

Hadron calorimeter calibration in carbon  
beam with kinetic energy  
 $T = 4.5 \text{ GeV}$  per nucleon

Калибровка адронного калориметра в  
пучке ядер углерода  
с энергией 4.5 ГэВ на нуклон

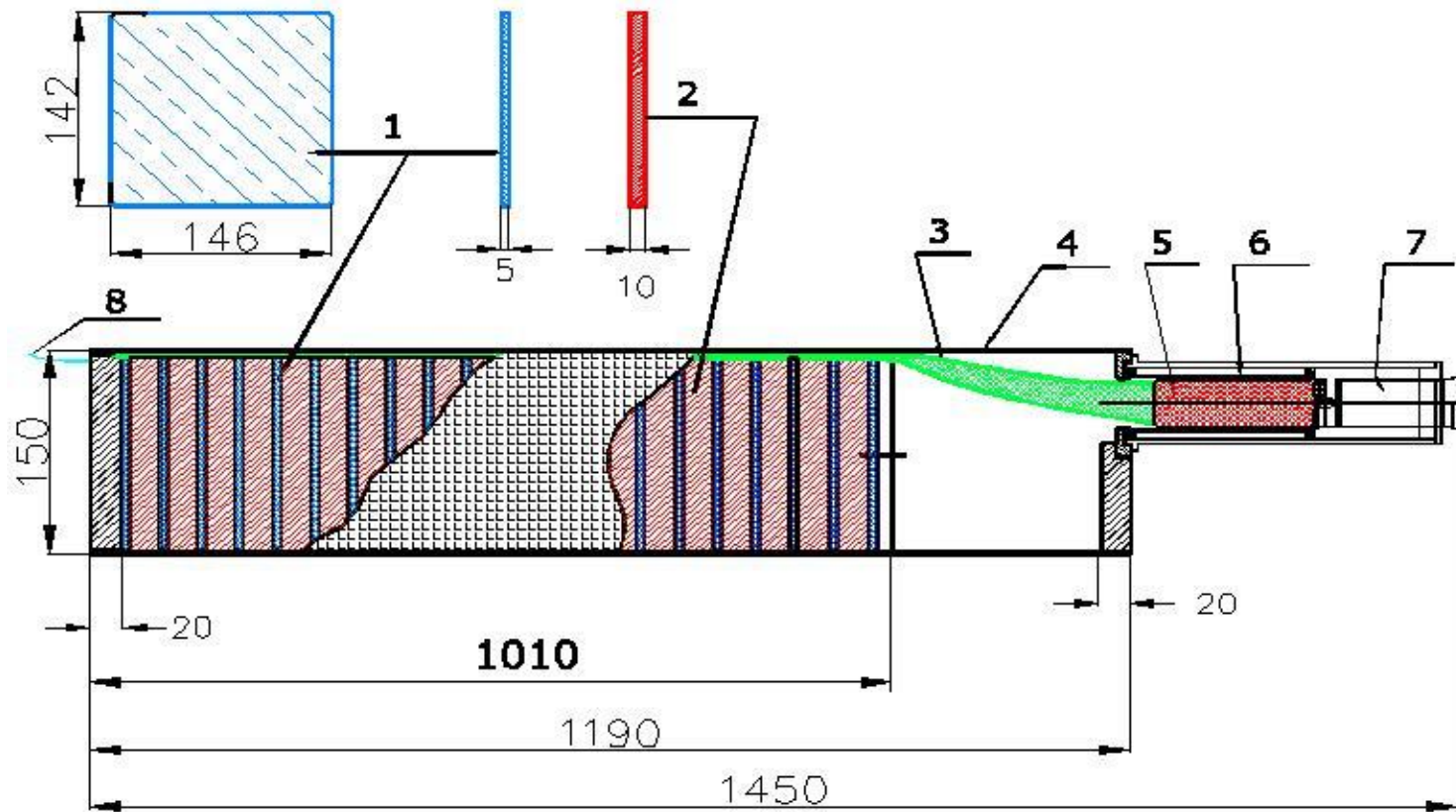
Oleg Gavrishchuk , LVHE JINR

- ZDC Setup 2017
- Calibration in transvers cosmic
- Beam calibration in Carbon beam  $T=4.5 \text{ GeV/N}$   
in Marth 2017

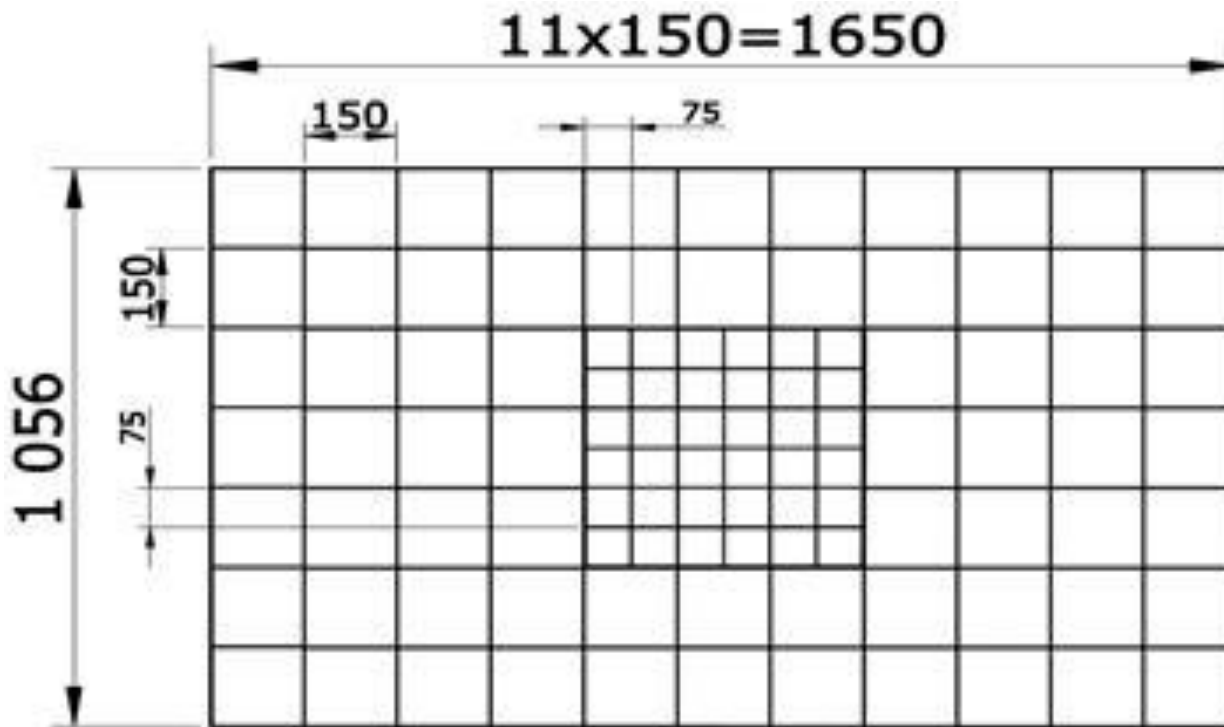
# ZDC setup 2015



# ZDC module design: 64 layers (5mm scint.+10mm Pb)



# ZDC dimension and cell sizes



**ZDC layout:** central part consist of 36 modules with sizes  $7.5 \times 7.5$  cm<sup>2</sup>, peripheral part contains 68 modules of  $15 \times 15$  cm<sup>2</sup>

# ZDC modules mapping

68	61	54	47	40	36	32	28	21	14	7			
67	60	53	46	39	35	31	27	20	13	6			
66	59	52	45	104	98	92	86	80	74	26	19	12	5
				103	97	91	85	79	73				
65	58	51	44	102	96	90	84	78	72	25	18	11	4
				101	95	89	83	77	71				
64	57	50	43	100	94	88	82	76	70	24	17	10	3
				99	93	87	81	75	69				
63	56	49	42	38	34	30	23	16	9	2			
62	55	48	41	37	33	29	22	15	8	1			

**ZDC layout:** central part consist of 36 modules with sizes  $7.5 \times 7.5 \text{ cm}^2$ , peripheral part contains 68 modules of  $15 \times 15 \text{ cm}^2$

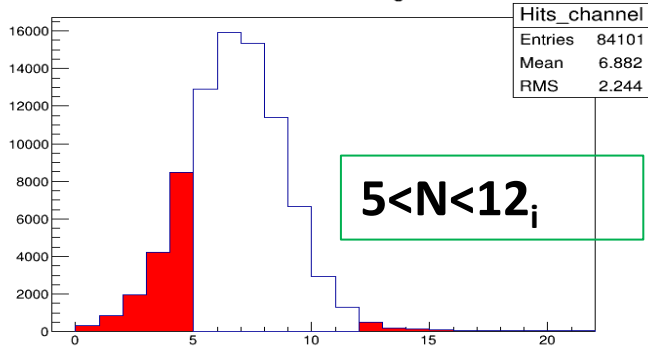


# ZDC setup 2017\_2018 for cosmic and beam tests



# Criteria for events selection in cosmic rays

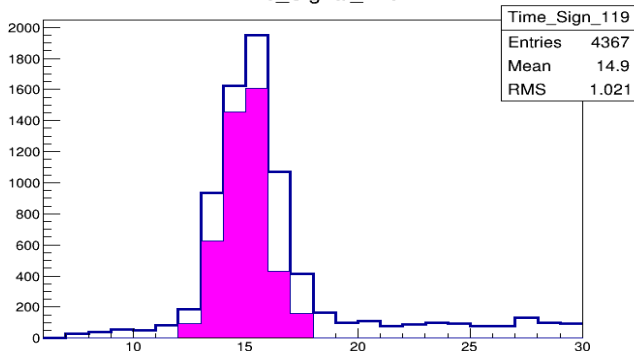
ZDC channels hitting rate



$5 < N < 12_i$

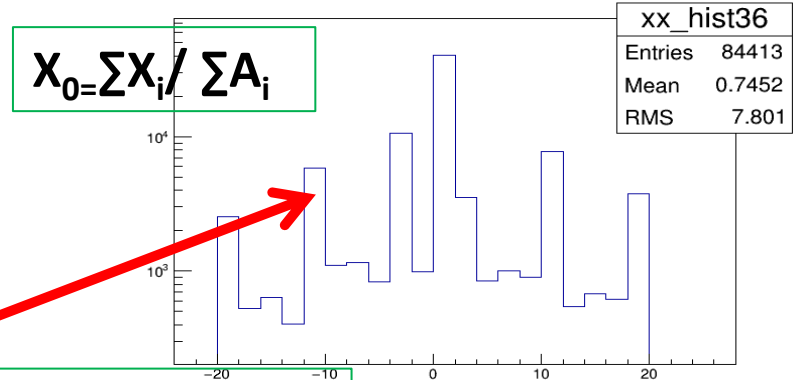
Hits distribution

Time\_Signal\_120



Time selection

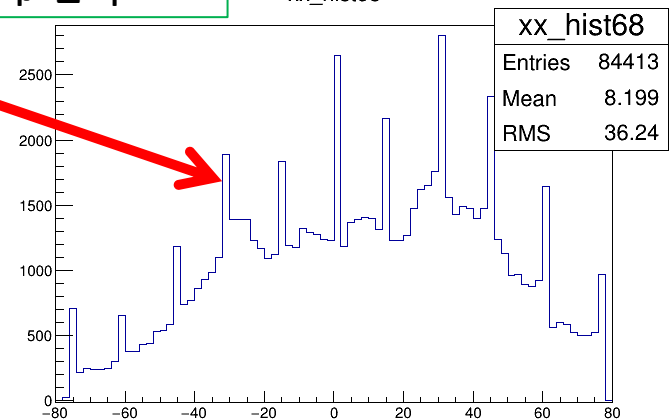
xx\_hist36



$$X_0 = \frac{\sum X_i}{\sum A_i}$$

$$D_x = \frac{\sum (X_i^2 - X_0^2) * A_i}{\sum A_i} = 0$$

xx\_hist68

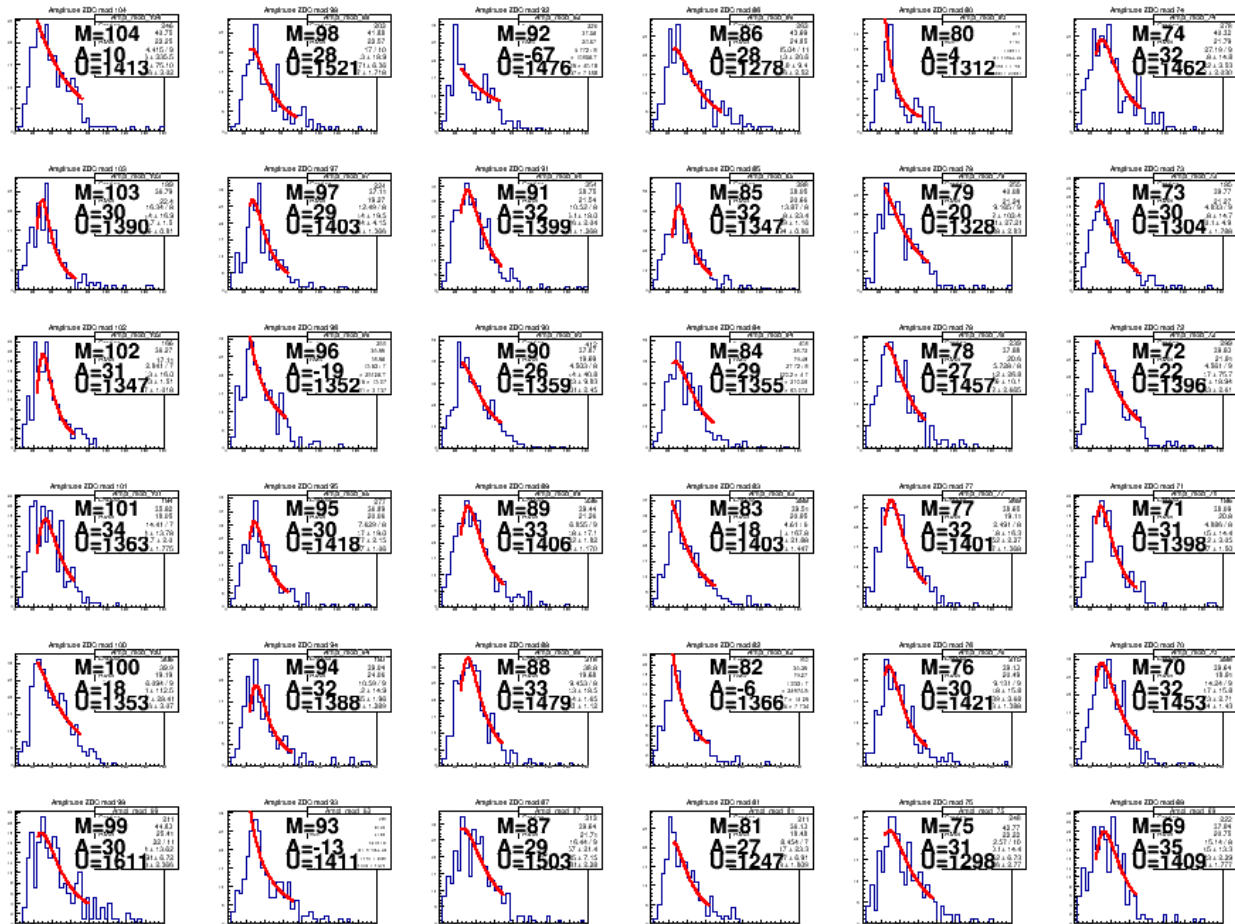


# Cosmic spectra for 68 outer cells

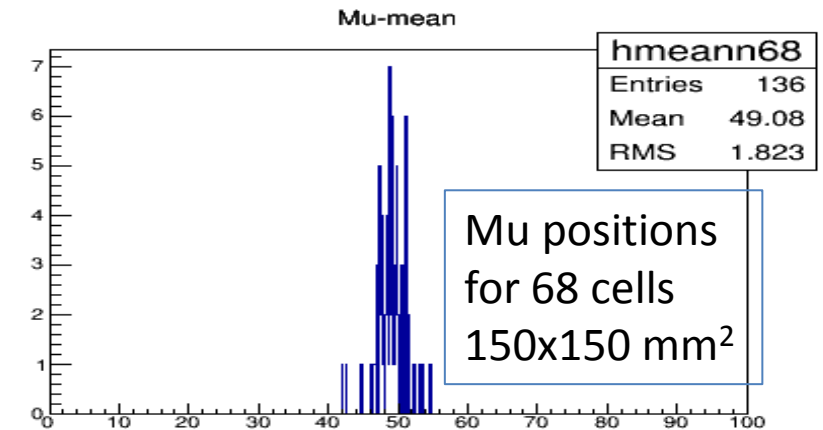
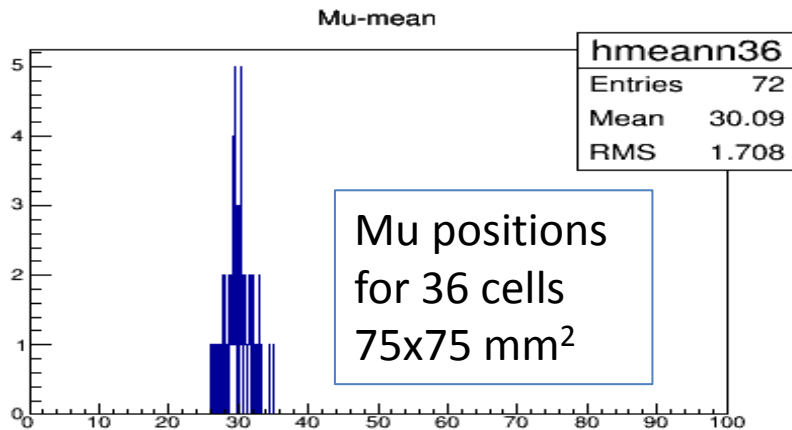
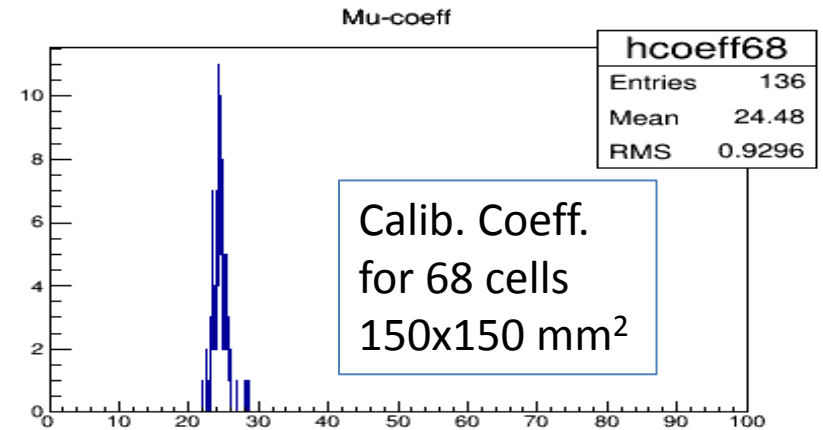
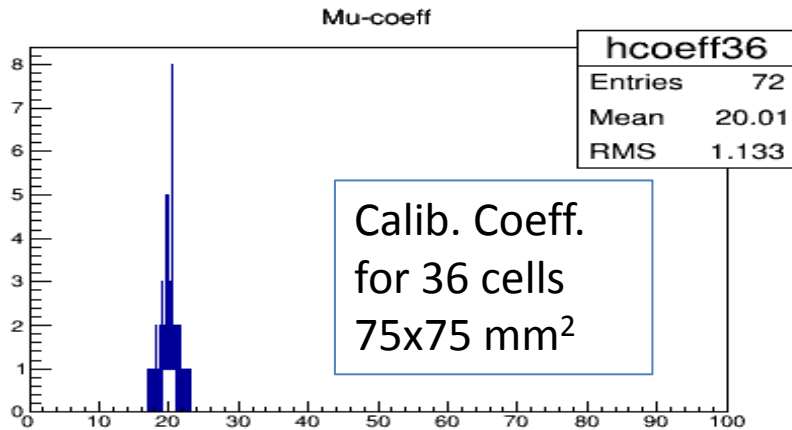




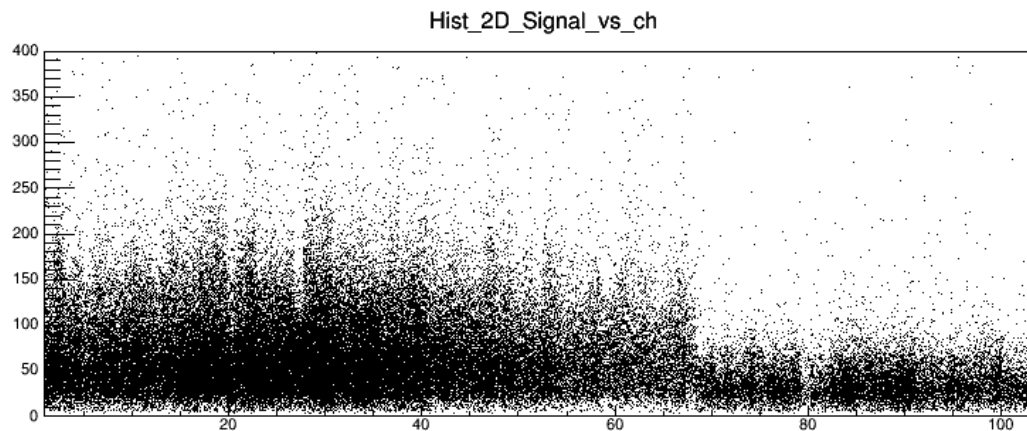
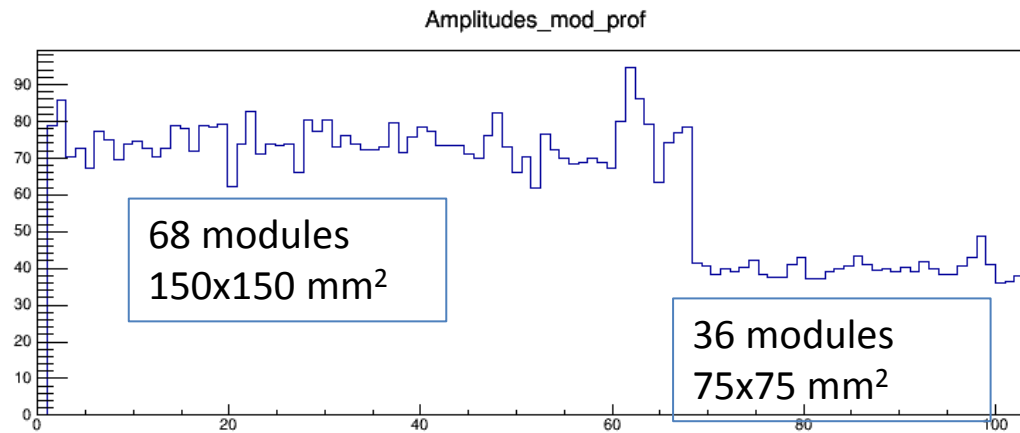
# Cosmic spectra for 36 inner cells



# Calibration coefficients: $k = \text{Const}[\text{MeV}] / \langle \text{Mu}[\text{Ch}] \rangle$

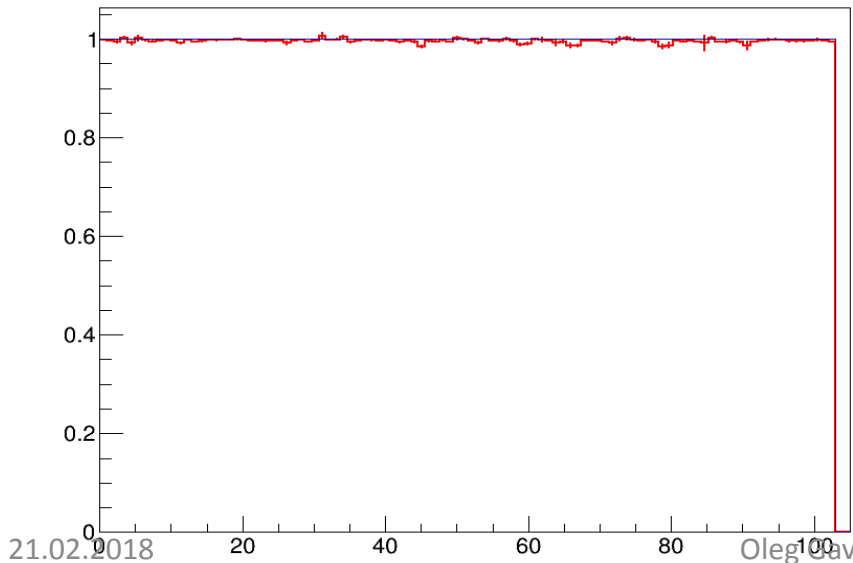
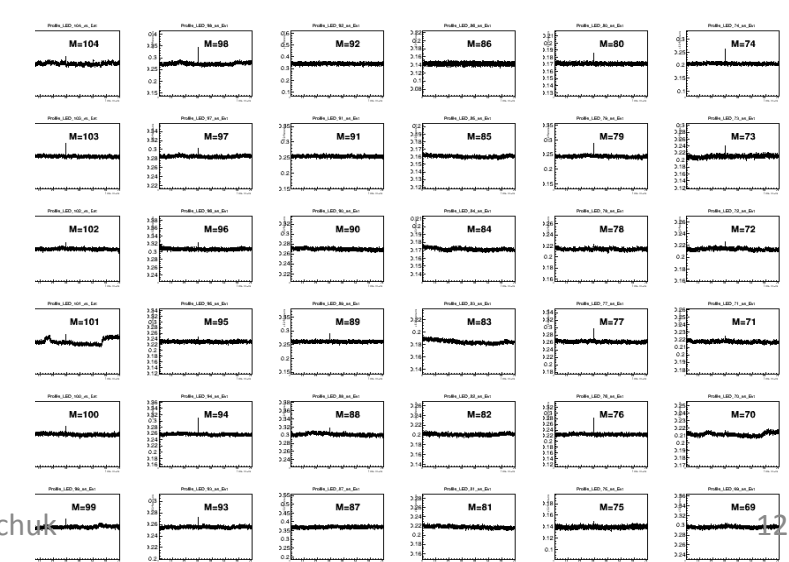


# Mu position for all ZDC cells



# LED monitoring: current/reference for all 104 ZDC cells during 1 week

LED\_Amp\_vs\_ch\_mpd\_run\_Glob\_1770



21.02.2018













Oleg Gavrishchuk

# 36 central(inner) cells 75x75 mm<sup>2</sup>



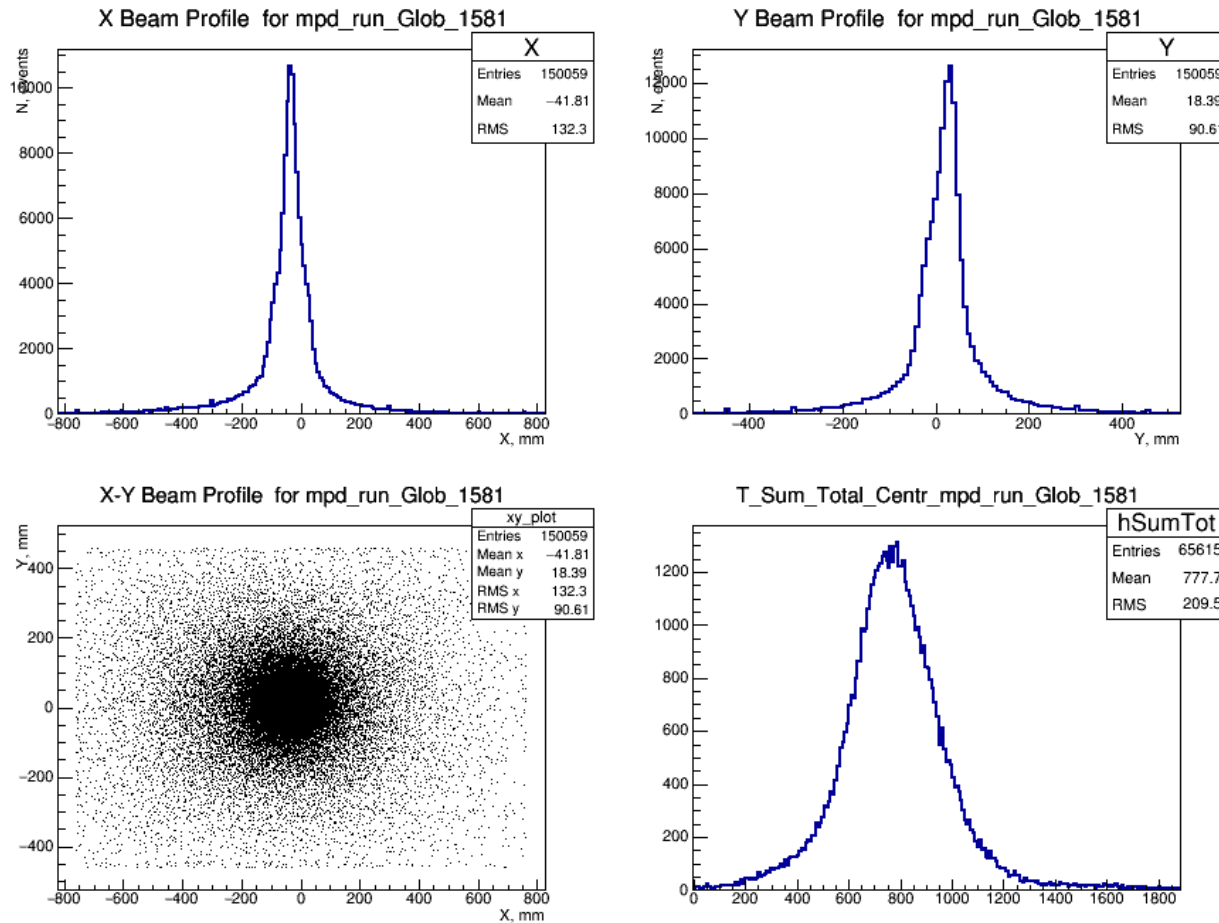


# ZDC modules numbering and scan's positions in carbon 4.5 GeV/N beam

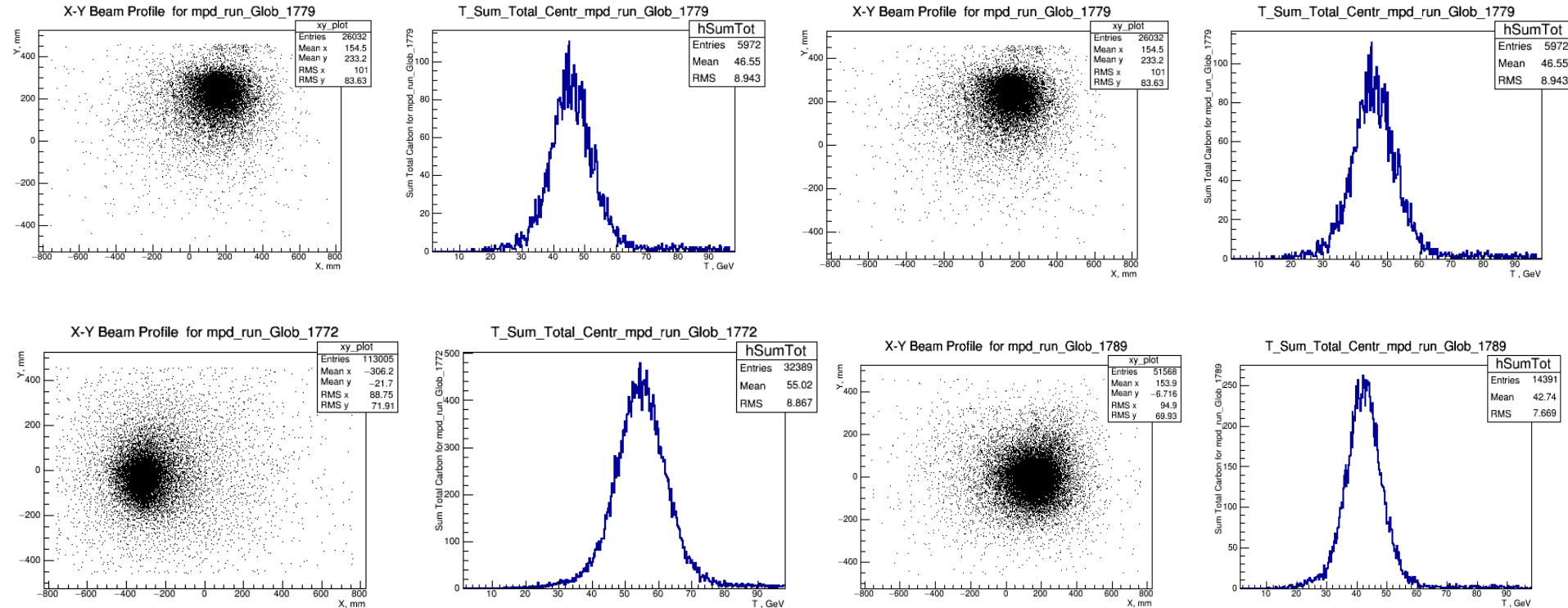
68	61	54	47	40	36	32	28	21	14	7			
67	60						27			6			
66	59	52	45	104	98	92	86	80	74	26	19	12	5
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21.02.2018 **ZDC layout:** central part consist of 36 modules with sizes  $7.5 \times 7.5 \text{ cm}^2$ , peripheral part contains 68 modules of  $15 \times 15 \text{ cm}^2$  Oleg Gavrishchuk 14

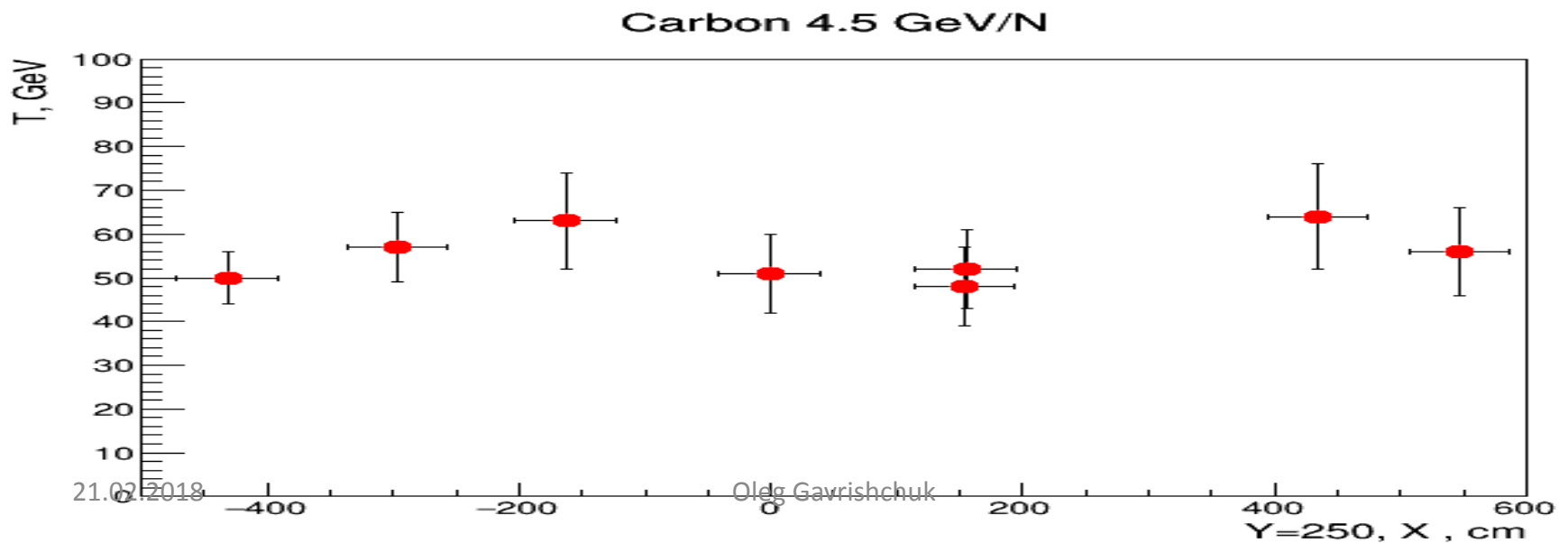
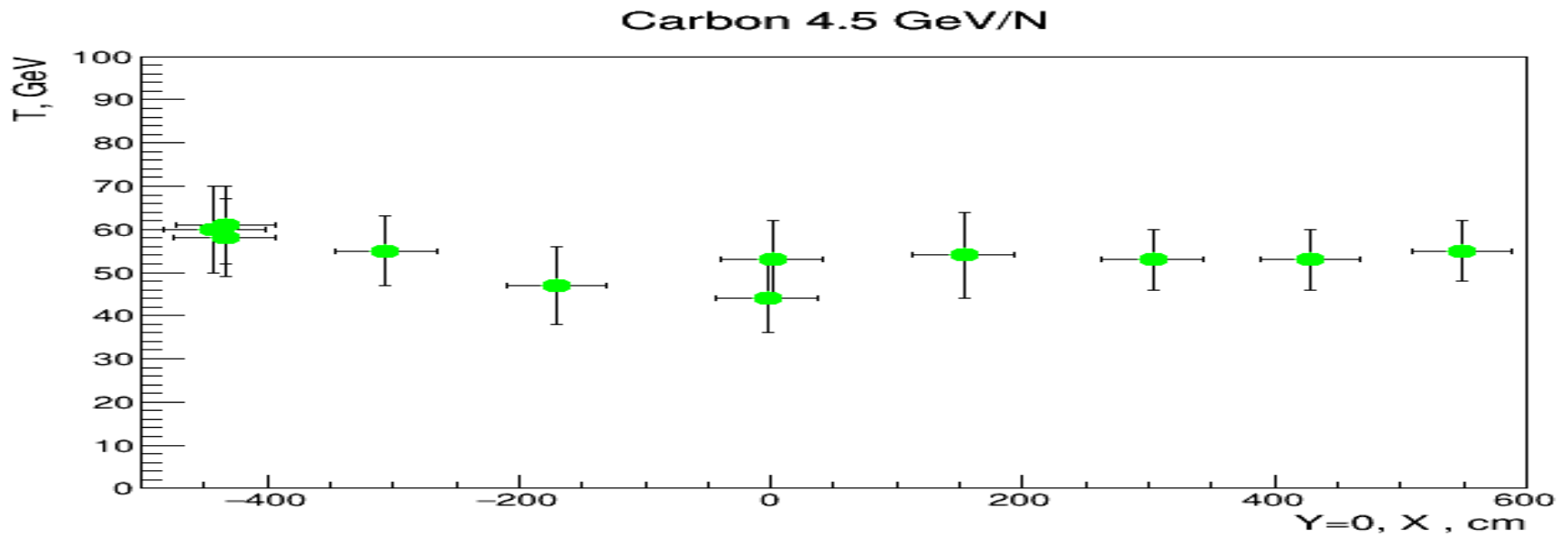
# X , Y Profiles, 2D profile , Carbon energy spectrum in certain ZDC position



# ZDC scan over X & Y (4 points from 20): 2D profiles and energy carbon spectra of 4.5 GeV/N in different X/Y beam positions

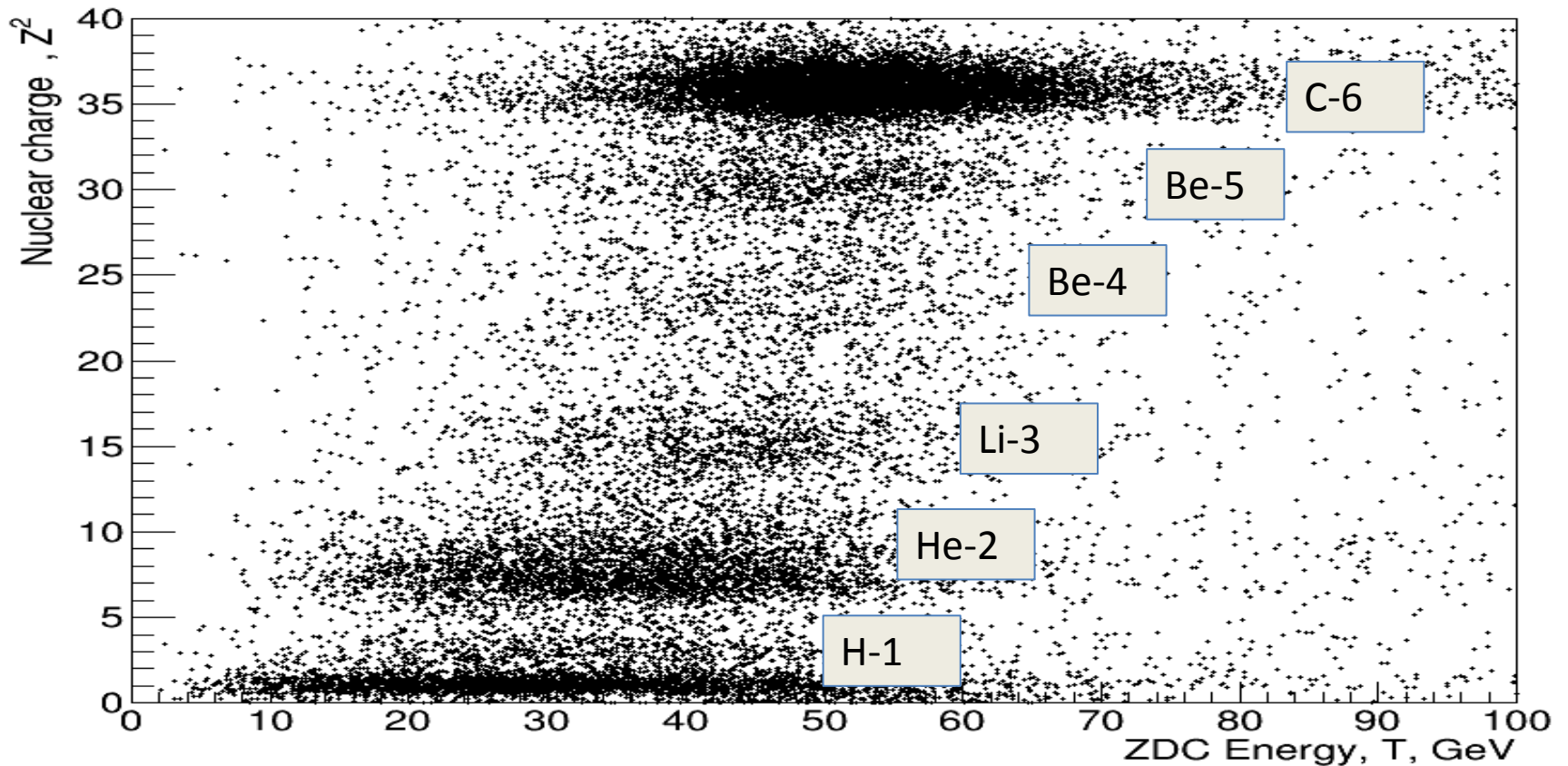


# Scan results with Carbon beam at $T=4.5$ GeV/N



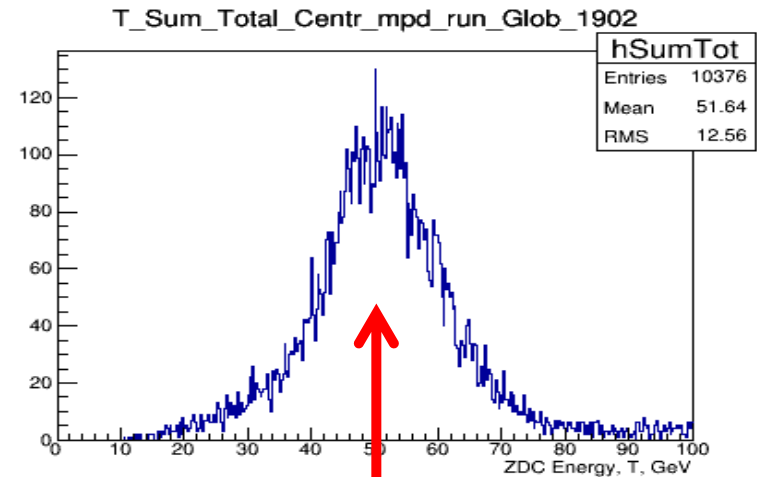
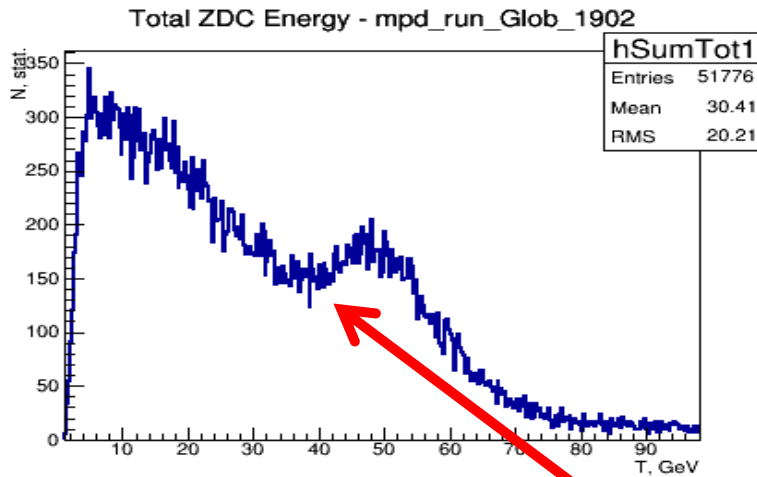
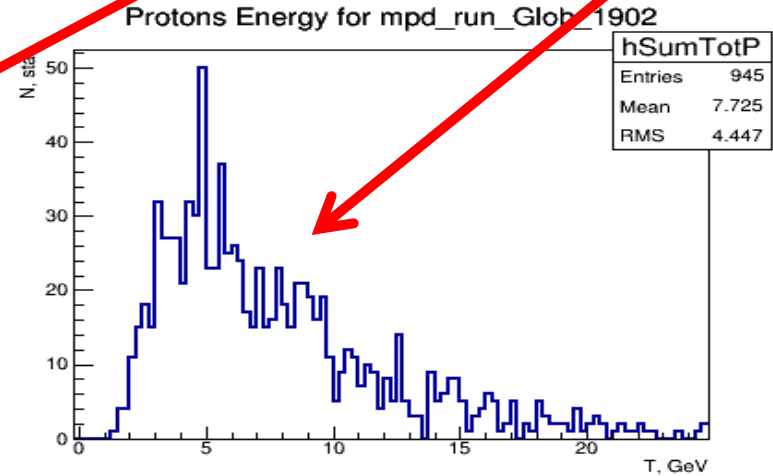
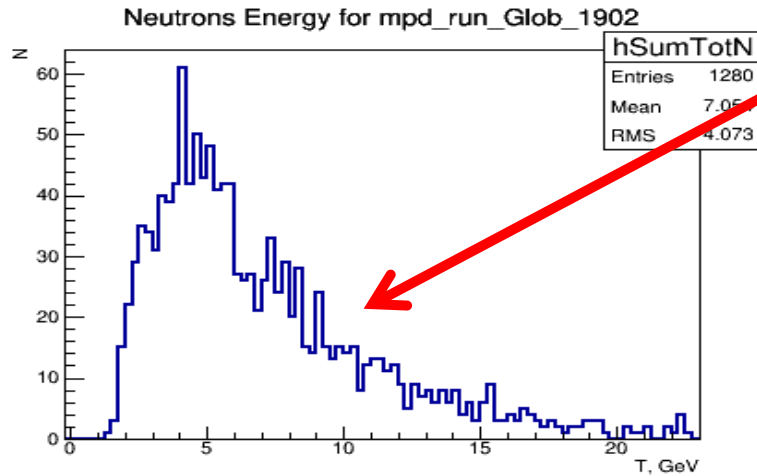
# 2D plots: ZDC Energy vs $Z^2$

Corr\_CUT\_SumTotal\_dEdX\_mpd\_run\_Glob\_1898





# Energy response in ZDC: Neutrons, Protons



Total energy

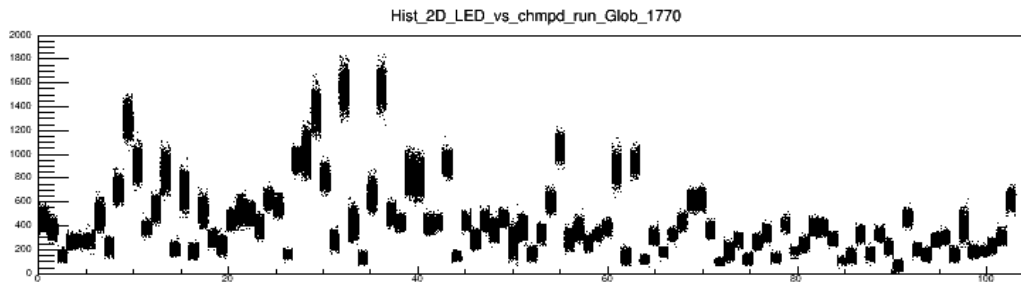
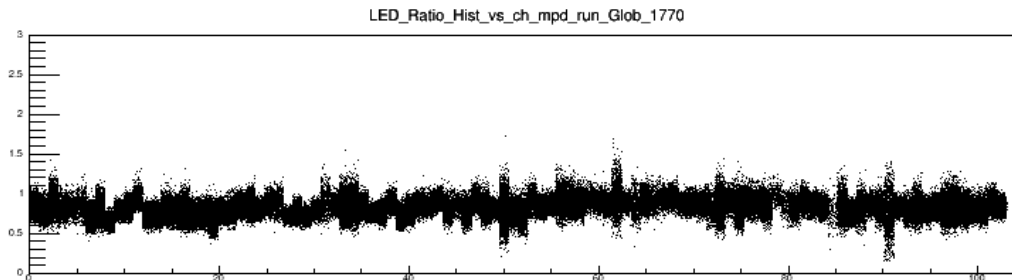
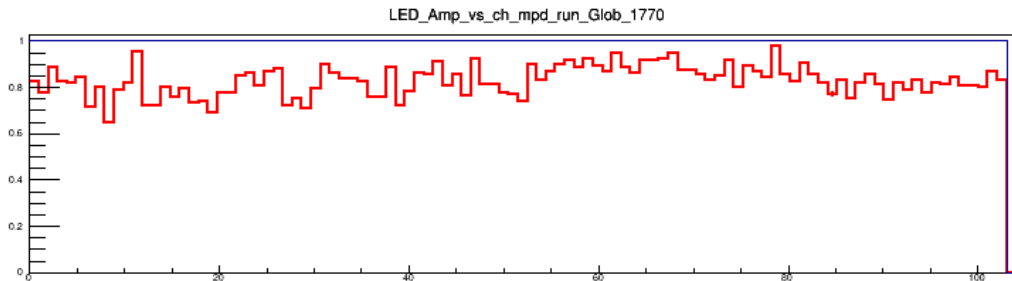
$^{12}\text{C}$

# Time estimation for ZDC calibration in Mart-April 2018 beam test

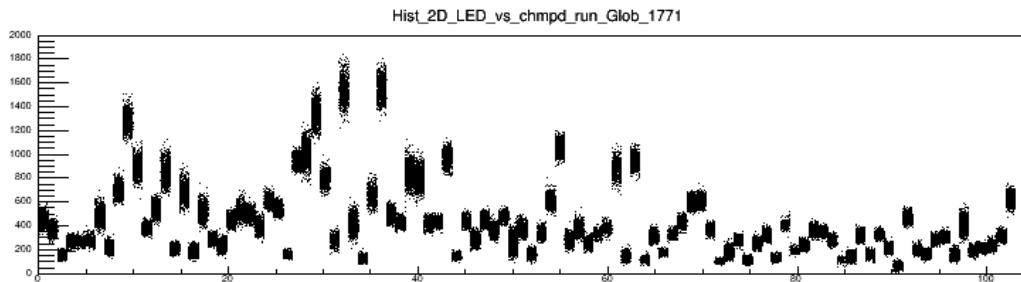
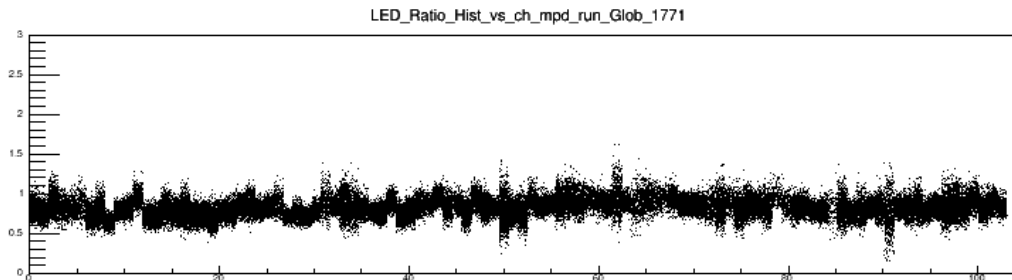
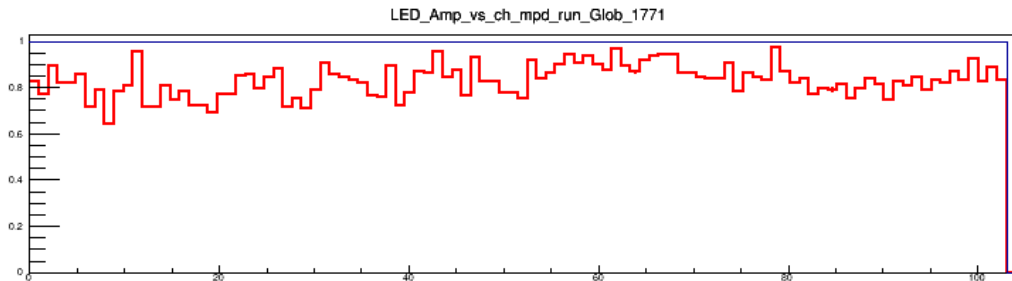
- ZDC calibration in carbon beam:
  - Scan over ZDC cannels – 30 points
  - 3 rows of 10 points
  - 10000 evets per point = 10-20 spills ~ 6 min/point
  - $30 * 6 = 180 \text{ min} \sim 3 \text{ h}$  (mx  $\frac{1}{2}$  shift)

**End of report**  
**Thanks for everybody!**

# LED monitoring

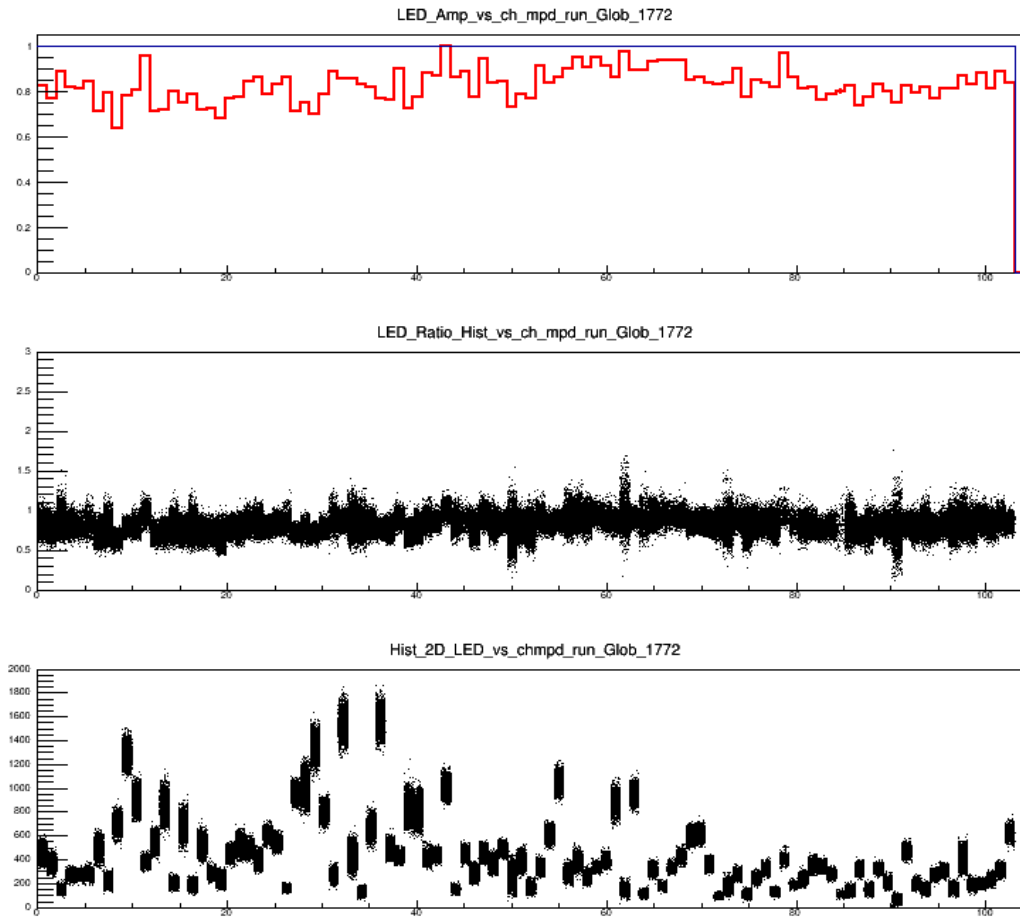


# LED monitoring





# LED monitoring



# LED monitoring

