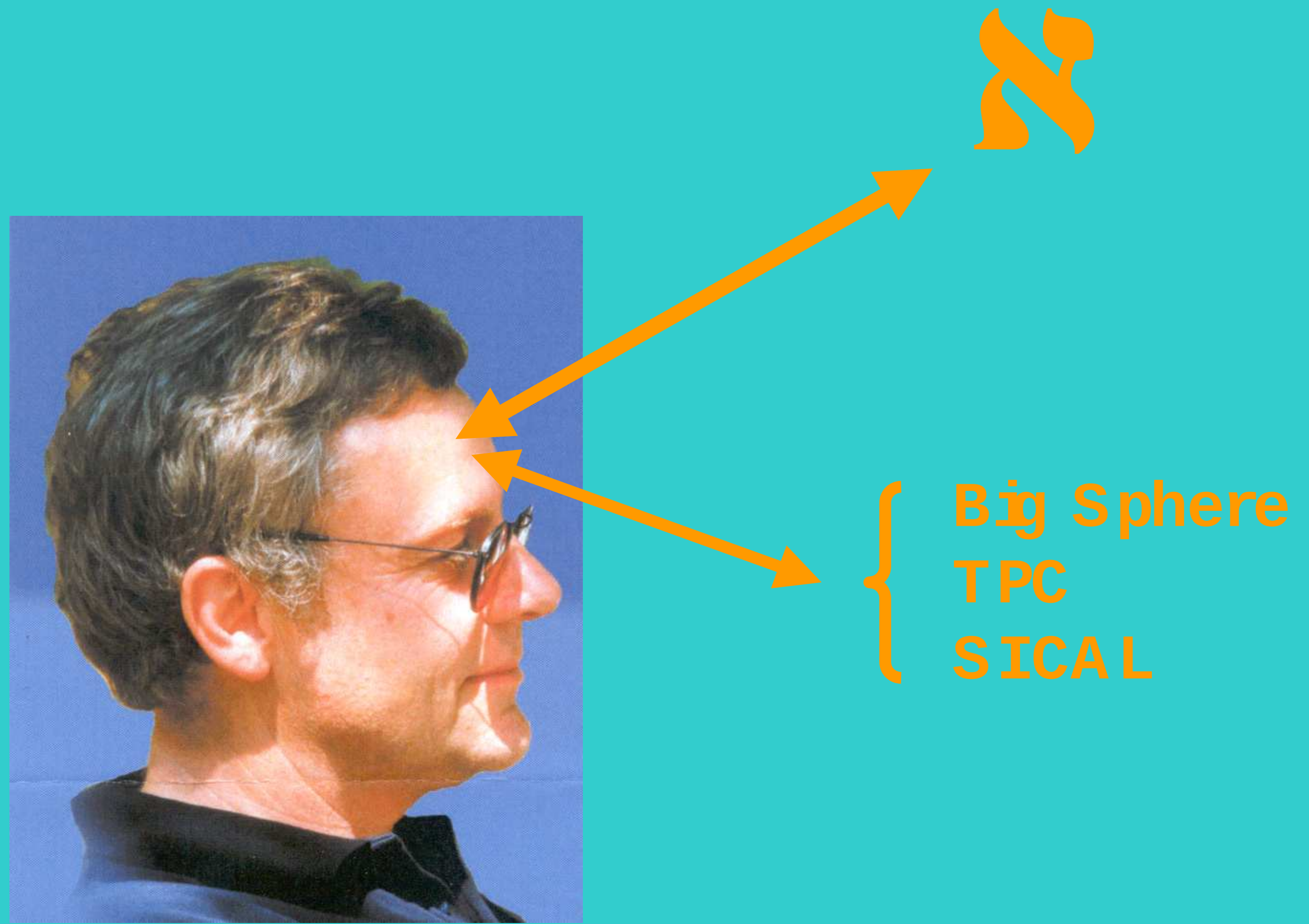
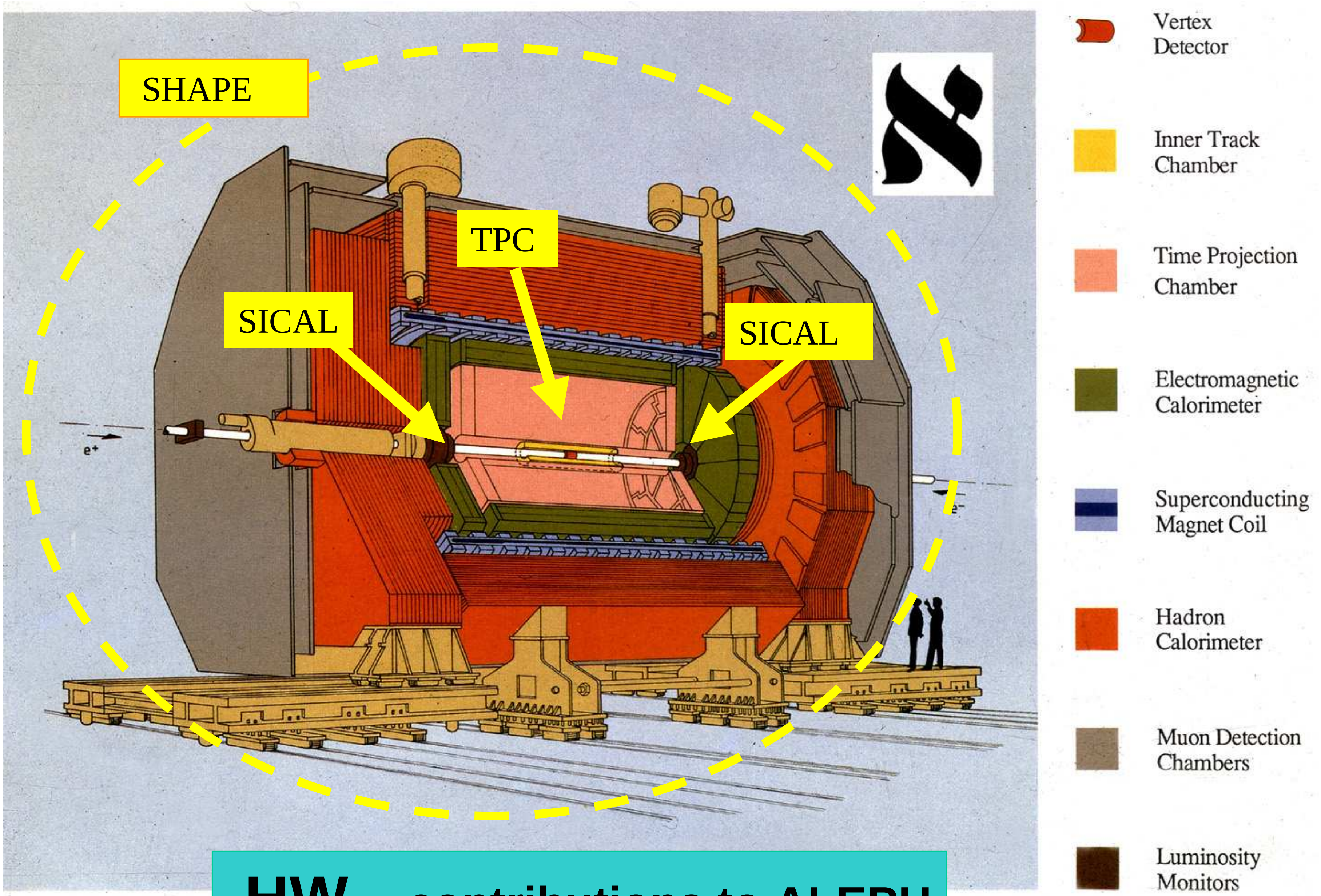
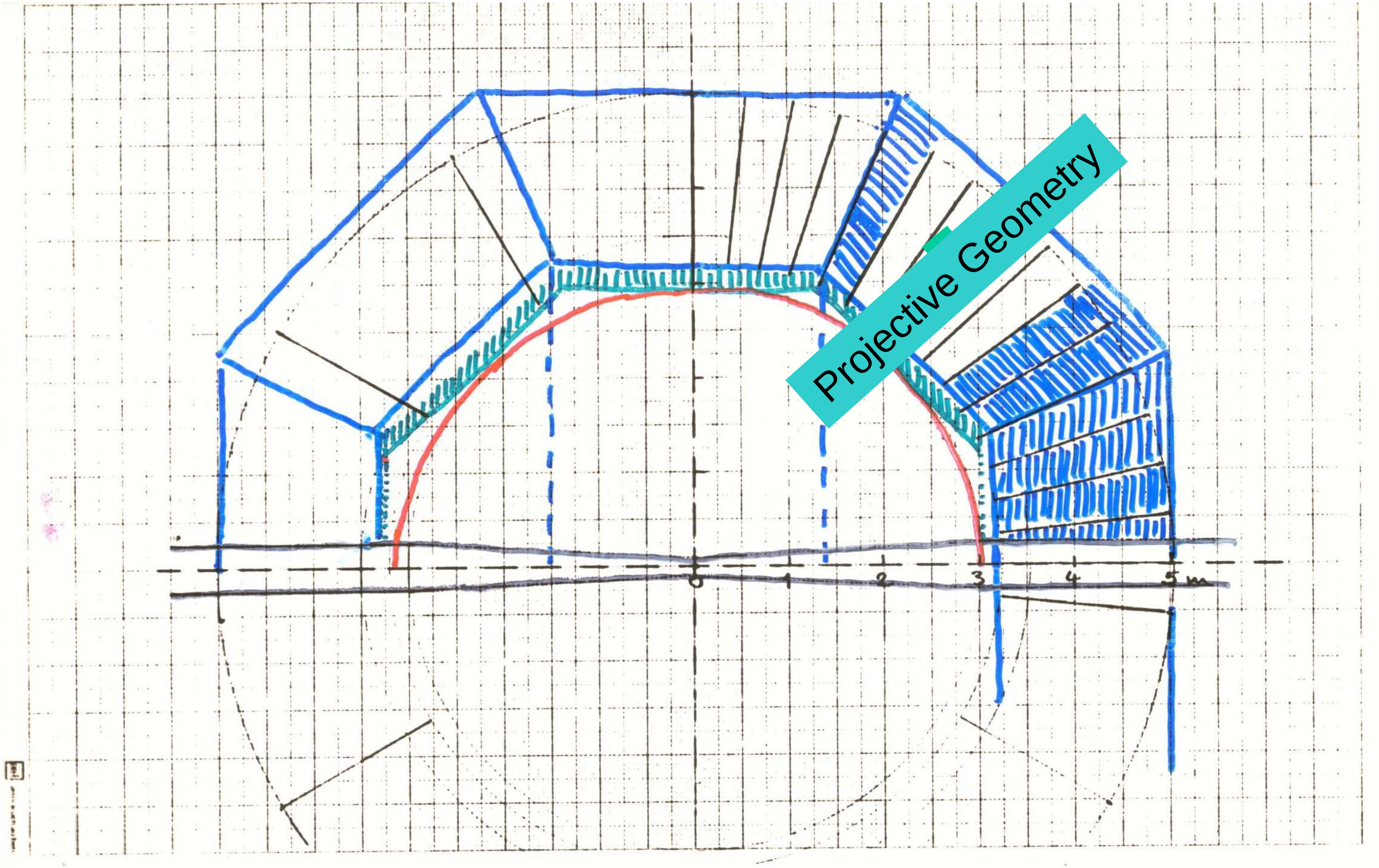
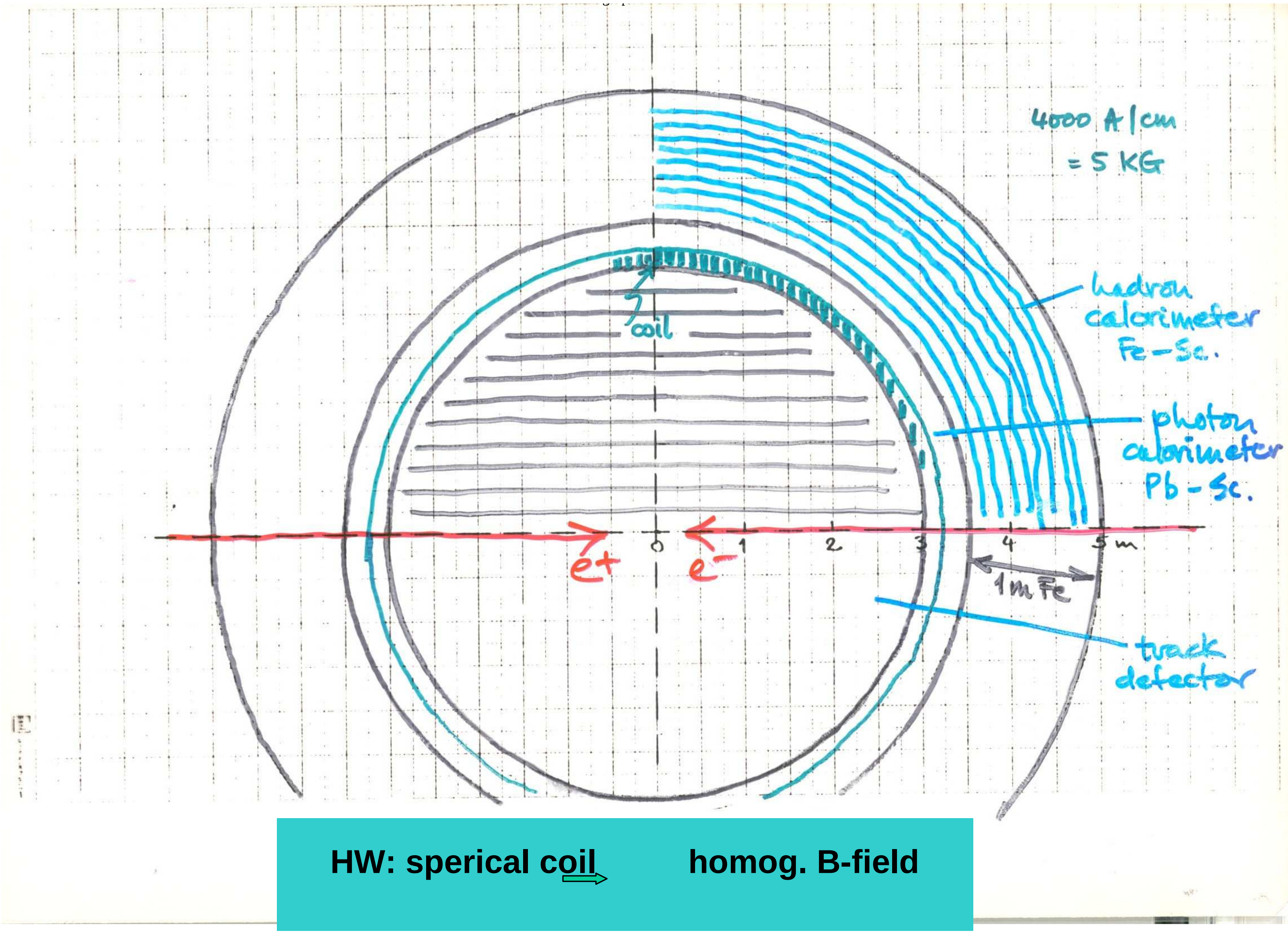

א
Big Sphere
TPC
SICAL



HW: contributions to ALEPH



Physics: Spherical Symmetry



HW: sperical coil ⇒ homog. B-field

comparison of sphere and cylinder

10 MW power available

	sphere	cylinder	
magnetic radius	3.0	2.8	m
length		±3	m
field	0.57T	0.54	T
$\Delta p/p^2$ at 60°	2.1×10^{-3}	1.9×10^{-3}	
coil weight	20t	23	t
plastic surface (soft)	4240	5790	m^2
(hard)	8740	11850	m^2
weight lead	300	410	t
iron	1730	2330	t
scintillator	50	70	t
cost iron (5/kg)	8.7	11.2	MSF
scintillator (500/m²)	5.2	7.1	MSF
coil	0.4	0.5	MSF
fixed cost	15.0	15.0	MSF
total cost	~30	~33	MSF

fixed cost assumed for
- wire construction & readout
- pulse-height work: tubes, bases, cables, light-guides
- drift-chambers for μ detection
- on-line computer, power installation
- assembly of calorimeter etc.

Heroes of the Hot Sphere

12 June, 1981

PRELIMINARY DESIGN FOR A BIG SPHERE FOR LEP

The Big Sphere Study Group

F. Dydak, L. Foà, M. Ferro-Luzzi, P. Heusse,
G. Petrucci, J. Steinberger and H. Wahl

INTRODUCTION

The symmetry of the one photon process is spherical, on the other hand the magnetic field for measuring the particle momenta has a well defined direction. These two contradictory properties must be resolved somehow in a general purpose detector design. The linear solenoid perhaps emphasizes the field, the spherical solenoid emphasizes the symmetry of the physics.

Another basic element entering into the design is that of the magnetic material: conventional or superconducting. So we might consider four basic structures: hot or cold, cylindrical or spherical. Here we present the elements of a hot sphere design.

This sphere is mainly composed of an approximately cylindrical central part and by two lateral parts shaped as truncated cones. The winding to produce the magnetic field is made of many copper conductor

Disadvantages

1. Complex construction of calorimeters and coil, in part due to projective geometry, in part due to conical ends.
2. Power cost $[3\ \text{M.W.} \times 5\ \text{yrs} \times 2000\ \text{hrs/yr} - 0.5\ \text{M.W.} \times 5\ \text{yrs} \times 4000\ \text{hrs/yr}] \times 0.07\ \text{F/KWH} = 1.4\ \text{MSF}$. This is perhaps not a lot.
3. Power psychosis
4. Central chamber construction More difficult because of size.
5. Central chamber accuracy Will it be possible to achieve the same systematics as in a smaller chamber?
6. The shower calorimeter has some ugly features, linked to edge effects where the BBQ and mountings are located, and to the non-rectangular shape. Both can be largely overcome, but only with many calibration constants.
7. It is not yet known if the double light conversion will work (is the light output sufficient?)
8. The project uses no novel techniques.
9. No possibility to use TPC.

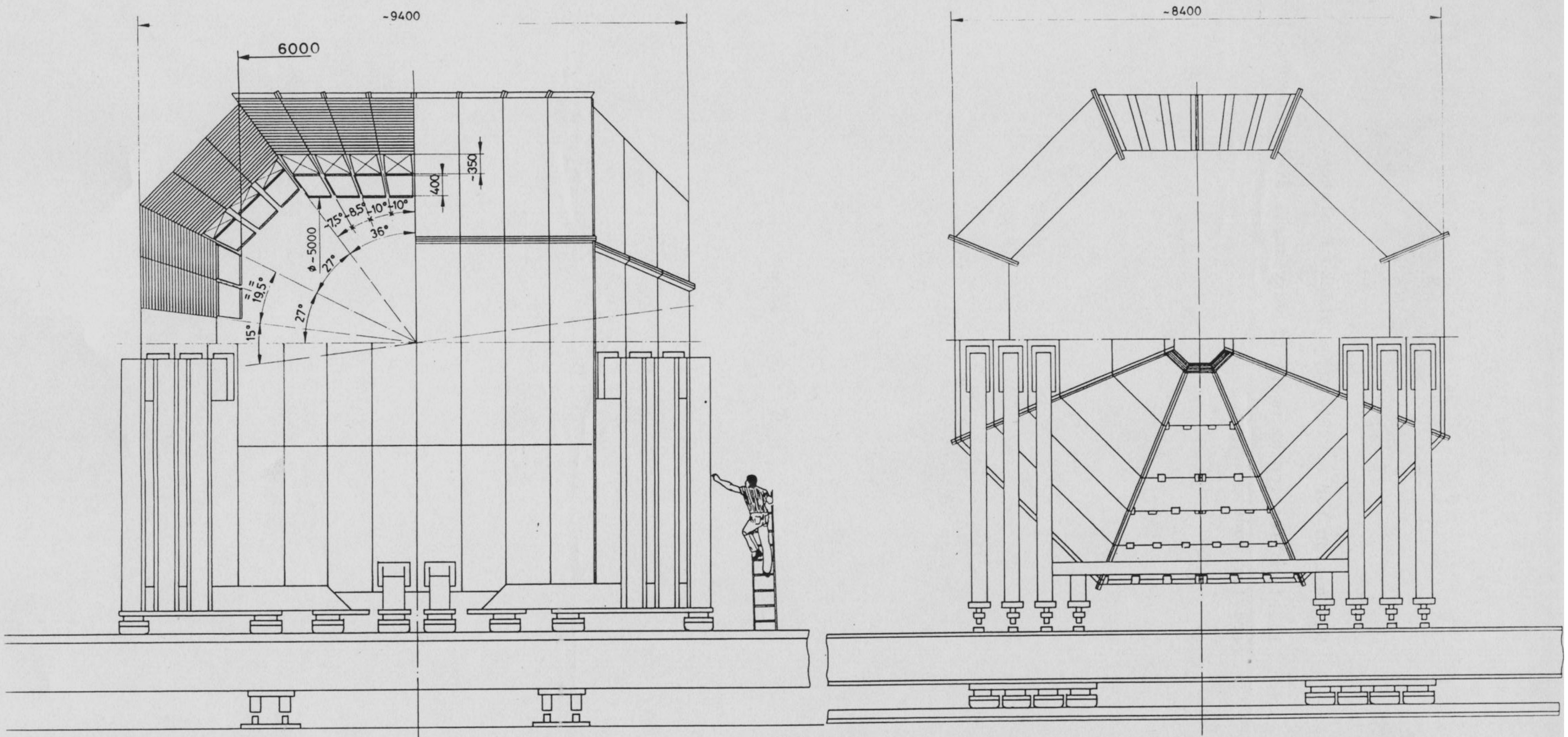


Fig 1a

Big Sphere Magnet

Solution:

SACLAY's superconducting coil 1.5 T

TPC is possible !

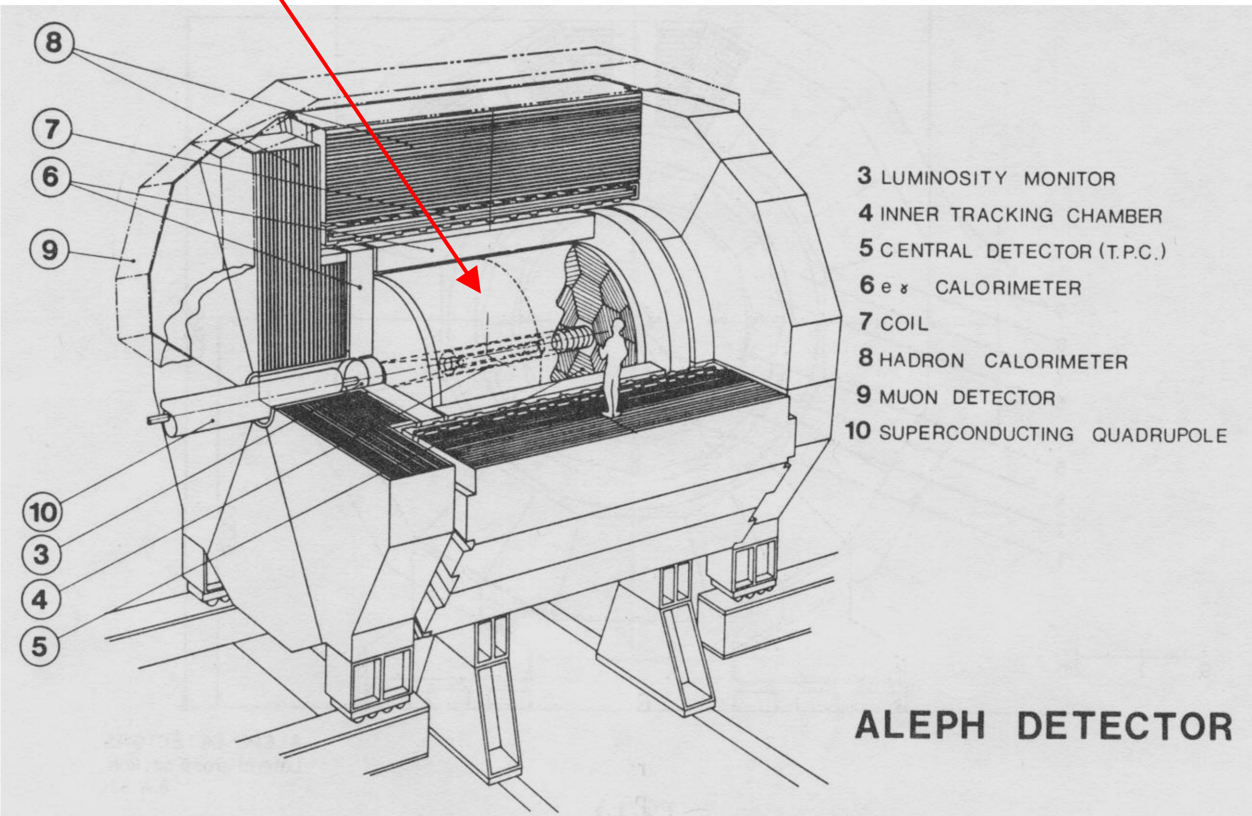


Fig. 1.1

TPC proposed by late Ulrich **Stierlin**
based on pioneering work of D.Nygren

9 July, 1981

REPORT OF THE TPC WORKING GROUP

W. Blum, J. May, R. Richter, R. Settles, U. Stierlin, H. Videau, H. Wahl

1. INTRODUCTION

We have looked into a solution for the central detector consisting of a time projection chamber (TPC) situated in a solenoidal magnetic field. We start by describing briefly the operation of the TPC.

The TPC is a large volume drift chamber which records many space points and ionization samples for each track. The electric and magnetic fields are parallel to each other and to the direction of the e^+e^- beams; see Fig. 1. The electric field is generated between the negatively-charged central plane and the two end planes at ground potential. Charged particles emanating from an e^+e^- annihilation move along helical paths, ionizing the chamber gas by producing knock-on electrons. These electrons drift along the field lines to the end planes where they are detected by a system of proportional wires with cathode read-out "pads". The sense wires are arranged in several hundred concentric rows about the beam axis and measure the pulse height and drift time of the arriving electron cloud.

6. CONCLUSIONS

We have identified the following problems of a TPC

- Homogeneity of the magnetic field

  If the inhomogeneities are larger than $\sim 10^{-3}$, corrections have to be applied to the measured points. We think that the effort of such corrections is comparable to the geometrical corrections necessary to obtain the wire positions in a chamber with long axial wires.

- Distortions due to the space charge of the positive ions drifting backwards. Using a gated grid,this effect can be sufficiently reduced. However, more tests with gating have to be done. To apply it in a detector a trigger (< 300 Hz) will be needed.

- The number of pad rows defines the number of space points. It is limited by the price of the associated electronics. We think that 16 pad rows is about the minimum needed.

- The necessary high voltage of ∿25 kV should not give any problem.

Advantages of the TPC compared to a chamber with long axial wires

- The simplicity of the construction is striking,
  the volume is free of wires,
  the detection system is on the planar end-planes,
  the wires are short and therefore the gain uniform even with small wire spacing.

- The performance of the TPC is not limited by the strength of the magnetic field; large fields are even preferable.

- The TPC is the only way to reach good particle identification by dE/dx measurement due to the large number of wires and to better gain control.

- The z-resolution is much better, which simplifies pattern recognition.

- The two track separation is good in z and rϕ.

50 000 channels
Complicated electronics

Amount of data

Space charge

Distortions

Angular effects
E x B

LEPC worried !

HW : electronics coordinator for TPC

dyn. range and resolution

H. Wahl Dez 83

reserve dynamic range = 1.25^2 → [illegible]

assume noise = 0.5% of mpv ± 0.5 ch.

dig. err. = 0.5% of mpv ± 0.4 ch

min. tot. error = 0.7% of mpv (most probable energy loss of min. ionizing particle)

2 pad response: signal = 0.5 mpv

try syst error ±2% ⇒ $(0.7\times10^{-2} \oplus 0.02\times0.5)/0.5 = 0.0244$ (add in quadrature) 57 μ

3 pads : $0.7\times10^{-2}/0.74 \oplus 0.02 = 0.022$

$0.7\times10^{-2}/0.13 \oplus 0.02 = 0.057$

$1.7\text{ mm} \times 1/\sqrt{12} \times 0.061 = 73\ \mu$

dig 0.5% of mpv / 0.4 ⇒ mpv is ch. 80 100

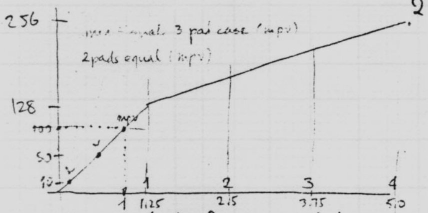
2 pad signal ch 40 each 49

min signal ch 10, max ch 59 (= 0.74 mpv) (min 11, max 74)

noise ± 0.4 ch ± 0.5 ch

dig. error ± 0.4 ch

max signal 500



above/at breakpoint : dig error ± ~~1.6~~ ch / 128 = 1.25% (order ±1.2 ch?)

noise ± 0.4 ch

syst ± 2% } 0.024

dyn range is then $\overset{12}{\cancel{500}}/80/0.74$ = 8.65 above max mpv

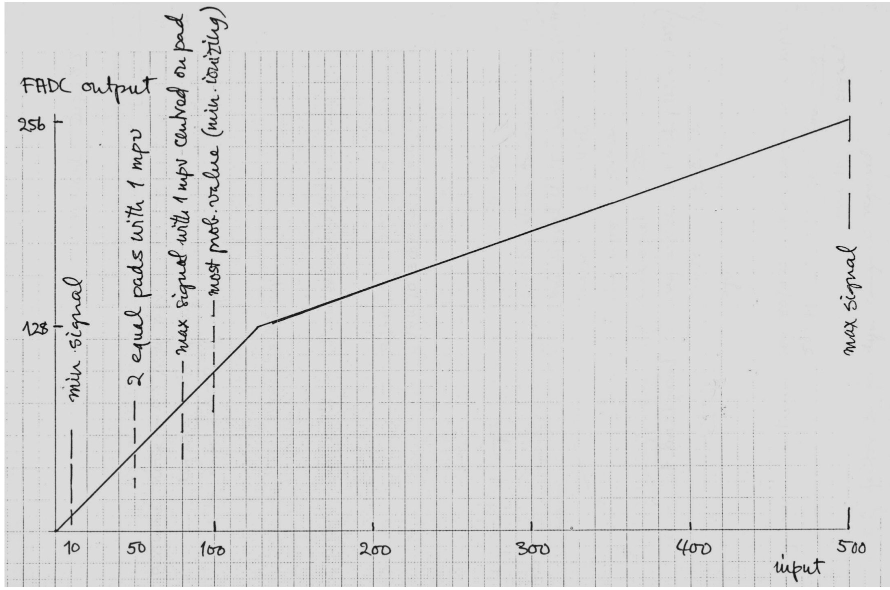
500/10 = 50 total dyn range (min to max signal)

if "only" factor 30 for dyn. range is required

⇒ factor 1.7 reserve for gain adjustment etc

⇒ all signals up by factor $\sqrt{1.7} \simeq 1.3$

take these values!



500 time samples
calibrated data (4 DCs)/ch
zero suppression

System:
120 FastBus crates

8 bits

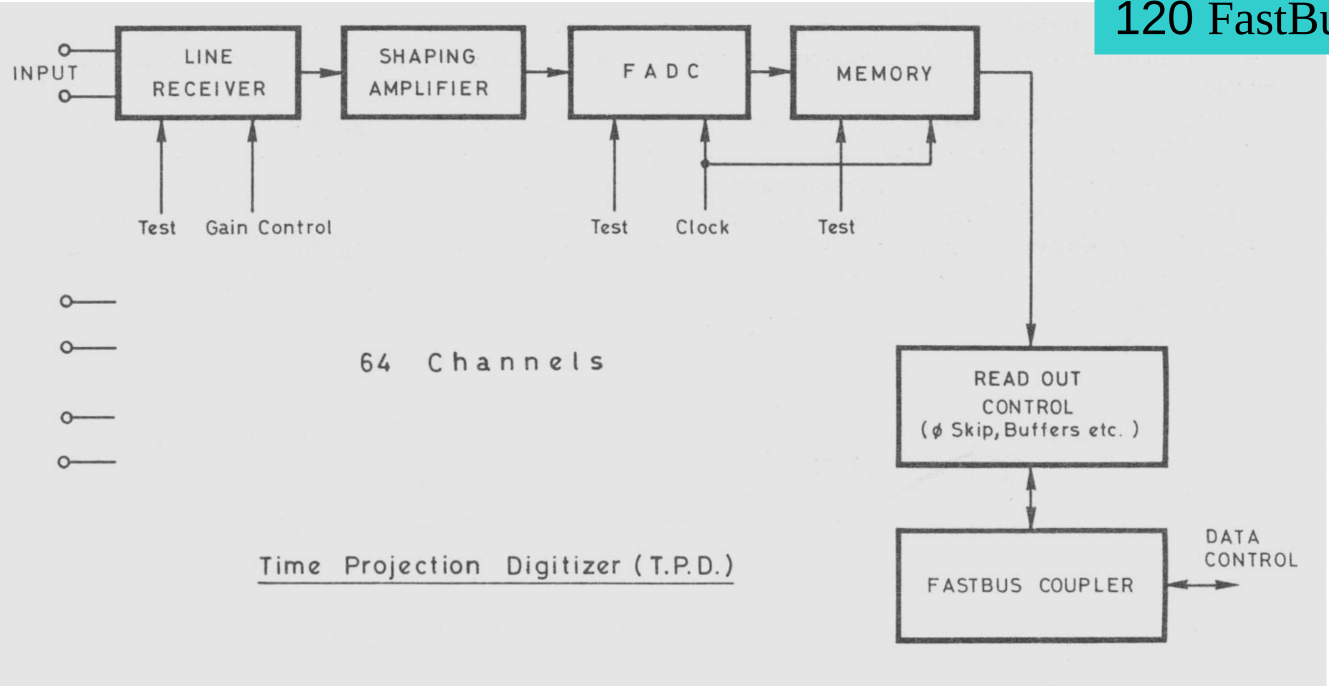
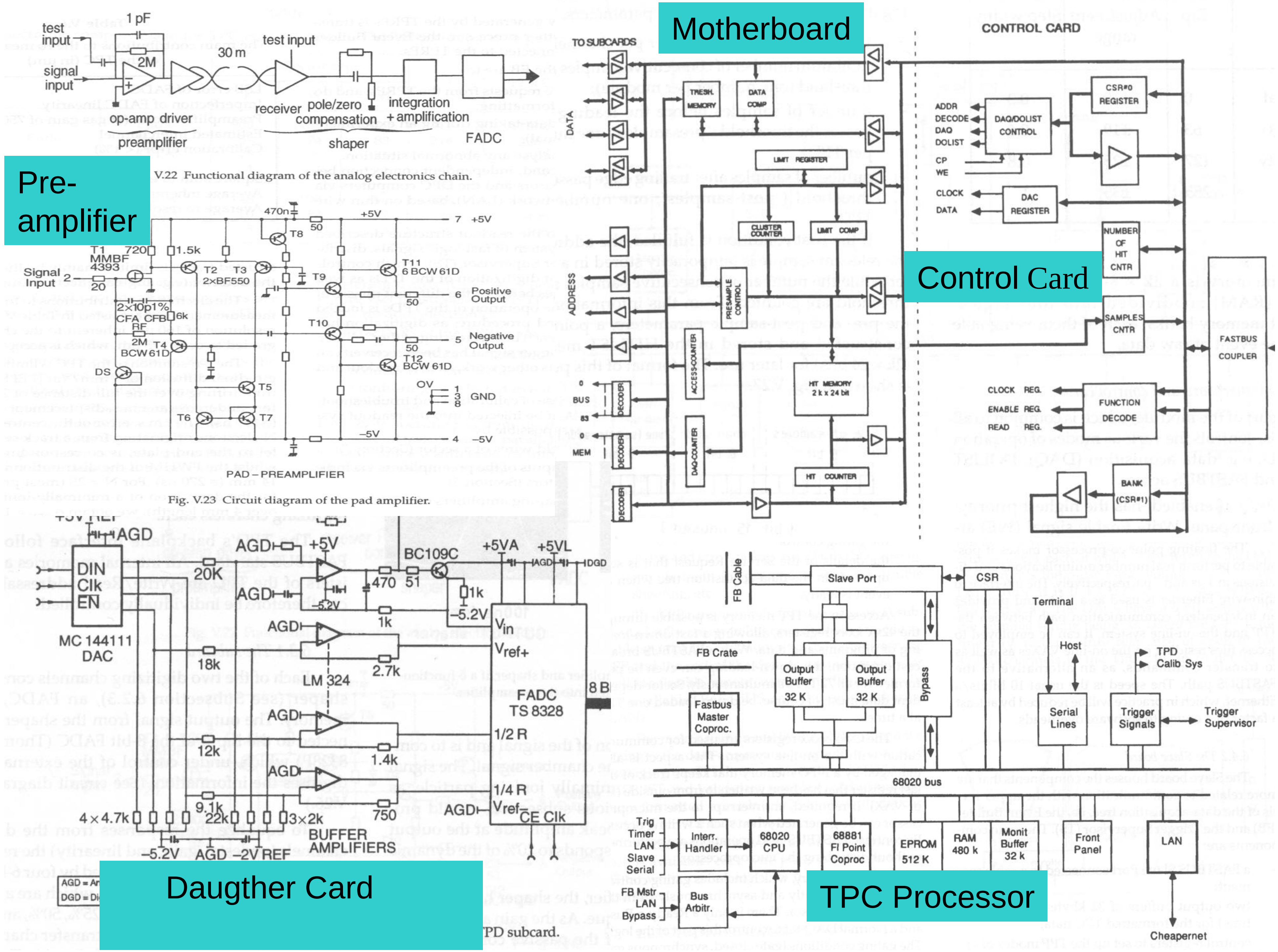
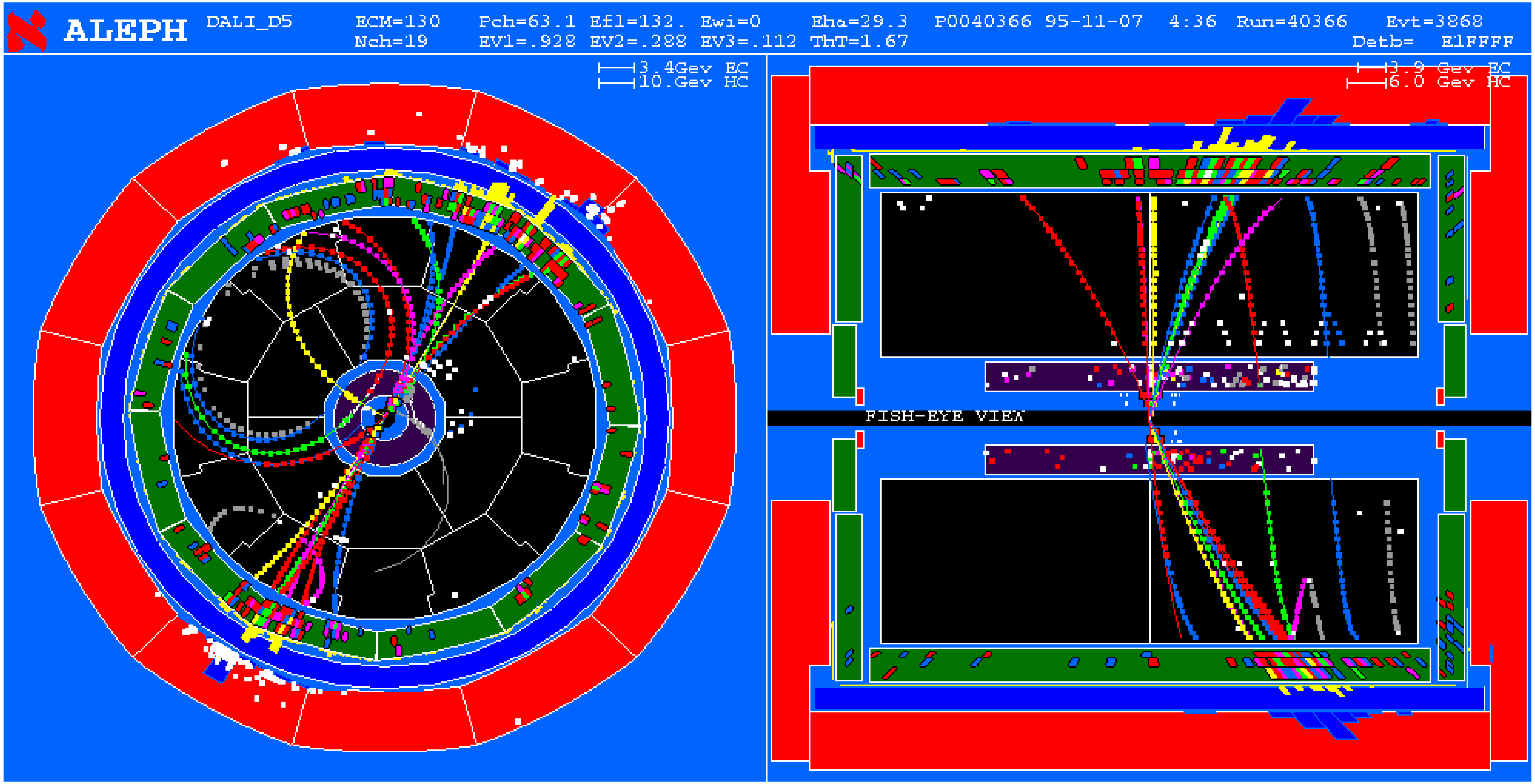


Fig. 4.3.5

Analog chain: MPI Munich
TPD: Bo Lofstedt – H.Verweij
TPP: Pisa – Amendolia et al.


Pre-amplifier
Motherboard
Control Card
Daugther Card
TPC Processor
V.22 Functional diagram of the analog electronics chain.
Fig. V.23 Circuit diagram of the pad amplifier.
PAD – PREAMPLIFIER
CONTROL CARD
BUFFER AMPLIFIERS
FADC TS 8328
68020 bus
TPD subcard.



3-D track points

HW: SICAL electronics

M E M O R A N D U M

To: H. Burkhardt,
P. Dornan/D. Websdale,
C. Cerri/G. Pierazzini,
J. Rander/J.-P. Schuller,
D. Schlatter/F. Piuz,
J. Steinberger

From: H. Wahl

Subject: Draft specs for silicon luminosity monitor electronics

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This is my understanding of yesterday's discussion on a first draft towards a specification for the read-out electronics required for the solid state luminosity monitor. Comments to J. Rander within two weeks please.

As a model we consider a linear response with uniform gain on all pads. This is a convenient but not necessarily the only choice. Following H. Burkhardt we assume a maximal pulse-height of 410 minimum ionizing particles on any pad at 46 GeV, and 380 minimum ionizing particles on average in gap 4. An eight bit ADC was suggested. If 400 particles are set to correspond to 100 ADC counts, the read-out would work up to 100 GeV without gain adjustment.

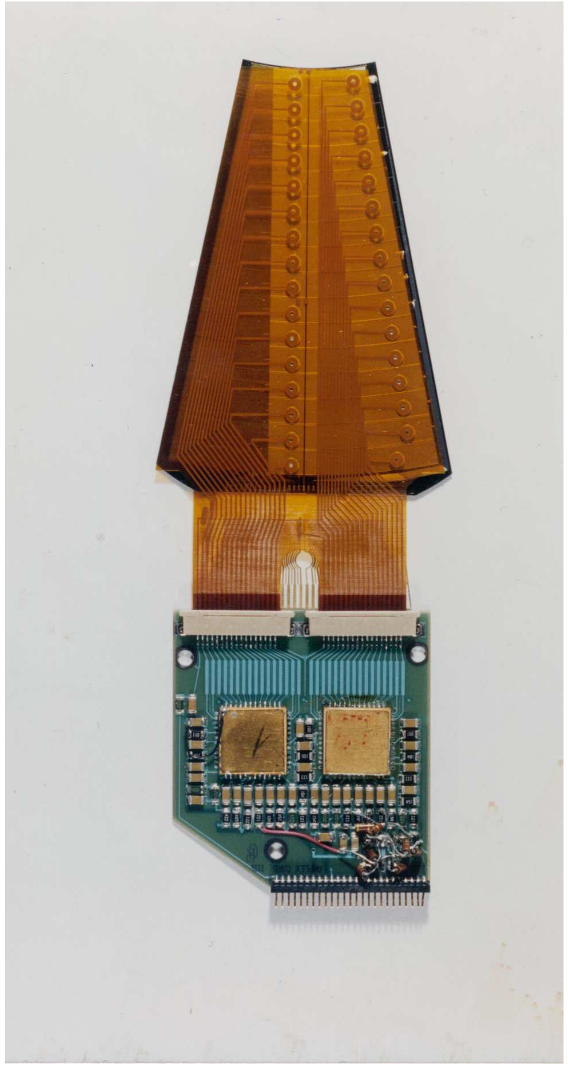
The following figures give each a ~1% contribution to the resolution at 50 GeV, if we also assume that ~100 channels contribute to each event (HB calculates 63 valid pads for a dynamic range of 1:100)*. One mip here is the one particle pulse-height in 0.3 mm silicon. Pad areas are in the range 1.4 to 3 cm^2 (capacitance 50–110 pF excluding wiring). x 0,5 cm 25-55

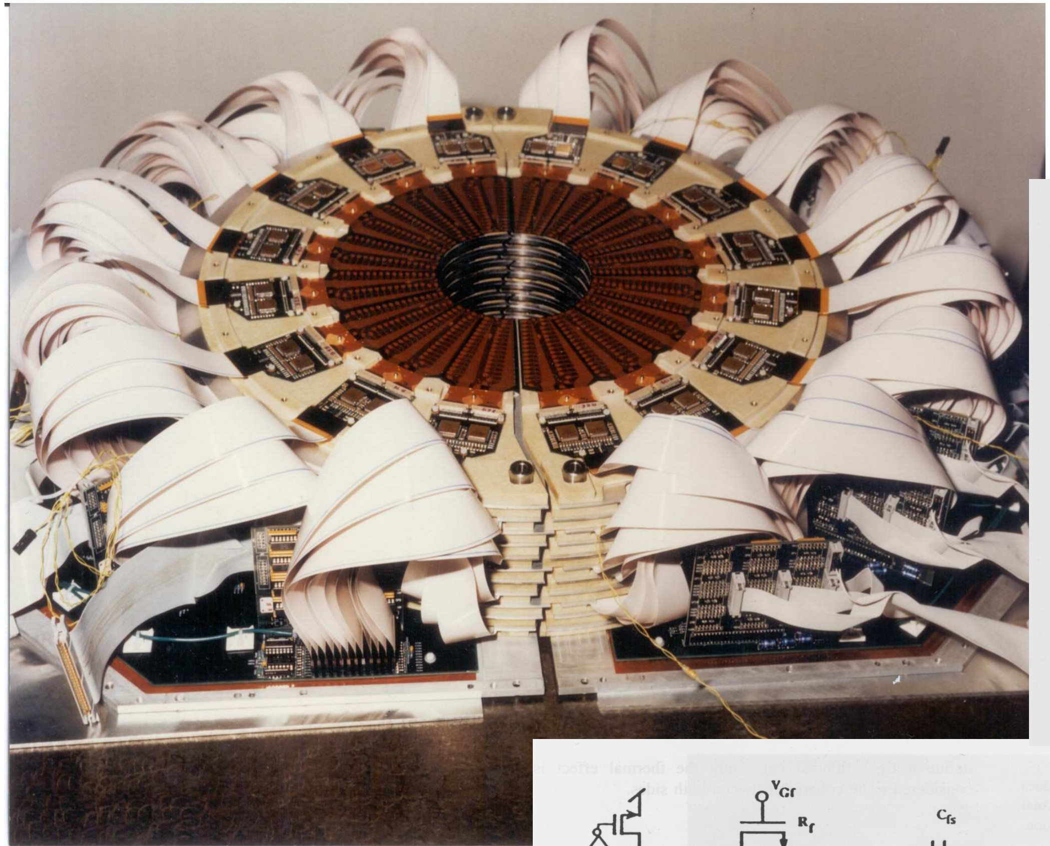
1. Resolution (digitization error + pedestal instabilities) ±0.3 counts.
2. Random noise ±1 mip per channel.
3. Coherent noise ±10 mips on the sum of 100 channels.
4. Rms non-linearity ±0.3 counts.
5. Channel to channel calibration to ±3%.

Further specs:

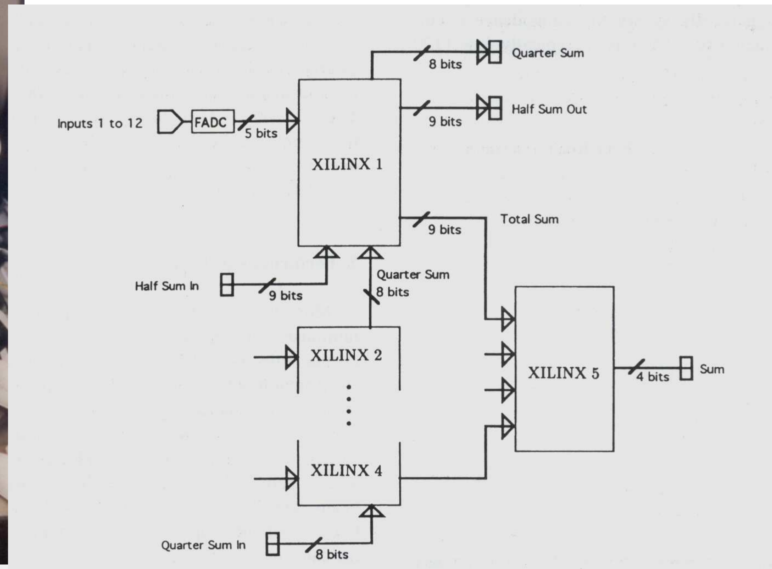
6. Gain tolerance ±25% (including mip to pF conversion uncertainty).
7. Trigger output (analog sum?).
8. Trigger delay <2.5 μsec. 1
9. Dead-time for read-out < few msec.

*) The normalization corresponds to 3% resolution equivalent to a total of 1100 particles at 46 GeV. This number should be checked. It may well be too pessimistic.





Trigger Mixer



AMPLEX- SICAL

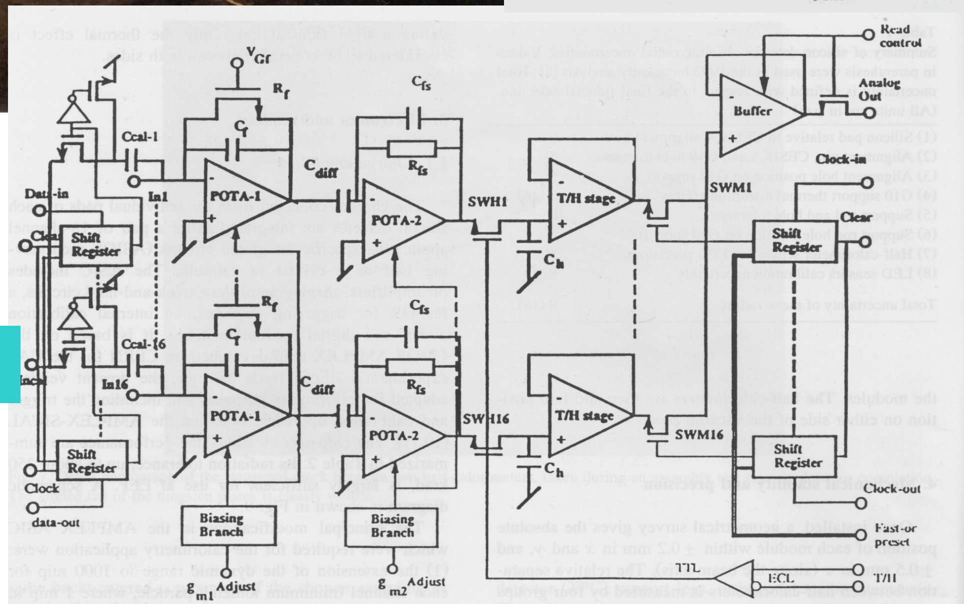
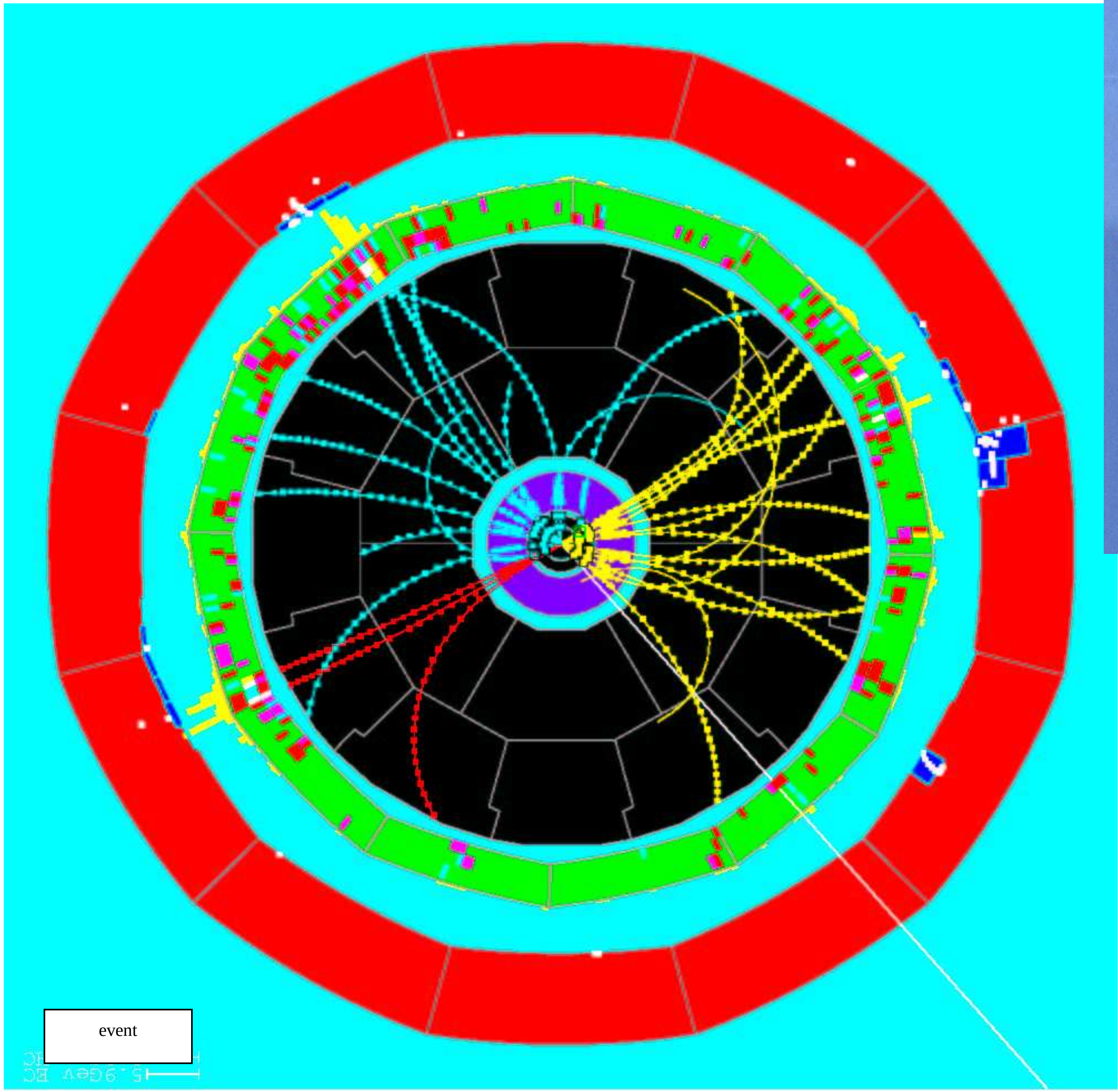


Fig. 9. AMPLEX-SICAL schematic diagram.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