Status of $\Xi^0 \rightarrow \Lambda^0\gamma$ analysis

February 14, 2004

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•**Abstract Submitted for the APR04 meeting of The American Physical Society:**

We have measured the Branching Ratio and Asymmetry of the Weak Radiative Ξ^0 Decay into $\Lambda^0\gamma$ using KTeV data obtained during the 1999 run period. The normalization mode was the decay $\Xi^0 \rightarrow \Lambda^0\pi^0$. We have identified a total of 5,770,829 $\Xi^0 \rightarrow \Lambda^0\pi^0$ and a total of 3,056 $\Xi^0 \rightarrow \Lambda^0\gamma$ decays (with an estimated 11.5% background therein). The Branching ratio has been measured to be:

Br($\Xi^0 \rightarrow \Lambda^0\gamma$)=(1.22 ± 0.03 ± 0.04)x$10^{-3}$ Br($\Xi^0 \rightarrow \Lambda^0\pi^0$)

and the Asymmetry: $\alpha(\Xi^0 \rightarrow \Lambda^0\gamma)$= -0.73 ± 0.10

Updated long writeup at: /home/user1/christo/ktevnotes/lg/lg.ps

$\bar{\Xi}^0 \rightarrow \bar{\Lambda}^0\pi^0$ selection

- $N_{nclus} > 1$ $N_{track} = 2$

- Fiducial cuts for $\bar{\Lambda}^0$ and $\bar{\Xi}^0$ vertices and $\bar{\Lambda}^0$ mass cut:
  The $\bar{\Xi}^0$ vertex is calculated by the center of gravity method.
  $|M_{\bar{\Lambda}^0} - 1.115684| < 0.010$ (GeV), $Z_{vtx\bar{\Lambda}^0} > Z_{vtx\bar{\Xi}^0}$
  $95.m < Z_{vtx} < 158.m$, $0.00043 < Y_{vtx}/Z_{vtx}$,
  $0.000376 < X_{vtx}/Z_{vtx} < 0.00124$

- Proton and pion momentum and containment cuts
  $0.08m < |X_P| < 0.22m$ and $|Y_P| < 0.07m$
  $0.235m < |X_{\pi^-}|$ or $|X_{\pi^-}| < 0.065m$ or $|Y_{\pi^-}| > 0.085m$
  $85.GeV < P_P < 600.GeV$ and $5.GeV < P_{\pi^-} < 150.GeV$
  $E_{\pi^-}(CSI)/P_{\pi^-} < 0.9$

- Kaon rejection cut: $M_K > 0.55GeV$

- $K_1 > 5.0$ GeV, $K_1 + K_2 > 18.0$ GeV. ($K_{ncl} > 1.0$GeV)

- Good separation of clusters on CSI:
  $d(\pi^-, \gamma_1) > 0.2m$, $d(\pi^-, \gamma_2) > 0.2m$, $d(\gamma_1, \gamma_2) > 0.2m$

$\Xi^0 \rightarrow \Lambda^0\gamma$ selection

- N_{nclus} = 1 or 2 N_{track} **=2** k>5.GeV and d($\gamma\pi^-$)>20.cm
- Fiducial cuts for Λ^0 and Ξ^0 (center of gravity method) vertices and Λ^0 mass cut

  $|M_{\Lambda 0}$ -1.115684|<0.005GeV $Z_{vtx\Lambda 0}>Z_{vtx\Xi 0}$

  95.m< Z_{vtx}<158.m, 0.00043<Y_{vtx}/Z_{vtx}, 0.000376<X_{vtx}/Z_{vtx}<0.00124
- Proton and pion momentum and containment cuts (same as $\Lambda^0\pi^0$).
- $|M_{\Xi 0}$ -1.315|<0.04GeV,$P_{T\Xi 0}$<0.07GeV ,$P_{T\Lambda 0}$(primary)>0.03GeV,$|\Delta Z_{\Xi 0}|$<15.m
- If N_{clus}=2 $M_{\pi 0}$<0.1GeV, $|Z_{\pi 0}-Z_{\Xi 0}|$>10.0m, M_K>0.55GeV
- F_{k1}<0.025mm, F_{k2}>0.05mm

$$F = \frac{(y_k - y_\Lambda)P_x^\Lambda - (x_k - x_\Lambda)P_y^\Lambda}{P_z^\Lambda} + \frac{x_k y_\Lambda - x_\Lambda y_\Lambda}{Z_{CSI}} \qquad P_x^T = P_y^T \Rightarrow F = 0$$

- Kaon rejection cut M_K>0.5GeV.
- χ^2<2.65

$$\chi^2 = \left(\frac{k_{miss}}{3.55}\right)^2 + \left(\frac{\Delta z_\Xi}{3.07}\right)^2 + \left(\frac{E_\gamma - 41.94}{18.48}\right)^2$$

$$k_{miss} = \frac{(1.3149 GeV)^2 - M_\Xi^2}{2(E_\Xi - P_\Xi)}$$

Trigger 10 and 11 results. UPA043-UPA333

	Total Trigger 10	Trigger 10.!11 +Trigger 10.11	Flux
$\Lambda^0\pi^0+\bar{\Lambda}^0\pi^0$	5,605,305	4,795,002+810,303	116,372,654 ± 270,270
$\Lambda^0\pi^0$	5,140,582	4,397,967+742,615	106,724,464 ± 248,233
$\Lambda^0\gamma+\bar{\Lambda}^0\gamma$	3,020-(307+34)	2,532+488-(307-34)	143,364 ± 3,272
$\Lambda^0\gamma$	2,737-(282+31)	2,291+446-(282+31)	129,718 ± 3,089

	Total Trigger 11	Trigger 11.!10 +Trigger 10.11	Flux
$\Lambda^0\pi^0+\bar{\Lambda}^0\pi^0$	1,492,417	682,114+810,303	30,614,548 ± 73,484
$\Lambda^0\pi^0$	1,372,862	630,247+742,615	28,162,068 ± 67,940
$\Lambda^0\gamma+\bar{\Lambda}^0\gamma$	842-(81+9)	354+488-(81+9)	39,418 ± 1,650
$\Lambda^0\gamma$	765-(74+8)	319+446-(74+8)	35,801 ± 1,542

Trigger 10 with Hadron-Anti correction:

	Total Trigger 10	Trigger 10.!11 +Trigger 10.11	Flux
$\Lambda^0\pi^0+\bar{\Lambda}^0\pi^0$	10,518,565	9,000,282+1,518,283	218,377,649 ± 490,214
$\Lambda^0\pi^0$	9,683,726	8,286,682+1,397,044	201,377,649 ± 463,342
$\Lambda^0\gamma+\bar{\Lambda}^0\gamma$	5,565-(577+64)	4,668+897-(577+64)	263,502 ± 4,636
$\Lambda^0\gamma$	5,060-(532+59)	4,237+823-(532+59)	239,154 ± 4,370

Trigger 10 Monte Carlo acceptance studies: ($a_{\Lambda\gamma}$ = -0.70)

	Generated	Trigger 10 acceptance	Trigger 11 acceptance
$\Lambda^0\pi^0$	3,999,908	192,663 (4.82 ± 0.011)%	194,990 (4.87 ± 0.011)%
$\Lambda^0\gamma$	999,907	18,685 (1.87 ± 0.014)%	19,076 (1.91 ± 0.015)%

Monte Carlo background study:

	Generated	Background left
$\Lambda^0\pi^0$	59,080,201	156
$\Sigma^0\gamma$	499,903	44

Branching Ratio result

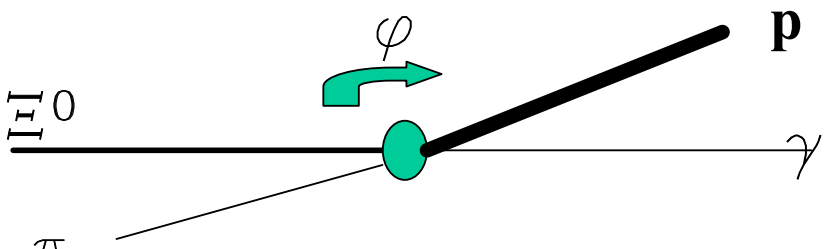
- Trigger 11 $\Lambda^0\gamma + \bar{\Lambda}^0\gamma$: $(1.29 \pm 0.05)\text{x}10^{-3}$
  Trigger 11 $\Lambda^0\gamma$: $(1.27 \pm 0.05)\text{x}10^{-3}$
  Trigger 10 $\Lambda^0\gamma + \bar{\Lambda}^0\gamma$: $(1.23 \pm 0.03)\text{x}10^{-3}$
  Trigger 10 $\Lambda^0\gamma$: $(1.21 \pm 0.03)\text{x}10^{-3}$

  Branching ratio from combined $\Lambda^0\gamma$ data : $(1.22 \pm 0.03)\text{x}10^{-3}$

Branching ratio systematic errors:

Source	**Error**
Trigger	0.02 (1.6%)
Asymmetry	0.02 (1.6%)
$\bar{\Xi}^0$ vertex reconstruction	0.02 (1.6%)
Total	0.04 (3.3%)

Asymmetry measurement.



In order to get the asymmetry of the $\bar{\Xi}^0 \rightarrow \Lambda^0\gamma$ decay we measured in the Λ^0 rest frame of reference the angle φ between the incoming $\bar{\Xi}^0$ and the outgoing proton. More specifically, we constructed the $\cos\varphi$ distribution for an unpolarized data sample, and we compared it with similarly constructed unpolarized Monte Carlo $\cos\varphi$ distributions with various values of asymmetry. For each value of Asymmetry in the Monte Carlo the level of agreement with data was measured by the χ^2 of the two $\cos\varphi$ distributions. The $\alpha(\bar{\Xi}^0 \rightarrow \Lambda^0\gamma)$ was selected to be the one corresponding to the minimum χ^2. After fitting a parabola at the vicinity of minimum (from both trigger 10 and 11 data) : $\alpha(\bar{\Xi}^0 \rightarrow \Lambda^0\gamma) = -0.73\pm0.10$.

Trigger 10: $\alpha = -0.74\pm0.10$ with $\chi^2_{min} = 7.42$ and

Trigger 11: $\alpha = -0.63\pm0.12$ with $\chi^2_{min} = 8.65$

The error comes from the maximum change in the value of asymmetry if we allow that minimum χ^2 to change by 1 unit, as well as from background uncertainties.

Other (recently published) results

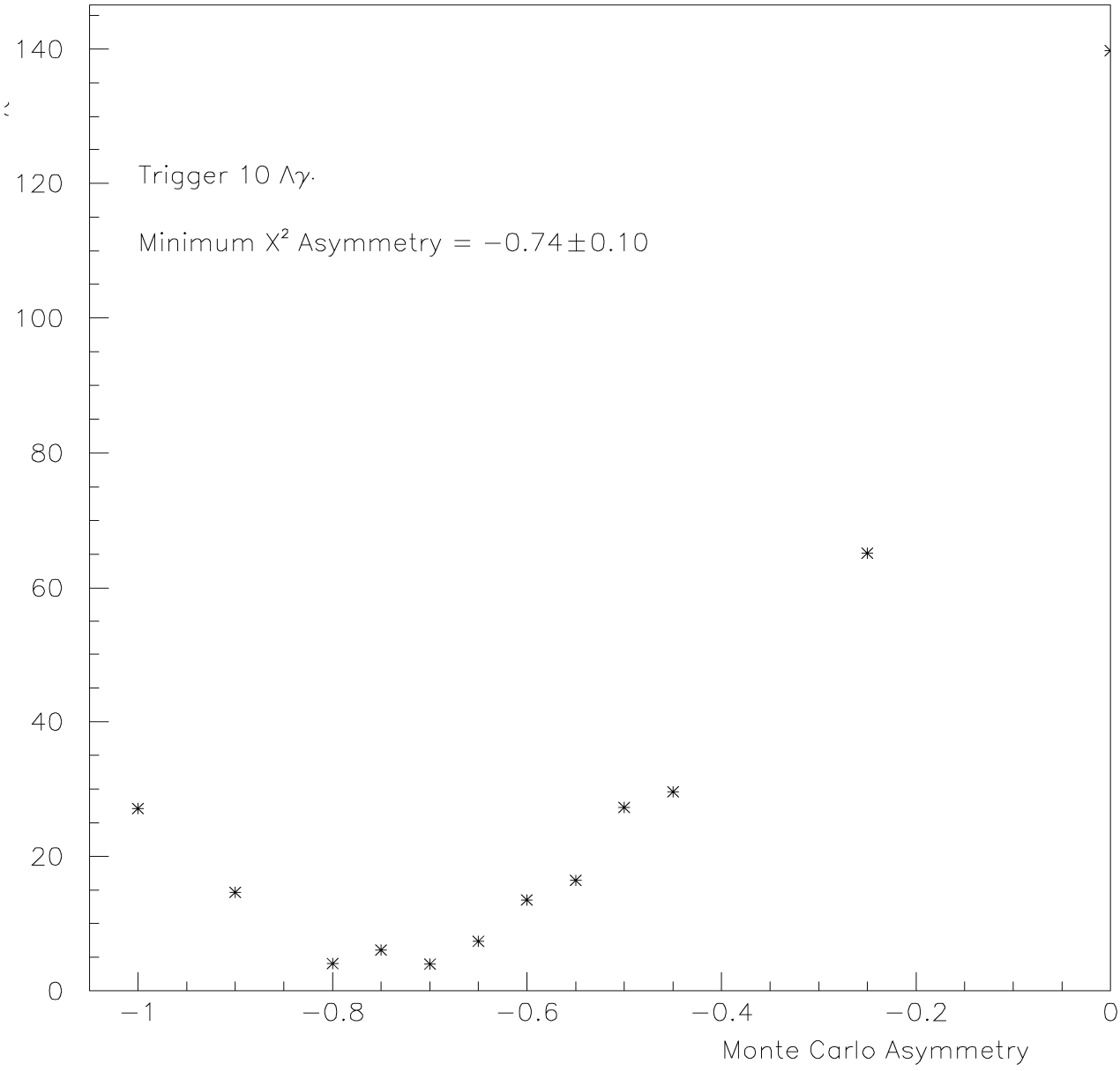
- The NA48 collaboration has recently (January 24 2004) submitted a paper (hep-ex/0401027) with their measurements on the WHRD $\Xi^0 \rightarrow \Lambda^0\gamma$.

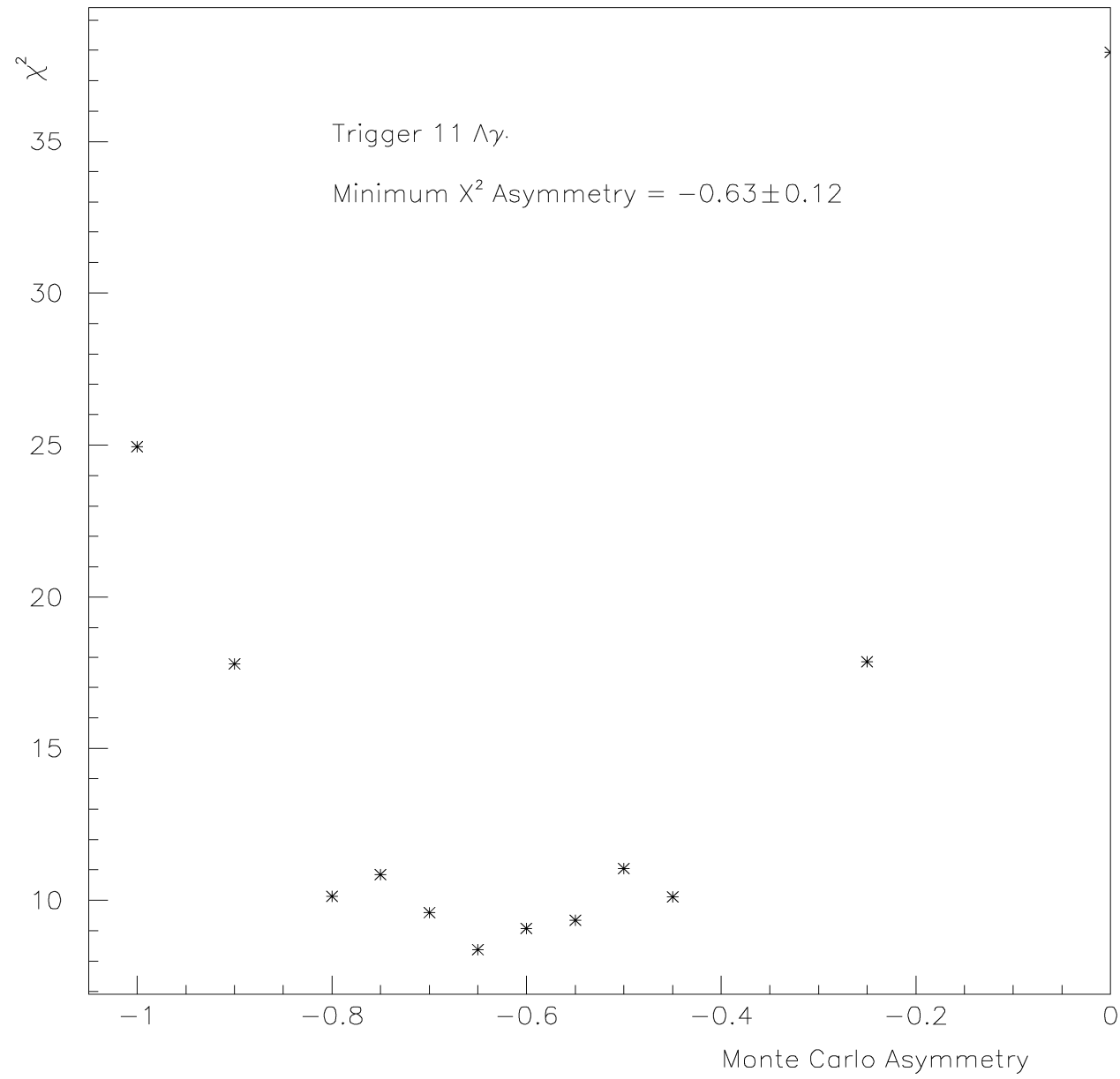
  The values of Branching ratio and Asymmetry they are quoting are:

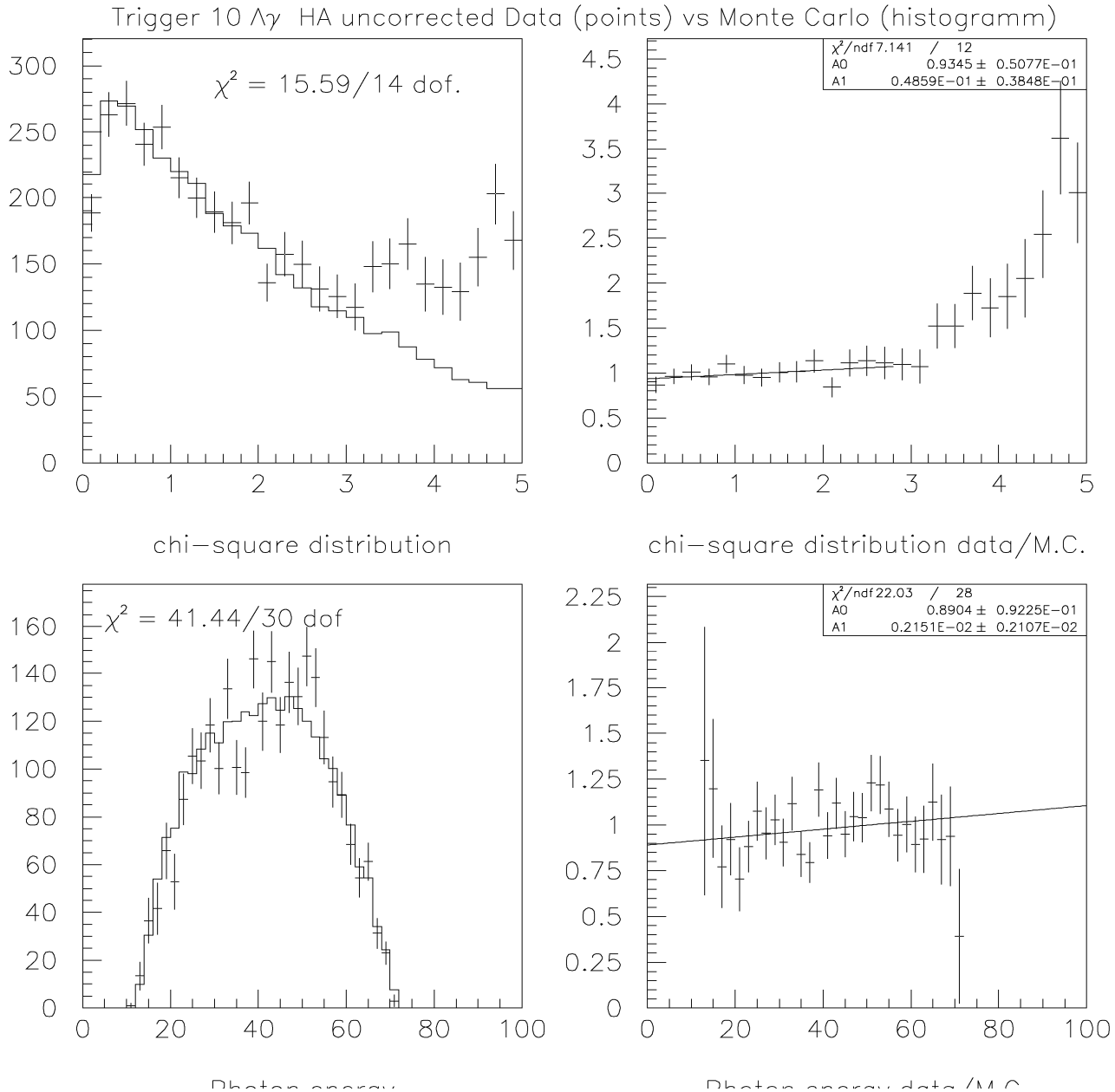
  $Br(\Xi^0 \rightarrow \Lambda^0\gamma) = (1.16 \pm 0.05 \pm 0.06)\text{x}10^{-3}\, Br(\Xi^0 \rightarrow \Lambda^0\pi^0)$

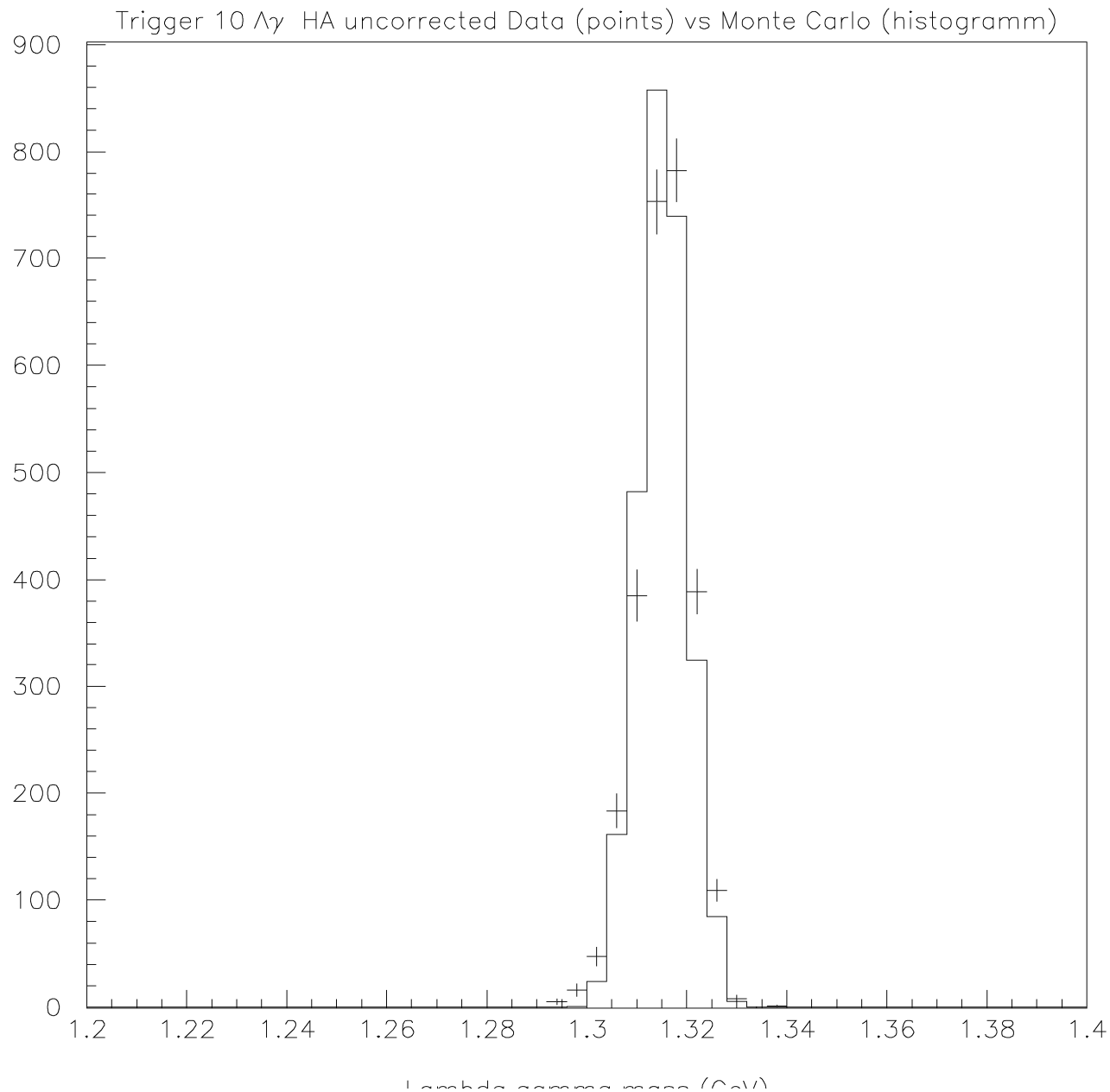
  $\alpha(\Xi^0 \rightarrow \Lambda^0\gamma) = -0.78 \pm 0.18 \pm 0.06$

- We are currently writing a paper based on the results presented.


Trigger 10 Λγ.
Minimum X² Asymmetry = −0.74±0.10
140
120
100
80
60
40
20
0
−1
−0.8
−0.6
−0.4
−0.2
0
Monte Carlo Asymmetry


χ^2
35
30
25
20
15
10
Trigger 11 $\Lambda\gamma$.
Minimum X^2 Asymmetry = -0.63 ± 0.12
−1
−0.8
−0.6
−0.4
−0.2
0
Monte Carlo Asymmetry


Trigger 10 Λγ HA uncorrected Data (points) vs Monte Carlo (histogramm)
χ² = 15.59/14 dof.
chi−square distribution
χ²/ndf 7.141 / 12
A0 0.9345 ± 0.5077E−01
A1 0.4859E−01 ± 0.3848E−01
chi−square distribution data/M.C.
χ² = 41.44/30 dof
χ²/ndf 22.03 / 28
A0 0.8904 ± 0.9225E−01
A1 0.2151E−02 ± 0.2107E−02


Trigger 10 Λγ HA uncorrected Data (points) vs Monte Carlo (histogramm)
900
800
700
600
500
400
300
200
100
0
1.2
1.22
1.24
1.26
1.28
1.3
1.32
1.34
1.36
1.38
1.4