First evidence of two-photon production of e^+e^- pairs at VEPP-2

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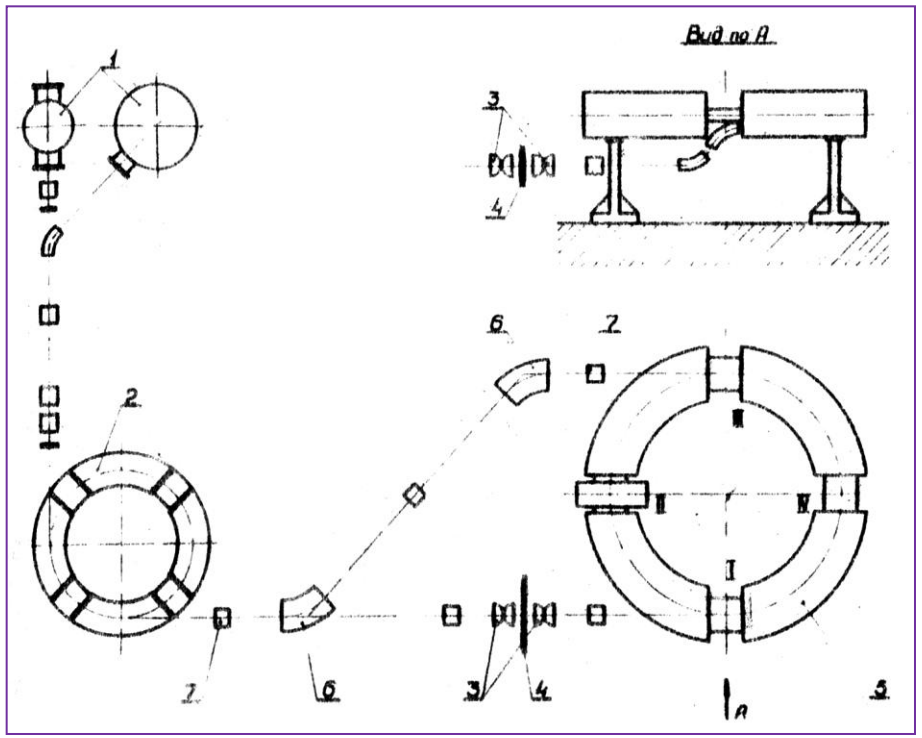
First colliding beam machines

Machine name	particles	2E(GeV)	L($cm^{-2}s^{-1}$)	year
AdA (Frascaty, Italy)	e^+e^-	0.5	10^{25}	1961
VEP-1(Novosibirsk,USSR)	$e^- e^-$	0.32	$5\cdot10^{27}$	1965
SLAC (Stanford, USA)	$e^- e^-$	1.0	$2\cdot10^{28}$	1965
VEPP-2(Novosibirsk)	**$e^+ e^-$**	**1.4**	**10^{28}**	**1966**
ACO (Orce, France)	$e^+ e^-$	1.1	10^{29}	1967
ADONE (Frascati, Italy)	$e^+ e^-$	3.0	$6\cdot10^{29}$	1970

In 1966 in Novosibirsk the group led by our first director A.M.Budker and his colleagues A.N. Skrinsky and A.A. Naumov had built and comissioned the electron-positron collider **VEPP - 2.**

e^+e^- collider VEPP-2 (1966-1970)



1 – linear accelerator
injector ILU

2 – synchrotron B-3M

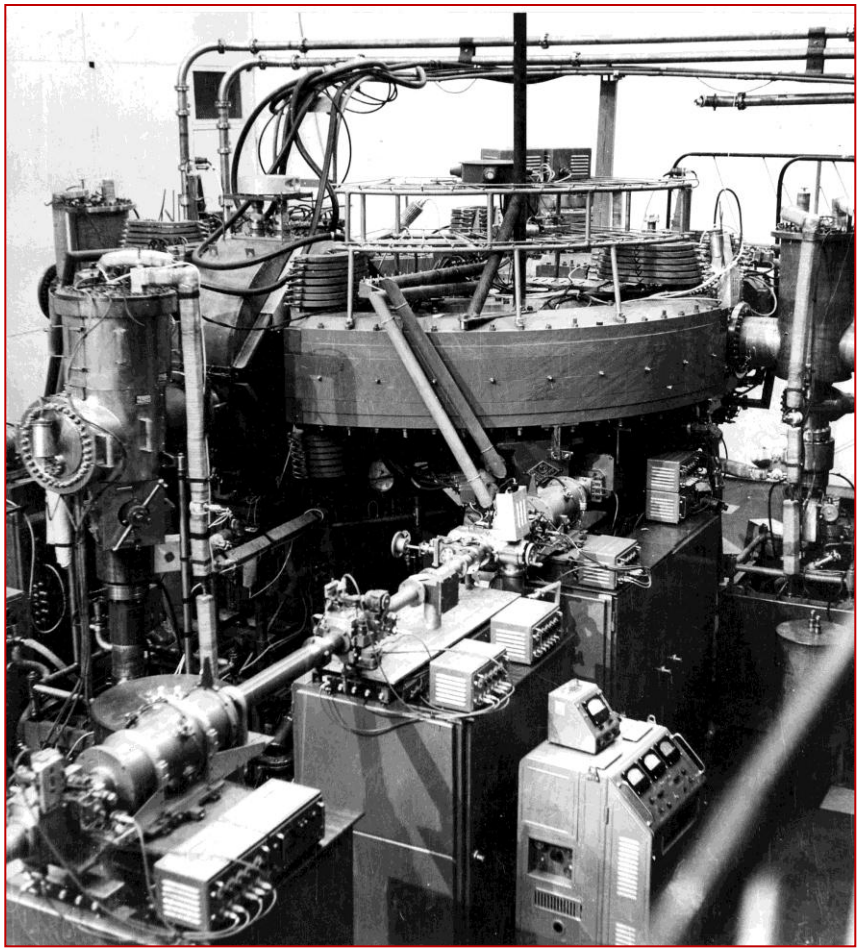
3 – $e^- \rightarrow e^+$ convertor

4 – collider storage ring
VEPP-2

$L \sim 10^{28}$ cm^{-2} s^{-1}

E_{max} = 700 MeV

e^+e^- collider VEPP-2 (1966-1970)

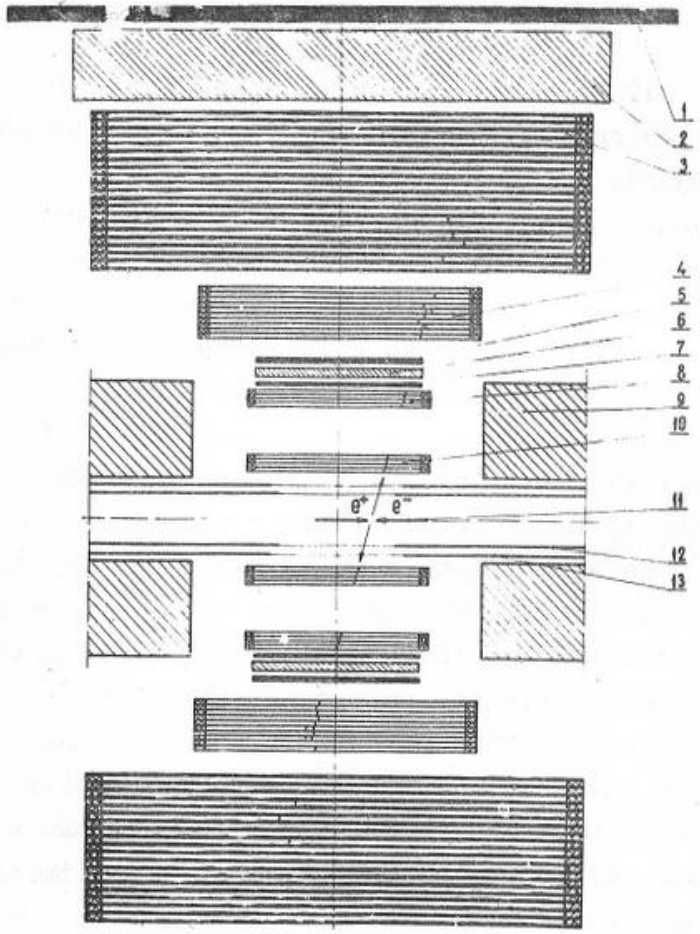


Detector at VEPP-2

The tracking spark chamber and scintillation counters allocated close to the beam. Then there are placed the so called "shower" and "range" spark chamber. These chambers are intended for particle indentification (electron – pion-muon separation). Then it is placed the lead absorber. Outside of the detector there is the cosmic veto scintillation counter.

Spark chambers were triggered by scintillations counters with 15 MeV threshold for electron and 35 MeV threshold for pions.

Solid angle ~15% 4π



Experiments at VEPP-2 (1966 - 1970)

$e^+e^- \to \rho^0 \to \pi^+\pi^-$

$e^+e^- \to K^+K^-$

$e^+e^- \to K_S K_L$

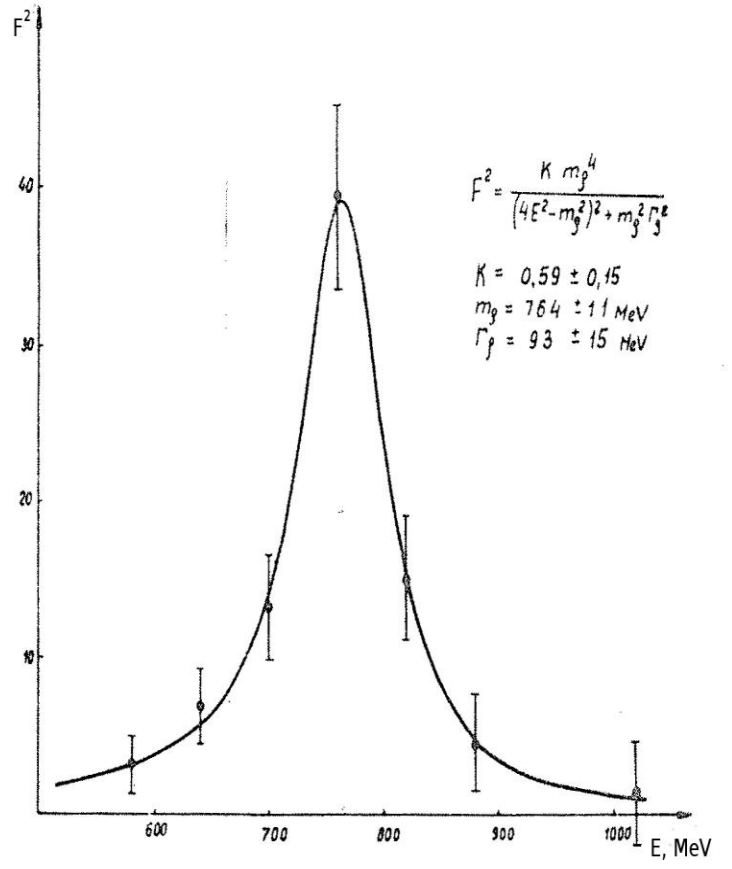
$e^+e^- \to \pi^+\pi^-\pi^0$

$e^+e^- \to 4\pi$

$e^+e^- \to \mu^+\mu^-$

$e^+e^- \to \gamma\gamma$

$e^+e^- \to e^+e^- e^+e^-$



Evidence for two-photon production of e^+e^- pairs at VEPP-2

In analysis of Φ(1020) data in 1969.

During data analysis about 100 unusual 2-tracks events had been observed.

1 – these events had small particle range, between 6 – 16 g/cm^2;

2 - both tracks direction were near the beam plane;

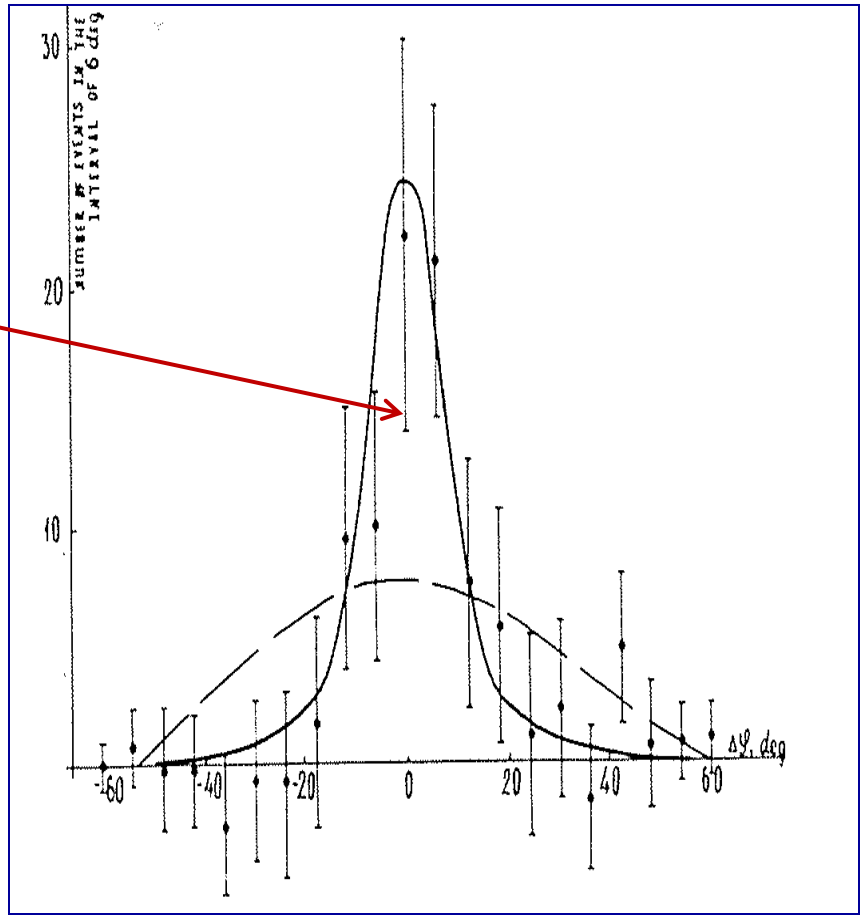
3 – these events by energy had no connection with Φ(1020) meson resonance dependence;

4 – multiple scattering angle for observed tracks ~ 5 was too large for thin foil of matter.

Using this data, one can estimate the effective energy versus type of the particles. Effective pions energy found to be lower than the threshold of the detector.

Conclusion:

Only electron – positron component didn't contradict with the threshold value.



Evidence for two-photon production of e^+e^- pairs at VEPP-2

1 – One of our colleagues Vladimir Balakin suggested that the observed events are from the $e^+e^- \rightarrow e^+e^- e^+e^-$ process , which was first discussed by Landau and Lifshitz in 1934.

2 – Vladimir Baier and Victor Fadin obtained the differential cross section for this process (Phys. Lett. 35B, 156, 1971).

3 - Good agreement between their calculation and experimental results validated the hypothesis on the process nature.

4 – In particular, the experimental and calculated distribution of the asimuthal discollinearity angle $\Delta\varphi$ for $|\Delta\theta| < 40$ is shown in the figure. It is seen that observed distribution well agrees with calculation, taking into account the multiple scattering and geometry of experiment.

For comparison the dashed line corresponds to independent and isotropic particle distribution.

5 – The article with the results of this experiment was published in journal Physics Letters in 1971.

Evidence for electron-positron pair electroproduction
V.E. Balakin, A.D. Bukin, E.V. Pakhtusova, V.A. Sidorov, A.G. Khabakhpashev,
Phys.Lett. B34 (1971) 663-664

Thank you for attention