UNIVERSITÀ
DEGLI STUDI
DI TORINO

Measurement of the K^0_s meson lifetime with ALICE

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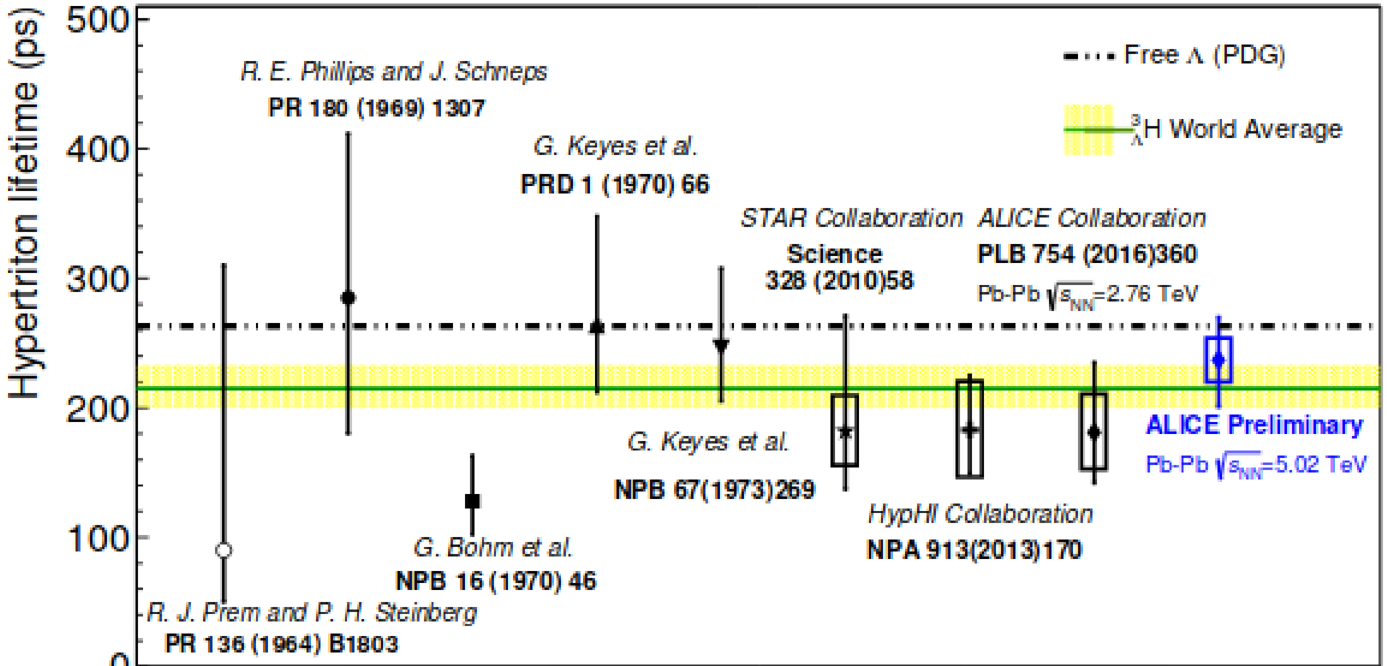
Analysis motivation

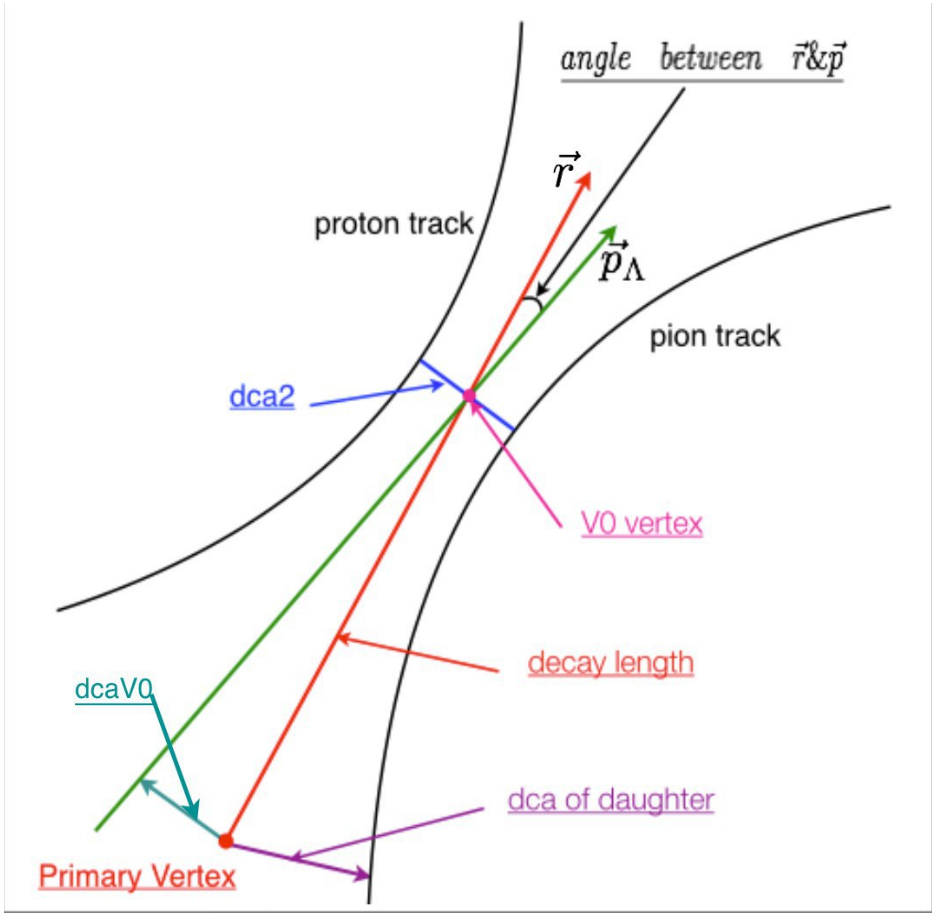
- Hypernucleus: nucleus that contains at least one hyperon in addition to nucleons
  - **Hypertriton** : bound state of proton , neutron and lambda
- Analysis to check possible presence of **systematic biases** in the hypertriton lifetime measurement
- **K^0_s chosen because:**
  - High production rate
  - Well known lifetime



V0 finding selections

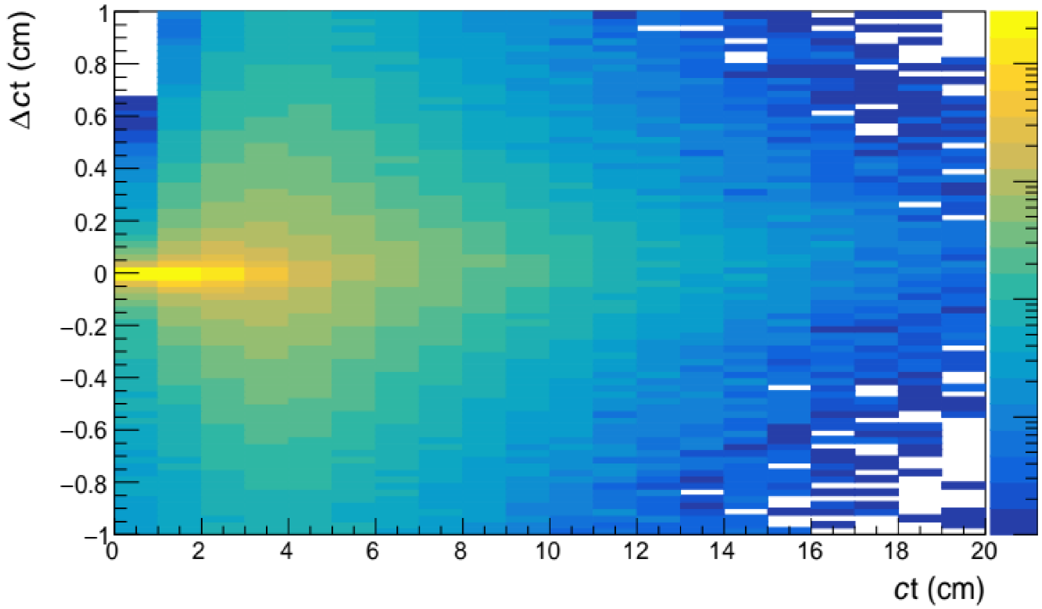
- **standard** values of the **cuts** for V0 analyses

Topological Variable	Cut
V0 tranv. Decay radius	> 0.50 cm
DCA Negative Track to PV	> 0.06 cm
DCA Positive Track to PV	> 0.06 cm
V0 Cosine of Pointing Angle	> 0.97
DCA V0 Daughters	< 1.0 σ
Rapidity Interval |y|	< 0.5
Daughter Track Pseudorapidity Interval	|η| < 0.8
Daughter Track Ncrossedrows	≥ 70



Monte Carlo : ct resolution

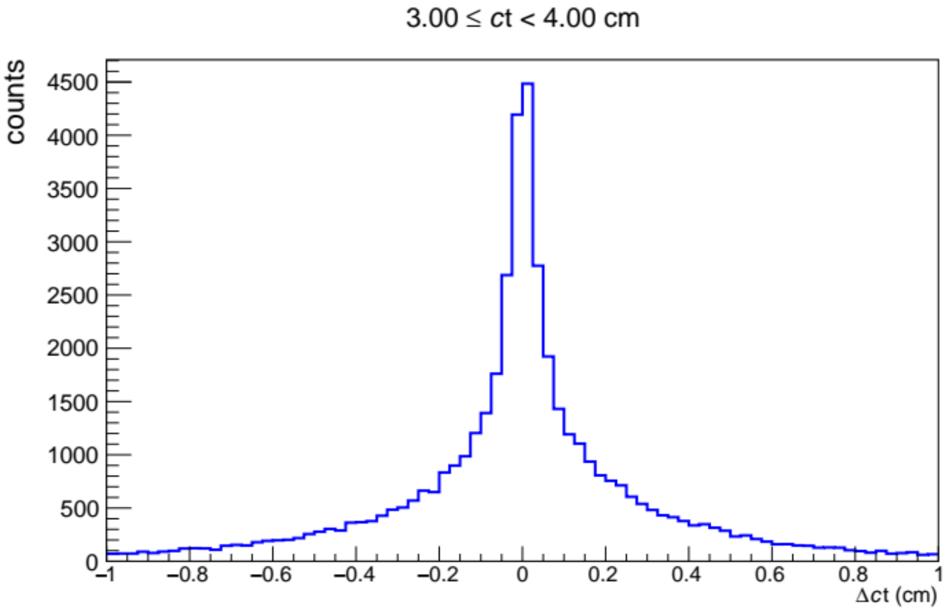
- Lifetime analyzed counting K^0_s production in **ct intervals**
  - Intervals have to be chosen considering our reconstruction performance



- Resolution obtained studying :

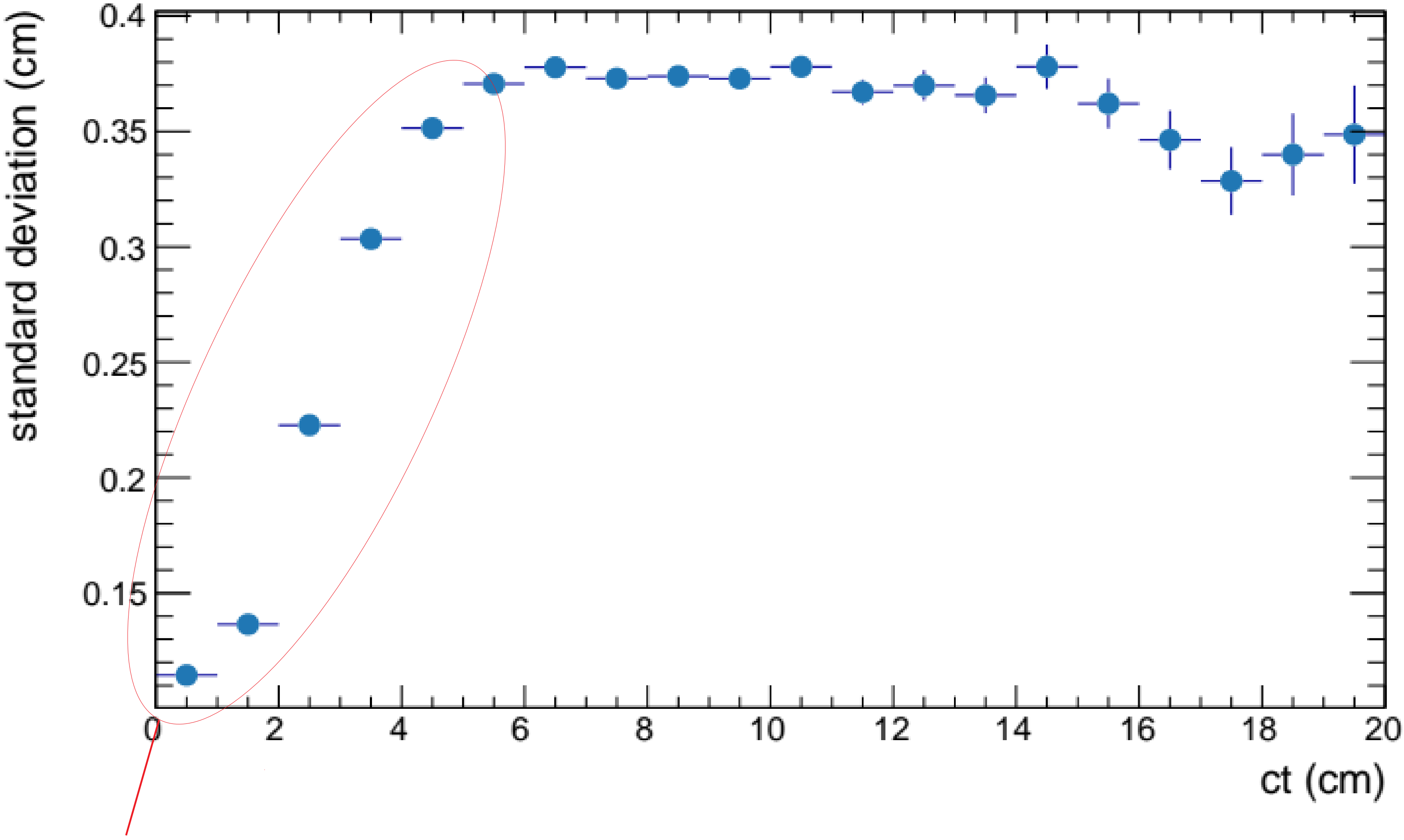
$$\Delta ct = ct_{K0s\,reconstructed} - ct_{K0s\,generated}$$

as function of K^0_s generated ct



- Marginal distribution over every ct bin is calculated to get its own standard deviation

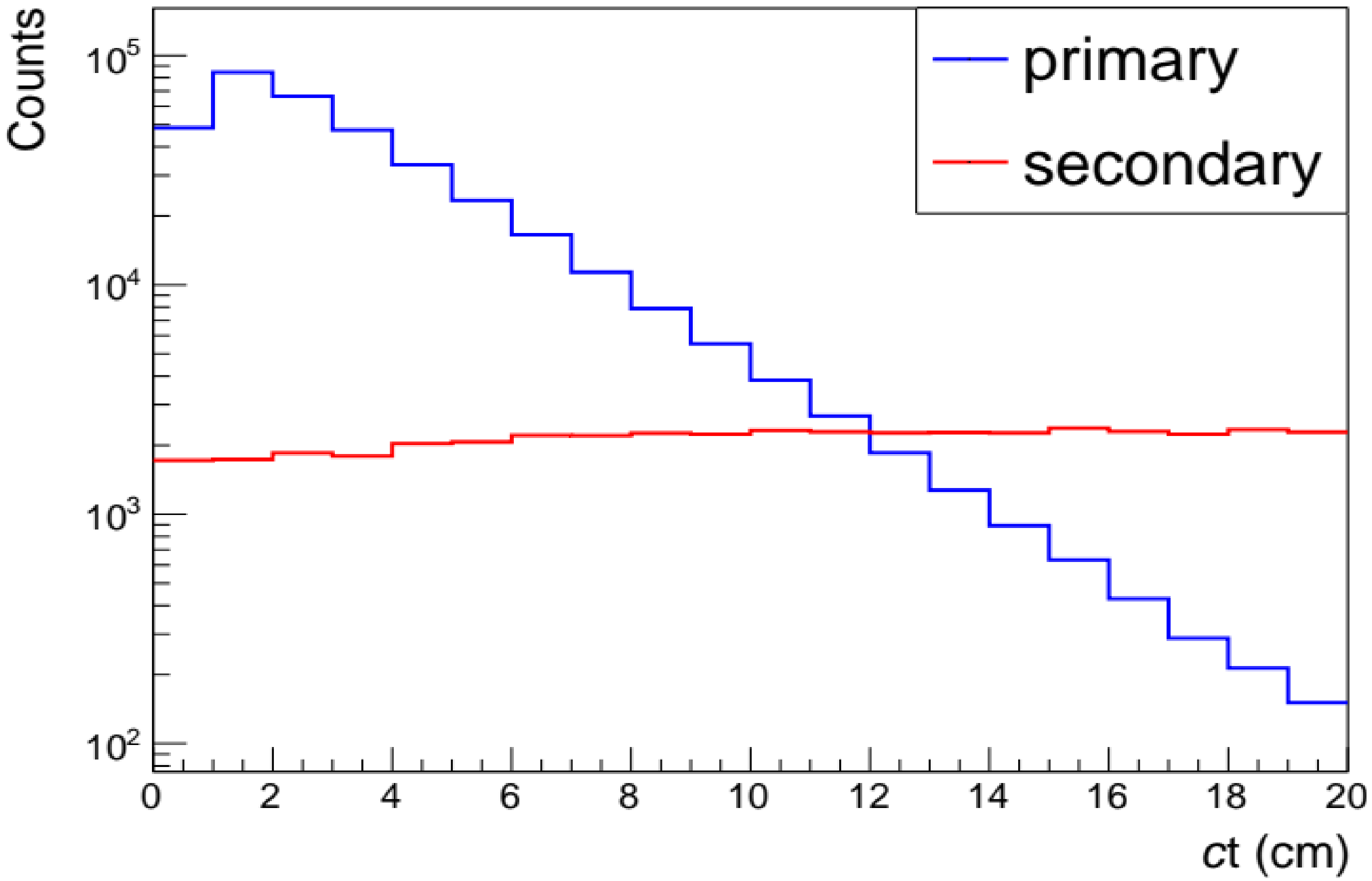
Monte Carlo: ct resolution



- **lower** standard deviation because of the SPD high resolution
- **bin widths** have been chosen to be **six times** the resolution
- **highest ct** considered: **20 cm**. Above that value no sufficient statistics

MC: K^0_s secondary from material

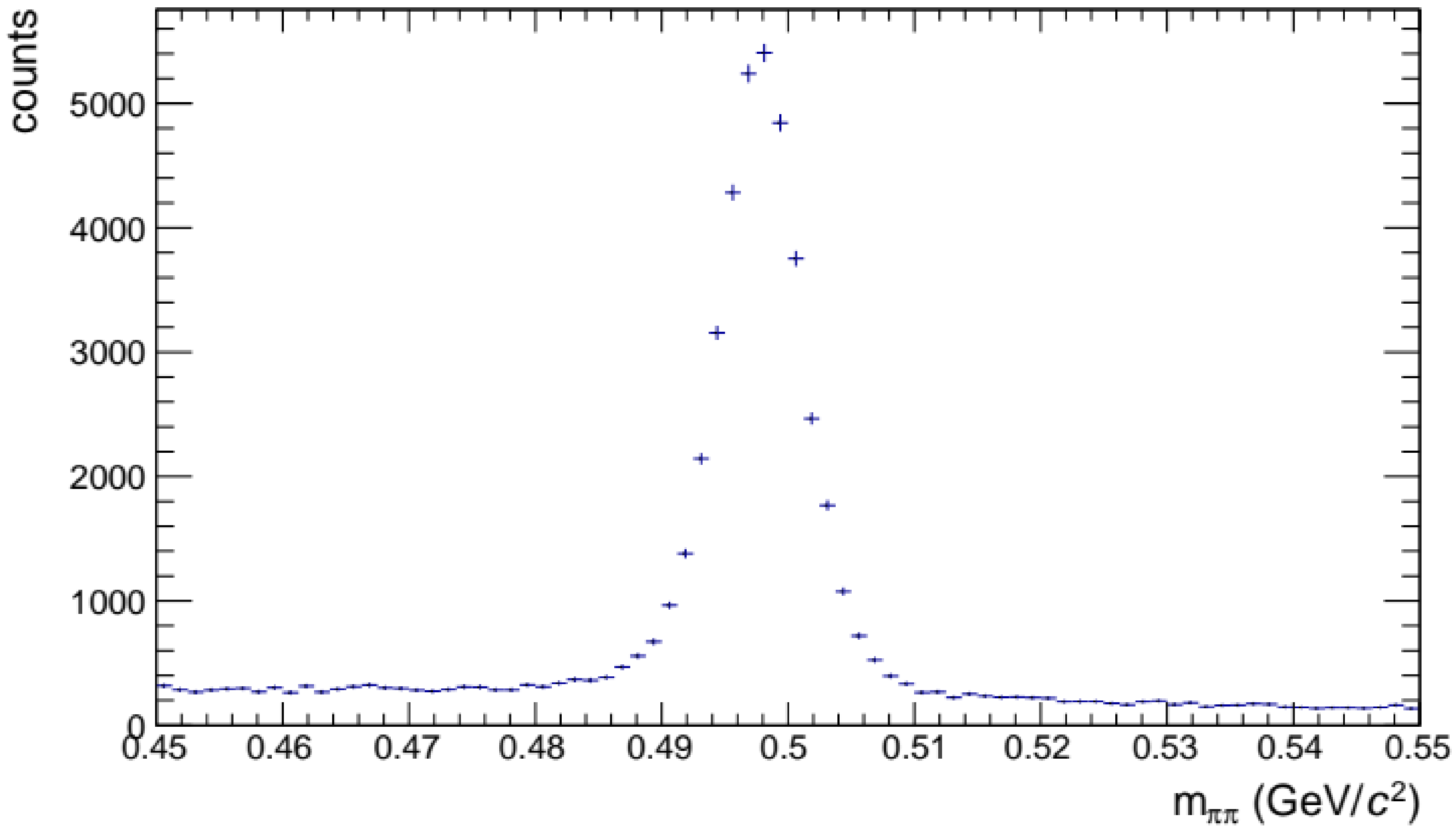
- K^0_s can also be produced by interaction of other particles with detectors, a study is performed on the Monte Carlo



- Analysis valid **only for primary K^0_s**

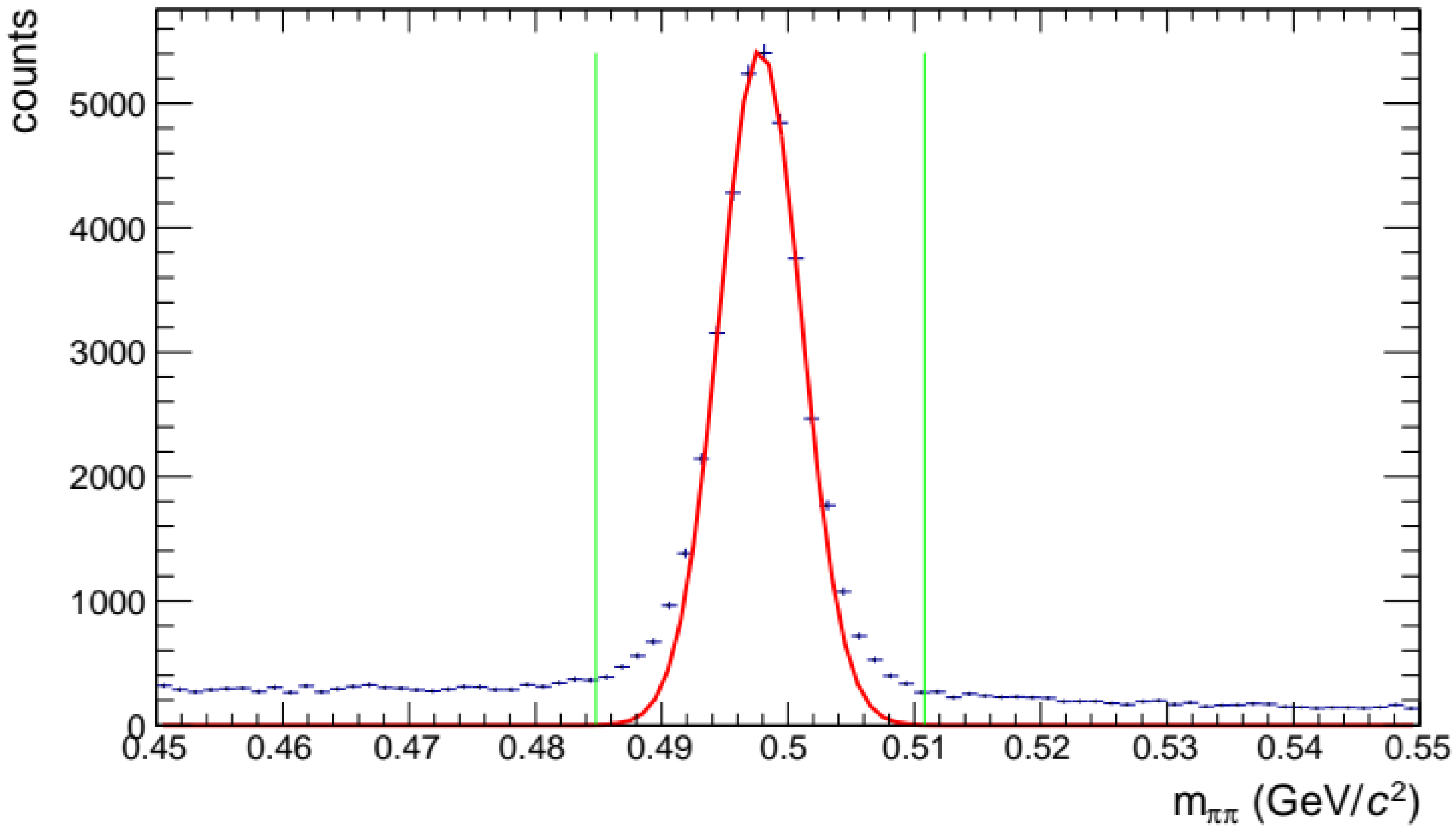
- It's not possible to distinguish primary from secondary, data **fitted where secondary particles are less important**

Signal extraction



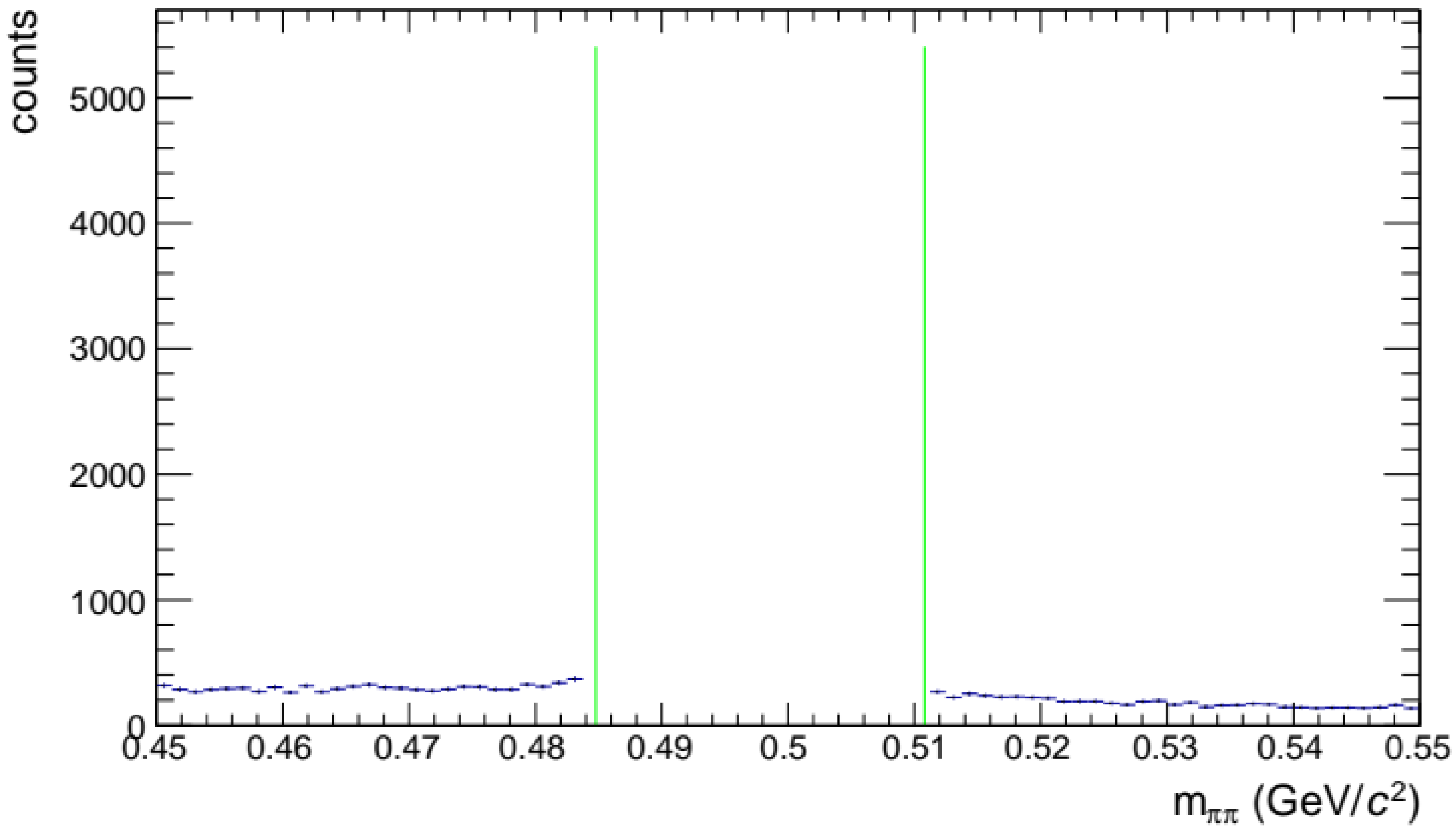
- **Every pair** of $\pi^+\pi^-$ forms a K^0_s candidate
  - $m_{inv} c^2 = \sqrt{(\sum_{daughters} E_i)^2 - \| \sum_{daugheters} c \vec{P}_i \|^2}$
  - Background is given by wrong associations

Signal extraction



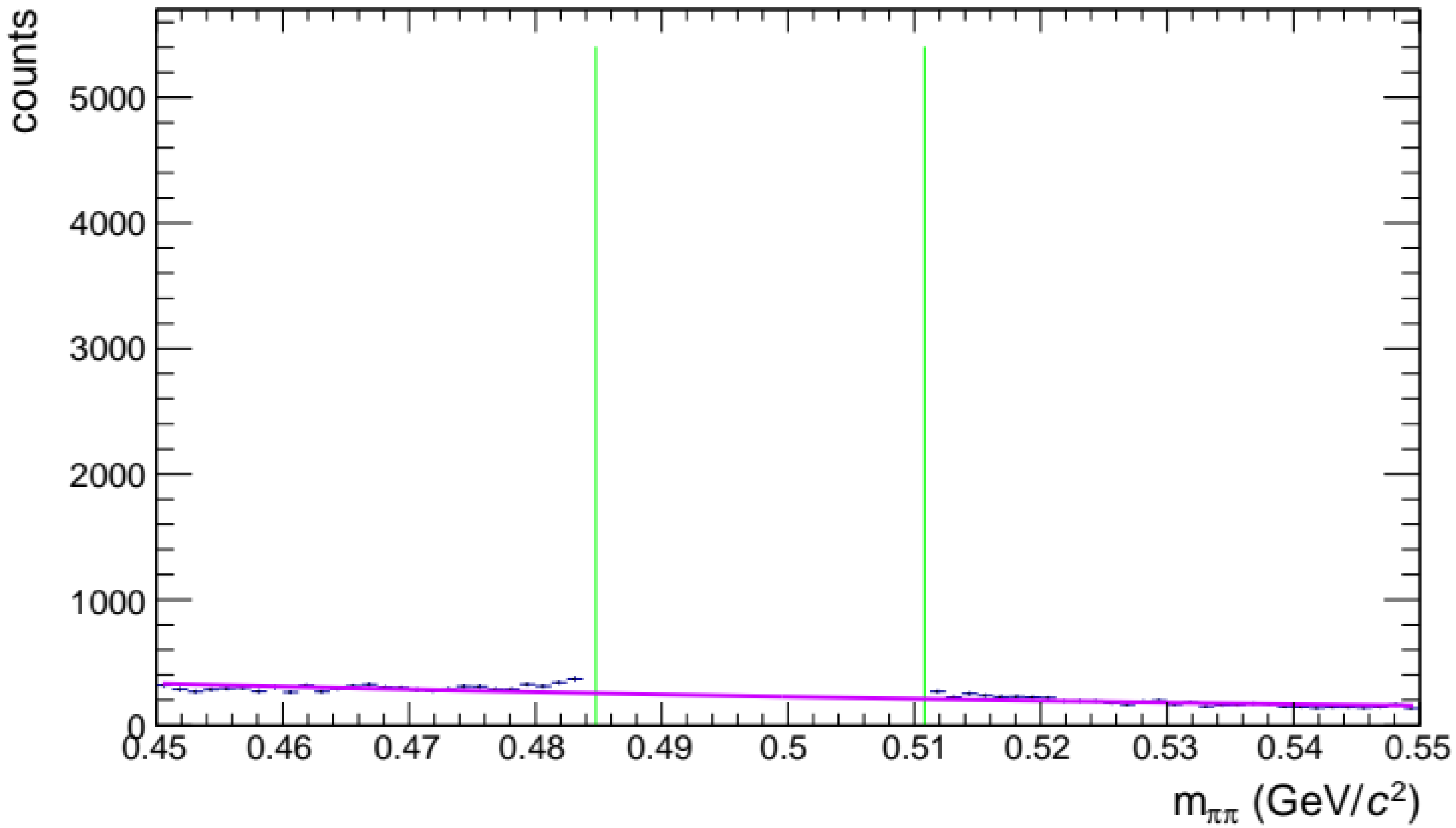
- The peak is fitted by a **gaussian**
  - Extraction will be done **[μ-4σ , μ+4σ]**

Signal extraction



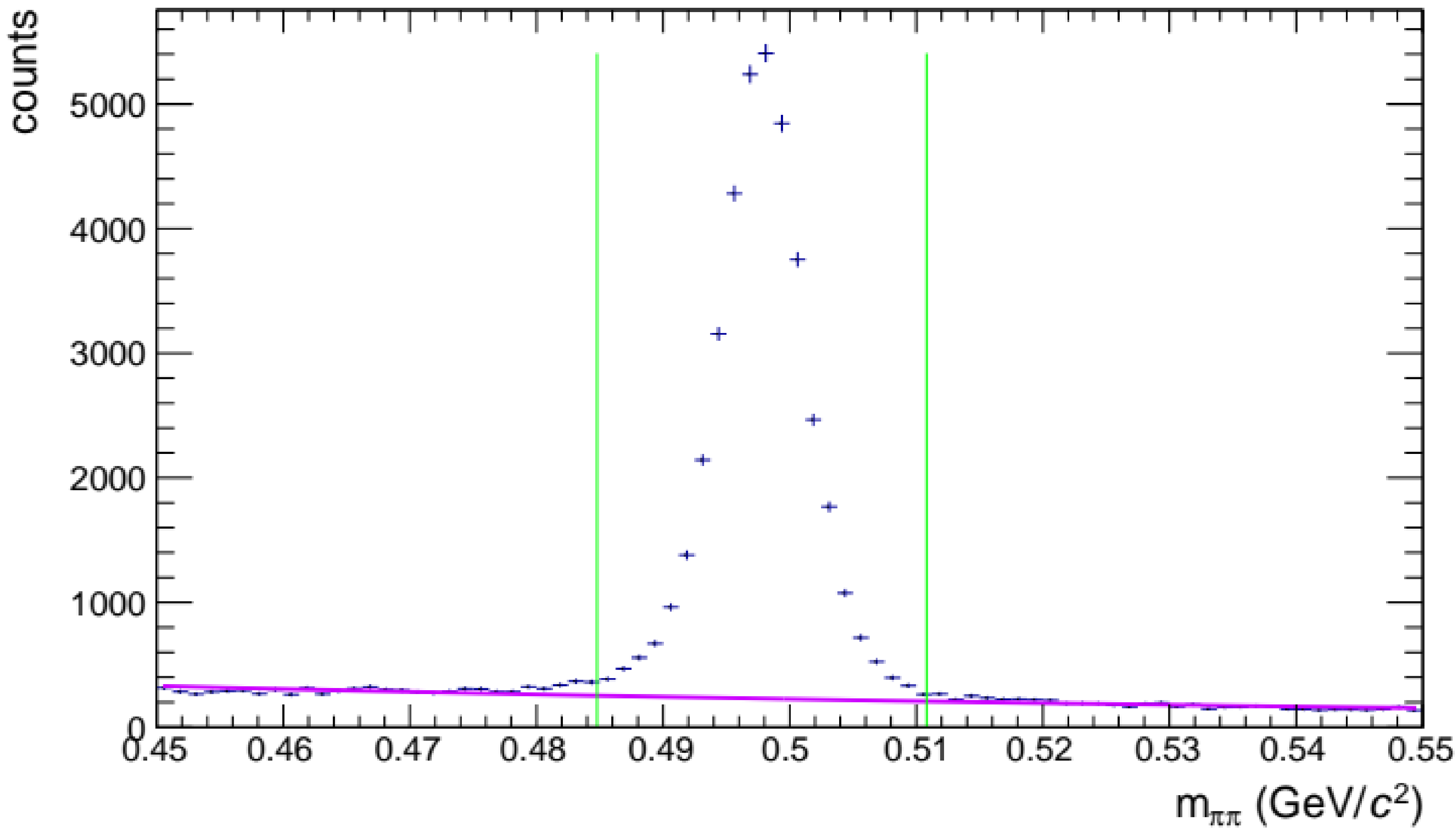
- Entries removed from invariant mass spectra inside the integration interval

Signal extraction



- Background is fit by an **exponential**

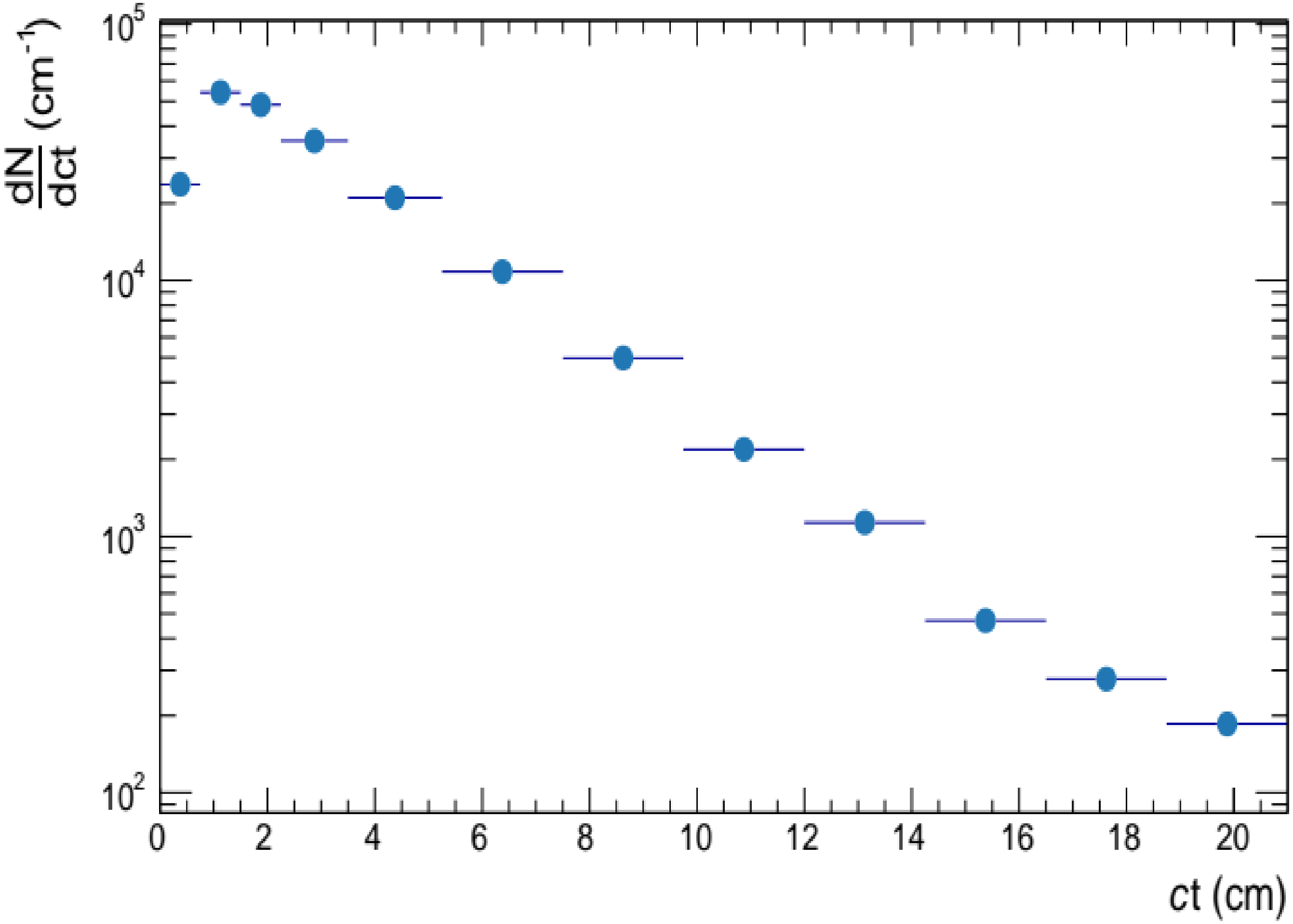
Signal extraction



- The number of K^0_s is given by : **histogram integral – background function integral**

K^0_s counting

- the signal extraction is made for every marginal distribution over ct bins

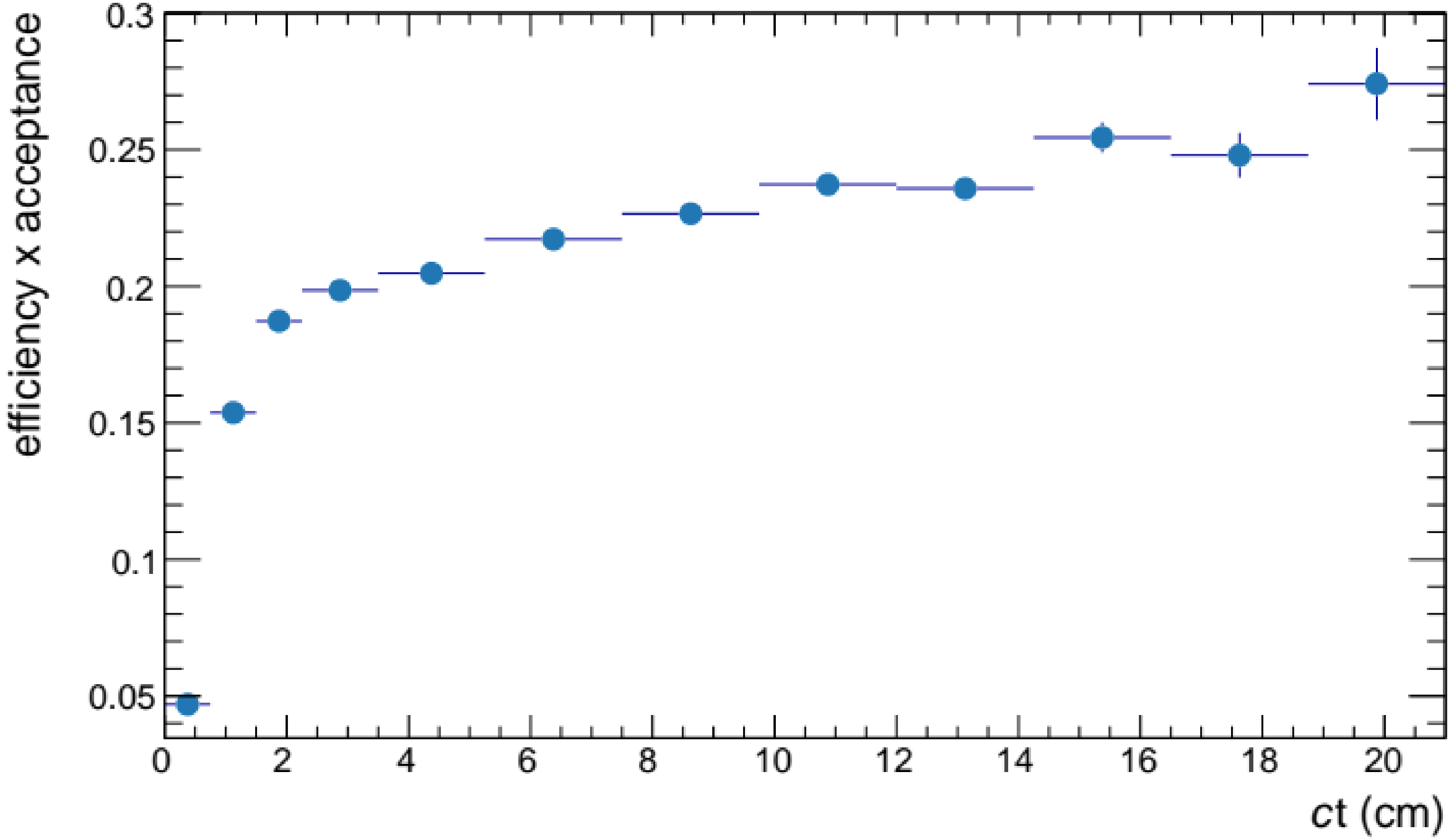


- The dN/dct is obtained dividing the K^0_s counts by the bin width of ct
- The lower counting of the first bin due to a low efficiency

Monte Carlo : efficiency x acceptance

- In the Monte Carlo simulation, K^0_s are transported through the detector and reconstructed like in real data

$$efficiency\ x\ acceptance = \frac{\#K_s^0\ recontructed}{\#K_s^0\ generated}$$



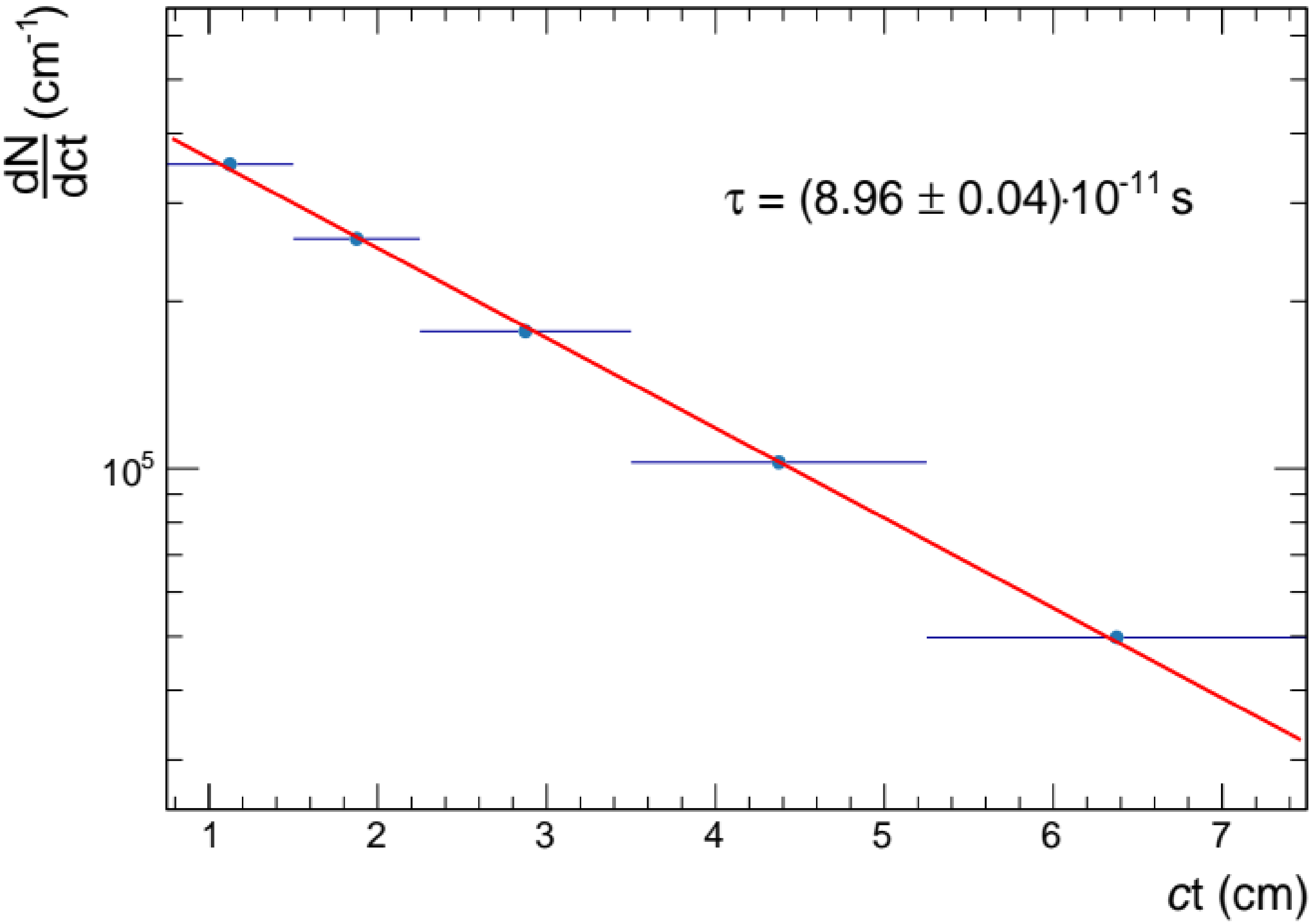
- Given the dramatic change in efficiency between bin1 and bin2, bin 1 will not be considered for lifetime estimation

Corrected K^0_s counting

- Dividing the calculated dN/dct by the efficiency x acceptance
- The data are fitted by an **exponential** :

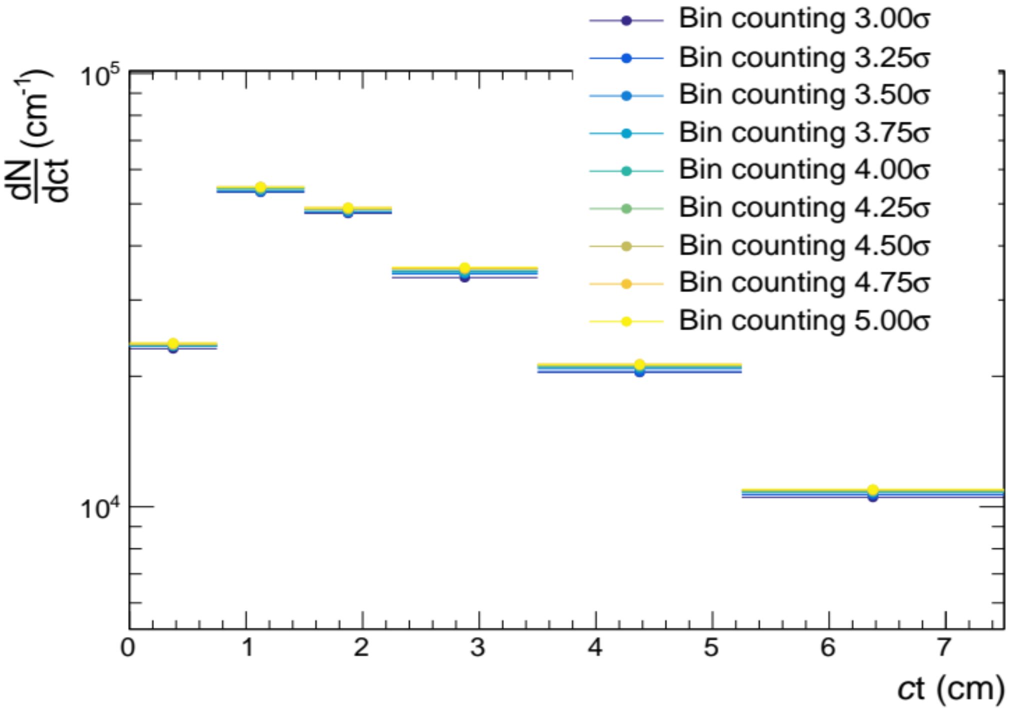
$$\frac{dN}{dct} = C \cdot \exp\left(\frac{-x}{c\,\tau}\right)$$

  - τ is the lifetime



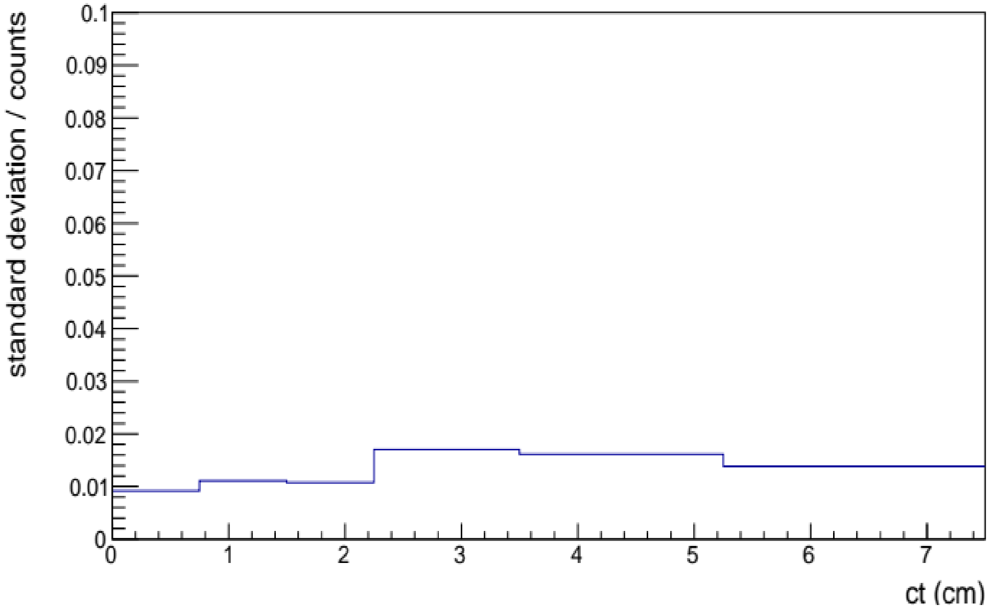
- **Low** statistical uncertainties
- Systematic uncertainties will be **dominant**

Systematic : signal extraction range



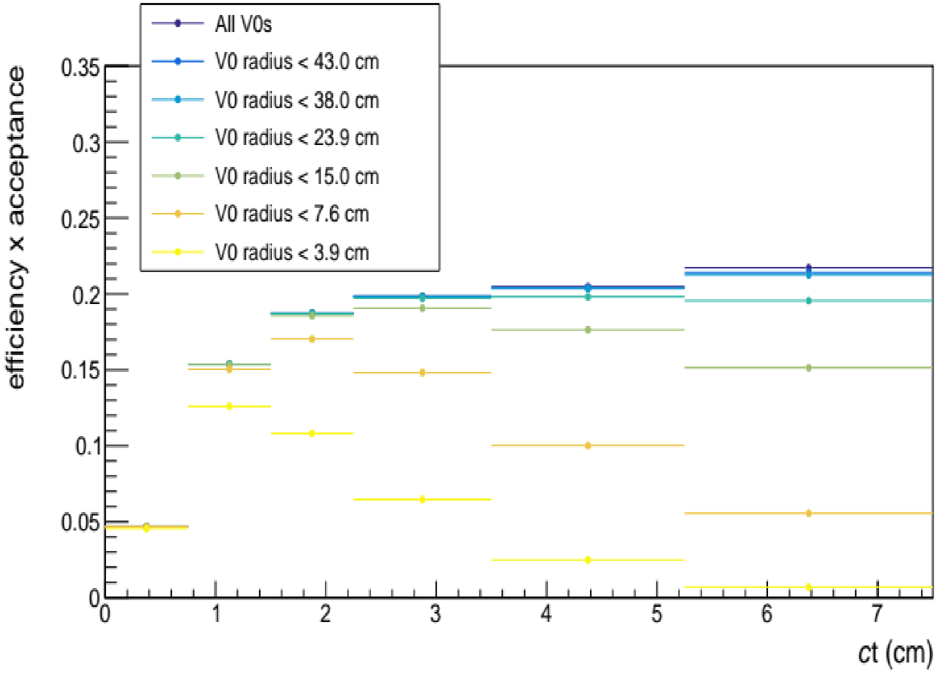
- Signal extraction has been repeated changing the range of integration

- The systematic uncertainty for each bin is the **standard deviation** of the counting at different range in that bin

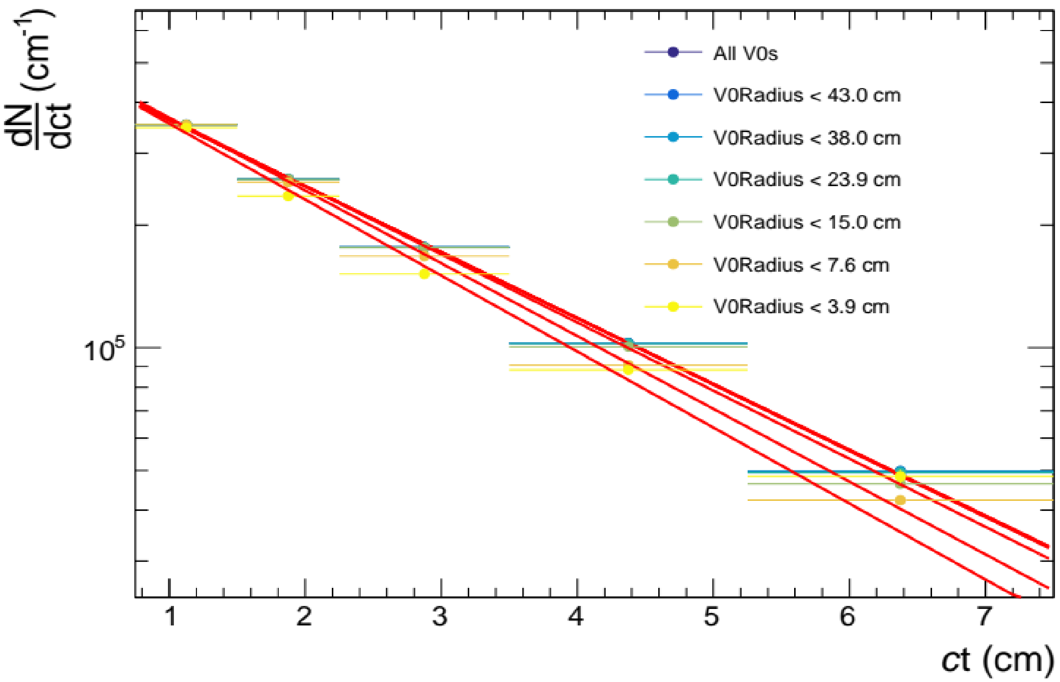


- Uncertainties seem to be **correlated**
  - Counts increase as the extraction range increase
  - The influence of the uncertainties on the determination of cτ is limited

Influence of crossed material



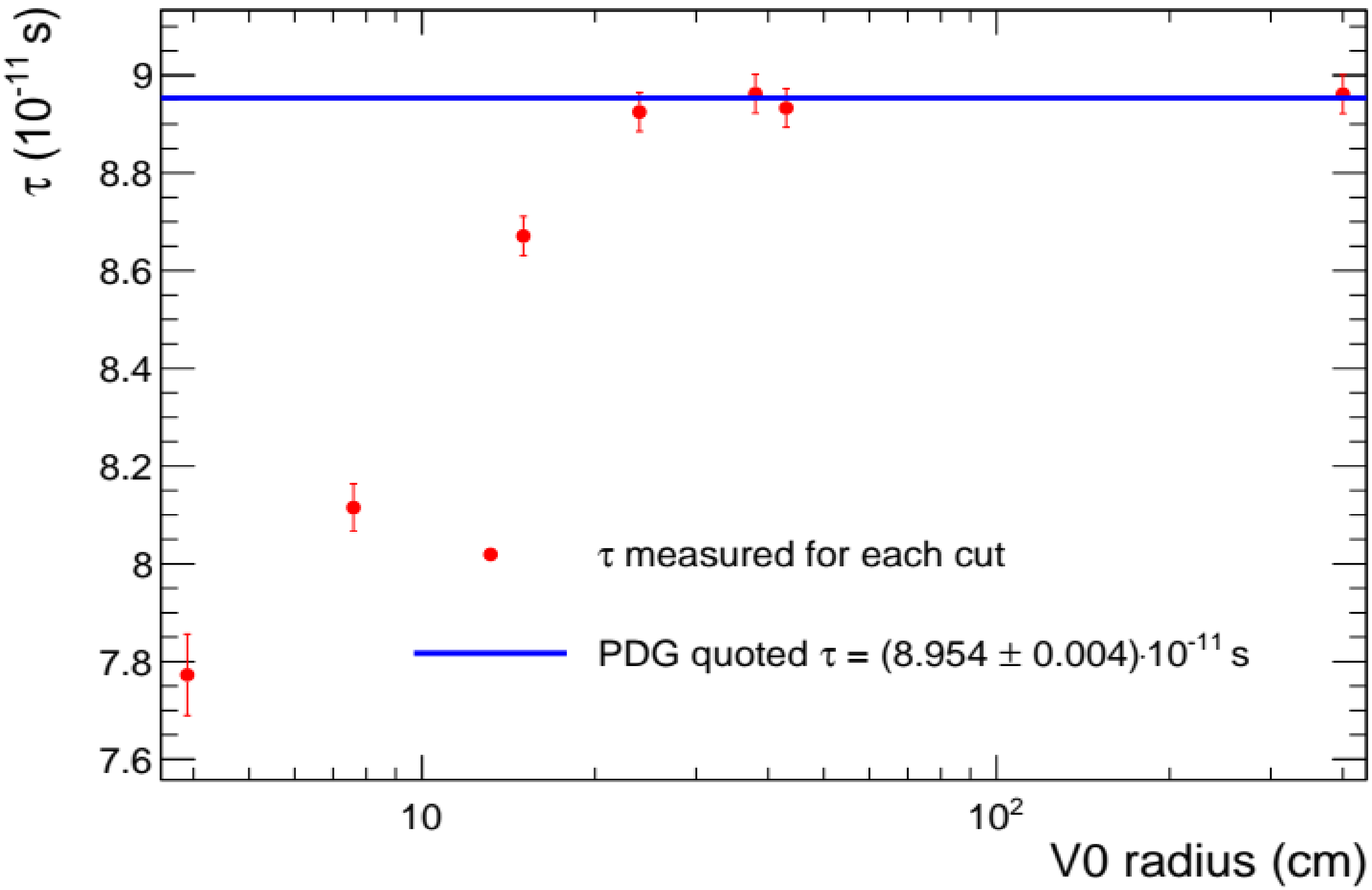
- to know if the K^0_s lifetime obtained depends on the material crossed the analysis has been repeated cutting on the distance from decay vertex to the beam line
- every cut corresponds to a **layer** of detectors



- the efficiency x acceptance **increases** with looser cuts

Influence of crossed material: lifetimes

- **plateau for high radius**, no evident dependence from crossed material



- contrary to what expected cutting at low distance lifetime decrease
- possible **discrepancy** between data and Monte Carlo

Conclusions

- K^0_s lifetime measured to be **compatible** within the uncertainties with that quoted in the PDG
  - Indication that the measure of hypertriton lifetime is **reliable**
- First evaluation of the signal extraction systematic uncertainty
  - **Mostly correlated uncertainty** that affects only marginally the K^0_s lifetime determination
- Strict cuts on the decay radius can affect the measurement
  - Data/MC agreement to be assessed
  - **Tight radius cuts are not used** in the lifetime determination analysis

Next steps:

- Analysis of the full data sample
- Complete study of the systematic uncertainties

K^0_s reconstruction and analysis

- Neutral particle like K^0_s can not be detected directly by ITS and TPC:
  - study on **$\pi^+\pi^-$ decay channel**
  - decay channel with neutral particles excluded to improve precision
- Decay vertex and momentum reconstructed by **tracking daughter particles**
- Lifetime extracted by measuring **K^0_s production as function of ct**:
- ct is obtained measuring :
  - L : distance between primary and decay vertices
  - P : total momentum of K^0_s
  - m : K^0_s mass

$$ct = \frac{c \cdot L}{P} \cdot m$$