



Analysis of geometrical cuts efficiency for Λ and K -short reconstruction in the Xe run

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Goals

- Derivation of values for geometric cuts for different cases of the signal value (70, 80, 90 and 100 % of the maximal signal).
- Approximation of the number of Λ and K_S^0 created during the experiment depending on rapidity and Pt.
- Verification of the stability of the geometric cuts for different cases of the signal value.

Data

- Experimental data obtained in the physical session at the beginning of 2023 with a beam energy of 3.8 GeV per nucleon, a CsI target and Xe beam.
- Dubna Cascade Model - Statistical Multifragmentation Model (DCM-SMM) Monte Carlo generator was used to model the data.
- 1 million experimental and Monte Carlo events were analyzed.

Data processing procedure

- Reconstruction of particle tracks was carried out.
- Mathematical algorithms were developed and implemented to search for the $\Lambda \rightarrow p + \pi^-$ and $K_S^0 \rightarrow \pi^+ + \pi^-$ decays:
 - shuffling pairs of particles with different signs
 - calculation of invariant mass
 - imposing a number of geometric restrictions (4) on the parameters of each pair

PV – primary vertex.

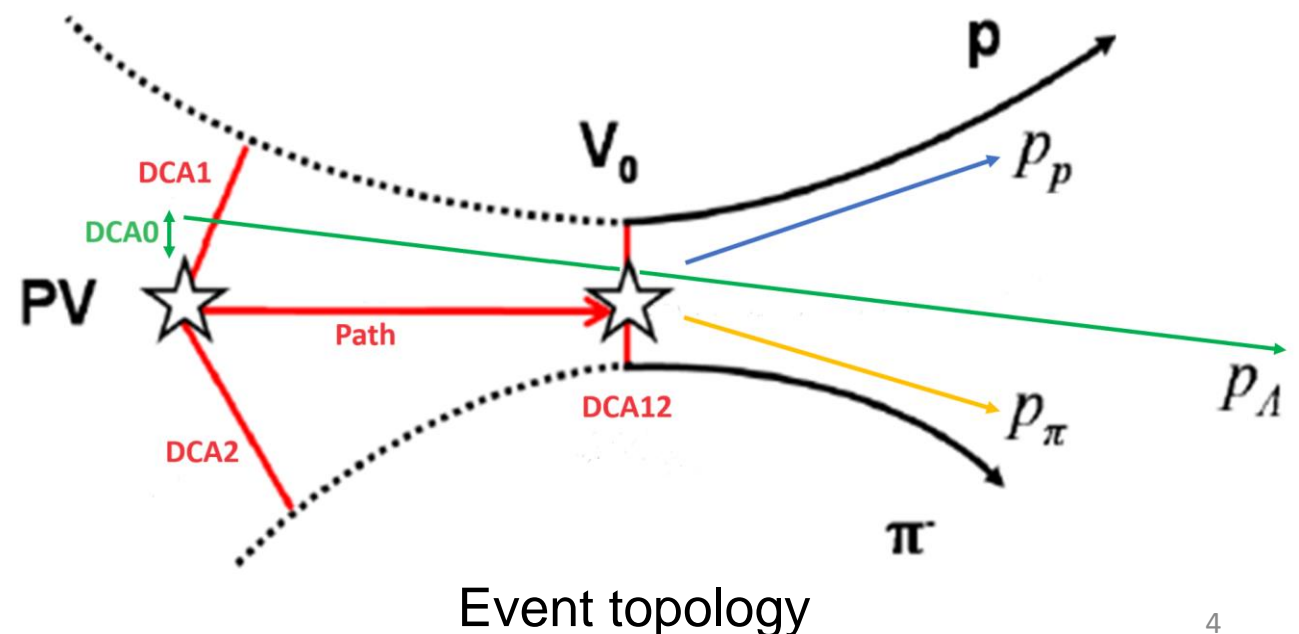
Path – the distance traveled by Λ from the primary vertex to the point of its decay.

DCA0 – the distance between the primary vertex and the projection of momentum of Λ .

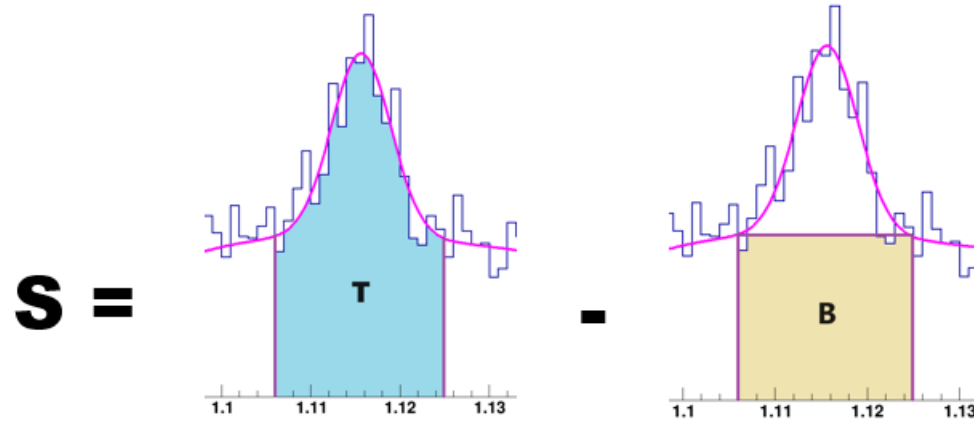
DCA1 – the shortest distance from the proton to the vertex.

DCA2 – the shortest distance from the negative π -meson to the vertex.

DCA12 – the distance between the proton and the negative π -meson at the decay point of Λ .



Fit parameters for signal selection

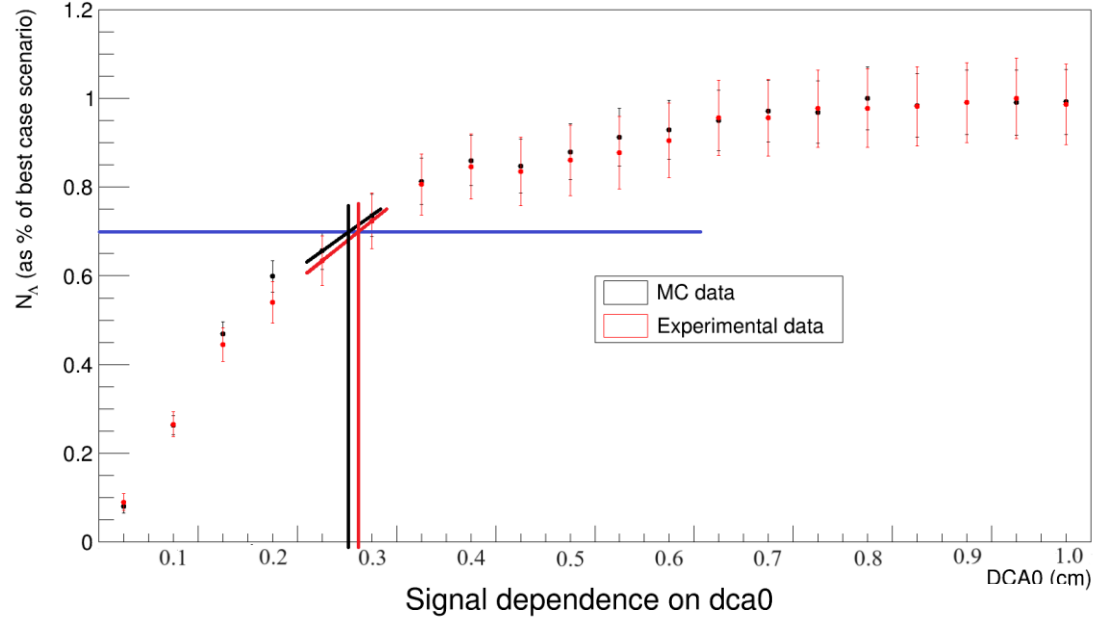


- $BG = A * \sqrt{(m - m_{threshold})} * e^{-B(m - m_{threshold})}$
- Significance: $\frac{S}{\sqrt{T}}$ \longrightarrow chosen as a measure of the optimal value
- Efficiency: $\frac{N_{signal}}{N_{generated}} * 100 \%$

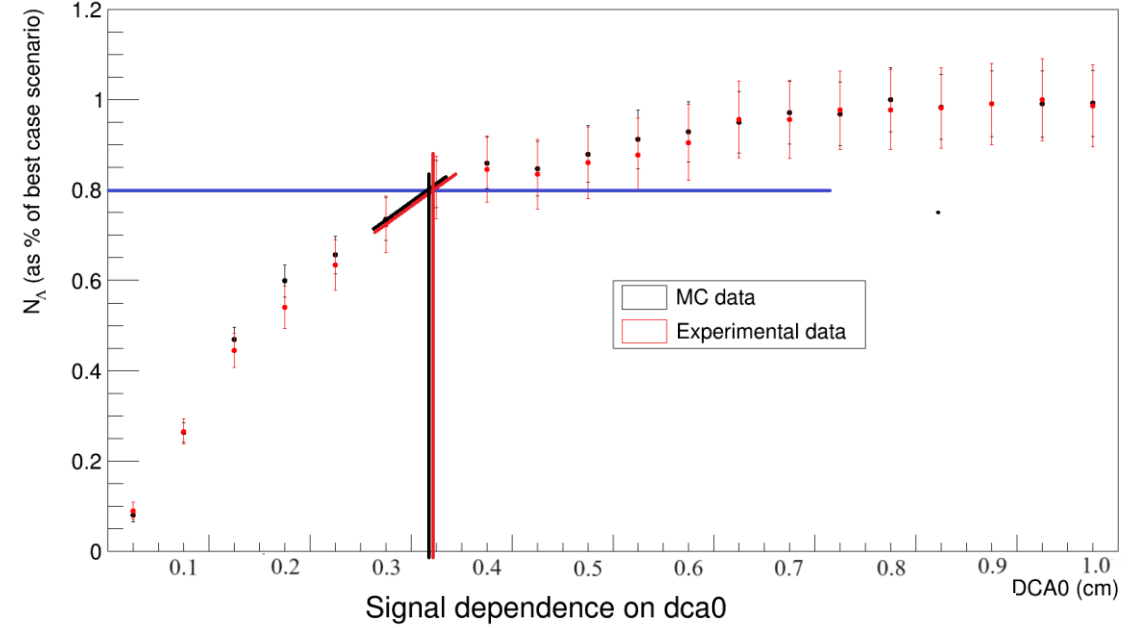
Results

Signal dependence on difference values of geometric restrictions for Δ

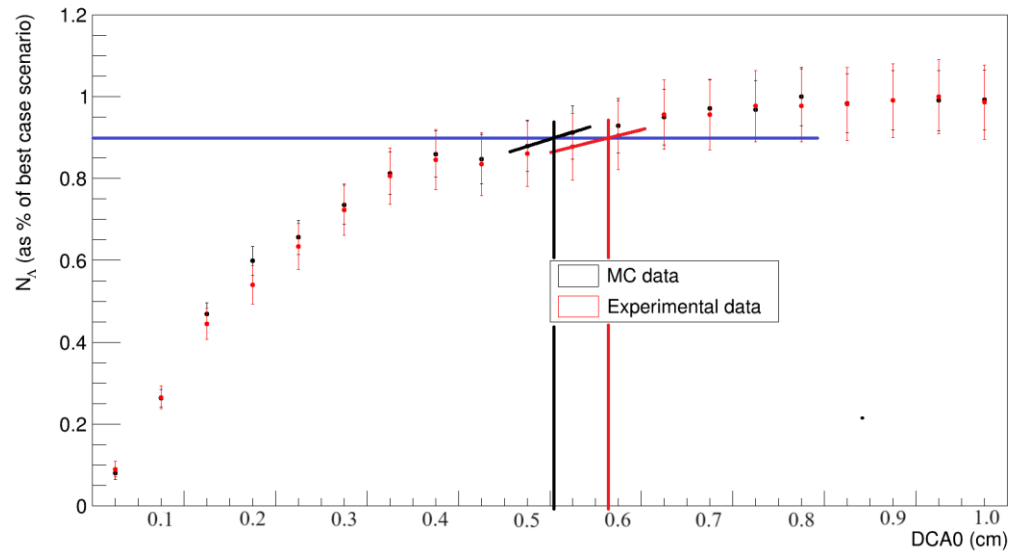
Signal dependence on dca0



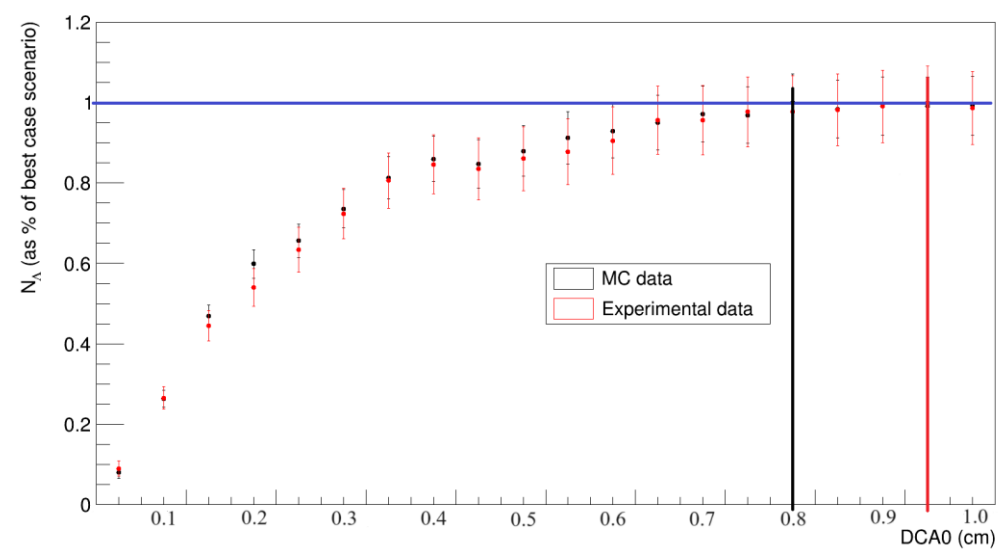
Signal dependence on dca0



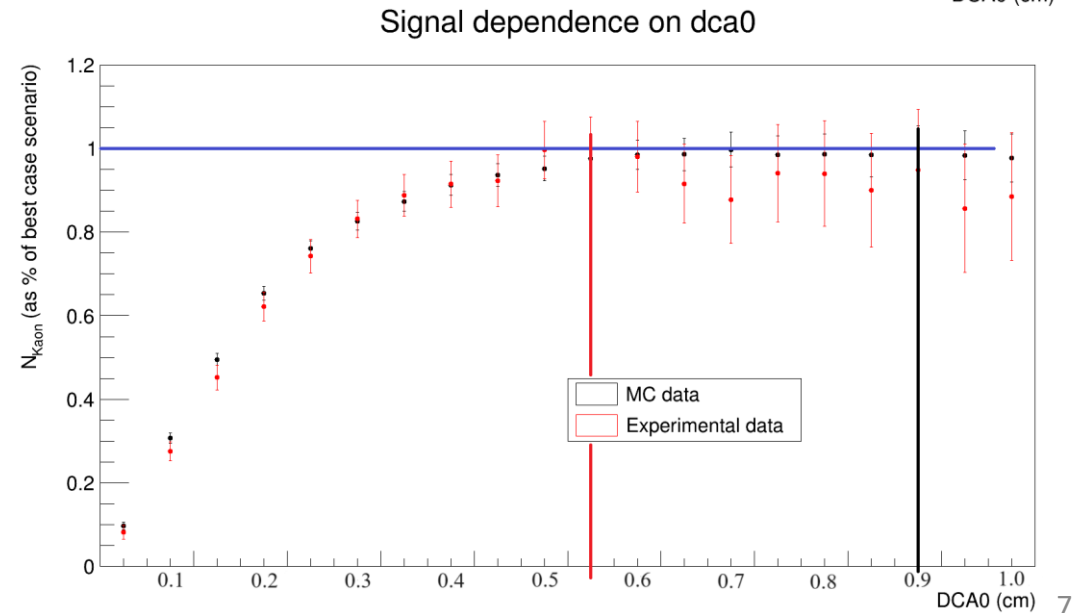
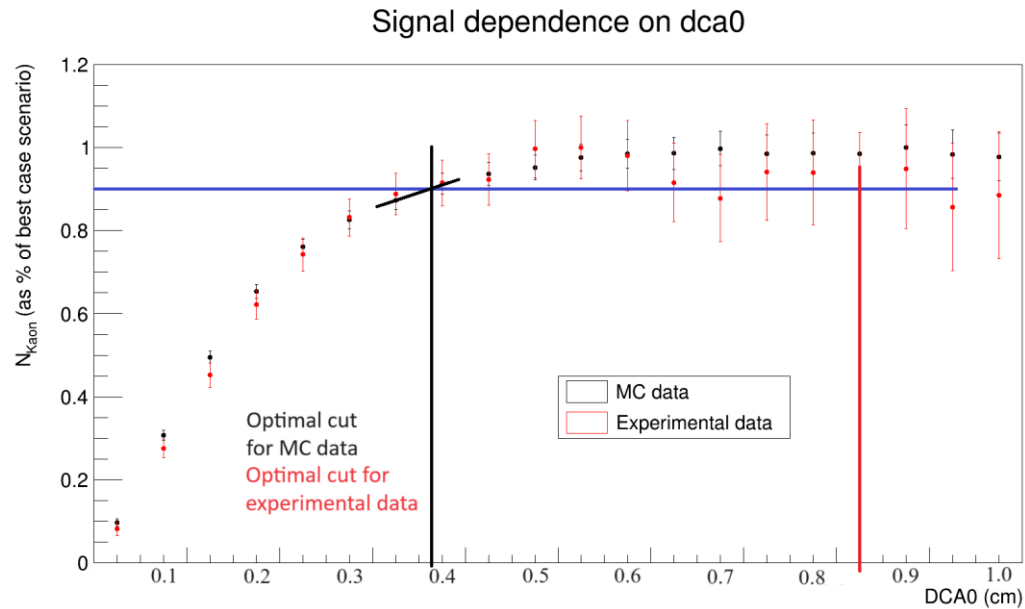
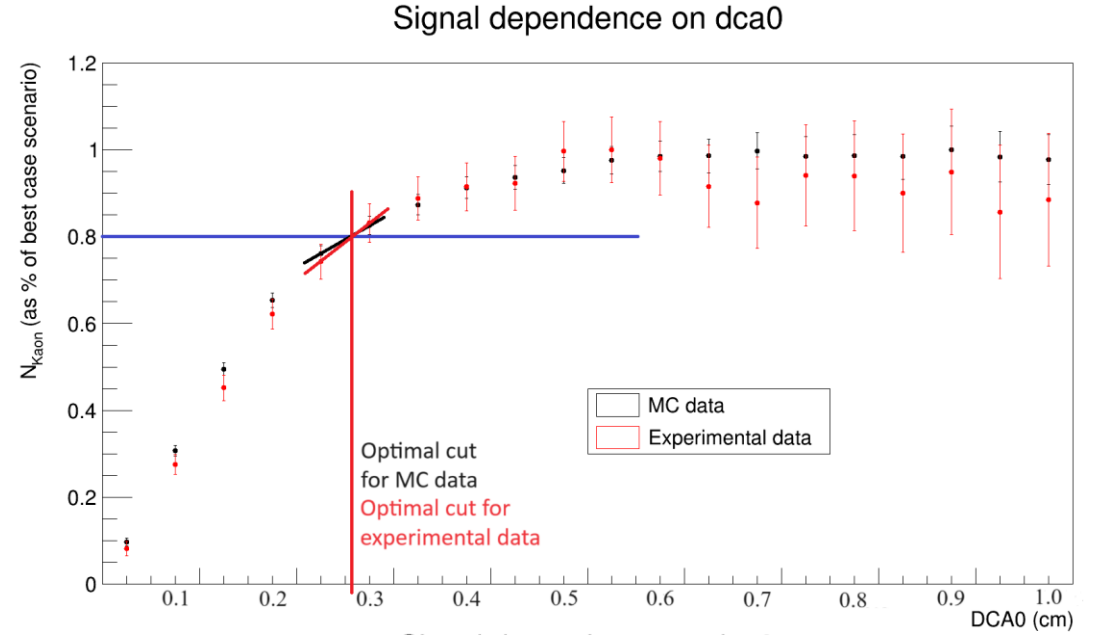
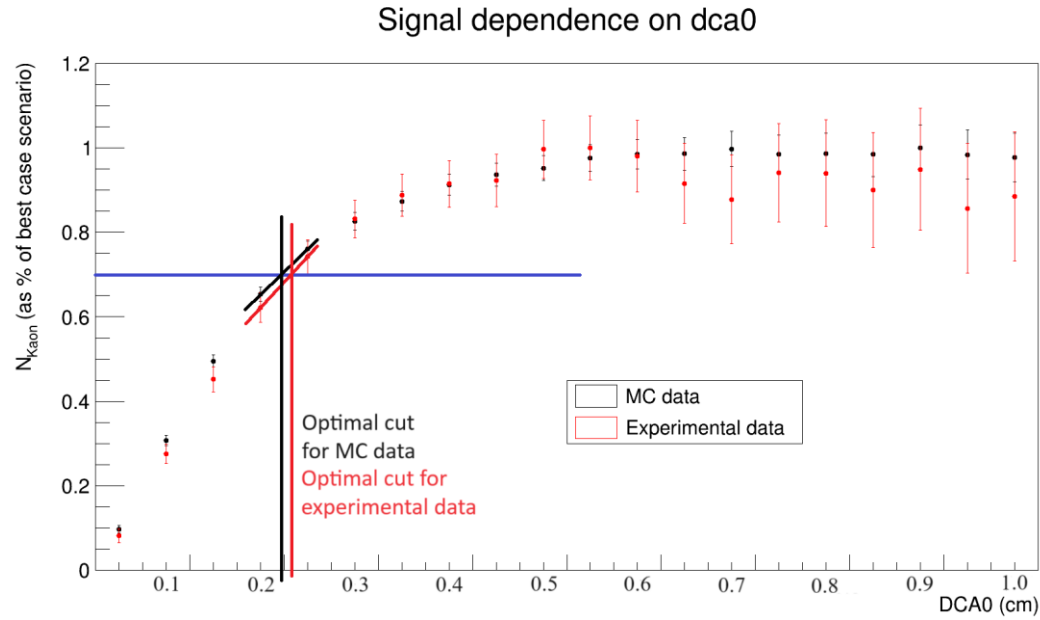
Signal dependence on dca0



Signal dependence on dca0



Signal dependence on difference values of geometric restrictions for K_S^0



Efficiency values

Λ depending on rapidity

Interval rapidity	0.4 - 0.6	0.6 - 0.8	0.8 - 1.0	1.0 - 1.2	1.2 - 1.4
Signal of 100%	0 ± 0	0.795 ± 0.026	2.22 ± 0.040	3.27 ± 0.046	0 ± 0
Signal of 90 %	0 ± 0	0.168 ± 0.012	0.728 ± 0.023	1.38 ± 0.030	0.635 ± 0.021
Signal of 80 %	0 ± 0	0.134 ± 0.011	0.592 ± 0.021	0.963 ± 0.025	0.315 ± 0.015
Signal of 70%	0 ± 0	0.108 ± 0.010	0.448 ± 0.018	0.678 ± 0.021	0.273 ± 0.014

Zero's in the table are caused by an absence of the signal in the interval of interest for the signal value at hand.

Λ depending on Pt

Interval Pt	0 - 0.23	0.23 - 0.46	0.46 - 0.69	0.69 - 0.92	0.92 - 1.15
Signal of 100%	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0
Signal of 90 %	0 ± 0	0.566 ± 0.012	0.573 ± 0.014	0.330 ± 0.014	0 ± 0
Signal of 80 %	0.117 ± 0.006	0.362 ± 0.010	0.359 ± 0.011	0.214 ± 0.011	0 ± 0
Signal of 70%	0.0954 ± 0.006	0.241 ± 0.008	0.251 ± 0.009	0.165 ± 0.010	0 ± 0

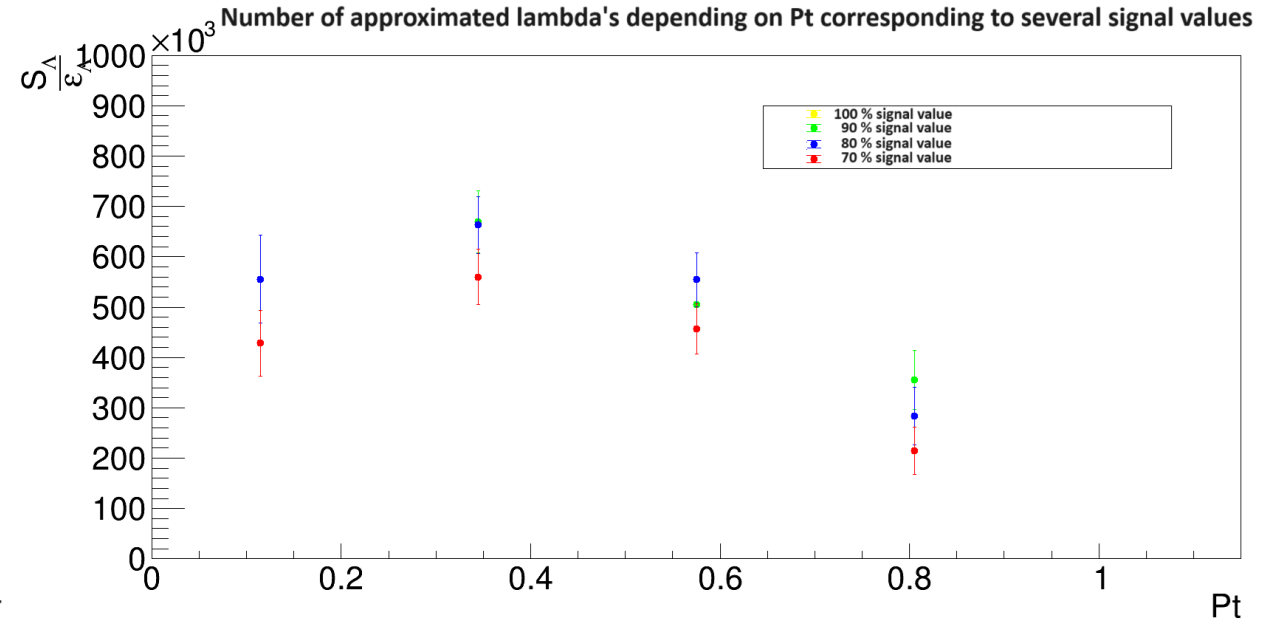
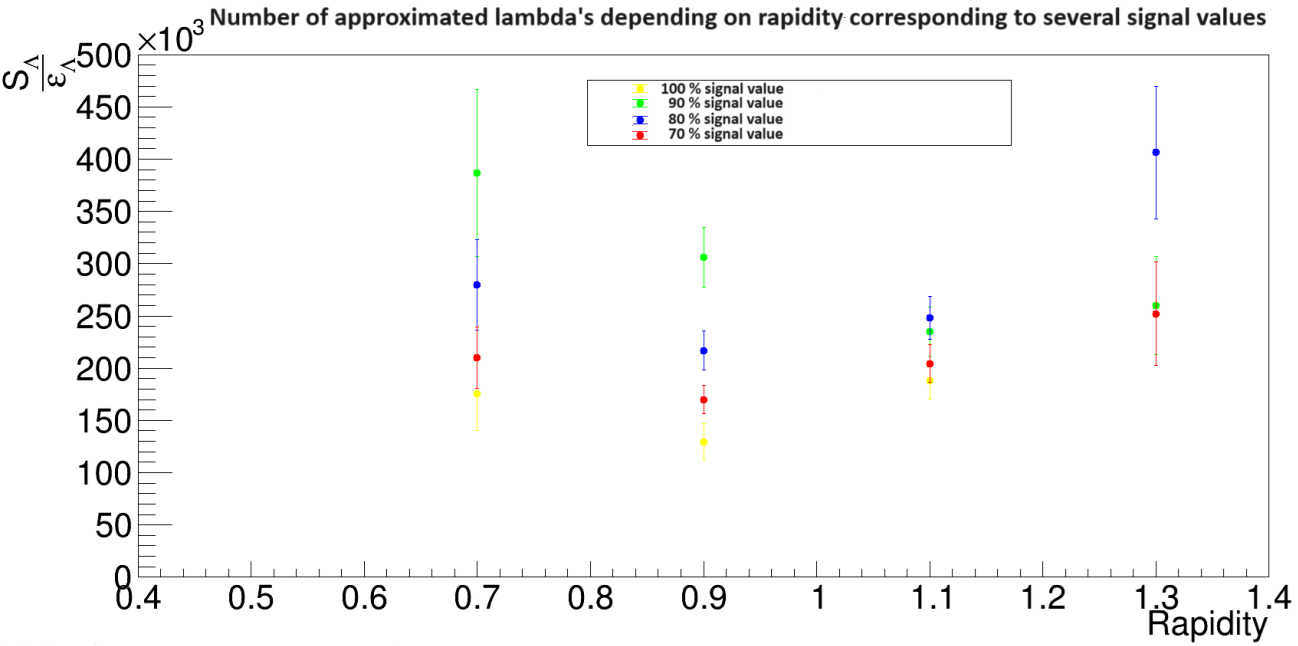
Efficiency values K_S^0 depending on rapidity

Interval rapidity	0.4 - 0.6	0.6 - 0.8	0.8 - 1.0	1.0 - 1.2	1.2 - 1.4
Signal of 100%	2.09 ± 0.063	0 ± 0	0 ± 0	0 ± 0	0 ± 0
Signal of 90 %	1.64 ± 0.056	0.551 ± 0.032	0 ± 0	0 ± 0	0 ± 0
Signal of 80 %	0.861 ± 0.041	0.632 ± 0.034	0 ± 0	0 ± 0	0 ± 0
Signal of 70%	0.539 ± 0.032	0.451 ± 0.029	0 ± 0	0 ± 0	0 ± 0

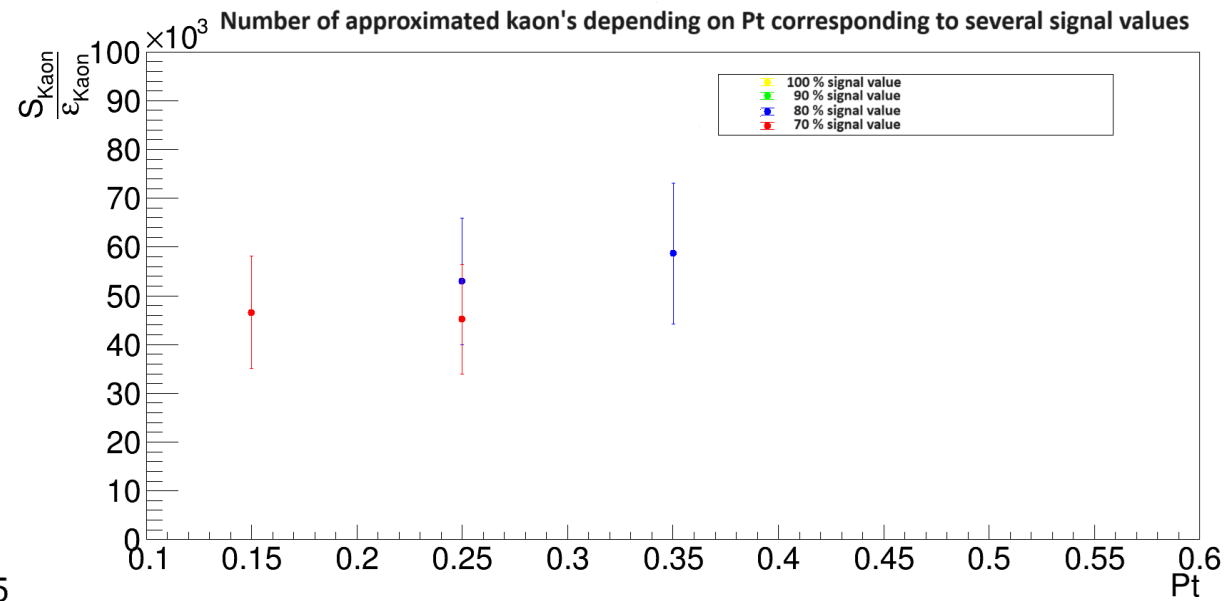
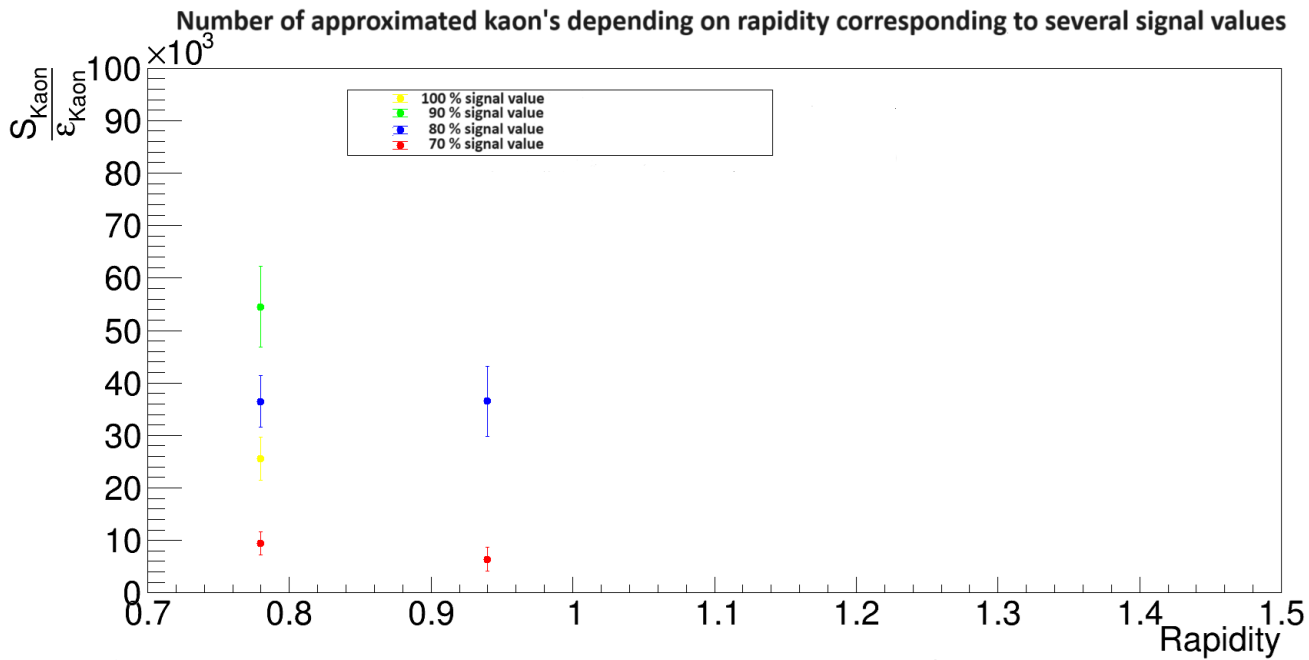
K_S^0 depending on Pt

Interval Pt	0 - 0.23	0.23 - 0.46	0.46 - 0.69	0.69 - 0.92	0.92 - 1.15
Signal of 100%	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0
Signal of 90 %	0.296 ± 0.016	0.284 ± 0.015	0 ± 0	0.415 ± 0.024	0 ± 0
Signal of 80 %	0.113 ± 0.010	0.216 ± 0.013	0.188 ± 0.014	0.201 ± 0.017	0 ± 0
Signal of 70%	0.144 ± 0.011	0.140 ± 0.011	0 ± 0	0 ± 0	0 ± 0

Number of approximated Λ



Number of approximated K_S^0



Conclusions

- Values for geometric cuts for different cases of the signal value were derived.
- The number of Λ and K_S^0 created during the experiment depending on rapidity and Pt were approximated.
- The geometric cuts seem to be unstable which probably has to do with disagreement between the MC and experimental data.

Backup

Cuts Λ

Signal of 70 %

MC:

Experimental:

6.48 cm \leq path \leq 50.0 cm
0.0 cm \leq dca12 \leq 0.255 cm
0.0 cm \leq dca0 \leq 0.275 cm
1.00 cm \leq dca2 \leq 10.0 cm

5.95 cm \leq path \leq 50.0 cm
0.0 cm \leq dca12 \leq 0.230 cm
0.0 cm \leq dca0 \leq 0.287 cm
1.02 cm \leq dca2 \leq 10.0 cm

Signal of 80 %

MC:

Experimental:

5.62 cm \leq path \leq 50.0 cm
0.0 cm \leq dca12 \leq 0.278 cm
0.0 cm \leq dca0 \leq 0.344 cm
0.814 cm \leq dca2 \leq 10.0 cm

4.85 cm \leq path \leq 50.0 cm
0.0 cm \leq dca12 \leq 0.287 cm
0.0 cm \leq dca0 \leq 0.348 cm
0.835 cm \leq dca2 \leq 10.0 cm

Signal of 90 %

MC:

Experimental:

4.51 cm \leq path \leq 50.0 cm
0.0 cm \leq dca12 \leq 0.402 cm
0.0 cm \leq dca0 \leq 0.528 cm
0.645 cm \leq dca2 \leq 10.0 cm

4.08 cm \leq path \leq 50.0 cm
0.0 cm \leq dca12 \leq 0.393 cm
0.0 cm \leq dca0 \leq 0.590 cm
0.651 cm \leq dca2 \leq 10.0 cm

Signal of 100 %

MC:

Experimental:

0.625 cm \leq path \leq 50.0 cm
0.0 cm \leq dca12 \leq 0.867 cm
0.0 cm \leq dca0 \leq 0.800 cm
0.465 cm \leq dca2 \leq 10.0 cm

2.50 cm \leq path \leq 50.0 cm
0.0 cm \leq dca12 \leq 1.02 cm
0.0 cm \leq dca0 \leq 0.950 cm
0.465 cm \leq dca2 \leq 10.0 cm

Cuts K_S^0

Signal of 70 %

Signal of 80 %

MC:

Experimental:

MC:

Experimental:

0.820 cm \leq dca1 \leq 10.0 cm

0.800 cm \leq dca1 \leq 10.0 cm

0.680 cm \leq dca1 \leq 10.0 cm

0.650 cm \leq dca1 \leq 10.0 cm

0.0 cm \leq dca12 \leq 0.275 cm

0.0 cm \leq dca12 \leq 0.375 cm

0.0 cm \leq dca12 \leq 0.363 cm

0.0 cm \leq dca12 \leq 0.550 cm

0.0 cm \leq dca0 \leq 0.223 cm

0.0 cm \leq dca0 \leq 0.233 cm

0.0 cm \leq dca0 \leq 0.281 cm

0.0 cm \leq dca0 \leq 0.281 cm

0.952 cm \leq dca2 \leq 10.0 cm

0.968 cm \leq dca2 \leq 10.0 cm

0.768 cm \leq dca2 \leq 10.0 cm

0.800 cm \leq dca2 \leq 10.0 cm

Signal of 90 %

Signal of 100 %

MC:

Experimental:

MC:

Experimental:

0.504 cm \leq dca1 \leq 10.0 cm

0.504 cm \leq dca1 \leq 10.0 cm

0.400 cm \leq dca1 \leq 10.0 cm

0.400 cm \leq dca1 \leq 10.0 cm

0.0 cm \leq dca12 \leq 0.550 cm

0.0 cm \leq dca12 \leq 0.660 cm

0.0 cm \leq dca12 \leq 0.900 cm

0.0 cm \leq dca12 \leq 1.00 cm

0.0 cm \leq dca0 \leq 0.390 cm

0.0 cm \leq dca0 \leq 0.850 cm

0.0 cm \leq dca0 \leq 0.900 cm

0.0 cm \leq dca0 \leq 0.550 cm

0.584 cm \leq dca2 \leq 10.0 cm

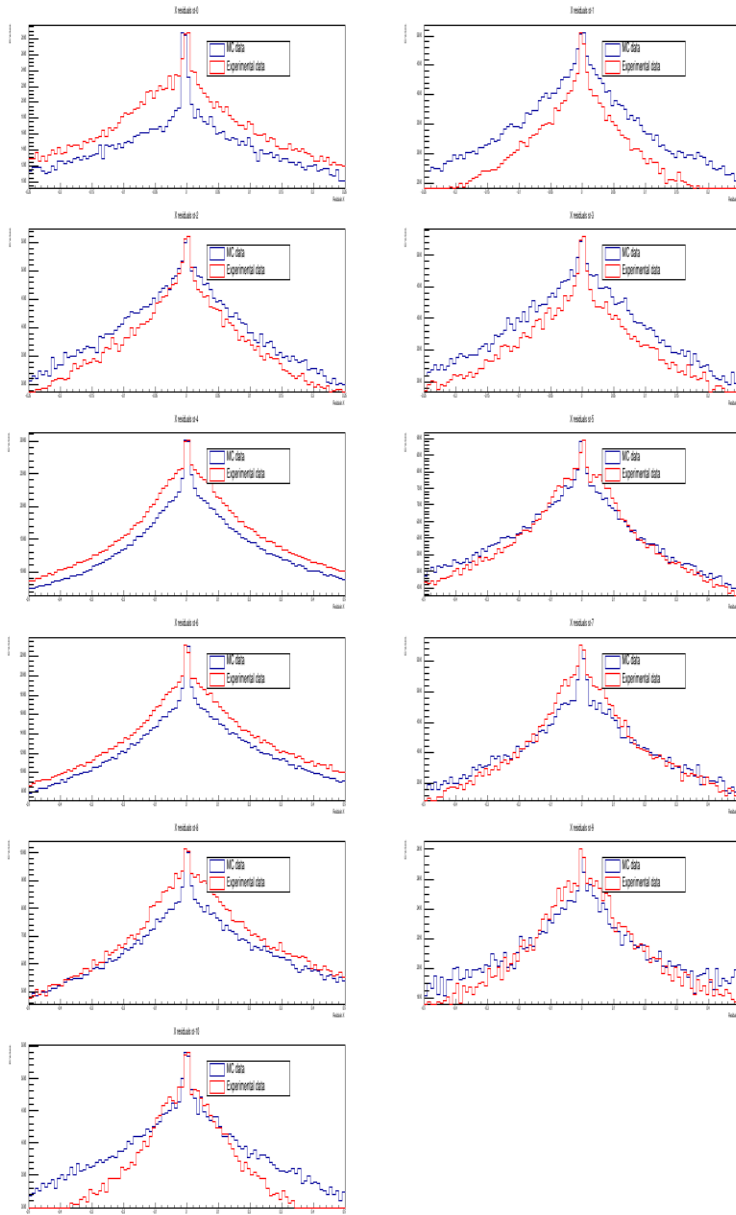
0.600 cm \leq dca2 \leq 10.0 cm

0.400 cm \leq dca2 \leq 10.0 cm

0.400 cm \leq dca2 \leq 10.0 cm

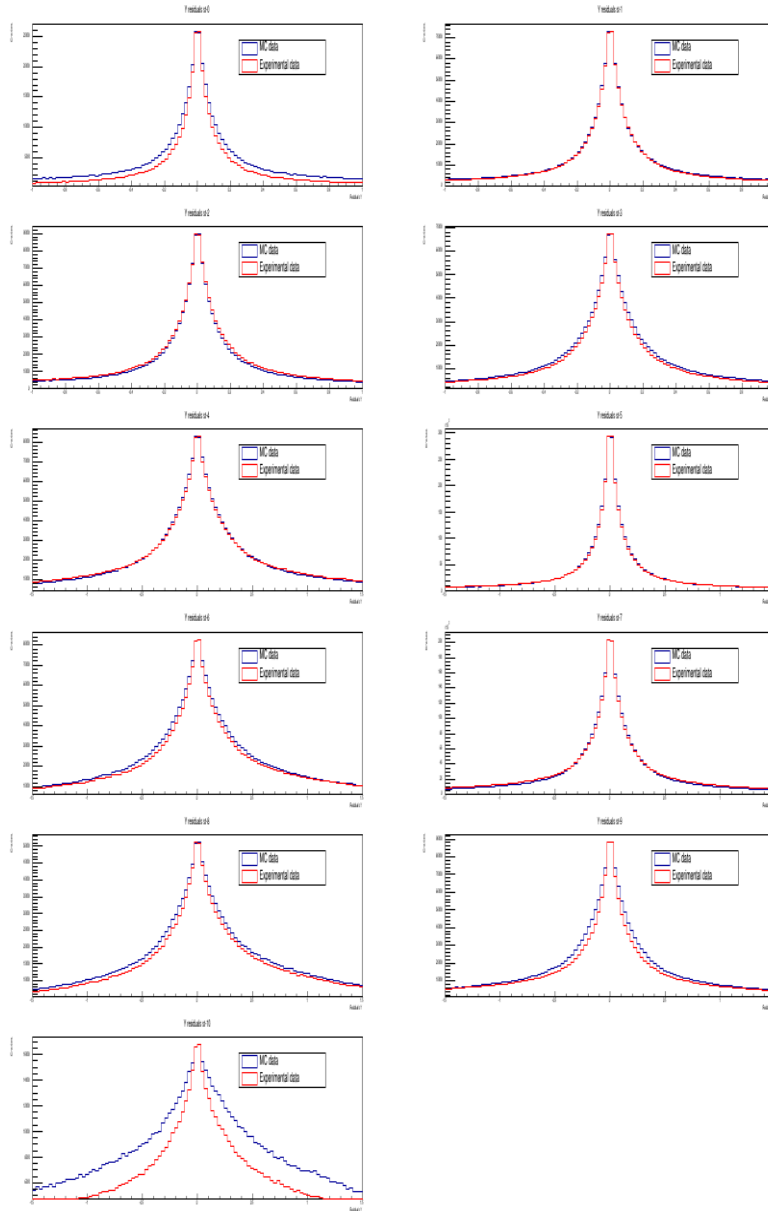
Residuals

X-residuals



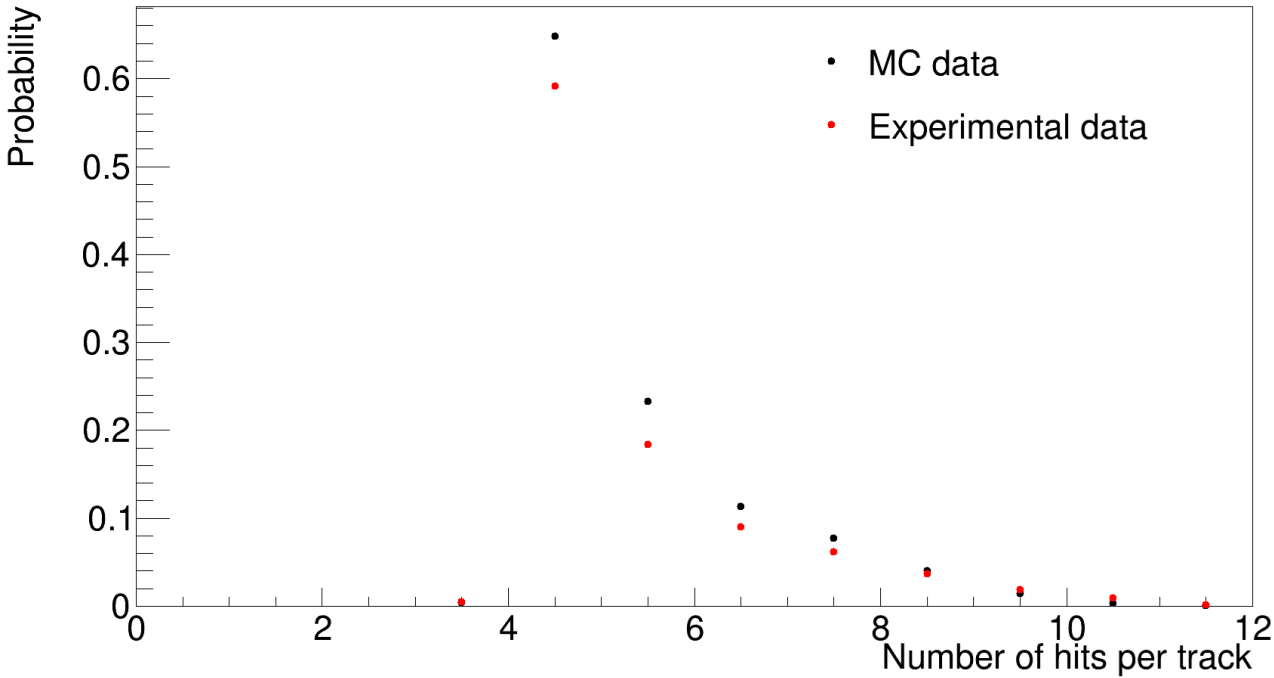
Residuals

Y-residuals

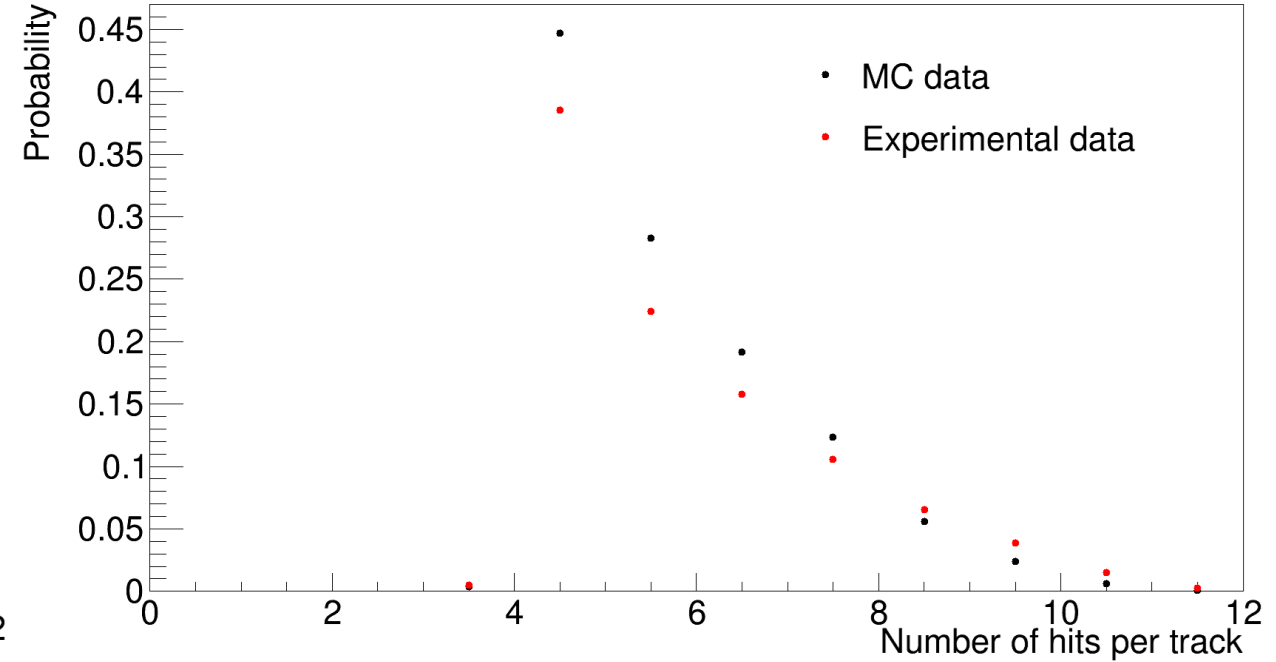


Comparison MC and experimental data

Comparison number of hits per track for negative p

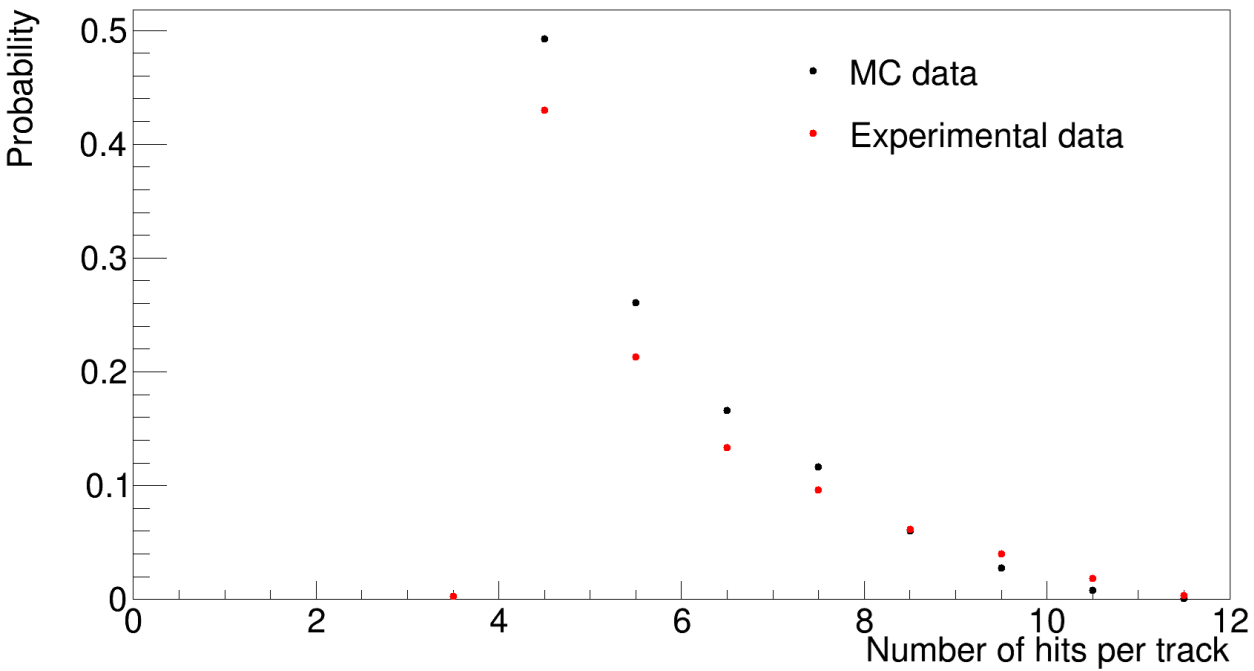


Comparison number of hits per track for positive p

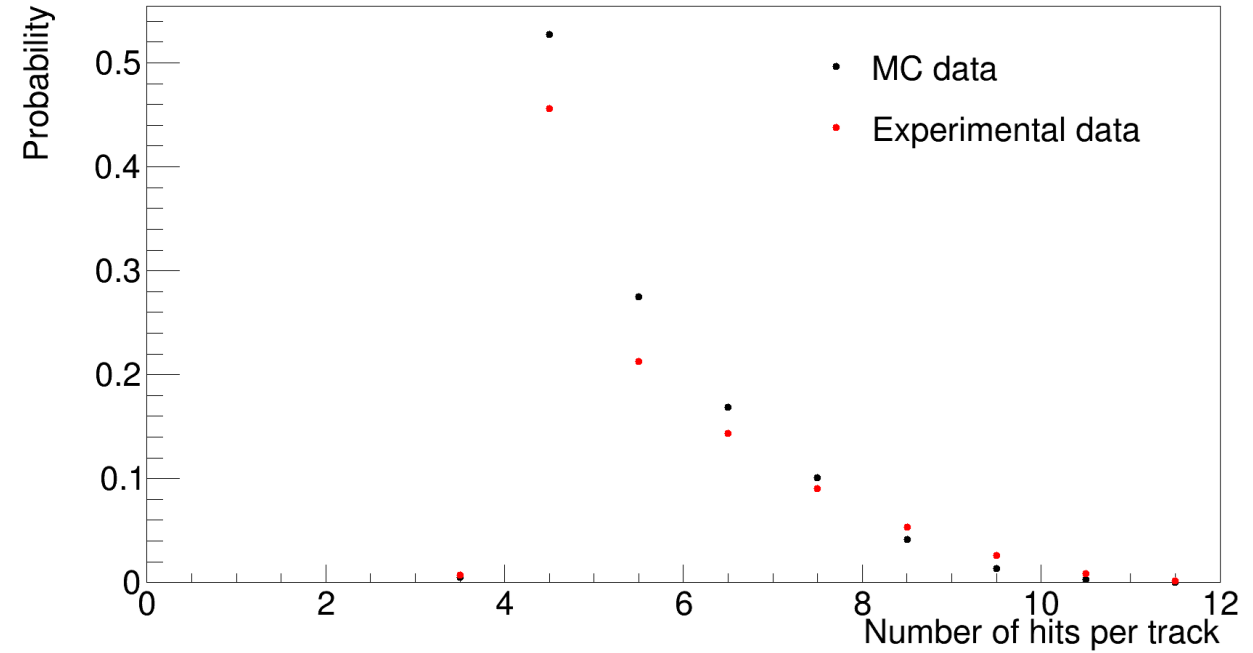


Comparison MC and experimental data

Comparison number of hits per track for positive y



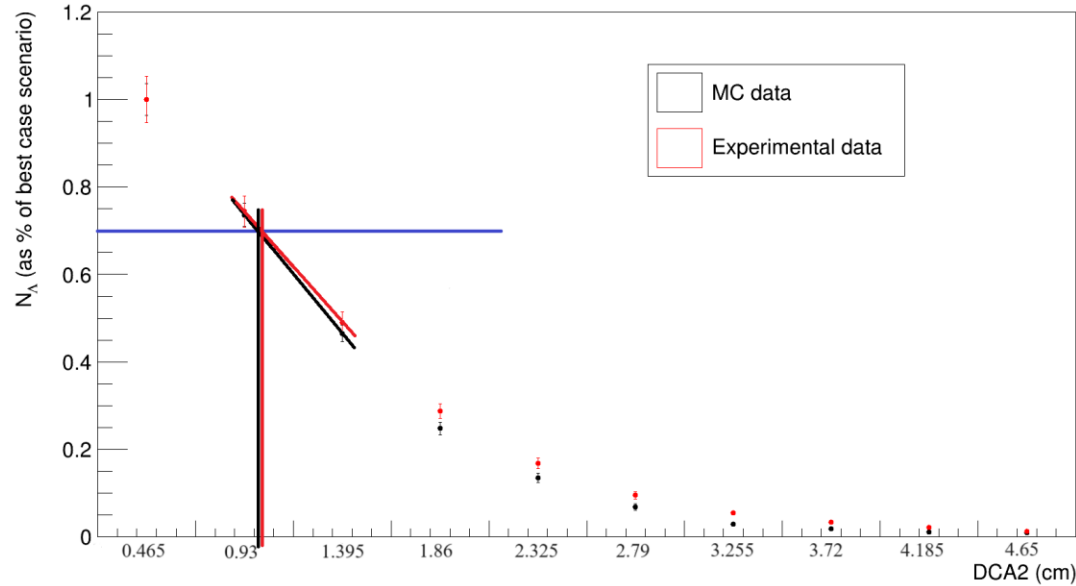
Comparison number of hits per track for negative y



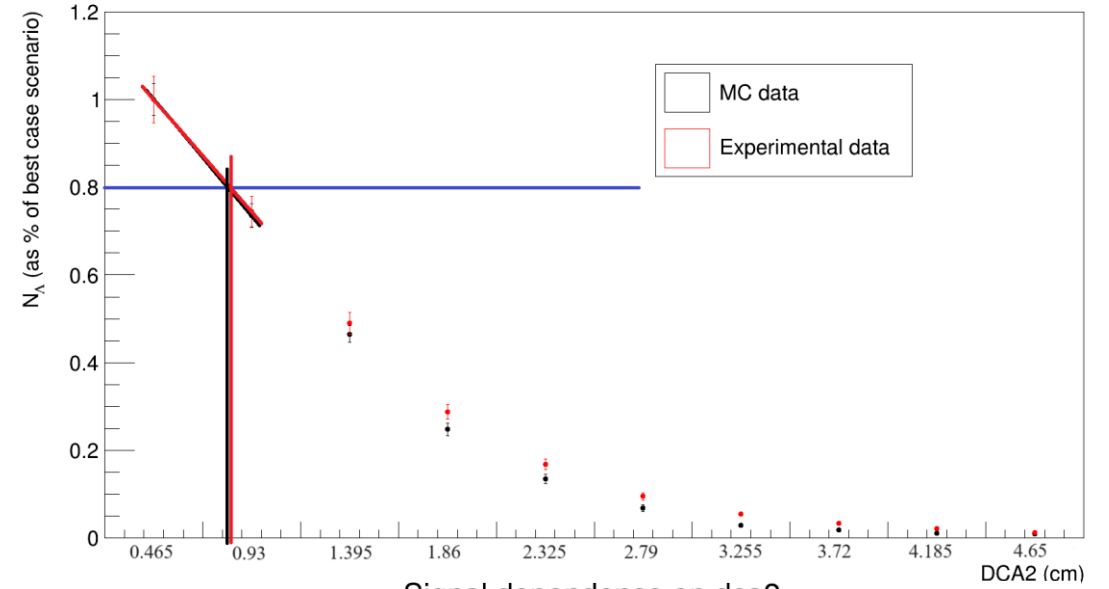
Signal analysis

Signal dependence on difference values of geometric restrictions for Λ

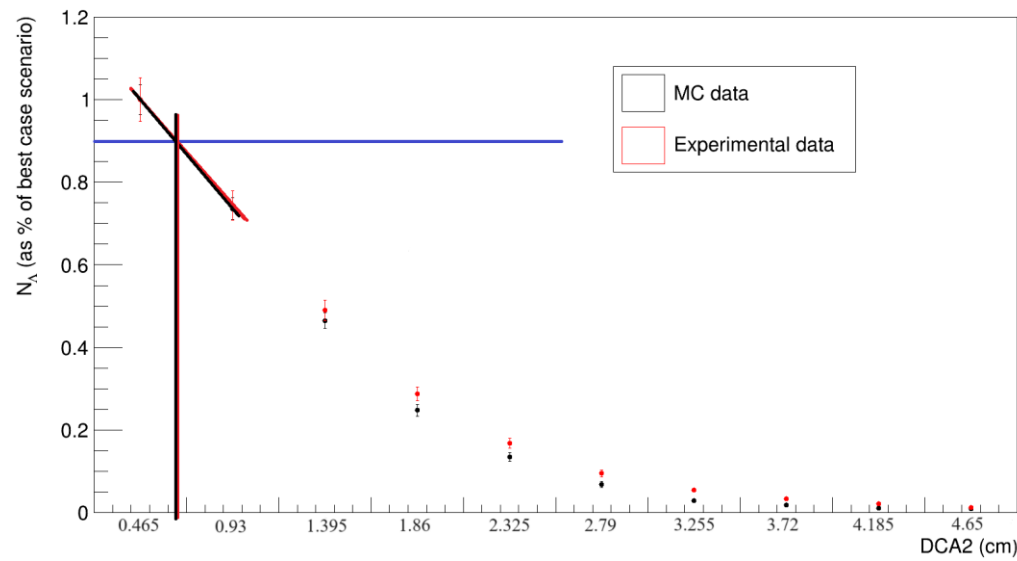
Signal dependence on dca2



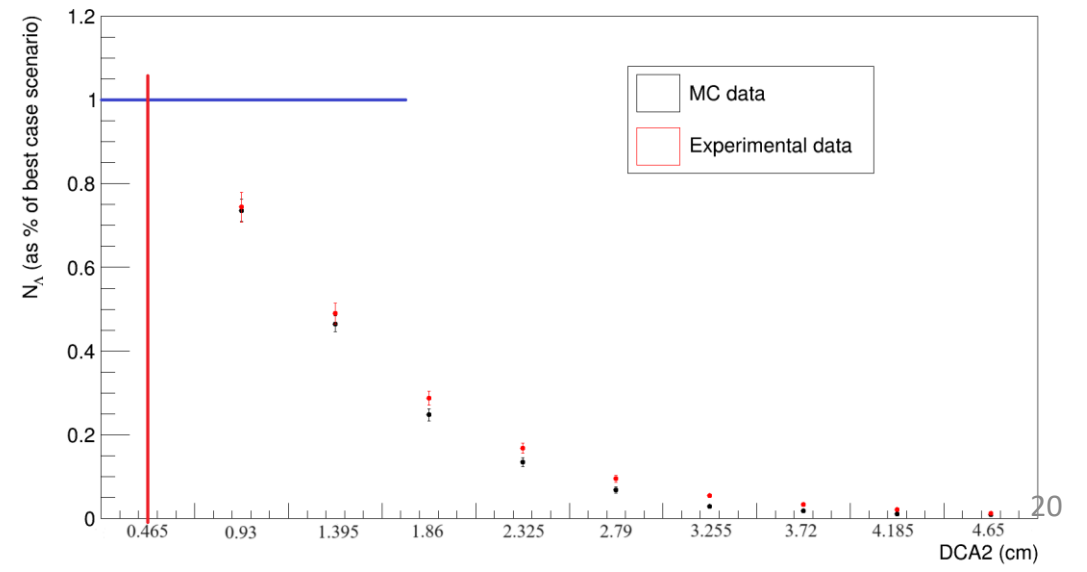
Signal dependence on dca2



Signal dependence on dca2



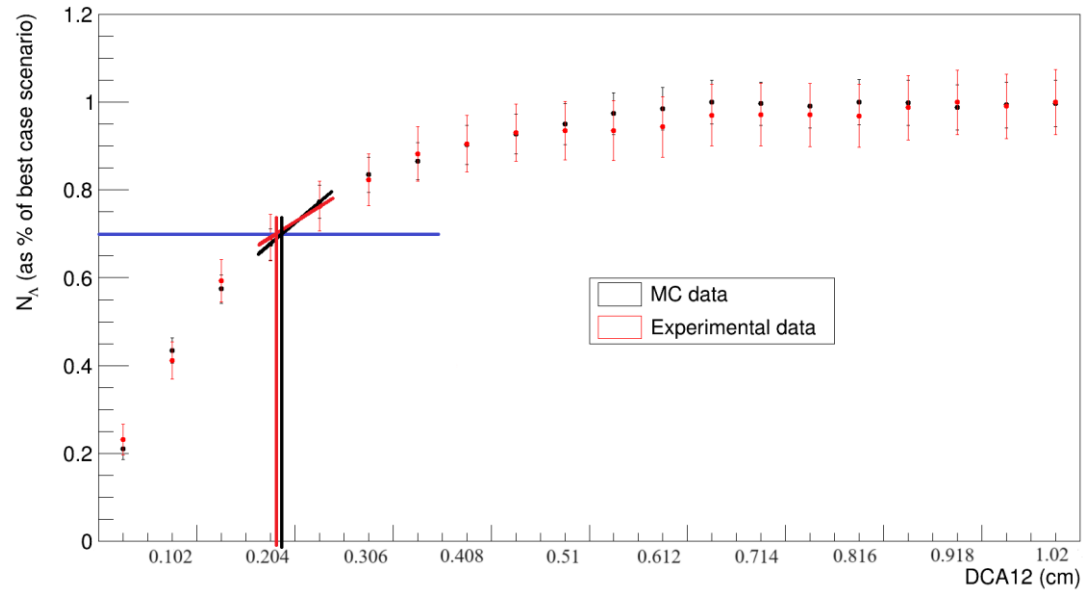
Signal dependence on dca2



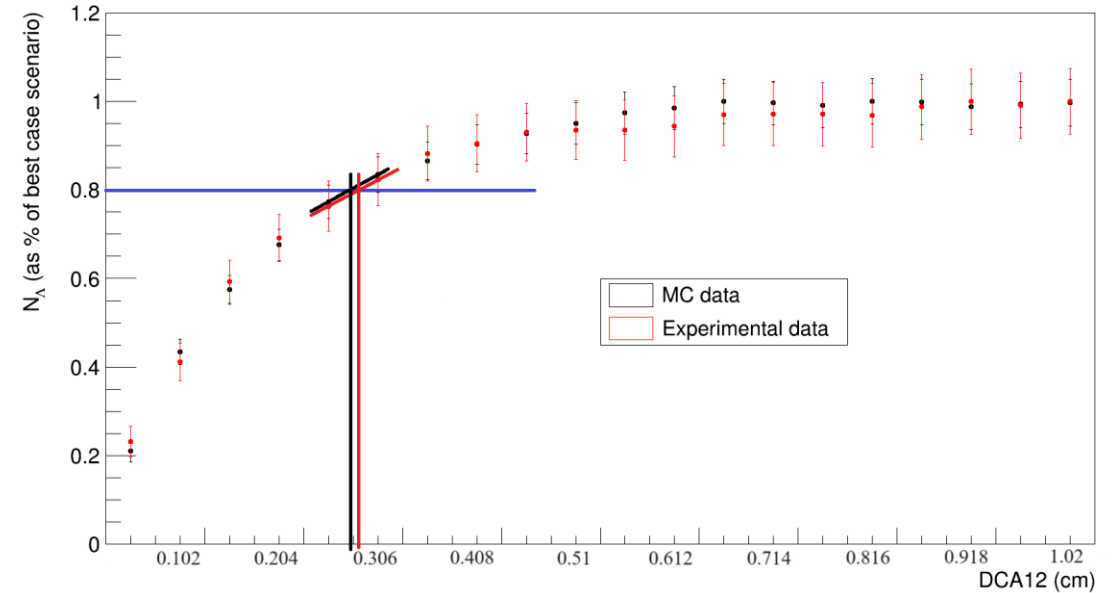
Signal analysis

Signal dependence on difference values of geometric restrictions for Λ

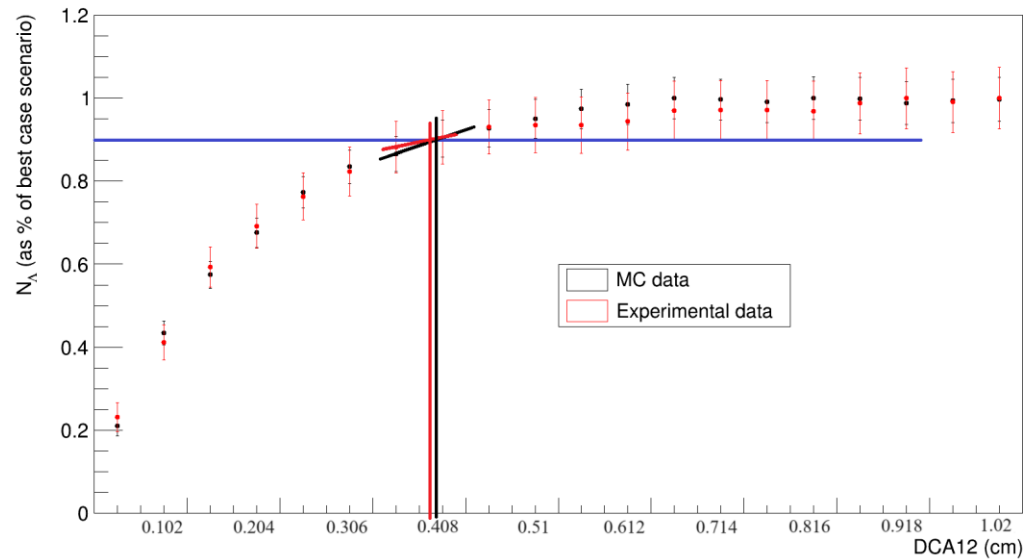
Signal dependence on dca12



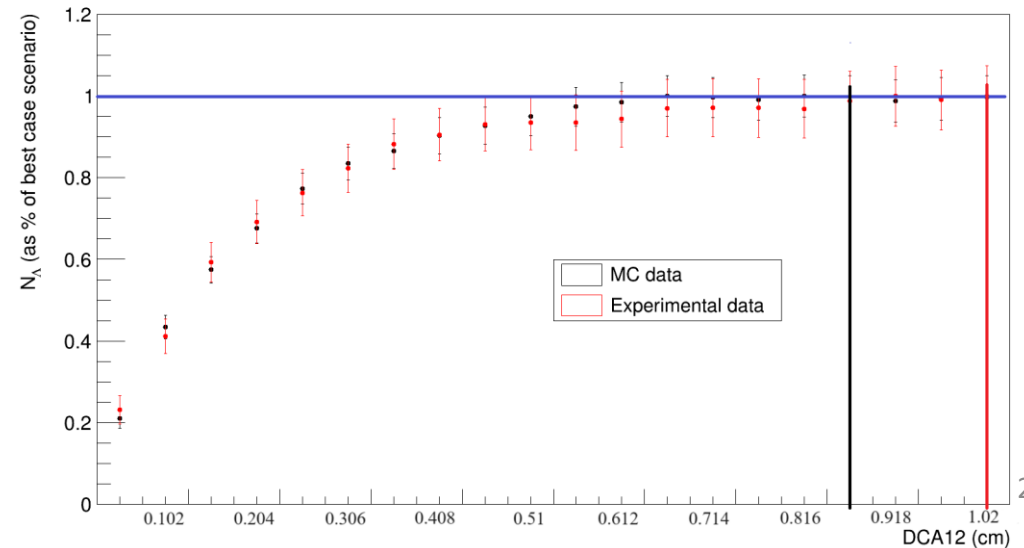
Signal dependence on dca12



Signal dependence on dca12



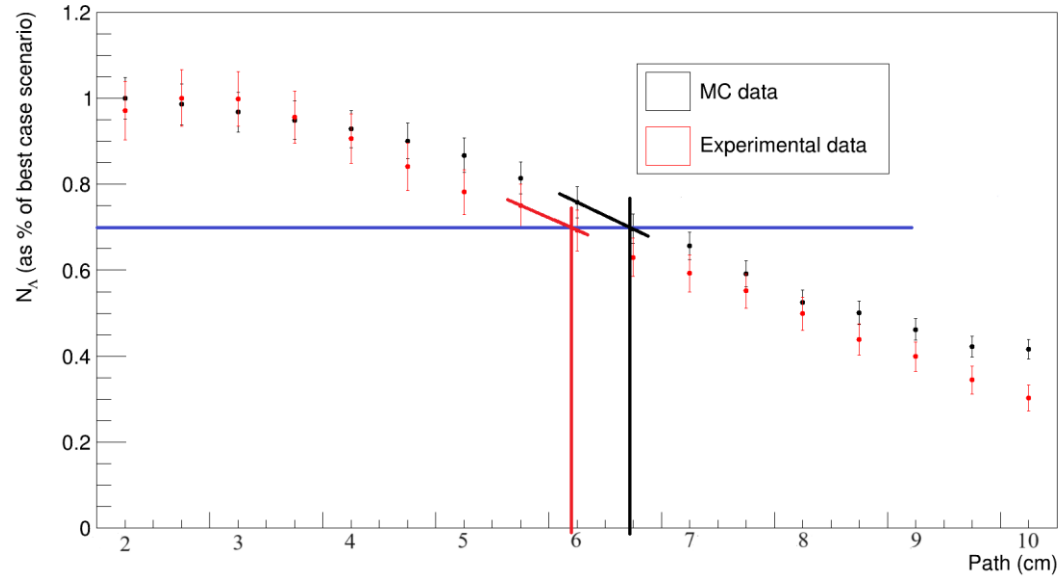
Signal dependence on dca12



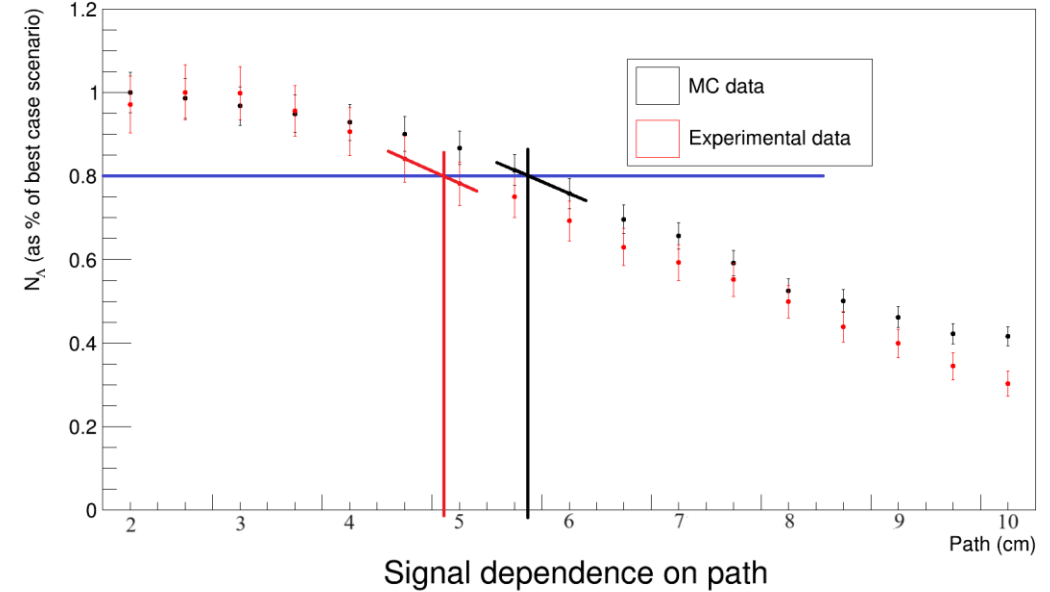
Signal analysis

Signal dependence on difference values of geometric restrictions for Δ

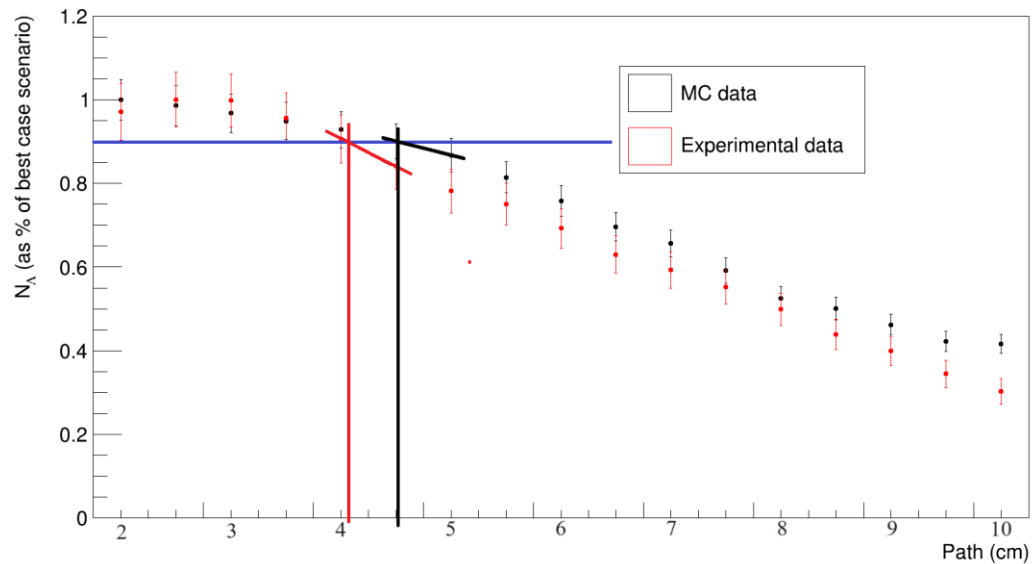
Signal dependence on path



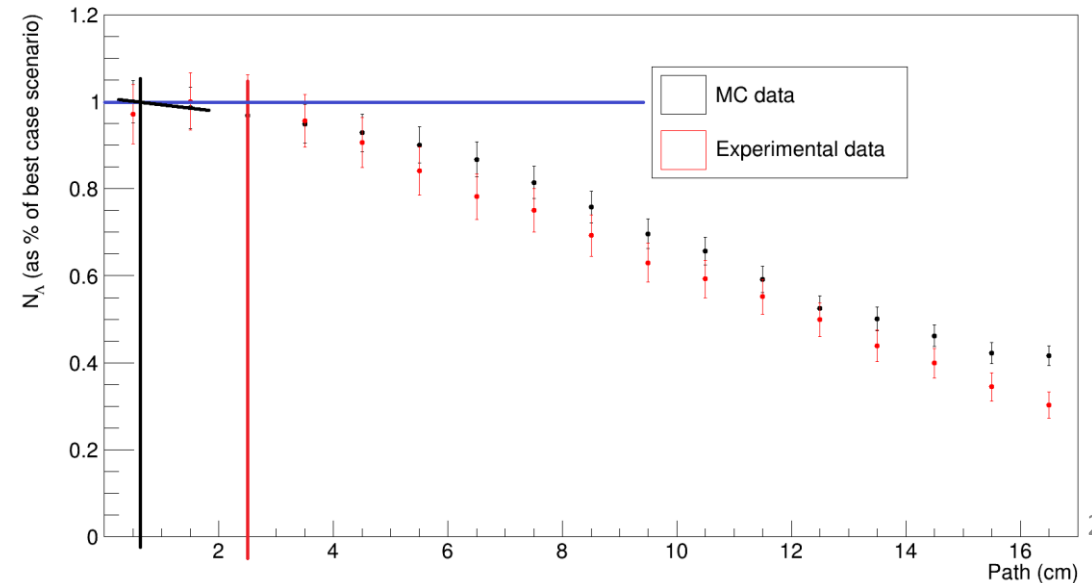
Signal dependence on path



Signal dependence on path

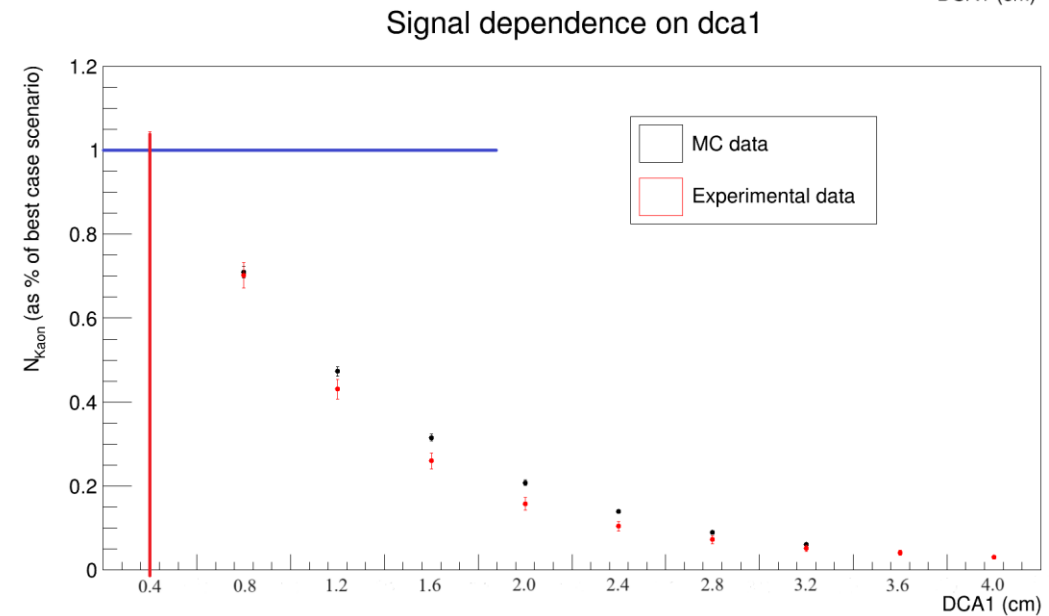
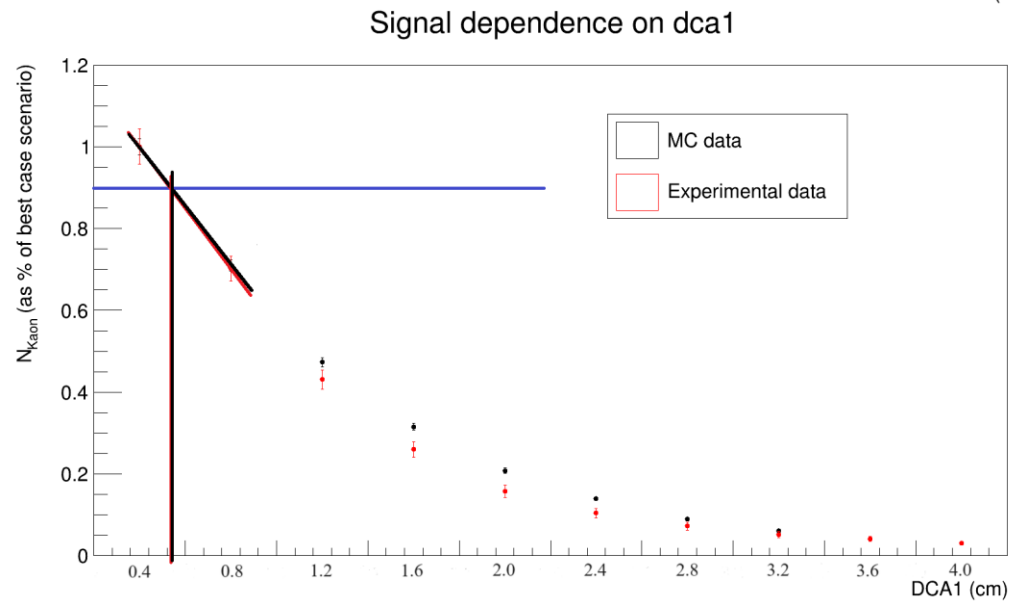
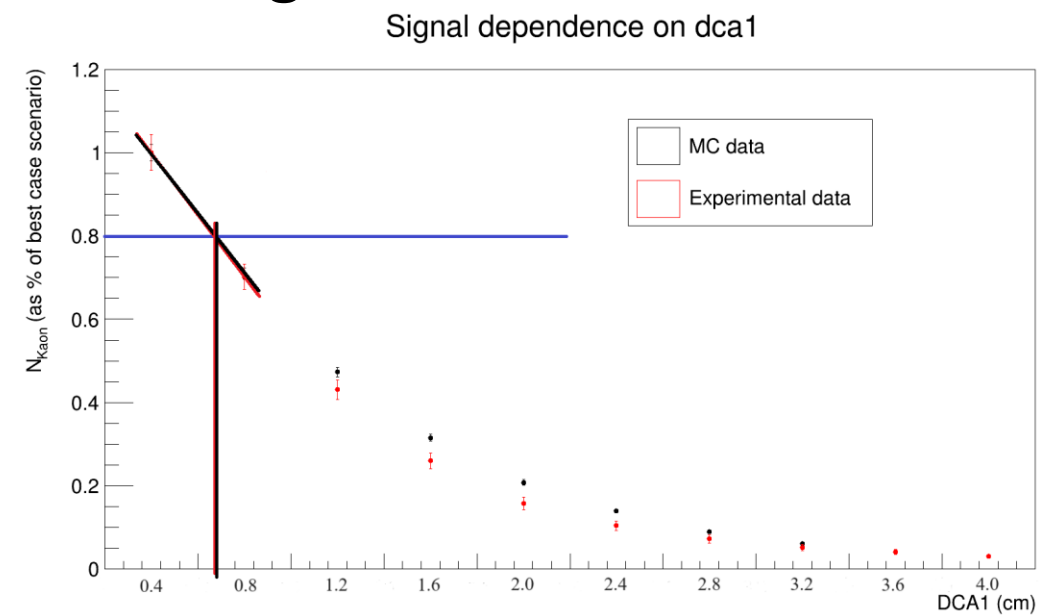
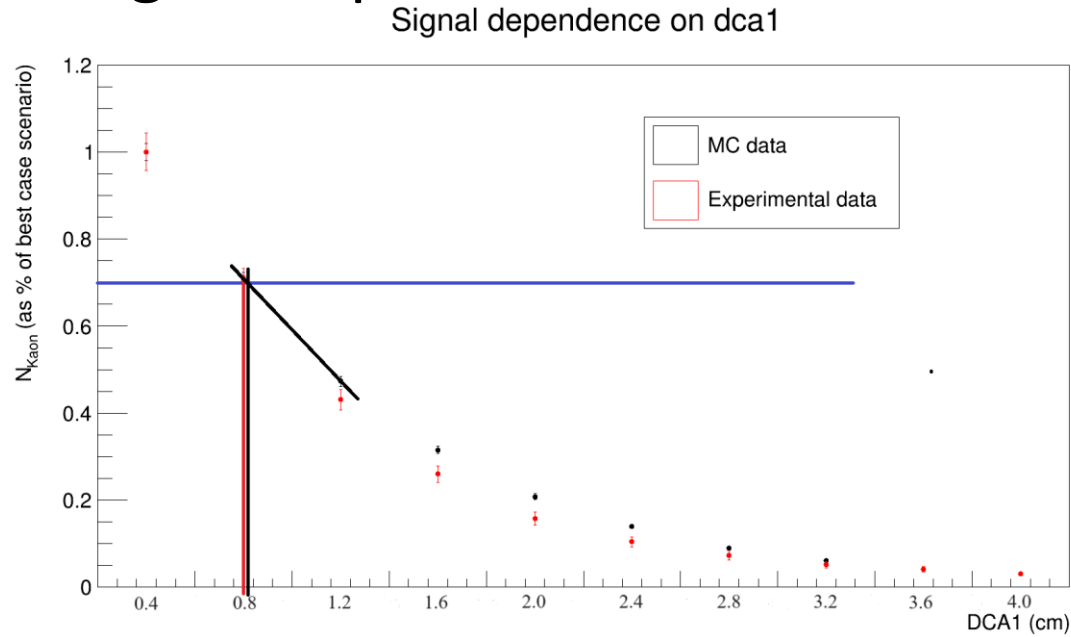


Signal dependence on path



Signal analysis

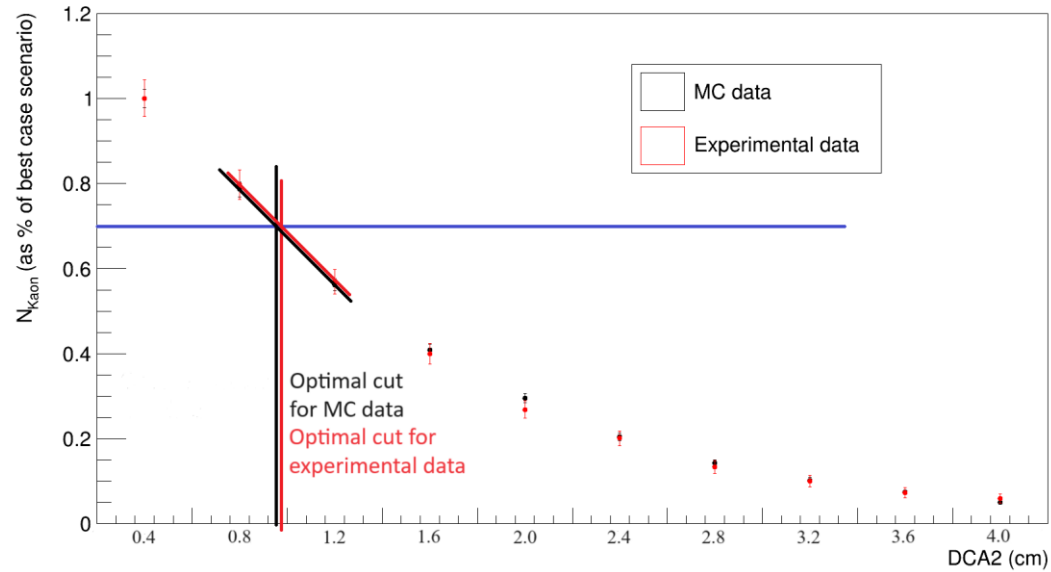
Signal dependence on difference values of geometric restrictions for K_S^0



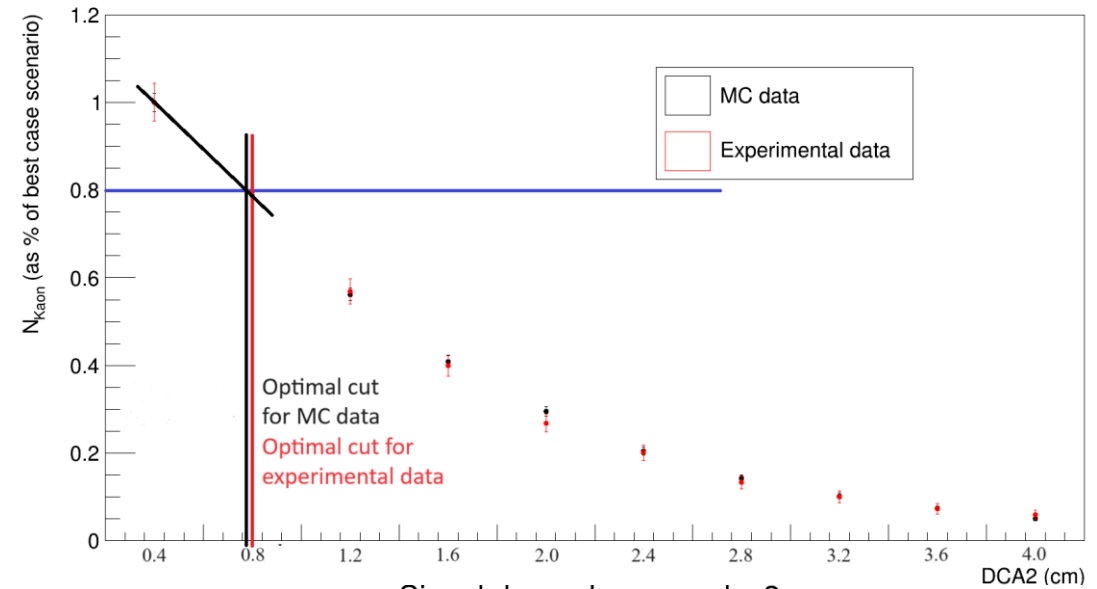
Signal analysis

Signal dependence on difference values of geometric restrictions for K_S^0

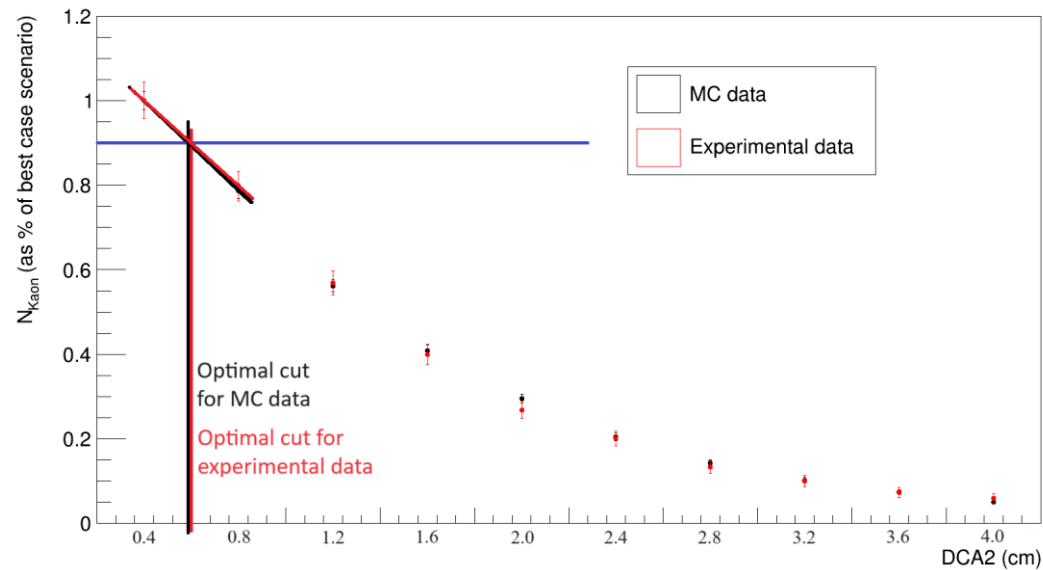
Signal dependence on dca2



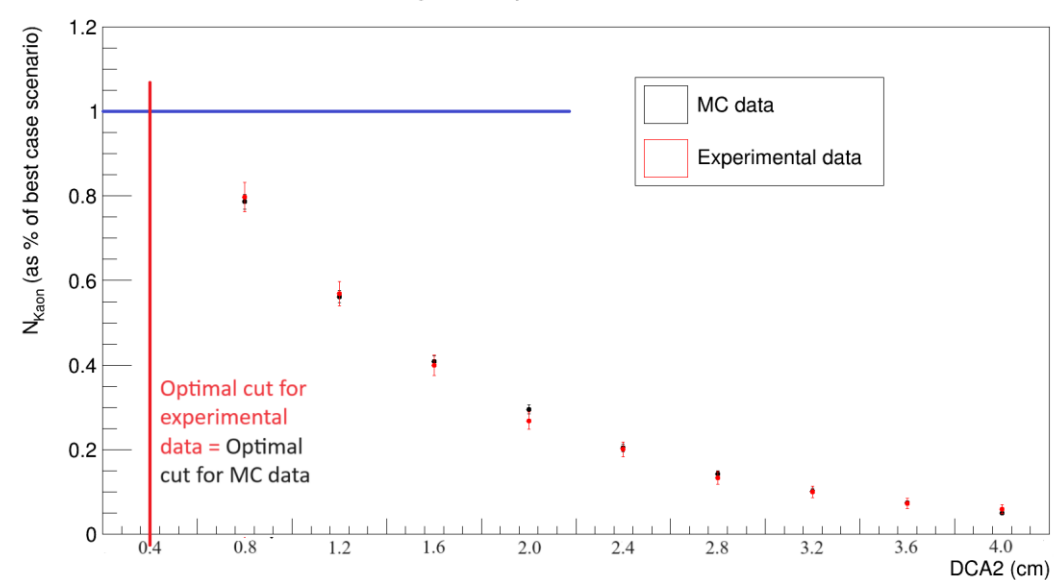
Signal dependence on dca2



Signal dependence on dca2



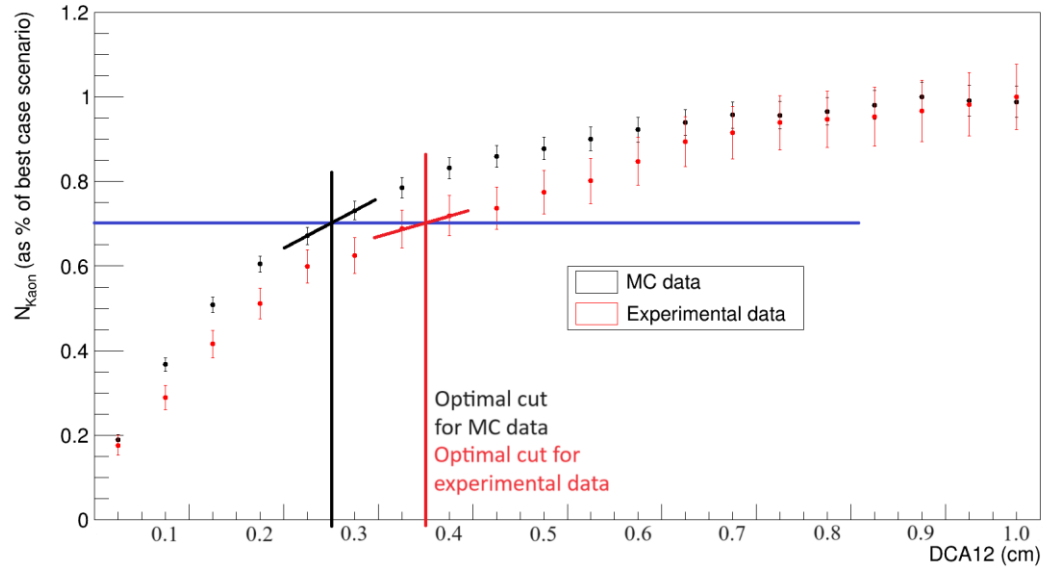
Signal dependence on dca2



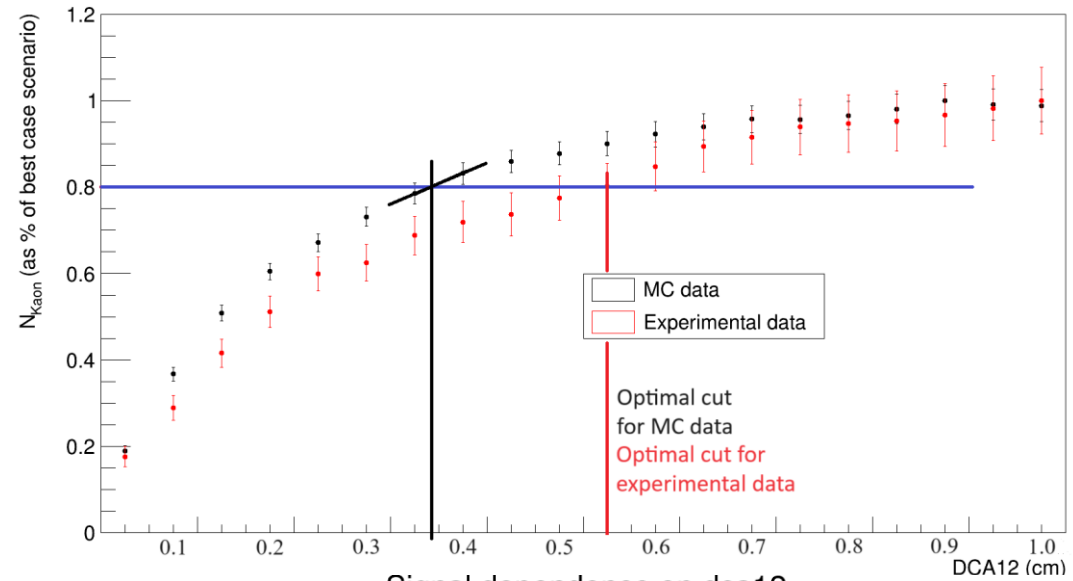
Signal analysis

Signal dependence on difference values of geometric restrictions for K_S^0

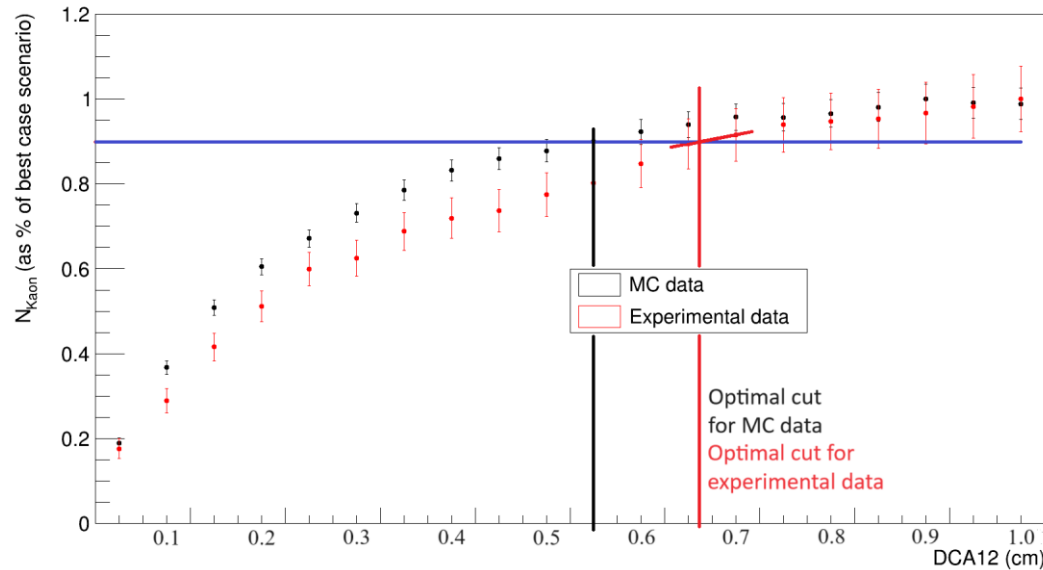
Signal dependence on dca12



Signal dependence on dca12



Signal dependence on dca12



Signal dependence on dca12

