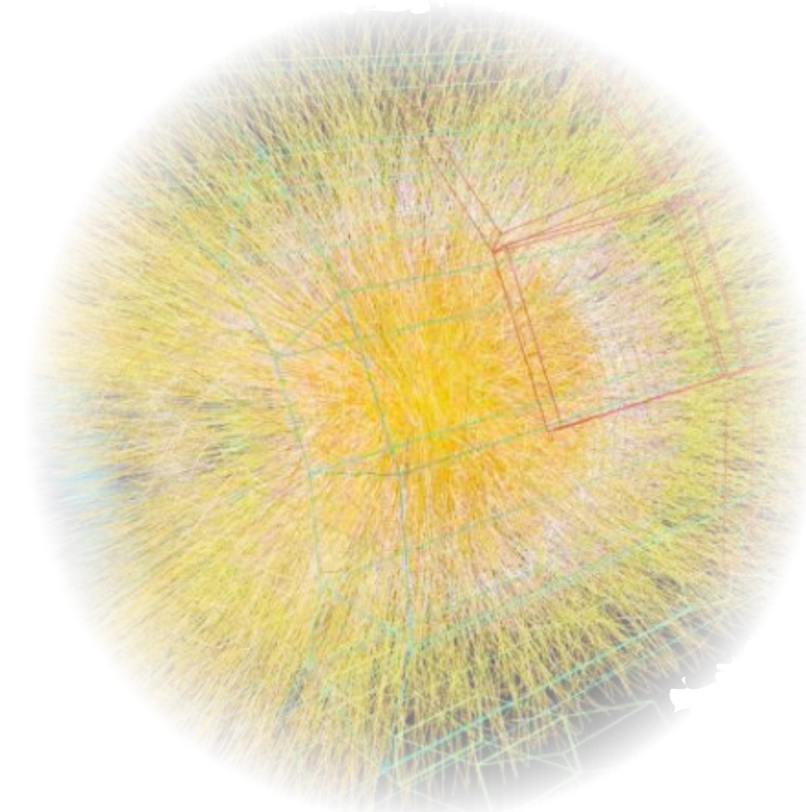
Femtoscopic pΛ Correlations in Pb-Pb Collisions at $\sqrt{s_{NN}}$ = 2.76 TeV

Hans Beck for the ALICE collaboration

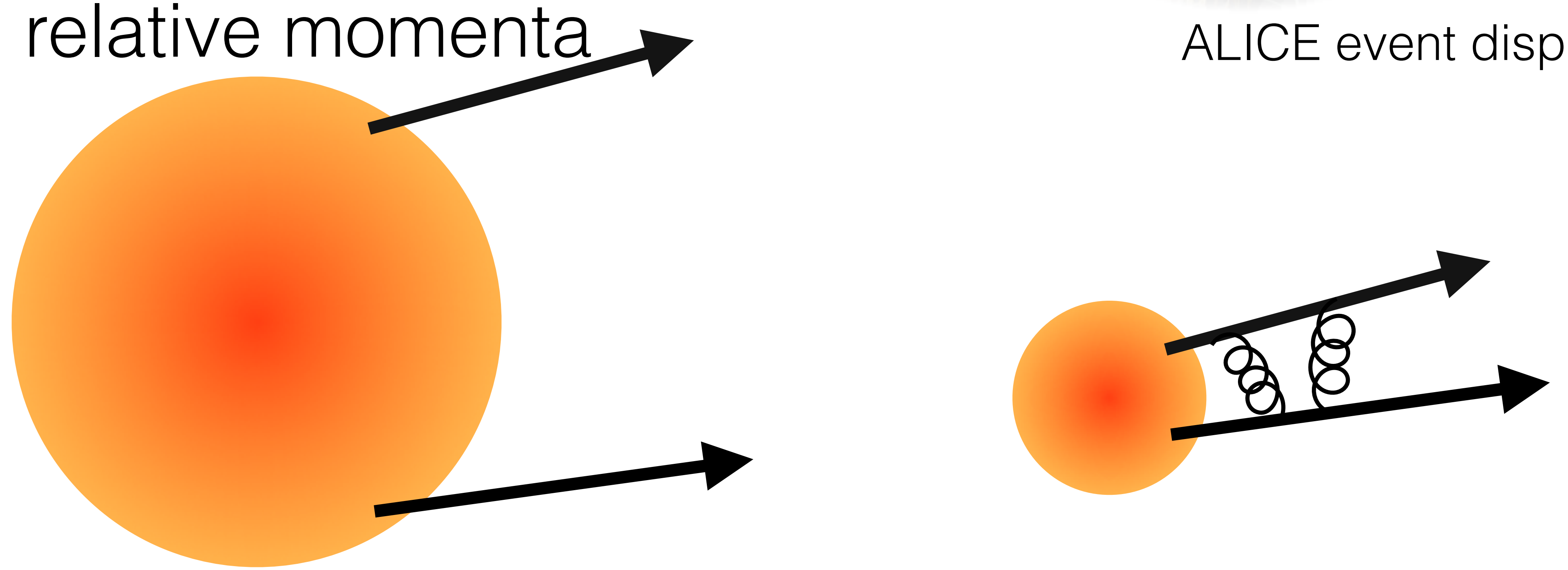
WPCF X, 25-29 August 2014, Gyöngyös, Hungary

Femtoscopy

- Measure the size of the particle emitting source
- Via two-particle correlations at small relative momenta



ALICE event display



large size
particles uncorrelated

small size
particles correlated

- Two-particle interaction has to be known

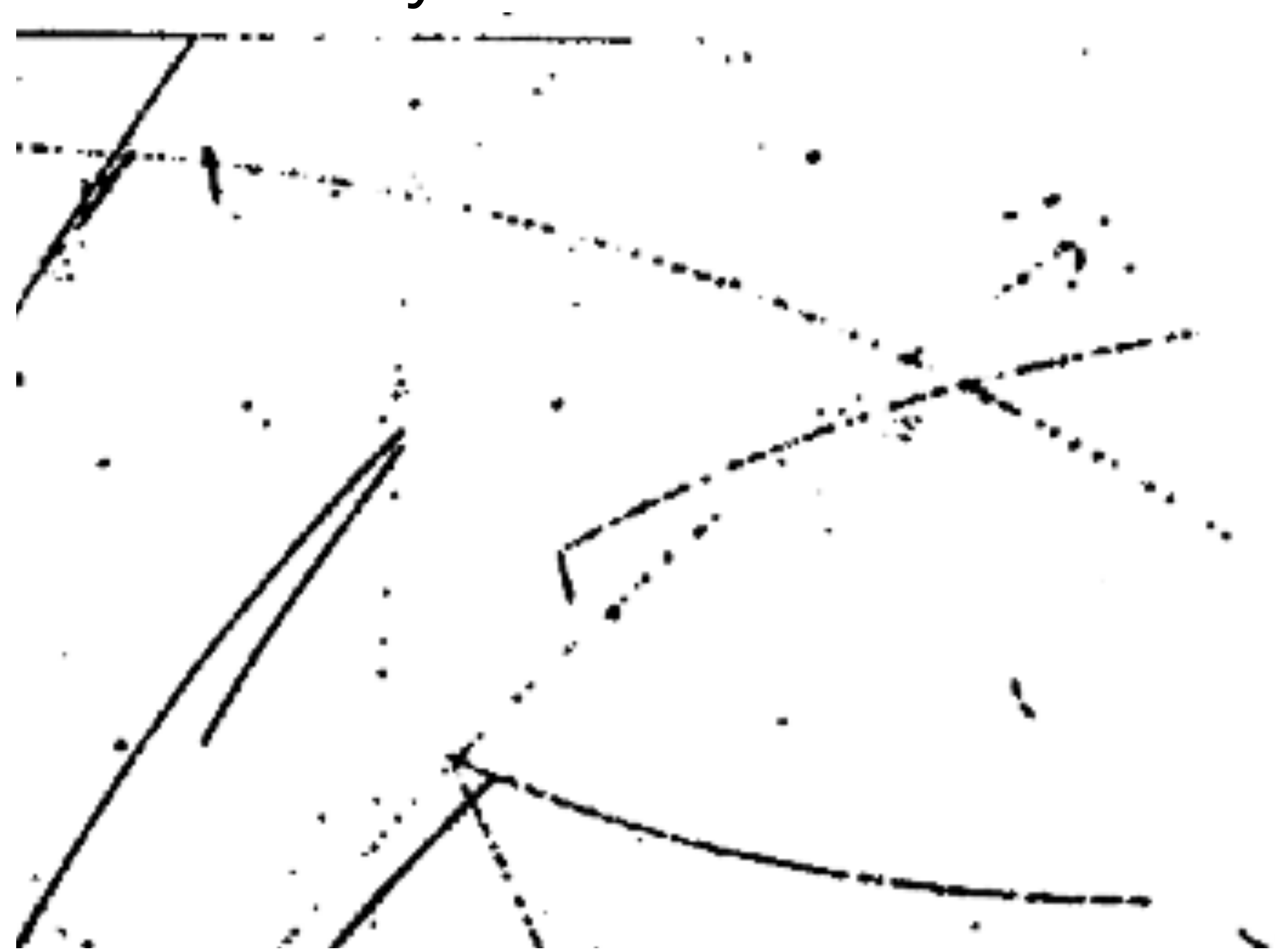
pΛ Interaction

- No Coulomb,
  no quantum statistics

- Strong interaction parameters known from, e.g., 1960s bubble chamber experiments

$$K^- + p \rightarrow \Lambda + \pi^0$$
$$\Lambda + p \rightarrow p + \Lambda$$

Saclay Bubble Chamber



B.Sechi-Zorn et al.,
Phys. Rev. **175** (1968) 1735

pΛ Interaction

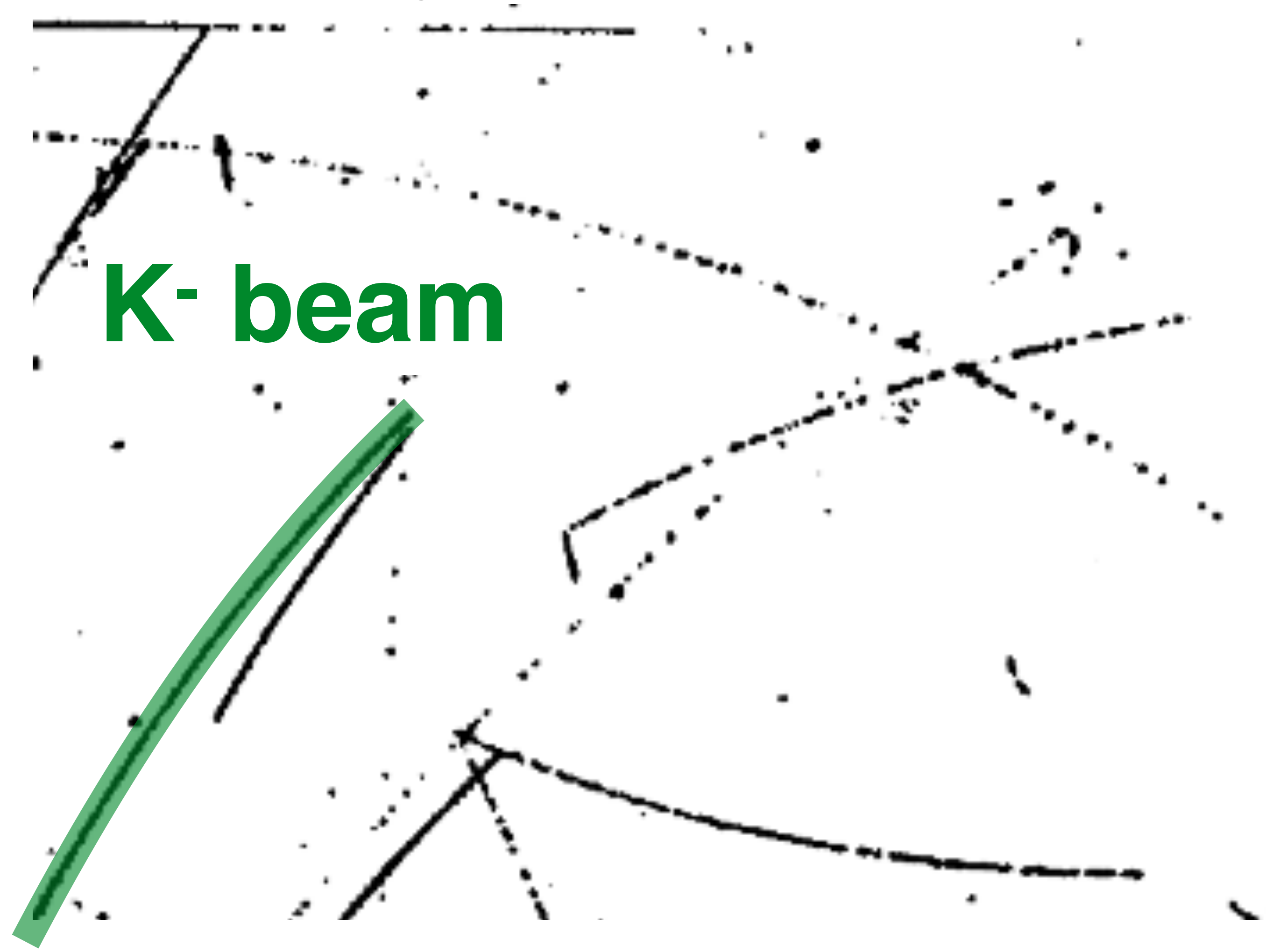
- No Coulomb,
  no quantum statistics

- Strong interaction parameters known from, e.g., 1960s bubble chamber experiments

$K^- + p \rightarrow \Lambda + \pi^0$

$\Lambda + p \rightarrow p + \Lambda$

Saclay Bubble Chamber



B.Sechi-Zorn et al.,
Phys. Rev. **175** (1968) 1735

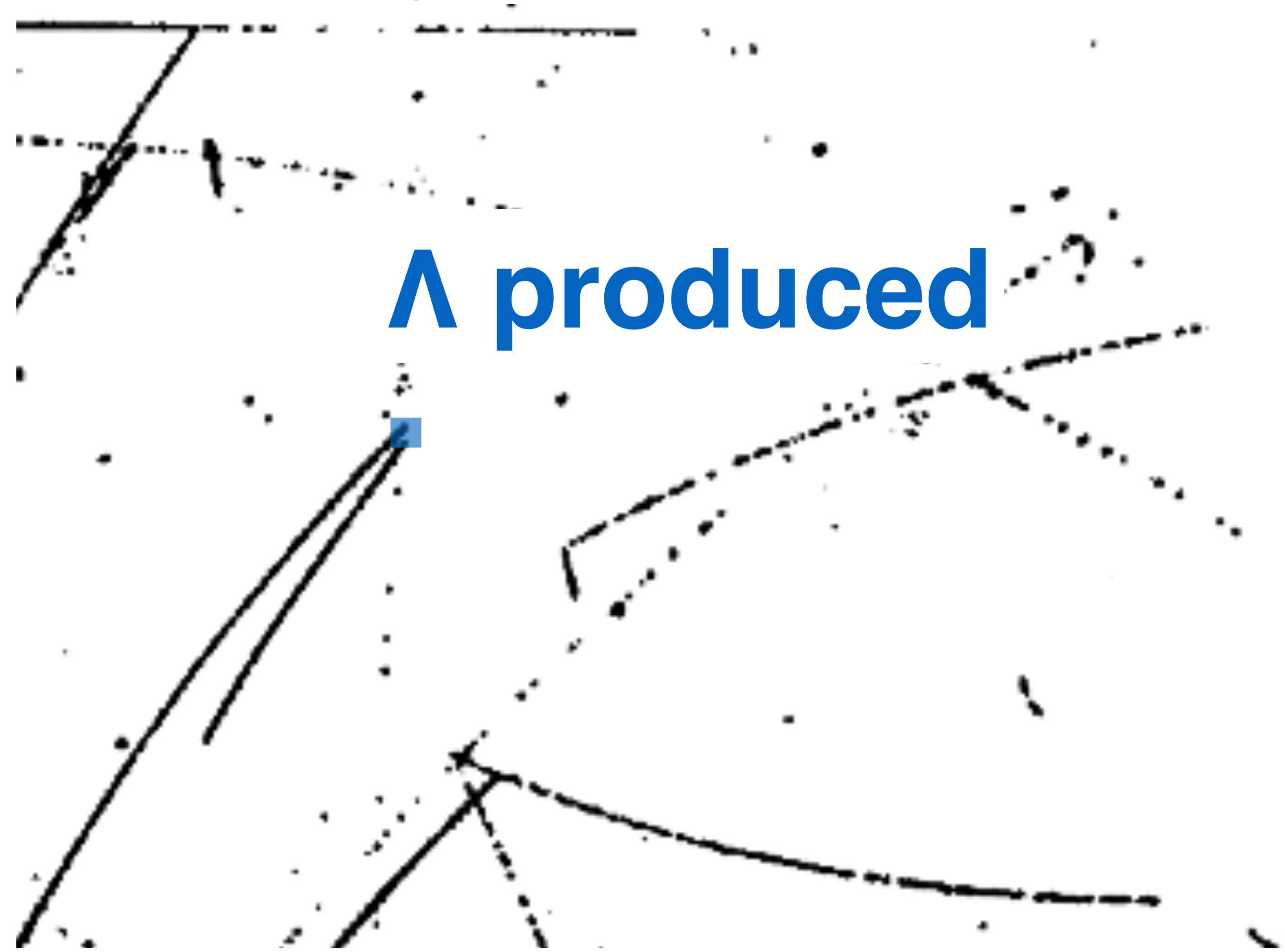
pΛ Interaction

- No Coulomb,
  no quantum statistics

- Strong interaction parameters known from, e.g., 1960s bubble chamber experiments

$K^- + p \rightarrow \Lambda + \pi^0$
$\Lambda + p \rightarrow p + \Lambda$

Saclay Bubble Chamber



B.Sechi-Zorn et al.,
Phys. Rev. **175** (1968) 1735

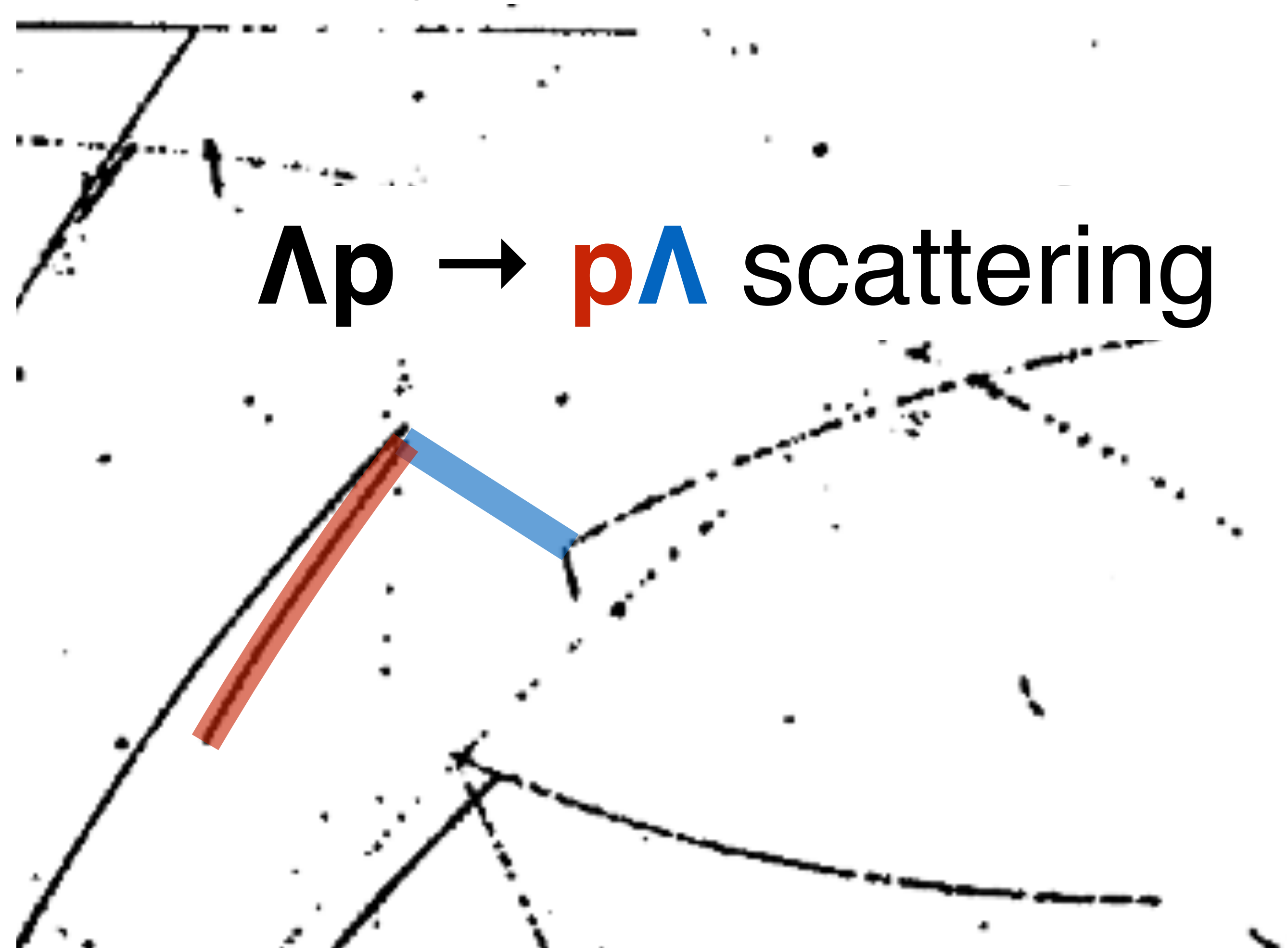
pΛ Interaction

- No Coulomb,
  no quantum statistics
- Strong interaction parameters known from, e.g., 1960s bubble chamber experiments

$K^- + p \rightarrow \Lambda + \pi^0$

$\Lambda + p \rightarrow p + \Lambda$

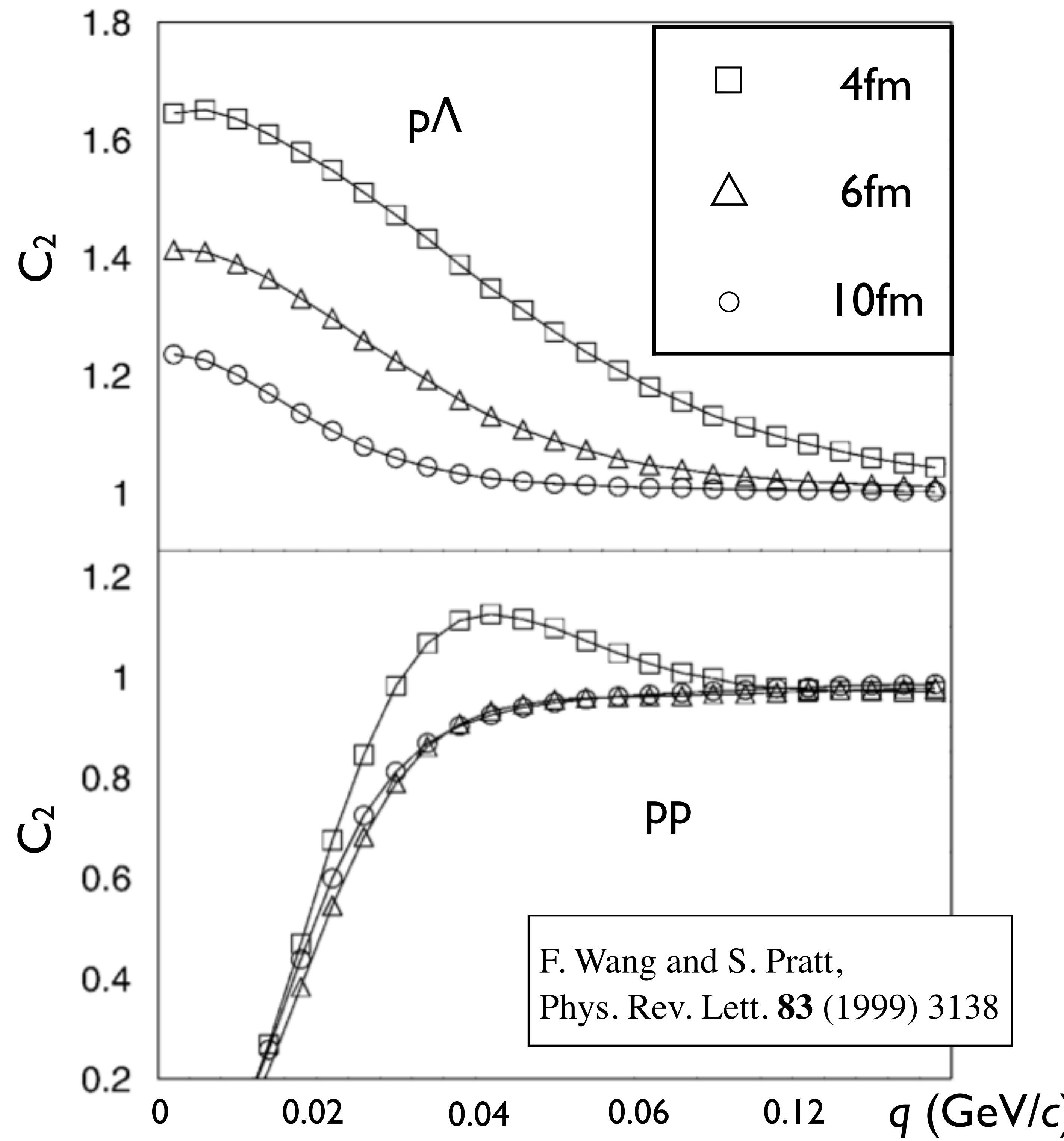
Saclay Bubble Chamber



B.Sechi-Zorn et al.,
Phys. Rev. **175** (1968) 1735

pΛ Interaction

- No Coulomb,
  no quantum statistics
- Strong interaction parameters known from, e.g., 1960s bubble chamber experiments
- C_2 affected in height and shape by source size
- Sensitivity maintained for radii > 4 fm

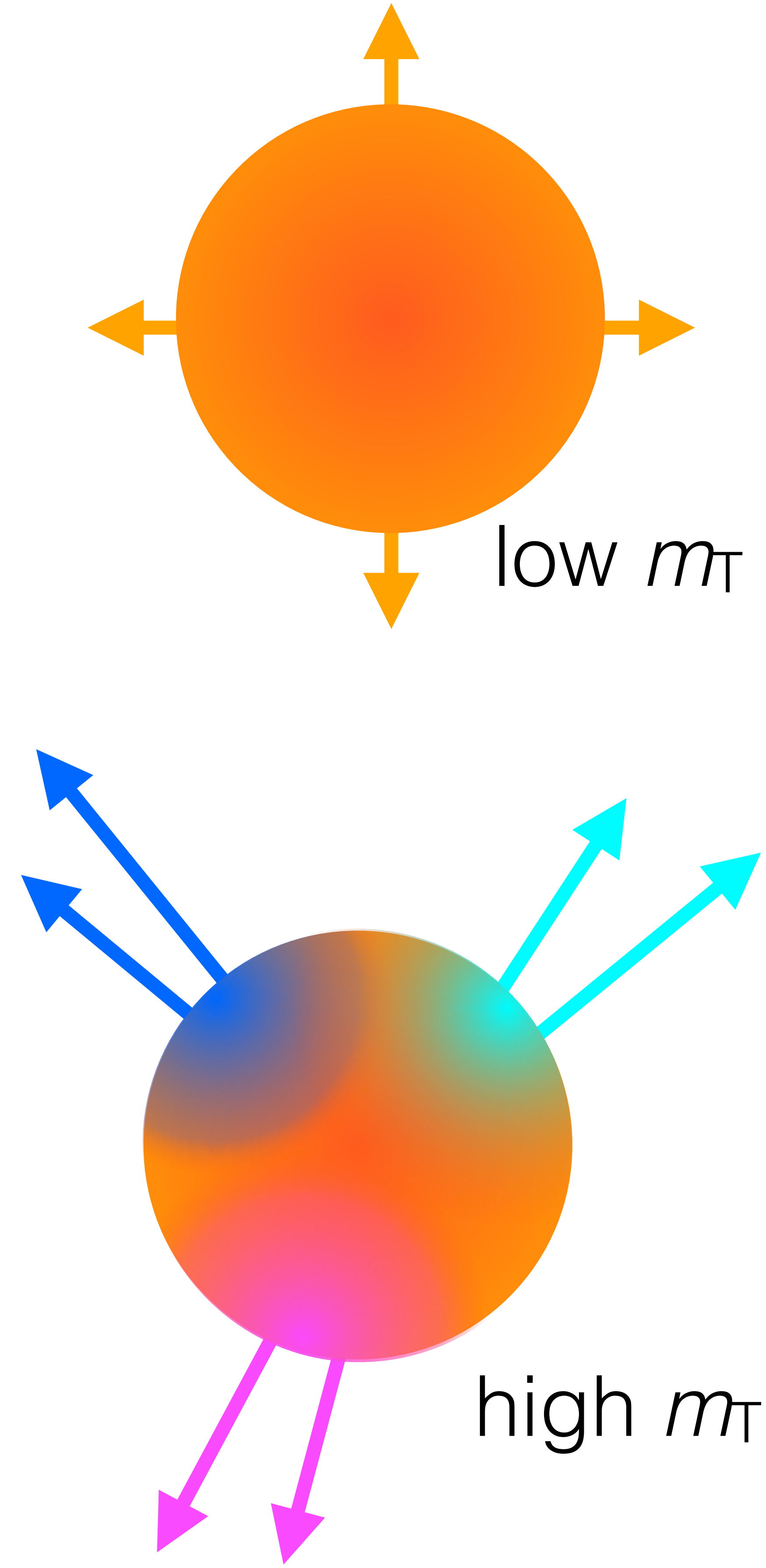


F. Wang and S. Pratt,
Phys. Rev. Lett. **83** (1999) 3138

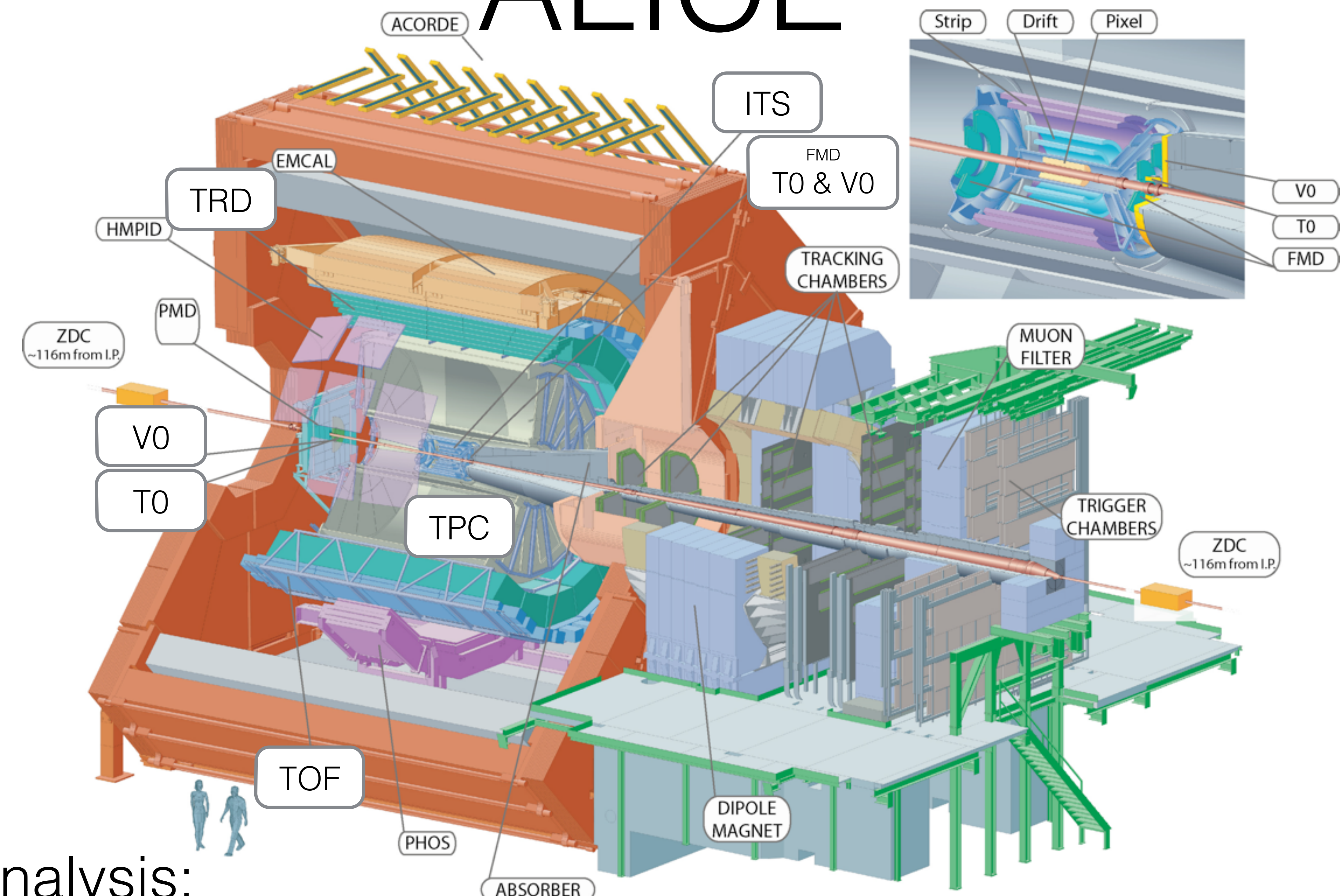
Motivation pΛ

- Expanding medium
- Thermal velocity $\sqrt{T/m_{\mathrm{T}}}$ competing with collective velocity
- m_{T} dependence of radii probes dynamics of the source
- Experimental m_{T} reach can be extended with heavy particles
- pΛ heaviest studied system so far

STAR: EPJ C **49** (2007) 75 NA49: PRC **83** (2011) 054906



ALICE

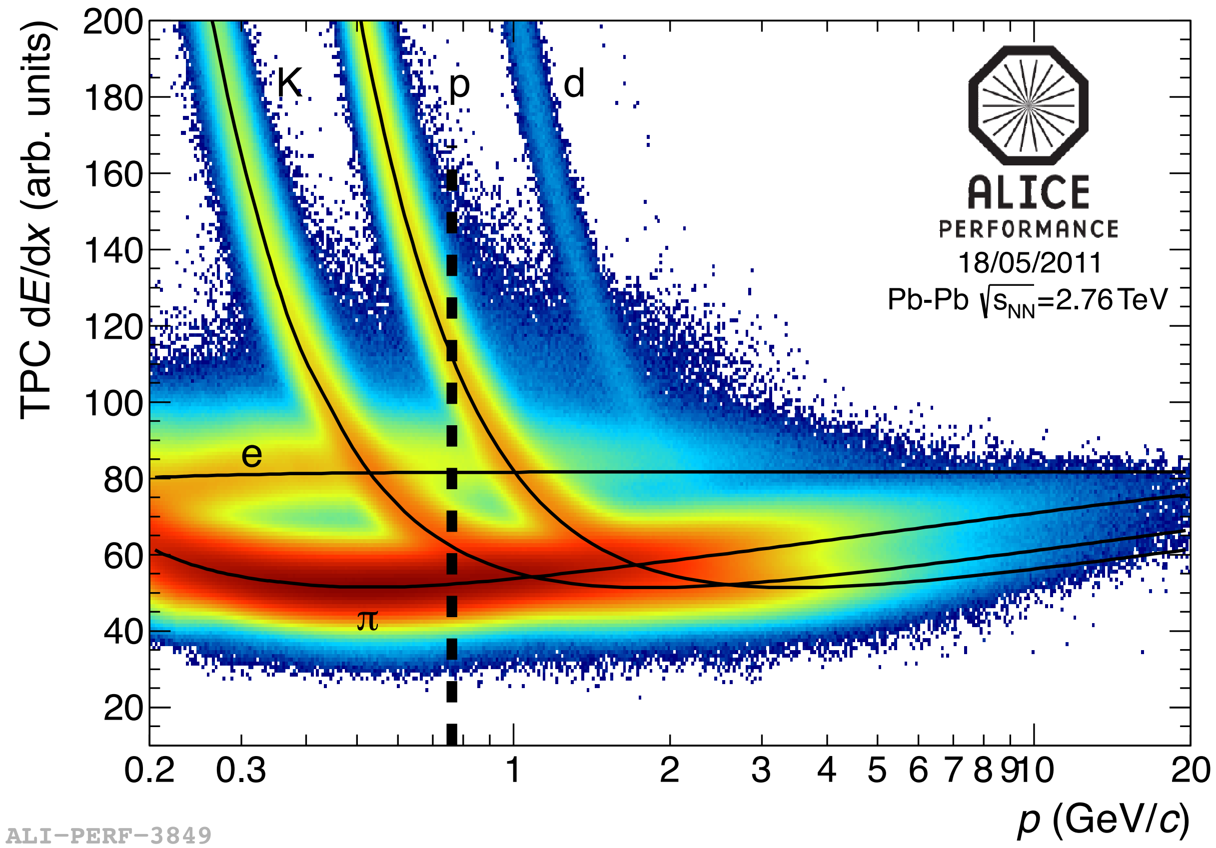


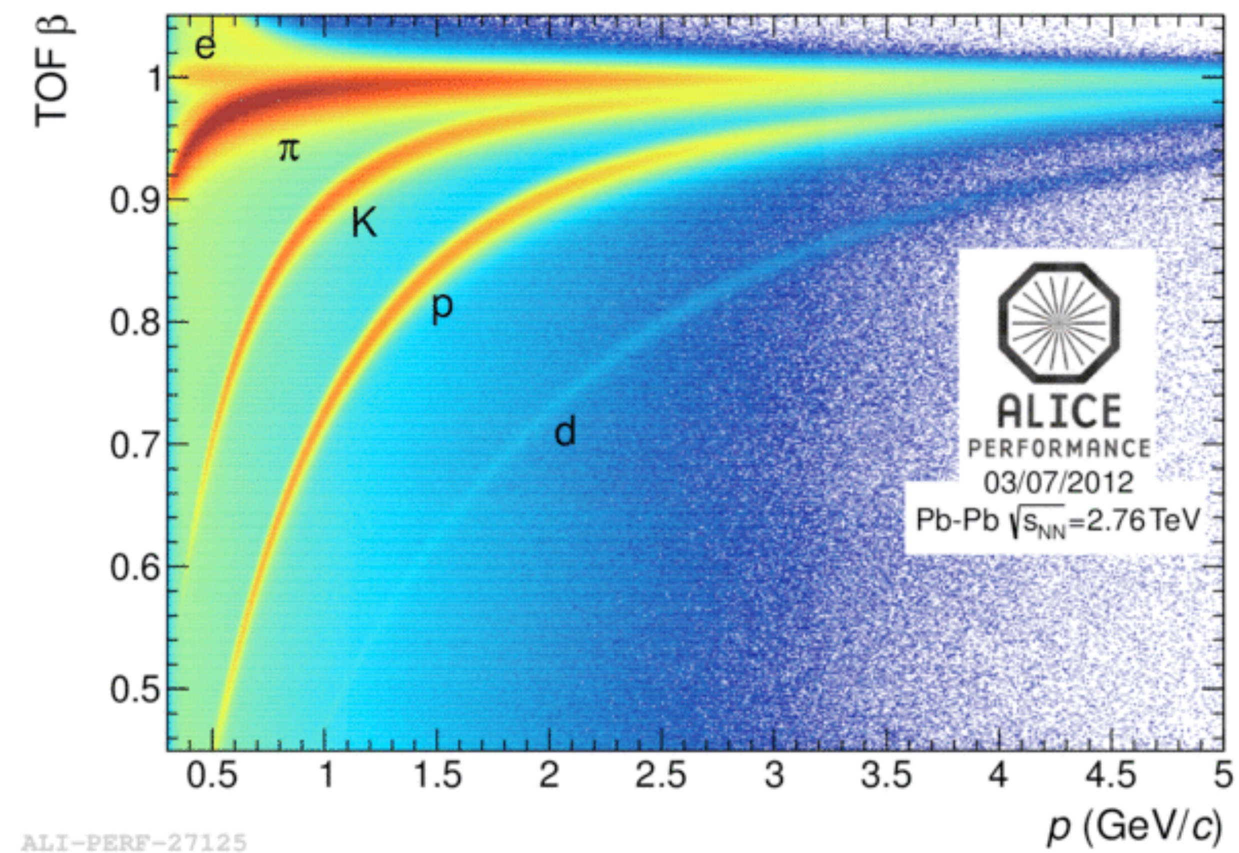
<u>This analysis:</u>

Trigger, centrality	Tracking	PID
T0, V0	ITS, TPC, TRD	TPC, TOF

Proton selection

- Depending on momentum, using TPC and/or TOF

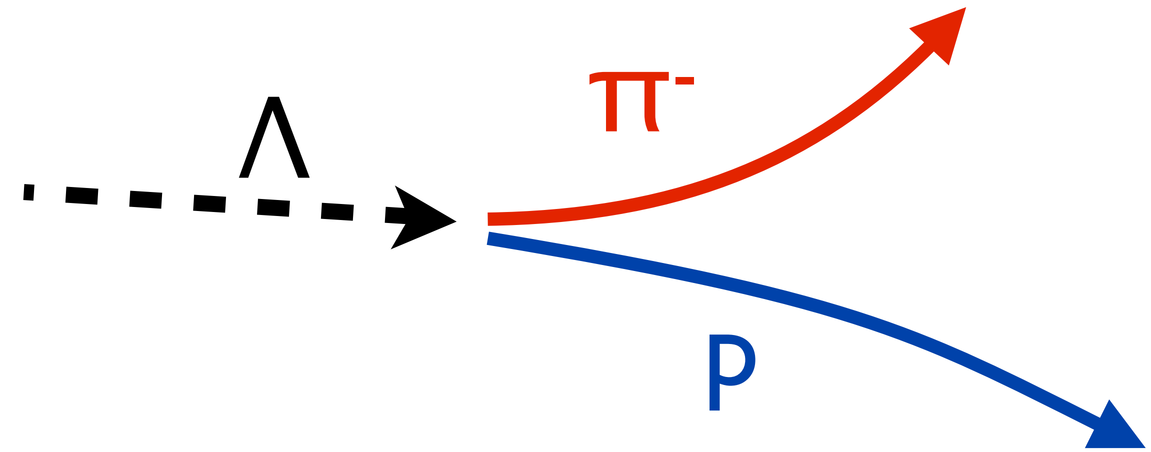




- TPC: proton separation > 4σ up to p = 0.75 GeV/c
- TOF: proton ID up to p = 5.0 GeV/c

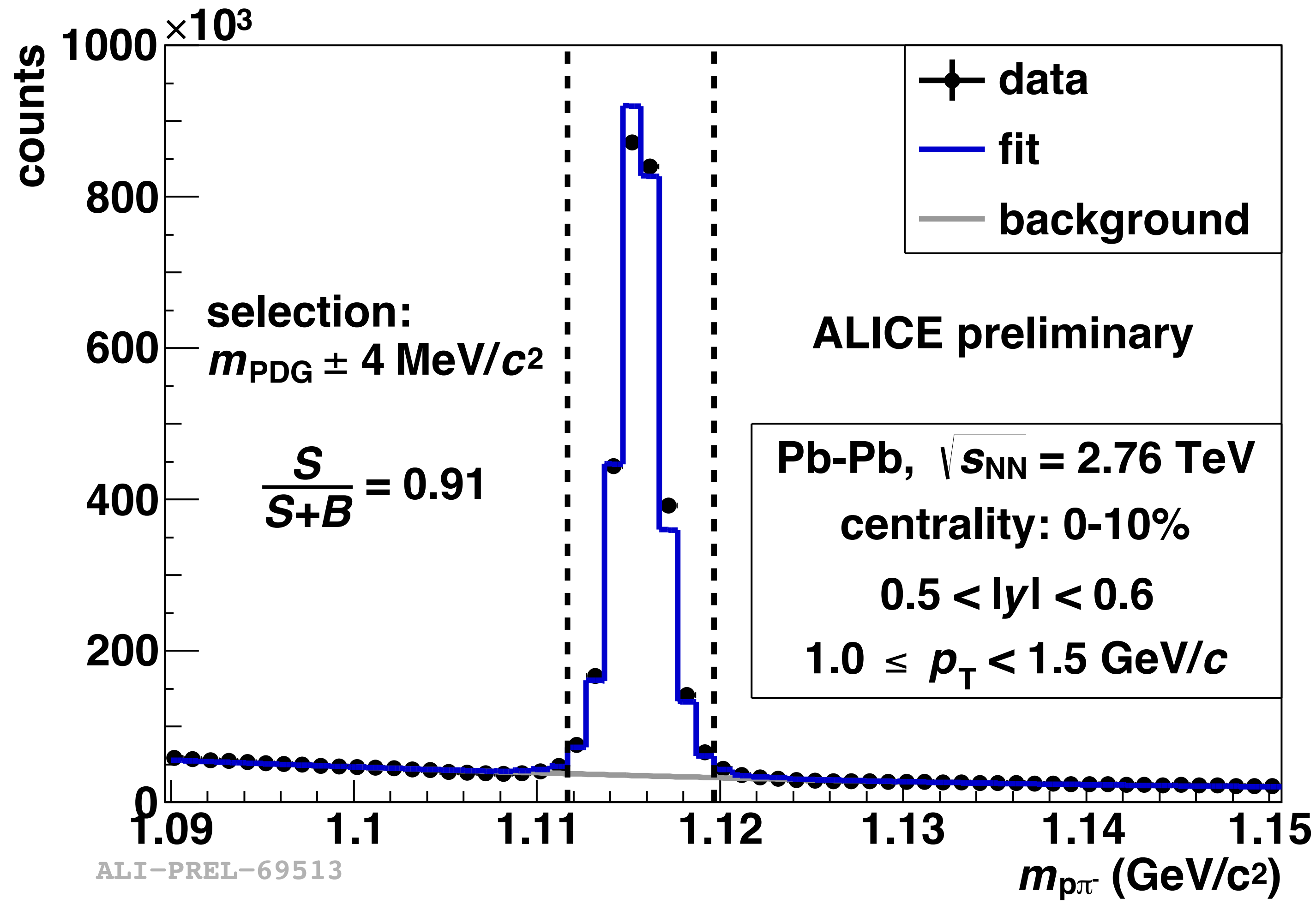
- Proton purity > 99% obtained everywhere

Λ selection



- Using V0 topology finder
- Reconstruct charged decay
- Identify via invariant mass
- Determine

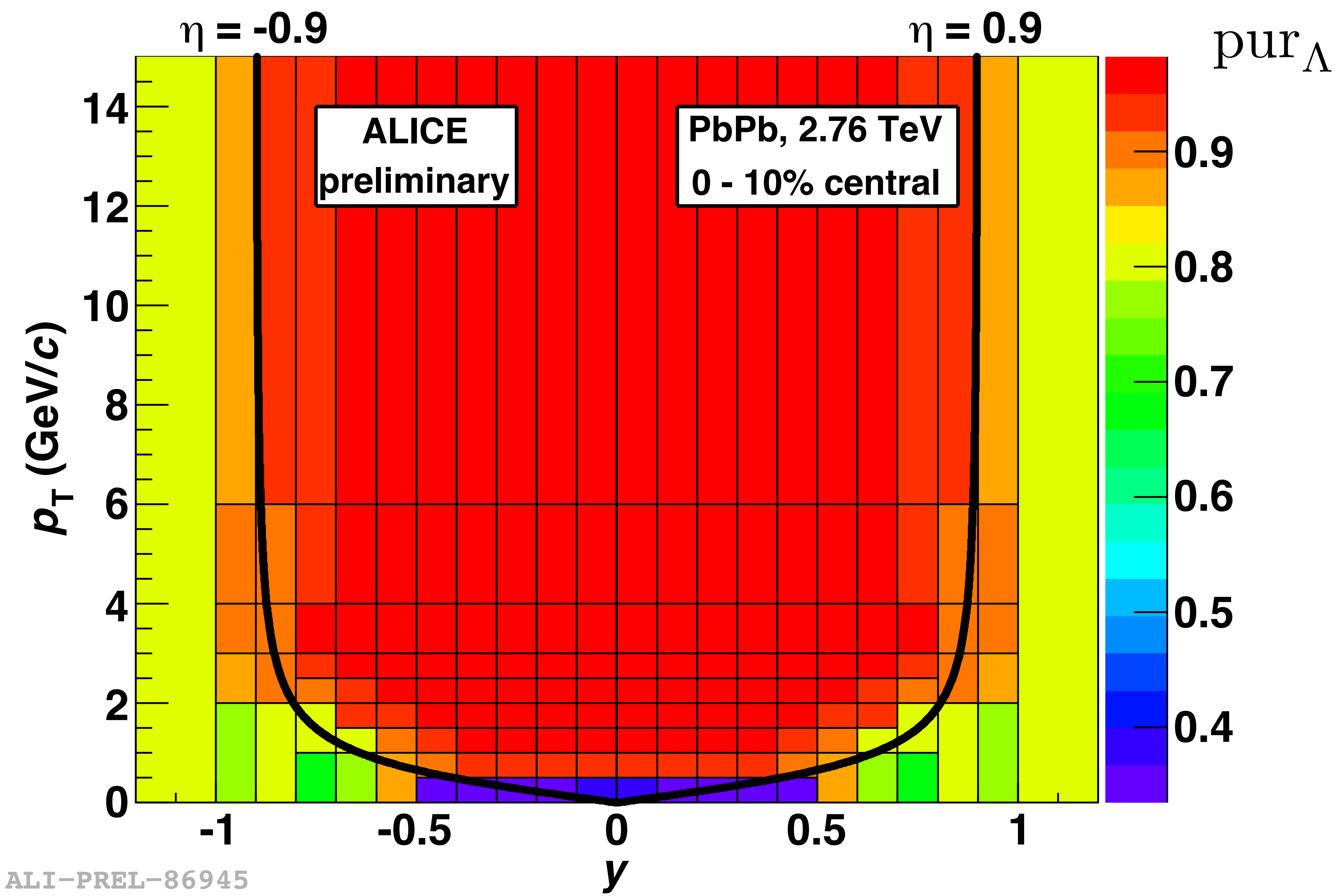
$$\mathrm{pur}_{\Lambda} = \frac{S}{S+B}$$



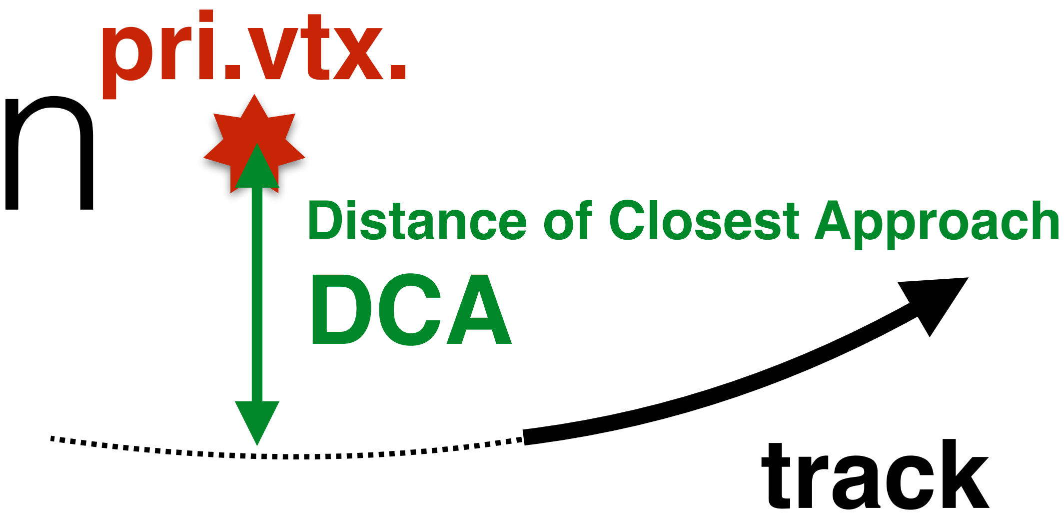
- Later use purity as correction factor to correlation function for uncorrelated background

Λ selection: purities

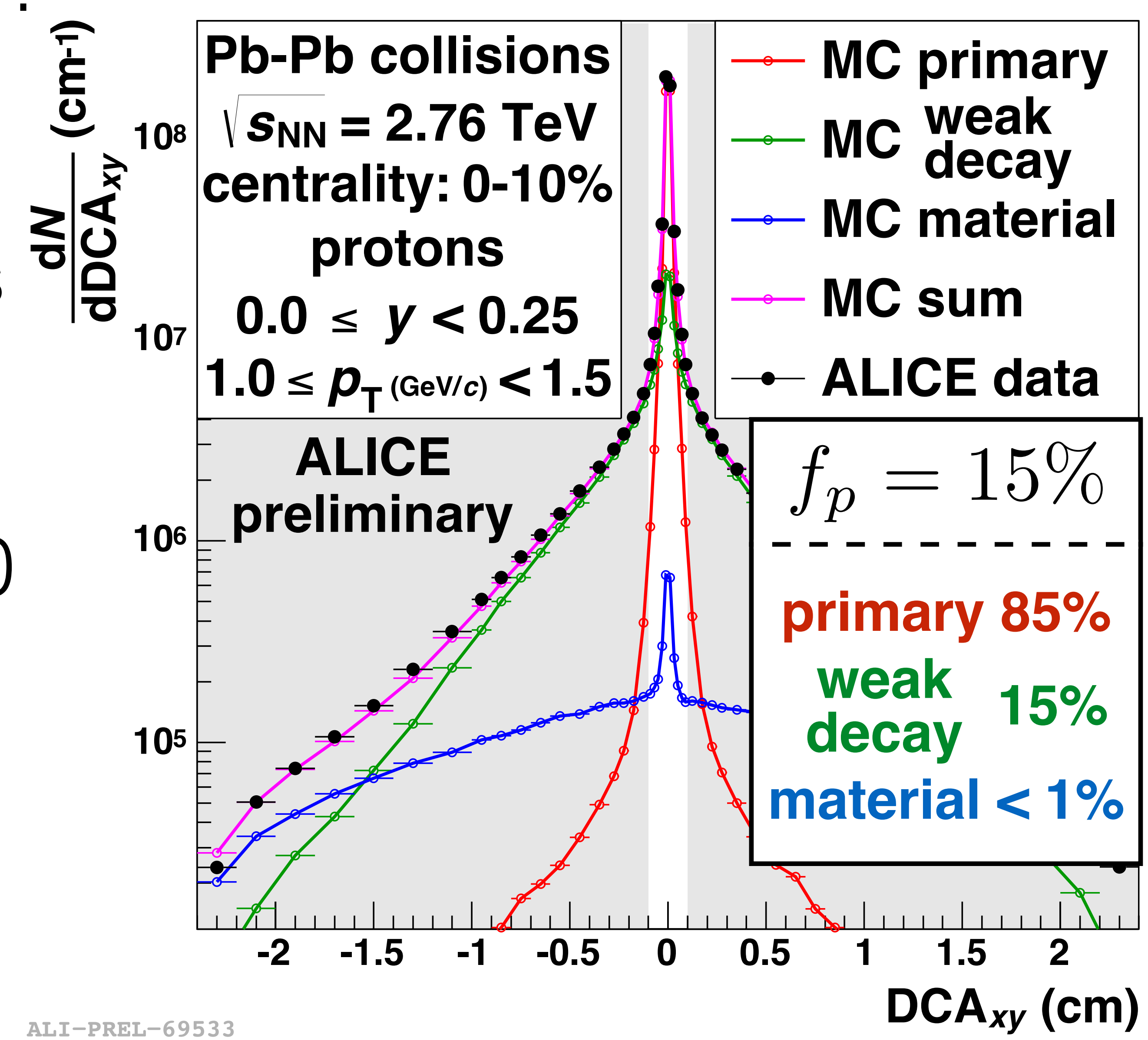
- Single particle purities for Λ and $\bar{\Lambda}$ in centrality and y,p_T



Proton feed-down



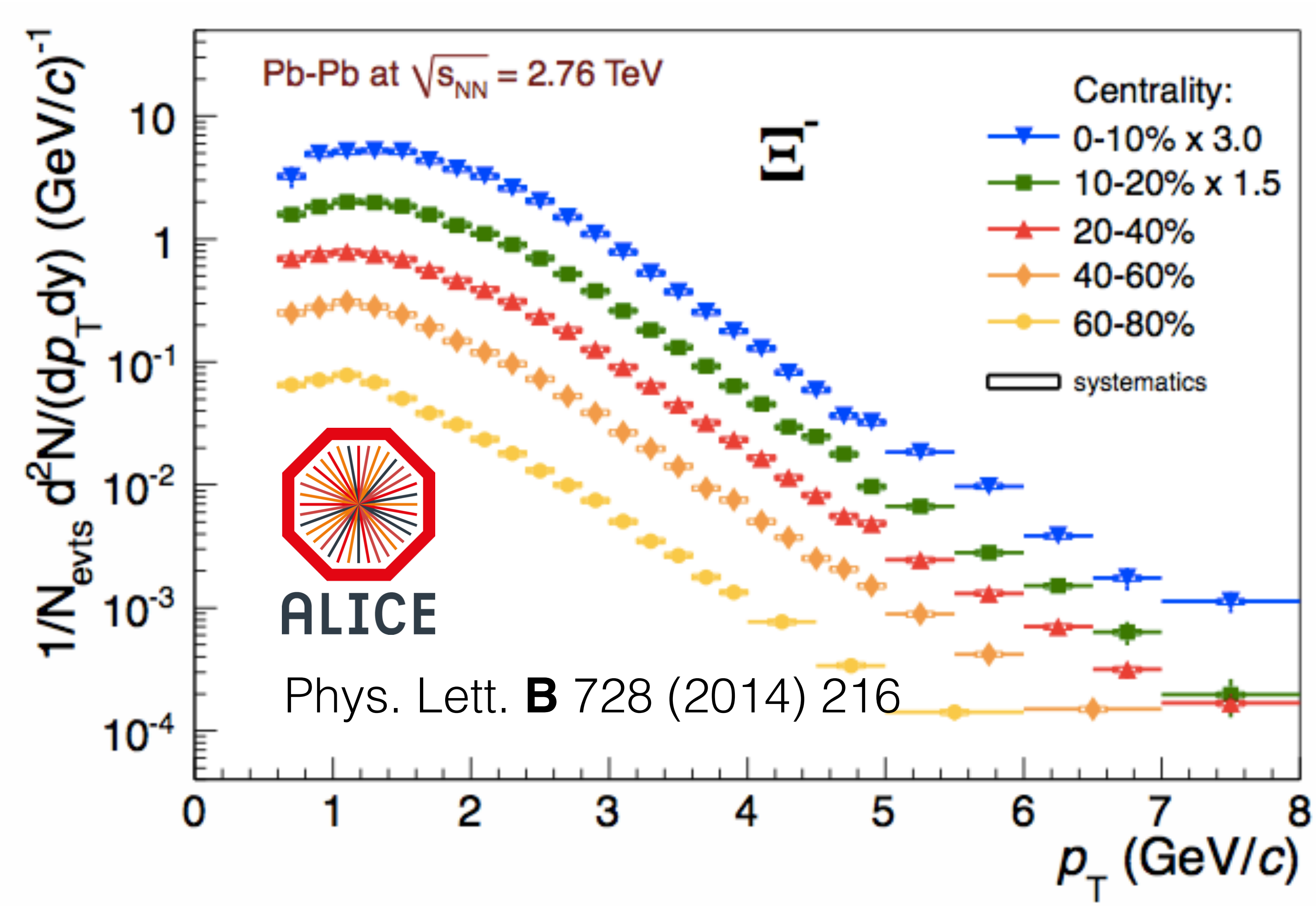
- Proton sample contaminated with decay products, mostly:
  $\Lambda \rightarrow p_{dec} \pi^-$
- pΛ pairs contain $p_{dec}\Lambda$ pairs
- No $\Lambda\Lambda$ correlation seen
  STAR: Nucl.Phys.A **914**, 410
  ➡ Uncorrelated feed-down
- Correct with feed-down fraction $f_\mathrm{p} = \frac{\text{feed-down}}{\text{all}}$



Λ feed-down

- Determine contribution from weak decays
  - Using measured spectra
  - Reconstruction efficiencies from MC

weak	BR
$\Xi^0 \rightarrow \Lambda\pi^0$	99.5%
$\Xi^- \rightarrow \Lambda\pi^-$	99.9%
$\Omega^- \rightarrow \Lambda K^-$	67.8%
$\Omega^- \rightarrow \Xi\pi$ ↳ $\Lambda\pi$	32.2%



Λ feed-down

- Determine contribution from weak decays
  - Using measured spectra
  - Reconstruction efficiencies from MC

weak	BR
$\Xi^0 \rightarrow \Lambda\pi^0$	99.5%
$\Xi^- \rightarrow \Lambda\pi^-$	99.9%
$\Omega^- \rightarrow \Lambda K^-$	67.8%
$\Omega^- \rightarrow \Xi\pi$ ↳ $\Lambda\pi$	32.2%

- Electromagnetic decays by thermal model
  - M.Chojnacki *et al.*, arXiv:1102.0273 [nucl-th]
  - A.Andronic *et al.*, Nucl.Phys.A **772** (2006) 167
    - varied temperature
  - F.Becattini *et al.*, PoS(CPOD 2013)010
    - hadronic and chemical freeze-out

E.M.	BR
$\Sigma^0 \rightarrow \Lambda\gamma$	100%

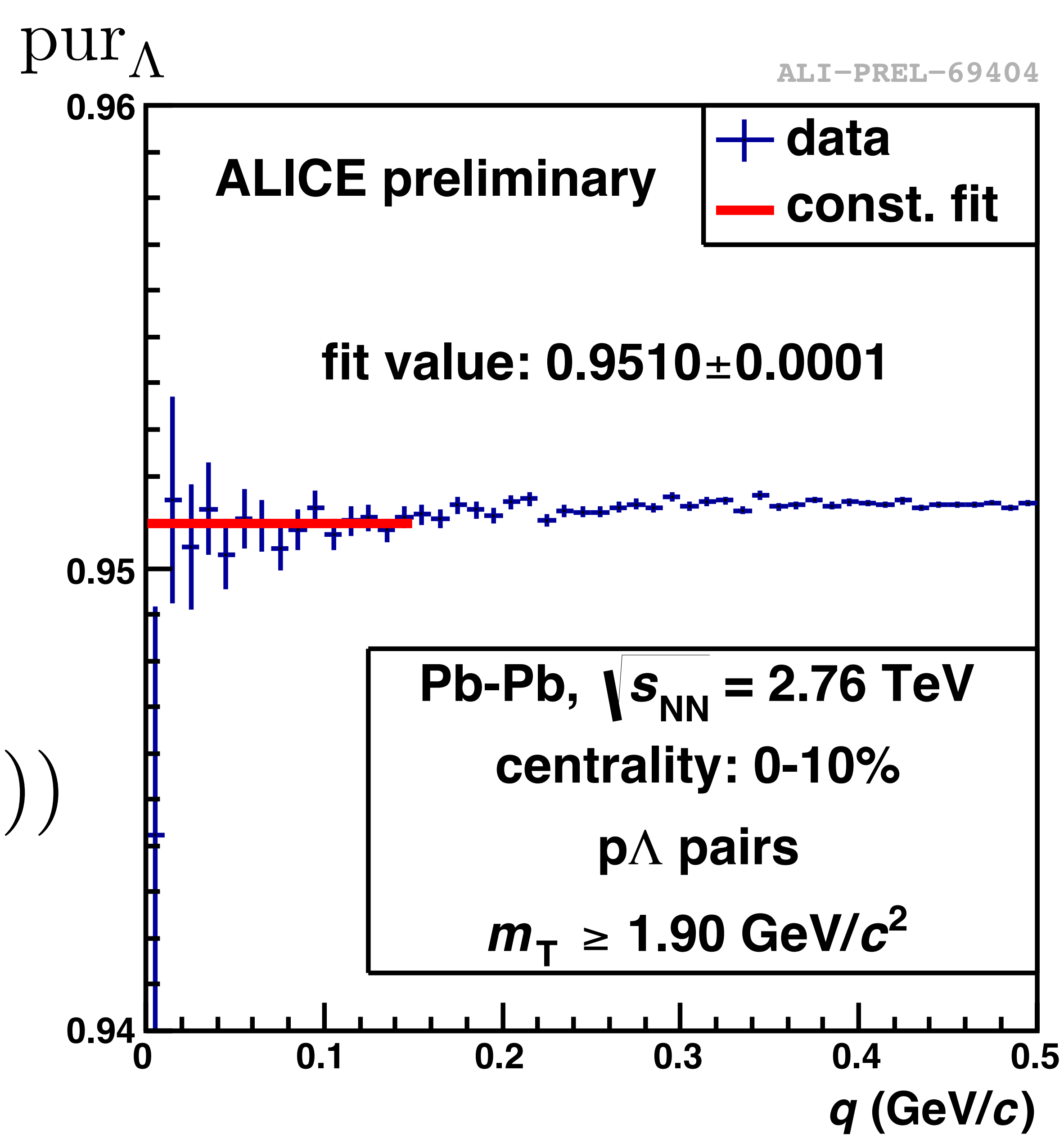
Corrections

- Raw correlation function:

$$C_2^{\mathrm{raw}}(q, m_{\mathrm{T}}) = \frac{\text{real events}}{\text{mixed events}}$$

- Purity:

$$\mathrm{pur}(q, m_{\mathrm{T}}) = \mathrm{pur}_{\Lambda}(q, m_{\mathrm{T}}) \cdot (1 - f_{\mathrm{p}}(q, m_{\mathrm{T}})) \cdot (1 - f_{\Lambda}(q, m_{\mathrm{T}}))$$

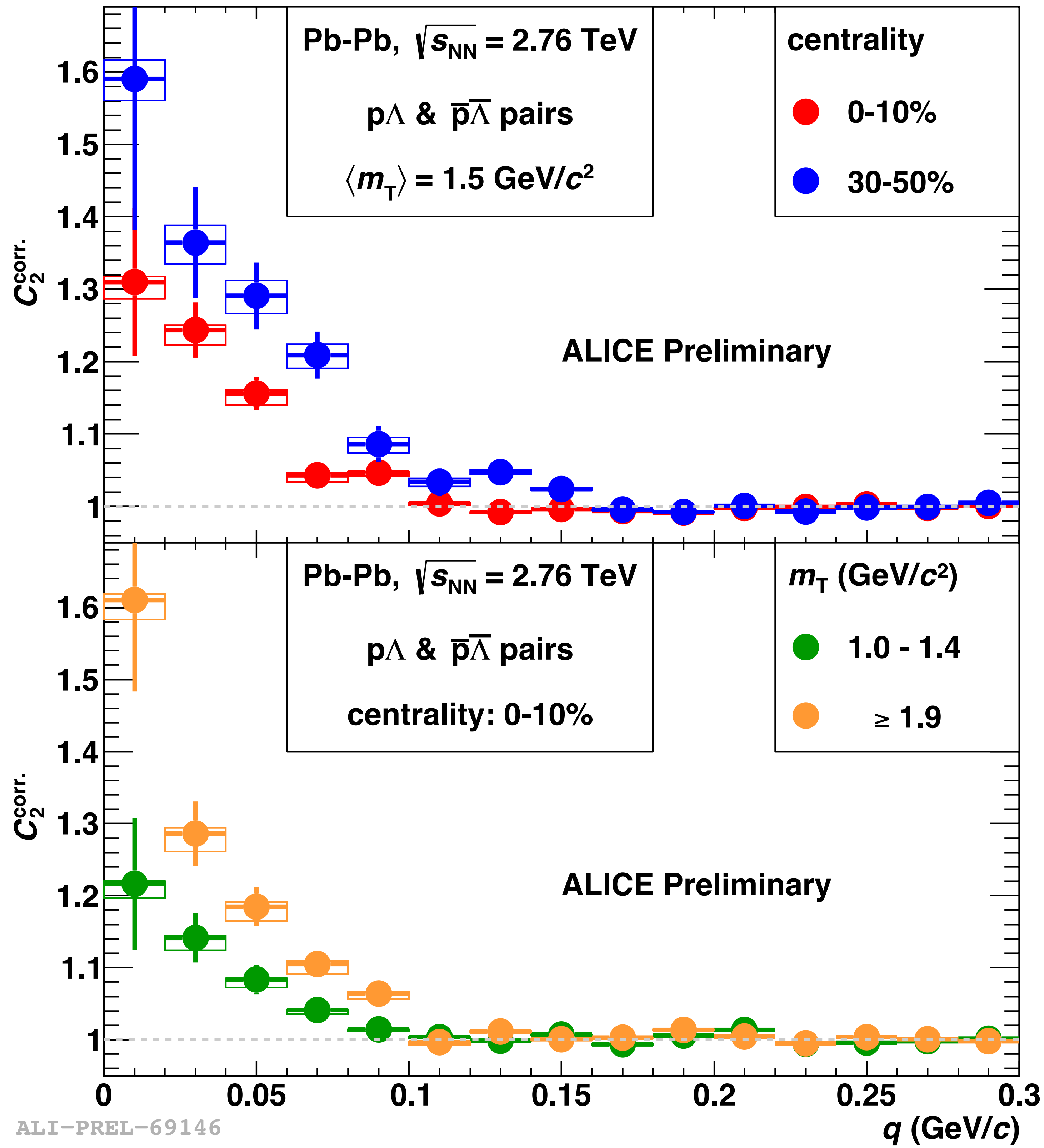


- Corrected correlation function:

$$C_2^{\mathrm{corr.}}(q, m_{\mathrm{T}}) = \left(\frac{1}{\mathrm{pur}(q, m_{\mathrm{T}})} \cdot (C_2^{\mathrm{raw}}(q, m_{\mathrm{T}}) - 1)\right) + 1$$

Results

- Exemplary $p\Lambda$ & $\bar{p}\bar{\Lambda}$ correlation functions
- Corrected for purity
- Not corrected for ~10 MeV momentum resolution
- Centrality and m_T dependence seen
- Note high m_T



Summary

- ALICE allows to obtain highly pure samples with rich statistics
- Obtained corrected pΛ correlation functions multi-differentially in centrality and m_T
- Reached largest m_T so far
- Expected centrality and m_T dependence seen
- Looking forward to extract radii with high precision