

A part of data collected by the KLOE experiment is provided, corresponding to an integrated luminosity of $\mathcal{L}=200 \text{ nb}^{-1}$ (download available file from e-learning).

The applied cuts of the event classification algorithm mostly select events of the kind:

$\phi \rightarrow K_S K_L$ with at least one of the two kaons decaying in the volume of the drift chamber (DC) ($\sim 4\text{m}$ diameter)

Some useful numbers:

$$\sigma(e^+e^- \rightarrow \phi) \cong 3 \mu b ; BR(\phi \rightarrow K_S K_L) \cong 0.34 ; \\ BR(K_L \rightarrow \pi^+\pi^-) \cong 0.002 ; BR(K_S \rightarrow \pi^+\pi^-) \cong 0.69$$

The global efficiency to detect the two decays $K_S \rightarrow \pi^+\pi^-$ (close to IP) and $K_L \rightarrow \pi^+\pi^-$ (in the DC volume) $\varepsilon = \varepsilon_S \cdot \varepsilon_L \sim 0.7 * 0.5 = 35\%$ from MC simulation.

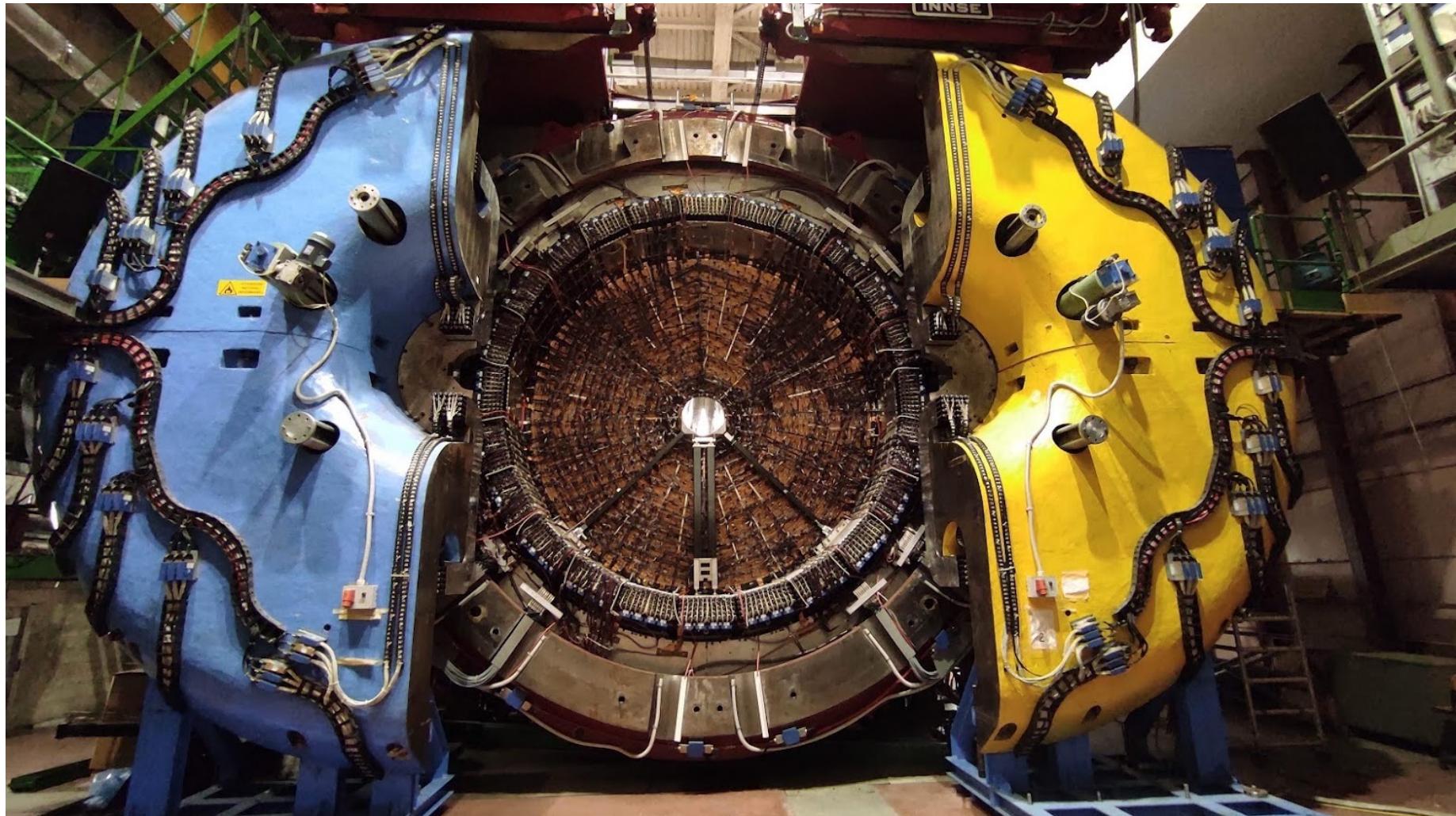
Assuming the ϕ meson produced at rest, the angular distribution of $K_S K_L$ pair produced is $dN/d\Omega \propto \sin^2(\theta)$

Search for the signal of the CP-violating $K_L \rightarrow \pi^+\pi^-$ decays in a fiducial volume (FV) in the drift chamber (typically $|z| < 120 \text{ cm}$; $35 < R(x,y) < 150 \text{ cm}$)

Evaluate the corresponding $BR(K_L \rightarrow \pi^+\pi^-)$

(assume a geometrical acceptance of the FV of $\sim 25\%$ in $|z| < 120 \text{ cm}$; $35 < R(x,y) < 150 \text{ cm}$)

KLOE detector



KLOE detector



KLOE

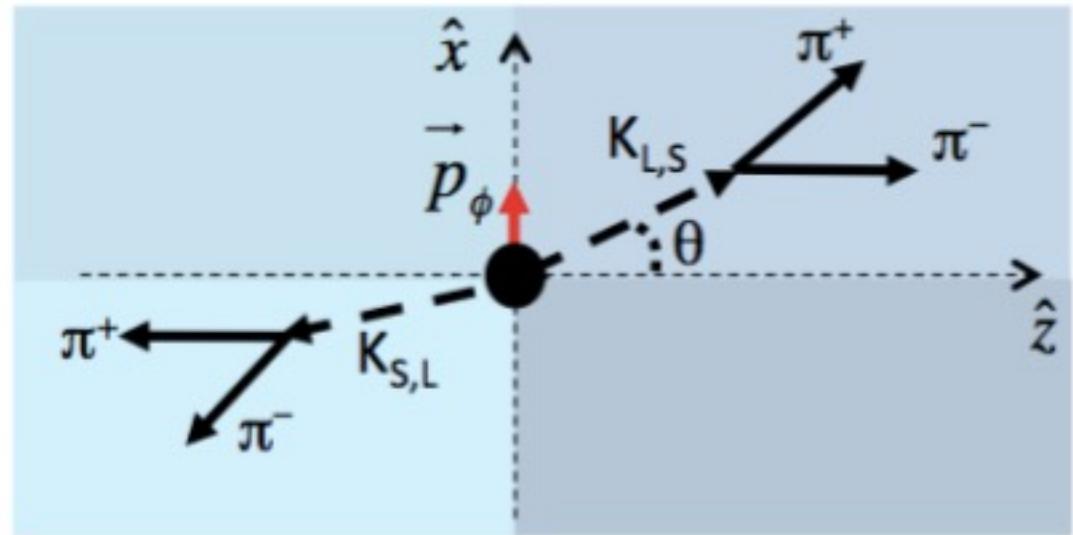
Specific KLOE case determines
the detector overall dimensions:

$$\phi \rightarrow K_0 \bar{K}_0 \rightarrow K_S K_L$$

$$p(K_0) = 110.6 \text{ MeV/c}$$

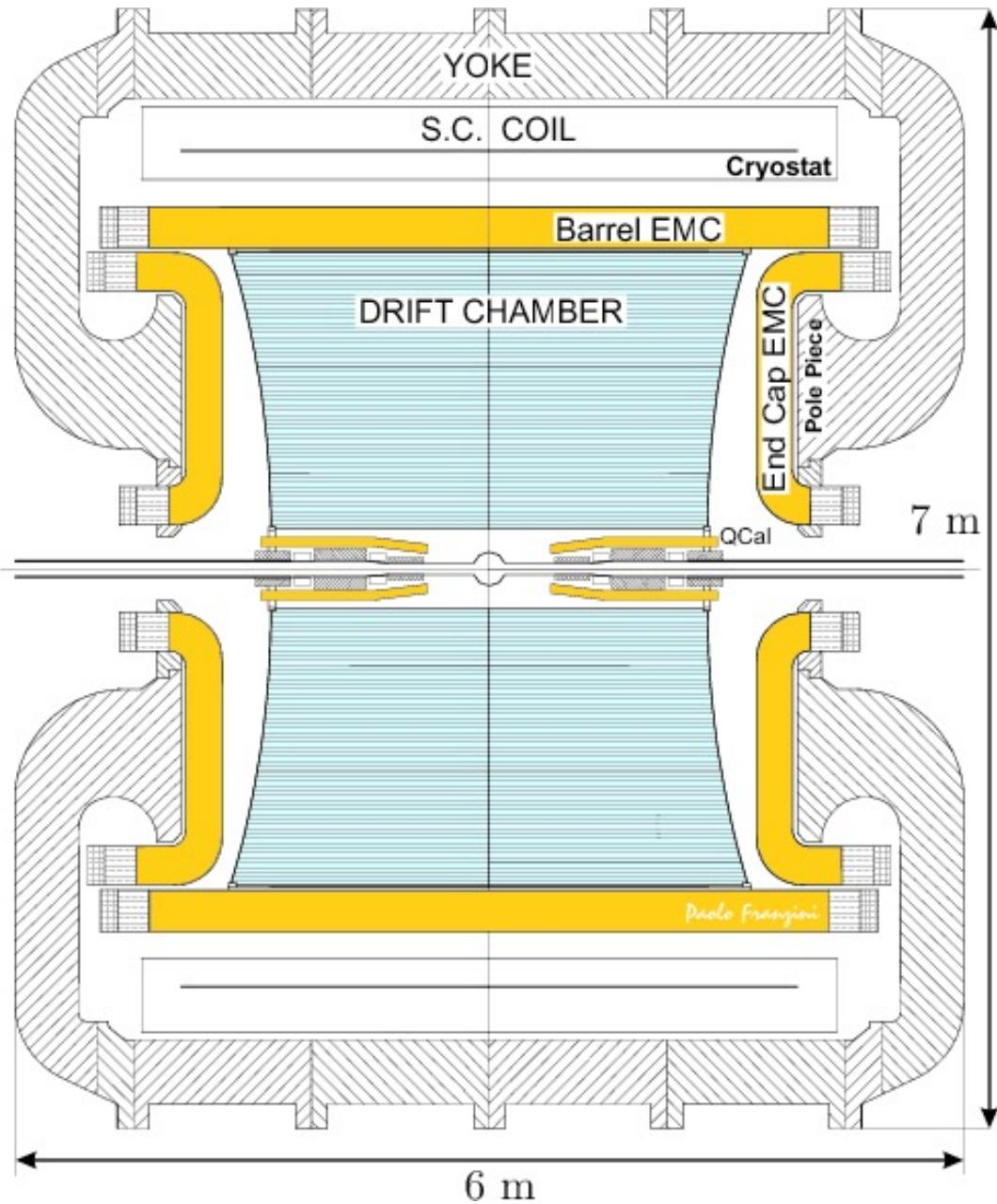
$$\tau(K_S) = 0.8954 \times 10^{-10} \text{ s}$$

$$\tau(K_L) = 5.116 \times 10^{-8} \text{ s}$$



view in the (x,z) plane
(the horizontal plane).

$$\begin{aligned} \rightarrow l(K_S) &= \tau(K_S) \beta \gamma c = 6 \text{ mm} \\ \rightarrow l(K_L) &= \tau(K_L) \beta \gamma c = 3.4 \text{ m} \end{aligned}$$



SuperConducting Coil + Return Yoke

$$B \approx 0.5 \text{ T}$$

typical curvature radii

$$R = p_T / 0.3B = 33 \div 330 \text{ cm}$$

Drift chamber

$\approx 10^4$ wires in stereo configuration
momentum measurement down to
50 MeV

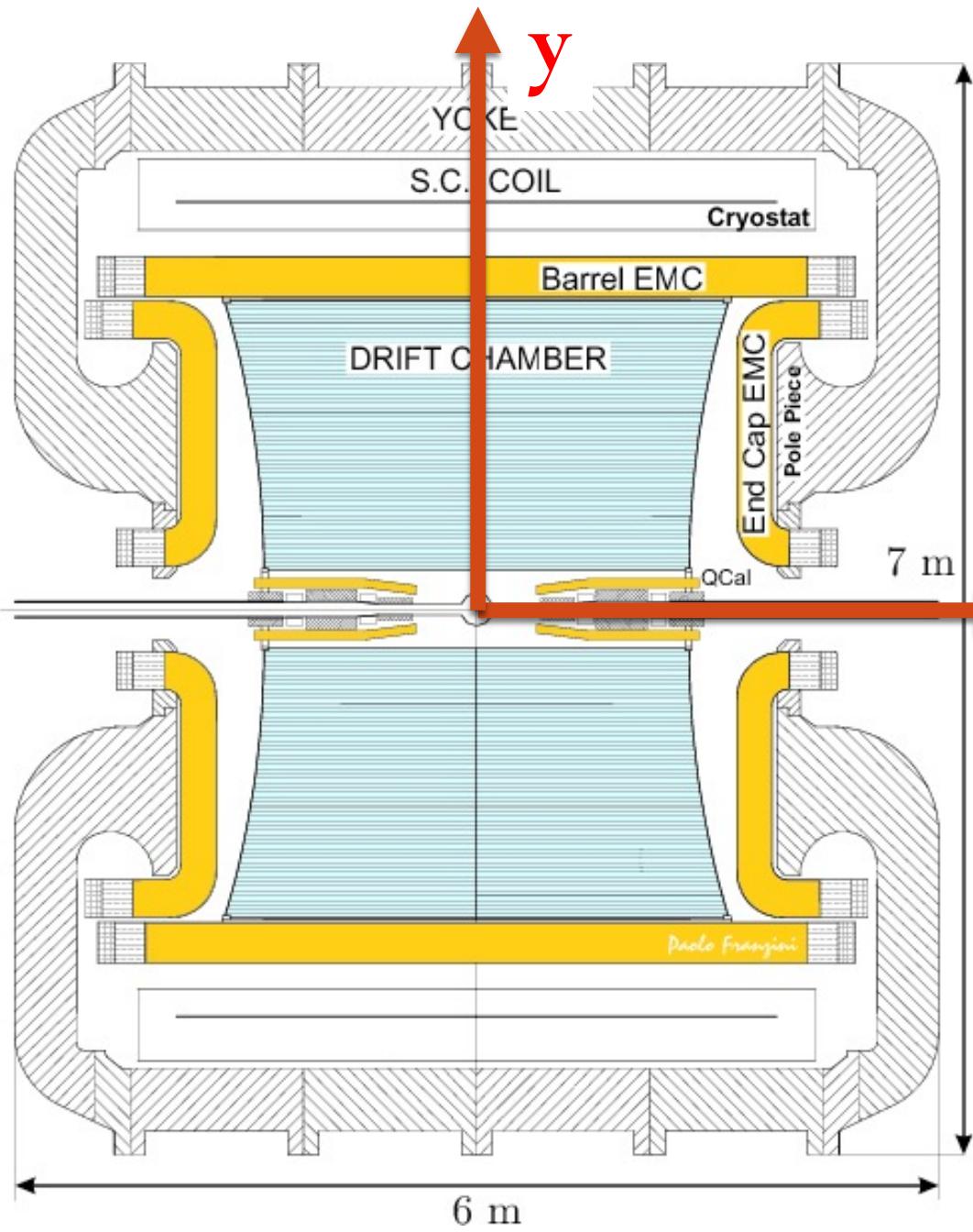
typical track: ≈ 30 hits with 200 μm
space resolution each.

Calorimeter

Lead-Scintillating fibers calorimeter
Read-out through 4880 PMTs
Energy resolution (record for
a sampling calorimeter)

$$\frac{\sigma(p_T)}{p_T} \approx 0.4\%$$

$$\frac{\sigma(E)}{E} \approx \frac{5.7\%}{\sqrt{E(\text{GeV})}}$$



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$\approx 10^4$ wires in stereo configuration
momentum measurement down to
50 MeV

Z

typical track: ≈ 30 hits with 200 μm
space resolution each.

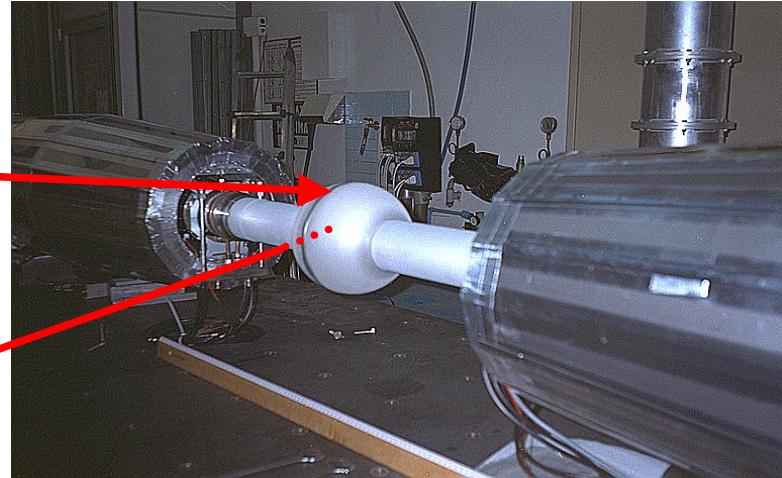
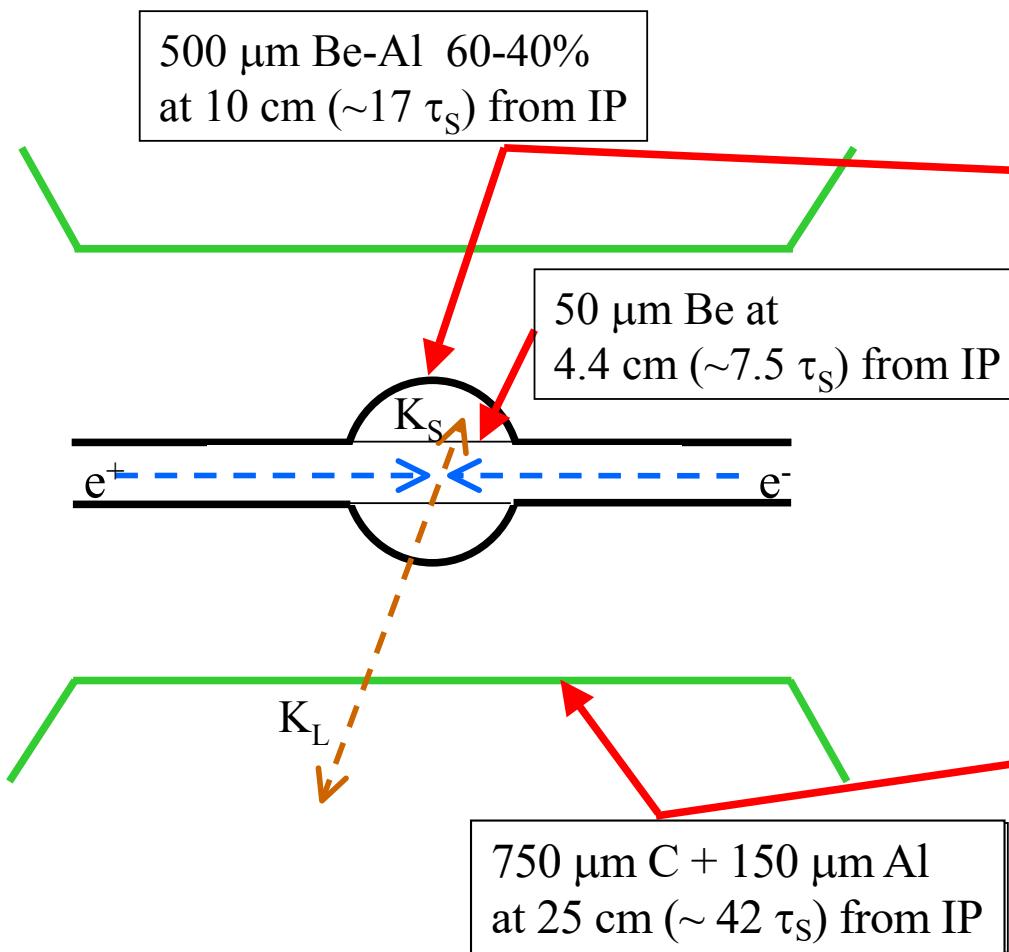
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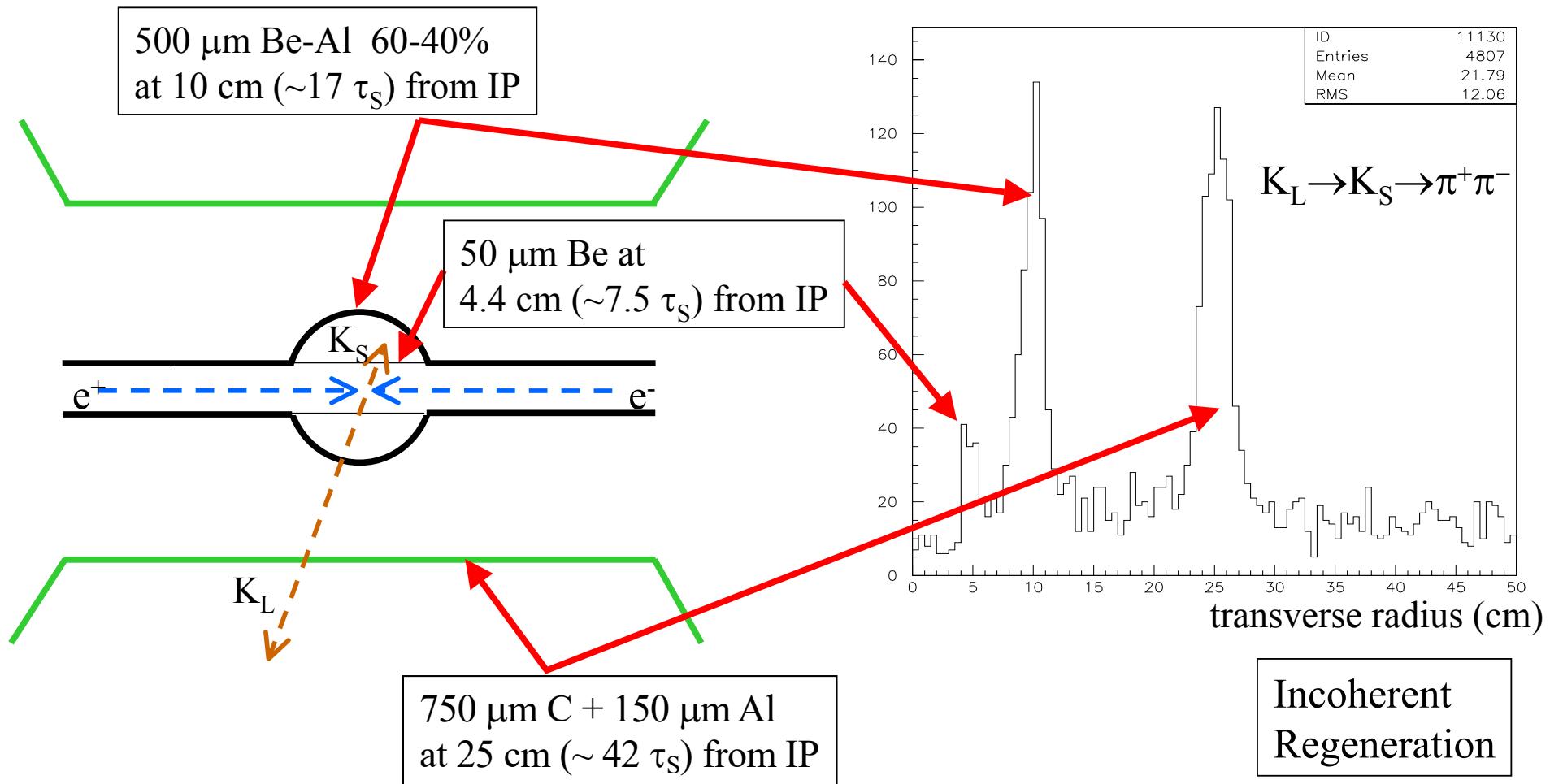
$$\frac{\sigma(p_T)}{p_T} \approx 0.4\%$$

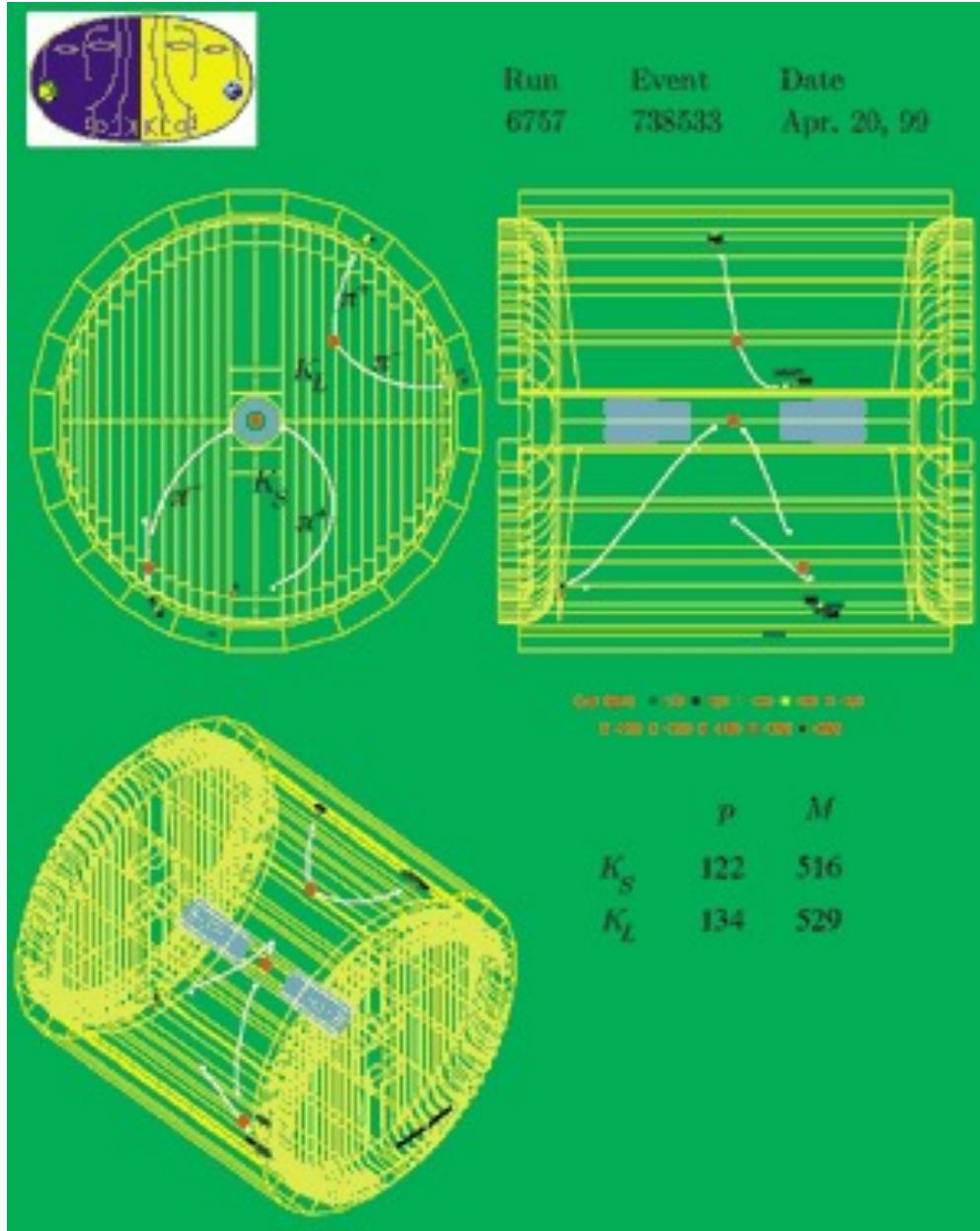
$$\frac{\sigma(E)}{E} \approx \frac{5.7\%}{\sqrt{E(\text{GeV})}}$$

Regenerators in KLOE



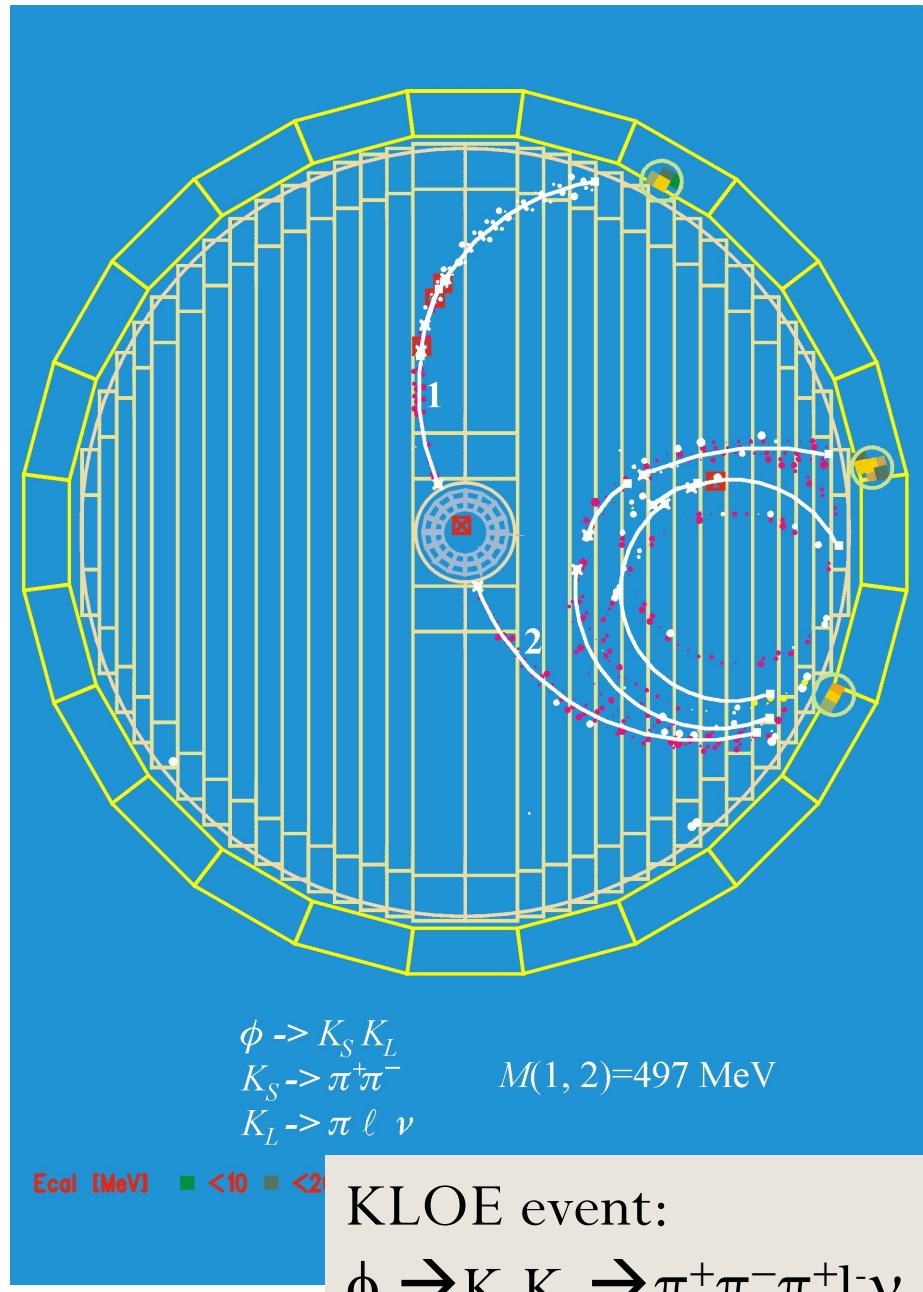
Regenerators in KLOE





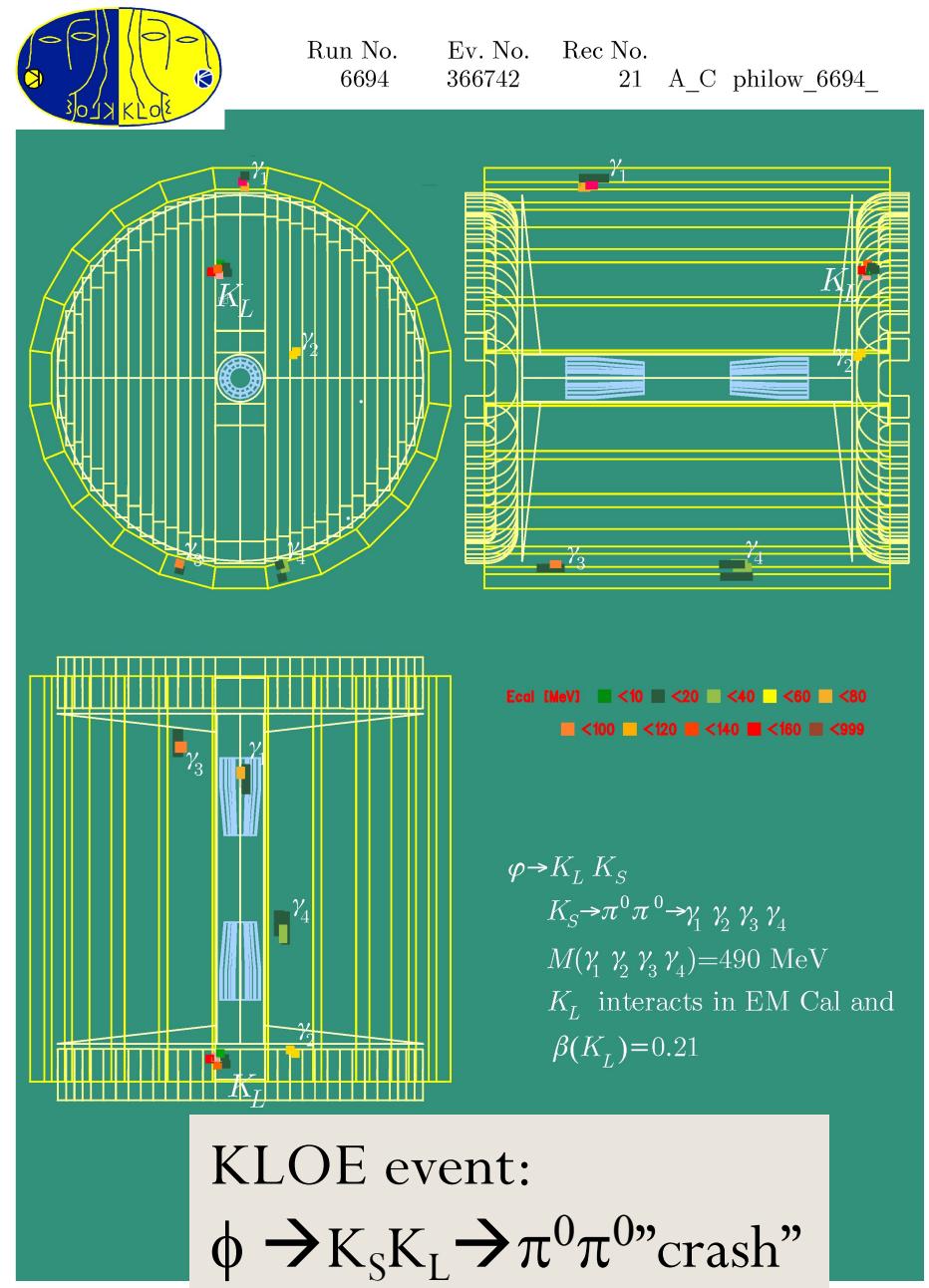
KLOE event:





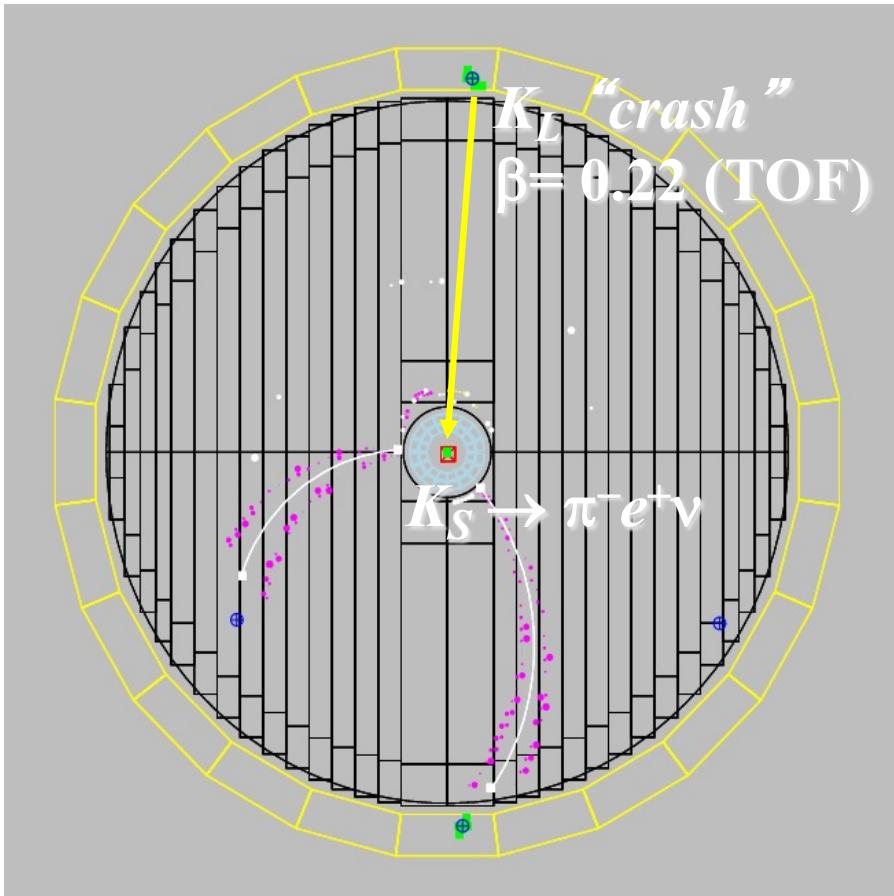
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Methods in Experimental Particle Physics

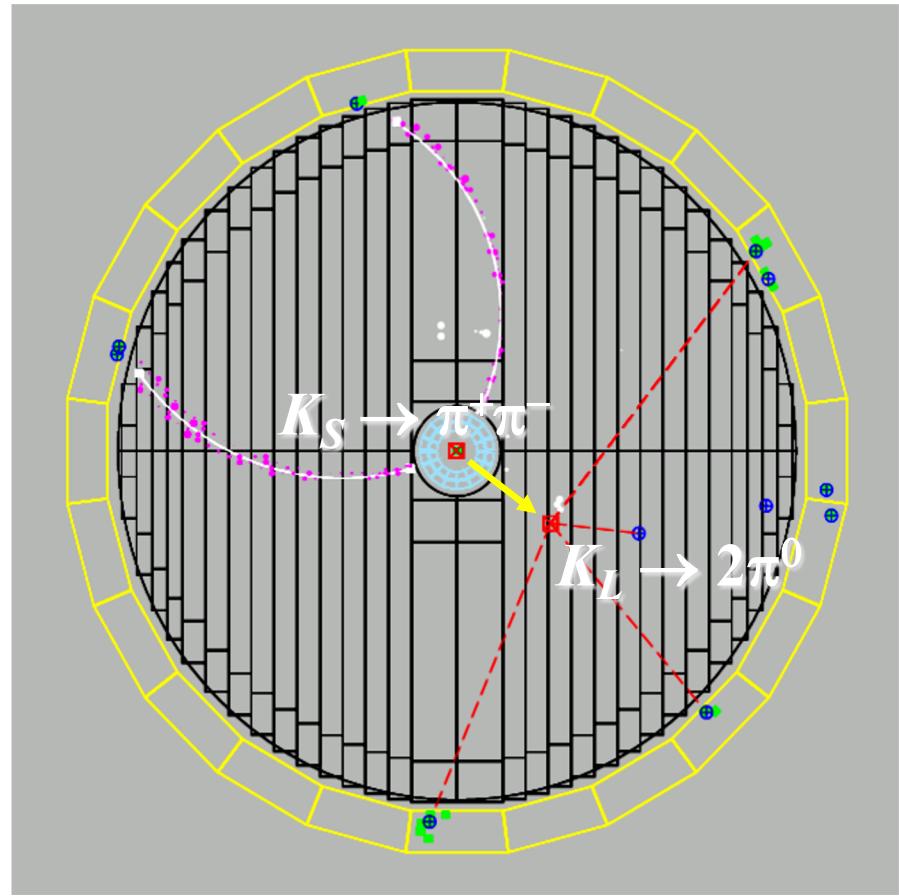


5/1/23

K_S and K_L Tagging at KLOE



K_S tagged by K_L interaction in EmC
Efficiency $\sim 30\%$ (largely geometrical)
 K_S angular resolution: $\sim 1^\circ$ (0.3° in ϕ)
 K_S momentum resolution: ~ 2 MeV



K_L tagged by $K_S \rightarrow \pi^+ \pi^-$ vertex at IP
Efficiency $\sim 70\%$ (mainly geometrical)
 K_L angular resolution: $\sim 1^\circ$
 K_L momentum resolution: ~ 2 MeV

DATA format

# vtx with two tracks of opposite curvature	XV (cm)	YV(cm)	ZV(cm)	Track1		Track1		Track2		Track2	
				PX(MeV)	PY(MeV)	PZ(MeV)	PX(MeV)	PY(MeV)	PZ(MeV)	PX(MeV)	PY(MeV)
1 event	1	0.216207	0.246072	1.364715	151.192932	-61.700985	54.802067	-209.739105	142.082977	5.926435	
1 event	1	0.54744	0.147788	2.055511	-124.688904	-169.867401	4.889555	140.067444	133.100037	96.255516	
....	1	-0.637978	17.959198	-5.421641	-23.862055	-39.697712	158.070496	7.350477	-37.824757	-70.982933	
1 event	1	0.016848	-0.265362	2.533573	-102.95047	51.7976	-212.848511	51.765907	-115.10733	132.78241	
1 event	1	-19.583483	-6.515633	79.462578	21.623899	-6.011866	-144.267212	41.538429	123.078117	-138.307068	
1 event	1	2.782617	-2.330386	0.482893	-158.41037	129.729691	36.743649	166.55484	-60.952431	-158.771179	
1 event	1	3.44611	0.57029	0.505198	-112.96521	-26.331266	-64.955383	64.430977	-60.49427	-13.346331	
1 event	2	24.917801	81.446152	-35.7575	-170.612686	171.111542	3.878695	61.945156	35.274967	11.448877	
1 event	3	-0.812381	2.61607	1.821378	-0.946177	49.62746	-3.556312	7.358061	52.636669	102.887619	
1 event	4	-47.49361	-2.539154	-2.435209	9.573653	-34.923115	-2.695846	-7.466088	33.787445	16.976818	
1 event	1	0.458308	0.208474	0.025205	-132.947449	-70.411674	-78.516739	232.114029	77.932884	59.212784	
1 event	1	0.13935	0.317906	1.306292	183.311096	180.444046	-49.993275	-104.58461	-119.794373	12.144162	
1 event	1	0.024716	-0.731149	0.505863	53.13118	132.668411	-74.407768	-66.093193	-226.150421	107.330704	
1 event	2	-6.006987	102.707573	-40.317795	-61.544205	113.136612	-92.700325	-51.048351	9.463421	138.443741	
1 event	1	-0.095098	-0.182251	1.818653	-114.756218	169.159454	22.188866	11.206058	-223.005402	-6.986384	
1 event	1	-12.901211	20.282257	32.621037	-69.12764	-23.869619	-19.511436	76.433334	26.39609	25.751688	
1 event	2	-11.951688	107.924591	72.273247	-68.34166	26.623821	22.928028	75.350578	-0.117513	-38.874512	
1 event	3	-9.751437	94.716454	-21.873085	59.287865	-23.327478	-17.295826	-55.110222	27.467651	27.847347	
1 event	1	-26.403742	-37.264133	34.794907	-55.873669	34.507099	4.255756	65.993042	-67.178741	-105.399956	
1 event	1	0.503347	0.6009	1.052054	118.943016	94.560379	-69.153465	-171.223038	-84.928909	171.85405	
....	2	132.279663	-143.104019	-128.781433	93.28791	65.269073	34.814198	-97.722786	-114.775955	-64.545181	
1	-0.909586	3.784796	0.747218	-4.193732	-160.618149	85.708519	-77.506699	102.036751	-56.064678		
1	18.190319	-41.375011	-29.705212	20.007298	-97.21891	3.186507	85.337387	-63.399883	-141.27977		
2	29.042398	-69.507927	-39.084293	133.066971	-654.882141	900.860229	-25.085421	1.210853	28.809818		
1	-3.371712	-1.293284	-5.830994	141.162506	61.888985	233.54274	-70.392815	0.09225	-185.690079		
1	0.52277	-0.398297	0.32997	-134.432327	165.791245	-128.765472	81.930328	-69.232941	158.335297		
1	0.841518	0.058689	-0.735348	152.723648	161.441864	34.932335	-59.458435	-190.926025	7.681769		
1	2.532751	0.388251	1.24073	53.518383	197.140533	92.323326	-107.997818	29.133915	-5.172422		
1	2.206218	-6.118976	0.009642	12.953211	-110.31588	-56.620358	27.173191	-46.440571	-32.549519		

For all events
the EFFECTIVE IP POSITION, MOMENTUM AND SQRT(S)
FROM BHABHA SCATTERING EVENTS ARE:

XPHI(CM)
0.3586895E-01

YPHI(CM)
0.7994639E-01

ZPHI(CM)
0.5481189

PXPHI(MEV)
-15.99512

PYPHI(MEV)
-0.1569512

PZPHI(MEV)
-0.7652826

SQRT(S) (MEV)
1019.4