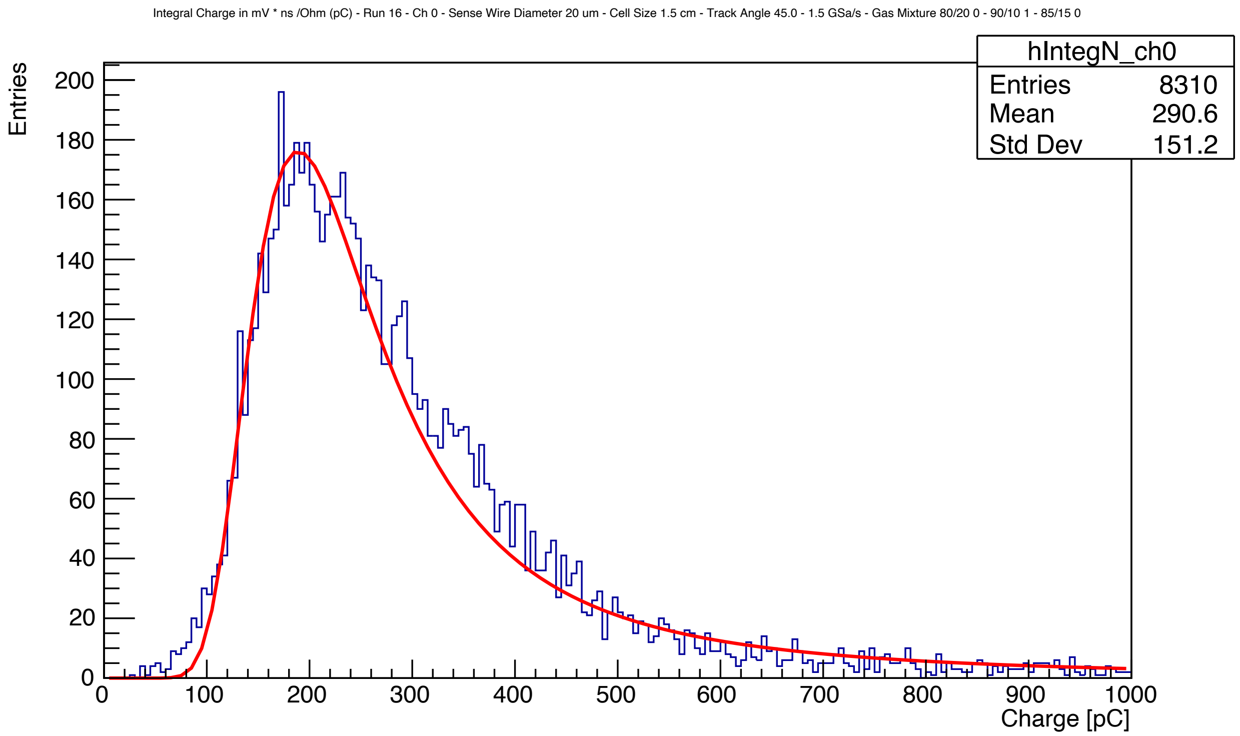
Test beam analysis update using RTA algoritm

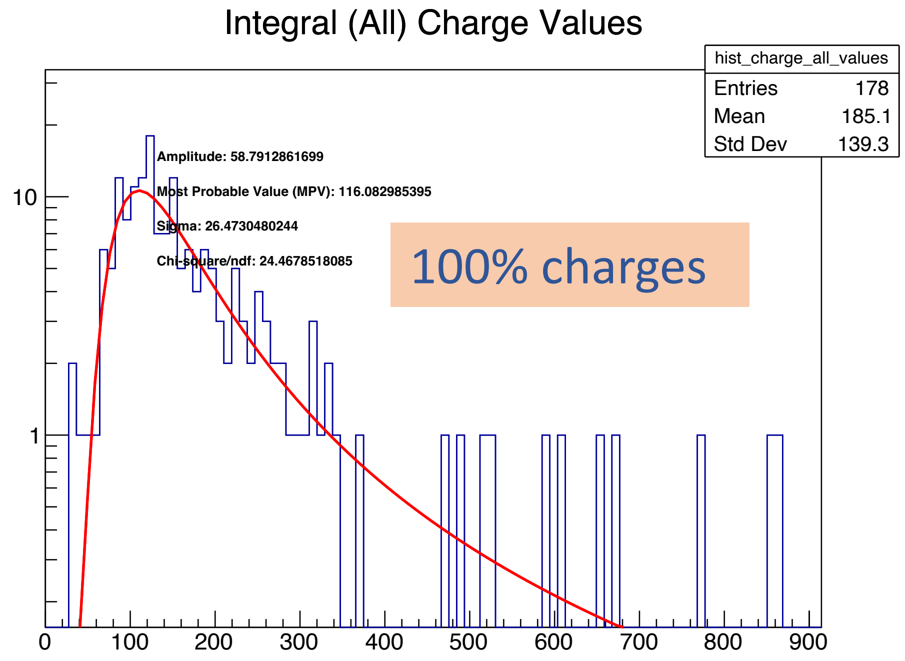
1-dE/dx Resolution study:

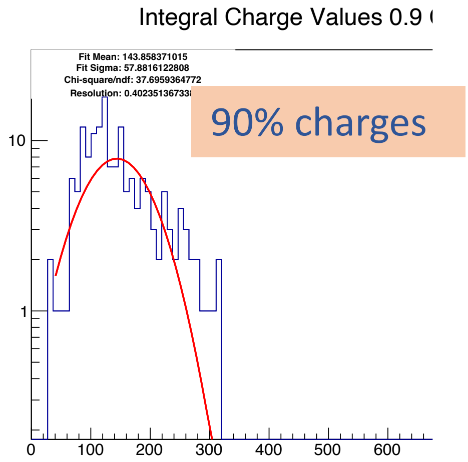
- Landau distribution for the charges.
- Measure charge of many samples (cells) along track.
- Get ”mean" charge over samples = dE/dx.
- Simple “mean” charge subject to large fluctuations ⇨“Truncated Mean” (robust).
- Reject samples with highest charge (typically) 20-30% and calculate mean (“truncated” mean) of remaining samples.
- Optimize truncation empirically (⇨best dE/dx resolution).

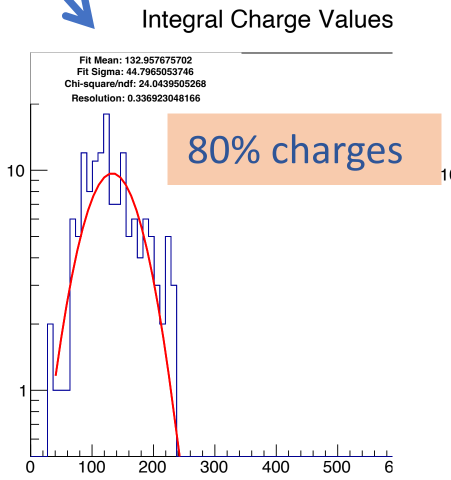


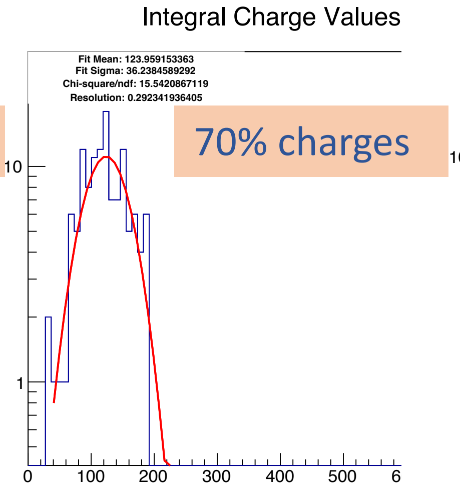
1- dE/dx Resolution study:

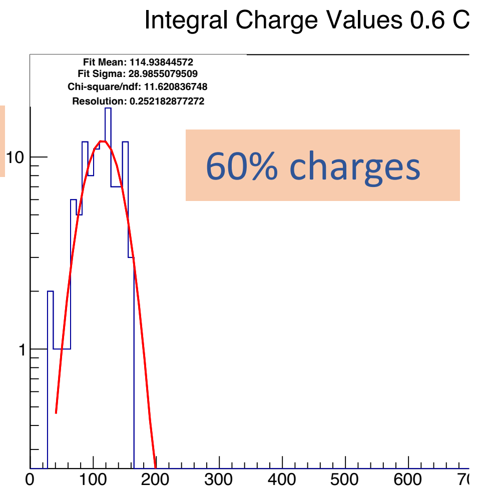
- 2m track length.
- Landau distribution for the charges.
- Optimize truncation empirically (⇨best dE/dx resolution).
- Tested the resolution for each.
- Selected the distribution with 80% of the charges to be compared with dN/dx.

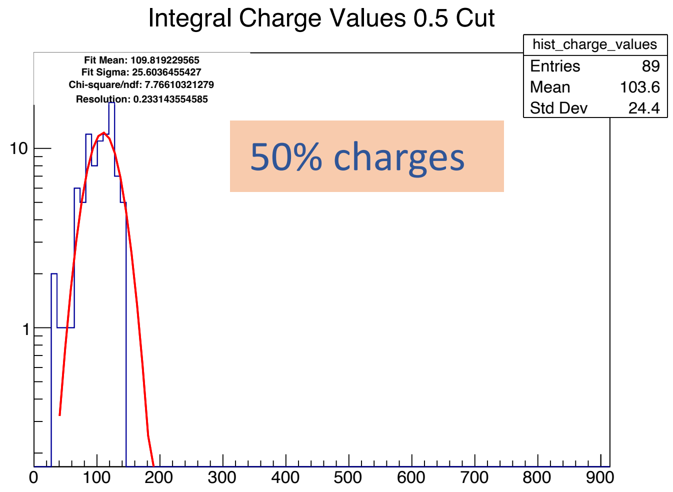






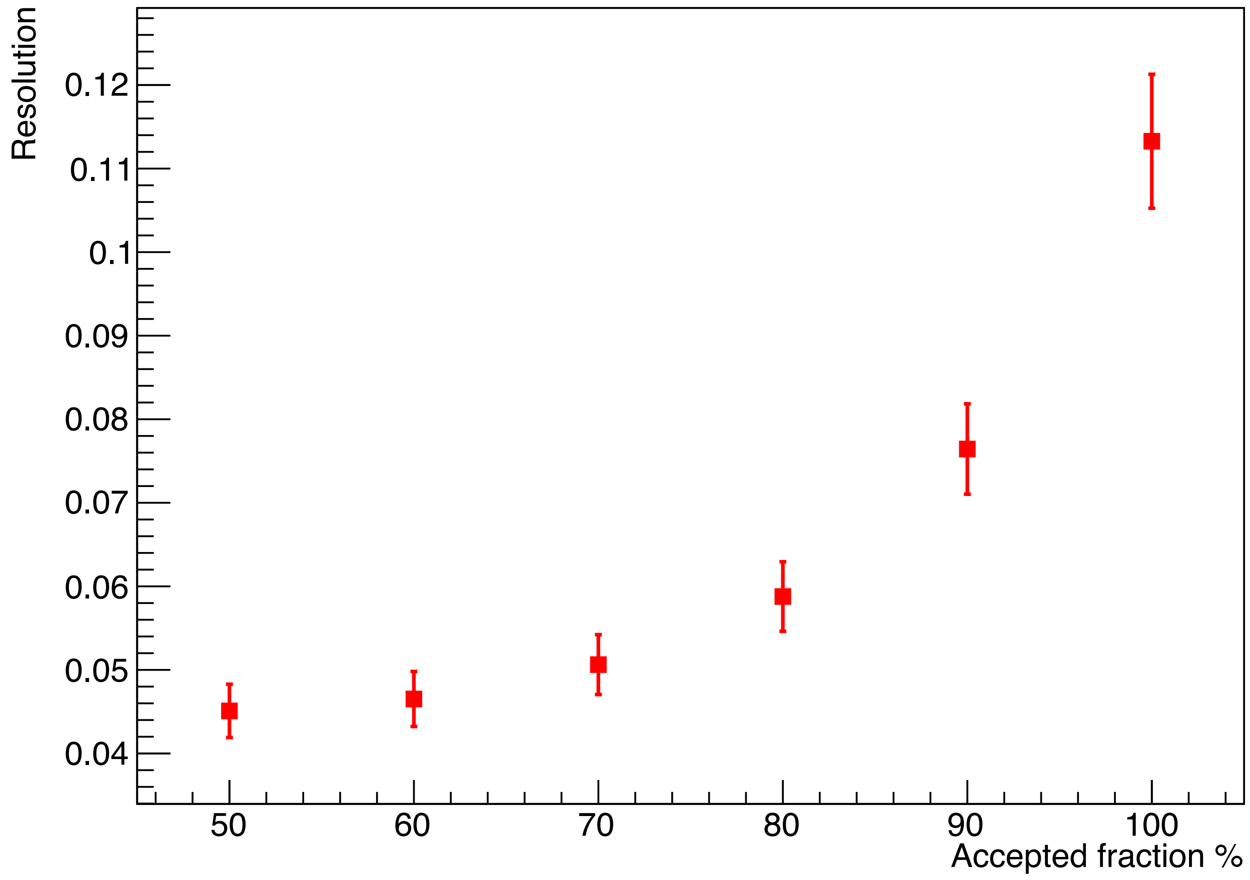






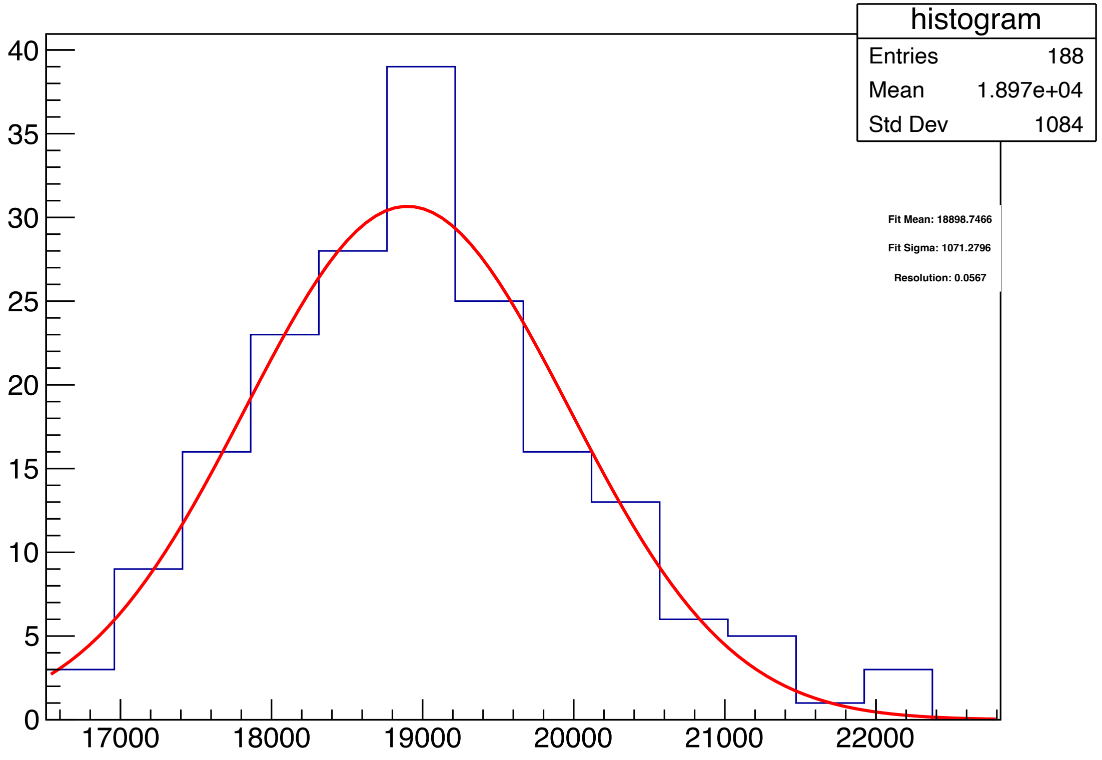
1- dE/dx Resolution study:

dE/dx Resolution Scan Vs accepted fraction of charge



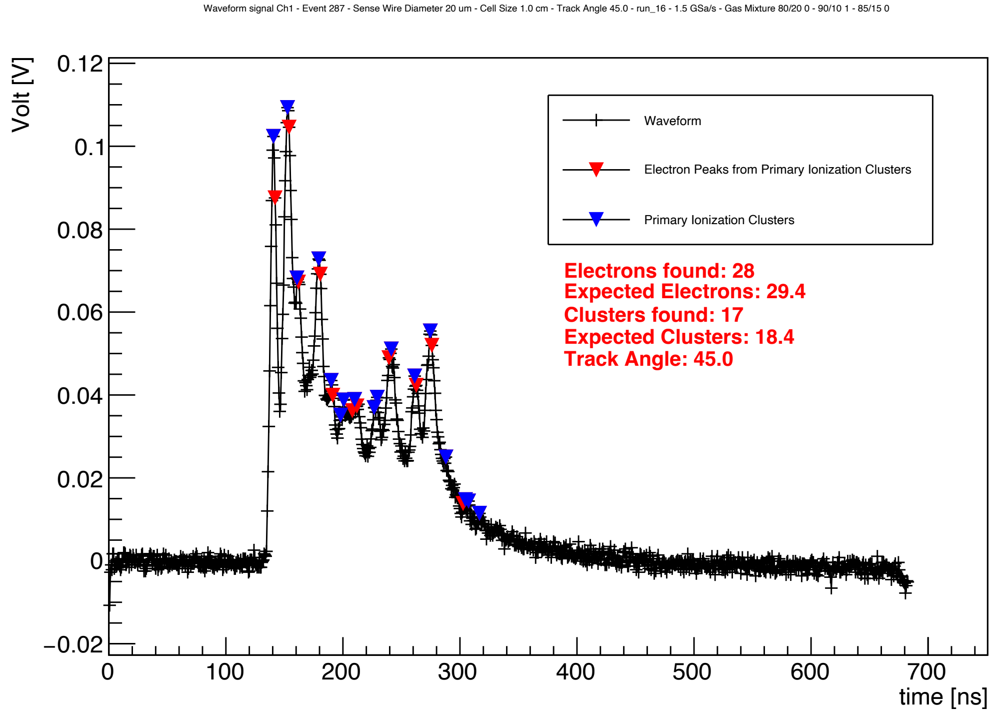
dE/dx resolution varies from 4.5% - 11% relying on the accepted fraction of the charges.

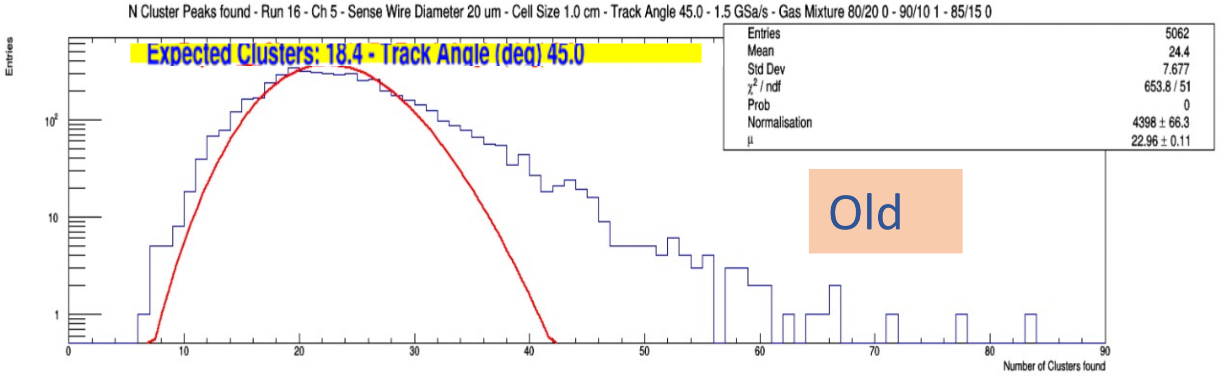
dE/dx Resolution (remove 20% higher charges for each track)

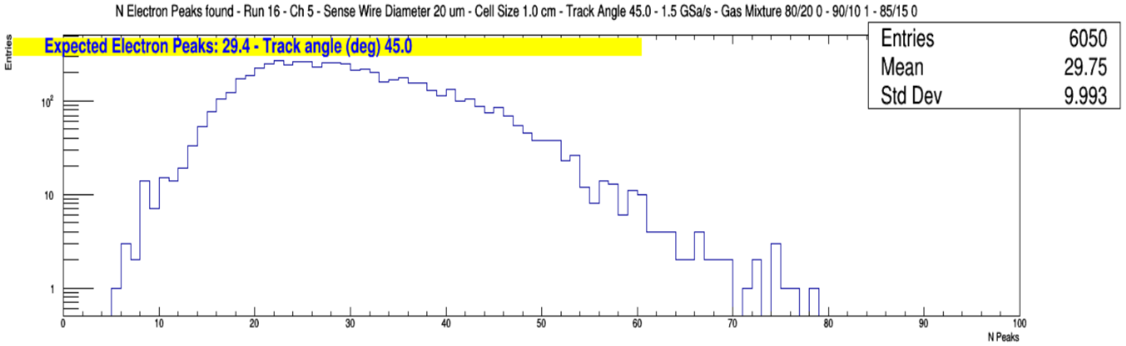


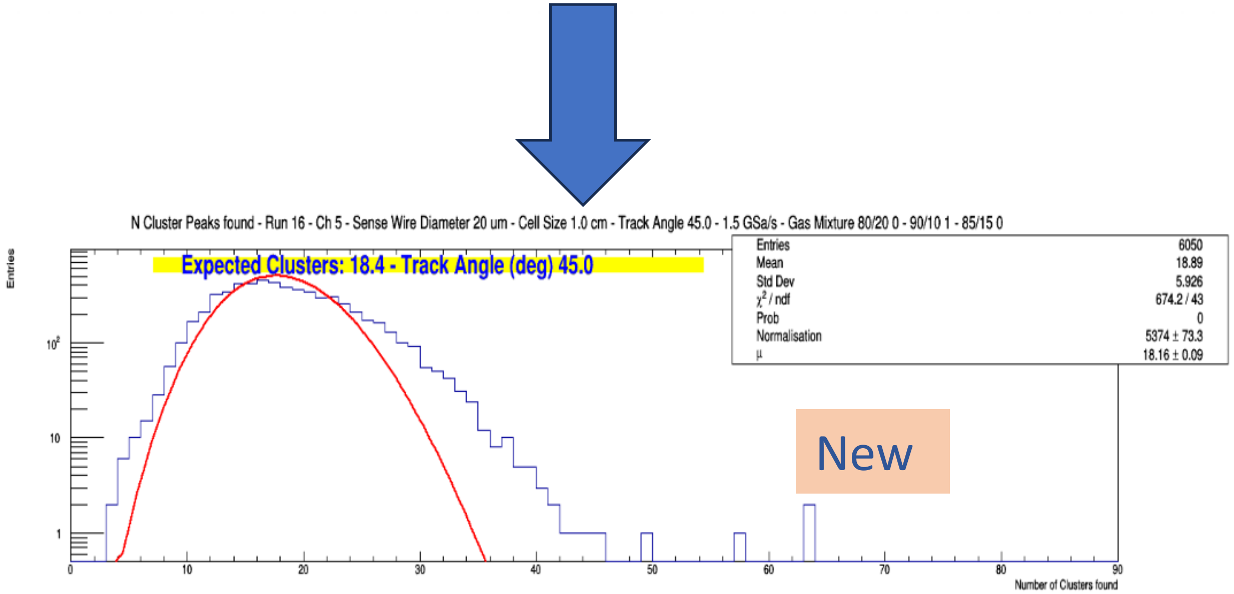
@2m long track we have dE/dx resolution 5.7%

2- dN/dx Resolution study:









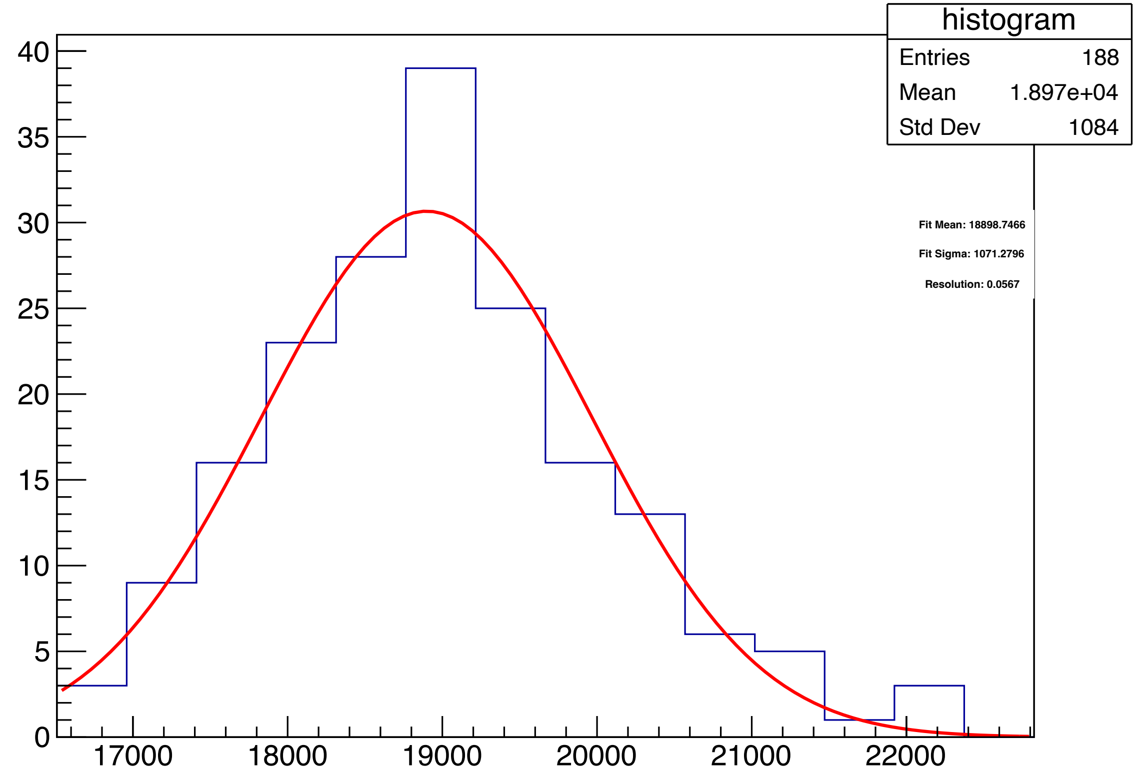
The distribution of the electron takes Landau distribution with number of detected electrons in acceptance with the expected number

Poissonian distribution of the number of clusters with number of detected electrons in acceptance with the expected.

2- dN/dx vs dE/dx Resolution:

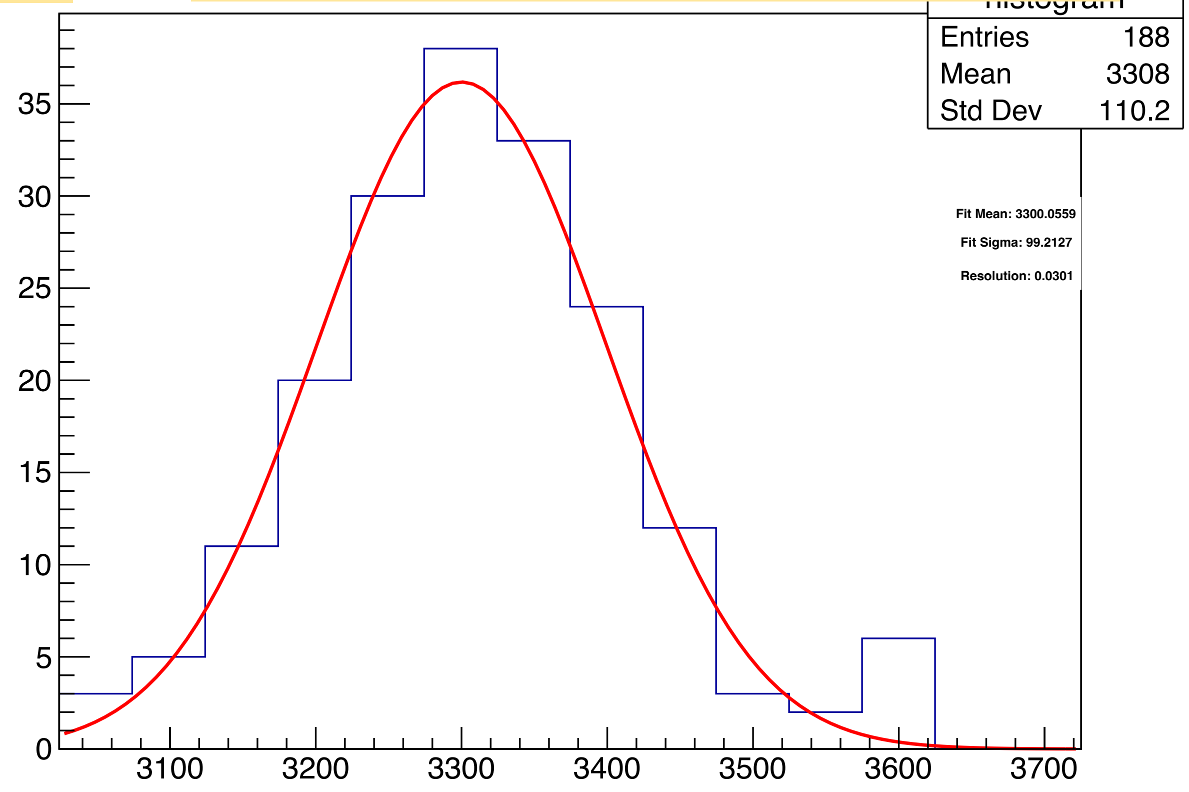
2m tracks length

dE/dx Resolution (remove 20% higher charges)



@2m long track we have dE/dx resolution 5.7%

dN/dx Resolution

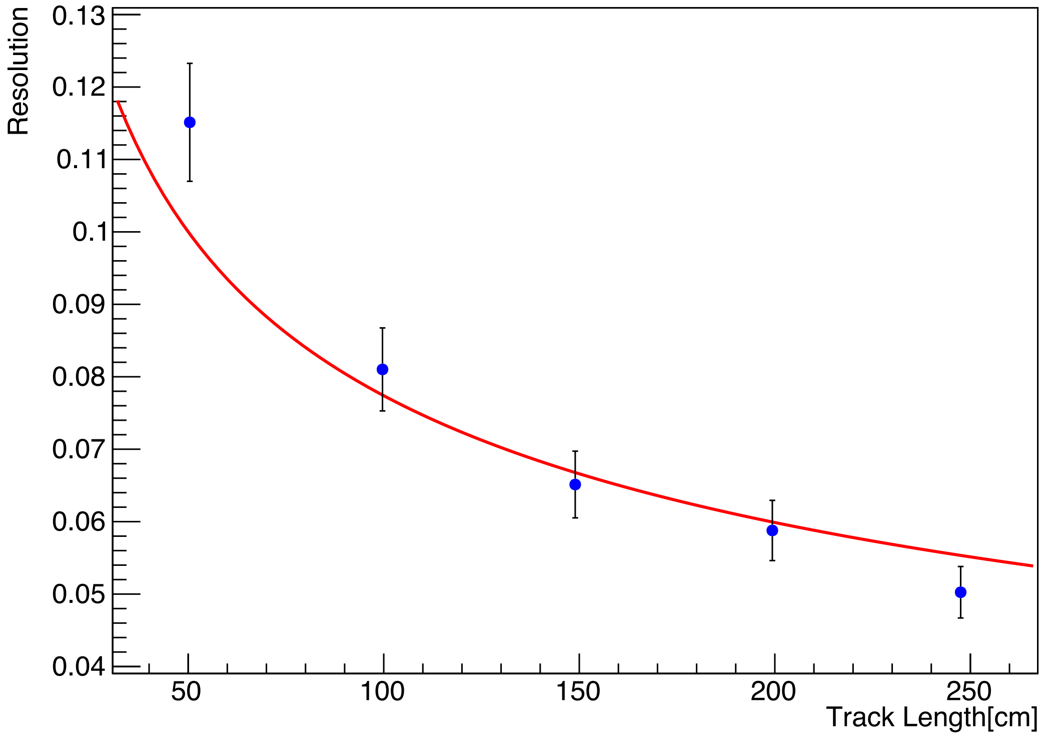


@2m long track we have dN/dx resolution 3%

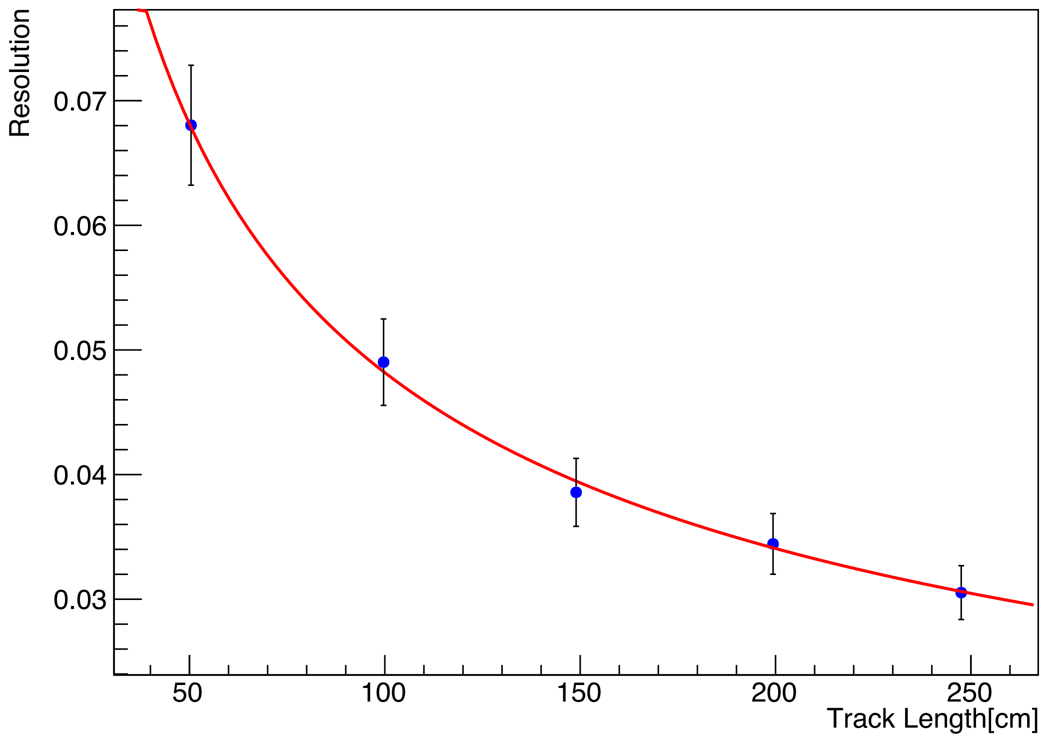
~ 2 times improvement in the resolution using dN/dx method

3- Resolution Scan:

dE/dx Resolution



dN/dx Resolution

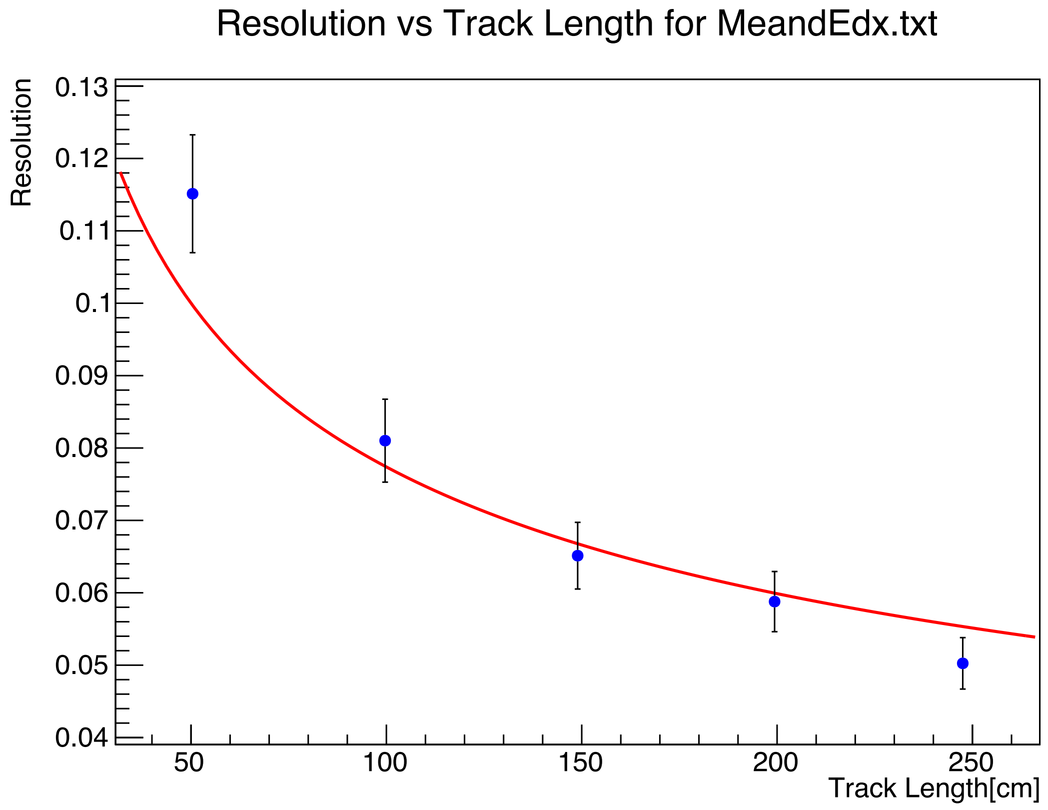


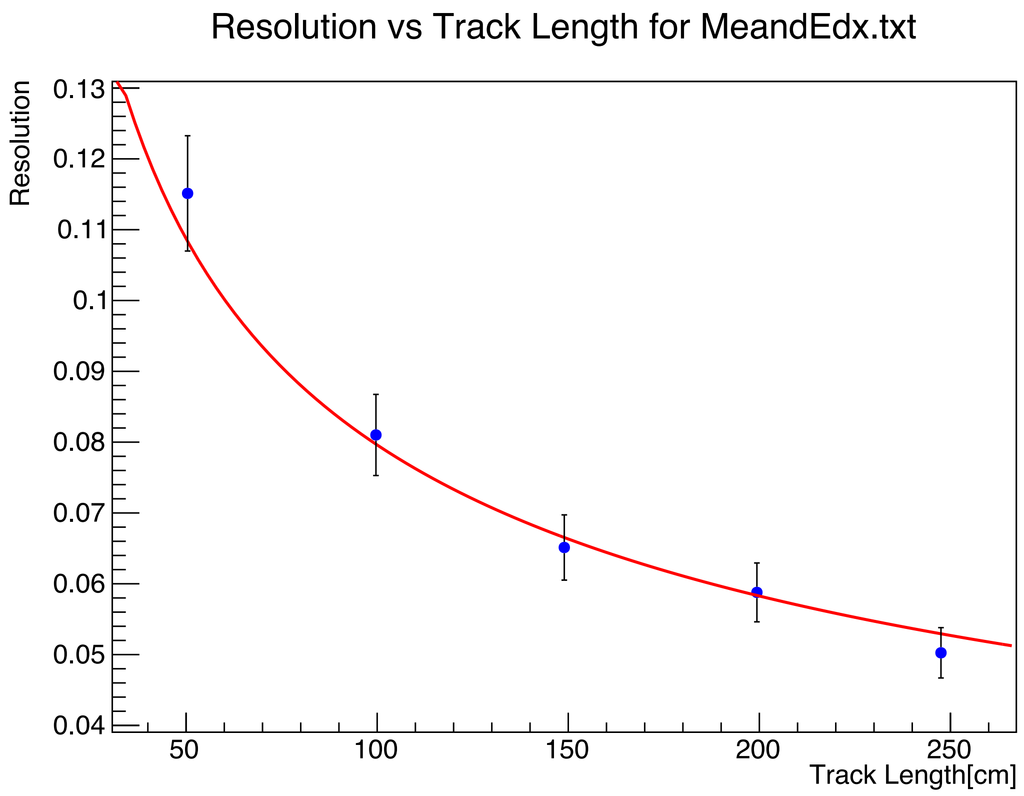
dE/dx resolution dependence on the track length $L^{-0.37}$

dN/dx resolution dependence on the track length $L^{-0.5}$

~ 2 times improvement in the resolution using dN/dx method

3- Resolution Scan:





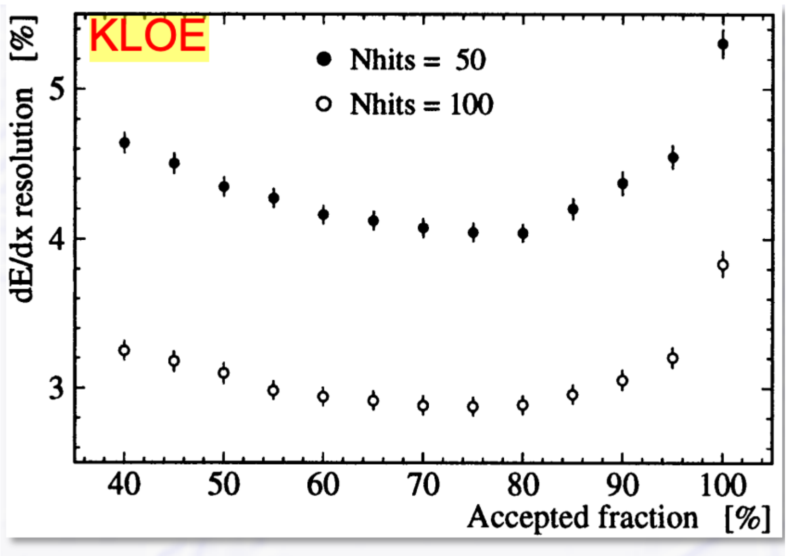
dE/dx resolution dependence on the track length $L^{-0.37}$

dE/dx resolution dependence on the track length $L^{-0.45}$

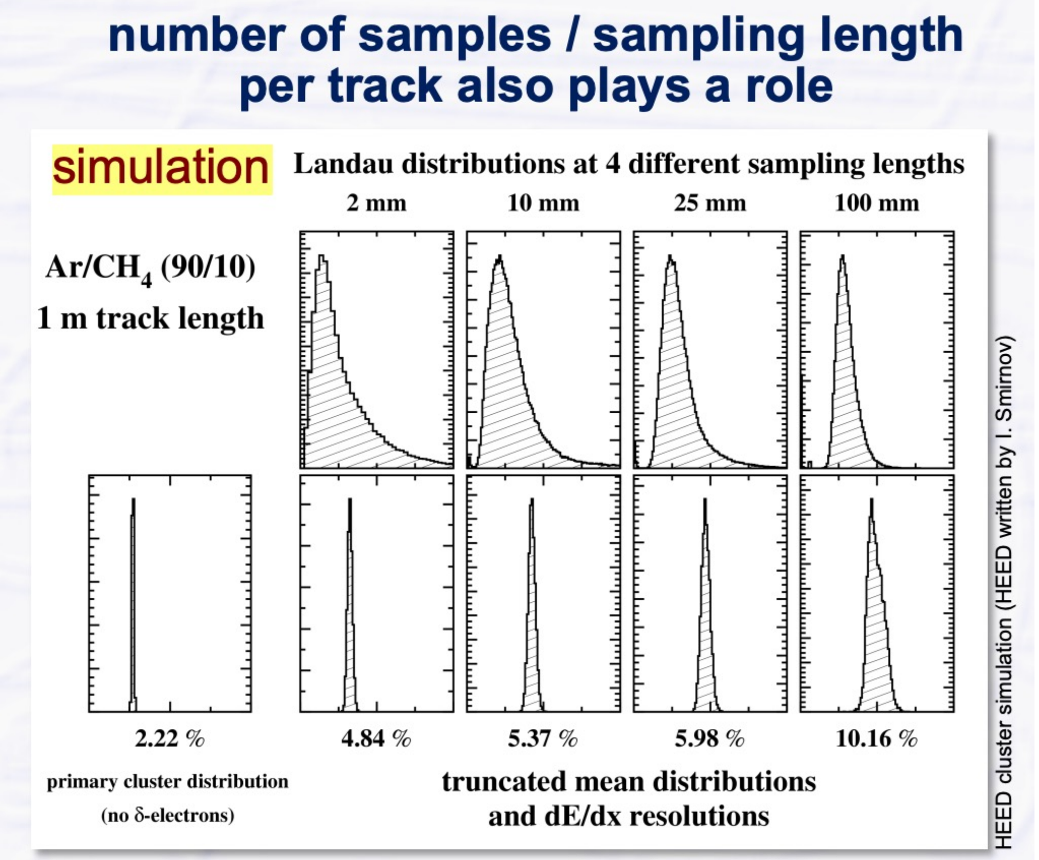
Alternative analysis for the resolution study

Classical dE/dx Measurement by charge:

- Measure charge of many samples (cells) along track.
- Get ”mean" charge over samples = dE/dx.
- Simple “mean” charge subject to large fluctuations ⇨“Truncated Mean” (robust).
- Reject samples with highest charge (typically) 20-30% and calculate mean (“truncated” mean) of remaining samples.
- dE/dx resolution depends on:
  - effective detector length L (track length x pressure). $L^{-0.37}$
  - Number of samples. $1/\sqrt{N}$



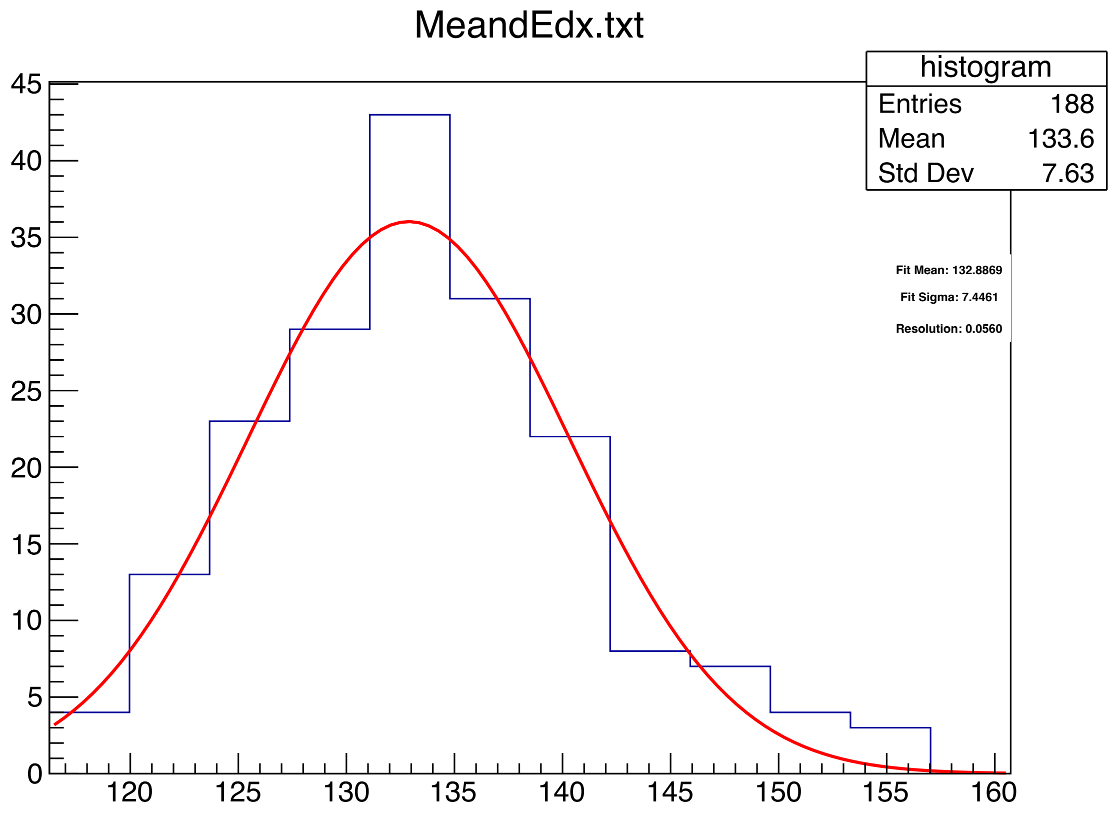
KLOE Collaboration, A. Andryakov et al., NIM A 409 (1998) 390-394



2- dN/dx vs dE/dx Resolution:

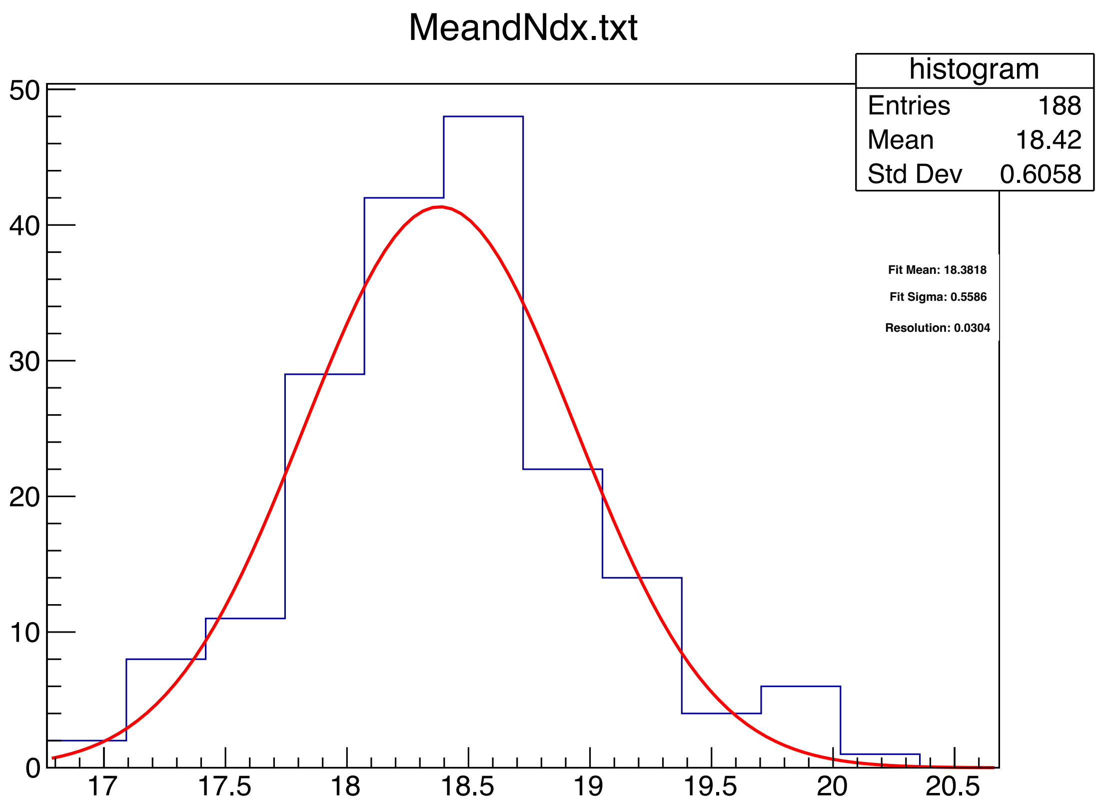
2m tracks length

dE/dx Resolution (Using 80% Truncated mean)



@2m long track we have dE/dx resolution 5.6%

dN/dx Resolution



@2m long track we have dN/dx resolution 3%

~ 2 times improvement in the resolution using dN/dx method

Backup

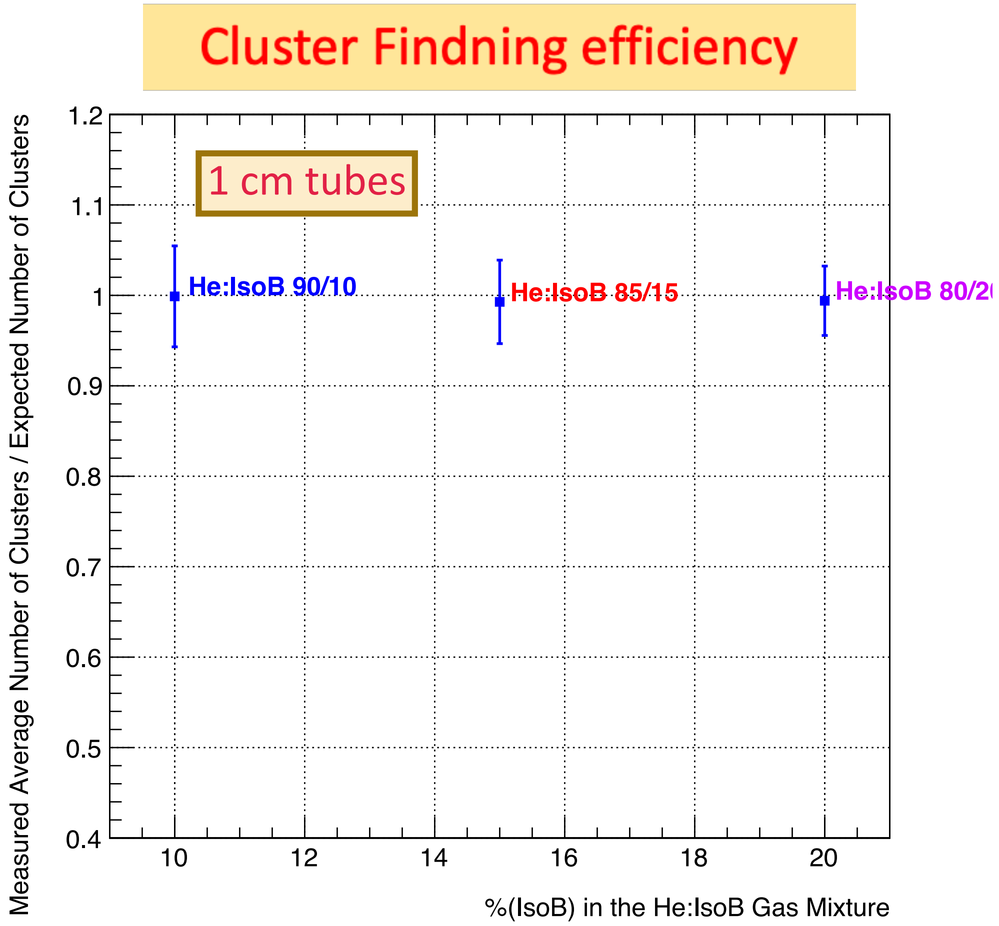
dE/dx Resolutions of major Particle Physics Detectors

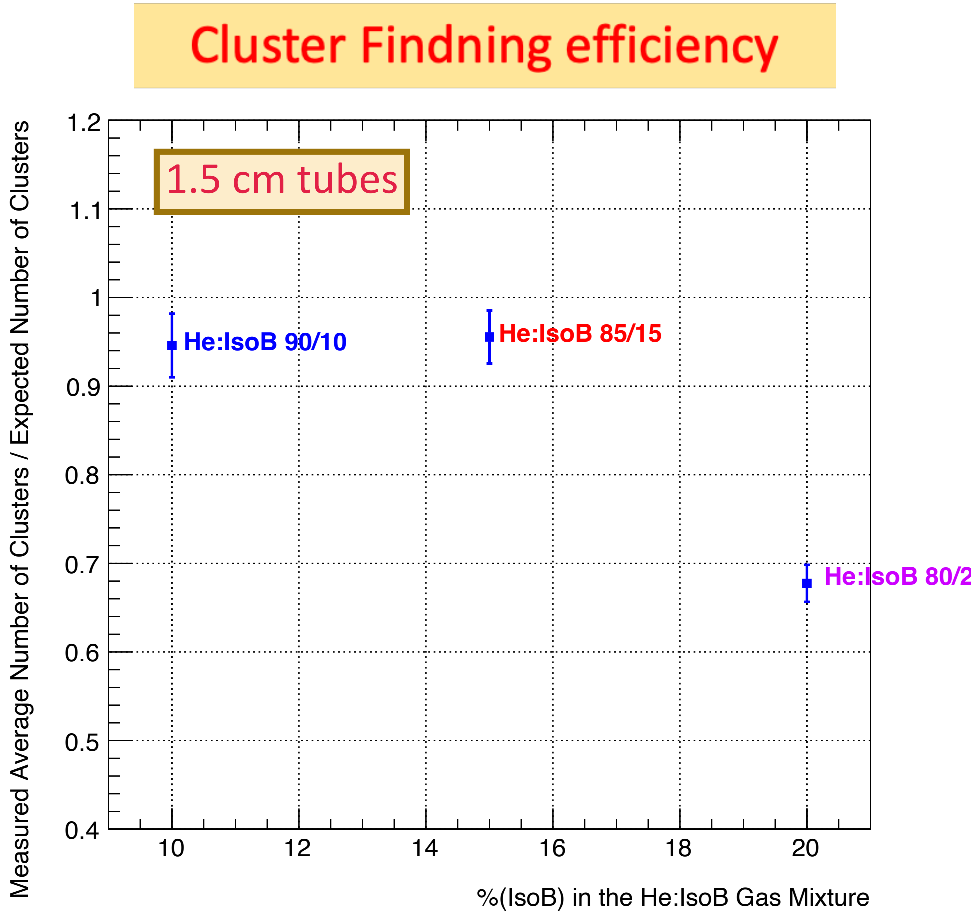
- **Input data for the 2021 "Lehraus" plot**

Detector	Accelerator	Type	Size (Ø x L)	B (T)	Gas Mixture	Pressure (bar)	Number of samples	Sampling length (mm)	Effective detector length (bar * m)	dE/dx resolution (%) isolated tracks	dE/dx resolution (%) dense tracks	Truncation (%)	Reference
ALEPH	LEP	TPC	3.6 m x 4.4 m	1.5	Ar/CH_4 (91/9)	1	338	4	1.35	4.5		8-60	D. Buskulic et al., NIM A 360 (1995) 481
ALICE	LHC	TPC	5.0 m x 5.0 m	0.5	Ne/CO_2 (90/10)	1	159	7.5, 10, 15	1.60	4.5	(5.0)	0-70	W. Yu, NIM A 706 (2013) 55, J. Alme et al., NIM A 622 (2010) 316
ARGUS	DORIS	drift cells	1.7 m x 2 m	0.8	C_3H_8/Methylal	1	36	18	0.65	4.1	(4.4)	10-70	Y. Oku, PhD Thesis, Univ. of Lund (1985), LUNFD6/(NFFL-7024)/
BaBar	PEP-II	drift cells	1.6 m x 2.8 m	1.5	$He/i\text{-}C_4H_{10}$ (80/20)	1	40	12	0.48	7.5		0-80	B. Aubert et al., NIM A 479 (2002) 1-116
BELLE	KEK-B	drift cells	1.9 m x 2.2 m	1.5	He/C_2H_6 (50/50)	1	47	16	0.75	5.5	(7.0)	0-80	E. Nakano, NIM A 494 (2002) 402-408
BES	BEPC	jet cells	2.3 m x 2.1 m	0.4	$Ar/CO_2/CH_4$ (89/10/1)	1	54	5	0.27	9.0		0-70	J.Z. Bai et al., NIM A 344 (1994) 319
CDF	TEVATRON	jet cells	2.6 m x 3.2 m	1.5	$Ar/C_2H_6/C_2H_6O$ (49.6/49.6/0.8)	1	32	12	0.38	7.0		?	D. Stuart, private communications
CLEO II	CESR	drift cells	1.9 m x 1.9 m	1.5	Ar/C_2H_6 (50/50)	1	51	14	0.71	6.2	(7.1)	0-50	Y. Kubota et al., NIM A 320 (1992) 66
CLEO III	CESR	drift cells	1.6 m x 1.9 m	1.5	He/C_3H_8 (60/40)	1	47	14	0.66	5.0		0-70	D. Peterson et al., NIM A 478 (2002) 142-146
CRISIS	TEVATRON	jet cells	1 m x 1 m x 3 m	-	Ar/CO_2 (80/20)	1	192	15	2.88	3.2		0-75	W.S. Toothacker et al., NIM A 273 (1988) 97
DELPHI	LEP	TPC	2.4 m x 2.7 m	1.2	Ar/CH_4 (80/20)	1	192	4	0.77	5.7	(6.2)	0-80	P. Abreu et. al., CERN-PPE/95-194, submitted to NIM
D0 FDC	TEVATRON	jet cells	1.2 m x 0.3 m	-	$Ar/CH_4/CO_2$ (93/4/3)	1	32	8	0.26	12.7		0-70	S. Rajagopalan, PhD Thesis, Northwestern University (1992)
H1	HERA	jet cells	1.7 m x 2.2 m	1.13	Ar/C_2H_6 (50/50)	1	56	10	0.56	10.0		---*	I. Abt et al., NIM A 386 (1997) 348-396
JADE	PETRA	jet cells	1.6 m x 2.4 m	0.48	$Ar/CH_4/i\text{-}C_4H_{10}$ (88.7/8.5/2.8)	4	48	10	1.92	6.5	(7.2)	5-70	K. Ambrus, PhD Thesis, Univ. of Heidelberg (1986)
KEDR	VEPP-4M	jet cells	1.1 m x 1.1 m	2.0	DME (100)	1	42	10	0.42	10.0		5-70	S.E. Baru et al., NIM A 323 (1992) 151
KLOE	DAΦNE	drift cells	4 m x 3.3 m	0.6	$He/i\text{-}C_4H_{10}$ (90/10)	1	58	28	1.62	3.5		0-80	A. Andryakov et al., NIM A 409 (1998) 390-394 (prototype)
MARK II	SLC	drift cells	3 m x 2.3 m	0.475	$Ar/CO_2/CH_4$ (89/10/1)	1	72	8.33	0.60	7.0		5-75	A. Bojarski et al., NIM A 283 (1989) 617
NA49	SPS	TPC	.8 m x 3.8 m x 1.3	-	$Ar/CH_4/CO_2$ (90/5/5)	1	90	40	3.60	4.7		10-65	B. Lasiuk, NIM A 409 (1998) 402-406
OBELIX	LEAR	jet cells	1.6 m x 1.4 m	0.5	Ar/C_2H_6 (50/50)	1	40	15	0.60	12.0		0-70	F. Balestra et al., NIM A 323 (1992) 523
OPAL	LEP	jet cells	3.6 m x 4 m	0.435	$Ar/CH_4/i\text{-}C_4H_{10}$ (88.2/9.8/2)	4	159	10	6.36	2.8	(3.2)	0-70	M. Hauschild, NIM A 379 (1996) 436
SLD	SLC	jet cells	2 m x 2 m	0.6	$CO_2/Ar/i\text{-}C_4H_{10}$ (75/21/4)	1	80	6	0.48	7.0		?	M. Hildreth, private communications
STAR	RHIC	TPC	4 m x 4.2 m	0.5	Ar/CH_4 (90/10)	1	45	17.2	0.77	8.0		0-70	M. Anderson et al., NIM A 499 (2003), 659
TOPAZ	TRISTAN	TPC	2.4 m x 2.2 m	1.0	Ar/CH_4 (90/10)	3.5	175	4	2.45	4.4	(4.6)	0-65	M. Iwasaki et al., NIM A 365 (1995) 143
TPC/2γ	PEP	TPC	2 m x 2 m	1.375	Ar/CH_4 (80/20)	8.5	183	4	6.22	3.0		0-65	G. Cowan, PhD Thesis, Lawrence Berkeley Lab. (1988), LBL-24715
ZEUS	HERA	jet cells	1.7 m x 2.4 m	1.43	$Ar/CO_2/C_2H_6$ (90/8/2)	1	72	8	0.58	8.5		?	W. Zeuner, private communications

* = inverse gaussian mean 1/sqrt[(dE/dx)i] used

1- Check the performance for different gas Mix: (Gas Mix Scan)

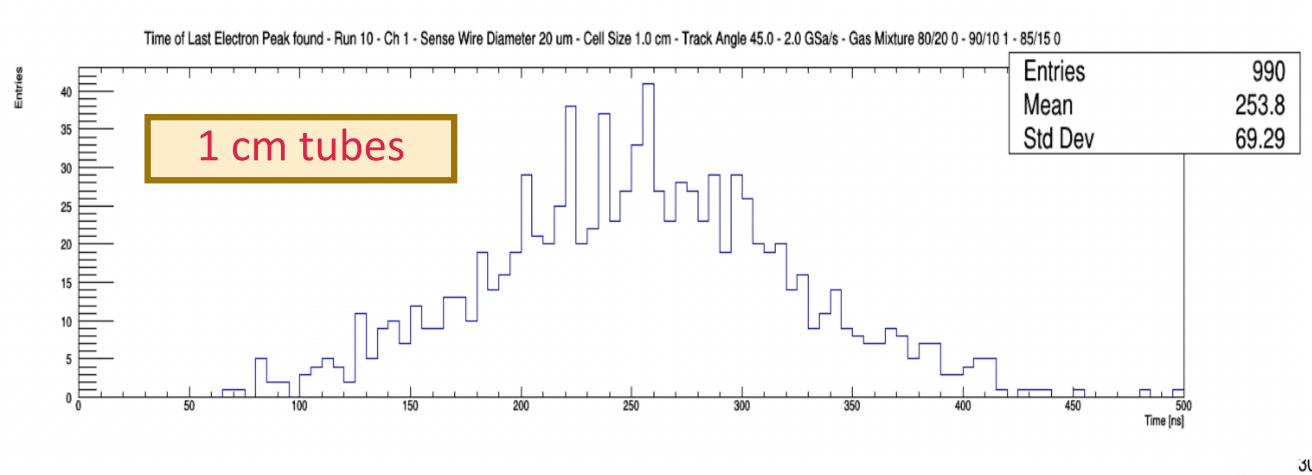


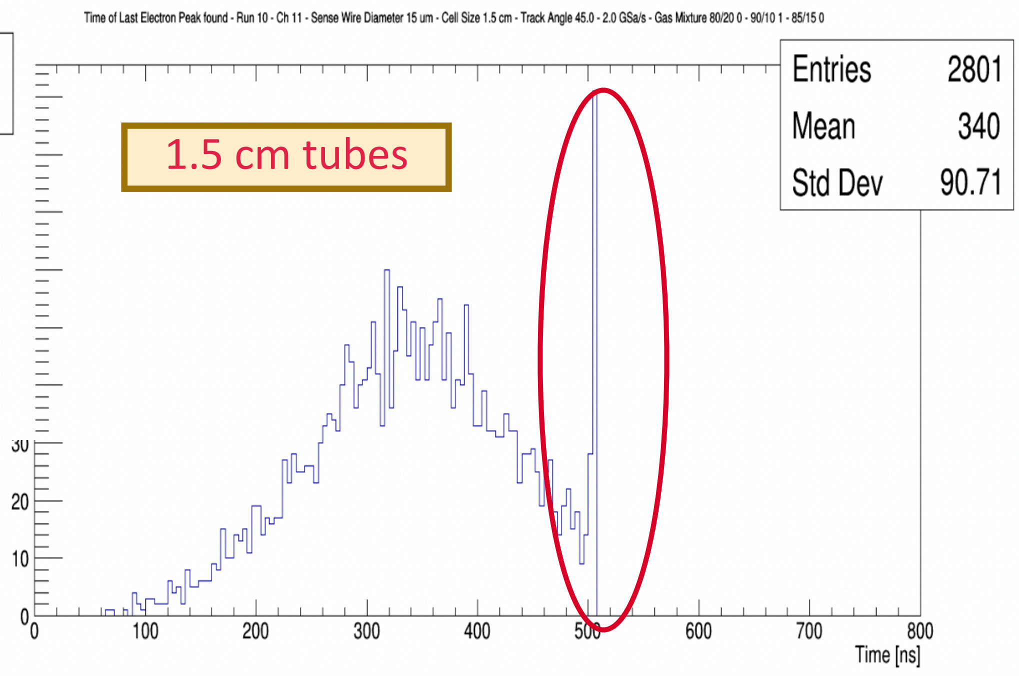


The clusterization cut has been optimised for each gas mixture to count for the change in the drift velocity.
Inefficiency 5% for 1.5 cm tubes using He:IsoB 90/10 & He:IsoB 85/15 and inefficiency ~ 30% using He:IsoB 80/20.

X

1.5 cm tubes inefficiency ~5-30%





We have 1024 bins,
@ 2GSa ➩ 1/2 ns/bin
➩ 512 ns.

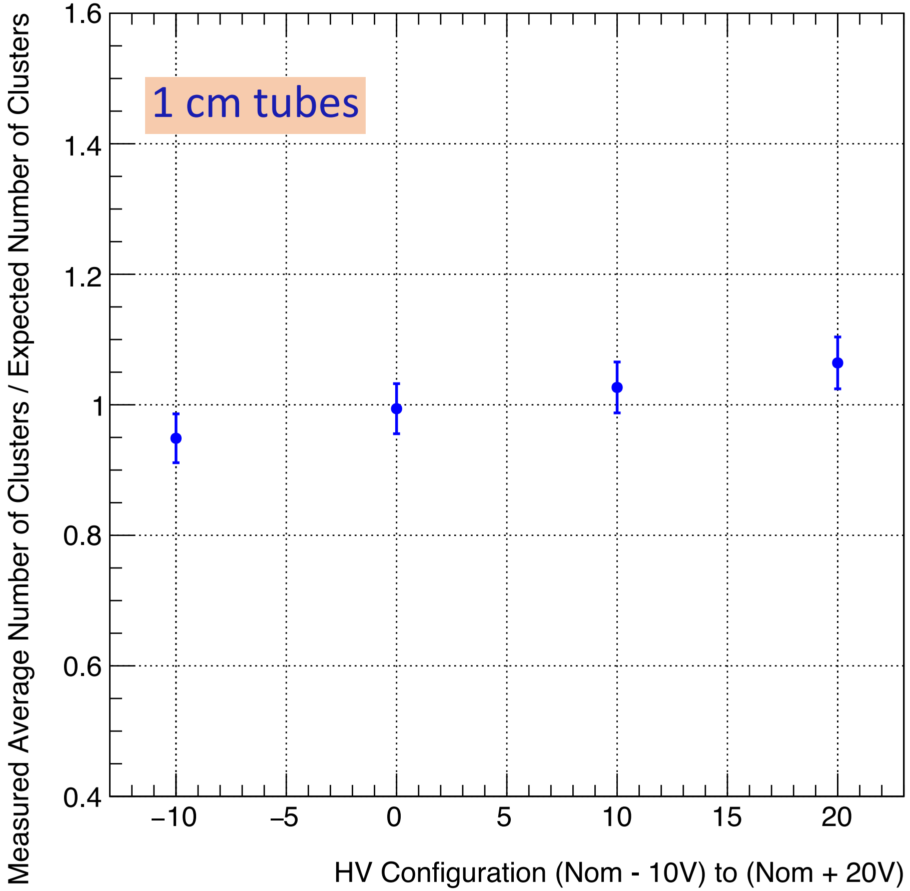
It is clear that we are loosing a not negligible part of the clusters.

2- HV scan:

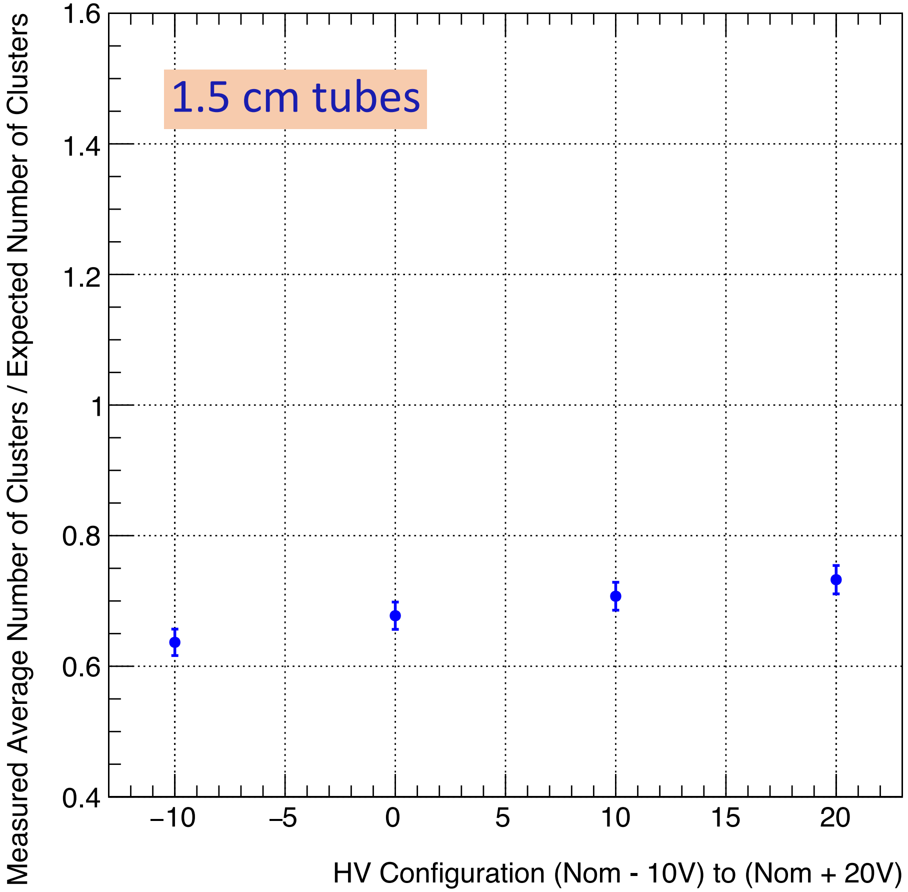
He:IsoB 80:20

Good stability with changing the HV

Cluster Findning efficiency



Cluster Findning efficiency



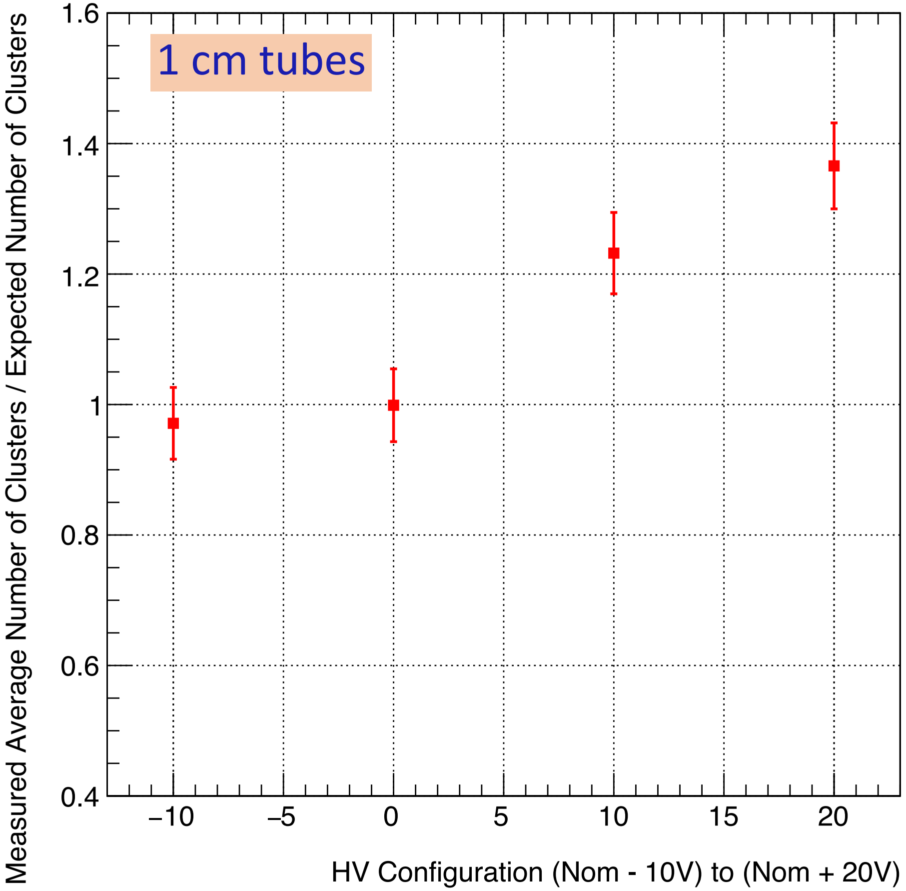
X

Inefficiency ~ 30% using He:IsoB 80/20 for 1.5 cm tubes

2- HV scan

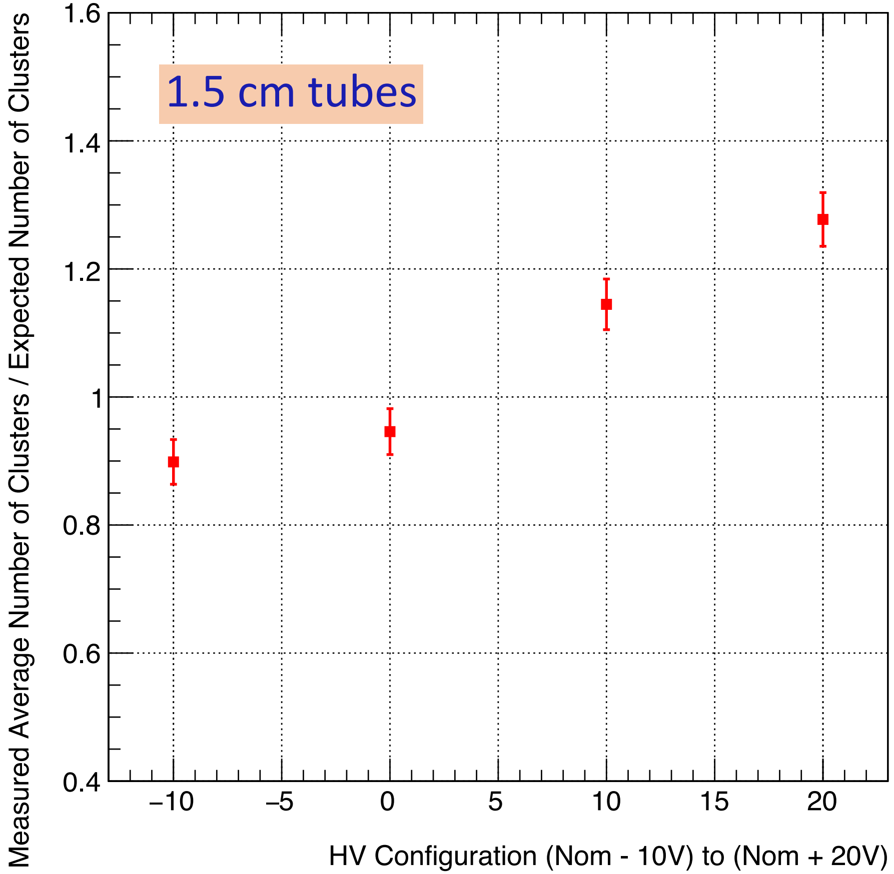
He:IsoB 90:10

Cluster Findning efficiency

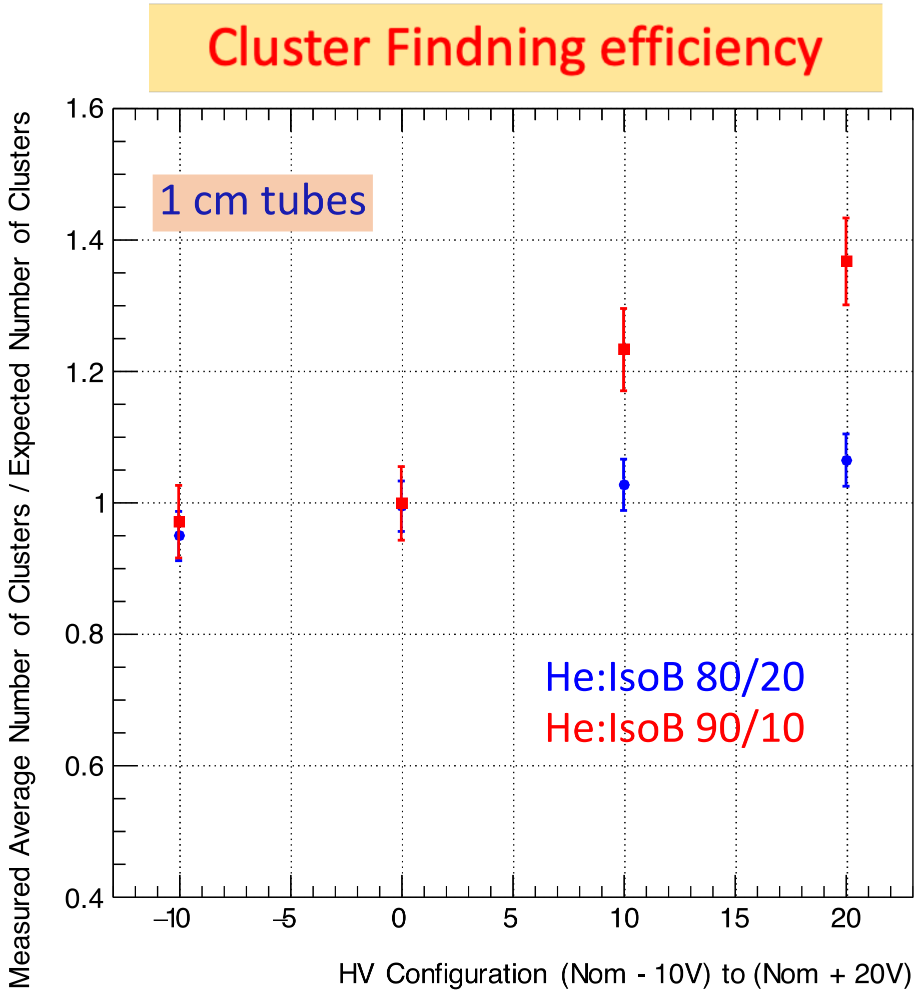


X

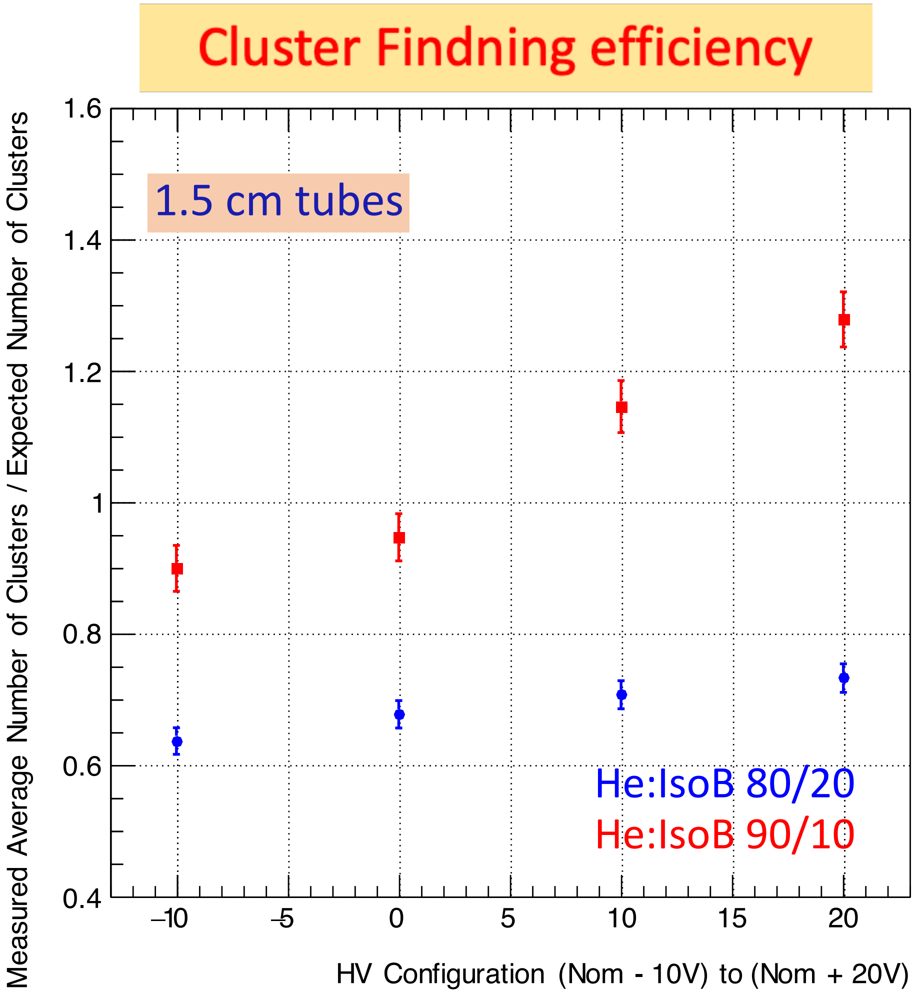
Cluster Findning efficiency



2- HV scan



Cluster Findning efficiency
1 cm tubes
Measured Average Number of Clusters / Expected Number of Clusters
1.6
1.4
1.2
1
0.8
0.6
0.4
−10
−5
0
5
10
15
20
HV Configuration (Nom - 10V) to (Nom + 20V)
He:IsoB 80/20
He:IsoB 90/10



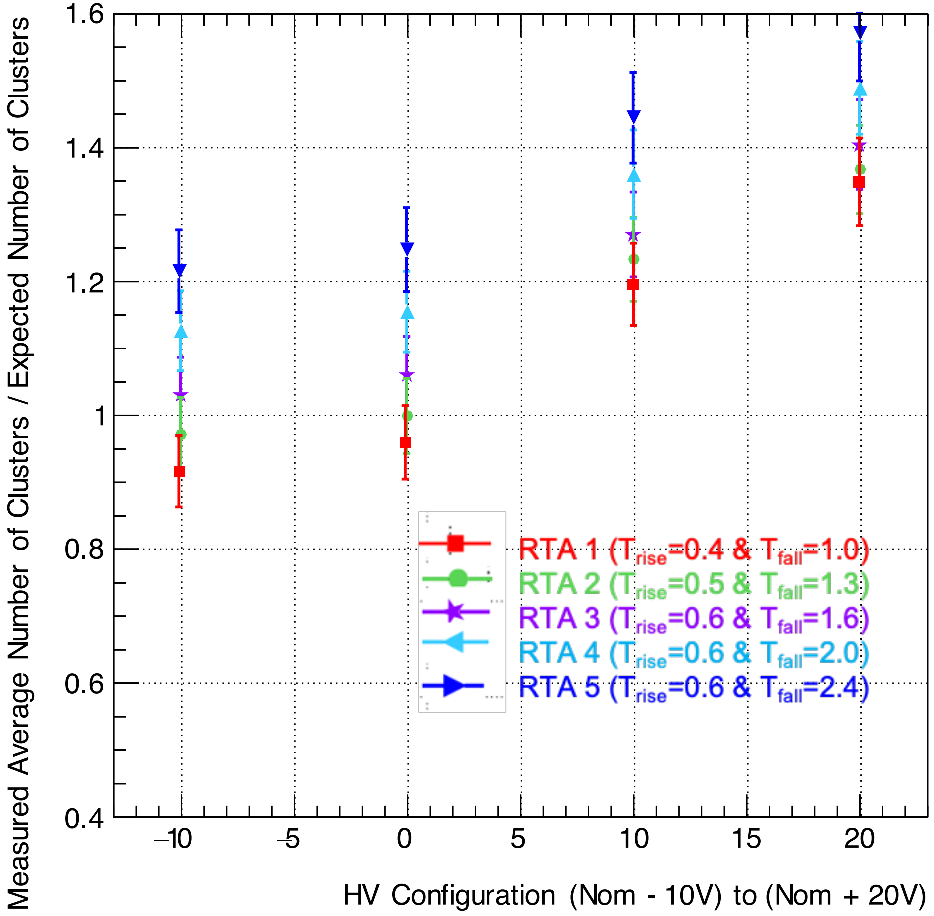
Cluster Findning efficiency
1.5 cm tubes
Measured Average Number of Clusters / Expected Number of Clusters
1.6
1.4
1.2
1
0.8
0.6
0.4
−10
−5
0
5
10
15
20
HV Configuration (Nom - 10V) to (Nom + 20V)
He:IsoB 80/20
He:IsoB 90/10

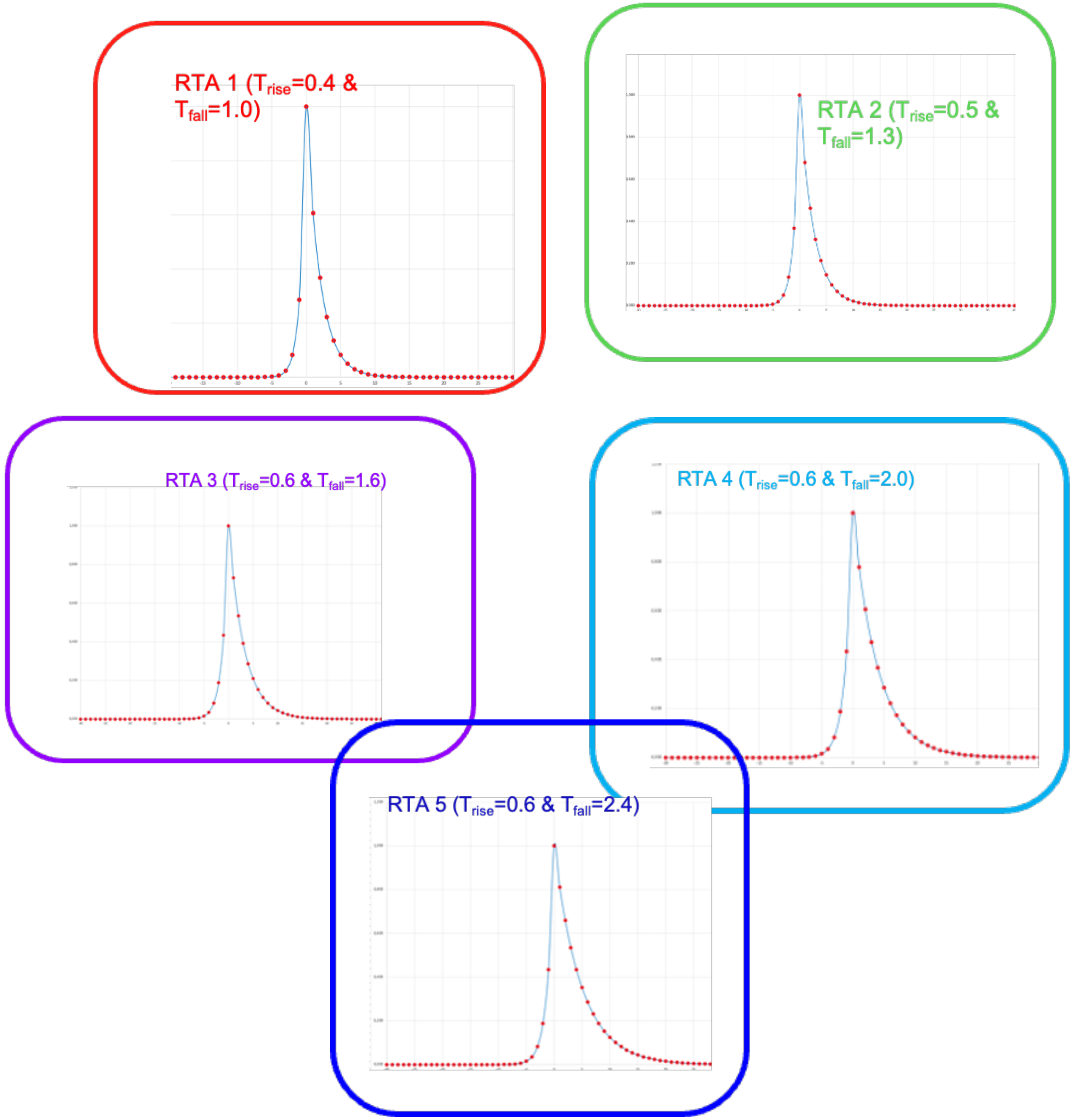
X

4- RTA scan

1 cm tubes

Cluster Findning efficiency



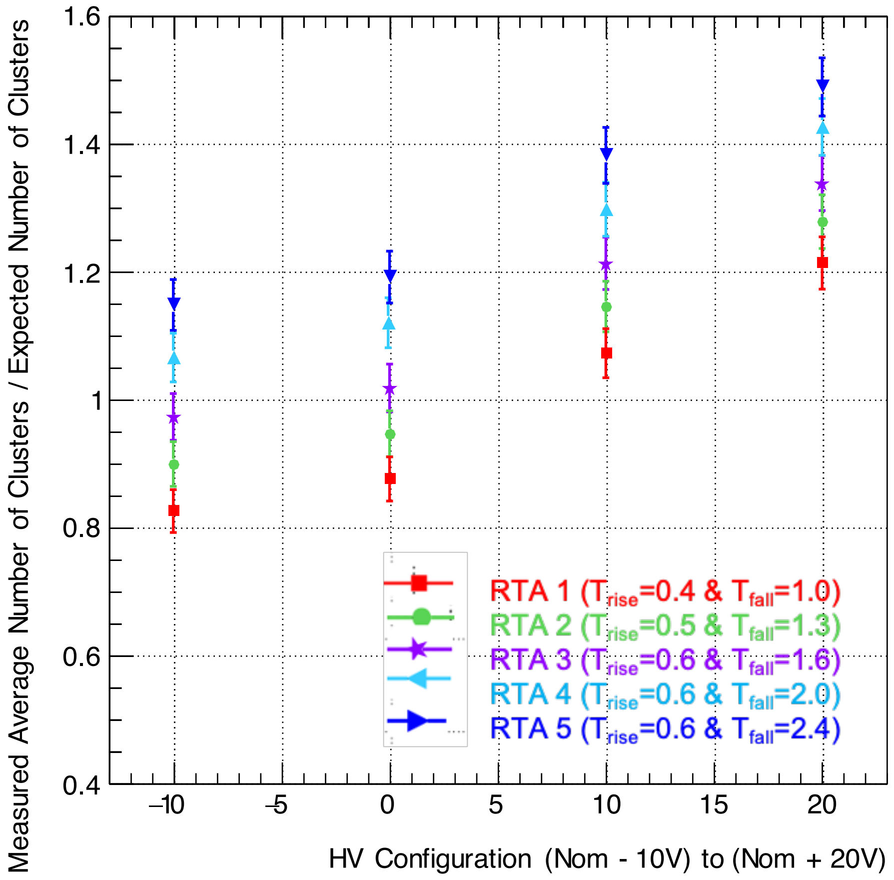


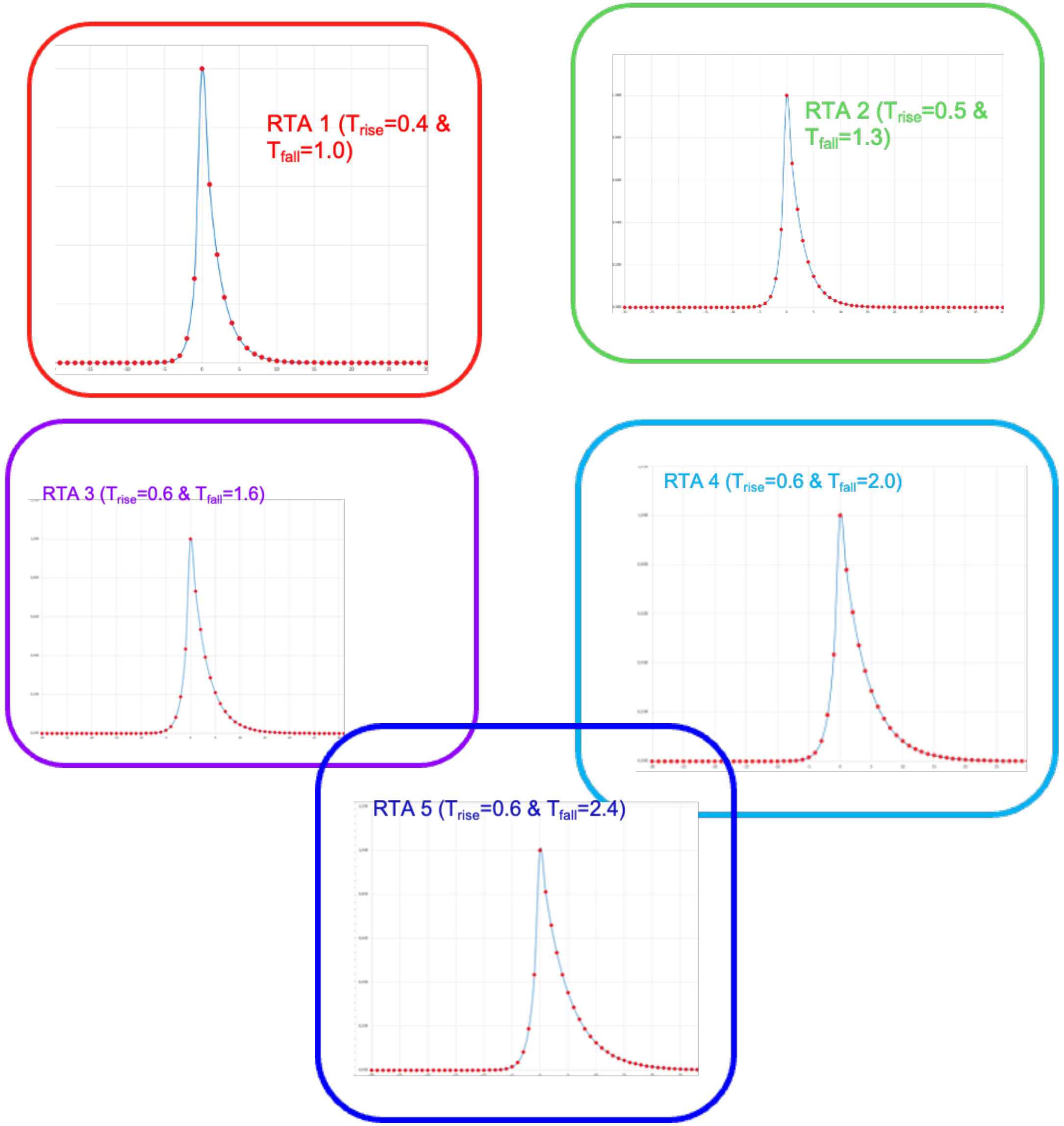
X

4- RTA scan

1.5 cm tubes

Cluster Findning efficiency





X