UNIWERSYTET JAGIELLOŃSKI W KRAKOWIE

ROK ZAŁOŻENIA 1364

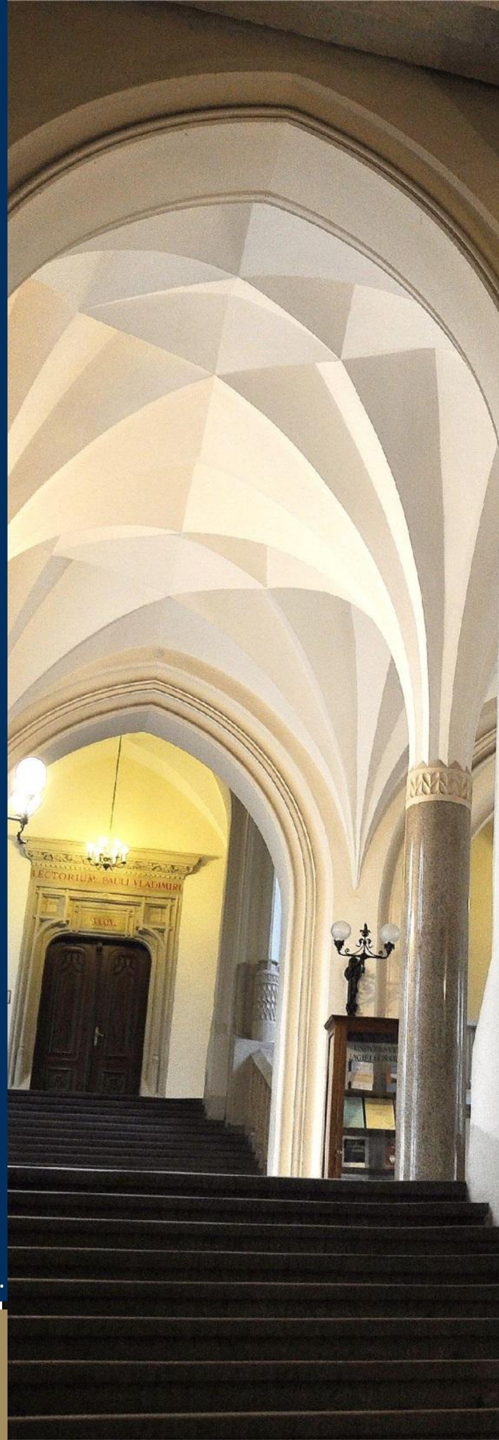
Hyperon studies and development of Forward tracker for HADES detector

Narendra Rathod
(Jagiellonian University, Poland)

HADES

Outline

1. Why do we want to study hyperons with HADES ?
2. Hyperon production and decay
3. HADES detector
4. New upgrades
5. Forward tracker
6. Summary of contribution



UNIWERSYTET JAGIELLOŃSKI W KRAKOWIE

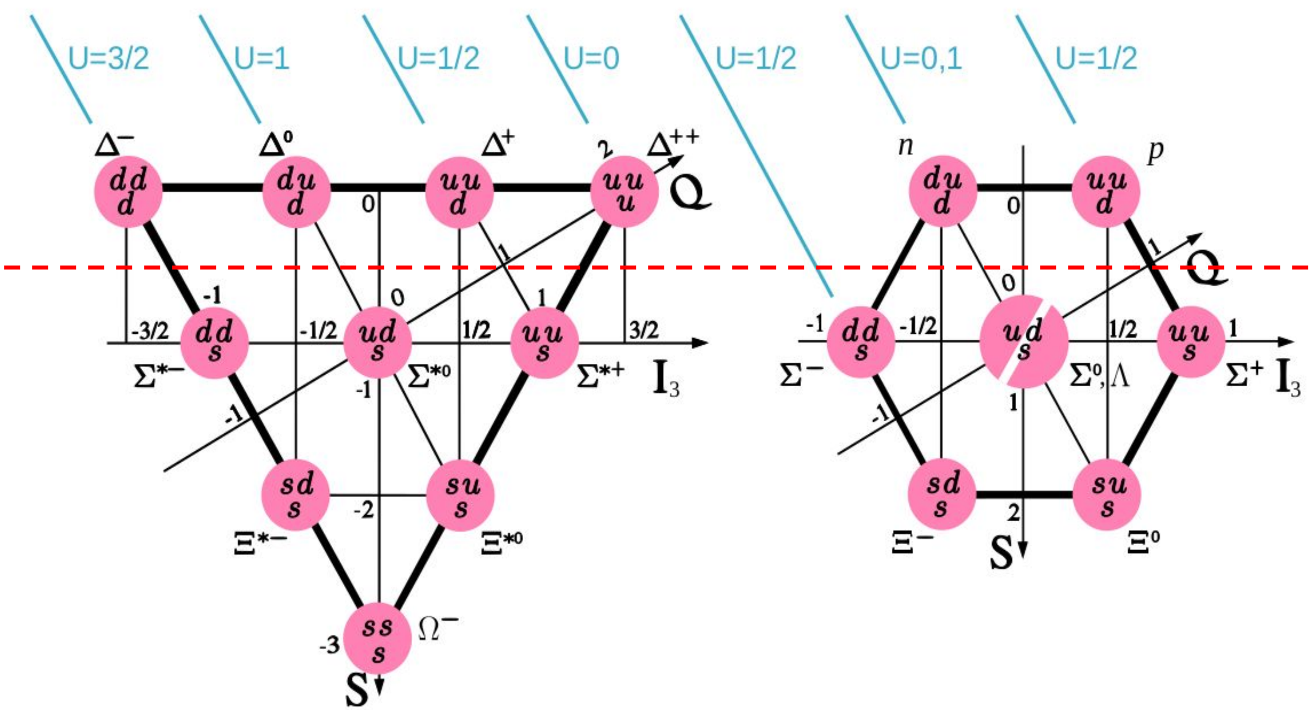
Narendra Rathod

Krakow June 23 – 28, 2019

narendra.shankar.rathod@doctoral.

Structure of hyperons

- Baryon is a type of composite subatomic particle which contains 3 valence quarks
- Ground states are measured and the structures are well known



Fermi National Accelerator Laboratory

FERMILAB-Conf-75/79-THY
October 1975

WHY ARE HYPERONS INTERESTING AND DIFFERENT FROM NONSTRANGE BARYONS?†

Harry J. Lipkin*
Weizmann Institute of Science, Rehovot, Israel,
Argonne National Laboratory, Argonne, Illinois 60439 and
Fermi National Accelerator Laboratory, Batavia, Illinois 60510

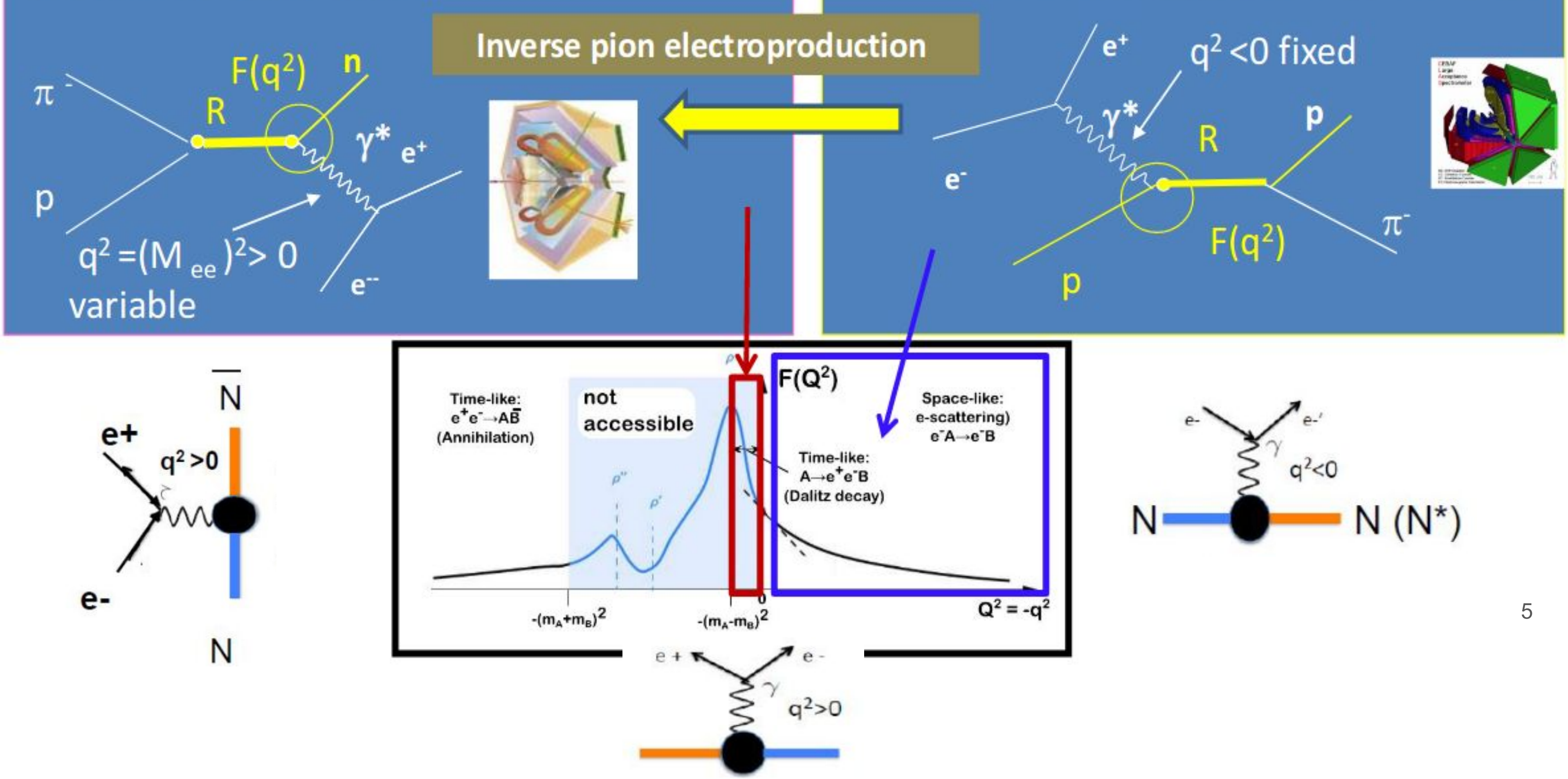
I. WHO NEEDS HYPERONS?

The first question to ask about any new topic is "who needs it?". One possible answer to "who needs hyperons?" is "seen one hadron, seen them all." All hadrons are alike in the zero approximation. A useful hyperon experiment must go beyond this zero approximation to observe the differences between hyperons and other hadrons. For example, a total cross section measurement for hyperon-nucleon scattering with errors too large to reveal the difference between hyperon-nucleon and nucleon-nucleon cross sections is not very useful.

Electromagnetic baryonic transitions in Time-Like and Space-Like region

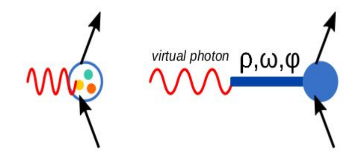
Time-Like electromagnetic form factors

Space-Like electromagnetic form factors

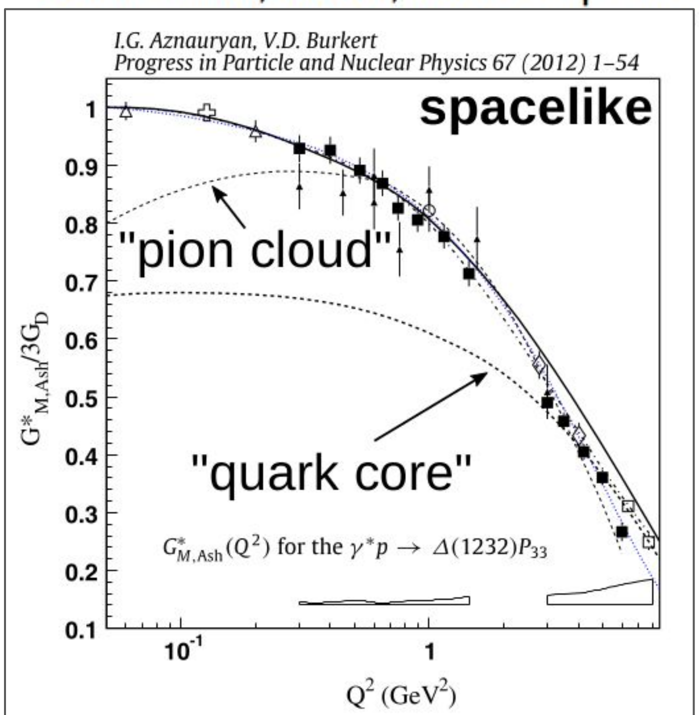


eTFF in Space-like and Time-like region

Dalitz decays, appearance of intermediate vector mesons **ρ/σ/Φ** $J_{PC} = 1^{--}$ (γ !)



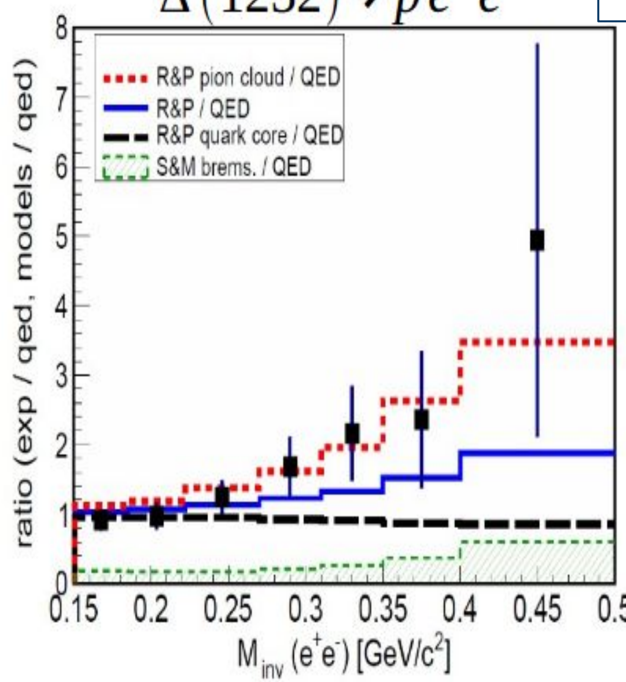
Data: CLAS, MAMI, Bates: e-p→Δ e-



Space-like region

Data: HADES PRC2017

$\Delta(1232) \to p e^+ e^-$



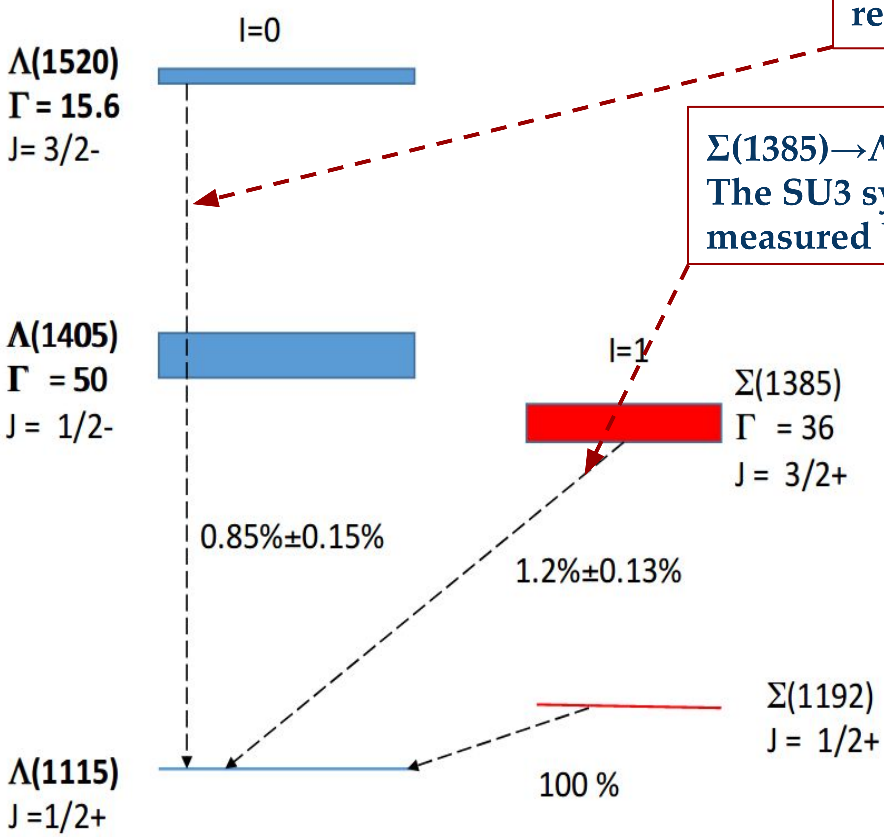
Sensitivity to meson cloud effects?

Time-like region

Our goals through Hyperon Decay

$\Lambda(1520) \rightarrow \Lambda(1116)\, e^+ e^-$
Never measured for time-like region, relatively high BR for space-like transition

$\Sigma(1385) \rightarrow \Lambda(1116)\, e^+ e^-$
The SU3 symmetry partner for transition $\Delta(1232) \rightarrow p\, e^+ e^-$ measured by HADES



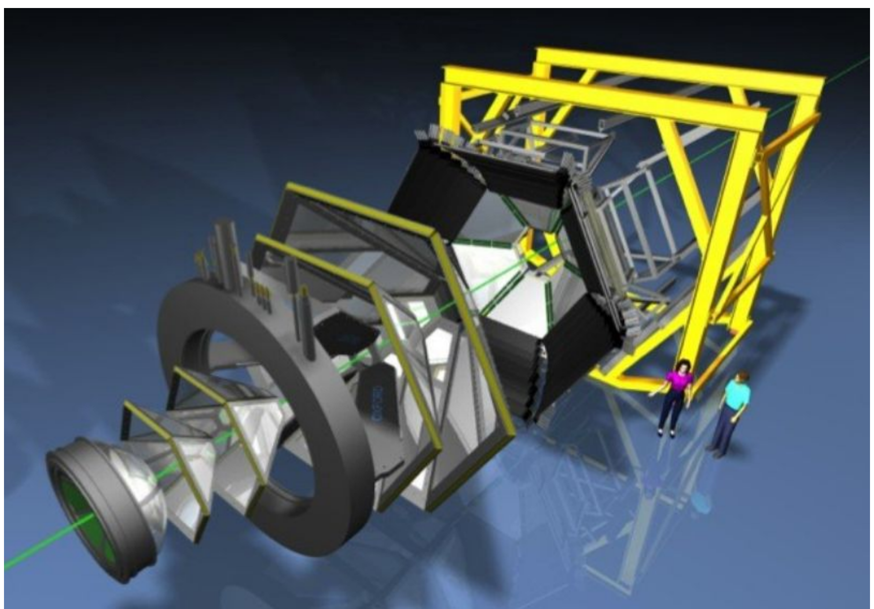
Taylor et al. (CLAS Collab.), Phys. Rev. C71 (2005) 054609

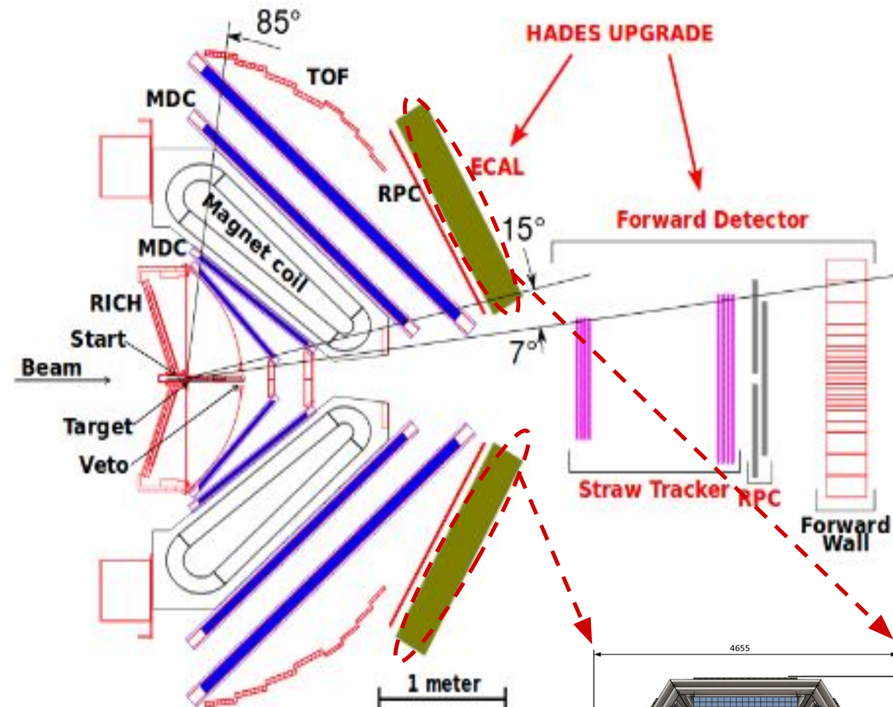
	Decay width Γ [KeV]			
Model	$\Delta(1232) \rightarrow p p \gamma$	$\Sigma^0(1385) \rightarrow \Lambda(1116)\, \gamma$	$\Lambda^0(1405) \rightarrow \Lambda(1116)\, \gamma$	$\Lambda^0(1520) \rightarrow \Lambda(1116)\, \gamma$
Quark Model	350-360	265-273	118-200	156-215
MIT BAG	-	152	17, 60	46
Soliton	-	170, 243	44, 40	-
Skyrme	309-348	157-209	-	-
Experiment		479 ± 120		167 ± 43

HADES: $\Gamma(\Delta(1232) \rightarrow p\, e^+e^-) = 0.66$ MeV, BR = $4.19 \cdot 10^{-5}$

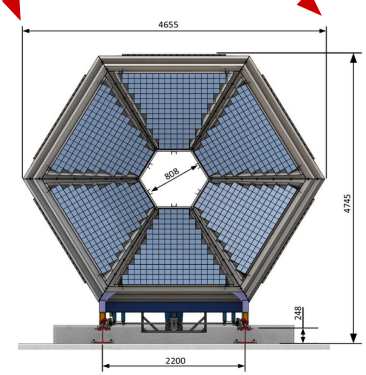
High Acceptance Di-Electron Spectrometer

Observable	Detector
p	Magnet+MDC
β	TOF+RPC
dE/dx	MDC+TOF
e+,e−	RICH
γ,e+,e−	ECAL
dp/p	1 % to 2 %



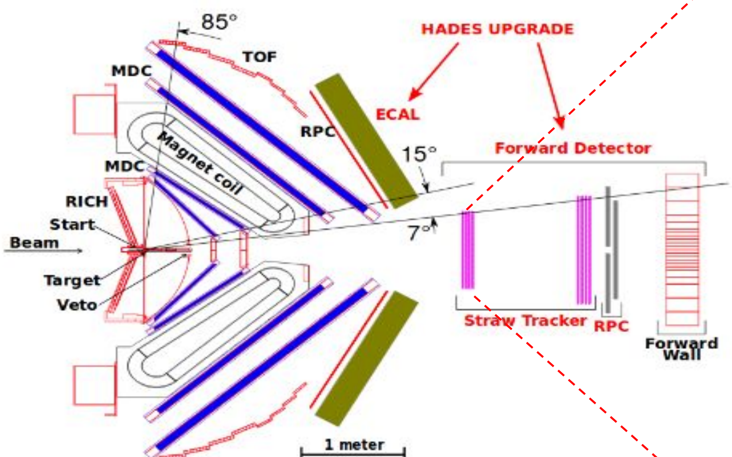


Geometry
full azimuthal, polar angles 18° - 85°

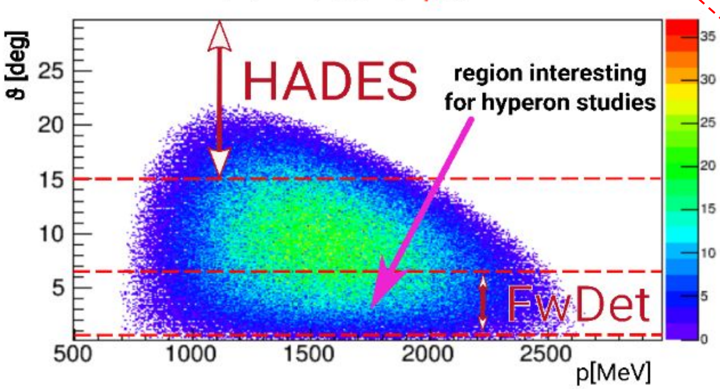


ECAL

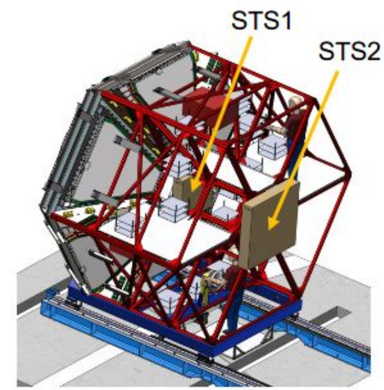
Straw tube Forward tracker

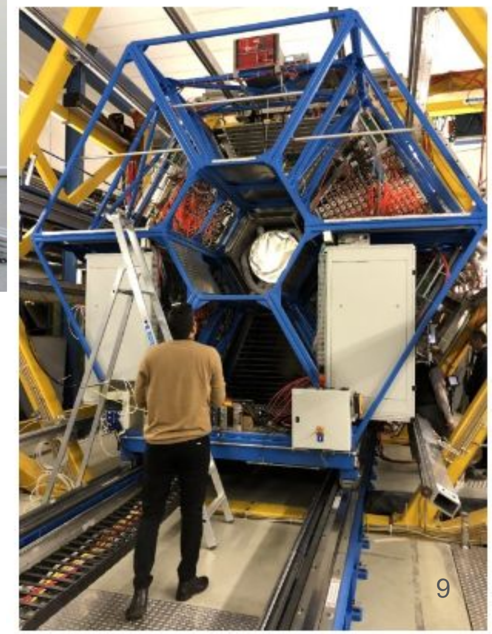


$$\Xi^- \to \Lambda \to p\pi^-$$



w/o Forward Detector only 8.7 %
of all possible p are reconstructed





JAGIELLONIAN UNIVERSITY IN KRAKOW
HADES
Narendra Rathod
Krakow June 23 – 28, 2019

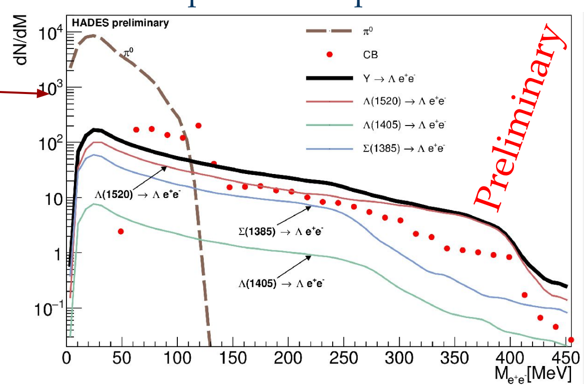
Simulation

Benchmark reactions:
- Radiative (Dalitz) hyperon decays: **Σ**(1385), **Λ**(1405), **Λ**(1520)
- Cascade production

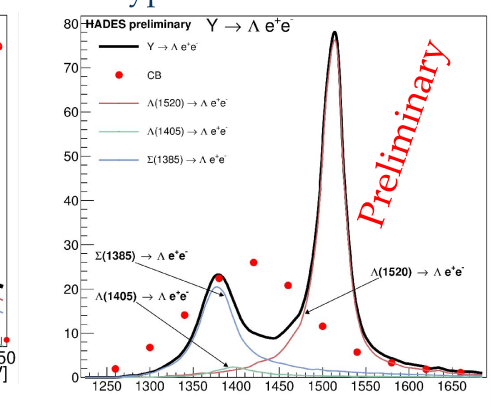
$p@(4.5\ GeV) + p \rightarrow p\ K^+\ K^+\Xi^-(\Lambda\pi^-)$

$p@(4.5\ GeV) + p \rightarrow p\ K^+\ Y^* \rightarrow p\ K^+\ Y\ e^+e^-$

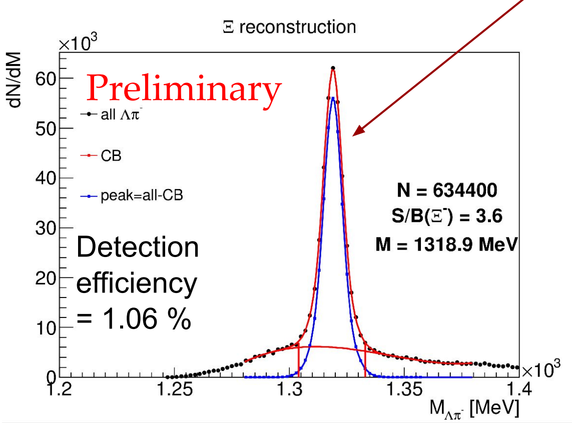
Dilepton mass spectrum

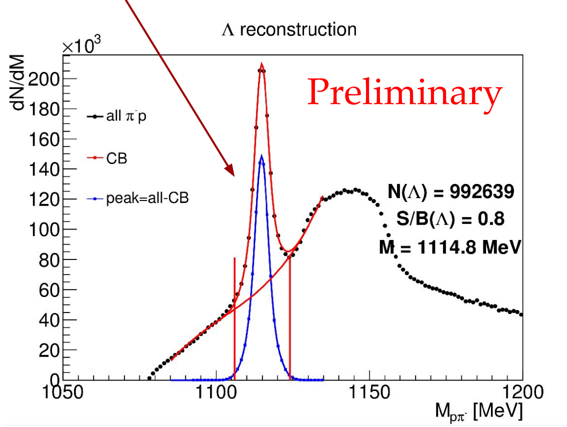


Hyperon resonances mass



Spectra include realistic background (π^0, etc)



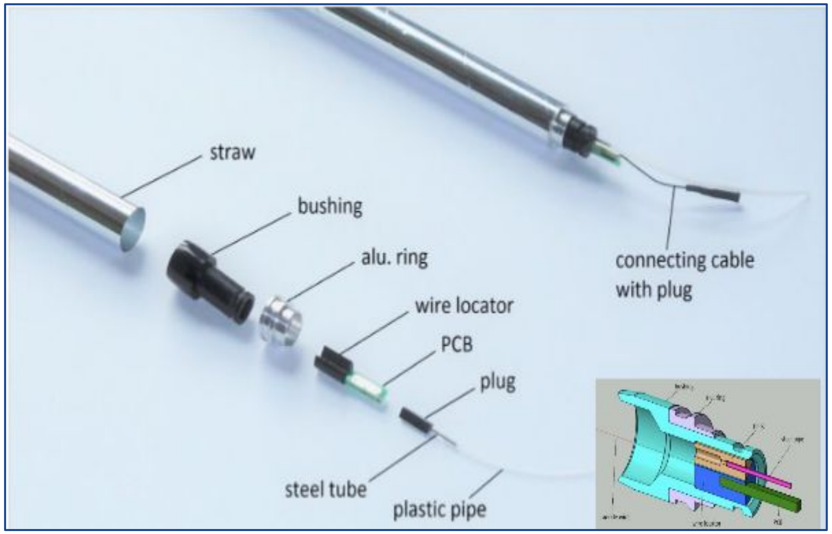


Work on improving the quality (resolution, etc) still ongoing

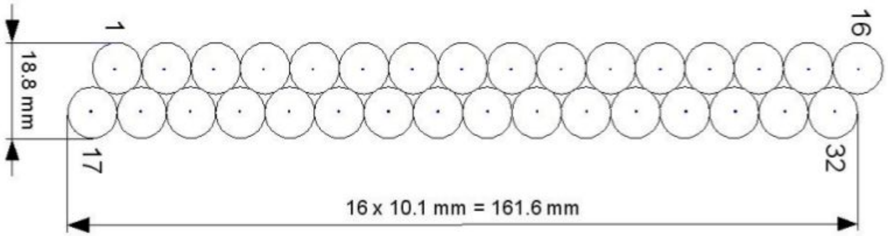
Straw Tube Detector

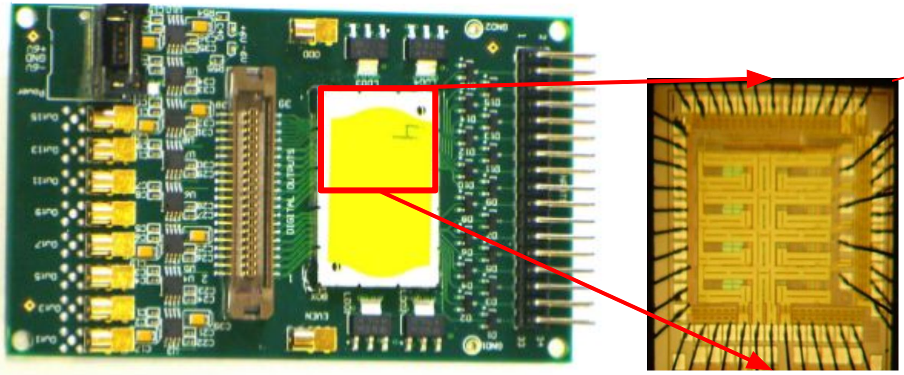
- ➔ Straw diameter = 10.1 mm, cathode thickness = 30μm aluminized Mylar, anode wire 20μm gold plated tungsten wire.
- ➔ Drift gas = Ar : CO_2, 90:10 with 2 bar overpressure.
- ➔ Time over threshold technique is used to measure energy loss

Single straws with their end plugs



Modular structure





Pasttrec chips

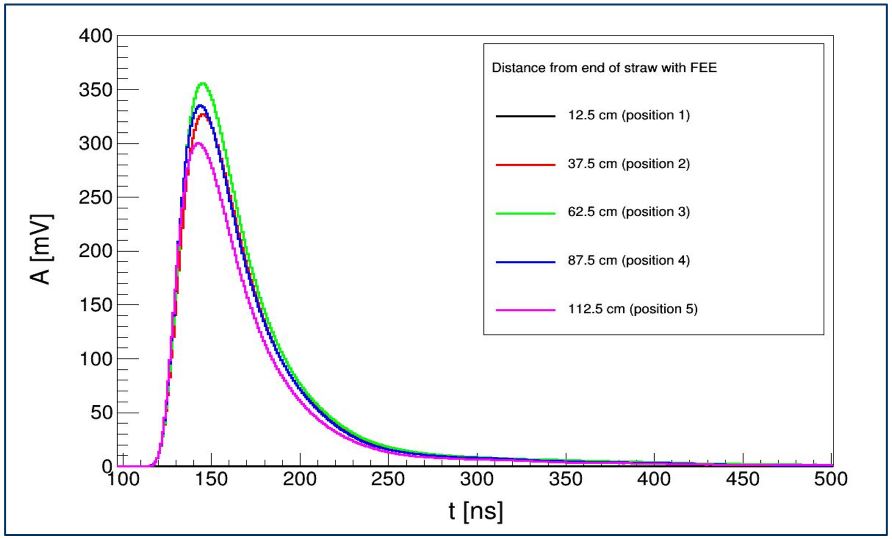
Frontend electronic card

D. Przyborowski et al., JINST_013P_0516. (2016)

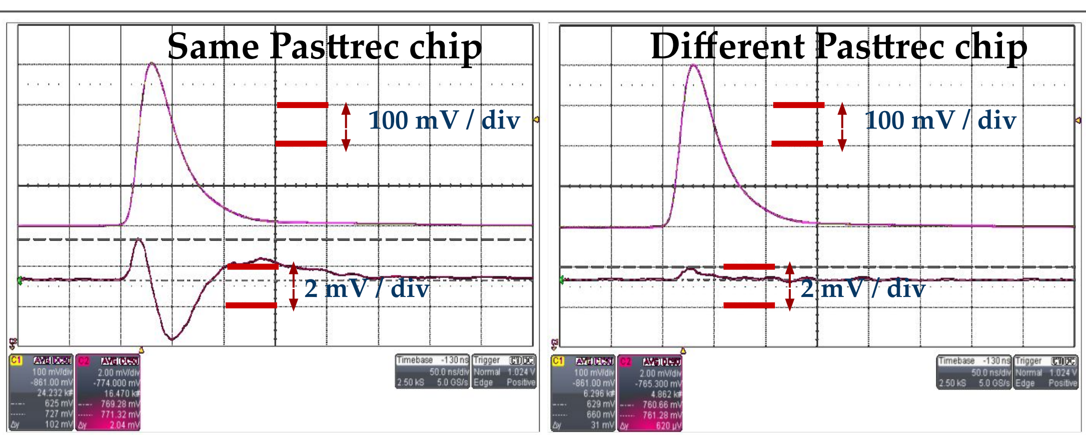
Provides 2 stage signal shaping

Performance of Straw tube detector

Amplitude variation along the straws



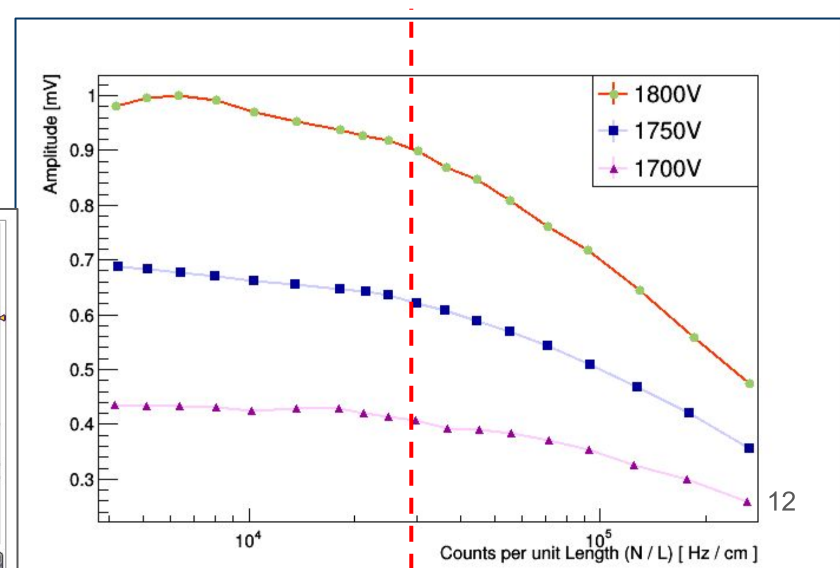
Electronic Cross-talk between the channels



- EPJ Web Conf. 199 (2019) 05022
- EPJ Web Conf., 199 (2019) 050183
- Basic Concepts in Nuclear Physics: Theory, Experiments and Applications Springer journal of Proceedings - Rabida-2018
- D. Przyborowski et al., JINST_013P_0516. (2016

Space charge distribution

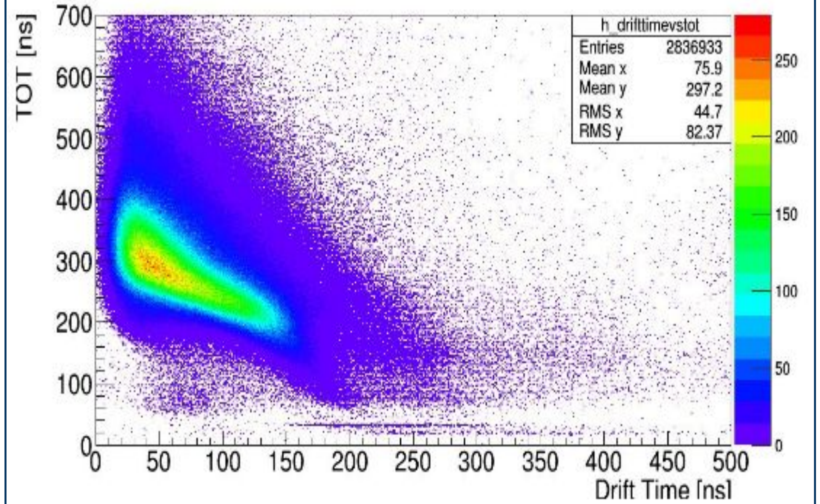
The amplitude drop at a rate of **25 kHz/cm** - the highest expected in the FT is about **10 %.**



EPJ Web Conf., 199 (2019) 05022

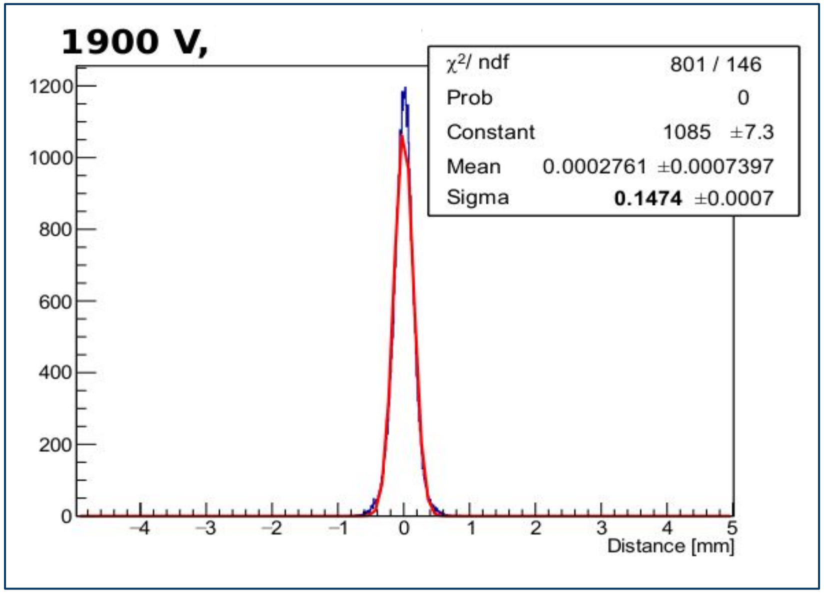
Results

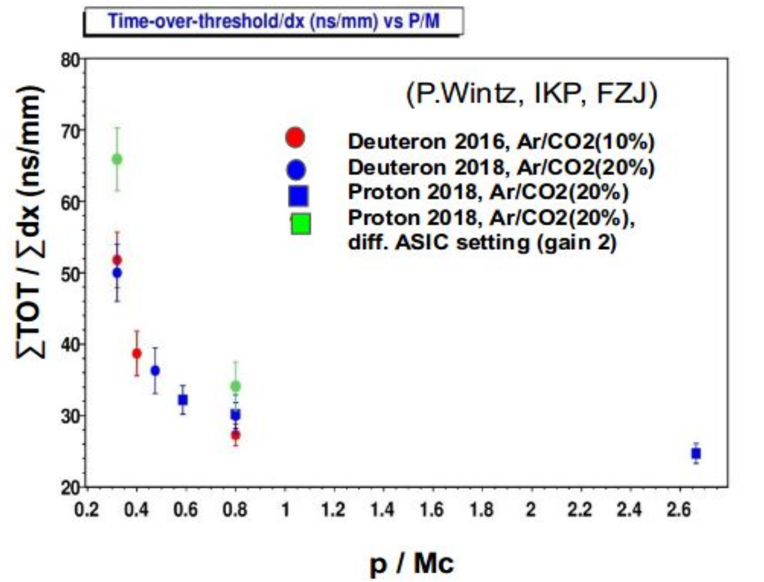
- Drift Time Vs TOT : Detector evaluation
- Spatial Resolution : ~ 150 μm
- PID separation observable in ∑TOT / ∑dx



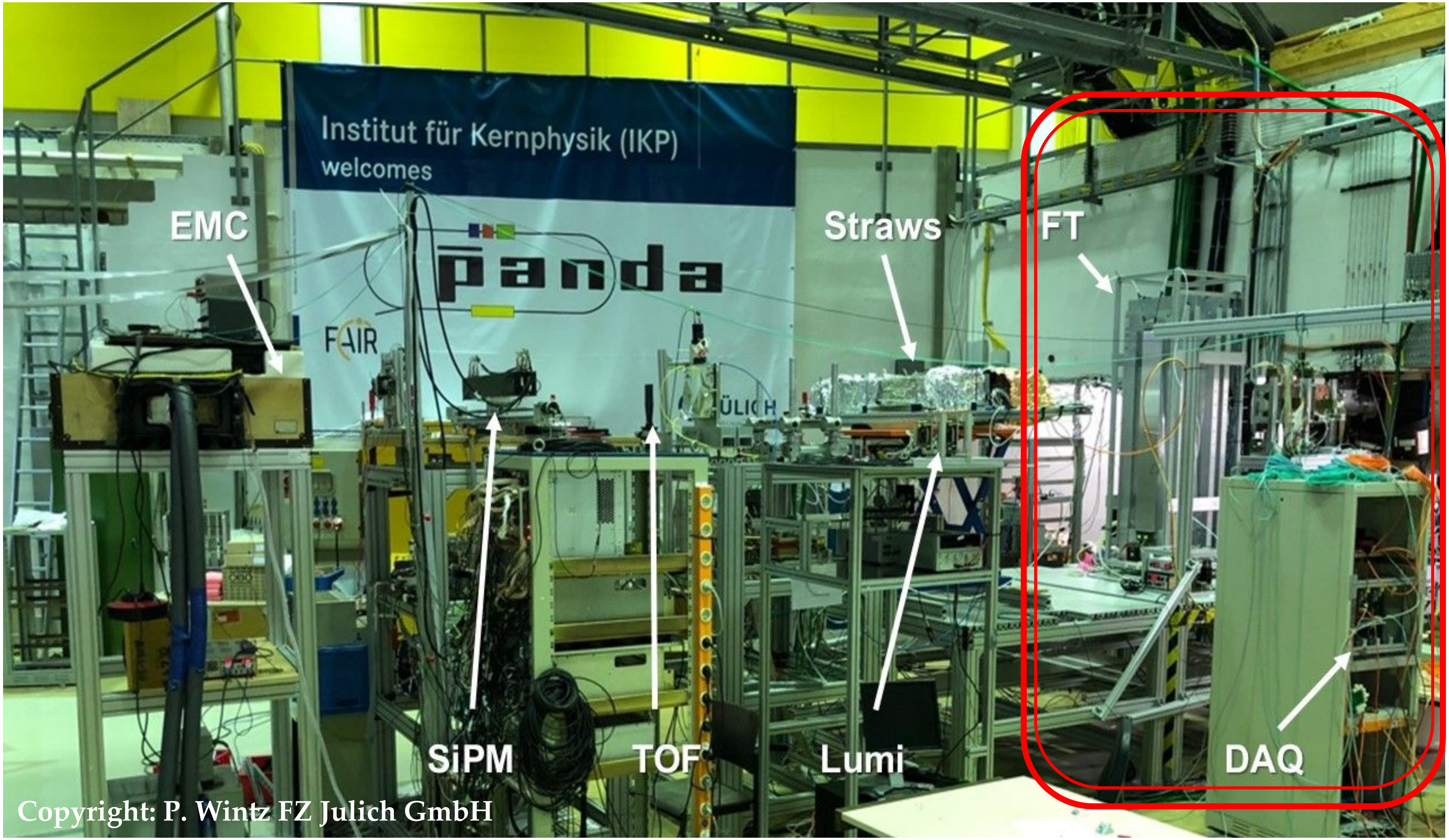
TOT Vs drift time correlation for 1750V and threshold 6 mV

Spatial resolution from 96 straws at 1900 V





Thank you


Institut für Kernphysik (IKP)
welcomes
panda
FAIR
EMC
Straws
FT
SiPM
TOF
Lumi
DAQ

JAGIELLONIAN UNIVERSITY IN KRAKOW

EST 1364

Narendra Rathod

Krakow June 23 – 28, 2019

en.uj.edu.pl

Hadronic channels studied by HADES — full list

→ pp@3.5 GeV

- "Inclusive Λ production in proton-proton collisions at 3.5 GeV", Phys. Rev. C95, (2017) 015207
- "Partial Wave Analysis of the Reaction p(3.5 GeV) + p → pK + Λ to Search for the "ppK" Bound State", Phys. Lett. B742 (2015) 242-248
- "Baryonic resonances close to the K $\bar{N}$ threshold: the case of Λ (1405) in pp collisions", Phys. Rev. C87 (2013) 025201
- "Production of $\Sigma^{+/-} \pi^{-/+}$ pK^+ in p + p reactions at 3.5 GeV beam energy", Nucl. Phys. A881 (2012) 178-186
- "Baryonic resonances close to the K − N threshold: the case of Σ (1385) + in pp collisions", Phys. Rev. C85 (2012) 035203

→ pNb@3.5 GeV

- "Σ 0 production in proton nucleus collisions near threshold", Phys. Lett. B781 (2018) 735-740
- "The Λ − p interaction studied via femtoscopy in p + Nb reactions at $\sqrt{s}_{NN}$ =3.18 GeV", Phys. Rev. C94 (2016) no.2, 025201
- "Two-particle correlation measurements in p+Nb reactions $\sqrt{s}_{NN}$ =3.18 GeV", J. Phys. Conf. Ser. 668 (2016) no.1, 012037
- "Subthreshold Ξ − Production in Collisions of p(3.5 GeV) + Nb", Phys. Rev. Lett. 114 (2015) 212301
- "Lambda hyperon production and polarization in collisions of p(3.5 GeV) + Nb",Eur. Phys. J. A50 (2014) 81

→ ArKCl@1.76 AGeV

- "Deep Subthreshold Ξ^- production in Ar+KCl Reactions at 1.76 AGeV", Phys. Rev. Lett. 103 (2009) 132301

Uniwersytet Jagielloński w Krakowie

Thank you