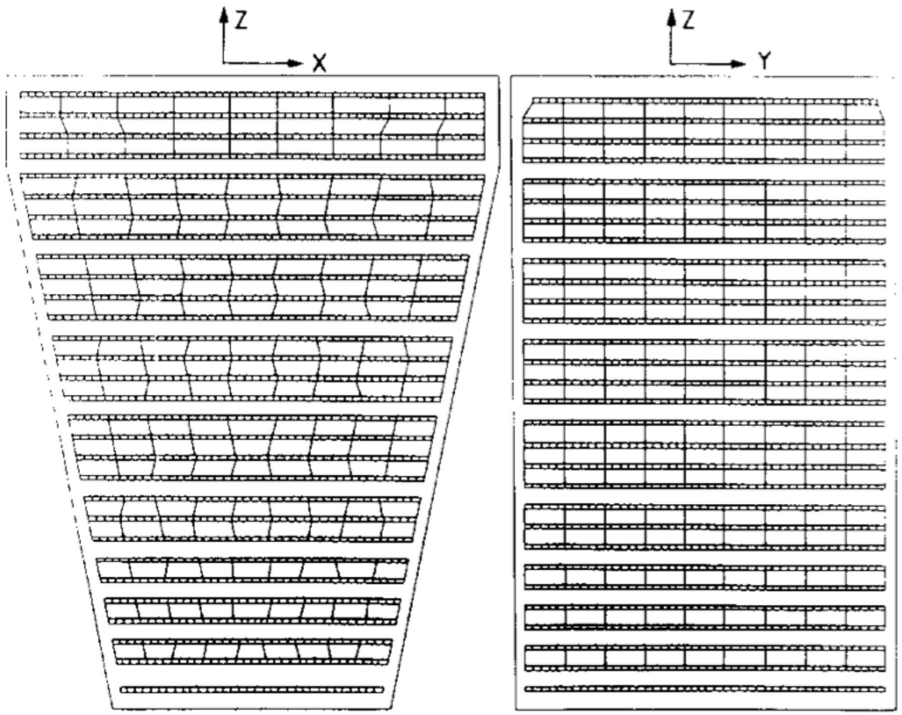


Muon chambers installed in L3



Hadron calorimeter module



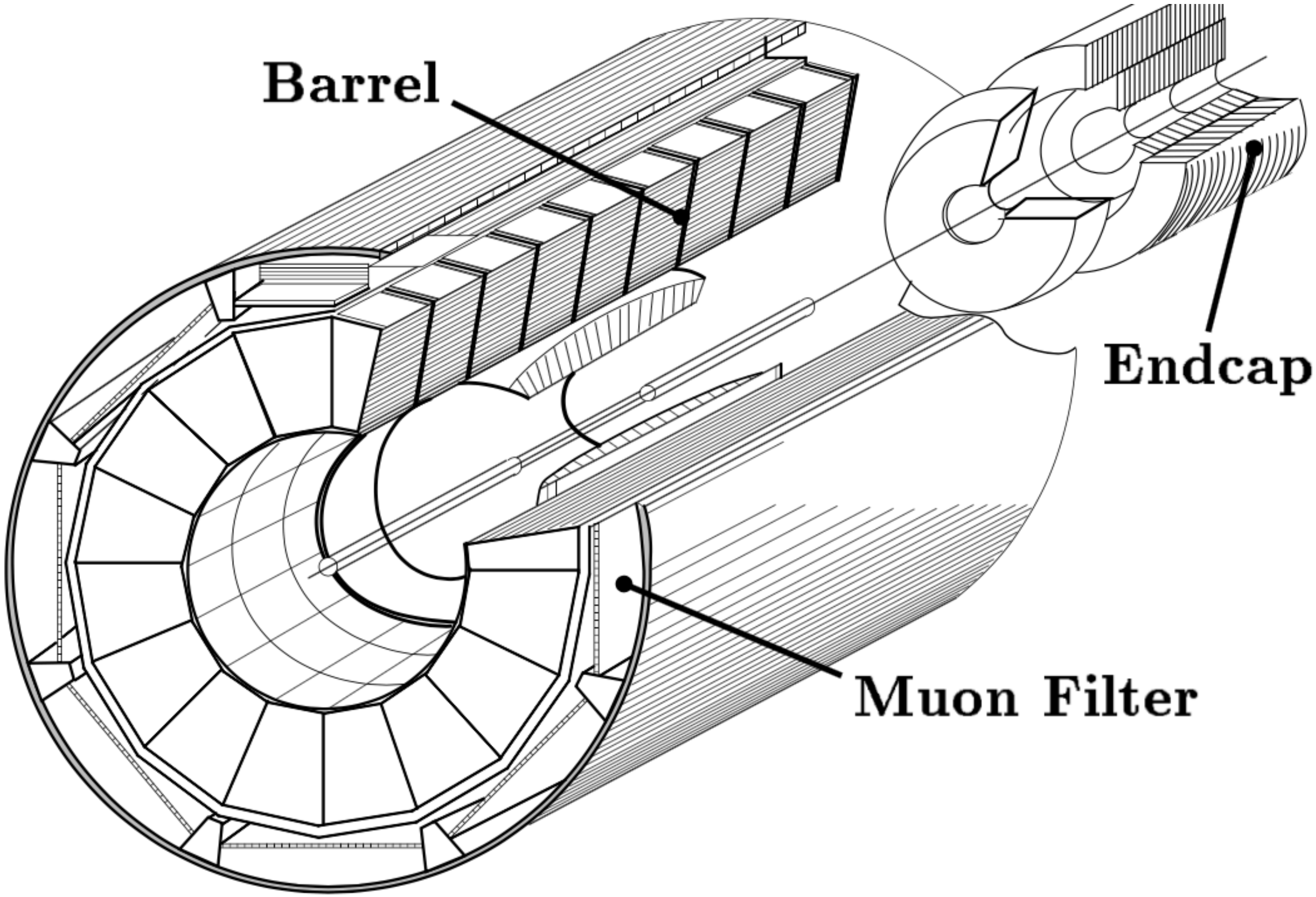


N.I.M. in Phys. Res. A272. (1988) 713

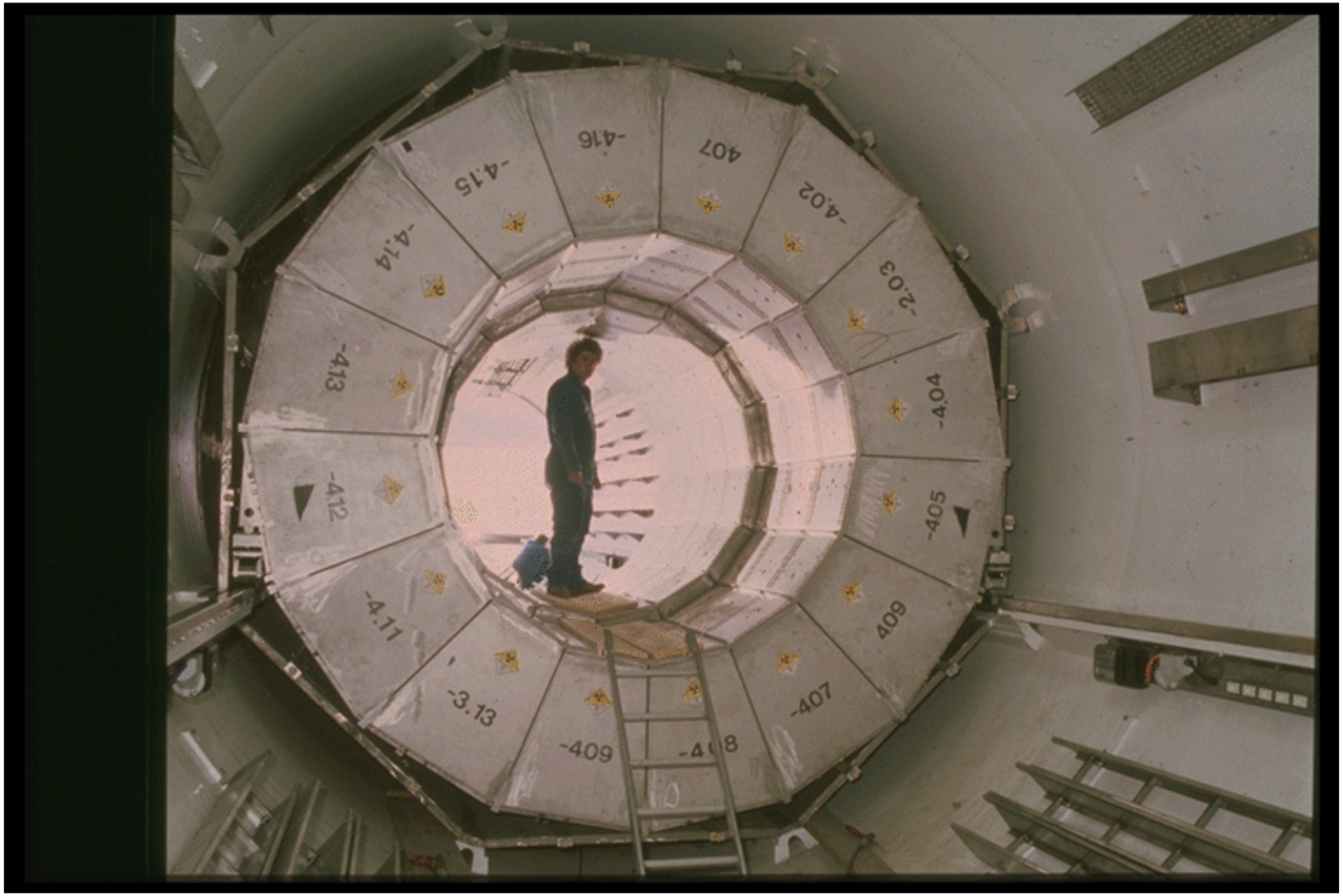
Uranium sampling calorimeter:

- 58 uranium ^{238}U plates interleaved with
- 60 planes of proportional wire chambers
- Measure ENERGY via range
- Measure Position via size of crossed proportional chambers .

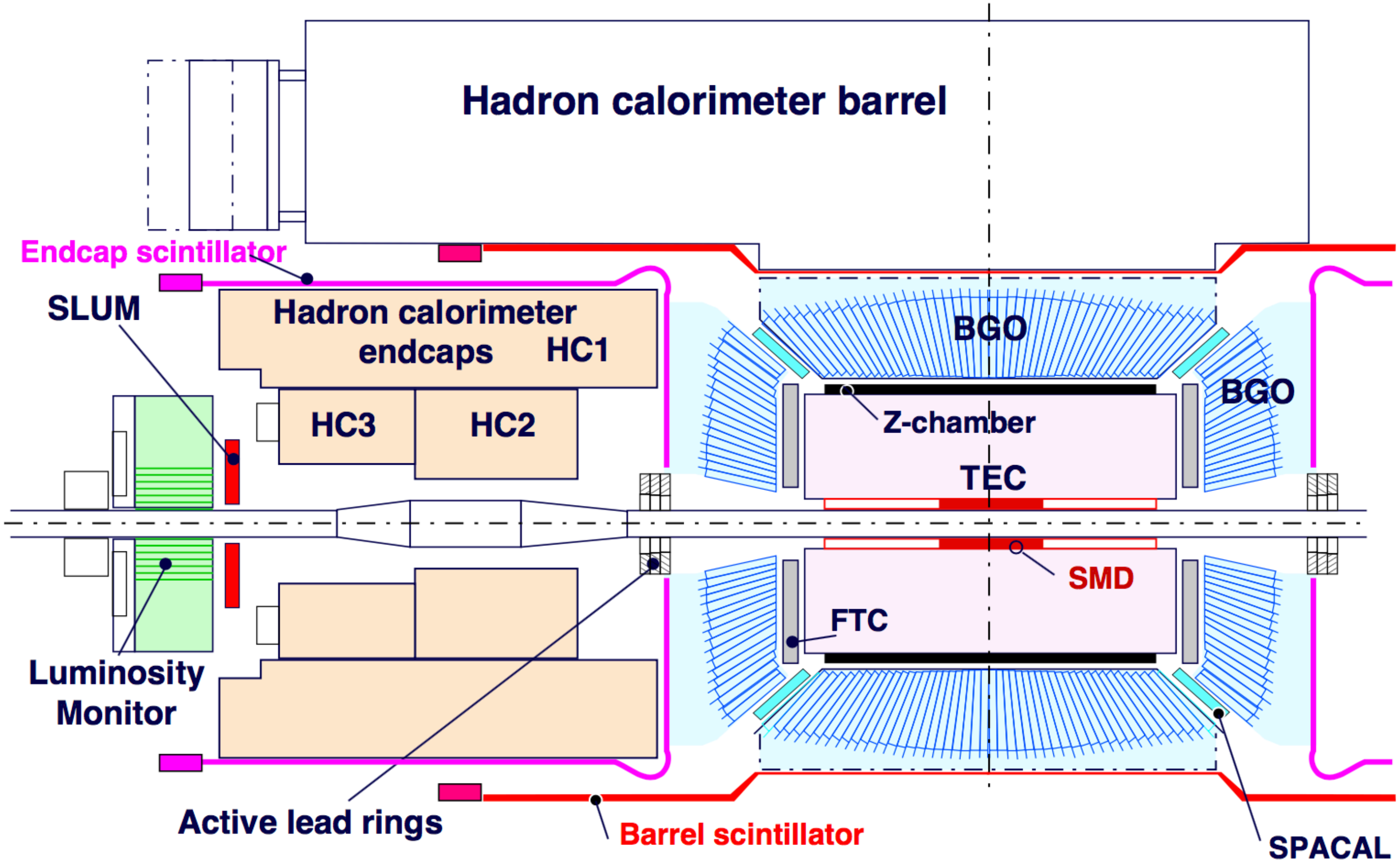
Hadron calorimeter Barrel and Endcap



Hadron calorimeter Barrel in L3



The Electromagnetic colorimeter with Hadron Calorimeter barrel and endcap

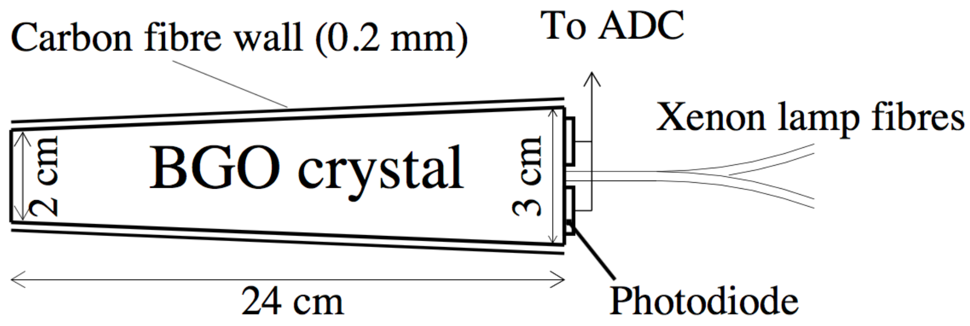


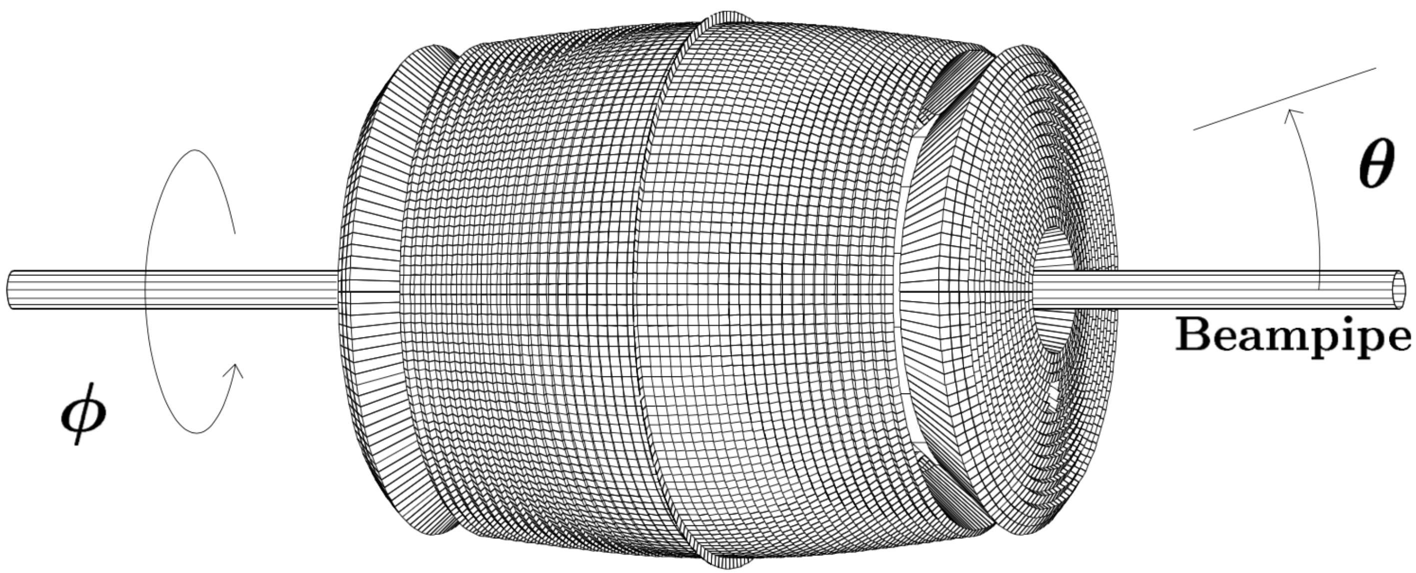
thesis.library.caltech.edu/252/8/08Chapter4.pdf

The Electromagnetic colorimeter BGO crystals

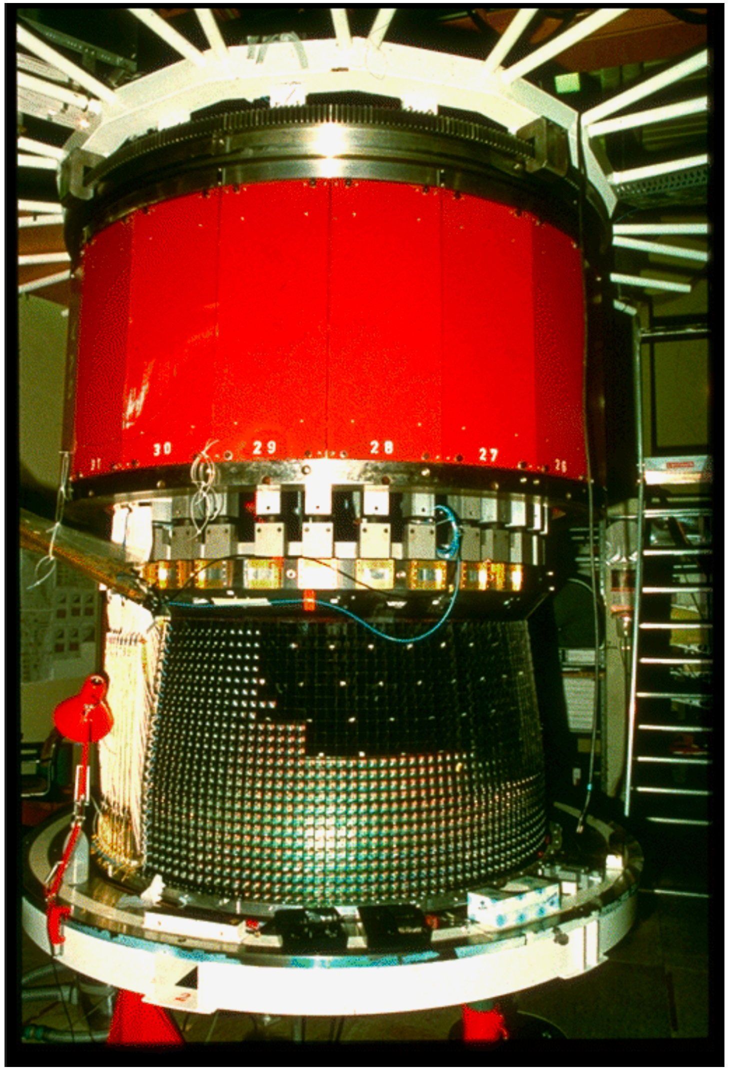
Energy measurement via light output of shower size.

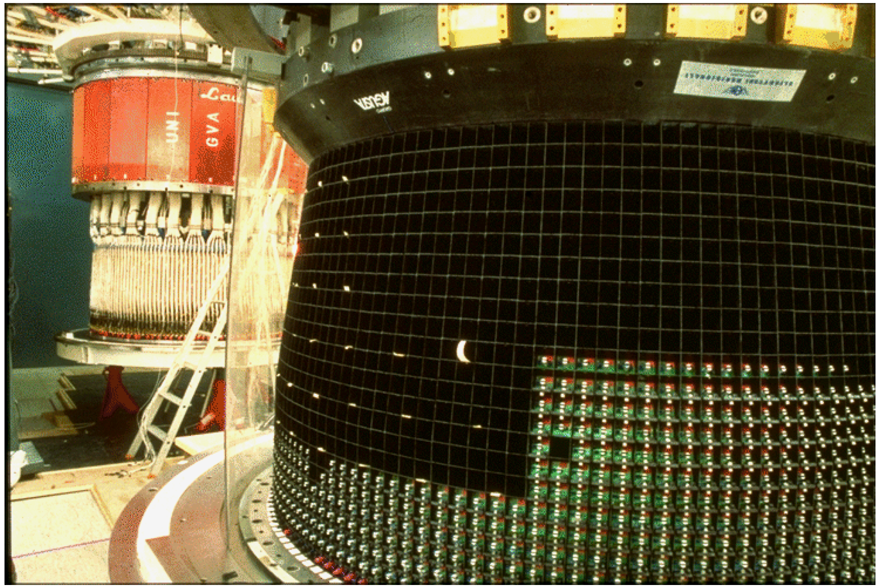
Position measurement via crystal size and geometrical position of the crystals.



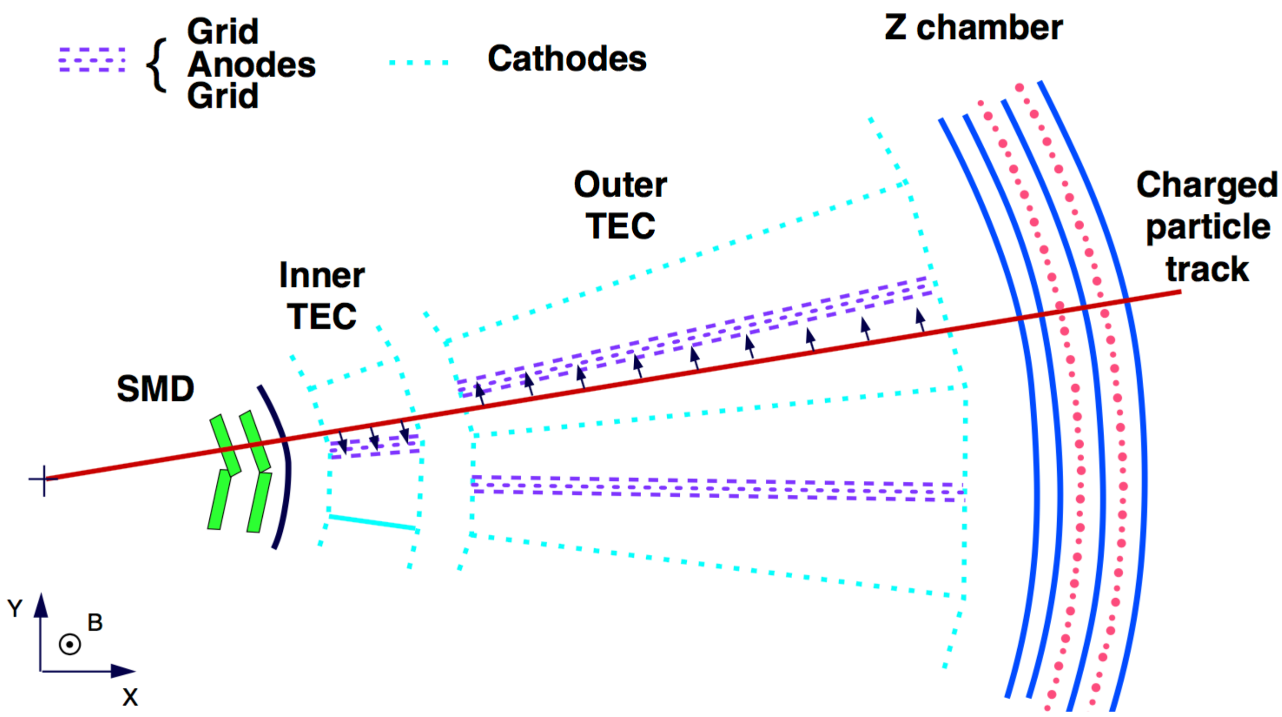


The Electromagnetic colorimeter before installation in L3





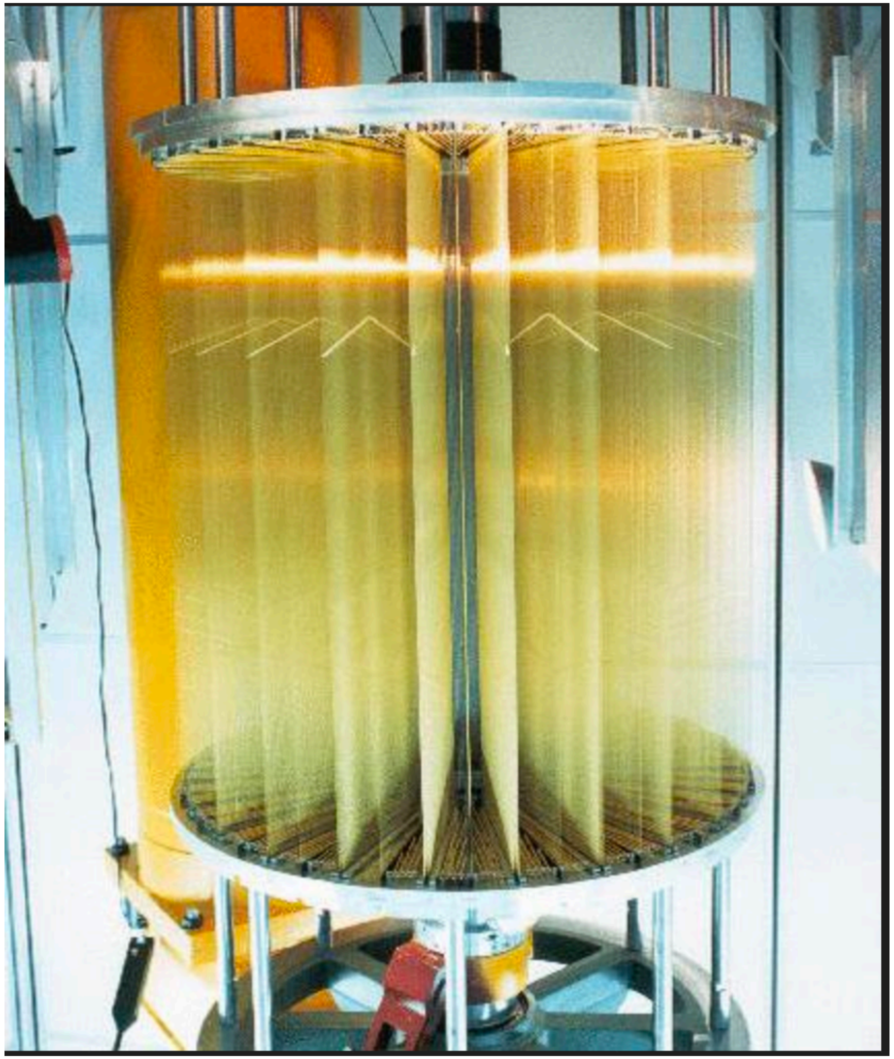
The principle of the Time Expansion Chamber TEC



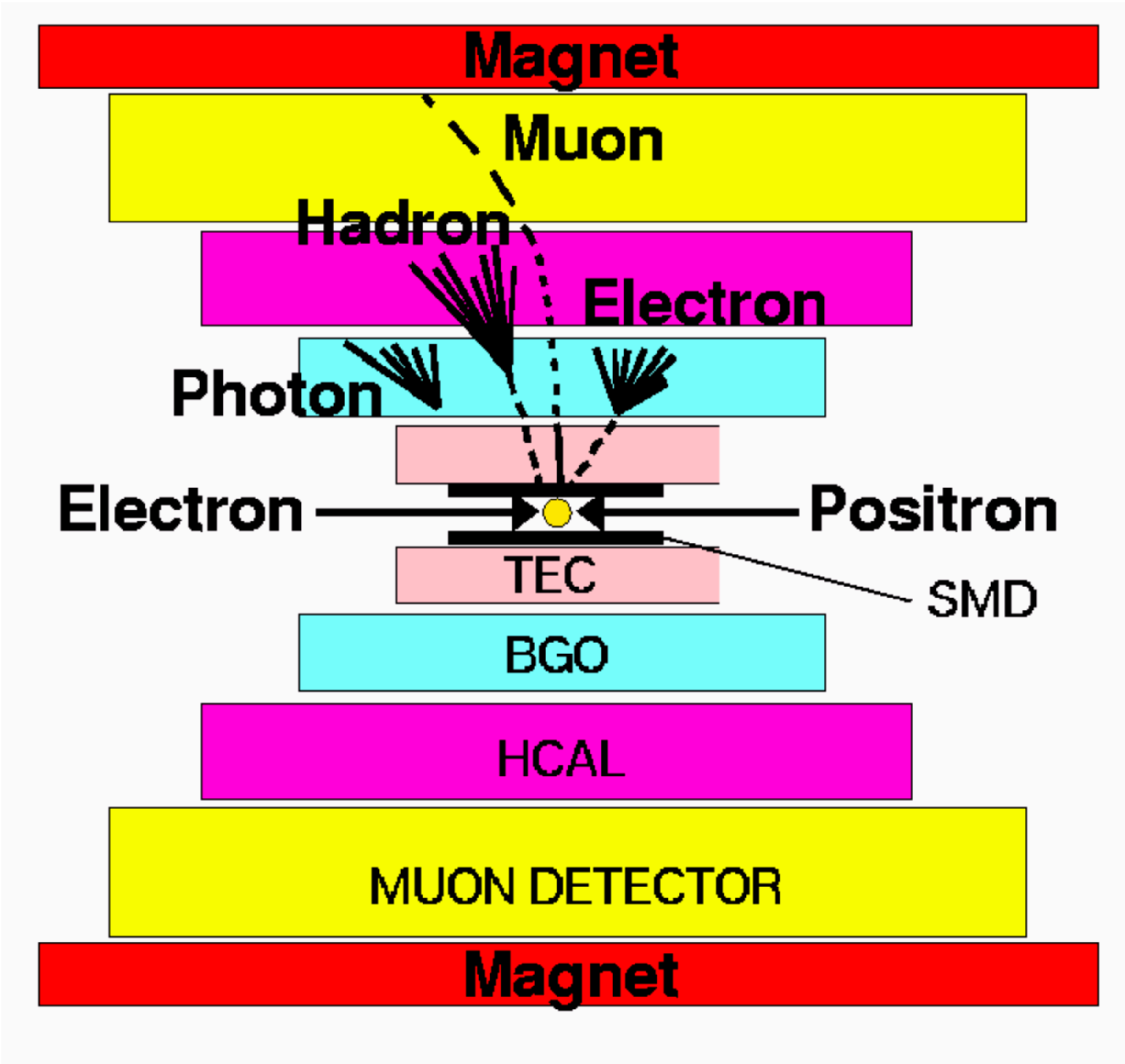
- Measurement of the coordinates of track via drift velocity and time tack of ionized particles (electrons and ions)

- Charge via curvature of the track in the longitudinal magnetic field of the L3 magnet.

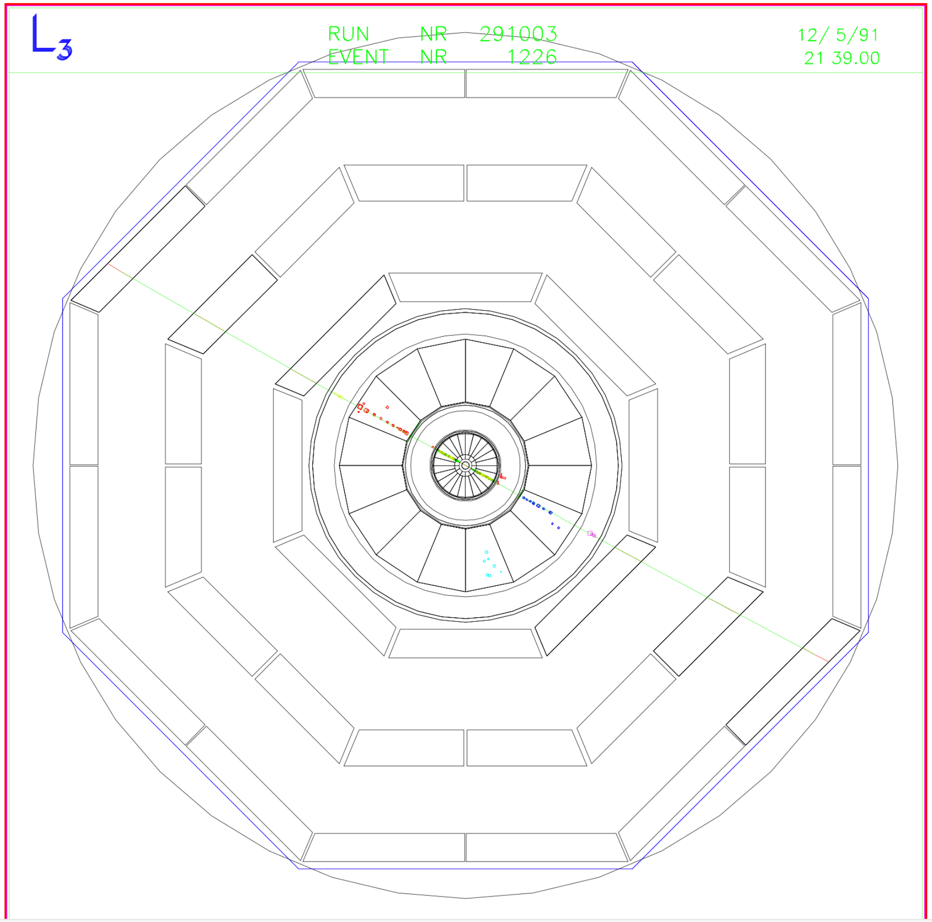
The TEC at the frame to mount the wires at ETHZ

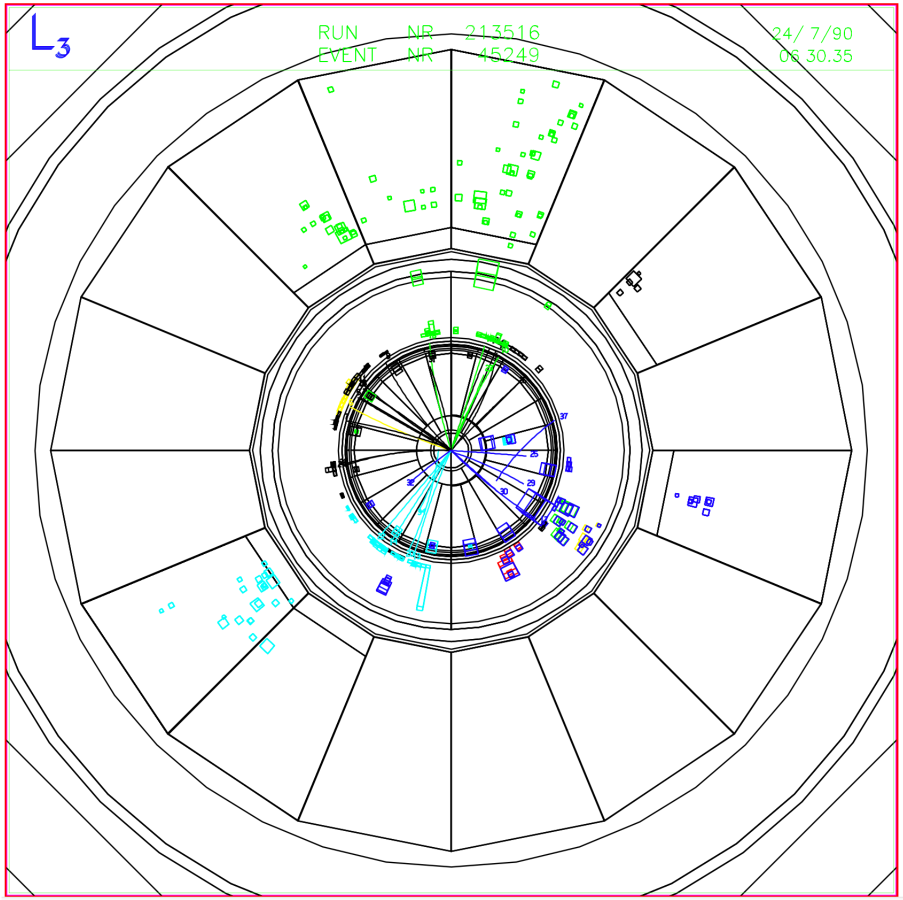


The schema of the L3 DETECTOR



Event selection

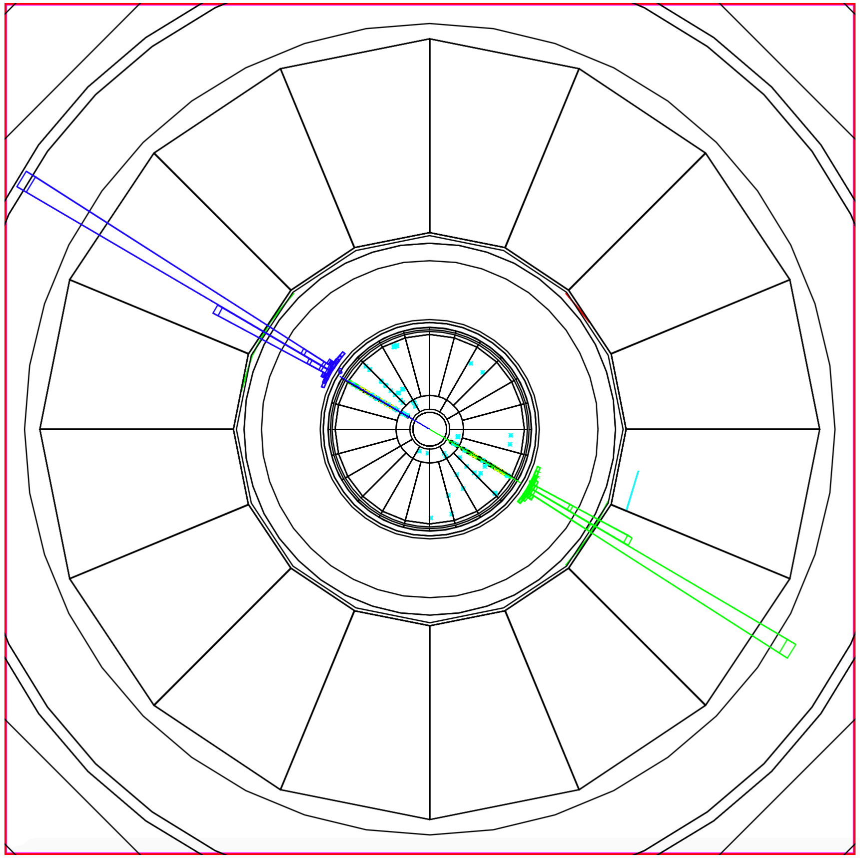


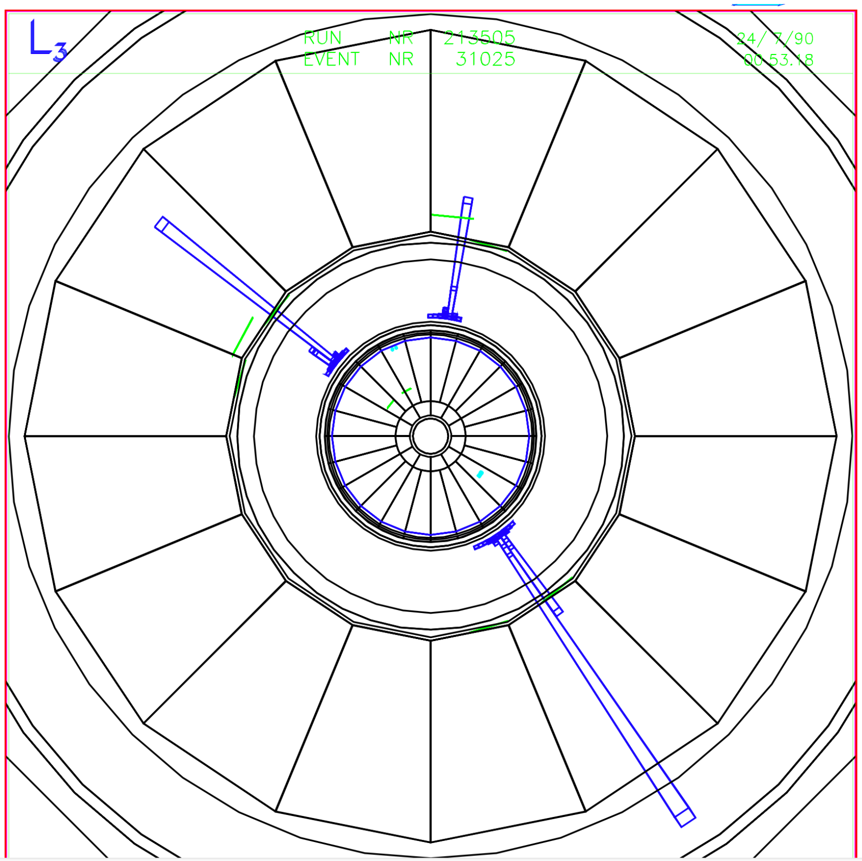


Muon EVENT

Hadron EVENT

Event selection





BHABA EVENT
$e^+ e^- \to e^+ e^-$

GAMMA GAMMA EVENT
$e^+ e^- \to \gamma\gamma(\gamma)$

Example of published work from the $\gamma\,\gamma$ group of L3

Tests of QED at LEP Energies using $e^+e^- \to \gamma\gamma(\gamma)$ and $e^+e^- \to \ell^+\ell^-\gamma\gamma$

CERN-PPE/95-41
March 31, 1995

Event Selection

In order to select events with two or more electromagnetic showers with polar angles in the range $14^0 < \theta < 166^0$, the following cuts are applied:

(1) the number of showers with energies above 2.0 GeV in the ECAL must at least 2 and less than 8.

(2) the total energy deposited in the ECAL must be higher than $0.7\sqrt{s}$.

(3) the shower profile must consist with that of an electron or photon.

(4) the acollinearity angle between the two most energetic showers is required to be less 40°.

To reject Bhabha and $e^+ e^- \rightarrow \gamma\gamma(\gamma)$ events.

(5) there is a track in the central tracking chamber, or there are hits in the forward-backward tracking chambers associated with either of two most energetic showers in the ECSAL.

Event Selection

To select $e^+ e^- \to \gamma\gamma\gamma$ events where all three photons are hard and well separated the following two cuts are applied in addition to cuts 1, 2, 3 and 5:

(6) there must be at least three showers in the ECAL separated from each other by at least 15° and the energy of the third most energetic shower must be greater than 5 GeV.

(7) the sum of the angle in space between the three showers has to exceed 350°.

In the data taking period from 1991 to 1993:

→ 1882 events $e^+ e^- \to \gamma\gamma(\gamma)$ and
→ 52 events $e^+ e^- \to \gamma\gamma\gamma$ get recorted.

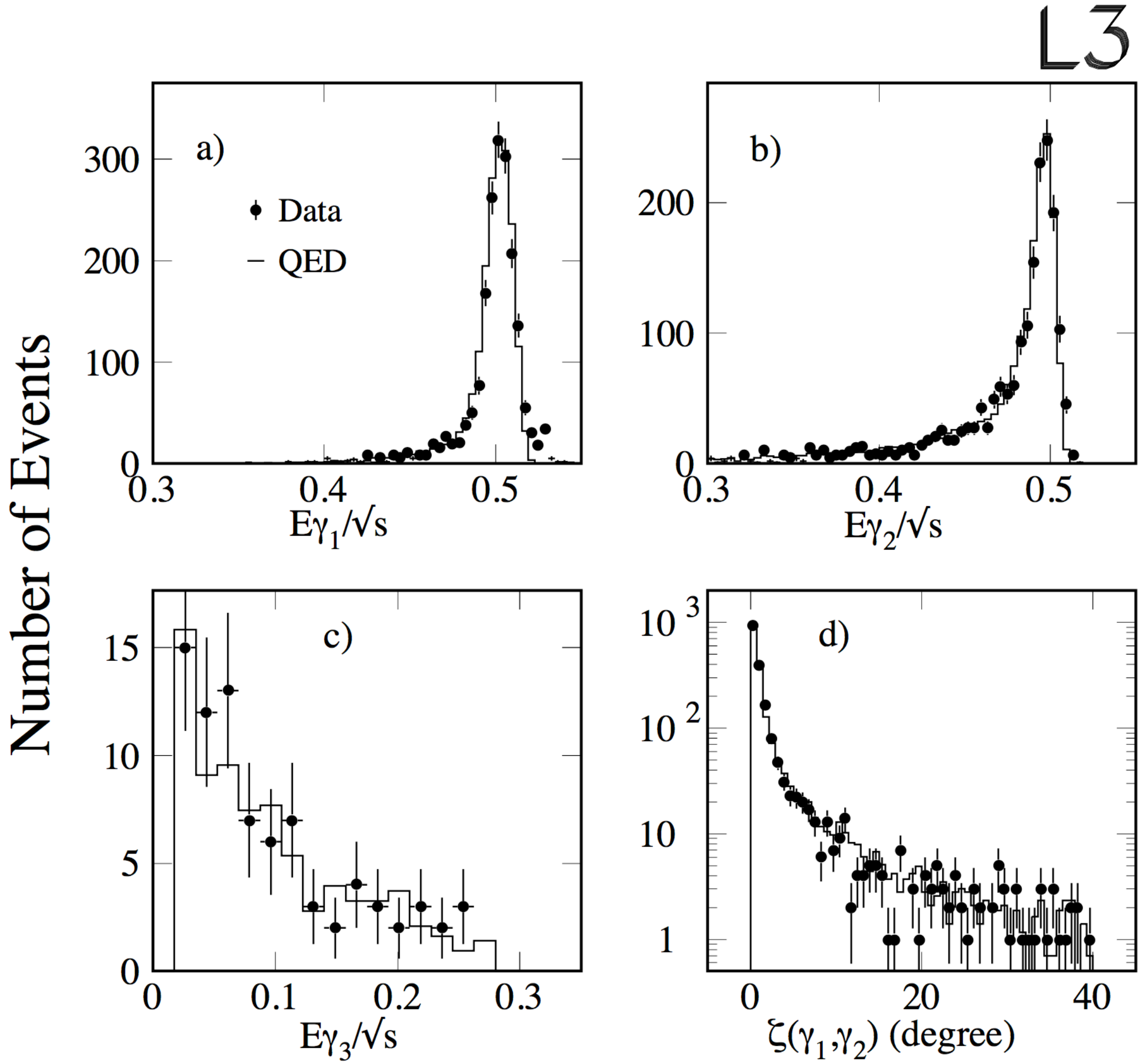


Figure 1: (a), (b) and (c) show the comparisons between the data and the QED predictions of the normalized photon energy spectra for the first, second and third most energetic photons, respectively. (d) shows the comparison of the acollinearity angle distribution between the two most energetic photons.

Luminosity L - Cross Section σ

$$L = \frac{n \cdot N_1 \cdot N_2 \cdot f}{A}$$

n -> Number of bunches

N_1 N_2 -> Particles in the bunch

f -> Repetition frequency

A -> Aria of the beam cross section in the interaction point

$\dot{N}$ -> Measured event rate per time

dt -> time differential

dΩ -> Solid angle

$$\dot{N} = \sigma_p \cdot L \quad \sigma_p = \frac{1}{L}\frac{dN}{dt} \quad \frac{d\sigma}{d\Omega} = \frac{1}{L}\frac{d^2N}{d\Omega \cdot dt}$$

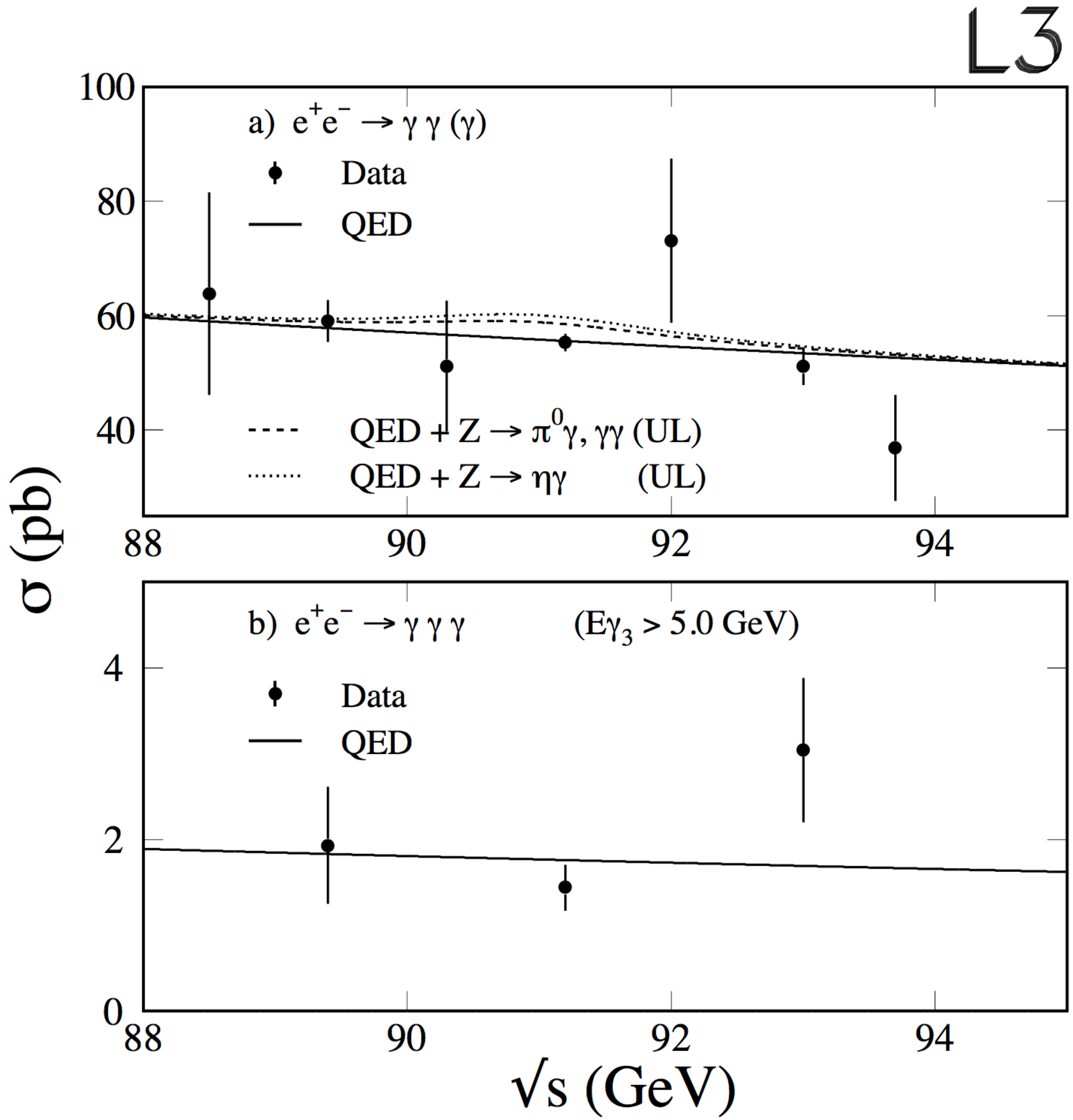


Figure 2: Comparison of the total cross sections between the data and the QED prediction as a function of center of mass energy. In (a) upper limits (UL), at 95% CL, on the rare and forbidden processes are also shown.

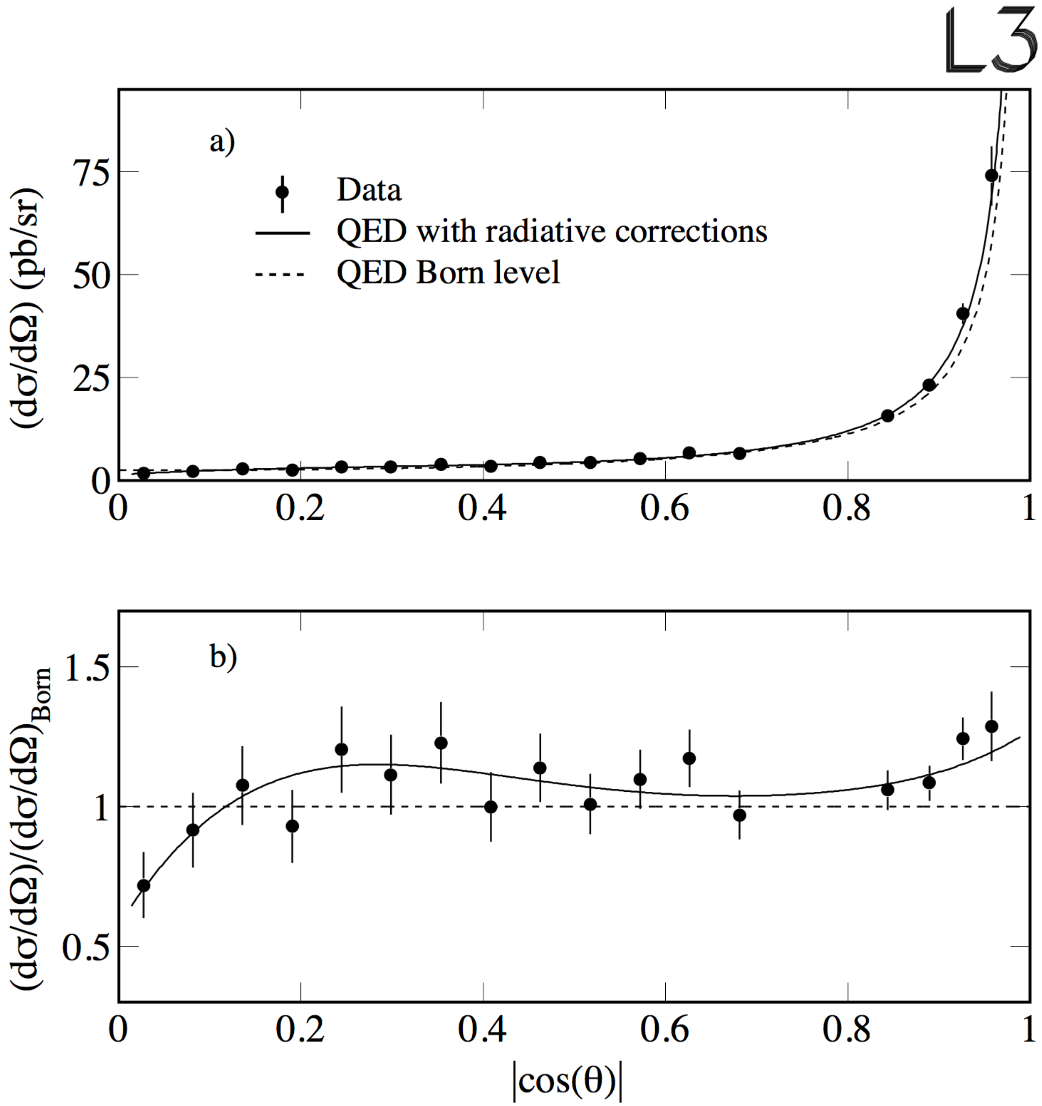


Figure 3: (a) shows the comparison of measured differential cross sections with the QED predictions for the process $e^+e^- \to \gamma\gamma(\gamma)$ as a function of $|\cos\theta|$. (b) shows the same cross sections normalized to the QED Born level prediction.

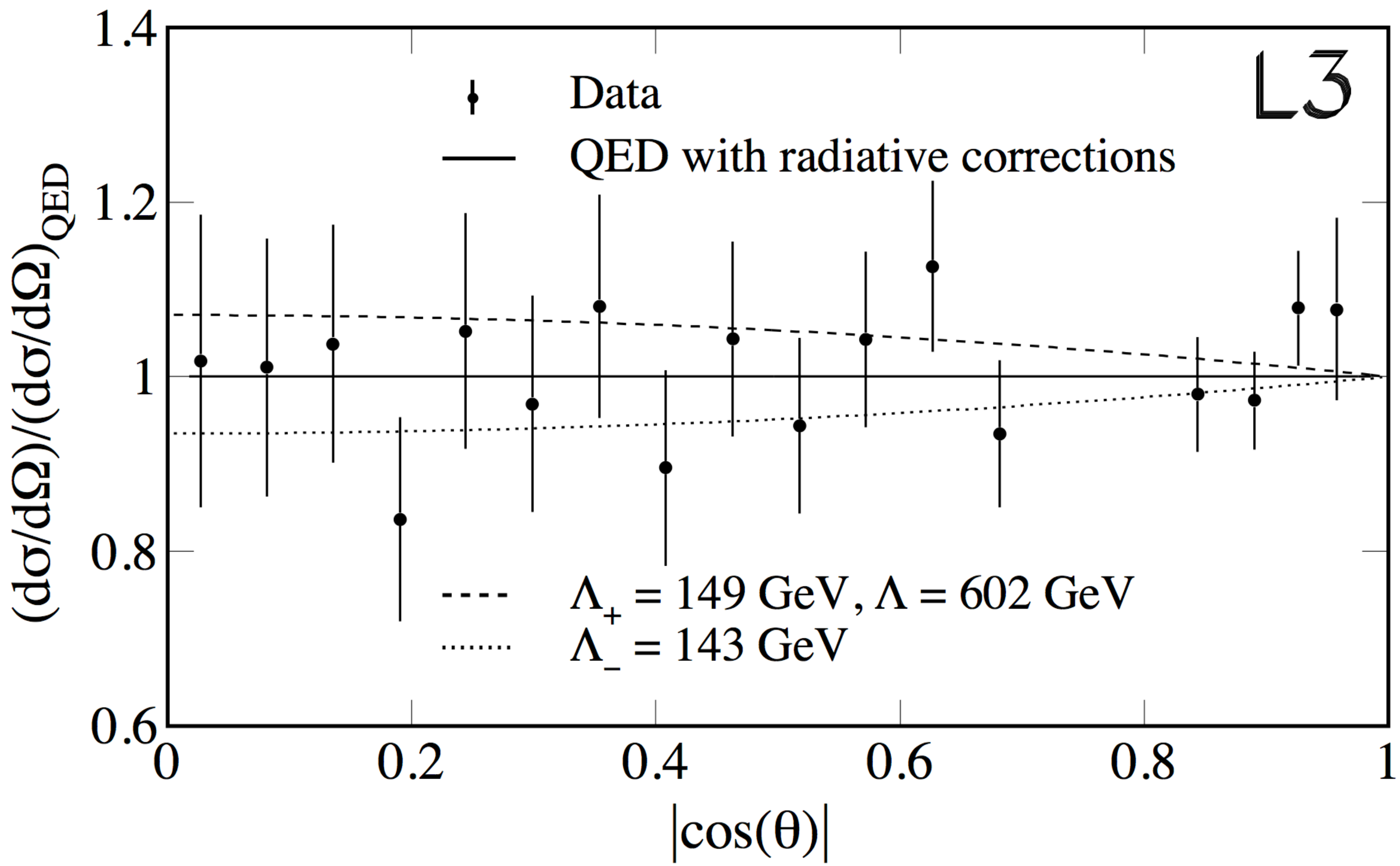


Figure 4: Comparison of the measured differential cross section with the QED predictions including the deviations for the parameter values shown in the figure, as a function of $|\cos\theta|$. The cross sections are normalized to the radiatively corrected QED cross section. The functional effect of Λ_+ and Λ is the same.

CONCLUSION of the of the paper from 1995

CERN-PPE/95-41 March 31, 1995

The measurements of total and differential cross sections for $e^+e^- \rightarrow \gamma\gamma(\gamma)$ are well described by QED. The measured total cross section for the process $e^+e^- \rightarrow \gamma\gamma\gamma$ is in good agreement with the QED prediction. At 95% CL, we set the following lower limits: the contact interaction energy scale parameter $\Lambda > 602$ GeV; the excited electron mass $m_{e^*} >146$ GeV; and the QED cut-off parameters $\Lambda_+ > 149$ GeV and $\Lambda_- > 143$ GeV. Upper limits are set, at 95% CL, on the branching fractions of Z decaying into $\gamma\gamma$, $\pi^\circ\gamma$, and $\eta\gamma$ of 5.2×10^{-5}, 5.2×10^{-5} and 7.6×10^{-5} respectively. The increased statistics indicates that there is no further evidence for a high $\gamma\gamma$ mass anomaly in the $\ell\ell\gamma\gamma$ channel.

GLOBAL FIT

After LEP was closed 2000 the ETH – gamma group performed a global fit of all

$$e^{+}\, e^{-} \to \gamma\gamma(\gamma)$$

data existing on the world.

This reaction was measured from 6 detectors:

- Venus and Topas,
- The LEP detectors: Aleph, Delphi, L3 and OPAL

Data are published between 1989 to 2003 between 55 GeV and 207 GeV, in a very usefully manner to calculate the differential cross section.

The detail numbers of measured events N_i, pin of measured angle $\Delta\left(|\cos\theta|\right)_i$, Luminosity L and Efficiency ε_i was published.

GLOBAL FIT

The measured differential cross section is a function of the

Number of measured events N_i

pin of measured angle $\Delta\left(|\cos\theta|\right)_i$

Luminosity L

Efficiency ε_i

$$\boxed{\left(\frac{d\sigma}{d\Omega}\right)_i = \frac{1}{2\pi\Delta(|\cos\theta|)_i}\frac{N_i}{L\varepsilon_i}}$$

GLOBAL FIT

We used all published differential cross sections $\frac{d\sigma}{d\Omega}(e^+e^- \to \gamma\gamma(\gamma))$ for a global $\chi^2 - TEST = f(1/\Lambda^4)$ including the luminosity L for all Energies.

GeV	VENUS 1/pb	TOPAS 1/pb	ALEPH 1/pb	DELPHI 1/pb	L3 1/pb	OPAL 1/pb
55	2.34					
56	5.18					
56.5	0.86					
57	3.70					
57.6		52.26				
91			8.5	36.9	140	7.2
133				5.92		
162				9.58		
172				9.80		
183				52.9	54.8	55.6
189				151.9	175.3	181.1
192				25.1	28.8	29.0
196				76.1	82.4	75.9
200				82.6	67.5	87.2
202				40.1	35.9	36.8
205					74.3	79.2
207					138.1	136.5

VENUS Z.Phys.C45 175 (1989)

TOPAS Phys.Lett.B284 144 (1992)

ALEPH Phys.Rept.216 253 (1992)

DELPHI Phys.Lett.B327 386 (1994)

DELPHI Phys.Lett.B433 429 (1998)

DELPHI Phys.Lett.B491 67 (2000)

L3 Phys.Lett.B531 28 (2002)

OPAL Phys.Lett.B275 531 (1991)

OPAL Eur.Phys.J.C26 331 (2003)

The parameter number of events N_i, efficiency ε_i , pin of the $\Delta\left(\left|\cos\theta\right|\right)_i$ and Energy we take from the mentioned papers above, here for example fromL3 Phys.Lett.B531 28 (2002) table 4

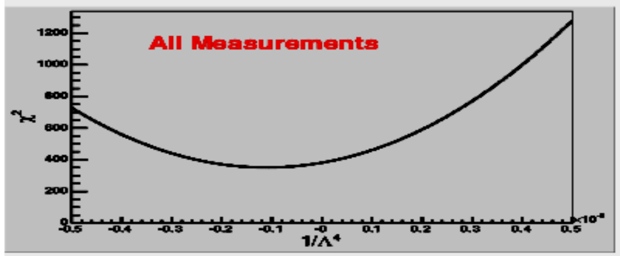
Table 4
Number of events, efficiency and radiative correction factor applied to the data as a function of $\sqrt{s}$ and of the event polar angle, $\cos\theta$. The values at $\sqrt{s} = 183$ and 189 GeV [5] are also listed. The uncertainty on the radiative correction factor ranges from 5% (first $\cos\theta$ bin) to 1% (last $\cos\theta$ bin) and is due to the finite Monte Carlo statistics

$\cos\theta$	Data events/Efficiency [%] ($\sqrt{s}$ in GeV)								Radiative correction
	183	189	192	196	200	202	205	207	factor
0.00–0.05	15/91.7	35/87.9	5/81.0	13/88.4	12/87.6	10/90.9	17/89.1	24/88.6	0.78
0.05–0.10	14/89.0	21/87.7	9/91.7	15/85.6	14/88.1	5/96.7	14/85.3	28/86.0	0.79
0.10–0.15	10/85.9	37/88.1	4/82.5	10/87.6	7/88.8	7/86.0	11/84.7	28/88.7	0.80
0.15–0.20	9/89.4	37/87.1	7/87.8	15/89.6	10/85.3	5/87.9	14/84.3	25/88.8	0.81
0.20–0.25	10/90.2	46/88.6	5/92.1	16/88.7	15/86.1	5/91.4	14/86.9	15/85.2	0.81
0.25–0.30	18/88.5	48/88.4	6/80.2	20/89.5	11/89.7	5/91.2	12/90.8	14/88.7	0.82
0.30–0.35	16/90.7	35/86.0	0/82.9	16/89.0	13/86.8	8/82.5	9/87.4	27/89.4	0.82
0.35–0.40	13/88.5	45/86.7	4/91.6	23/89.2	16/89.0	9/89.6	13/92.4	24/89.9	0.82
0.40–0.45	13/87.7	41/86.0	8/77.8	19/87.5	10/87.2	9/92.0	17/88.4	31/87.9	0.83
0.45–0.50	12/88.5	57/88.6	10/93.2	20/90.3	12/89.5	7/83.3	16/86.8	37/89.4	0.84
0.50–0.55	23/88.8	74/88.4	5/85.2	23/87.8	14/92.7	7/85.5	21/88.6	47/88.4	0.84
0.55–0.60	17/86.6	50/86.6	8/84.4	20/88.8	18/86.1	11/84.6	27/84.4	41/87.7	0.85
0.60–0.65	31/82.5	73/82.9	10/82.6	31/84.1	26/85.1	15/82.9	24/86.4	47/82.1	0.86
0.65–0.70	21/77.7	66/77.9	9/76.8	29/77.5	32/78.3	15/76.7	28/76.3	61/75.2	0.87
0.70–0.75	8/17.0	27/16.3	2/15.4	11/17.3	7/17.8	6/16.0	9/16.5	10/16.7	0.87
0.75–0.80	5/14.3	20/13.5	2/11.6	11/12.3	10/14.7	3/14.9	5/13.2	20/12.6	0.88
0.80–0.85	38/53.5	103/52.5	19/55.8	41/53.2	27/49.7	20/47.1	40/52.1	61/50.4	0.89
0.85–0.90	78/79.8	223/80.7	26/73.6	92/74.9	74/74.3	33/74.9	72/76.3	137/76.7	0.91
0.90–0.95	73/66.8	258/66.6	45/65.6	114/66.0	83/66.0	36/67.4	83/63.9	154/63.7	0.95
0.95–0.96	35/69.1	78/67.2	16/67.4	33/66.7	28/66.3	11/66.1	24/63.7	61/62.9	1.00

GLOBAL FIT III

Including this information it is possible to perform the global fit $\chi^2 - TEST = f(1/\Lambda^4)$

$$\chi^2 = \sum_{i,j} \left\{ \frac{\frac{d\sigma^{meas}}{d\Omega}(|\cos\theta|_i, E_j) - \frac{d\sigma^{QED+new}}{d\Omega}(|\cos\theta|_i, E_j, \Lambda)}{\Delta\left[\frac{d\sigma^{meas}}{d\Omega}(|\cos\theta|_i, E_i)\right]} \right\}^2$$



The error for ± Λ is calculated in the common way for ONE σ

$$\chi^2 = \chi^2_{\min} + \sigma^2$$

Results of the GLOBAL FIT

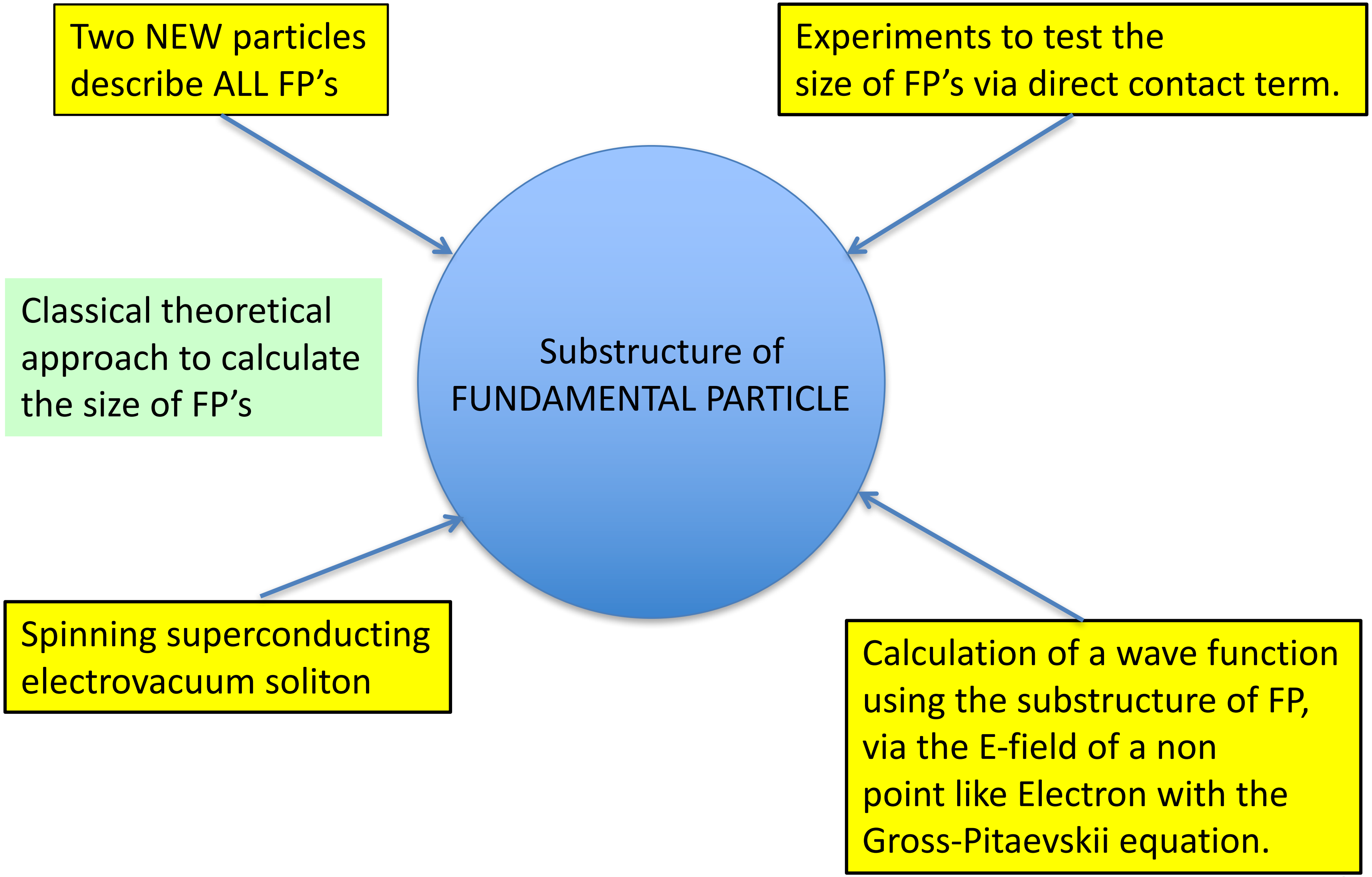
The table shows differential cross sections are used to perform a fit for the hypothesis of a heavy electron e* and the assumption of a possible finite size of interaction area.

The use of an overall data set results in a significance of 5.5 x σ.

The smaller data set of D. Bourilkov, Phys.Rev. D64 (2001) R071701 results in 2.6 x σ.

Heavy electron e*	$(1/\Lambda^4) = -(1.11 \pm 0.20) \times 10^{-10} GeV^{-4}$ $\chi^2 / dof = 351/287$	$\Lambda = \Lambda_+ = m(\lambda = 1) = 308 \pm 56 GeV$	
Finite size of e	$(1/\Lambda^4) = -(4.05 \pm 0.73) \times 10^{-13} GeV^{-4}$	$\Lambda = \Lambda_6 = 1253.2 \pm 226.1 GeV$	$r = 15.7 \times 10^{-18} cm$

CONCLUSION


Two NEW particles describe ALL FP’s
Experiments to test the size of FP’s via direct contact term.
Classical theoretical approach to calculate the size of FP’s
Substructure of FUNDAMENTAL PARTICLE
Spinning superconducting electrovacuum soliton
Calculation of a wave function using the substructure of FP, via the E-field of a non point like Electron with the Gross-Pitaevskii equation.

CONCLUSION

Theory chain:

NEW Scheme of FB

General Relativity

SOLITON

Superconductivity

Gross-Pitaevskii equation

Wave function

Lorenz contraction

RADIUS ANNIHILATION starts

Experiment chain:

e+ e- Experiment at CERN

Direct contact TERM

5 – σ EFFECT

ANNIHILATION RADIUS

R = 1.59*10^-19 [m]