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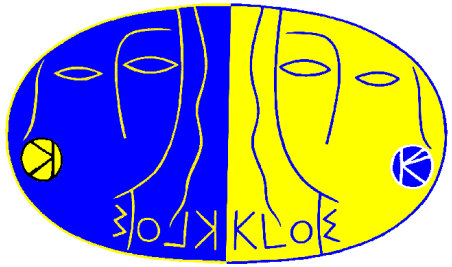
Fabio Ambrosino (Napoli)

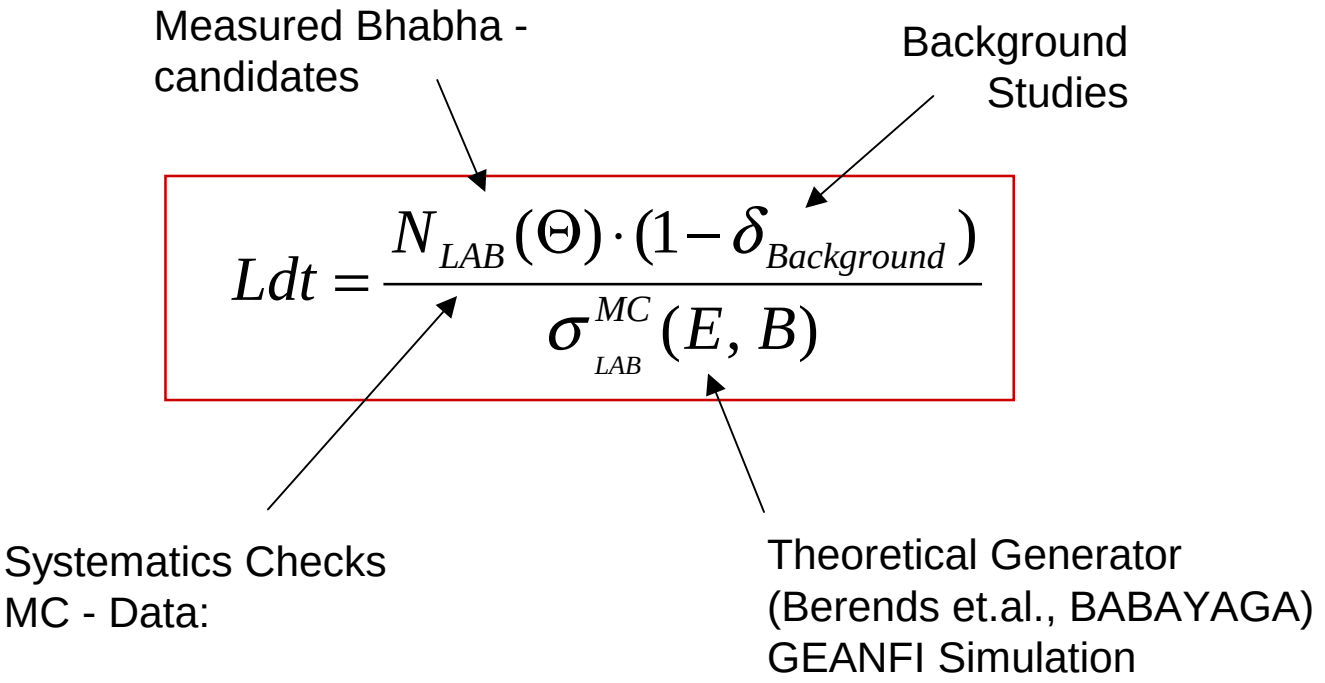
KLOE Physics Workshop
La Biodola, 25. May 2001

KLOE Luminosity Measurement



Large Angle Bhabhas
Very Large Angle Bhabhas
Gamma Gamma Luminosity

Master Formula



Monte Carlo Driven Approach !

use Selection/Cuts which are well described by MC (Theory & Experiment)

LAB

LAB - Selection - Cuts:

$| T_{CL1} - T_{CL2} | < 4$ ns
$N_{Hits\ DC} > 50$

$45° < \Theta_{+-} < 135°$
Acoll. (r, φ) < 10 °
300 MeV < E_{+-} < 600 800 MeV *
cos(Acoll. (3d)) < - 0.975 *

* inserted in 2000

Investigation of '99-LAB's showed:

- Experimental Angular Distributions in good agreement with MC - Distributions (ONLY EmC !)

- $\gamma\gamma$ - Contamination ❶

  Contamination with $\gamma\gamma$ - Events which make Pair Production

  Big Systematic Effect due to Miscalibration of EmC

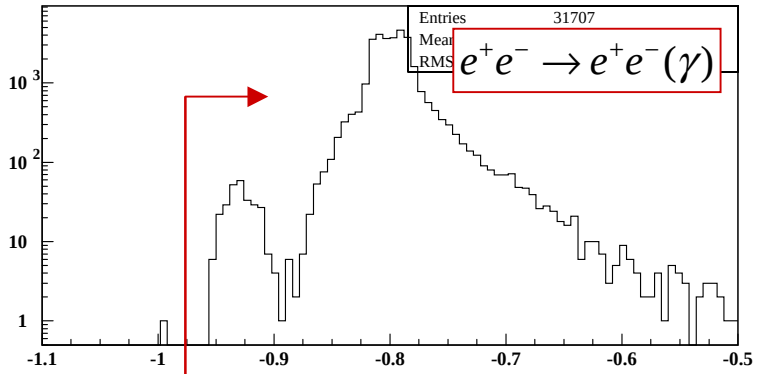
  (Intrinsic Resolution of EmC $\Delta E \approx 42$ MeV @ 510 MeV)

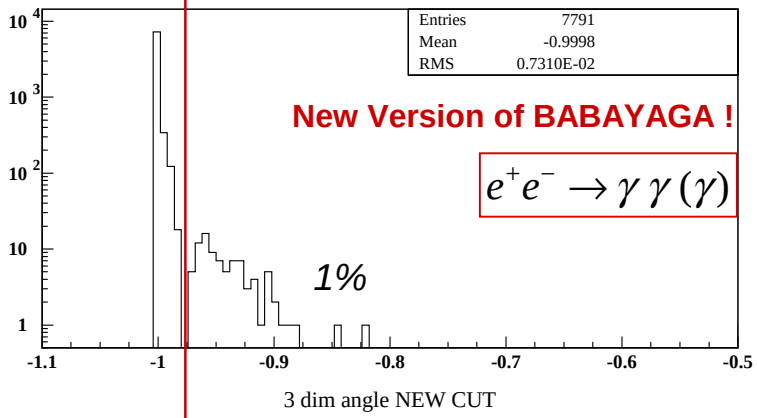
  ❷

  Contamination with $\pi^+\pi^-\gamma$, $\pi^+\pi^-\pi^0$

LAB since DB-V6

❶ 3dim - Accolinearity $\cos\psi = \dfrac{x_{Cl1} \cdot x_{Cl2}}{|x_{Cl1}| \cdot |x_{Cl2}|}$



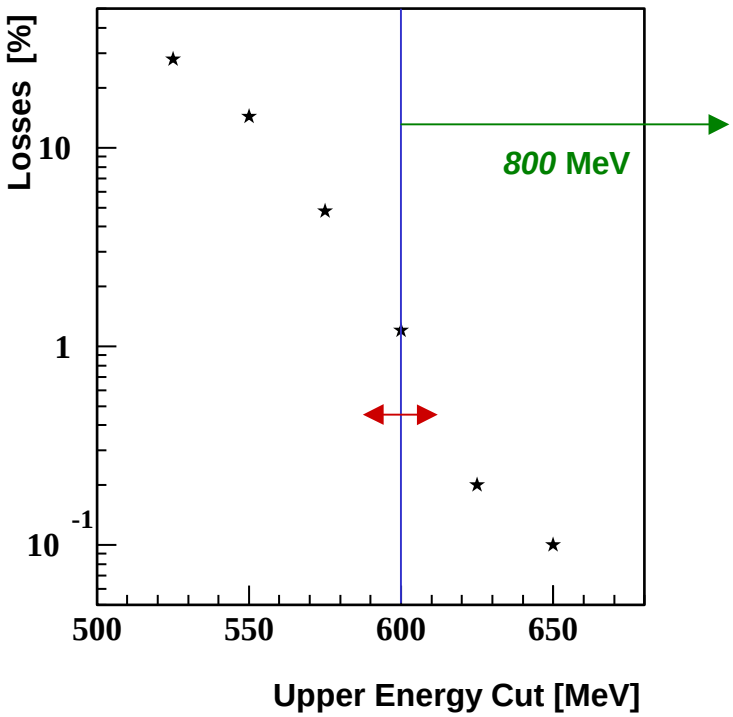


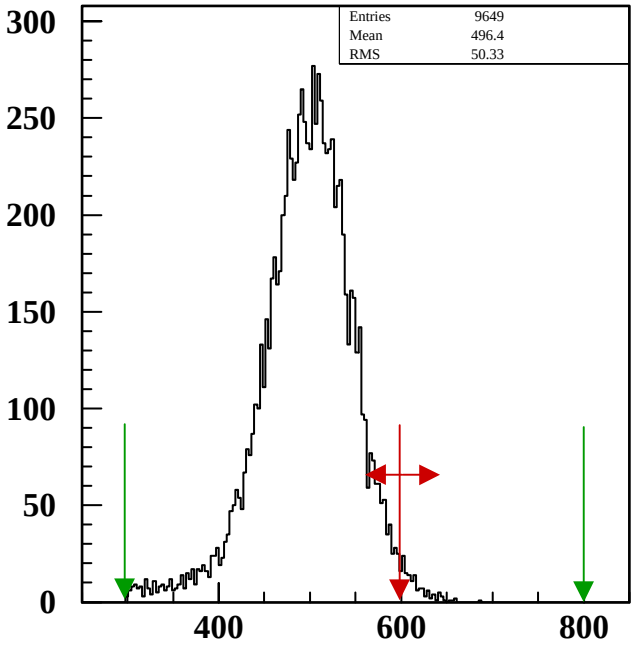
cos ψ > -0.975

LAB since DB-V7

❷ *Upper Energy Cut FILFO moved from 600 to 800 MeV*

300 MeV < E_{CL} < *800* MeV





Energy icl1 FILFO

$\delta L / L_{00} < 3\ \%$

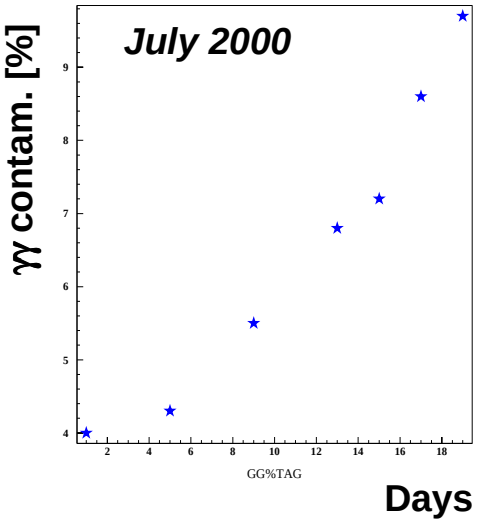
In 2000 < DB-V7 due to variations of EmC Energy Calibration

LAB

DB-V3 1999 Data
cross section=758 nb
Luminosity = LAB * (1 - 2.4 %)

DB-V4 July - Aug. 2000
B=0.52T cross section=780 nb
dramatic $\gamma\gamma$ - contamination (noisy channels)

Fraction of LAB-events w/o charged vertex →



Luminosity table will be provided using this data as an input

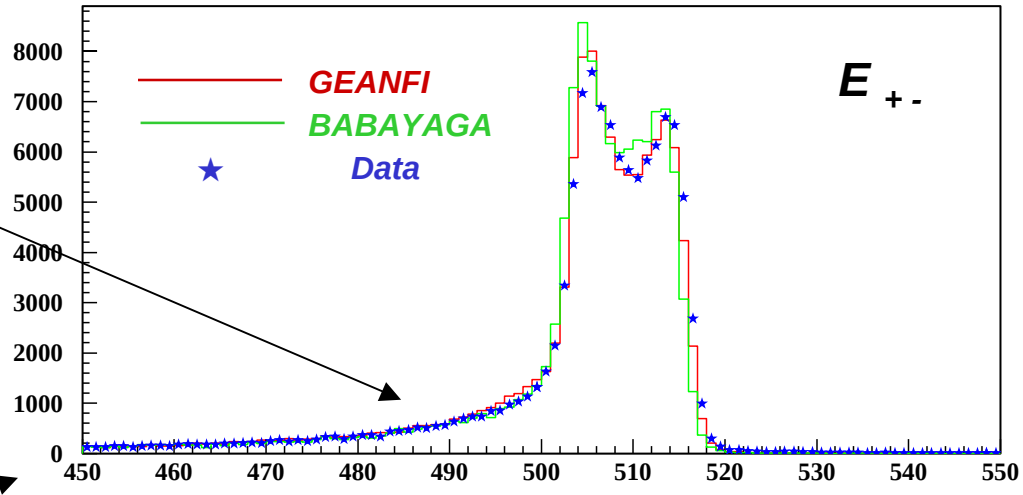
DB-V6 Sept. 2000;
❶ 3dim. Accolinearity ($\gamma\gamma$ -Events) cross section=780 nb
Luminosity = LAB * (1 - 1.2 %) ; strong variations due to δE_{EMC}

DB-V7, DB-V8 from Oct. 2000 ;
❷ Cluster Energy-Cut moved to 800MeV cross section=797 nb
Luminosity = LAB * (1 - 1.2 %) ; less sensitive to δE_{EMC}

VLAB: Distributions

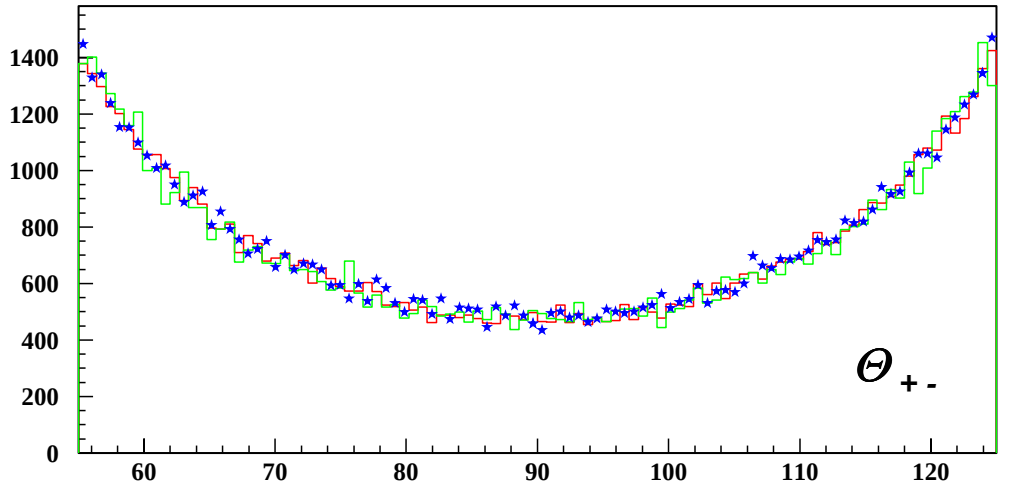
Excellent Agreement

Radiative Tail well described by Theory



Energy sel. Tracks

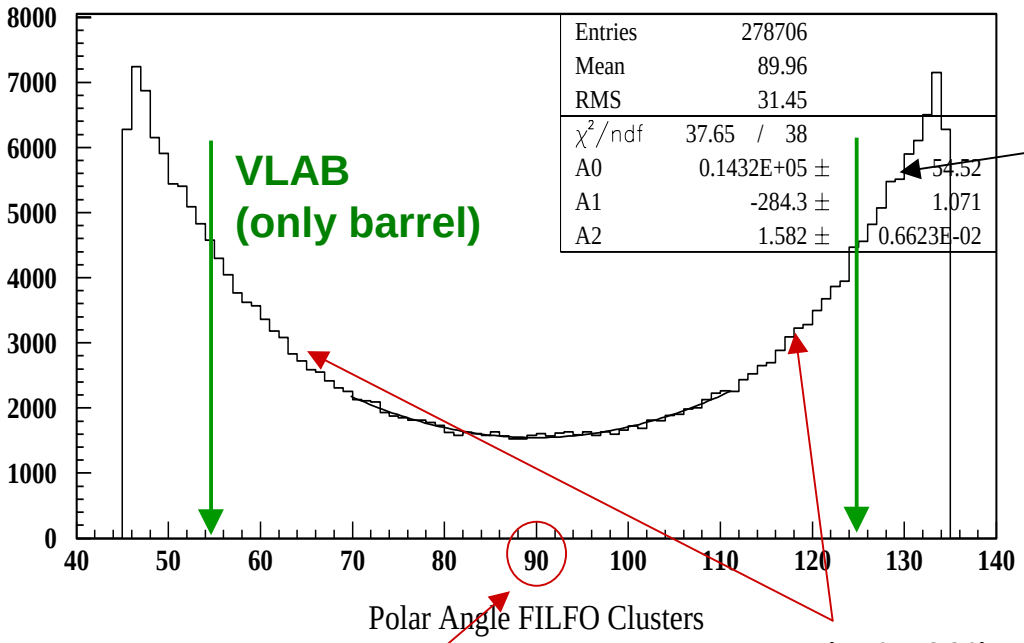
Cut at 400 MeV
Losses negligible



Polar Angle sel. Tracks

VLAB: Systematics

Cut on Polar Angle of Clusters (EmC) selected by FILFO-LAB's



Small loss (<0.3%) at intersection Barrel - Endcap

❶ Fit P2 around 90°
(Centre of Distribution)
$X_0 = (89.86 \pm 0.50)°$

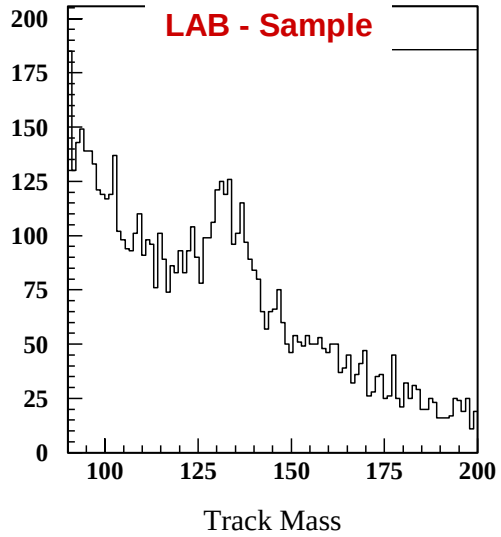
❷ $\dfrac{(45° - 90°) - (90° - 135°)}{(45° - 135°)} < 0.1\%$

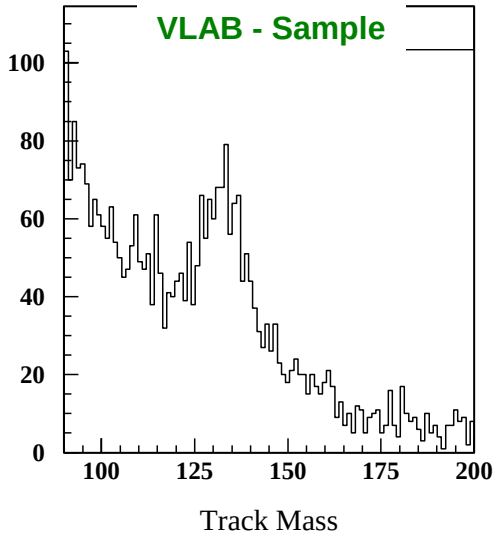
No left - right - Asymmetry

$< 0.5\ \%\ \ \delta L / L$

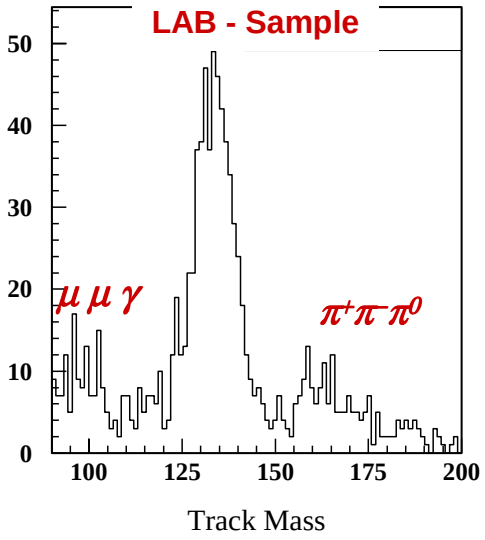
VLAB: Background

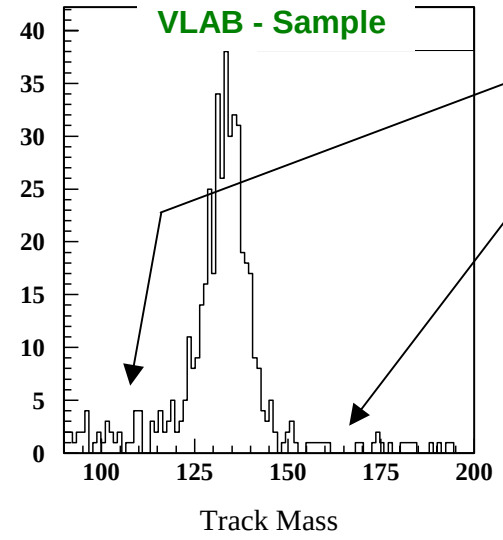
Before Likelihood





After Likelihood





$\mu\mu\gamma$

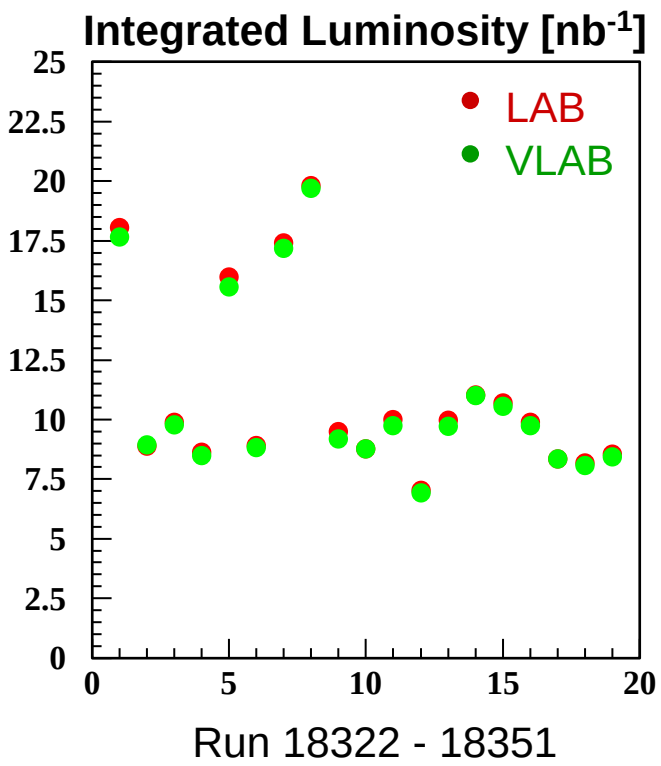
$\pi^+\pi^-\pi^0$

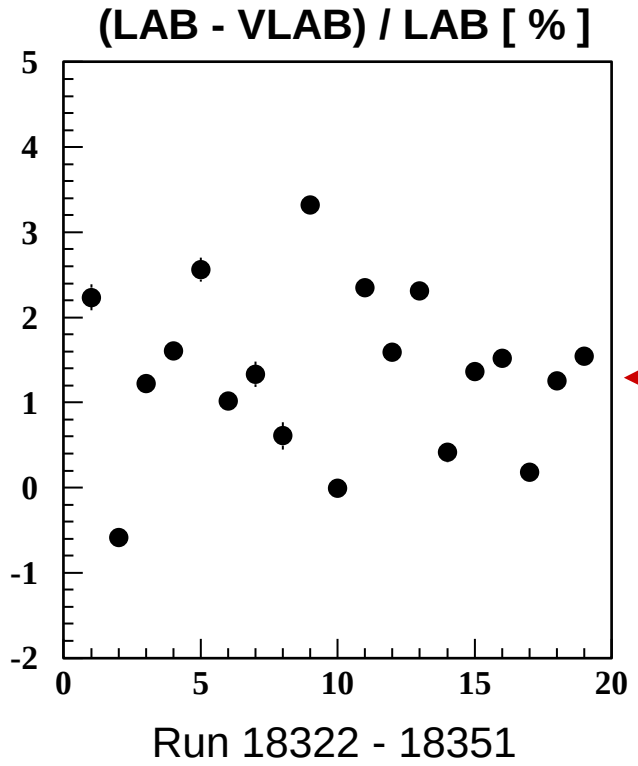
Removed by $E_{+-} > 400$ MeV Cut

0.3 % backgr.

LAB vs VLAB

…. more long term test for DB-V7 going on !





expected difference 1.2 %
due to LAB background

N_{LAB} * (*1 - 1.2%*) / **798.6nb = (*207.0 ± 0.5*) nb^{-1}**

N_{VLAB} * (*1 - 0.3%*) / **424.2nb = (*206.0* ± 0.7)nb^{-1}**

Summary I : VLAB

- VLAB - Routine is well tested and shows expected results;

Most tested and accurate Method for Luminosity - Measurement

$\delta L / L < 2\%$

- Inserted in Datarec Version 8;
- VLAB had been recalculated recently for DB-V7 and for reprocessing of DB-V6;
- More Work on Systematics Studies has to be done ---> *Outlook*

- Use $\gamma\gamma$ - Counter as independent cross check ---> *GGL*

Outlook

look for Permille Effects !

- 1E6 MC - Production (GEANFI , BABAYAGA) to reduce stat. Error on effective cross section and use latest reconstruction
- FILFO - Efficiency
- Description of Bremsstrahlung at DC walls by GEANFI
- Effect of Beam - Energy
- Effect of Beam - Interaction - Point $\neq$ (0,0,0)

- Number of VLAB - candidates written in DB on a file - by - file - basis
  (statistical accuracy poor for a single run: $30nb^{-1} \rightarrow \delta L = 0.9\ \%$)
- VLAB - Information available on Slow Control

GGL

GGL = Gamma - Gamma - Luminosity

- BABAYAGA Version 2.0 calculates $e^+ e^- \rightarrow \gamma\gamma\,(\gamma\gamma)$
  and allows to use γ - γ - Events for Luminosity - Evaluation

- on FILFO - Level using the same phase space cuts as for LAB:

  $45° < \Theta_\gamma < 135°$
  $E_\gamma > 300$ MeV
  Θ_γ - Acollinearity $< 10°$

  Effective cross section = 118 nb

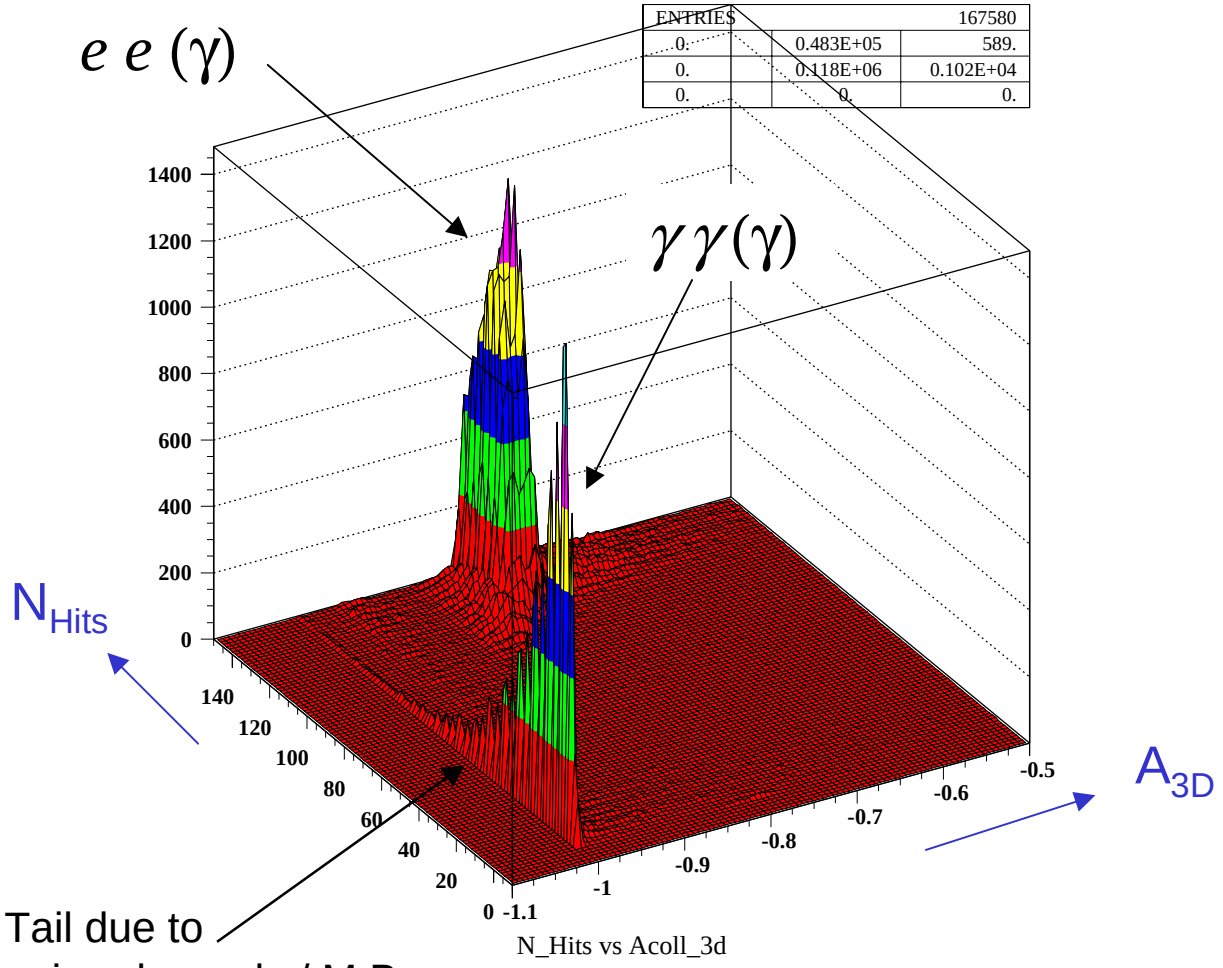
  +

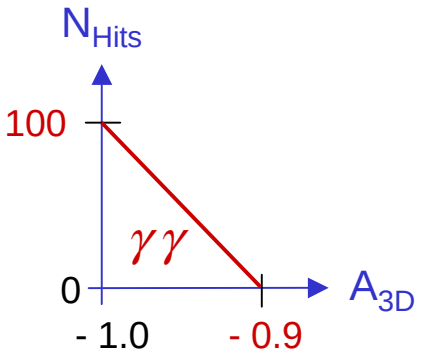
  Cut in Scatterplot N_{Hits} - 3dim. Acollinearity A_{3D}

- Inserted in Datarec Version 8

GGL

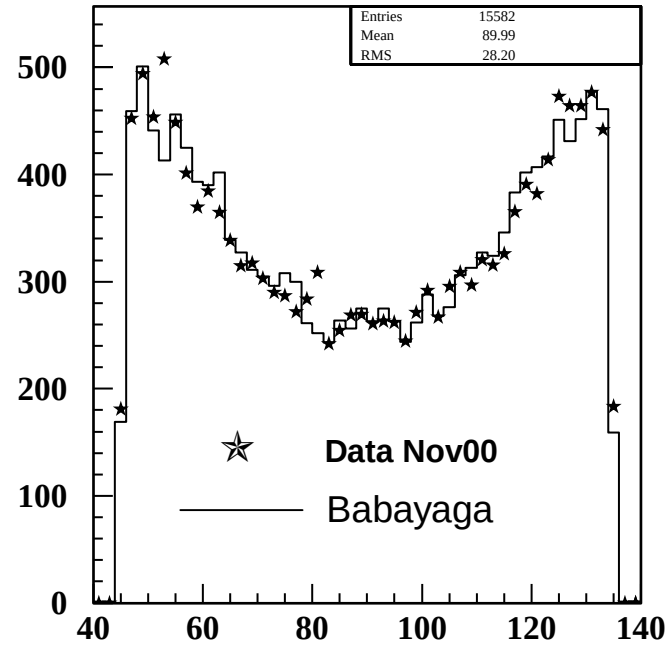
Data Nov 2000



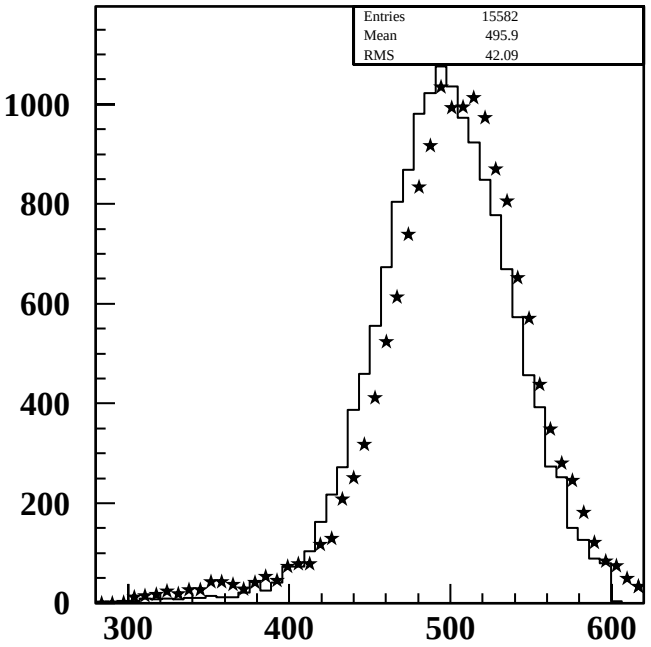


GGL

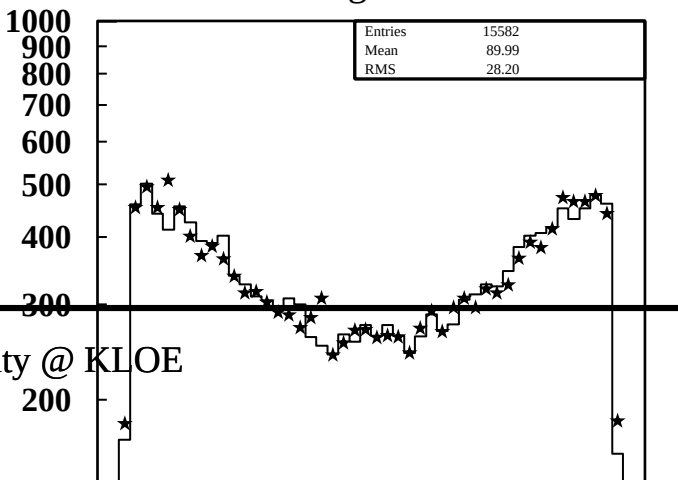
Distributions after GGL Event Selection

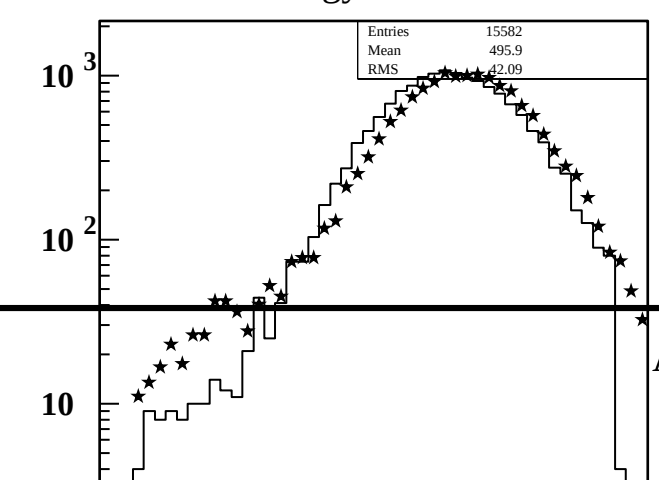


Polar Angle Clusters



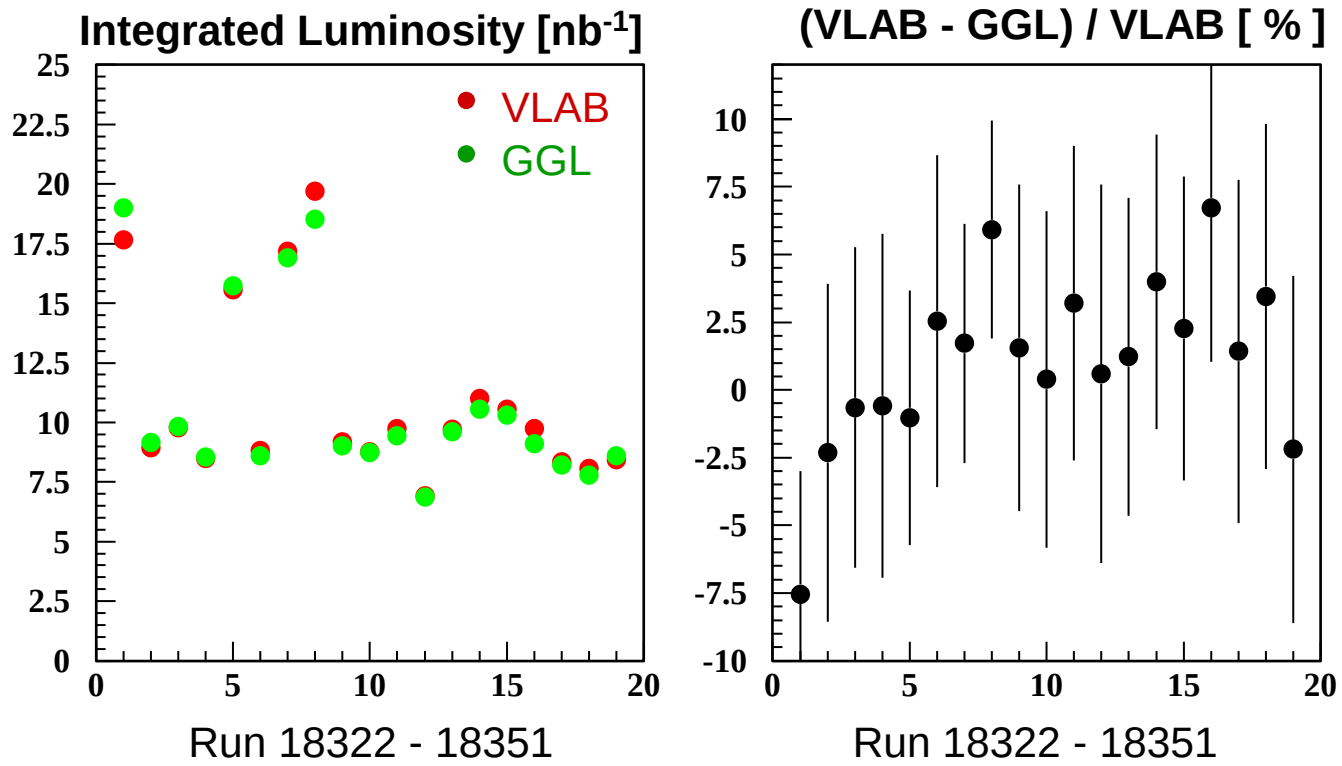
Energy Clusters





GGL vs VLAB

…. more long term test for DB-V7 going on !



N_{VLAB} * (*1 - 0.3%*) / 424.2nb = (***207.0*** ± 0.7) nb^{-1}

N_{GGL} / 117.8nb = (***204.5 ± 1.3***) nb^{-1}

Summary II

- No Limitations for Luminosity Measurement with Systematics on 1% Level found , but further studies have to be done !

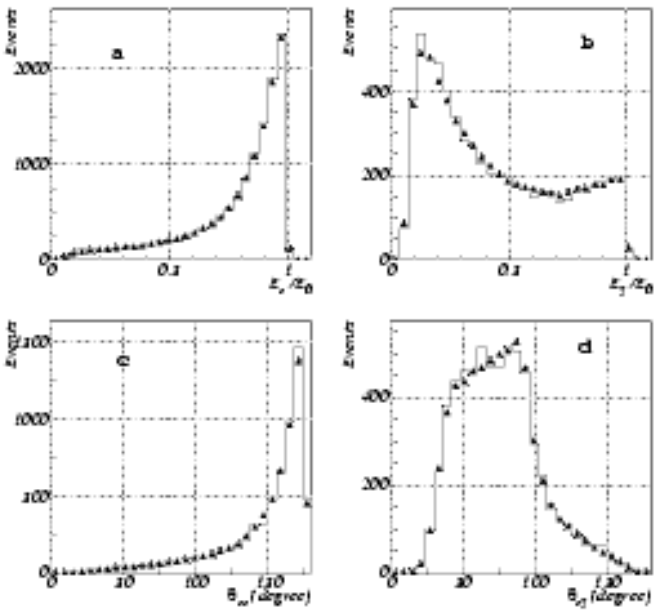
- **According to many theoreticians the theoretical knowledge of the Large Angle Bhabha Process on the Percent-Level is very challenging**

  all we can say:
  Berends - and BABAYAGA - Generator agree on permille level

- **Bhabha Studies were so far intended for Luminosity Measurement**

  in addition are we able to extract some physics ?

  Study of QED processes $e^+e^- \rightarrow e^+e^-\gamma(\gamma)$ with the SND detector at VEPP-2M Eur.Phys.J.C 12(2000)



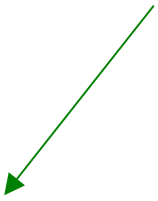
Luminosity @ KLOE

Data

Trigger → Bhabhas on Barrel

EmC Reconstruction

Golden Bhabha & $\gamma\gamma$ $\Theta > 25°$ ← **FILFO** → LAB $\Theta > 45°$



GGL: γ γ

Θ > 45°

DC
Reconstruction

VLAB (precise!)

Θ > 55°, DC - Info

VLAB

Starting sample: FILFO LAB -sample
minimum bias due to FILFO - LAB - selection!

55° **<** Θ_{+-} **<** ***125 °***
Acoll. (r, φ) < ***9°***
300 **MeV <** E_{+-} **<** ***800*** **MeV**

Events Selection:

2 Tracks from I.P. with opp. charge
(r_{xy} < *7.5* cm; r_z < *15* cm)
First Hits are separated from each other > 50 cm

VLAB Cuts:

55° **<** Θ_{+-} **<** ***125 °*** (only Barrel EmC)
Acoll. (r, φ) < ***9°***
400 **MeV <** E_{+-} **<** ***600*** **MeV**

Θ_{+-} = EmC: Polar Angle Resolution (ca. *0.1* °)
E_{+-} = DC Tracks: σ_E = 1.1 MeV

Effective cross section = 424 nb
0.15% statistical error per 1 pb^{-1}

Ratio
VLAB / LAB

MC: 100%

Data: 100% - 1.2%
contamination

MC: (52.9 ± 0.6) %

Data: (52.6 ± 0.2) %