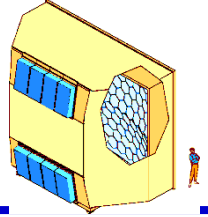
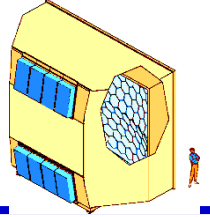
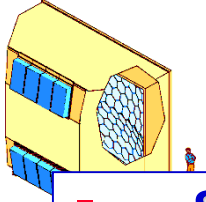


RICH news



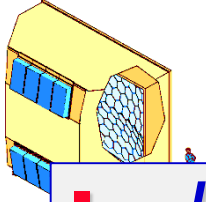
- ***RADIATOR GAS ACTIVITY***
- ***NEW PHOTON DETECTORS***



RADIATOR GAS, THE PROBLEM

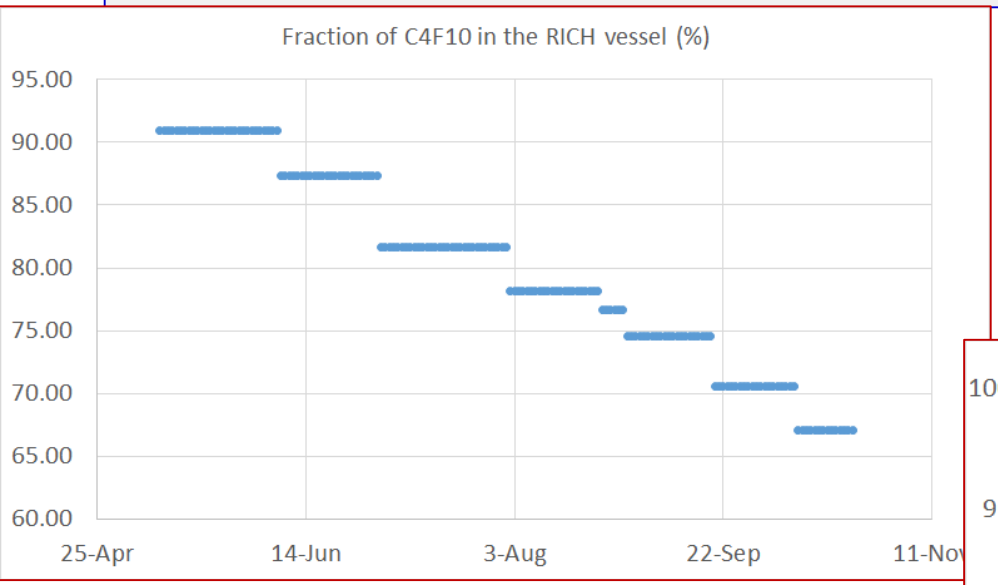
- **So far:** C_4F_{10} **from 3M**
  - 3M has stopped production (known)
- **The 2017 problem:**
  - Last batch from 3M: bad = unknown contaminants, not removable with the cleaning procedure
  - RICH operated with a mixture of C_4F_{10} & N_2
- **Moreover, the monochromator system (transparency measurements in UV) failed in Summer 2017**
  - Now FIXED: work in last Winter shutdown
- **Way-out baseline as in September 2017:**
  - New radiator gas : C_4F_8O → new gas system
  - C_4F_8O - studied for BTEV, ALICE RICH upgrade
  - C_4F_8O – physical (included optical) properties ~ C_4F_{10}

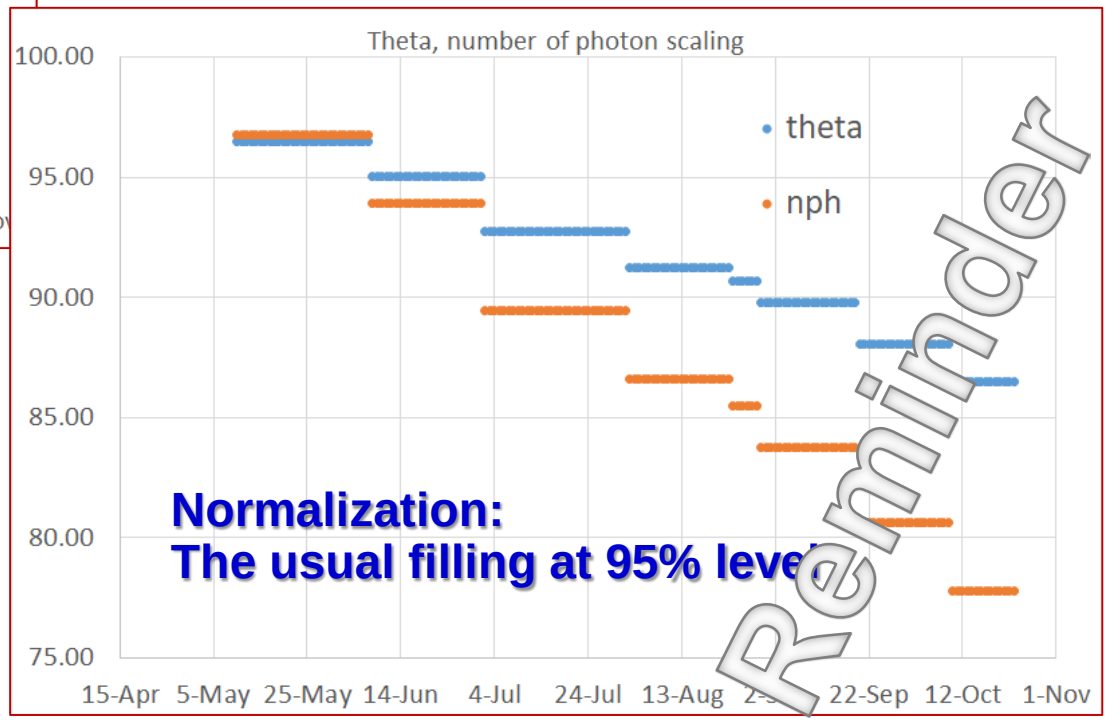
Reminder



THE EFFECT in RUN 2017

- ***Indicative* figures to appreciate the size of the effect**
  - **From the data analysis exact figures we will extract exact figures**





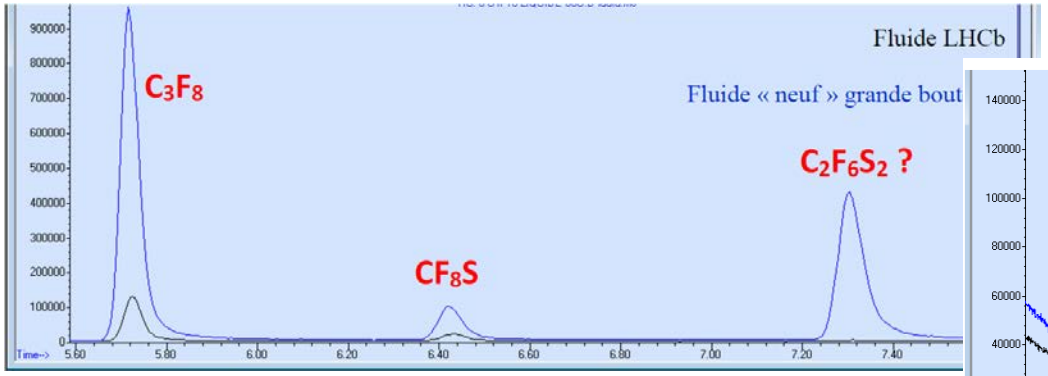
STATUS in MAY 2018

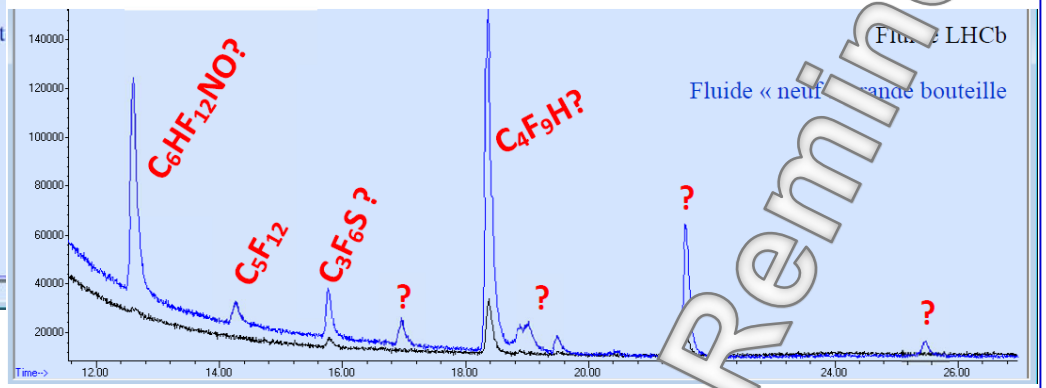
- **MONOCHROMATOR SYSTEM**
  - New PMTs with new wavelength-shifter coating
  - Optical components cleaned
  - Electronics refurbished, some new components

  → Now properly working

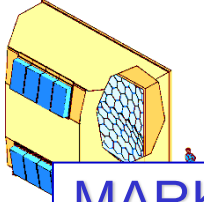
- **Understanding the BAD gas**
  - High-tech gaschromatography

  → The presence of extra polluting components, not detected before, in the last 3M batch is <u>confirmed</u>





Reminder



MARKET SURVEYING

MARKED SURVEYING with target C_4F_8O and C_4F_{10}

- 3M (US) confirmed no production of C_4F_{10} or C_4F_8O
- Airgas (US, now property of Air Liquide): no offer
- SynQuestLab Inc. (GB): no offer
  - they provided C_4F_8O to ALICE
- F2 Chemicals (UK) can provide C_4F_{10} **also in large amounts**
  - at a cost ~ double the previous 3M one

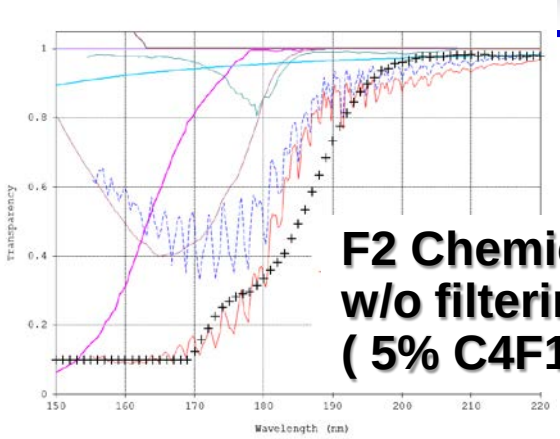
→ We purchased 2 samples from 2 different production batches (20 kg each) from F2 Chemicals
  - For initial studies and characterization

→ After marked surveying, **change of the baseline option**:

C_4F_{10} with present gas system requiring extraordinary maintenance
  - To be confirmed after studying the small-size samples

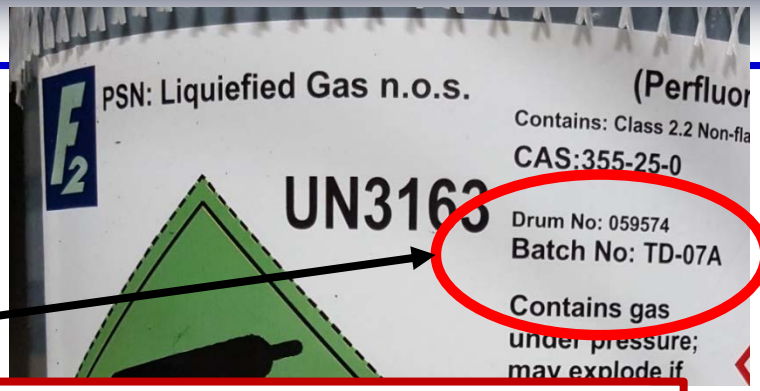
Reminder

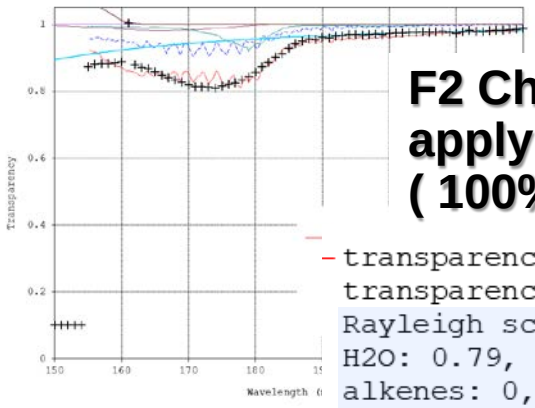
F2 CHEMICALS SAMPLES



F2 Chemicals sample w/o filtering (5% C4F10, 95% N2)

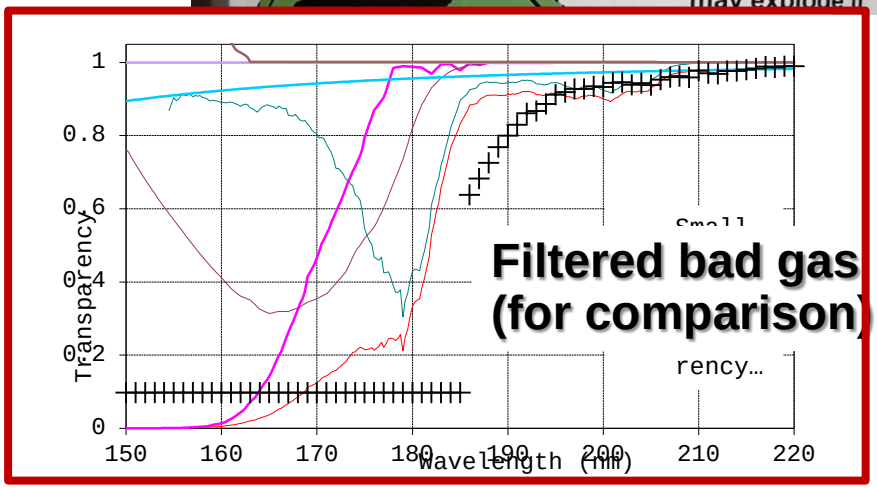
Sample 1



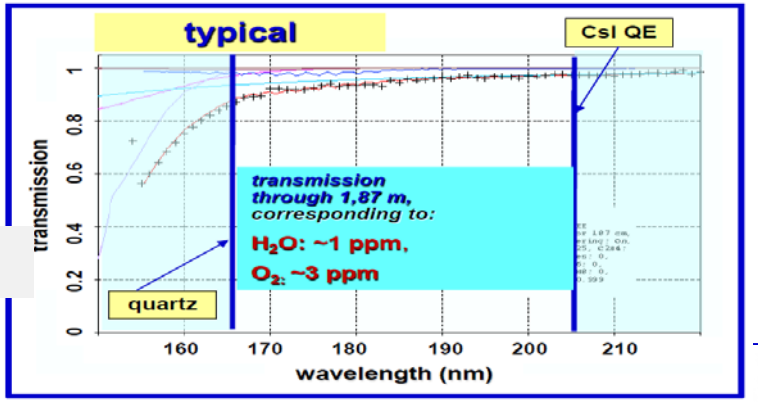


F2 Chemicals sample applying filtering (100% C4F10)

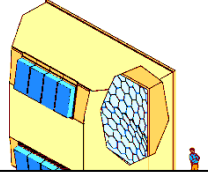
transparency 28/09/2017
transparency for 187 cm,
Rayleigh scattering: On, O2: 0,
H2O: 0.79, C2H4: 0, other
alkenes: 0, C2H2: 12.34, C6H6:
0.041, nC4H10: 0, C3H8: -9.42,
fudge factor: 1.004



Filtered bad gas (for comparison)



NEVER SO PURE ! **BEST FROM THE PAST →**

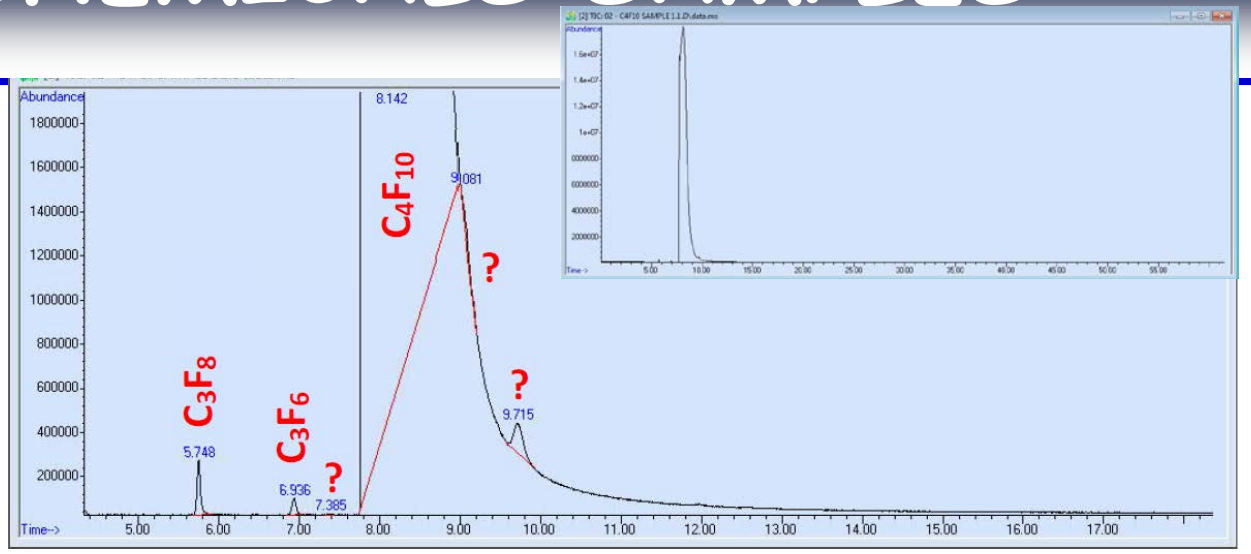


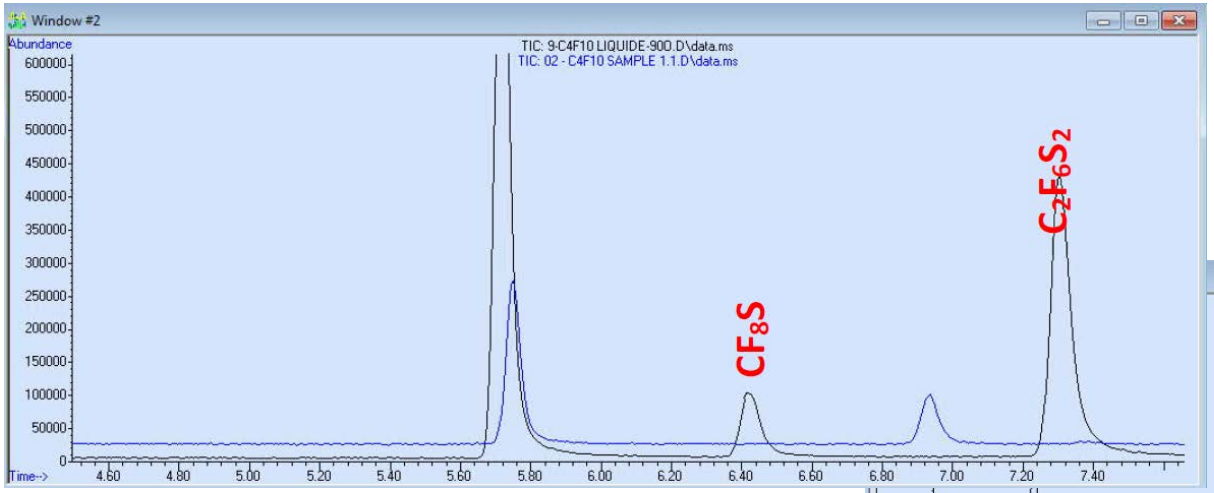
F2 CHEMICALS SAMPLES

Gas Chromatography @ CERN

Peak	Bouteille 1	Bouteille 2
1 (C2F6?)	nd	0.000
2 (C3F8)	0.025	0.045
3 (C3F6)	**0.011**	0.001
4 (C4F10)	99.964	99.954

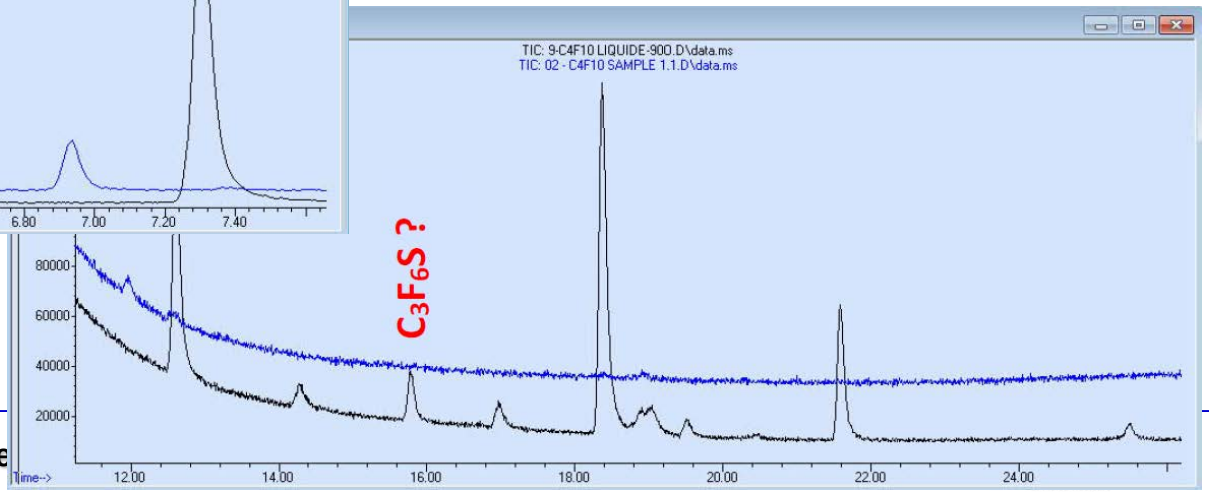
C3F6 (double liaison)

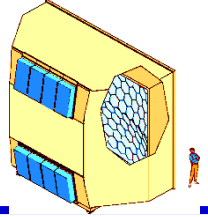




Comparison “bad gas” - Sample 1 :

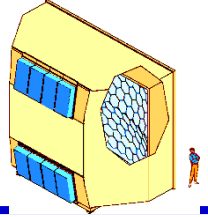
No sulfur components identified
In F2 Chemical gas !



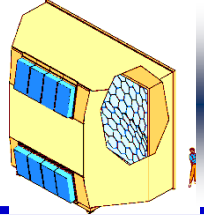


CONCLUDING ABOUT THE GAS

- C4F10 from F2 Chemicals is fine
- Premature to estimate the rate of the cleaning losses



- ***RADIATOR GAS ACTIVITY***
- ***NEW PHOTON DETECTORS***



STATUS OF THE NEW PHOTON DETECTORS

- **DETECTOR ELECTRICAL STABILITY:**
  - **Active Surface: 95% electrically fully stable**
    - **thanks to HV segment studies and related implementation**
    - **instabilities related to THGEMs**

- **RESITIVE MM by discrete elements (original architecture)**
  - **Extremely stable at gains > 200 (MM layer only)**
  - **All current sparks induced by THGEM sparks**

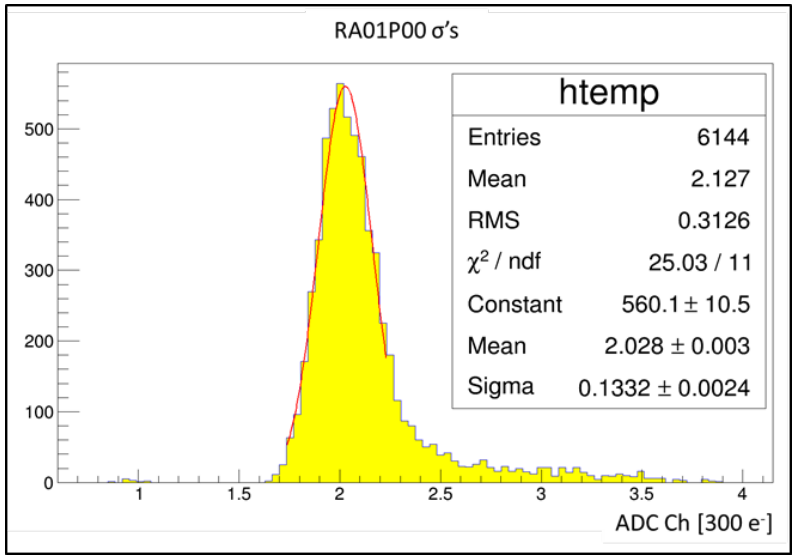
- **OVERALL HYBRID DETECTOR PERFORMANCE**
  - **Gain: ~15 k**
  - **Spark rate < 1/h in all the 4 detectors**
  - **Spark recovery time ~ 10 s**

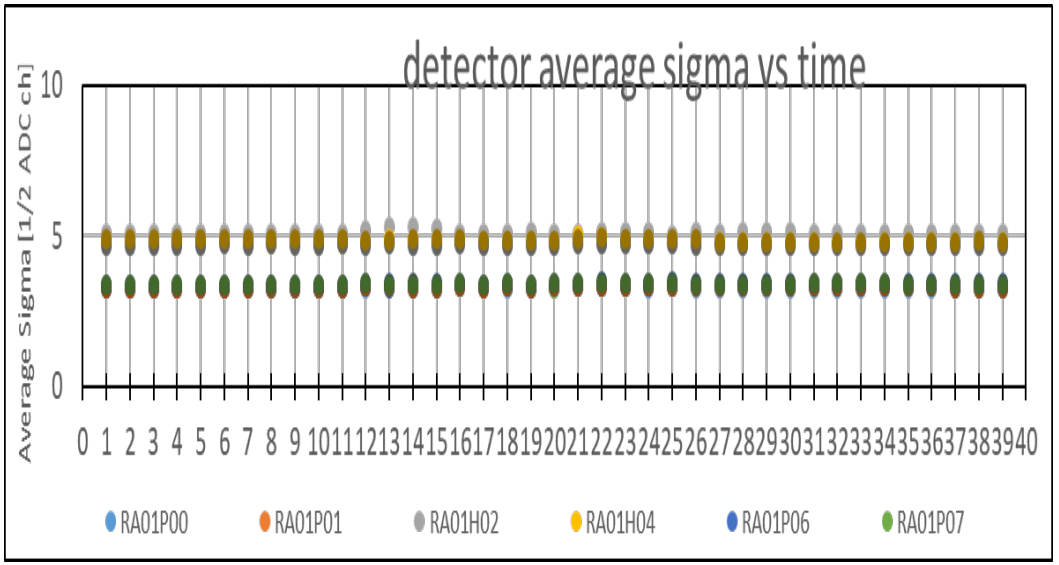
- **NOISE FIGURES:**
  - **$<\sigma>$ ~ 900 e- in all the 4 detectors**

Reminder

UPDATE about NOISE STUDIES

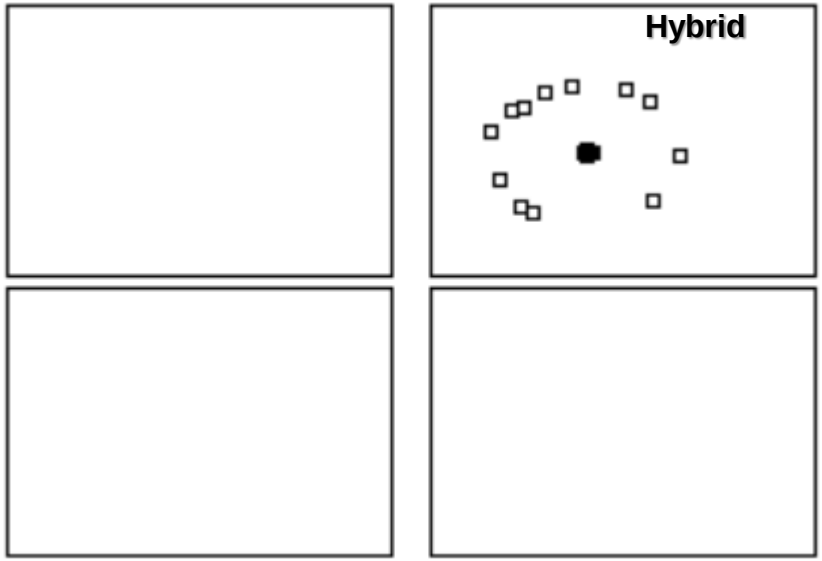
- **NOISE FIGURES:**
  - **<σ> ~ 800 e- in all the 4 detectors**
  - **very stable in time**



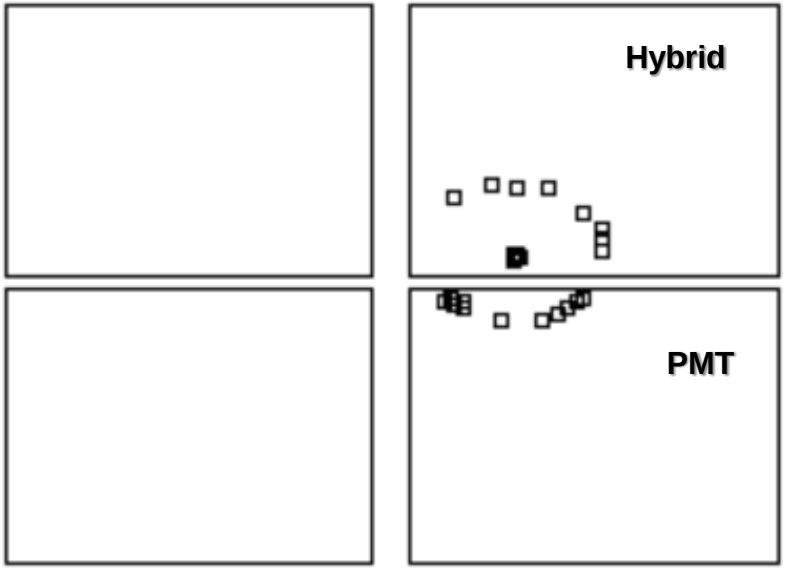


EVENT DISPLAY

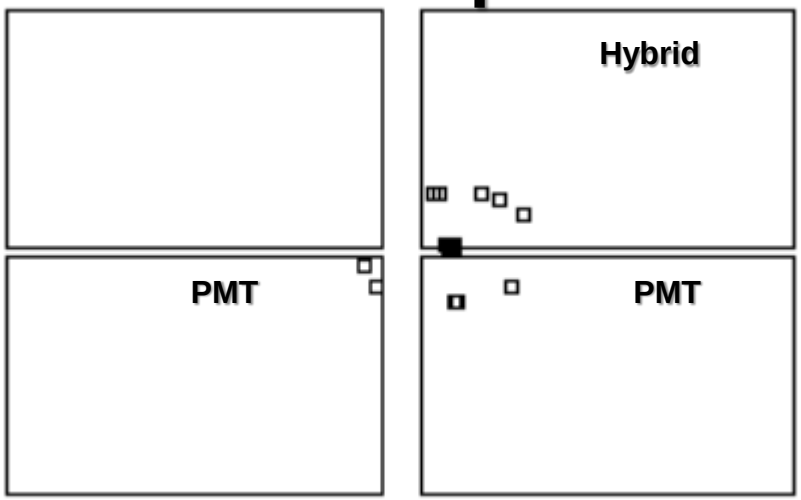
6.36 GeV pion



6.76 GeV pion

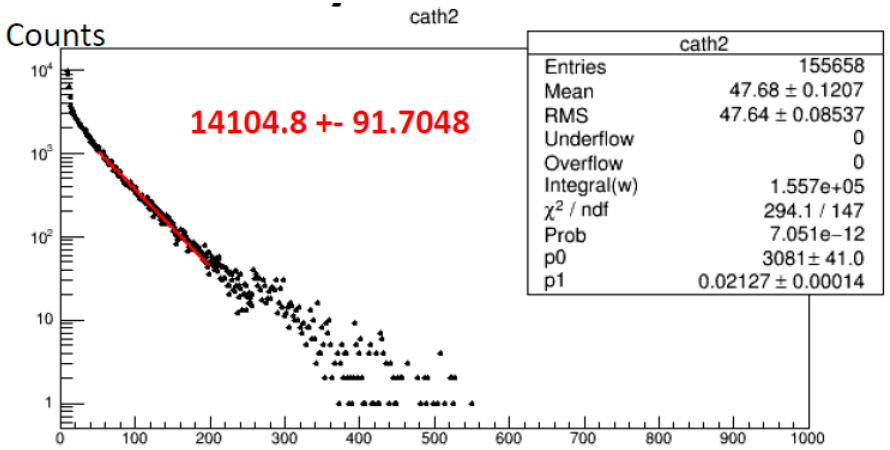


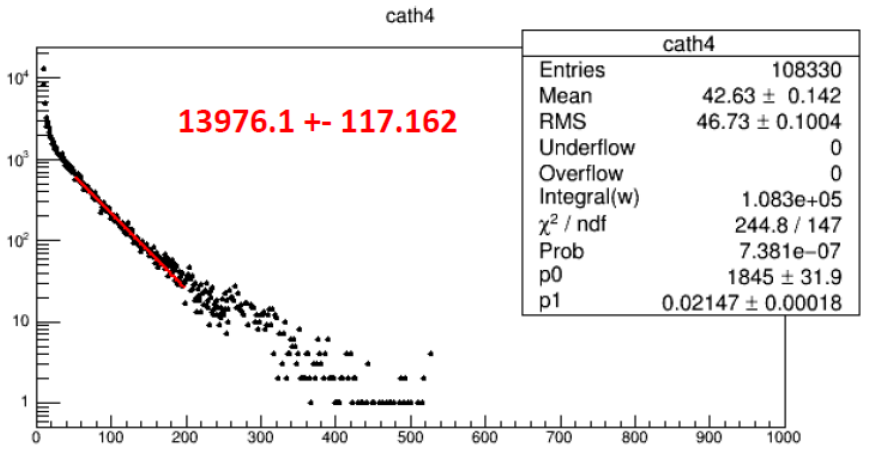
6.4 GeV pion



more and more details
about detector characterization
on Wednesday
at the analysis meeting

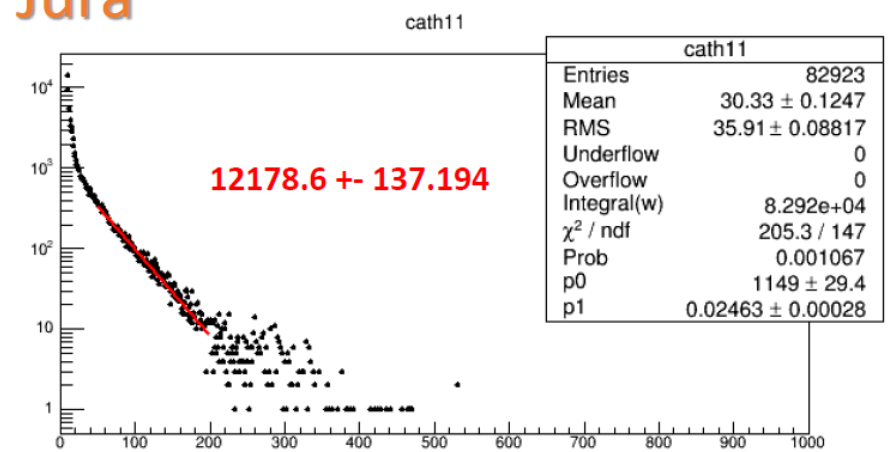
GAIN

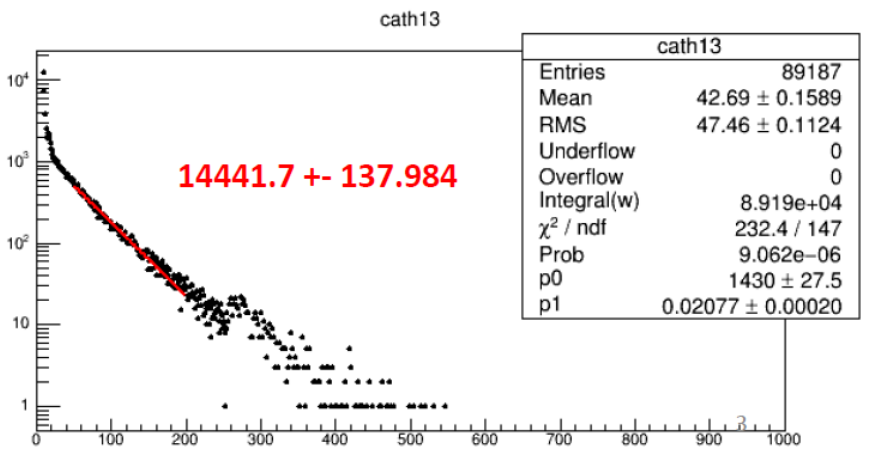


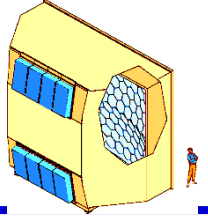


Jura

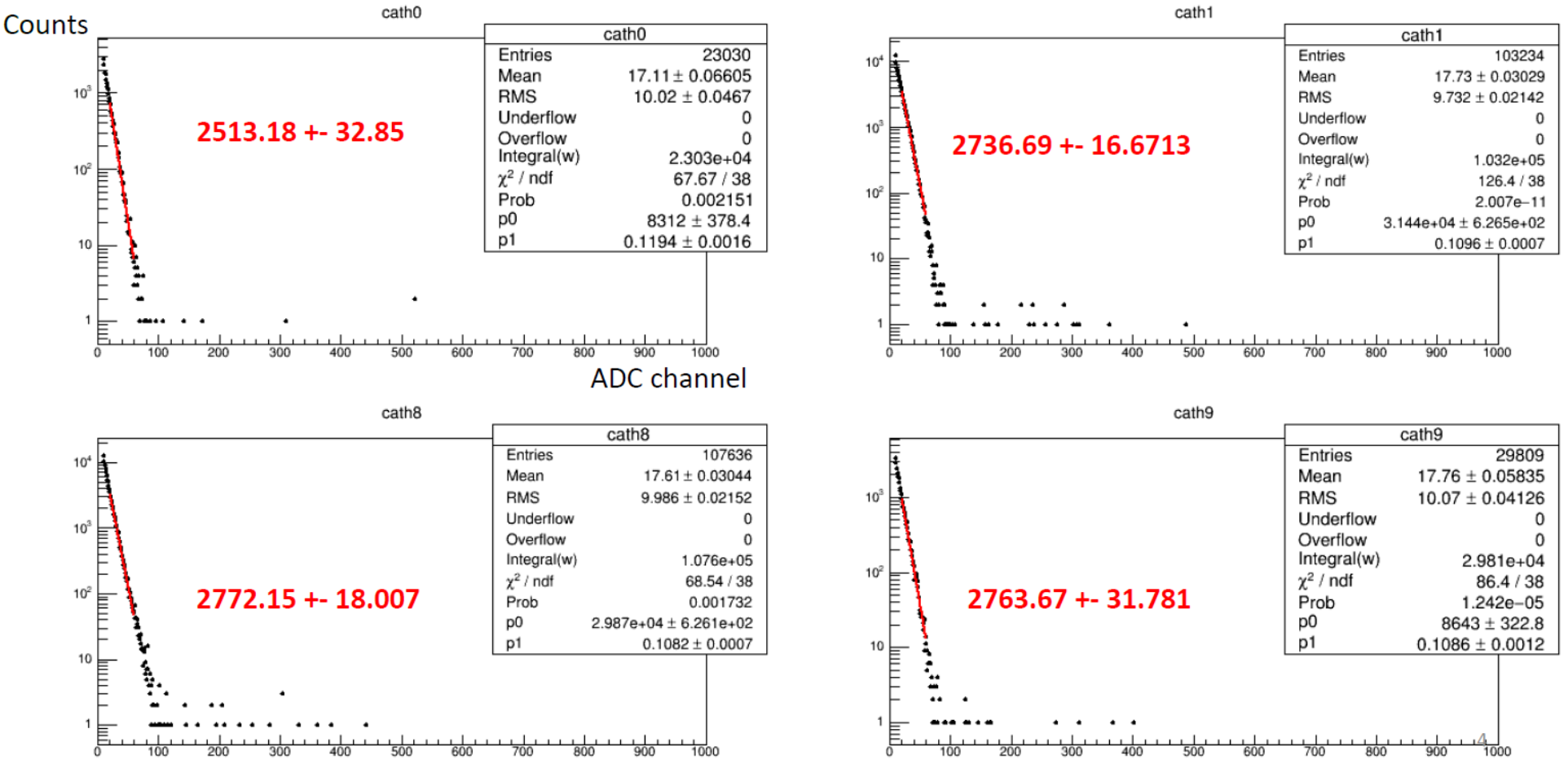
ADC channel





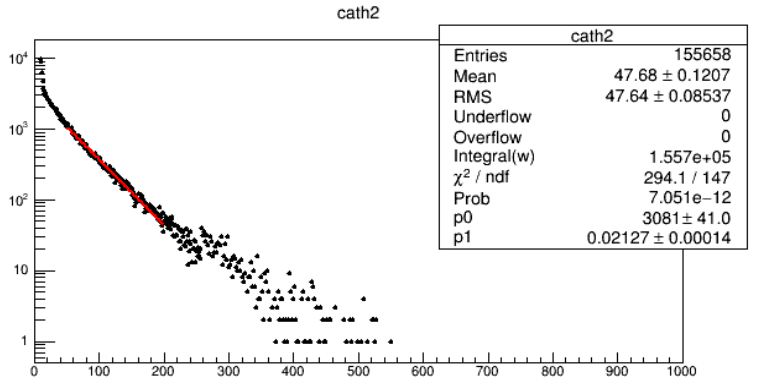


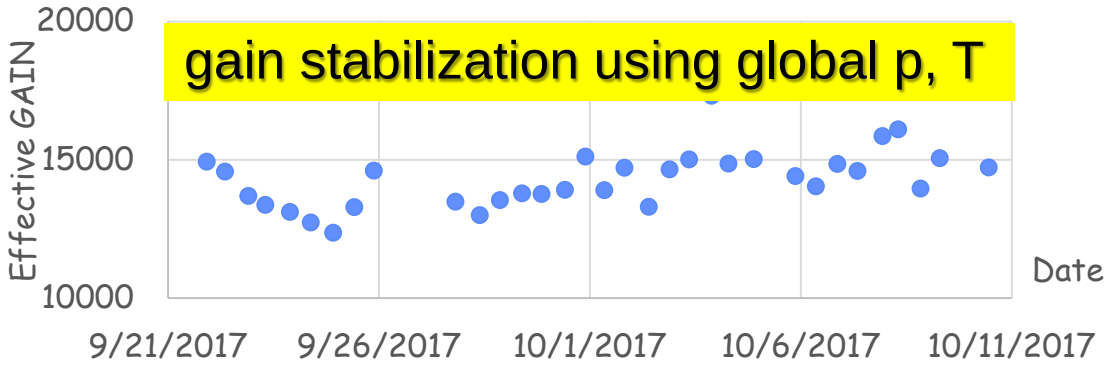
GAIN MWPC (for comparison)

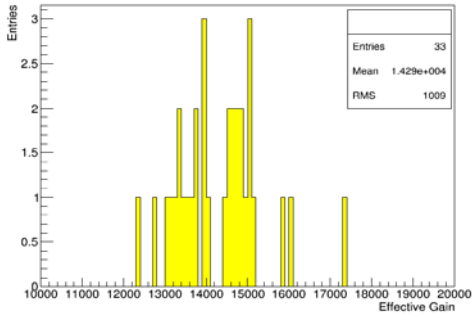


GAIN STABILITY vs TIME

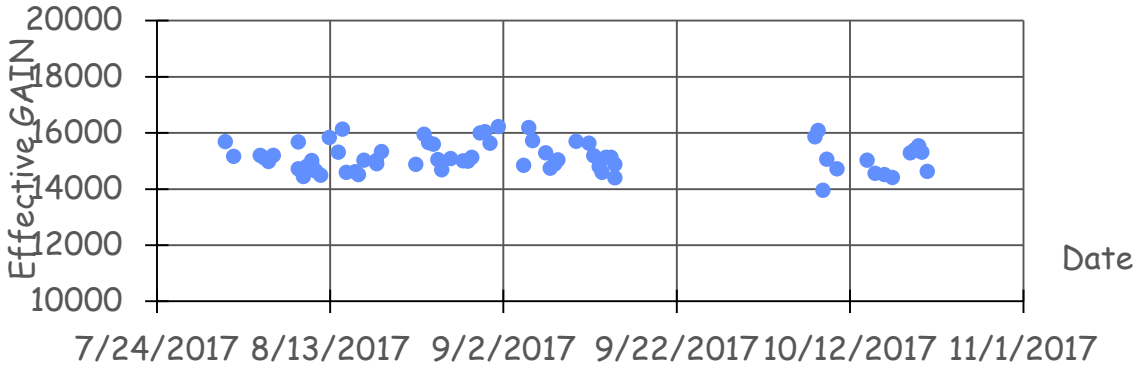
GAIN EXTRACTED FROM SINGLE PHOTON AMPLITUDE SPECTRA

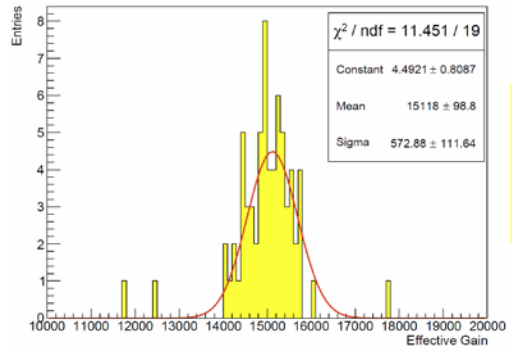




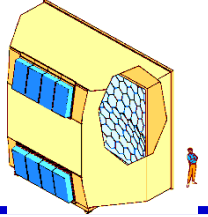


global corrections: **σ/mean ~ 7%**

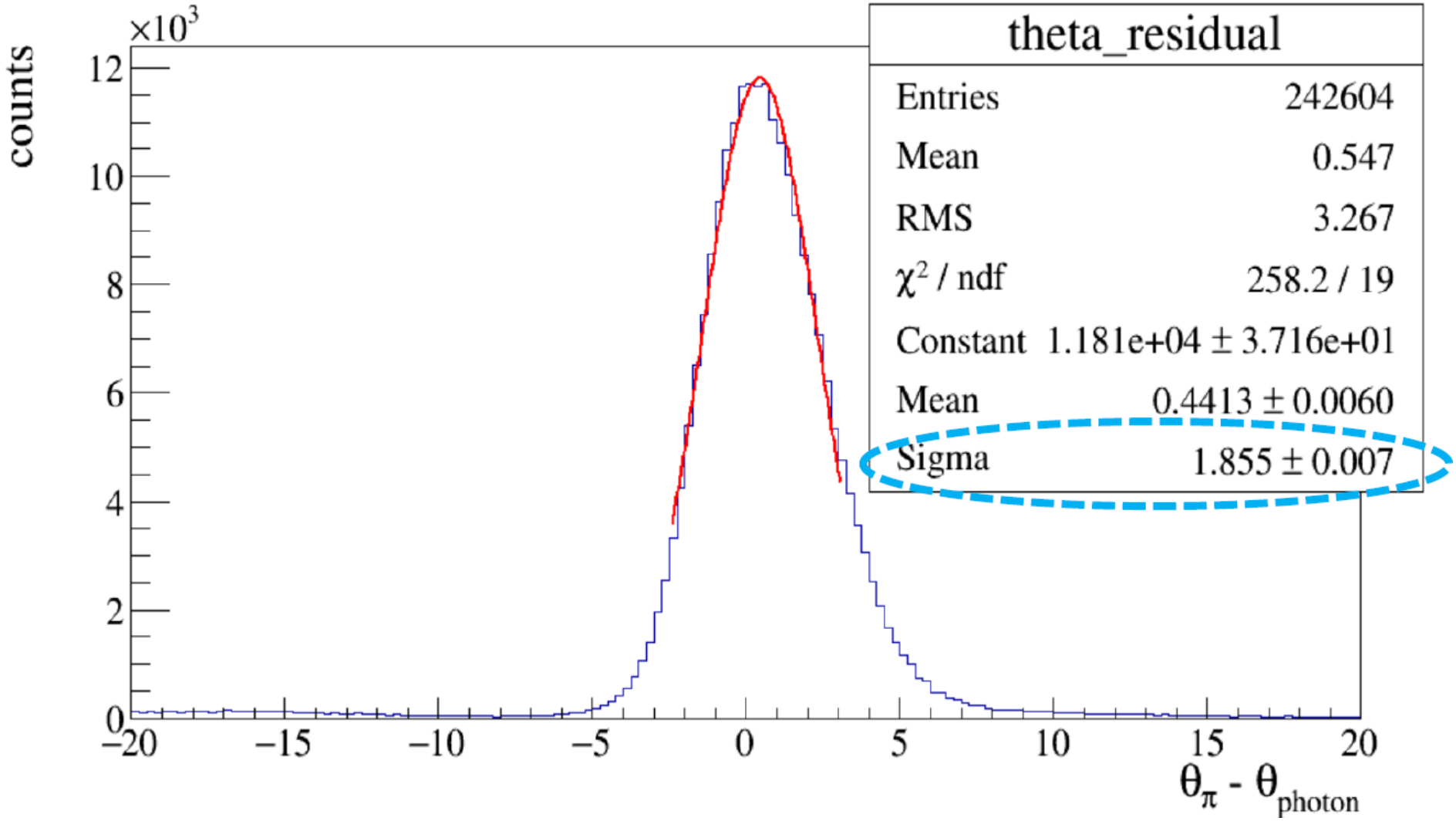




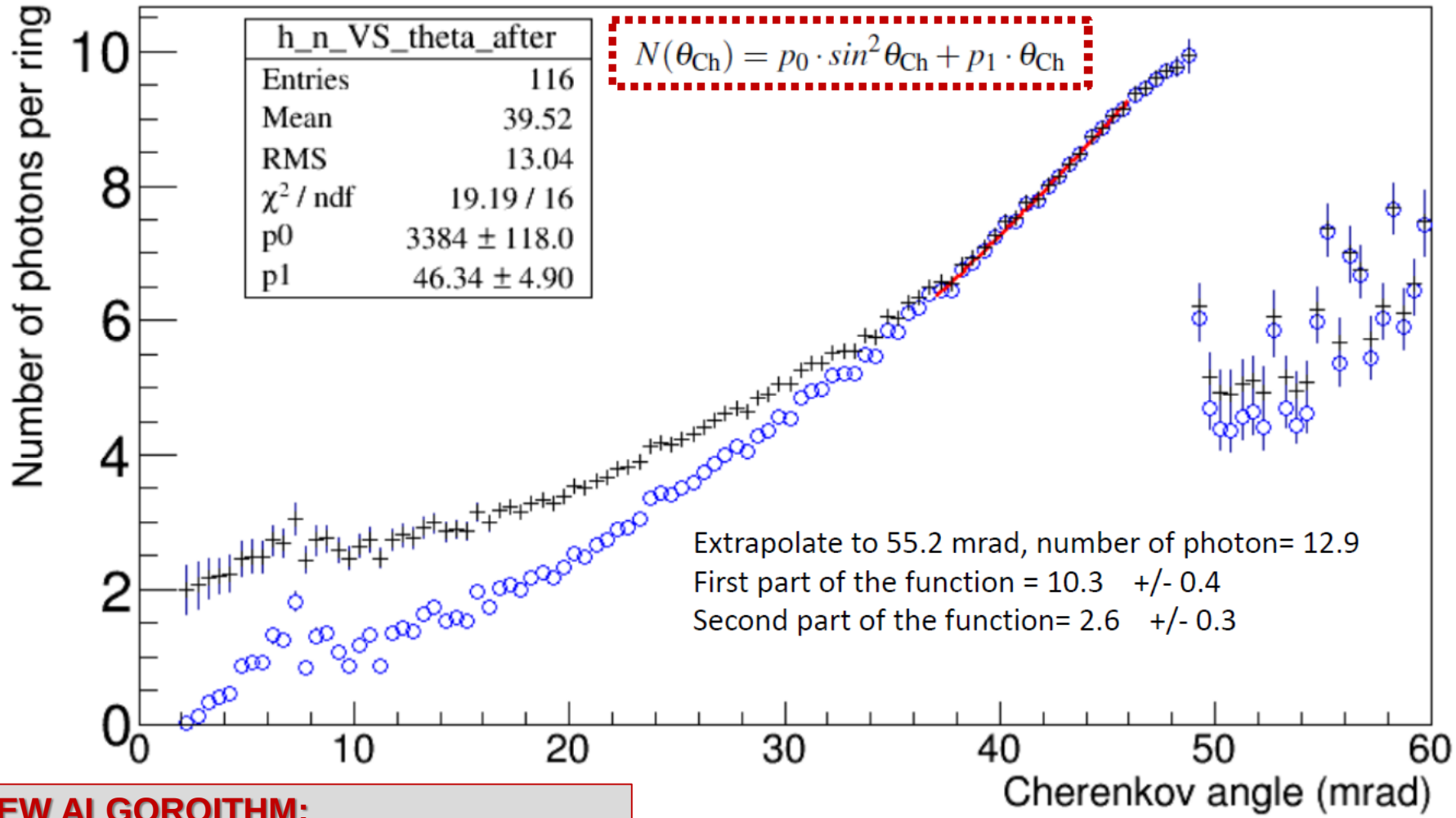
individual corrections: **σ/mean ~ 4%**



RESOLUTION


theta_residual
Entries 242604
Mean 0.547
RMS 3.267
χ² / ndf 258.2 / 19
Constant 1.181e+04 ± 3.716e+01
Mean 0.4413 ± 0.0060
Sigma 1.855 ± 0.007
counts
×10³
θπ - θphoton

NUMBER OD PHOTONS/RING

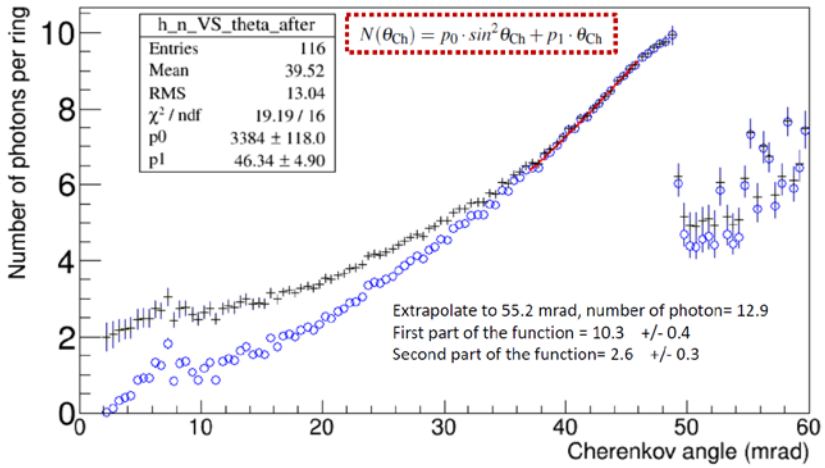


NEW ALGOROITHM:
Taking into account
the binomial nature of the distribution
when using "half rings"

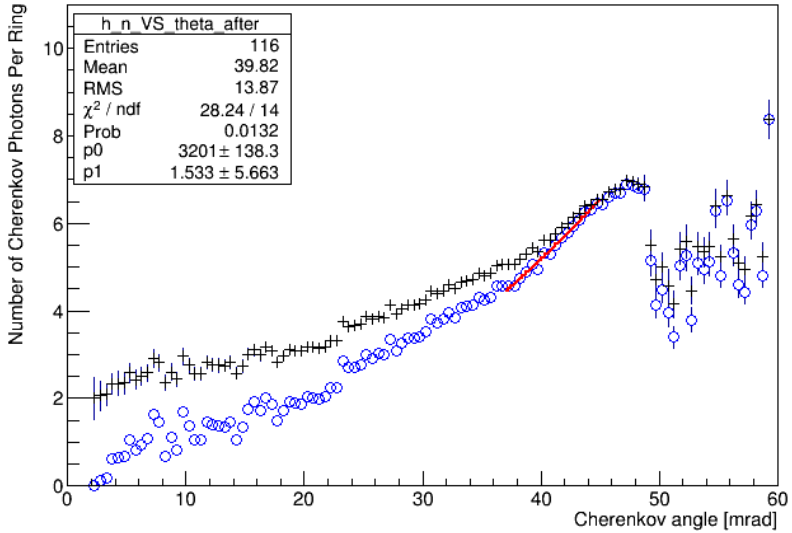
NUMBER OF PHOTONS & QE

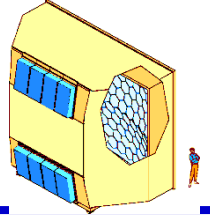
QE_det2 / QE_det4 = 1.10

Nph.s_det2 / Nph.s_det4 = 1.06



Number of photon VS theta

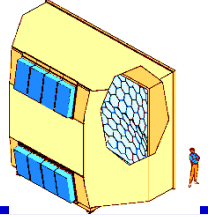




CONCLUDING ABOUT THE NOVEL PDs

- **MPGD-based photon detectors ACCOMPLISH THEIR MISSION**
  - From the characterization exercises:
  - stable gain and large gain
  - resolution as expected
  - good number of detected photoelectrons

- **Technological achievement - for the FIRST TIME:**
  - **single photon detection is accomplished by MPGDs**
  - **THGEMs used in an experiment**
  - **MPGD gain > 10k in an experiment**

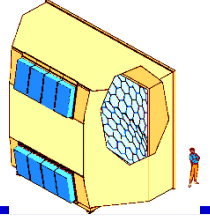


ABOUT FUTURE

- **A fully reliable RICH needed for the 2021 run and the future physics with our spectrometer**

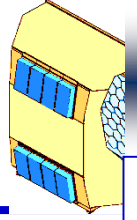
THEREFORE →

- **We have submitted a request to INFN to complete the photon detector upgrade equipping with hybrid MPGD-based PDs the side part of RICH-1**



A FULLY RELIABLE RICH, A MUST FOR THE 2021 RUN

- K-identification for flavor separation in D data (as for the p data)
  - For p data: identified single h and identified h-couples
- Relevance of reinforcing the later RICH domain to have good efficiency at large x_Bj : here the cross-section is small !
- The RICH: a key-ingredient for a large range of COMPASS physics
  - See also the next two slides
- More homogeneous photon-detector system
- Refurbishing the existing detectors is in any case work and costs
- A robust RICH for the future physics program with the spectrometer (spectroscopy, exclusive reactions with polarized target, anti-matter production)



physics with muon beam and PID

completed analyses:

longitudinally polarised targets

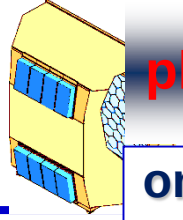
flavour separation of helicity distributions – d and p	PLB 680 (2009) 217 PLB 693 (2010) 227 (148 cit.)
gluon polarisation from open charm muoproduction	PLB 676 (2009) 31 PRD 87 (2013) 052018

“unpolarised” targets

D* and D Meson Production	EPJC 72 (2012) 2253
Multiplicities of charged pions (d)	PLB 764 (2017) 001
Multiplicities of charged kaons (d)	PLB 767 (2017) 133
K− over K+ multiplicity ratio (d)	sub PLB

transversely polarised targets

Collins and Sivers asymmetries for pions and kaons – d and p	PLB 673 (2009) 127 (292 cit.) PLB 744 (2015) 250
Dihadron asymmetries with PID – d and p	in preparation
Λ polarisation transfer – d and p	in preparation



physics with muon beam and PID

ongoing analyses (2016 and 2017 data):

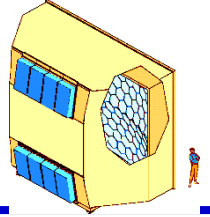
unpolarised p target

- Azimuthal asymmetries
- P_T distributions
- Multiplicities of charged pions and kaons
- Exclusive Vector Meson production

future analyses (2021 data):

transversely polarised d target

- Collins and Sivers asymmetries
- Other single hadron asymmetries
- Dihadron asymmetries
- Λ polarisation transfer
- Exclusive Vector Meson production



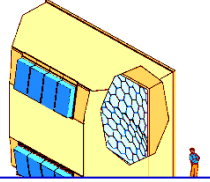
COMPLETING THE RICH UPGRDE

NOW

MWPC	HYBRID	HYBRID	MWPC
MWPC	MAPMT	MAPMT	MWPC
MWPC	MAPMT	MAPMT	MWPC
MWPC	HYBRID	HYBRID	MWPC

> 2018

	HYBRID	HYBRID	
HYBRID	MAPMT	MAPMT	HYBRID
HYBRID	MAPMT	MAPMT	HYBRID
	HYBRID	HYBRID	

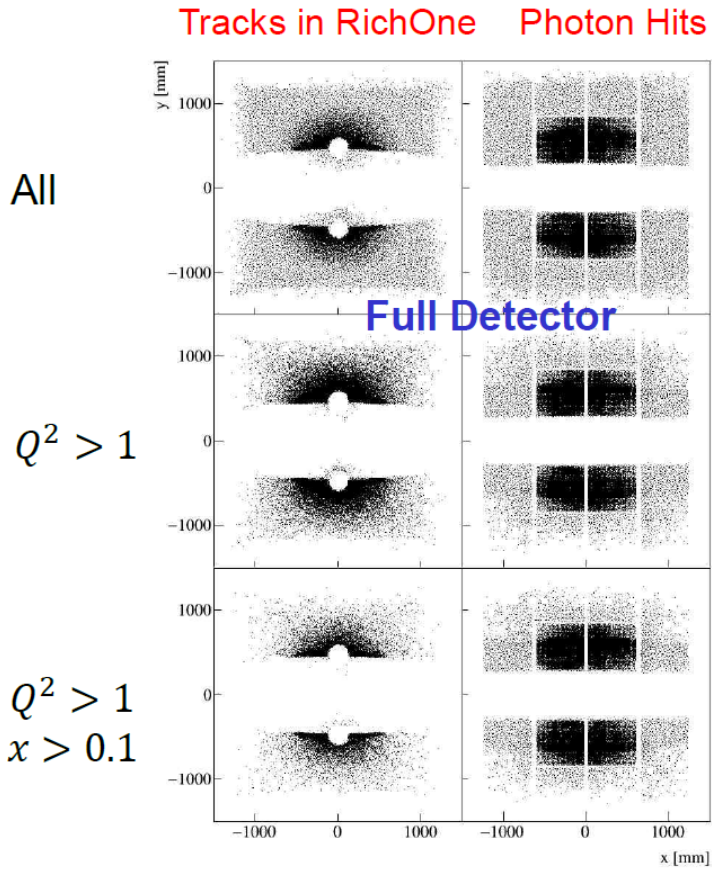


RICH W/O CORNERS 1/4

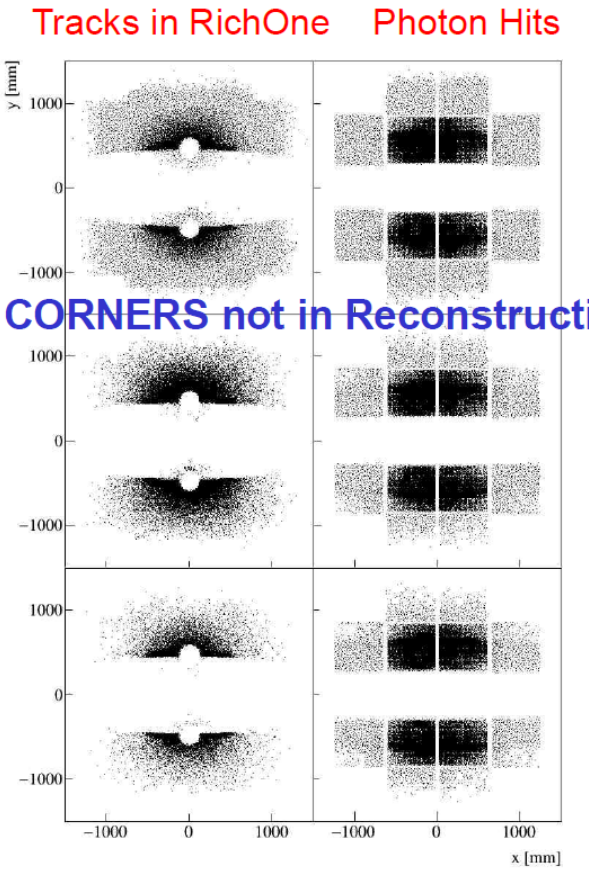
Concerning acceptance,

the most demanding item in COMPASS physics: (SI)DIS

Analysis performed on 2010 data: corner cut at DDD level



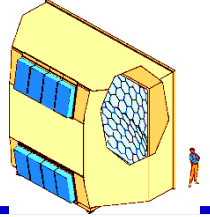
Full Detector



CORNERS not in Reconstruction

Overall loss is 1.2%

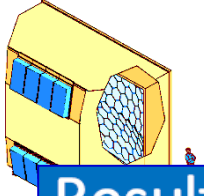
Material from A. Bressan



RICH W/O CORNERS 2/4

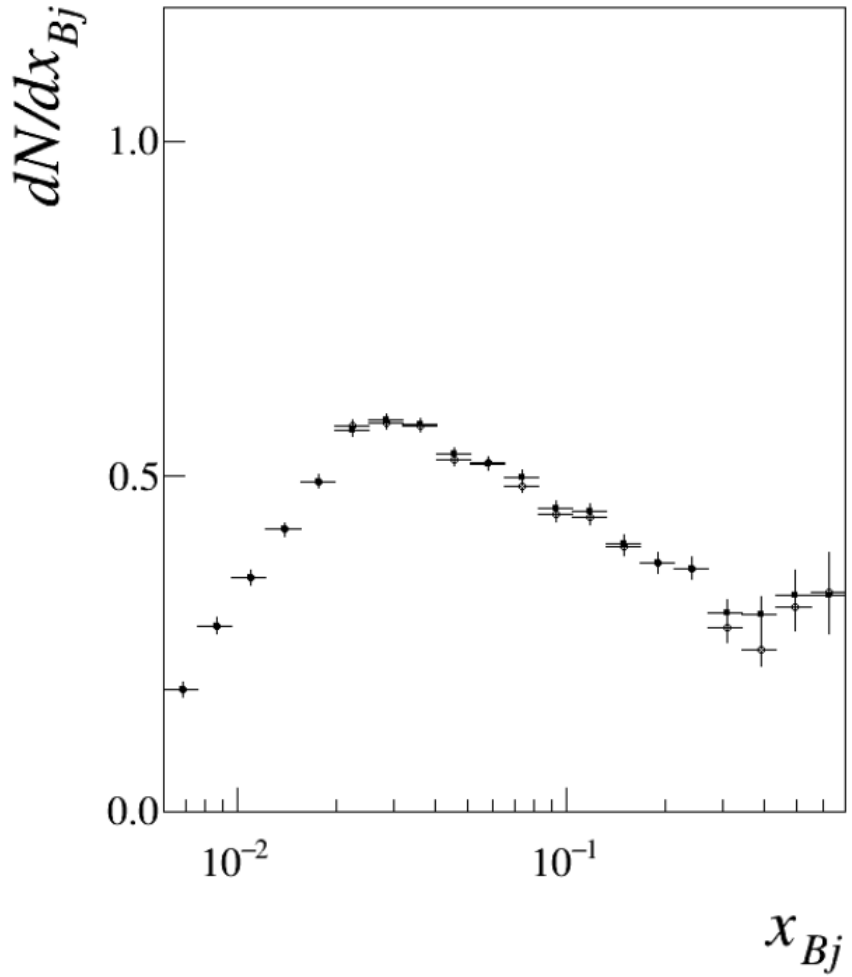
Data selection

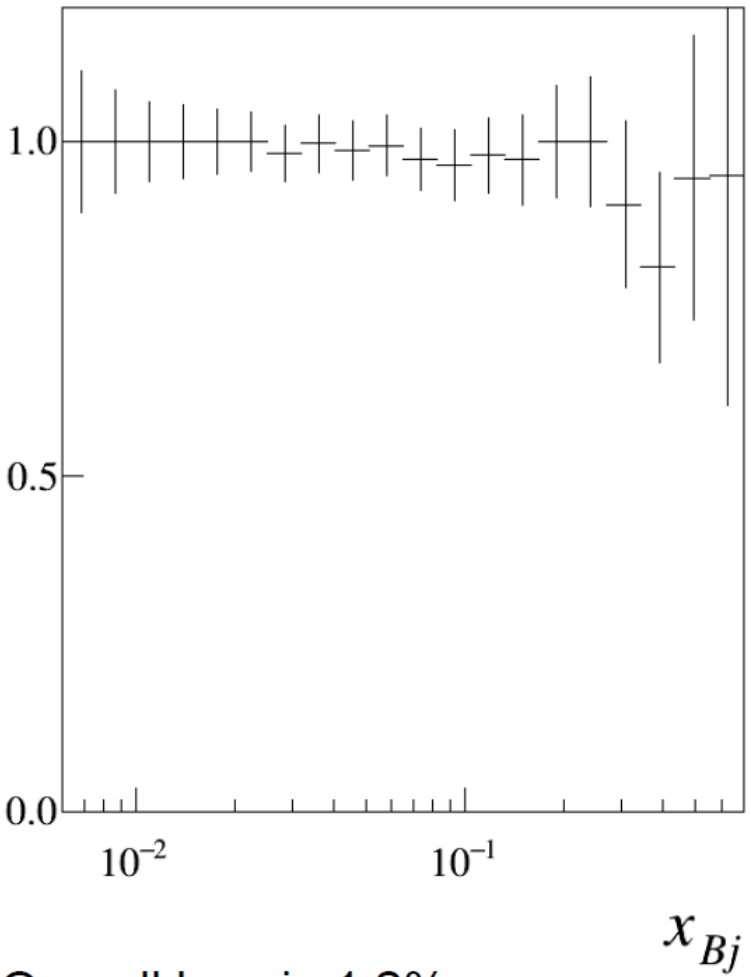
- Very simple Likelihood selection
  - Standard DIS cuts
  - $z > 0.1$
  - Momentum in the range between 2 GeV/c and 50 GeV/c
  - First selection of the maximum likelihood among the e, mu, pi, K and p (normalized to the background likelihood)
  - Likelihood cuts:
    - $\frac{\mathcal{L}_{max}}{\mathcal{L}_{bck}} > 1.2$
    - $\frac{\mathcal{L}_{max}}{\mathcal{L}_{2nd\,max}} > 1.05$



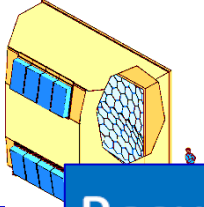
RICH W/O CORNERS 3/4

Results – Effect of RICH with no CORNERS



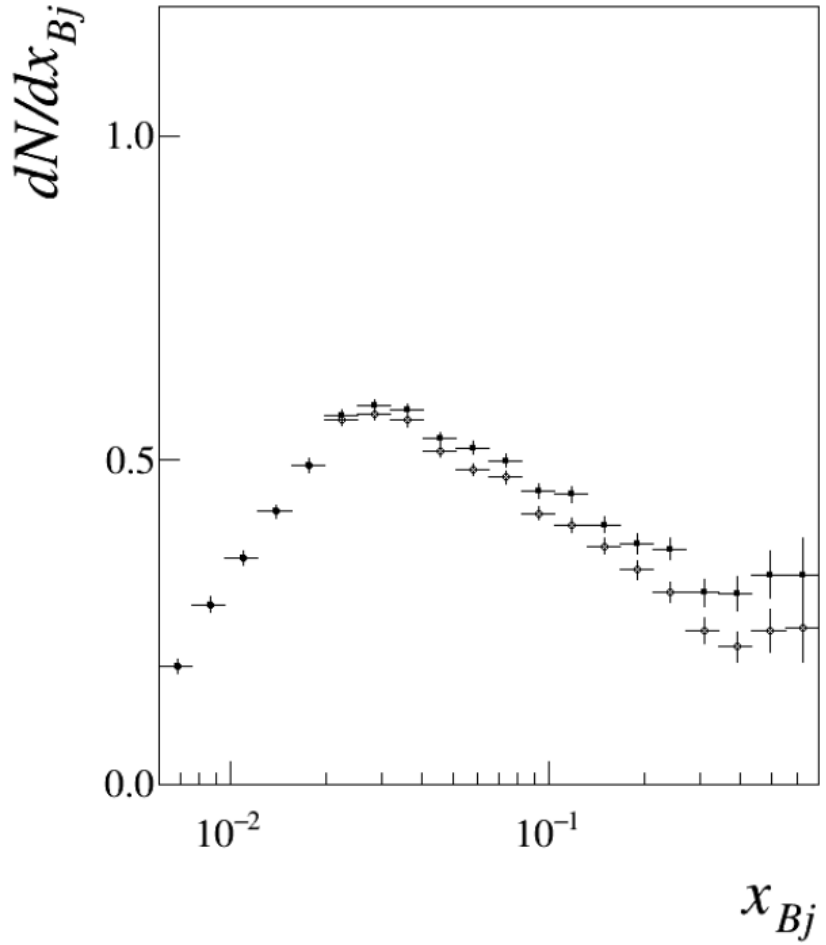


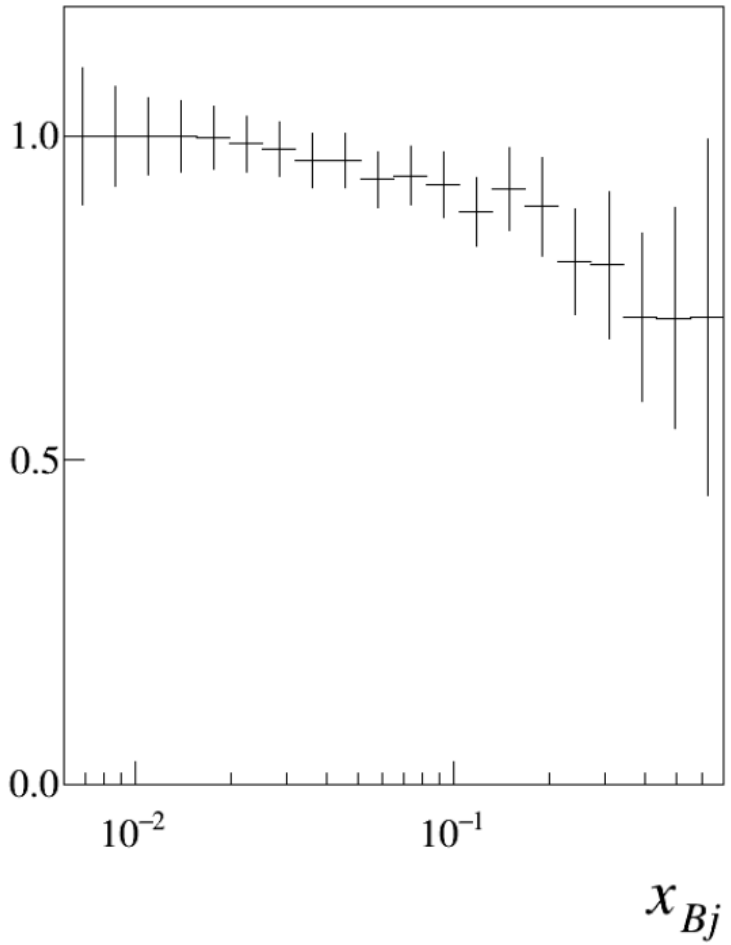
Overall loss is 1.2%



RICH W/O CORNERS 4/4

Results – Effect of RICH with no SIDES





Overall loss is 5%, but 30% at large x