14th Collaboration Meeting of the BM@N Experiment at NICA

V.I.Veksler and A.M.Baldin Laboratory of High Energy Physics, JINR, Мая 13 – 15, 2025

Status of baryon femtoscopy in Ar run

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for BM@N collaboration

Correlation function from experimental data of Ar run (TOF-700 identified)

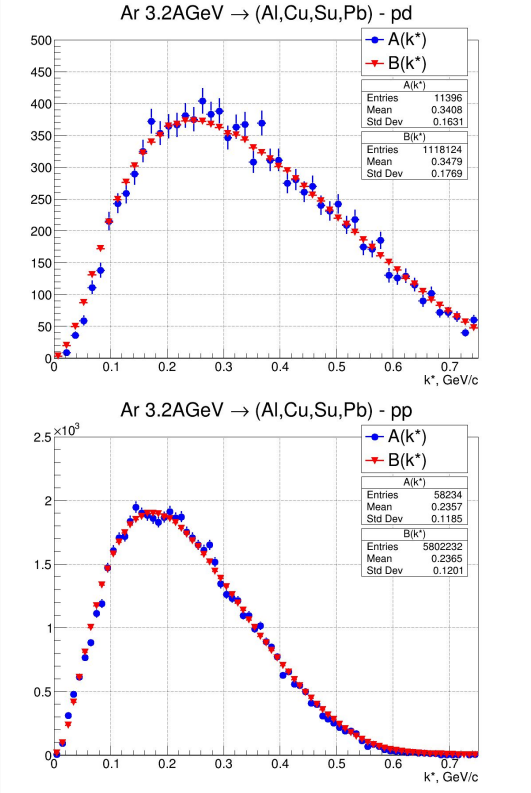
Correlation function calculated as:

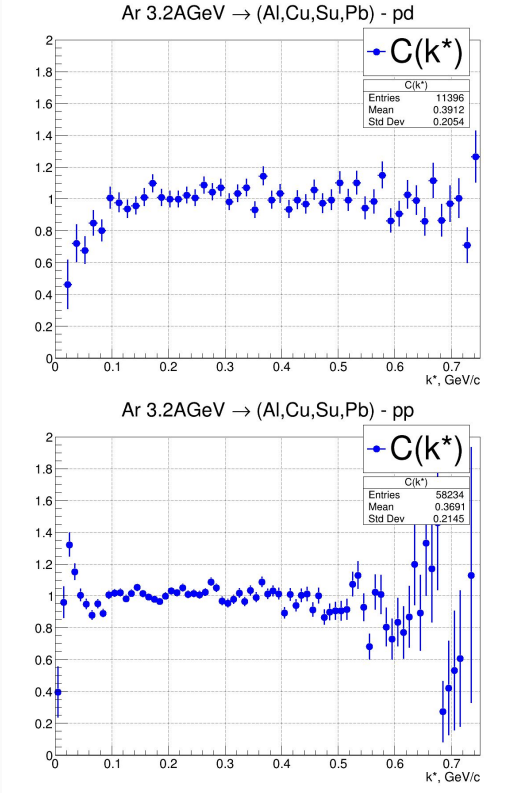
$$C(k^*) = \frac{A(k^*)}{B(k^*)}$$

$$k^* = \frac{1}{2} \cdot |\overrightarrow{p_1^*} - \overrightarrow{p_2^*}|$$

A - correlated pairs
B - uncorrelated (mixing)

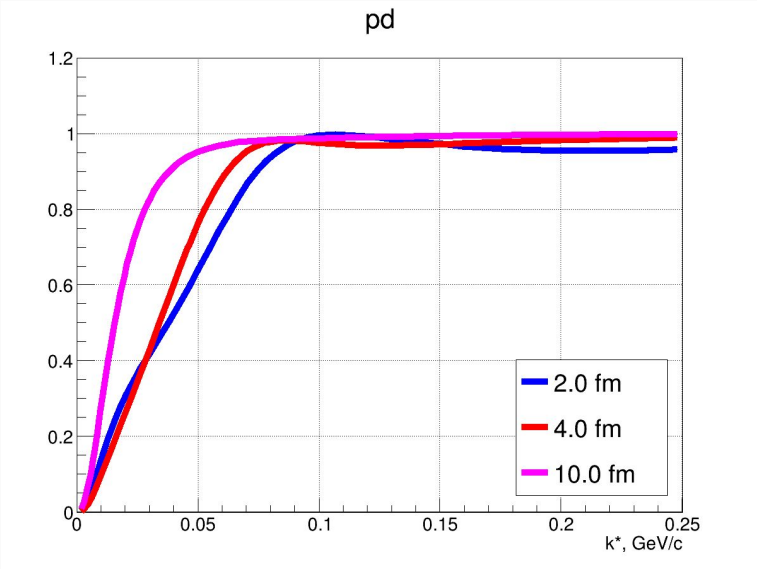
Rapidity: *0.5 < y ≤ 1.7*

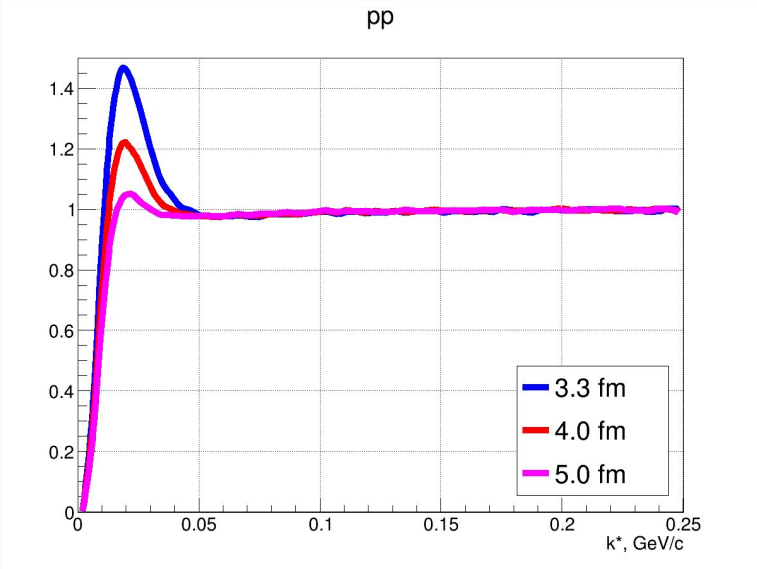




Aim: Determining effective radius of proton and deuteron sources

Calculated correlation functions:





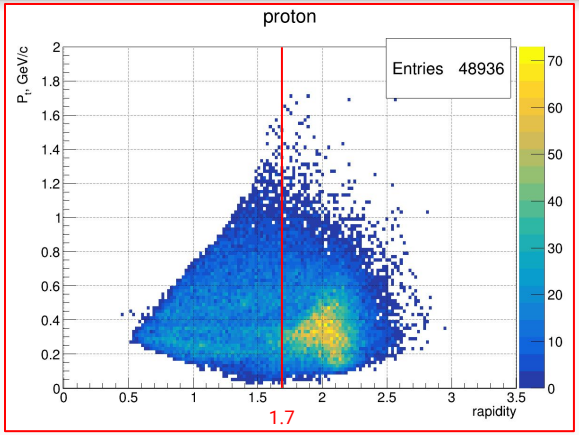
The FSI calculation assumes:

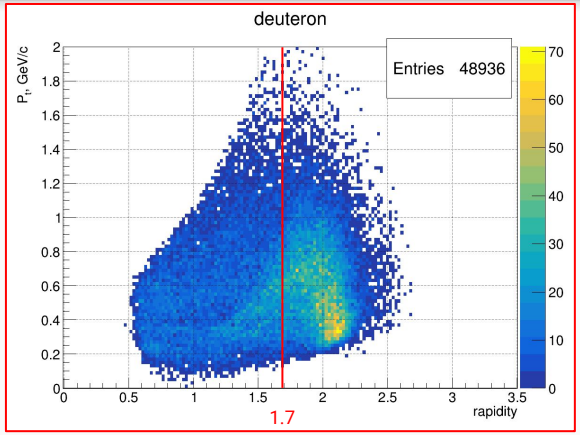
- a Gaussian r-distribution $\sim exp(-\frac{r^2}{4r_0^2})$ where $r^2 = (\overrightarrow{r})^2, \overrightarrow{r} = \overrightarrow{r_1} - \overrightarrow{r_2}$
- short-range FSI dominated by s-wave
- approximate account of the inner region of the short-range FSI potential (valid if r_0 is larger than the effective potential radius)

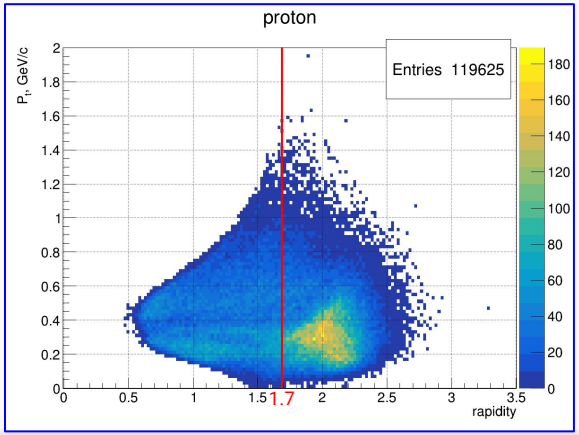
Ar 3.2AGeV → (Cu,Ar,Sn,Pb) Experimental data & Monte Carlo simulation

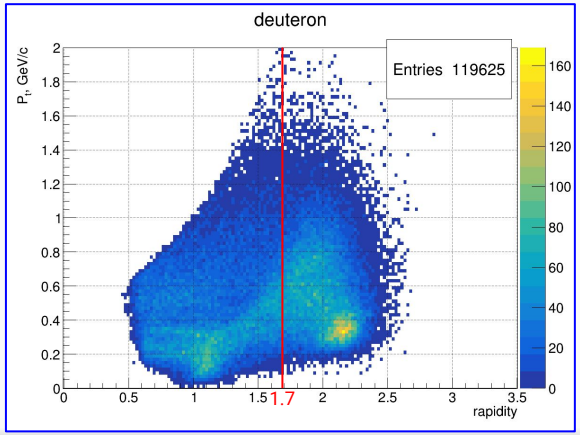
Experimental data

DCMSMM GEANT4 MC



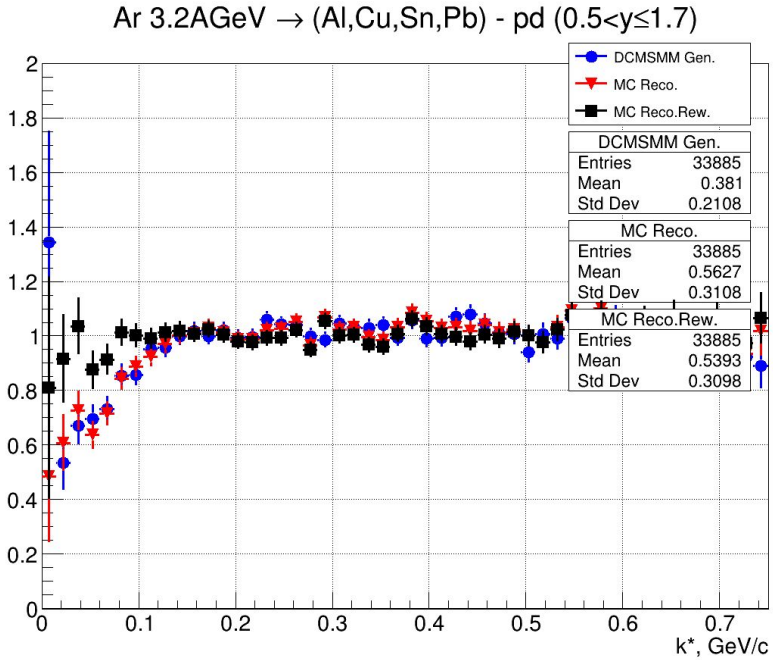


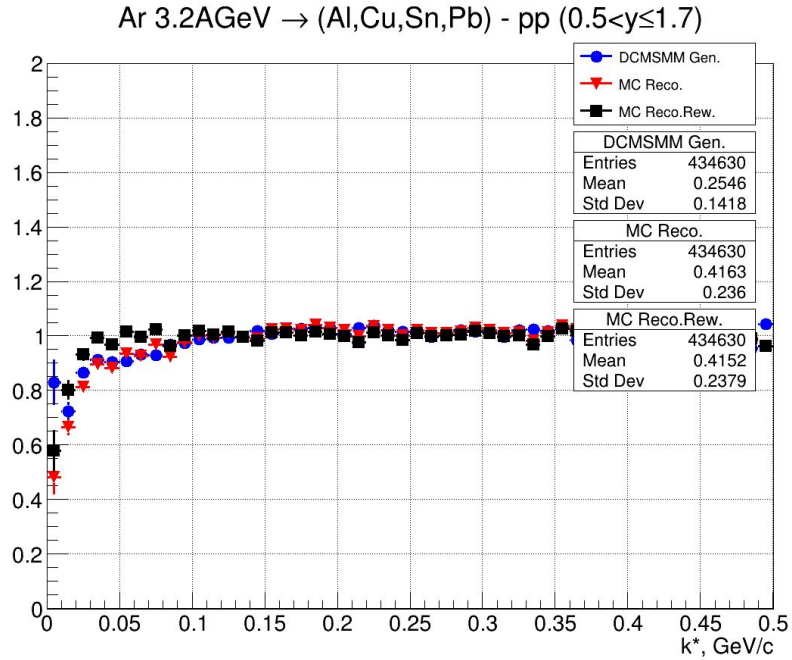




Rapidity:
$0.5 < y \leq 1.7$

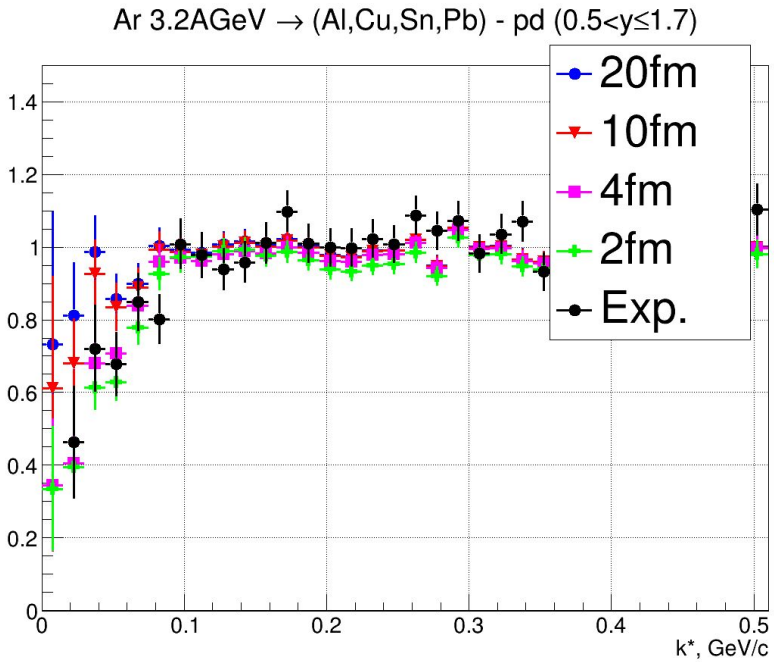
Correlation function from MC

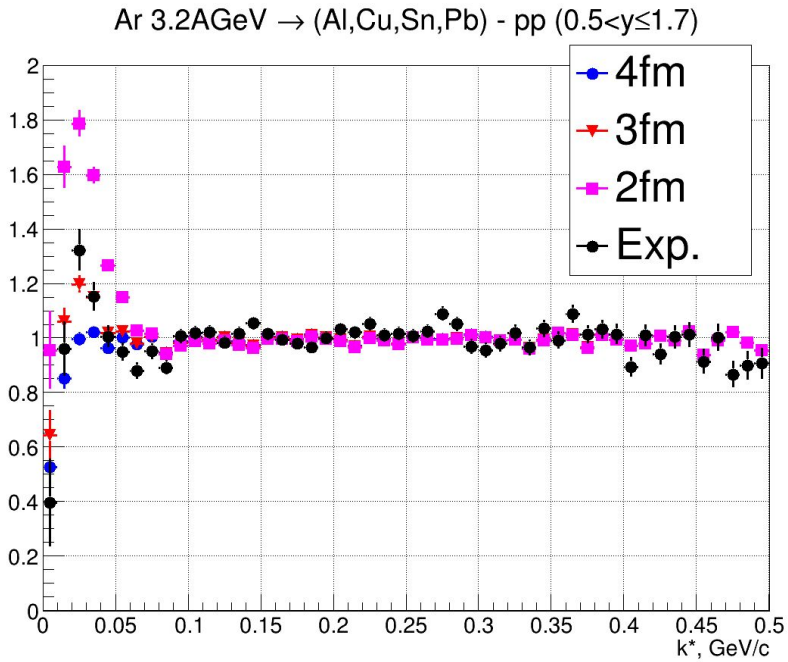




- DCMSMM Gen. - Generator's itself correlation function (obtained from MCTrack) - k^*_{GEN}
- MC Reco. - Correlation function from identified particles in reconstructed MC events - k^*
- MC Reco. Rew. - Reweighted correlation function (transfer function of the detector) - $w_{GEN} = C^{-1}(k^*_{GEN})$

Correlation function

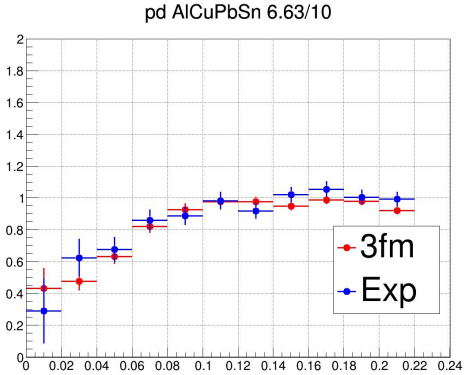


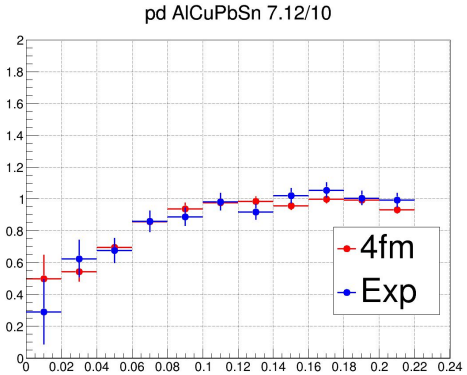


$$C(k^*) = A(k^*, w_{GEN} w_{FSI}) / B(k^*)$$

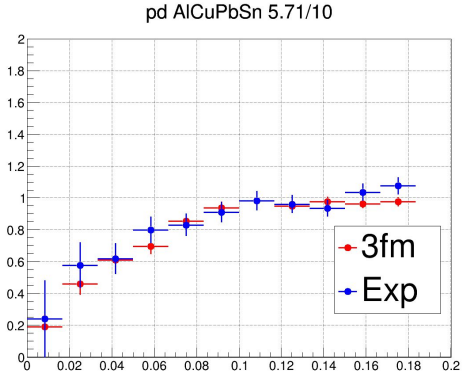
χ^2-test pd Ar → Al,Cu,Sn,Pb

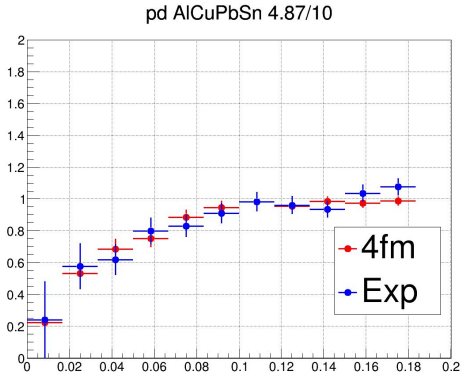
0.5 GeV/c 25 bin



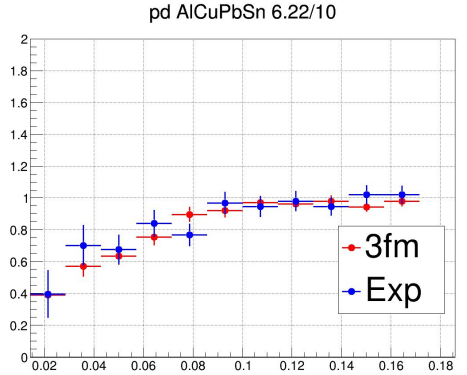


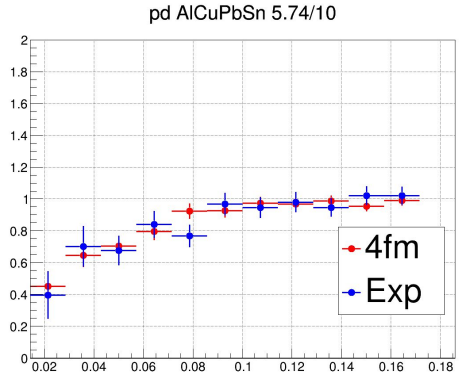
0.5 GeV/c 30 bin





0.5 GeV/c 35 bin

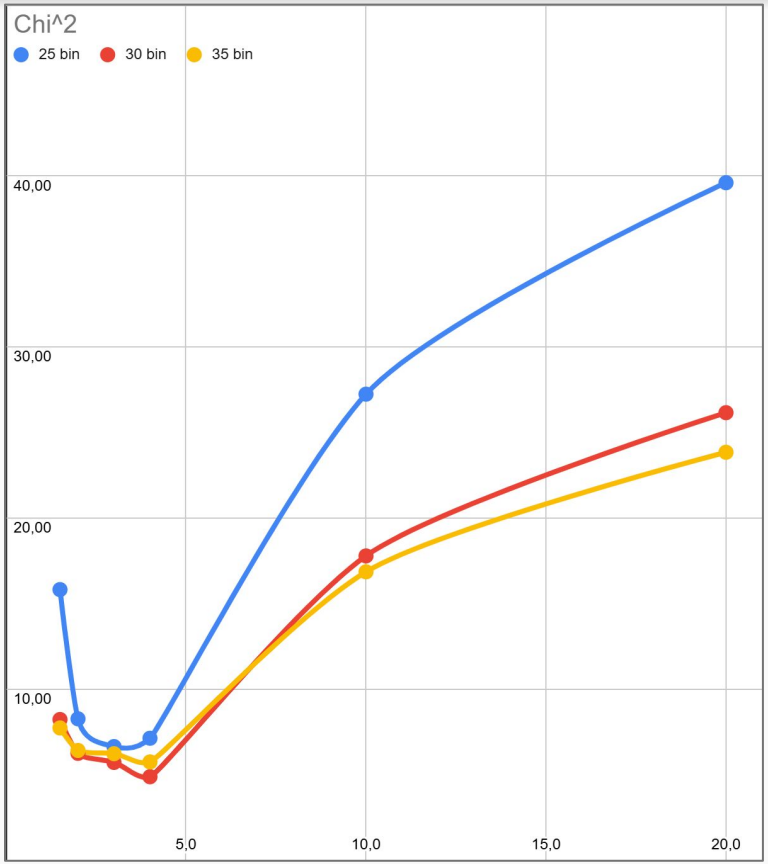




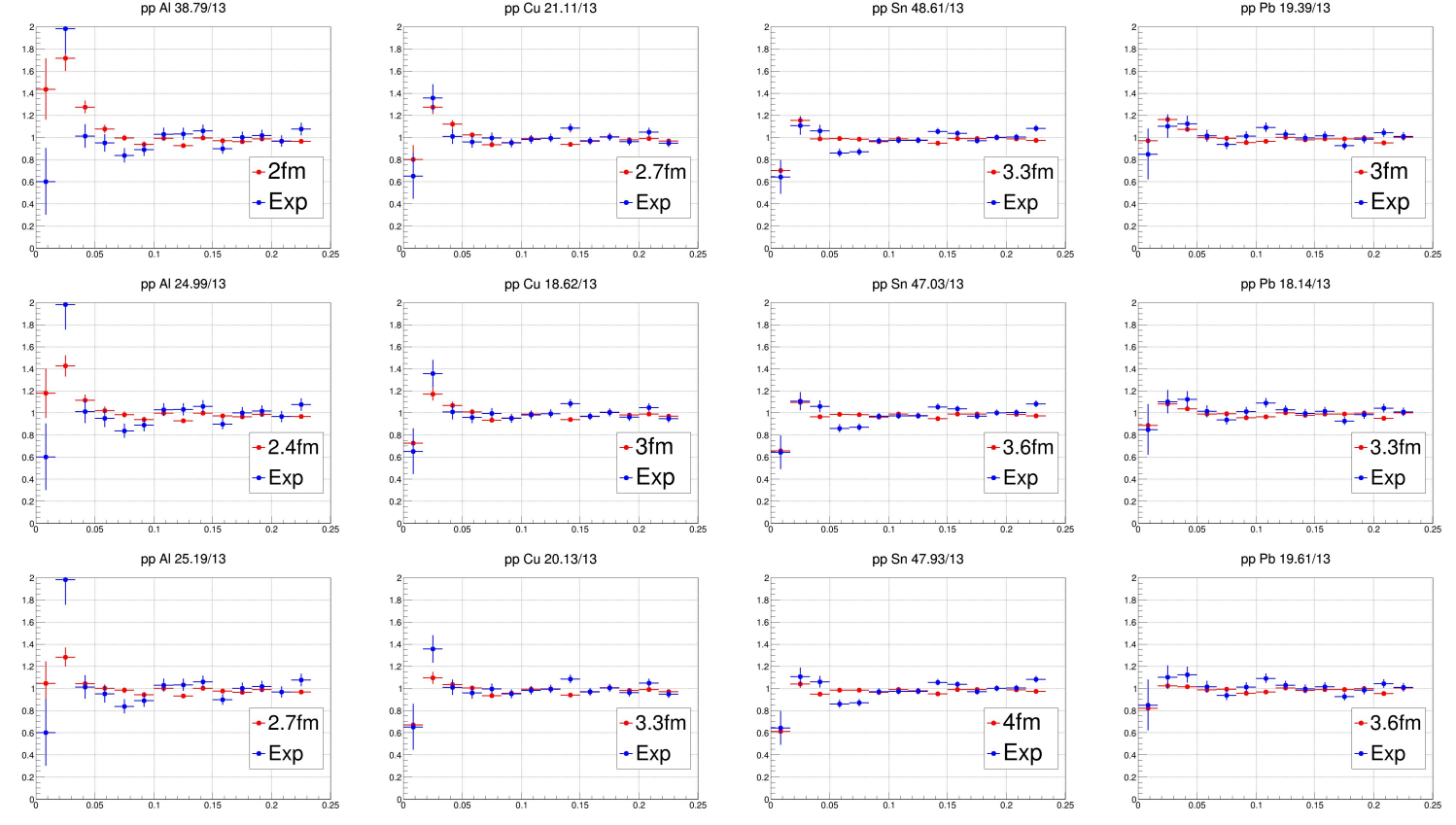
χ^2-test pd Ar → Al,Cu,Sn,Pb

χ^2

	0 - 500 MeV/c		
Ro, fm	25 bin	30 bin	35 bin
1,5	15,81	8,21	7,72
2,0	8,26	6,24	6,41
3,0	**6,63**	5,71	6,22
4,0	7,12	**4,87**	**5,74**
10,0	27,24	17,78	16,85
20,0	39,61	26,16	23,84
NDF	10	10	10
bins	1..11	1..11	2..12



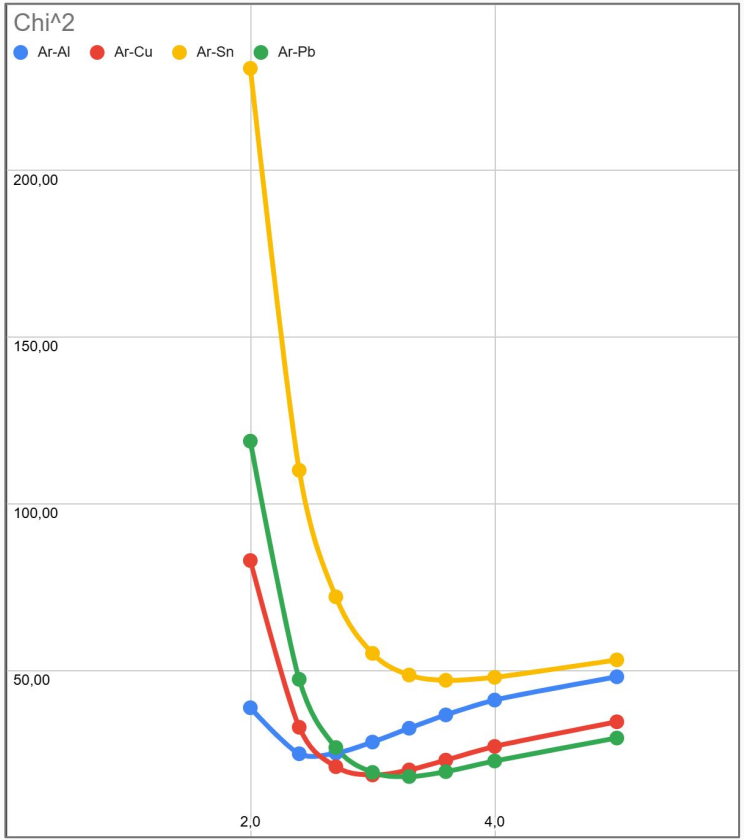
χ^2-test pp Ar→Al, Ar→Cu, Ar→Sn, Ar→Pb



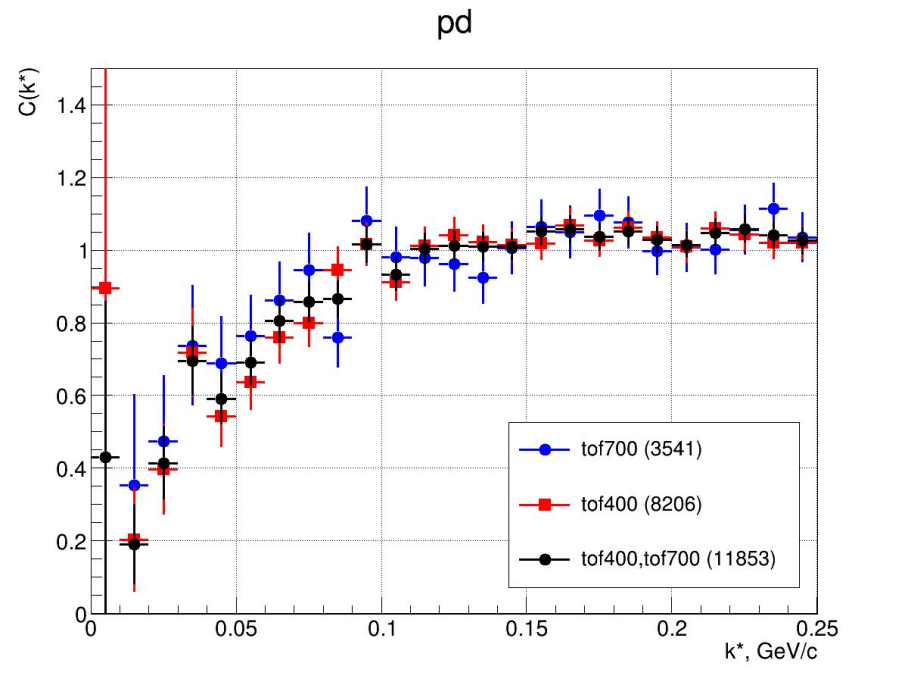
χ^2-test pp Ar→Al, Ar→Cu, Ar→Sn, Ar→Pb

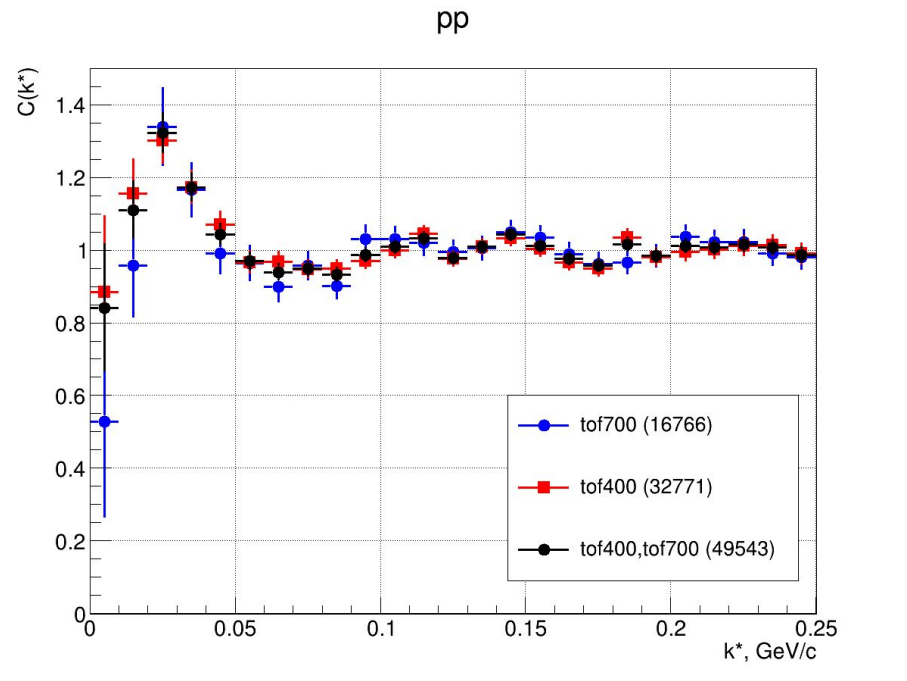
χ^2

r, fm	NDF	Ar-Al	Ar-Cu	Ar-Sn	Ar-Pb
2,0	13	38,79	82,98	230,69	118,79
2,4	13	**24,99**	32,93	110,06	47,32
2,7	13	25,19	21,11	72,08	26,84
3,0	13	28,49	**18,62**	55,11	19,39
3,3	13	32,64	20,13	48,61	**18,14**
3,6	13	36,64	23,08	**47,03**	19,61
4,0	13	41,11	27,18	47,93	22,81
5,0	13	48,09	34,58	53,15	29,70



Correlation function from TOF-700 & TOF-400 data





Further steps

- Get common dst with TOF-400 and TOF-700 identified data
- Obtain appropriate MC with identification from both TOFs
- Determine r_0 from p-p and p-d correlations on full set of Ar-run data
- Analyse p-d and p-p on Xe-run data
- Go to other particles species

Thank you for attention!

Radii

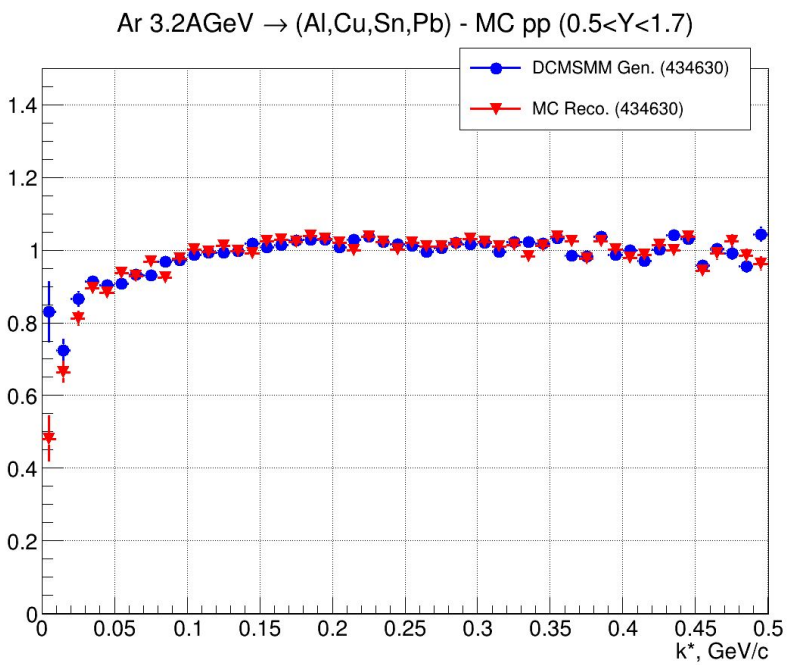
	A	A^1/3	$R^{d}_{coal}(pT = 0)$, fm*
Ar	**40**	**3,4**	
Al	27	3,0	2.7 ± 0.3
Cu	63	4,0	2.5 ± 0.2
Sn	120	4,9	2.8 ± 0.2
Pb	208	5,9	3.1 ± 0.2

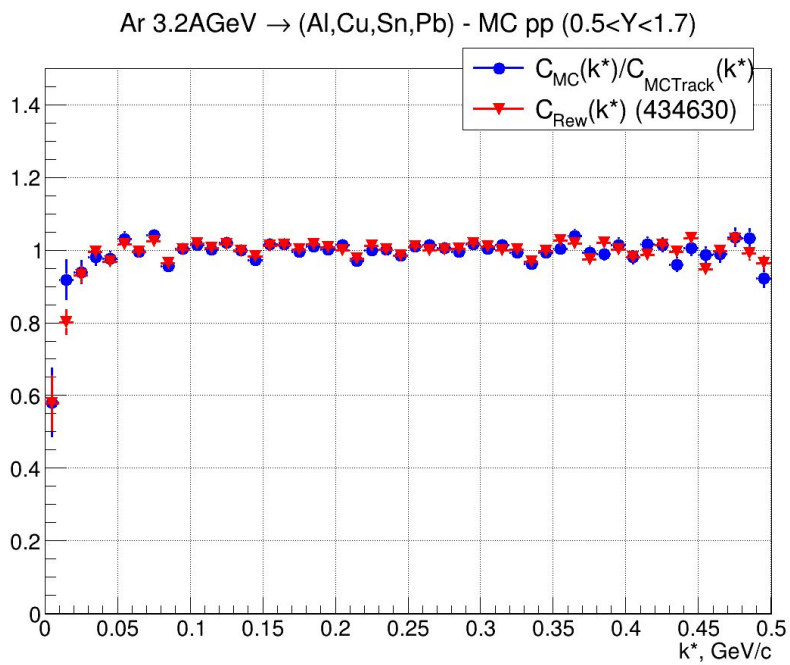
p-p

- 2.4
- 3.0
- 3.6
- 3.3

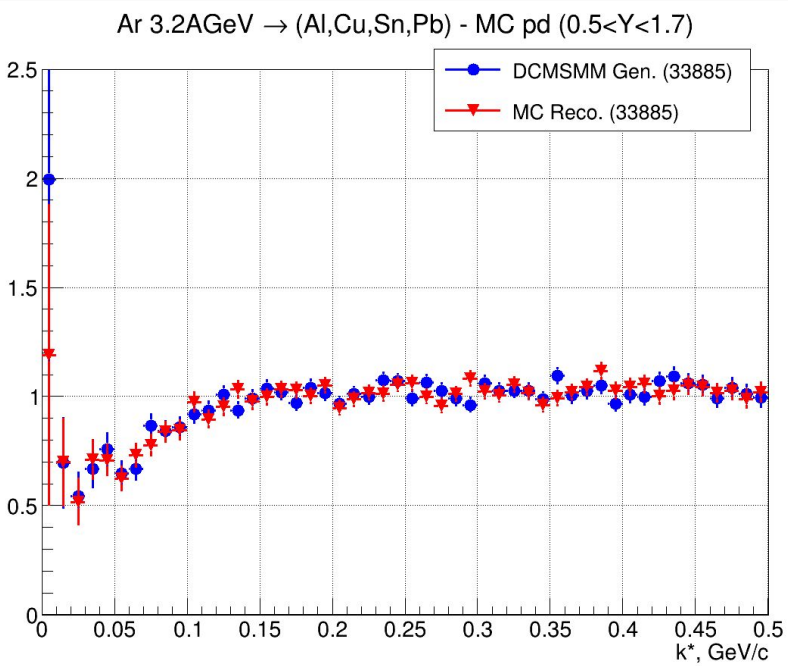
* Production of protons, deuterons and tritons in 2 argon-nucleus interactions at 3.2A GeV (draft)

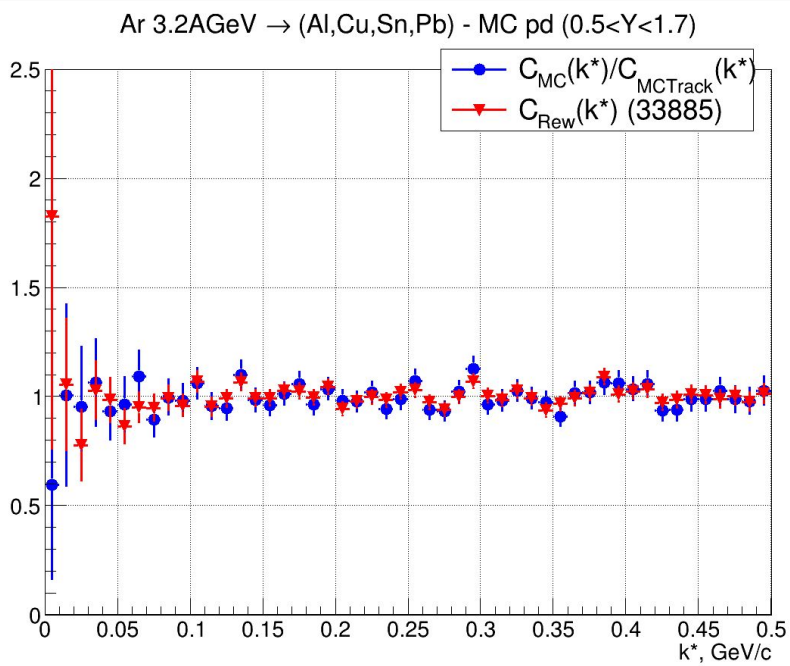
DCMSMM Ar 3.2AGeV - Reweighting with Gen. C(k*)



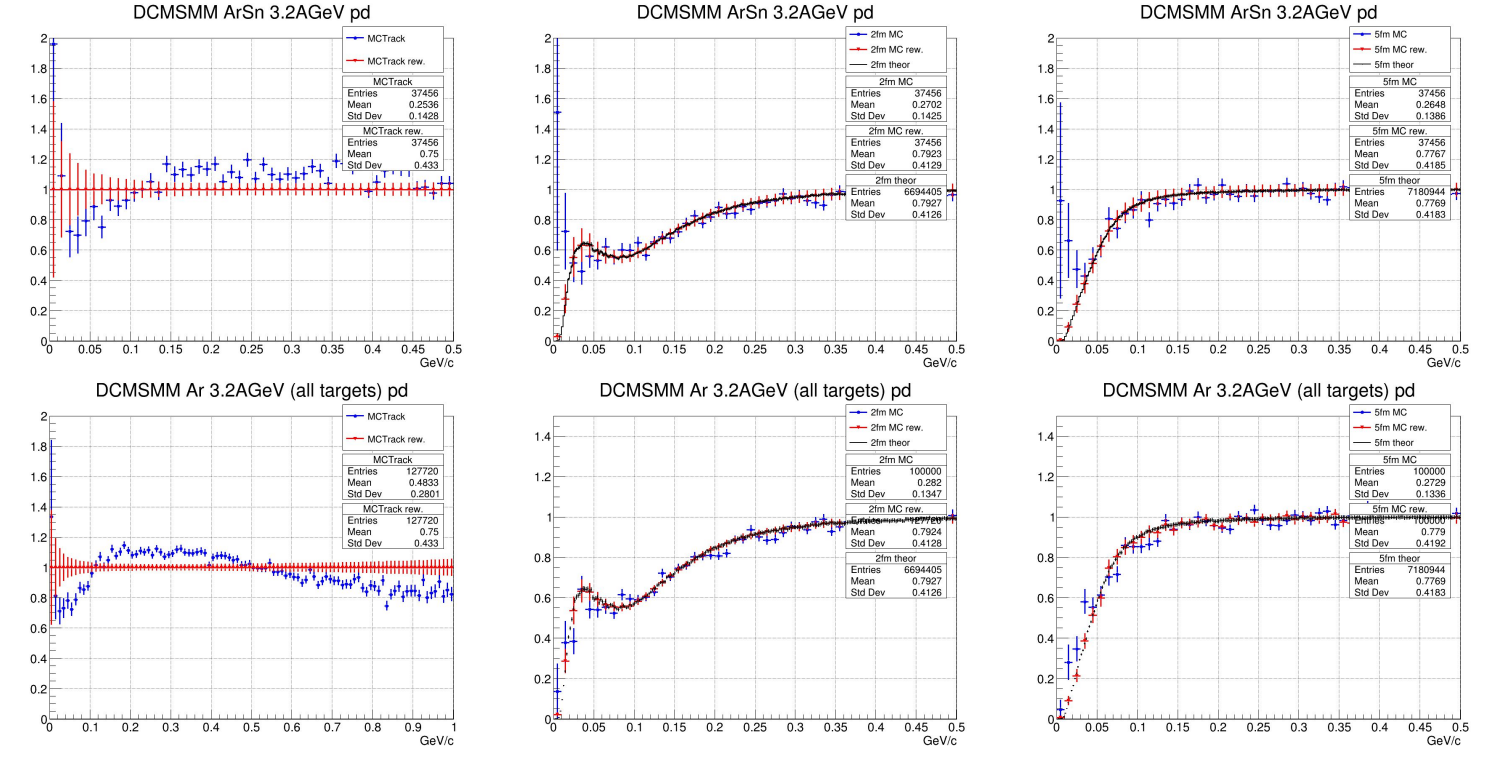


DCMSMM Ar 3.2AGeV - Reweighting with Gen. C(k*)

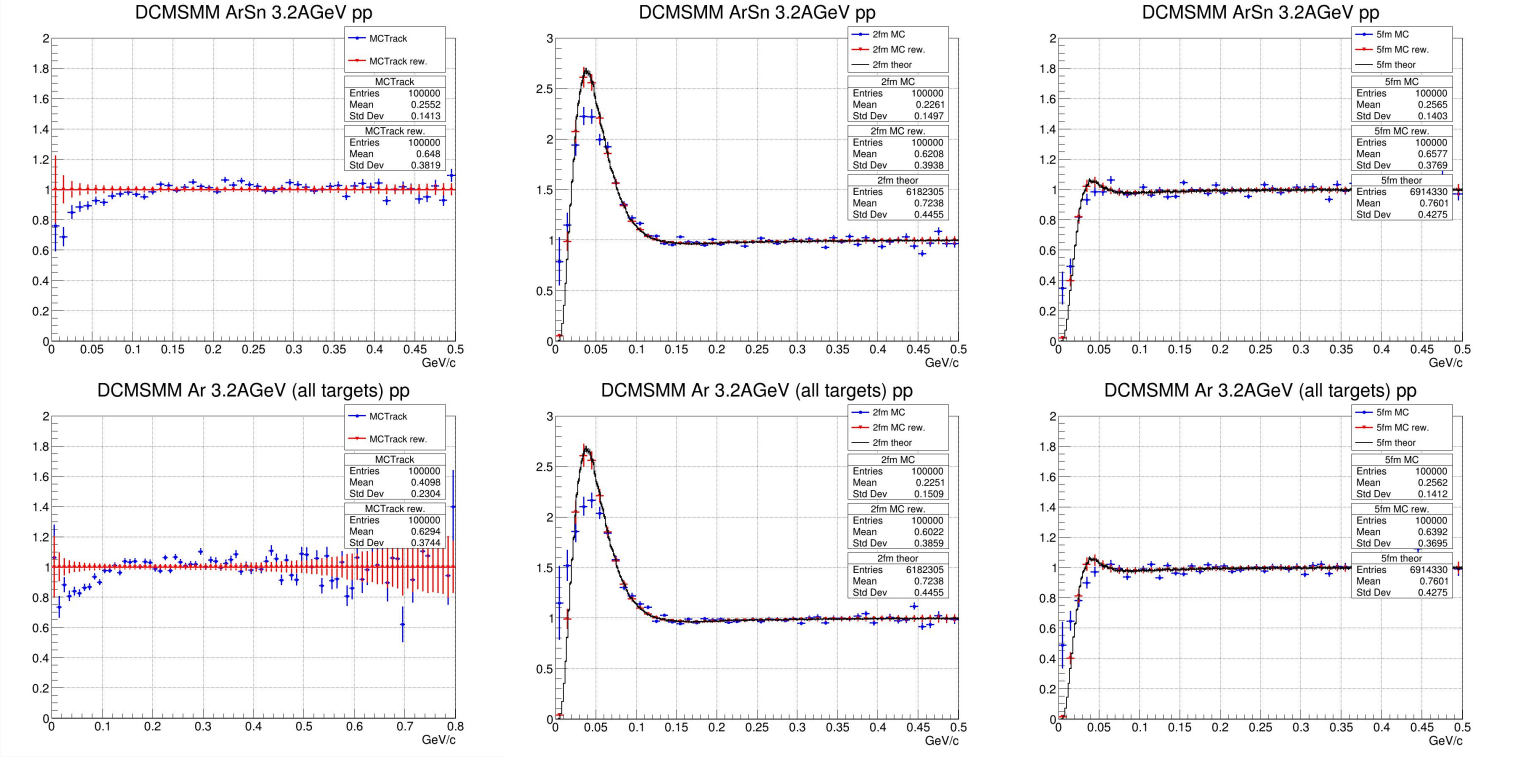




DCMSMM Ar 3.2AGeV - Reweighting with Gen. C(k*)



DCMSMM Ar 3.2AGeV - Reweighting with Gen. C(k*)



TOF-700 & TOF-400