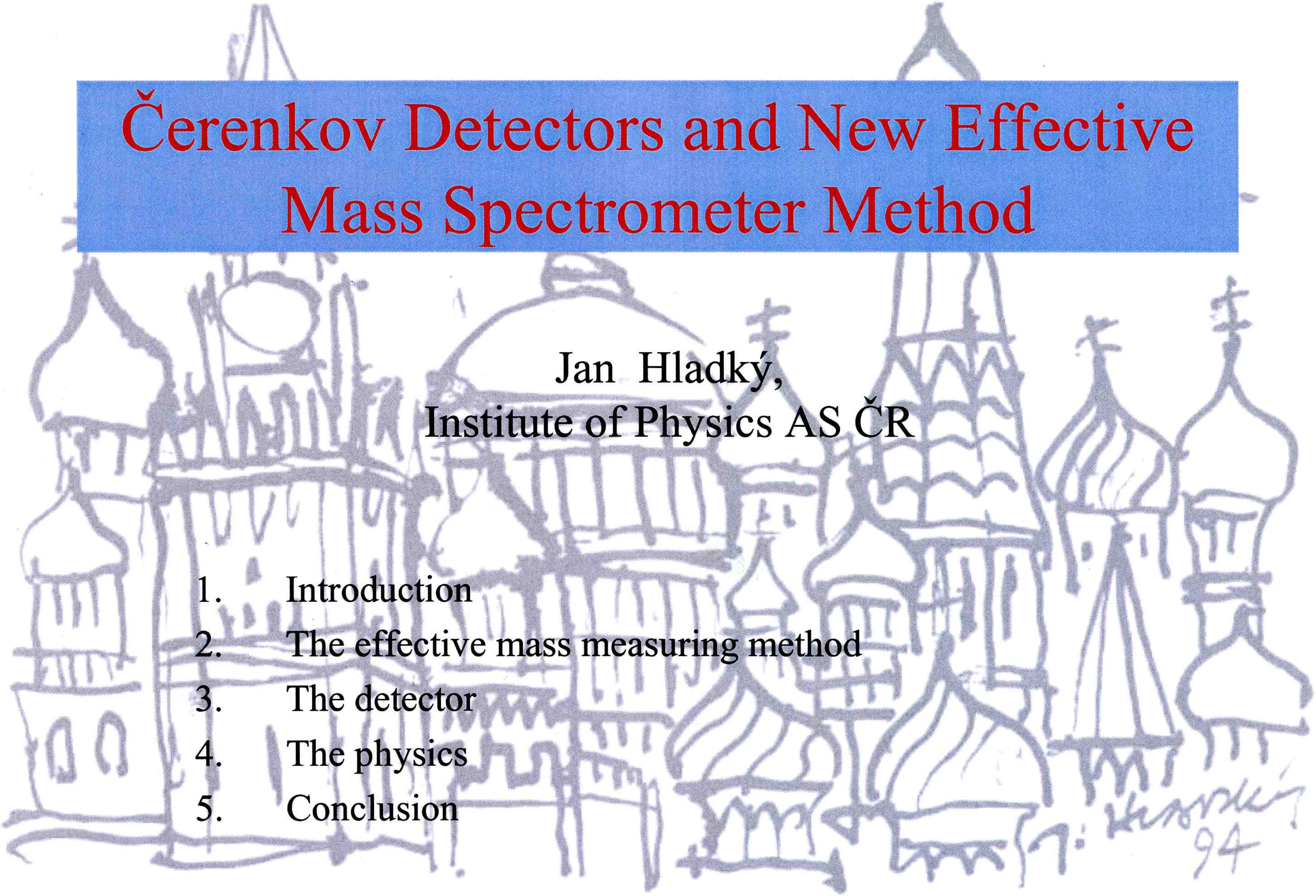

Čerenkov Detectors and New Effective Mass Spectrometer Method

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1. Introduction
2. The effective mass measuring method
3. The detector
4. The physics
5. Conclusion

1. Introduction.

My talk, which is perhaps opposite to other talks presented in the conference, is meant mostly as a historical touch.

I want to remained here two personalities, first of all

P.A. Čerenkov, borned 100 years ago and secondly

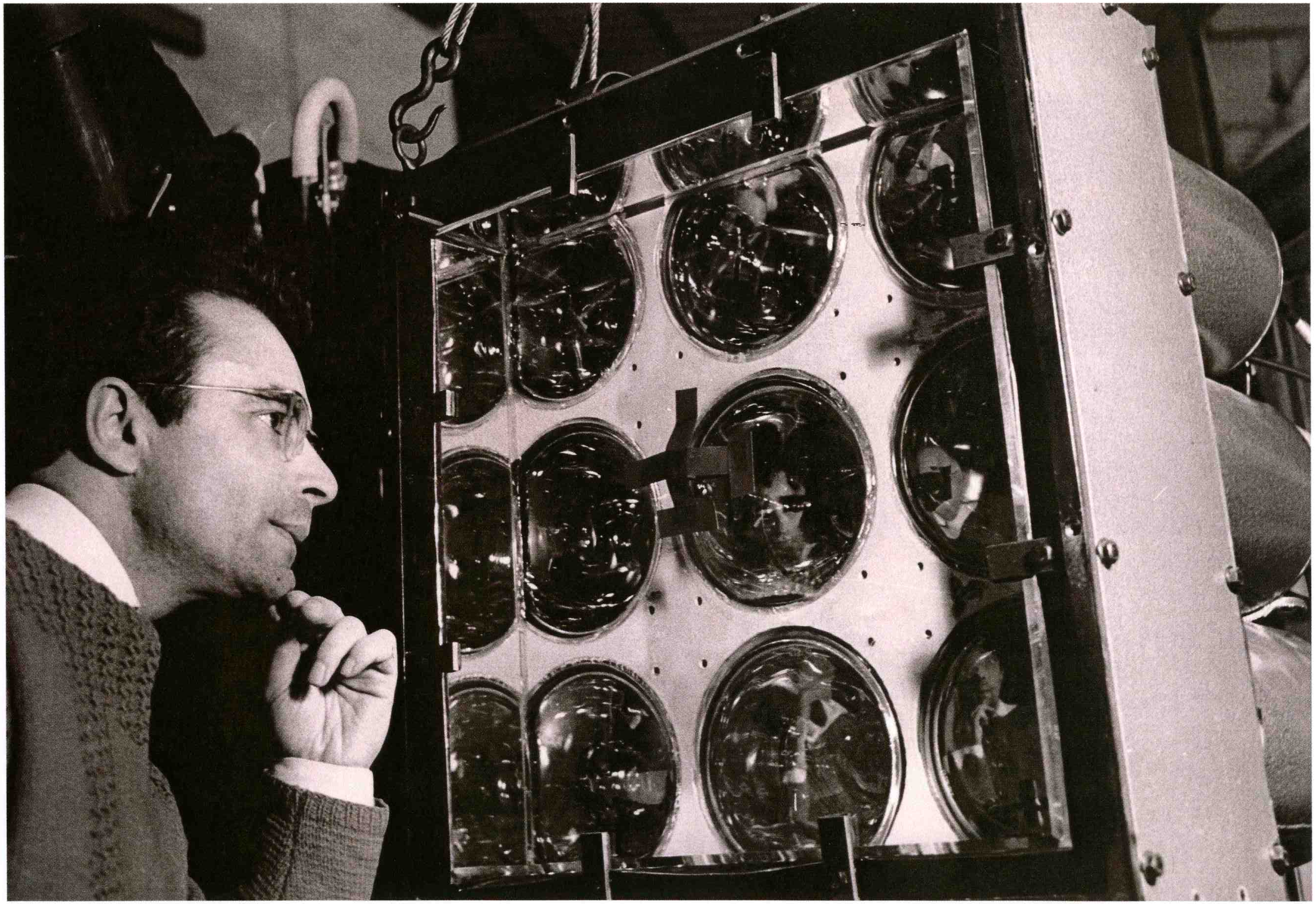
M.N. Khachaturyan, who died at the end of last December.

The first one was for a long time the director of the laboratory participated directly in our experiment in JINR Dubna.

Its members are my closest collaborators since 1966 up to now either in Dubna or in DESY Hamburg.

The second one, M.N. Khachaturyan, was my boss during my long term stay in the Laboratory of High Energy Physics in Dubna. He was in charge of the group of three pioneers (the engineer V.S. Pantuev and Ph.student M.A. Azimov) using firstly lead glass to detection Čerenkov radiation in the real physical experiment. (Before them, as I know, has been lead glass calorimetry used here, in Lebedev Institute by E.M. Leikin to methodical purposes). The Khachaturyan group also with the members from Lebedev Institute used firstly the lead glass calorimetry (called in russian "Čerenkov counter of totally absorption") in combination with track detectors – spark chambers and by such a way "New method for measurement of effective mass of resonances" has been in JINR Dubna developed.

Let me briefly describe the method and its use firstly in High Energy Laboratory in Dubna and then in other laboratories abroad.



2. The effective mass measuring method.

The idea to measure effective mass in counter experiment has been originated in the study of decay products of the resonance as precise as possible using rather low statistics of the events.

The most experiments in that time used usually missing mass method, i.e. indirect way to the reconstruction of the resonance mass peaks. This lead sometimes to the misinterpretation of results (on can remind the story of A2(1300) resonance splitting, measured in CERN in two experiments etc.)

The effective mass of the resonance is expressed in the form:

$$M^2 = \left(\sum_i E_i\right)^2 - \left(\sum_i \vec{p}_i\right)^2 \qquad (1)$$

Where *i* is the number of its decay particles.

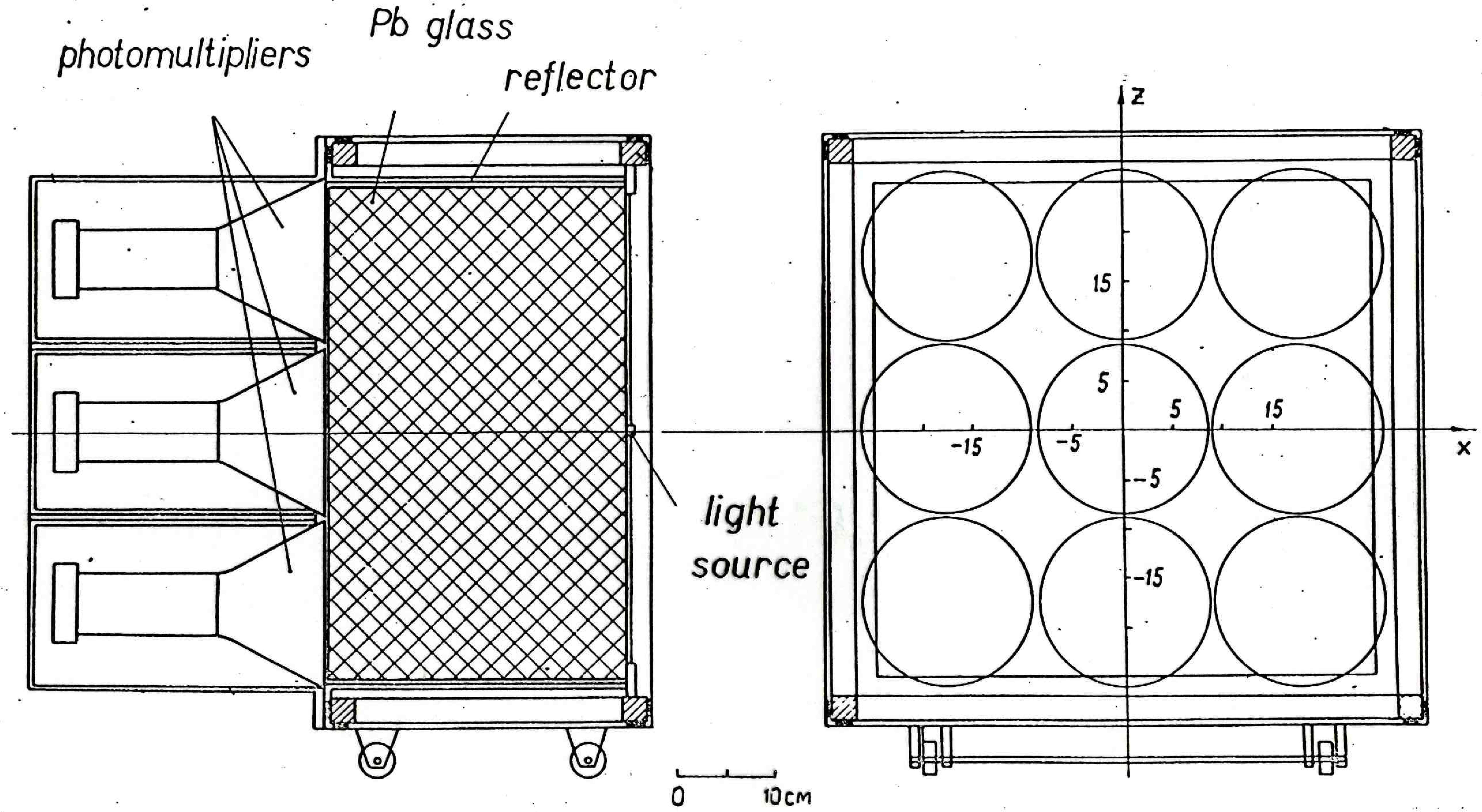
In the case when the resonance decays in two particles has the equation (1) very simple form as :

$$M^2 = 2E_1E_2(1-\cos\theta) \qquad (2)$$

where E_1 and E_2 are the energies of the decayed particles and θ is the angle between their direction. The use of the lead glass calorimetry for the measurements of the energies of the decay products was crucial to reach the best precision of the effective mass of the resonance.

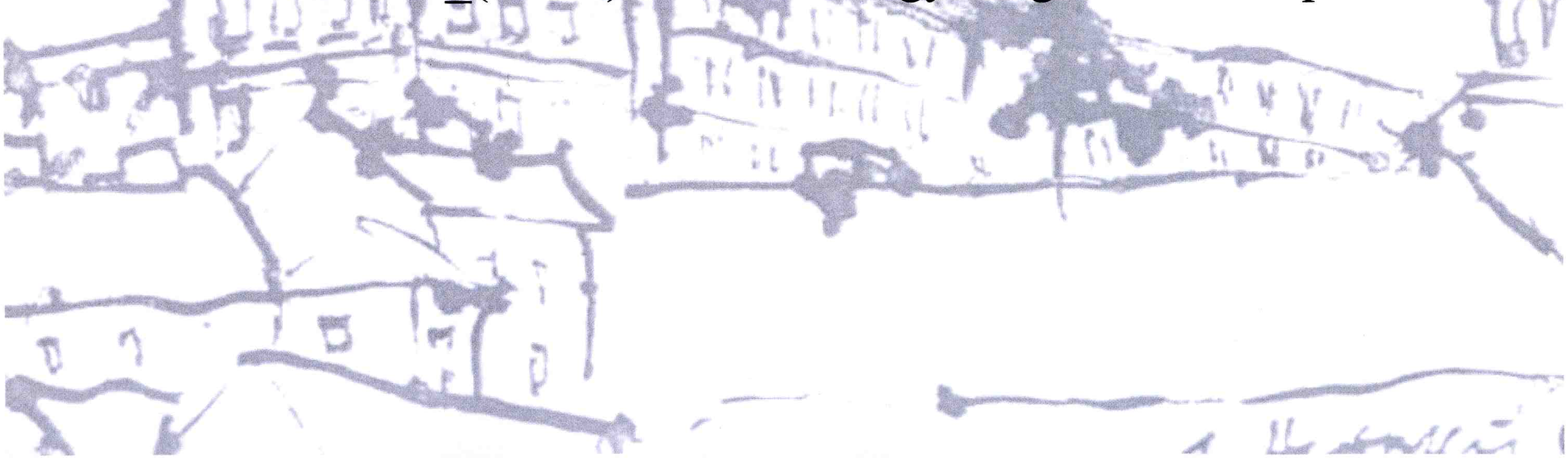
The way how to convert the idea with lead glass calorimeter to the real experiment was very difficult. Production of the lead glass blocks needed very fine and developed technology, which was not accessible for usual soviet industry. The very high requirements on homogeneity, high transparency and other optical and mechanical parameters could be fulfilled only by special high accesible producer (usually closed in yaschchik). Also handling with the glass during the experimental procedure needed a special care.The lead glass TF – 1 has been used.

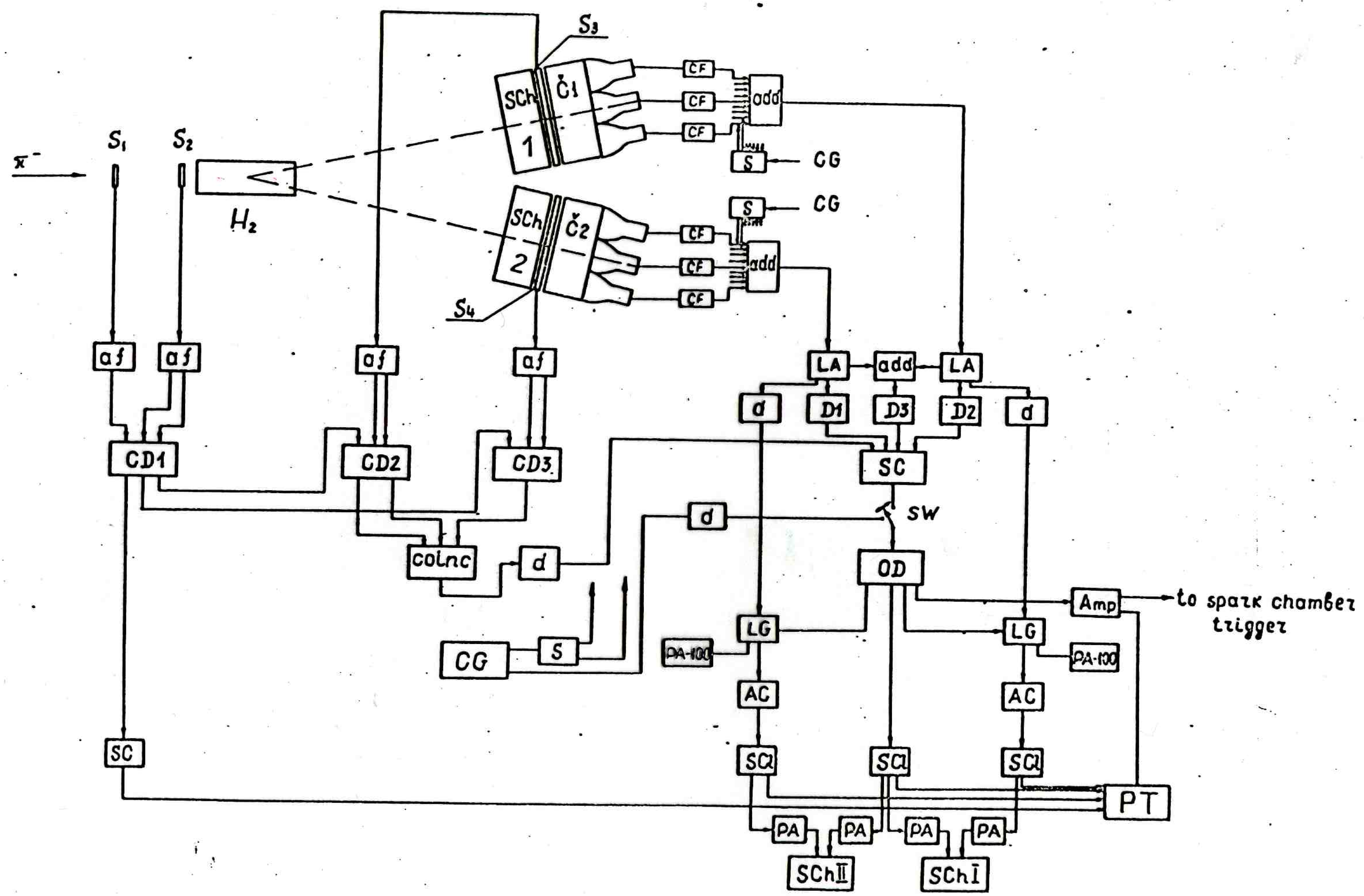
After several methodical tests and few dedicated experiments [1] with smaller lead glass blocs, the two big ones of the size 50x50x30 cm and 50x50x20 cm were used for main experiments.



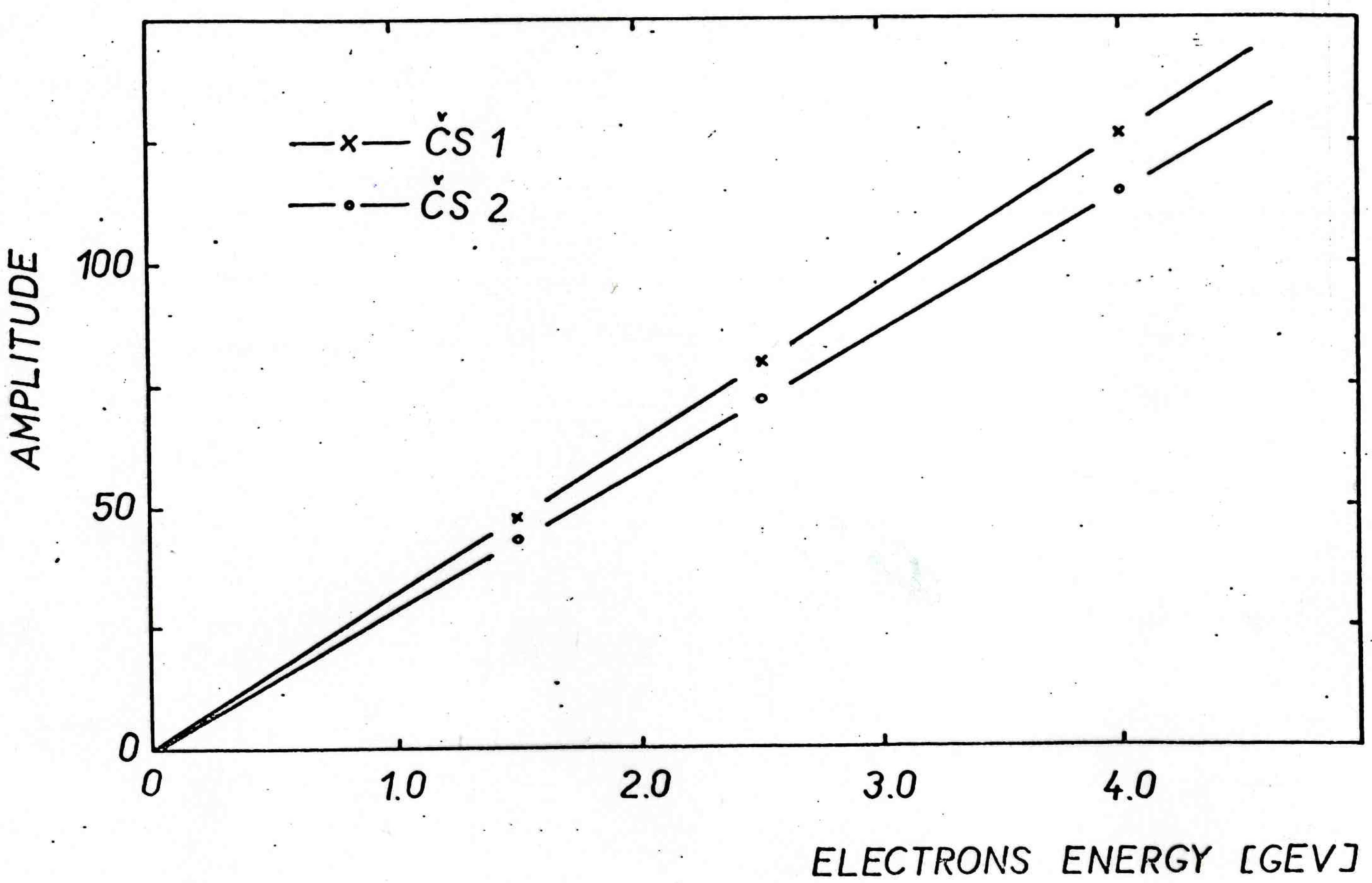
photomultipliers
Pb glass
reflector
light source
0
10cm
z
x
15
5
-5
-15

Each block was observed by nine spectrometric photomultipliers of a diameter of 17 cm of photocathode, type FEU-49. They covered about 70% of the back area of the glass block.
Very sophisticated electronic has been developed to convert Čerenkov light from the lead glass blocks into measurable signal.
It enabled to obtain the calibration curves to be linear in the energy range needed between 1 to 4 GeV. To avoid additional errors owing to possible complementary effects e.i. topography, angular dependence etc. the precise calibrations have been often made.
Finally, the energy resolution of both calorimeters has been found in the interval of +_(5 to 7)% in the energy range used in experiment.

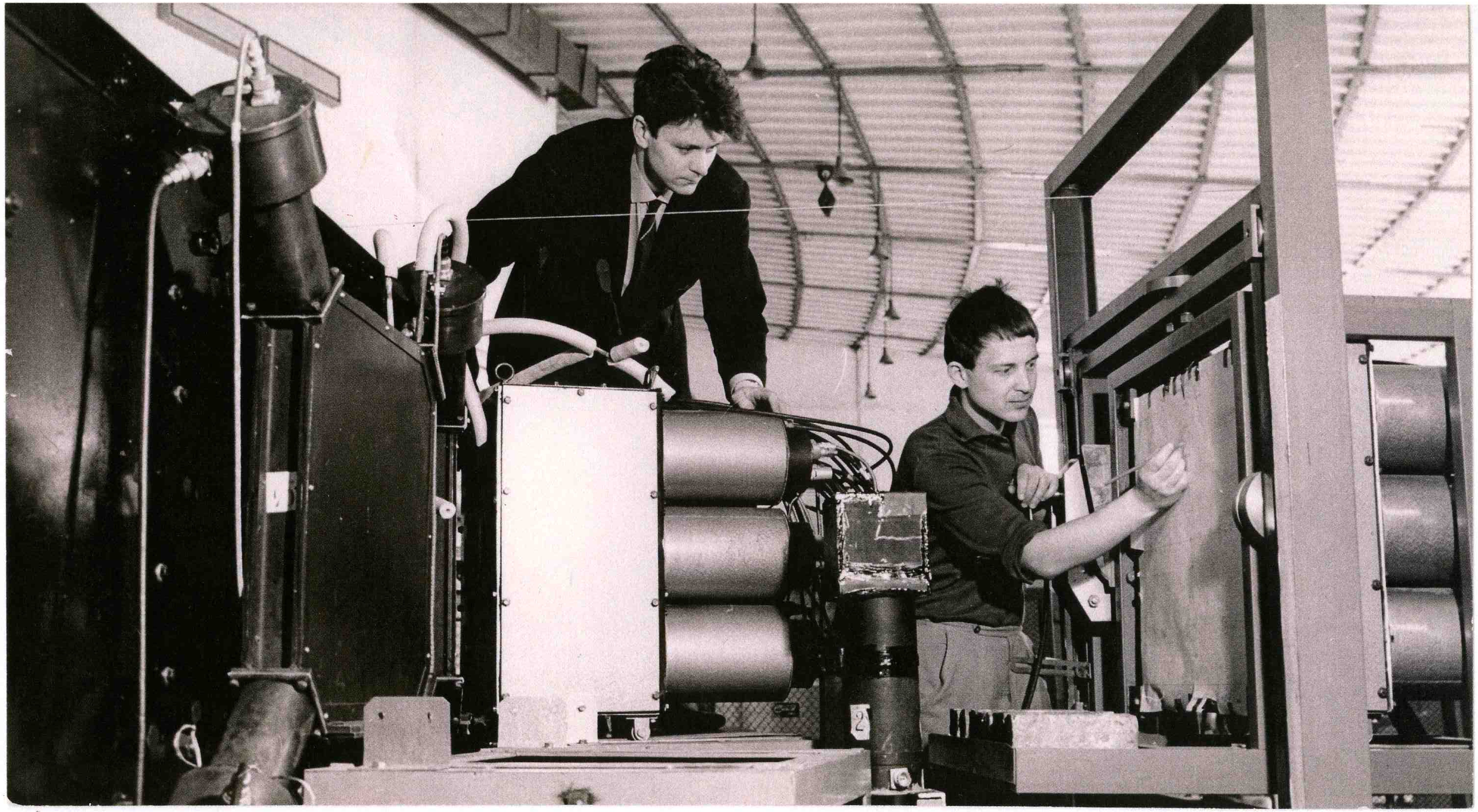




π⁻
S1
S2
H2
S3
S4
SCh 1
Č1
SCh 2
Č2
CF
add
S
CG
af
CD1
CD2
CD3
coinc
d
LA
D1
D3
D2
SC
SW
OD
Amp
to spark chamber trigger
LG
PA-100
AC
SCl
PT
PA
SChII
SChI
CG



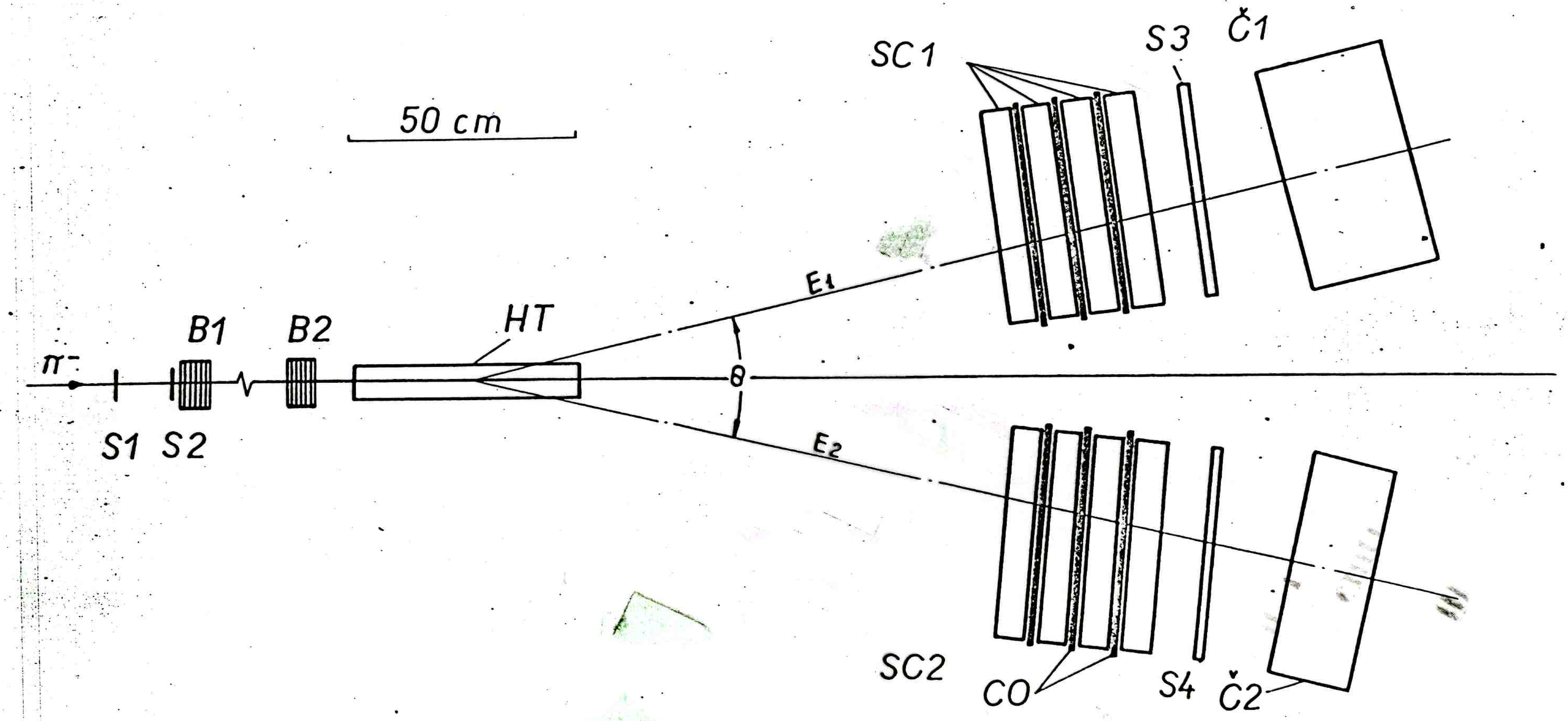
—×— ČS 1
—∘— ČS 2
AMPLITUDE
100
50
0
0
1.0
2.0
3.0
4.0
ELECTRONS ENERGY [GEV]



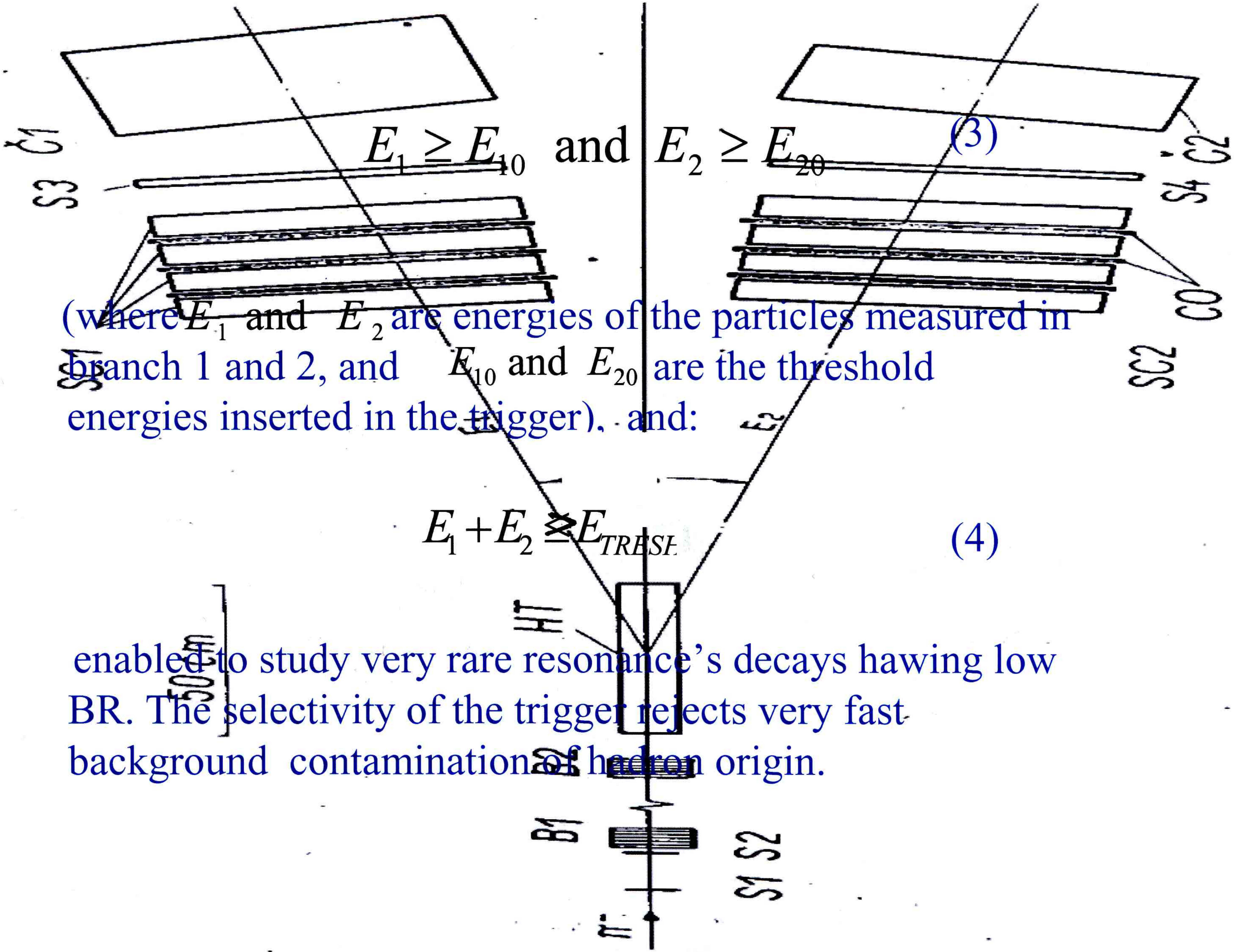
3. The detector.

The detector had two branches independently instrumented and movable relative to fix target on the opening angle θ , which has been optimized under the minimal decay angle of the resonance studied. Each branch contained spark chambers set with Cu converters, scintillation counters and lead glass spectrometer.

The physical program performed on 10 GeV proton synchrophasotron in the High Energy Physics Laboratory has been concentrated to the study of the electromagnetic decays of the resonances. Very fast selective trigger owing to mostly Čerenkov spectrometers under the conditions:



50 cm
SC 1
S 3
Č1
E1
HT
B1
B2
π⁻
θ
S1
S2
E2
SC2
CO
S4
Č2

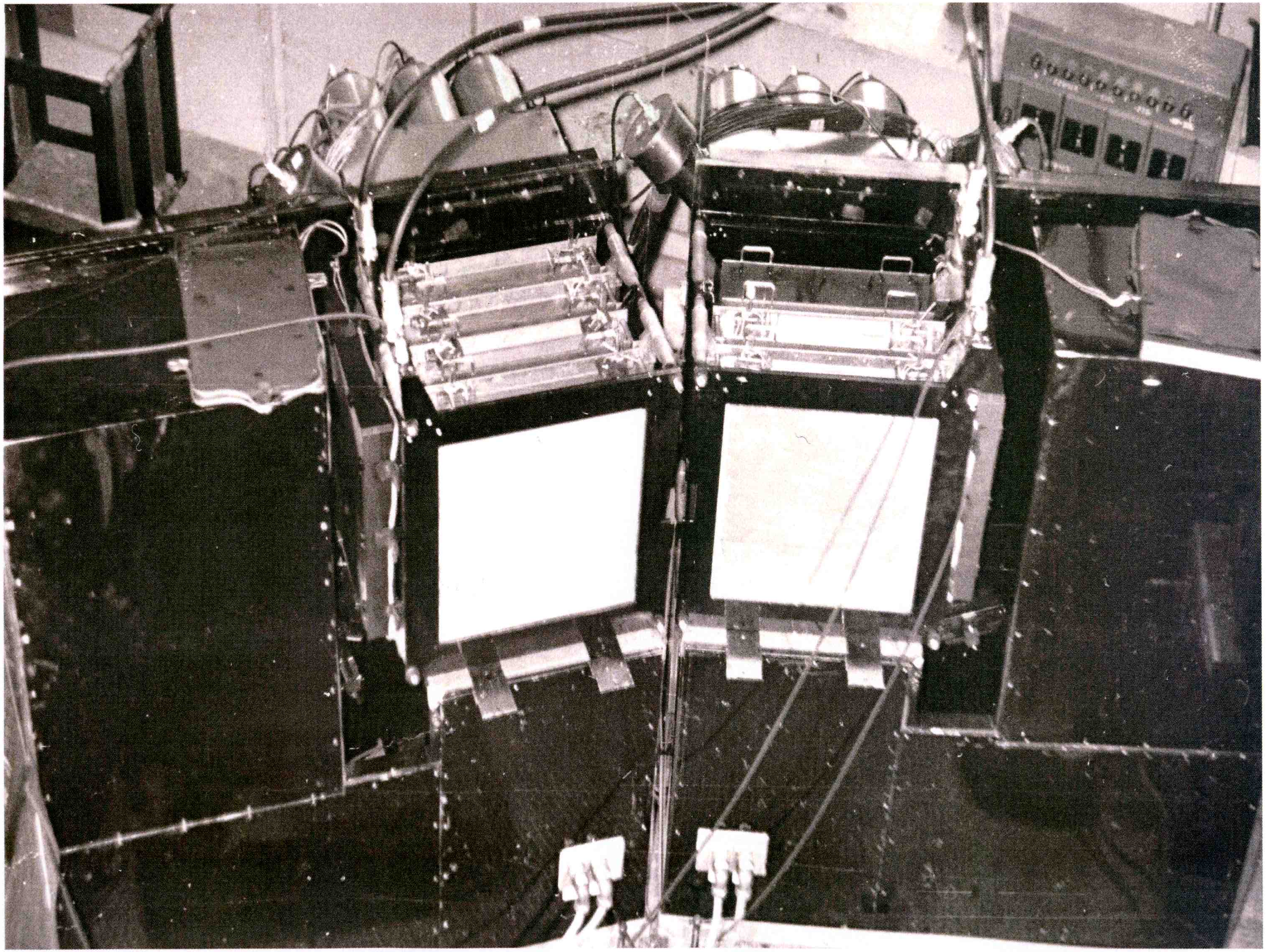


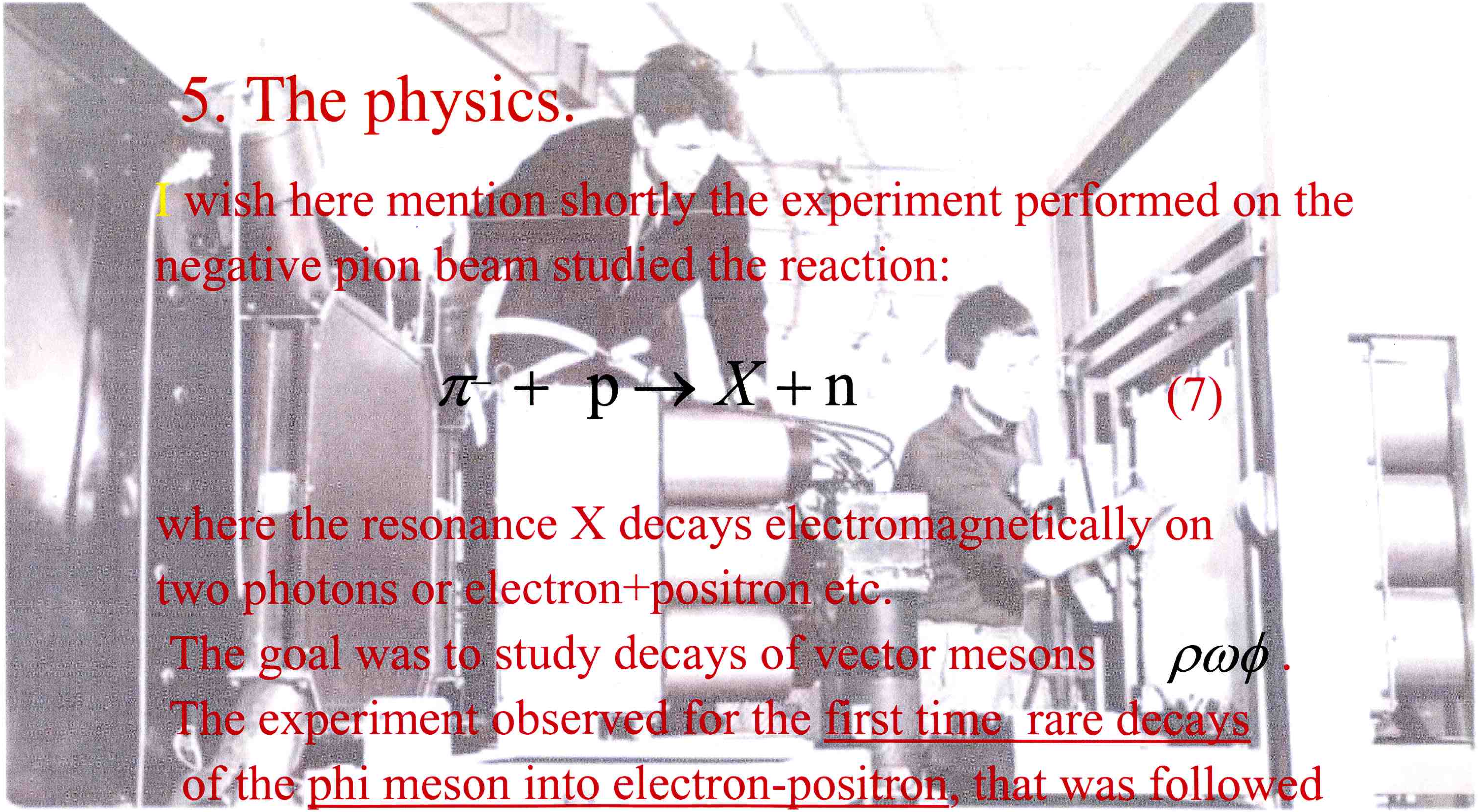
$$E_1 \geq E_{10} \quad \text{and} \quad E_2 \geq E_{20} \qquad (3)$$

(where E_1 and E_2 are energies of the particles measured in branch 1 and 2, and E_{10} and E_{20} are the threshold energies inserted in the trigger), and:

$$E_1 + E_2 \geq E_{TRESH} \qquad (4)$$

enabled to study very rare resonance's decays hawing low BR. The selectivity of the trigger rejects very fast background contamination of hadron origin.





5. The physics.

I wish here mention shortly the experiment performed on the negative pion beam studied the reaction:

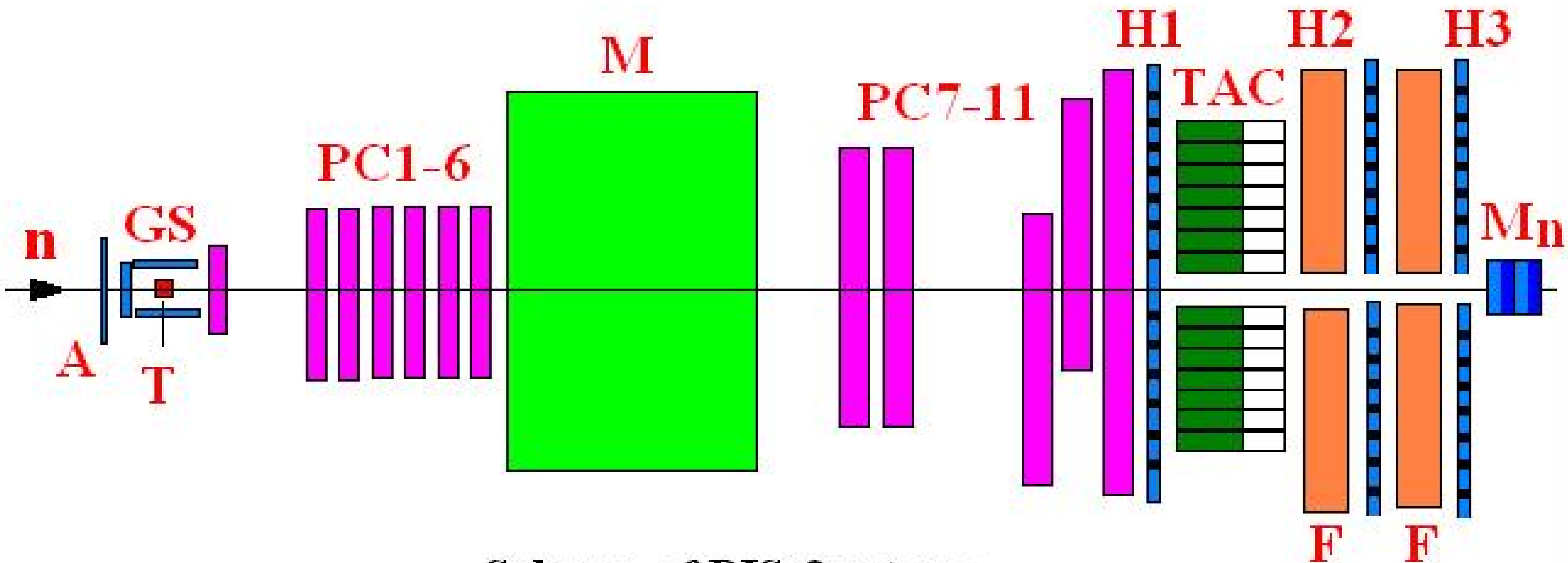
$$\pi^- + p \rightarrow X + n \tag{7}$$

where the resonance X decays electromagnetically on two photons or electron+positron etc.

The goal was to study decays of vector mesons $\rho\omega\phi$.

The experiment observed for the <u>first time rare decays</u> of the <u>phi meson into electron-positron</u>, that was followed immediately by CERN and DESY-MIT experiments.

Spectrometer BIS-2

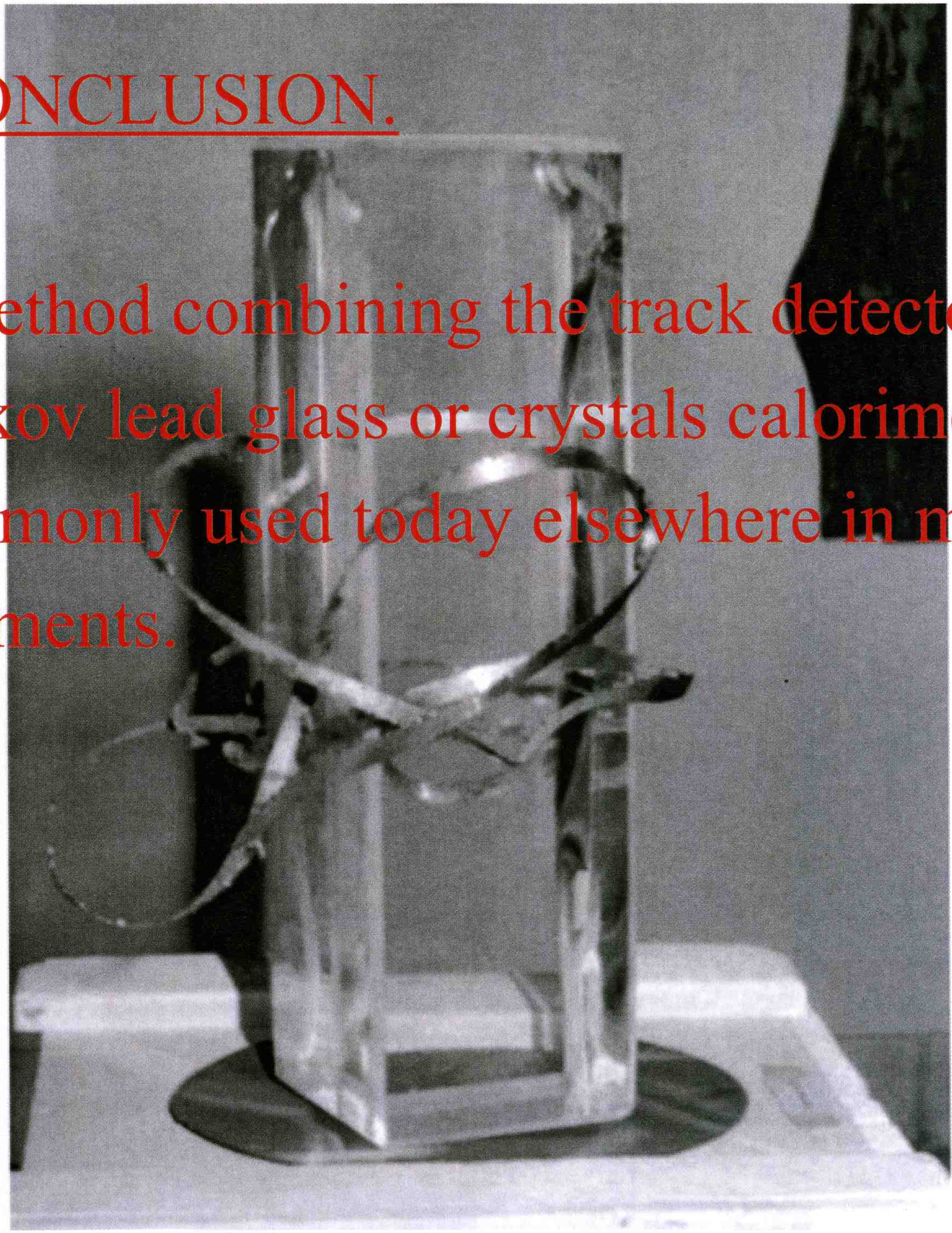


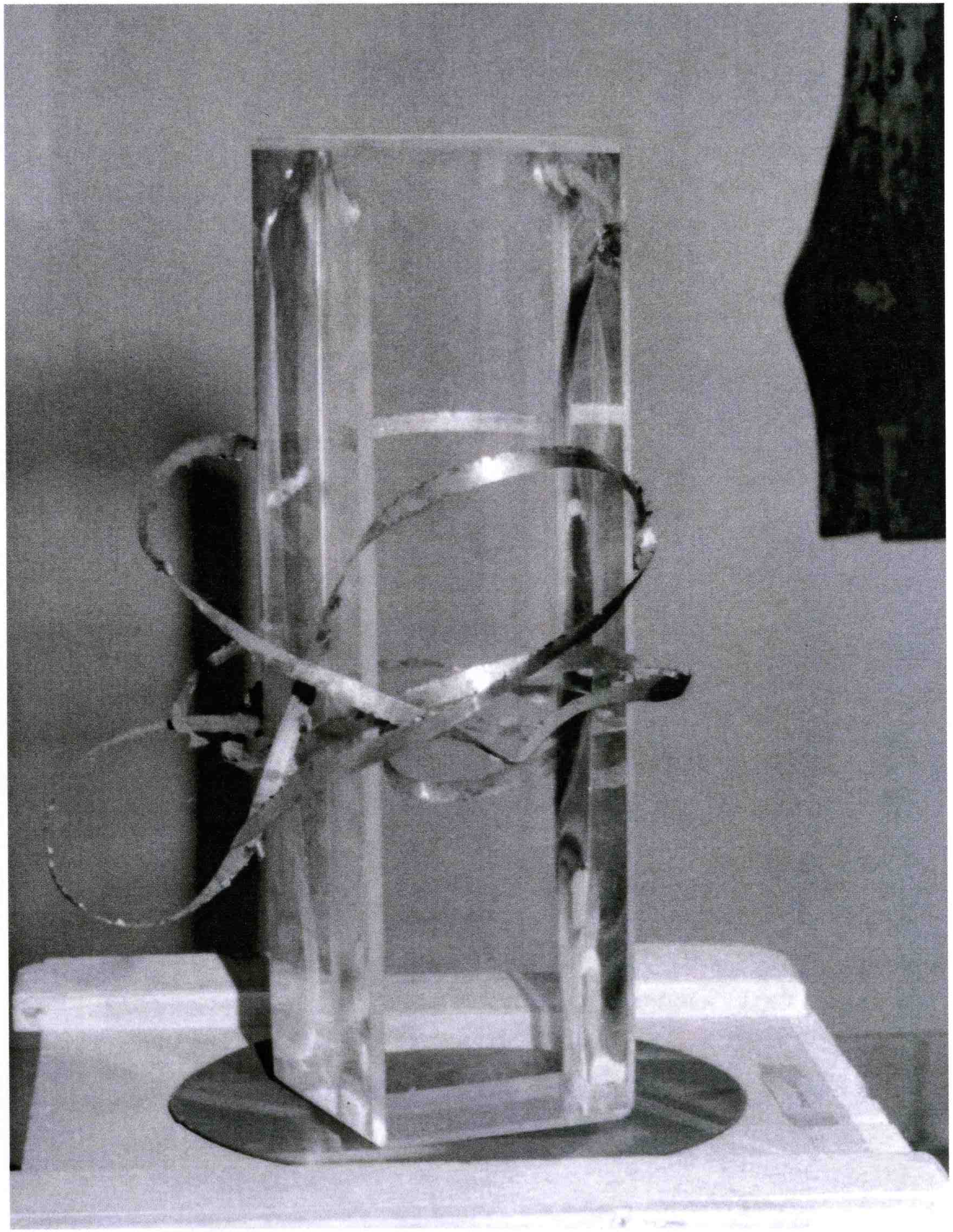
Scheme of BIS-2 set up:

M - magnet SP - 40, A- anticoincidence counter, F - iron filters, PC1-11 - multiwire proportional chambers, GS - scintillation counters, TAC - godoscope of the full absorbtion Cherenkov counters, T - target, H1-3 - scintillation hodoscopes, M_n - neutron beam monitor

5. CONCLUSION.

The method combining the track detector with Čerenkov lead glass or crystals calorimeters is commonly used today elsewhere in many experiments.



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