



SPD meeting,
2 December 2020

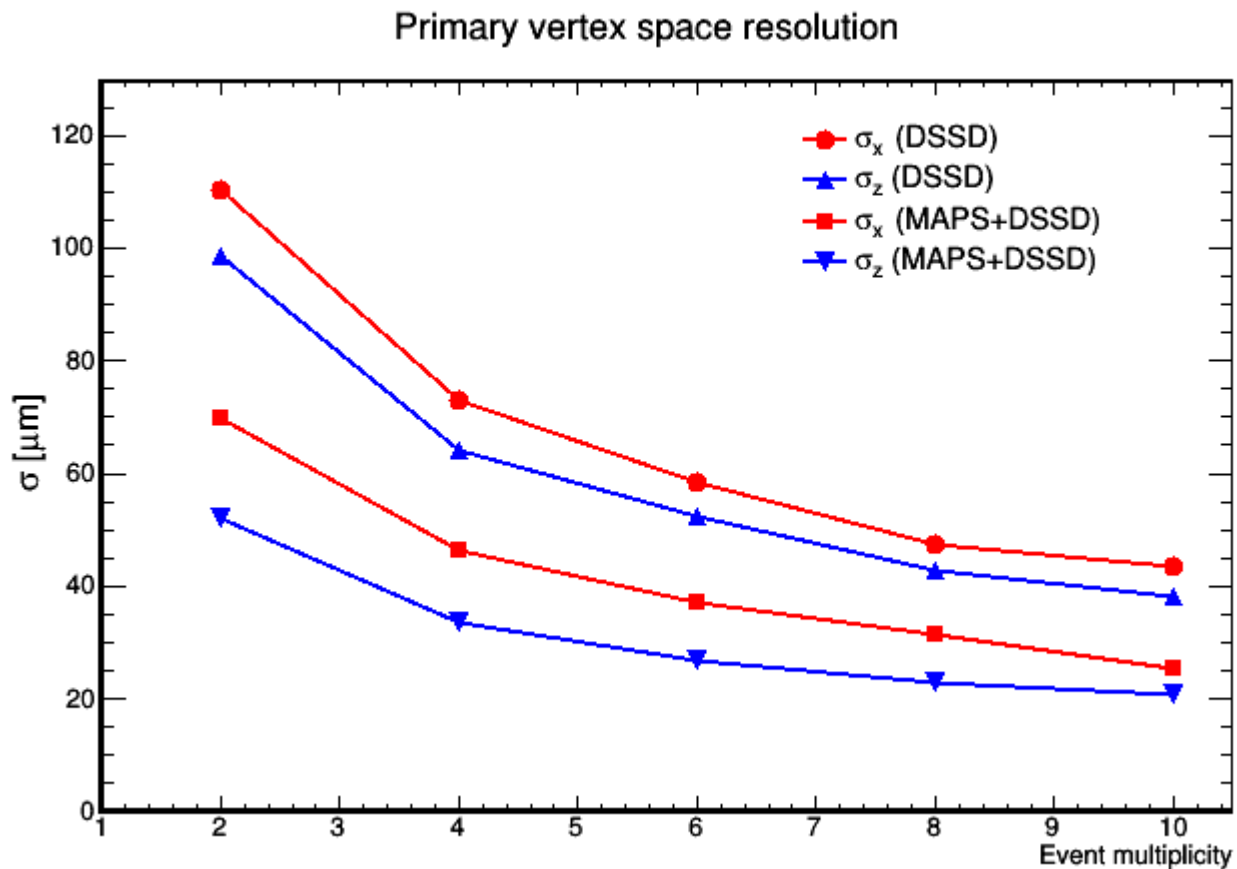
Vertex and short-lived particles
reconstruction in SPD experiment

V. Andreev

Vertex detector (option)

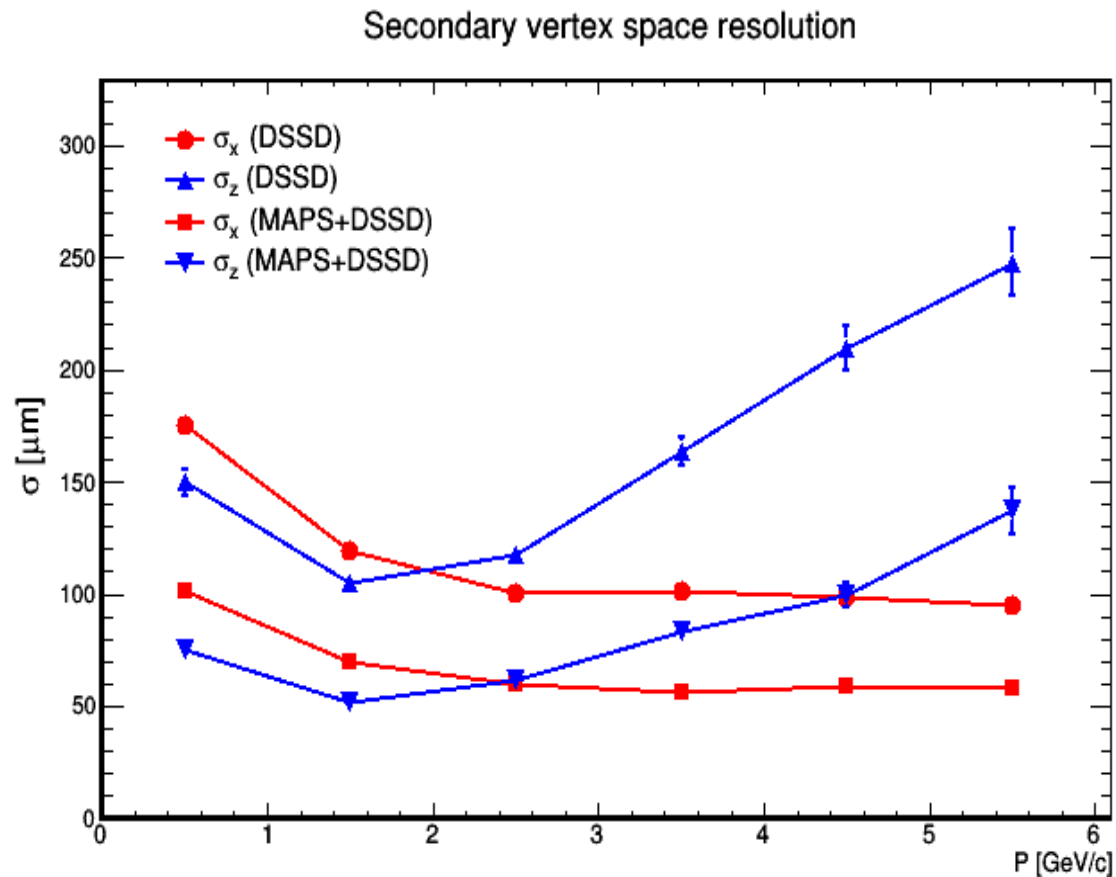
1. different configuration of silicon vertex detector in SPDRoot simulation
2. DSSD (c.t. = 300 mkm, 5 layers) => option = v0;
3. DSSD (c.t. = 50 mkm, 5 layers) => option = v1;
4. MAPS (c.t. = 50 mkm, 5 layers) => option = v2;
5. MAPS (c.t. = 50 mkm, 1,2,3 layers) + DSSD (c.t. = 300 mkm, 4,5 - layers) => option=v3;
6. Errors
MAPS: $u = v = 4$ mkm (effective)
DSSD: $u(z) = 23$ mkm, $v(x) = 11$ mkm (effective)

Primary vertex (vtx+straw)



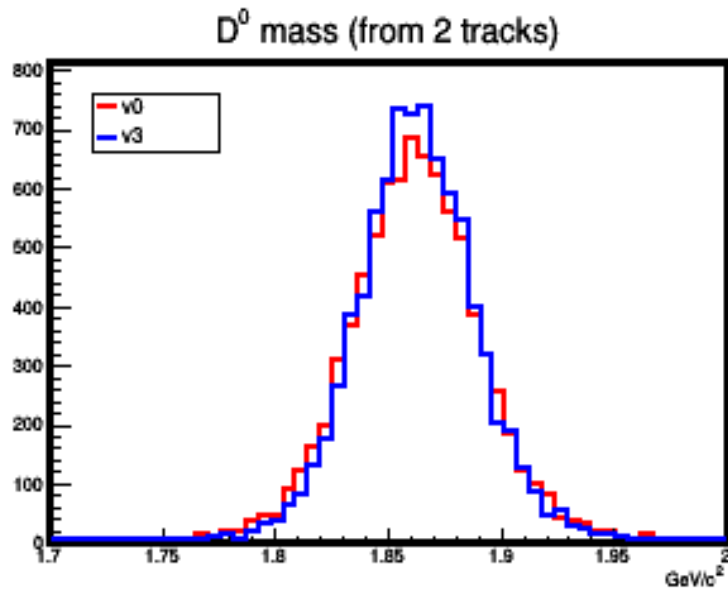
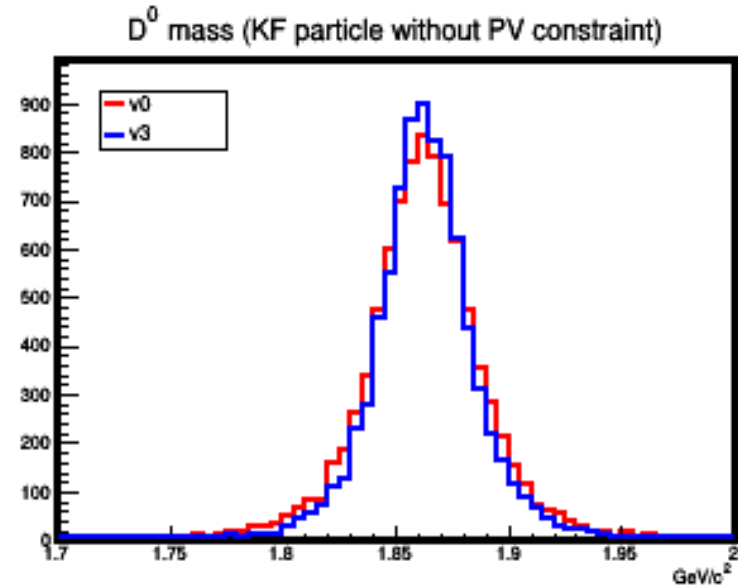
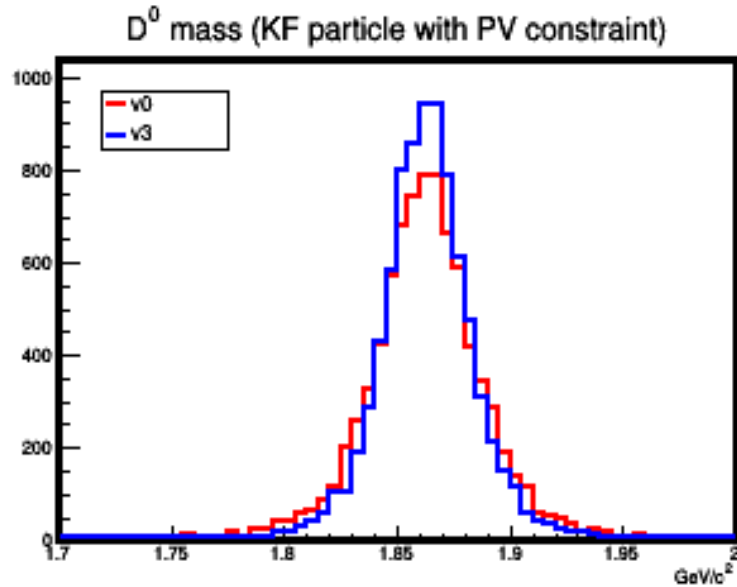
It were simulated samples with 2, 4, 6, 8 and 10 muons ($\mu^+ \mu^-$) and reconstruct primary vertex (PV) using only muons

D⁰ in Pythia6 (vtx+straw)



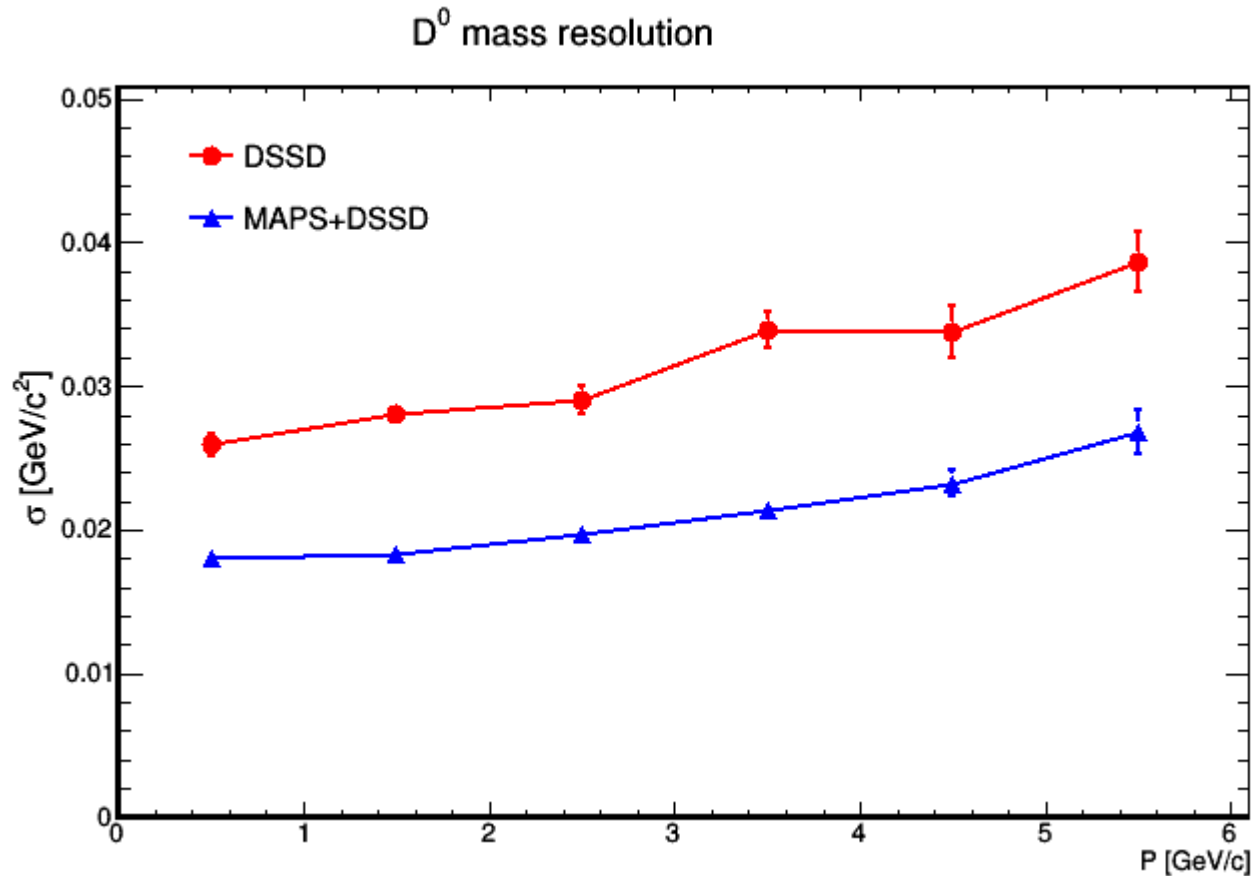
Simulated 10 muon (5 μ^+ and 5 μ^-) and add D⁰ from Pythia6 and then reconstruct secondary vertex (SV) for D⁰ meson (used K⁻ and pi⁺)

Invariant mass of D^0 (vtx+straw)



Simulated 10 muon ($5 \mu^+$ and $5 \mu^-$) and add D^0 from Pythia6 and then reconstruct secondary vertex (SV) for D^0 meson (used K^- and π^+)

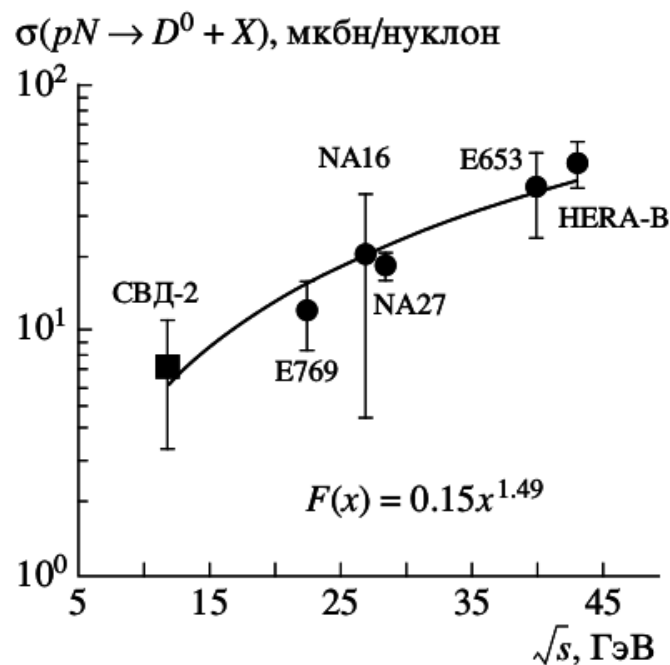
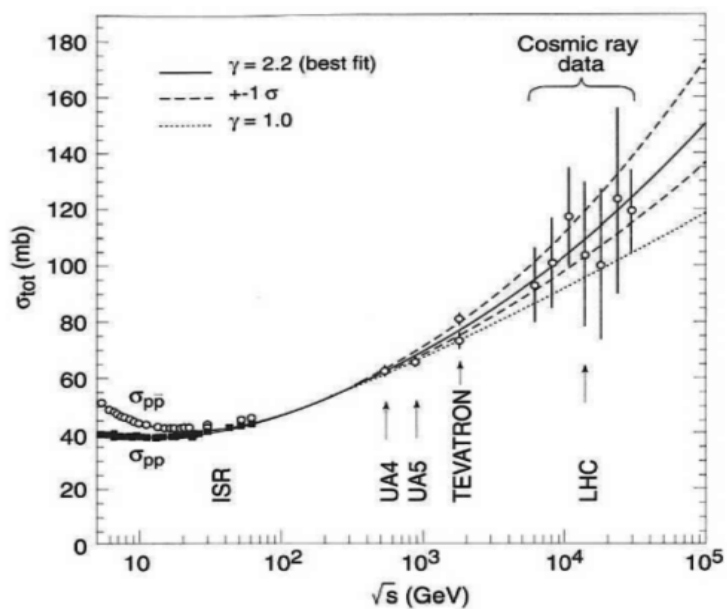
Invariant mass of D^0 (vtx+straw)



Simulated 10 muon (5 μ^+ and 5 μ^-) and add D^0 from Pythia6 and then reconstruct secondary vertex (SV) for D^0 meson (used K^- and π^+)

Selection of $D^0 \rightarrow K^- \pi^+$ (vtx+straw)

1. consider $D^0 \rightarrow K^- \pi^+$ decay (BR 3.9 %) => $c\tau = 122.9 \mu\text{m}$, $M = 1864,84 \text{ MeV}/c^2$
2. simulate 50000 Minimum Bias (MB) events with Pythia6, $\sqrt{s} = 27 \text{ GeV}$
3. additionally simulate 10000 D^0 events, Pythia6 (~70% reconstruction efficiency)
4. consider $K^- \pi^+$ combination in event

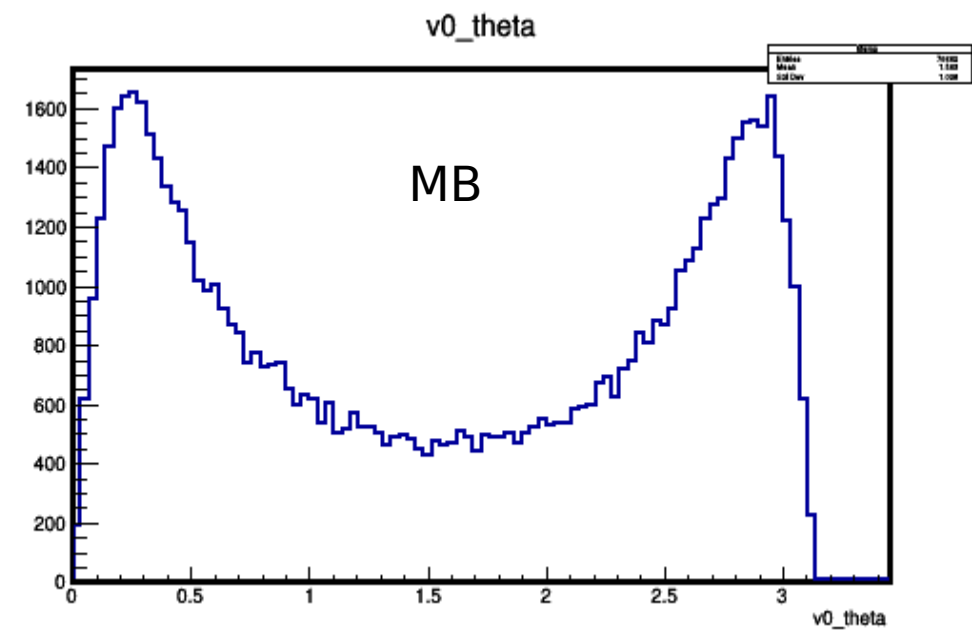
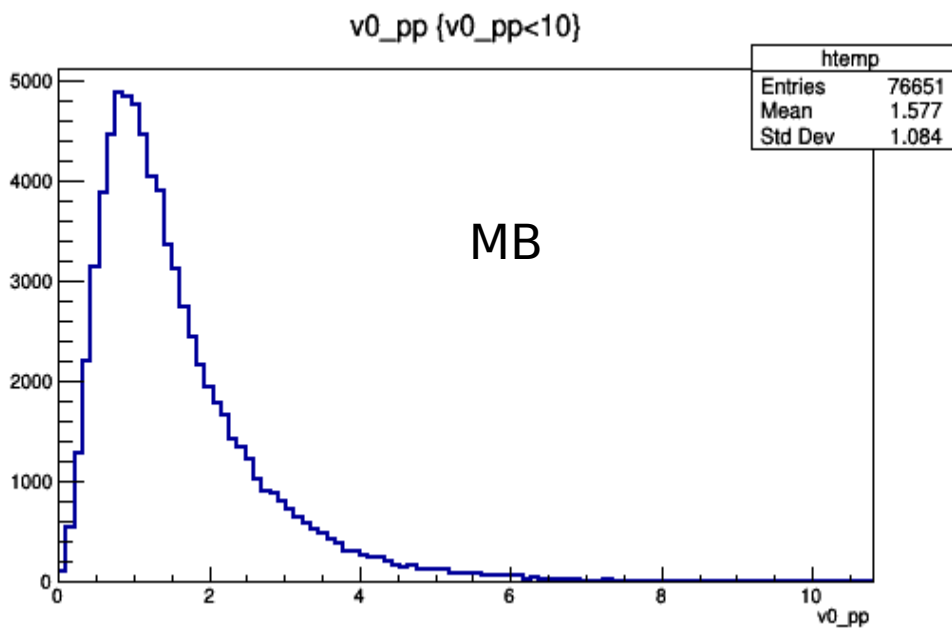
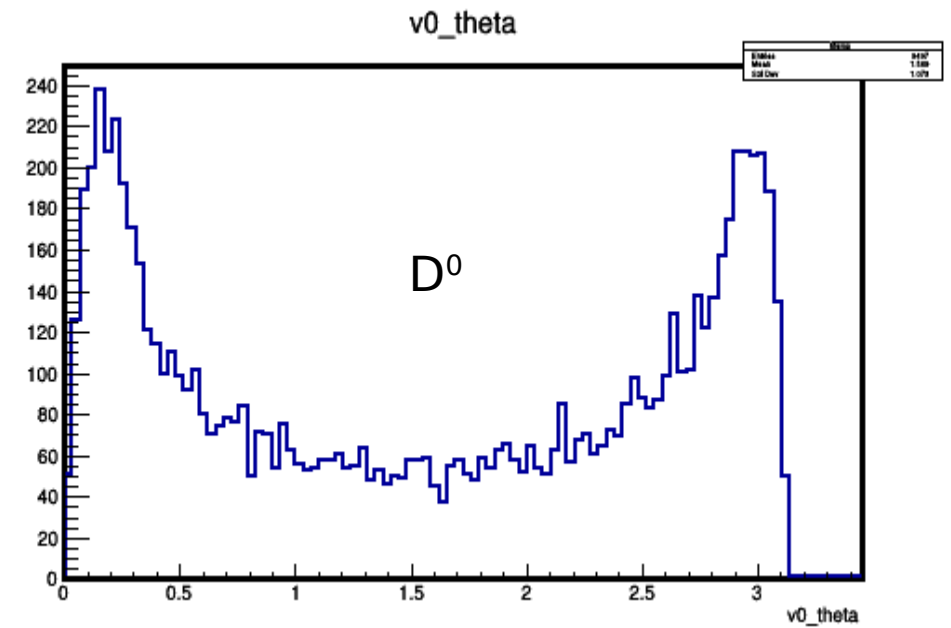
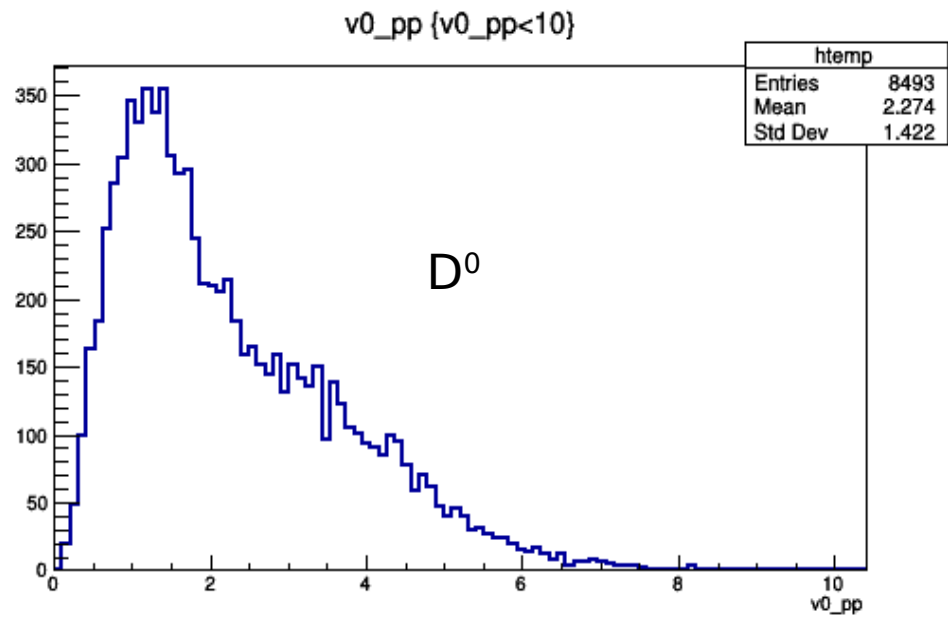


MB ~40 mb and D^0 production ~20 mkm

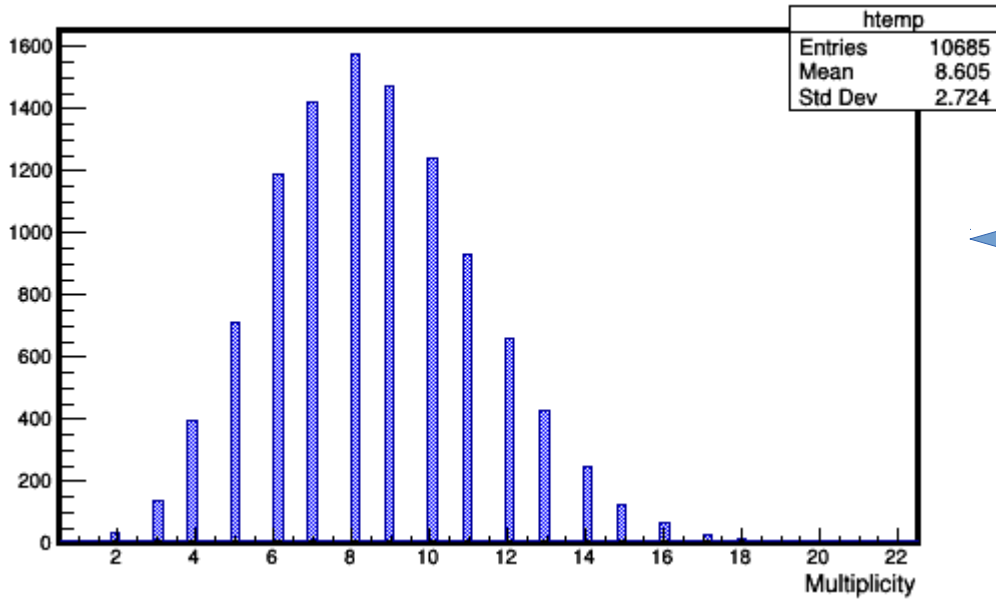
$2 \cdot 10^3$ MB events and only 1 D^0 event

$5 \cdot 10^4$ MB events and only 1 D^0 event with $D^0 \rightarrow K^- \pi^+$ decay

Minimum Bias and D^0 with Pythia6

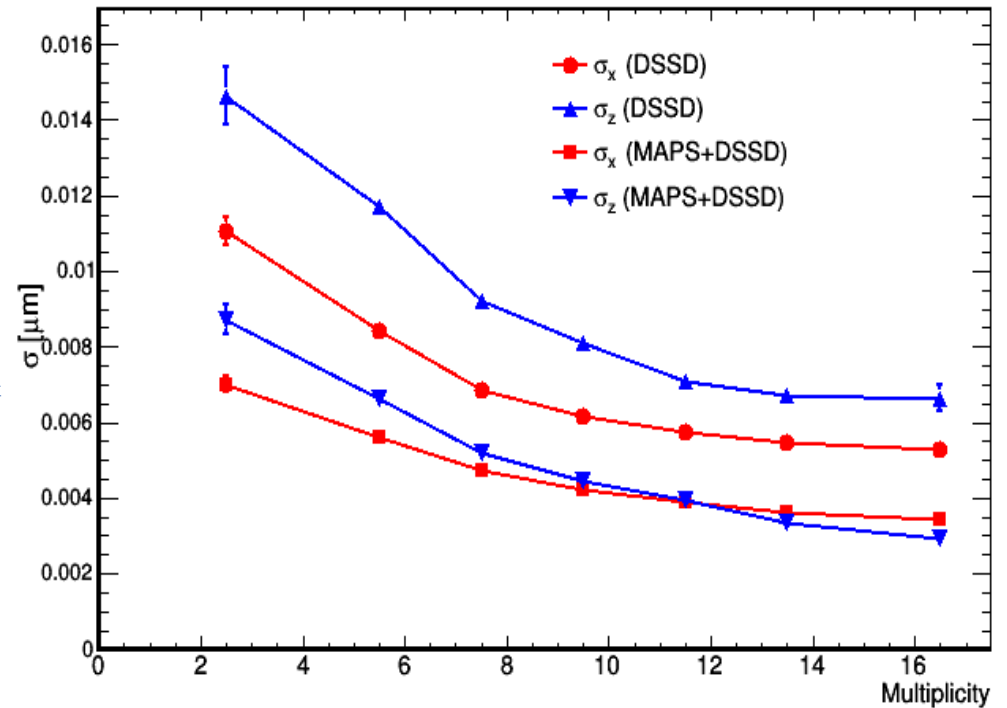


Minimum Bias with Pythia6



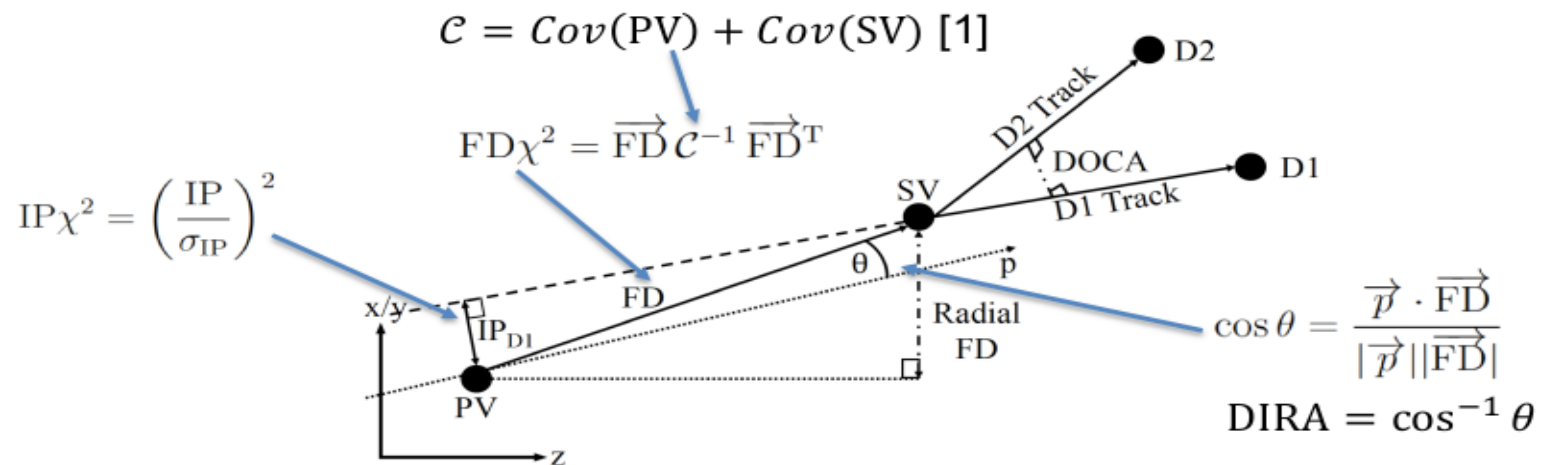
Charged tracks multiplicity for MB events with presence of V0 candidate (~20%)

Primary vertex space resolution (MB)



Primary vertex space resolution for MB

Selection of $D^0 \rightarrow K\pi^+$ (vtx+straw)



1. distance between 2 daughter particles (DOCA)
2. select tracks on the base of chi2 of track and primary reconstructed vertex

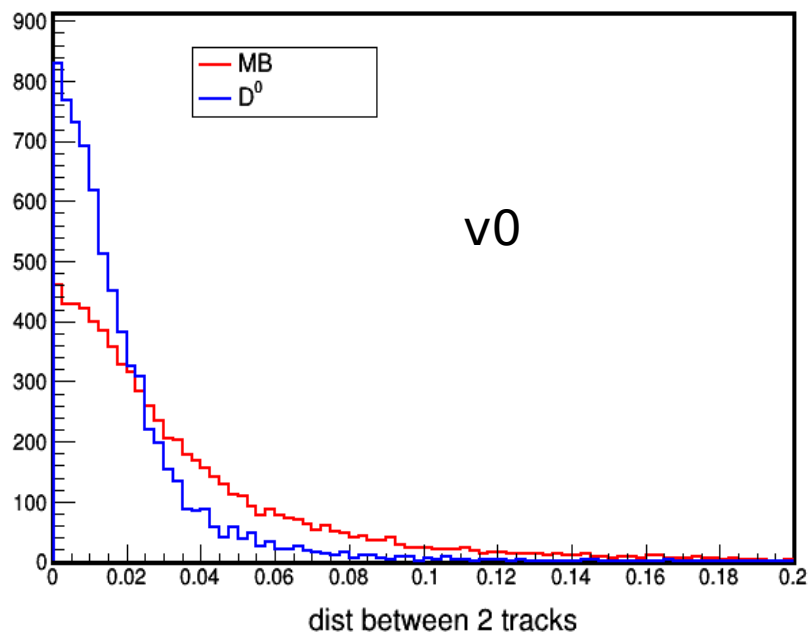
$$\chi_{prim}^2 = \Delta \mathbf{r}^T (C_{track} + C_{PV})^{-1} \Delta \mathbf{r},$$

where Δr - distance between track and the primary vertex position, C_{track} is a covariance matrix of a track and C_{pv} is a covariance matrix of primary vertex

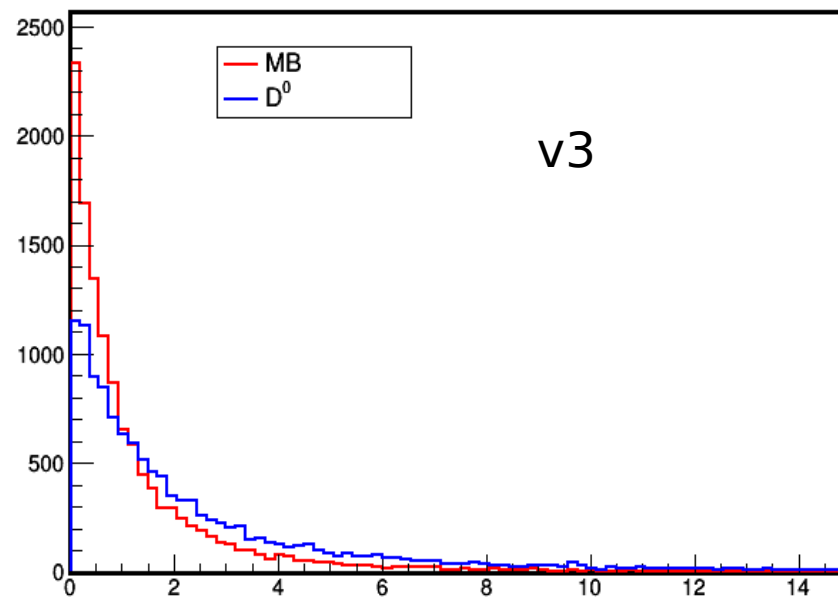
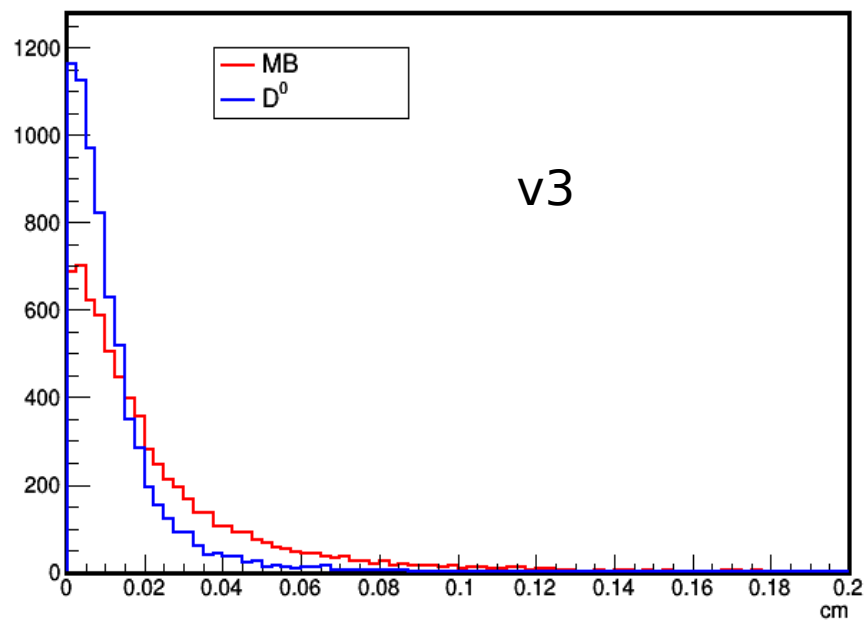
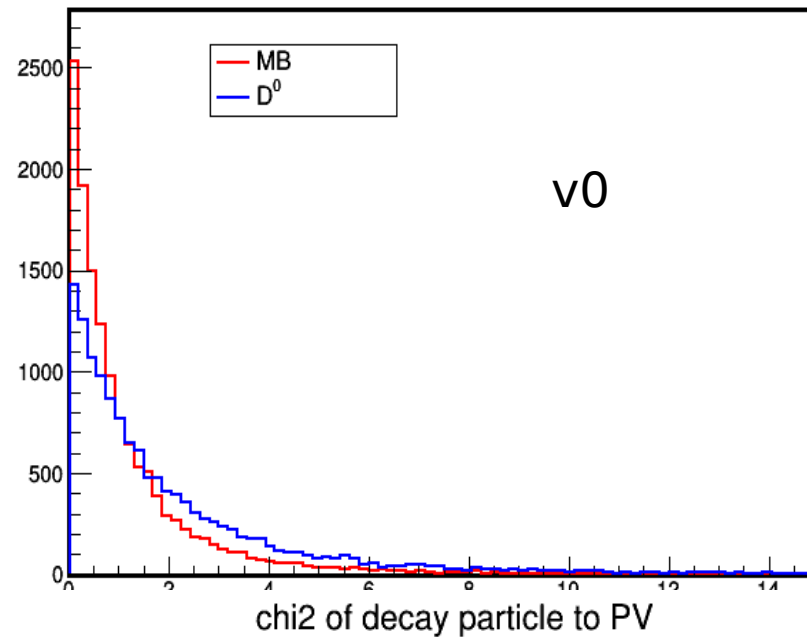
3. check L / dL - decay length normalized on the error
4. θ angle of daughter particle (π^+)
5. angle of V0 candidate and primary vertex ($\cos \theta$)

D⁰ vs MB

dist between 2 tracks

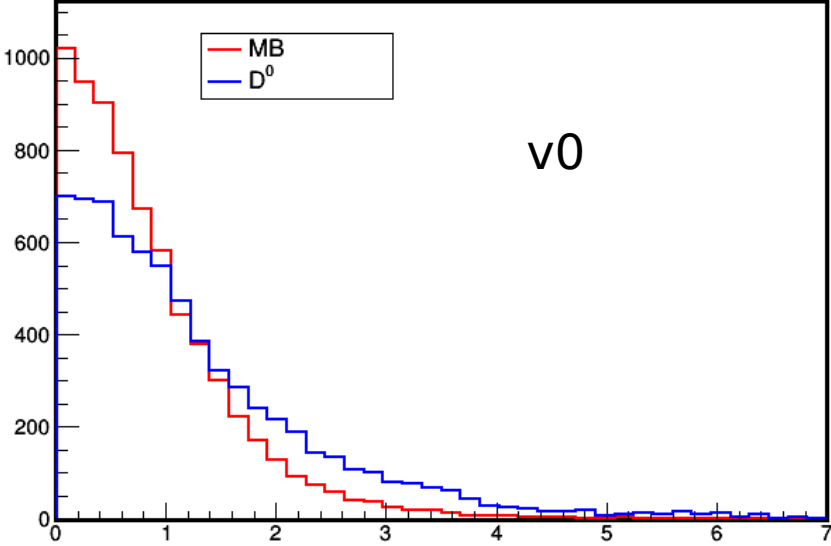


chi2 of decay particle to PV

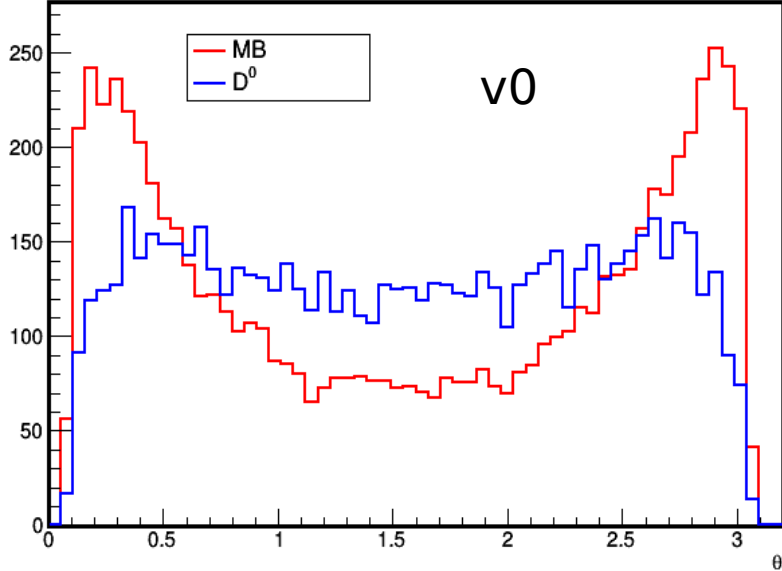


D⁰ vs MB

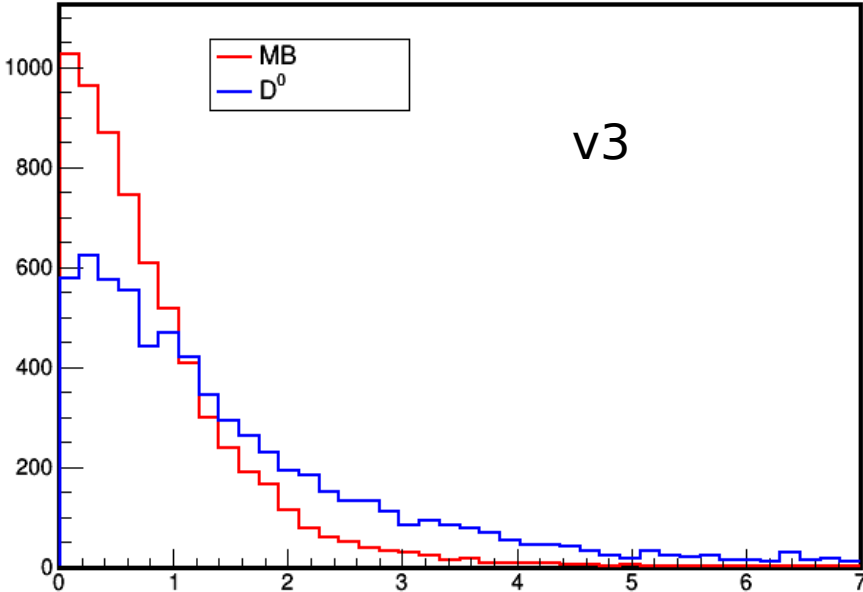
L/dL of D⁰ candidate



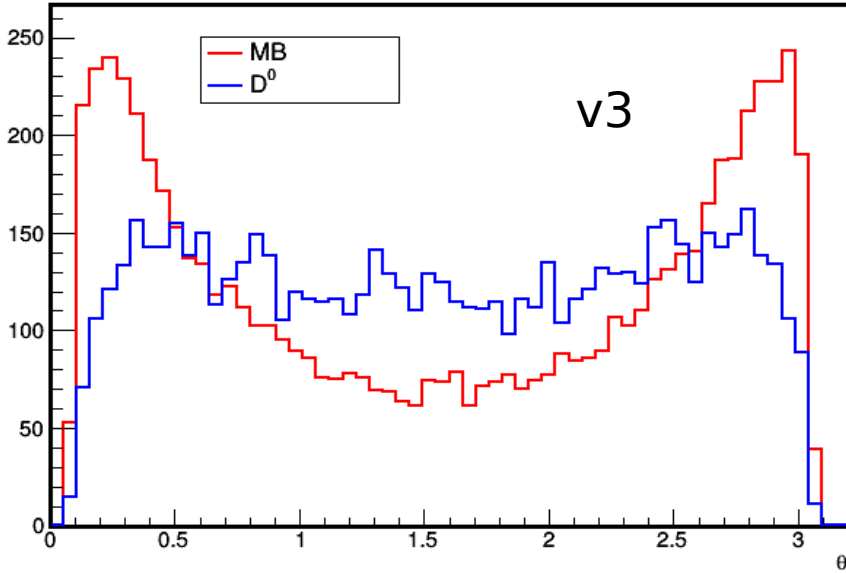
θ of π^+ in V0 candidate



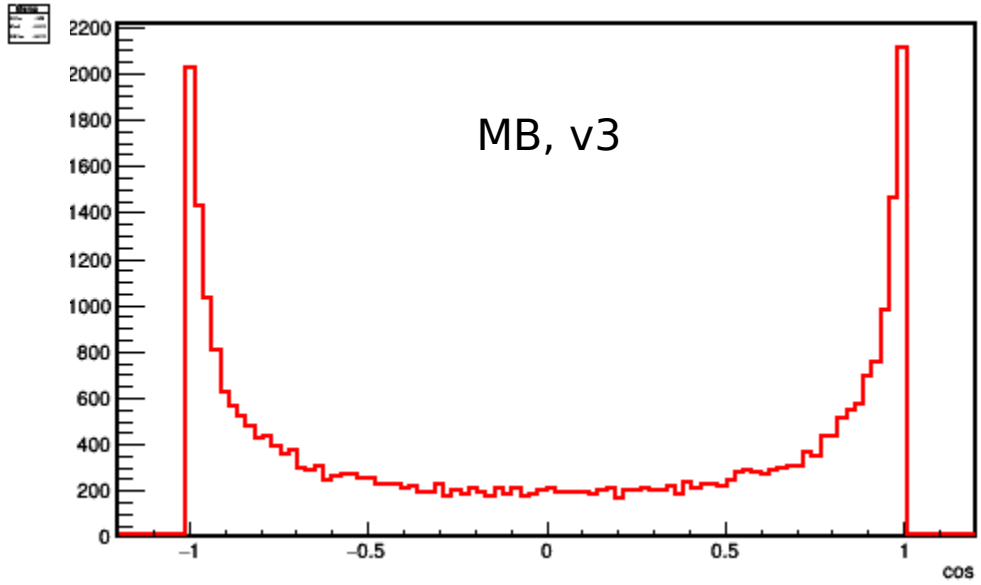
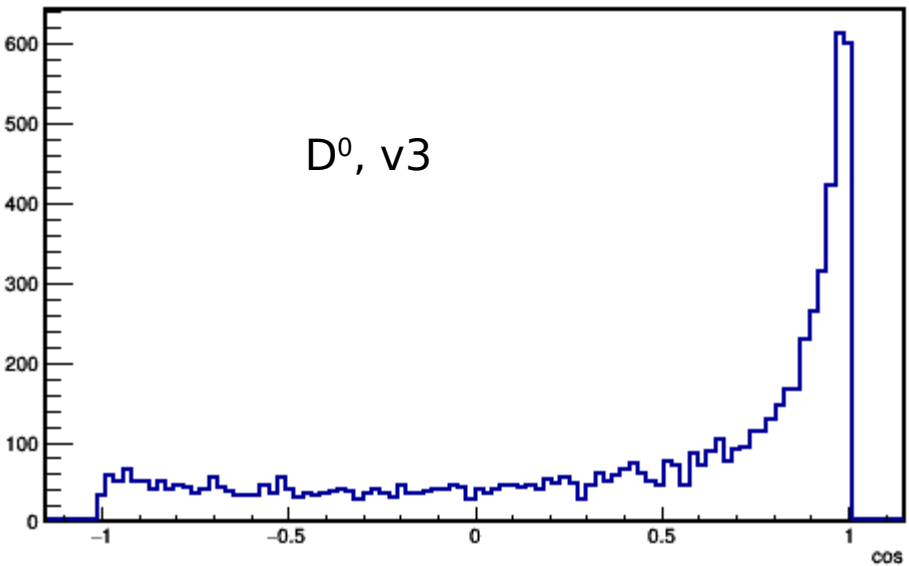
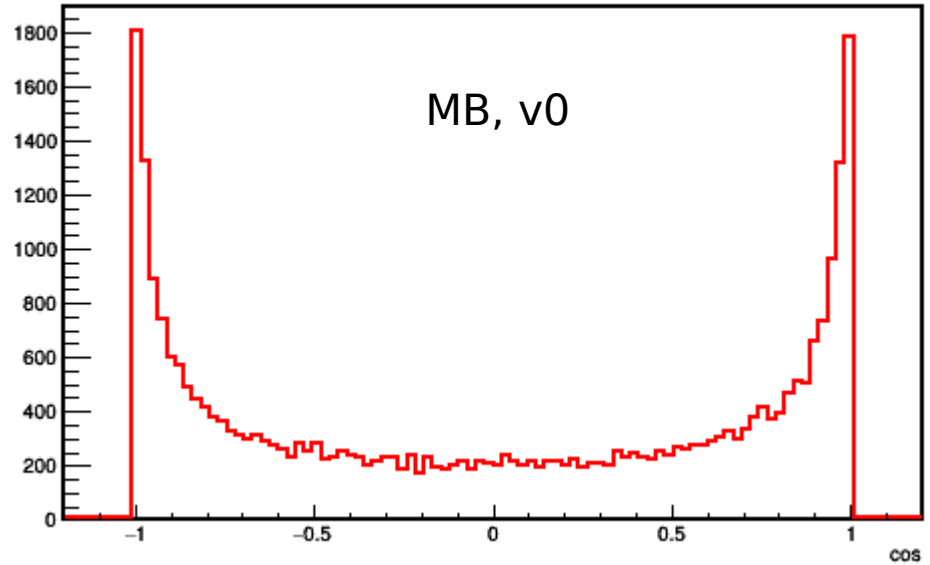
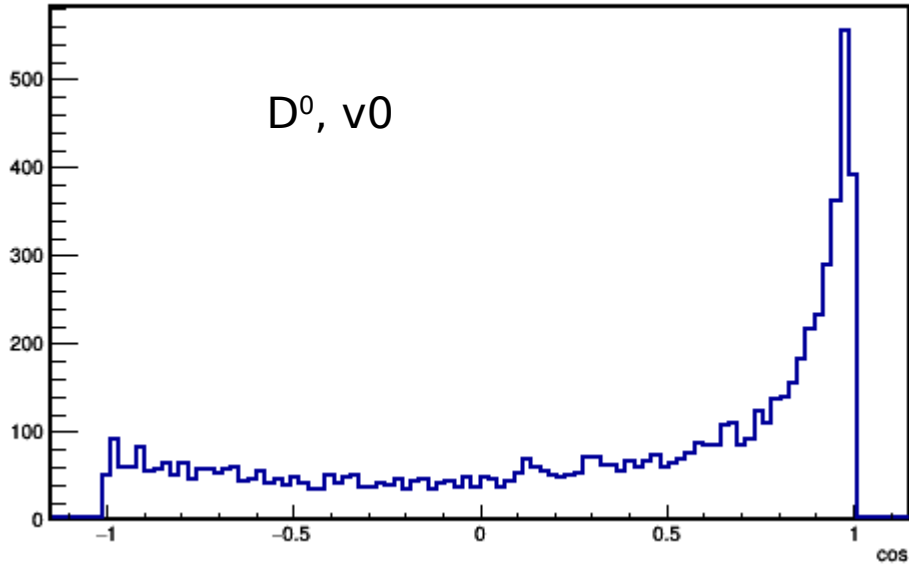
L/dL of D⁰ candidate



θ of π^+ in V0 candidate



D⁰ vs MB



Legend

Legend

Selection of D^0 events

1. consider samples with equal number of D^0 and MB events
2. selection criteria is chosen with condition of 50% efficiency for D^0 events
3. produce ratio S/B for different D^0 momentum ranges

		tot	$0 < p < 1.4$	$1.4 < p < 2.7$	$p > 2.70$
	no selection	1.12	0.73	1.12	2.47
1	v0	1.97	1.47	1.84	3.53
	v3	1.81	1.22	1.79	4.15
2	v0	2.19	1.24	2.27	5.54
	v3	2.73	1.36	3.00	8.09
3	v0	1.67	0.85	1.74	4.30
	v3	2.26	0.97	2.43	7.55
4	v0	1.71	1.24	2.14	3.90
	v3	1.67	1.19	2.11	4.76
5	v0	1.61	0.87	1.50	3.66
	v3	1.94	0.90	1.88	4.97
1+2+3+4+5	v0	19.6	11.3	26.0	47.8
	v3	33.7	18.1	40.7	130.0

4. finally take into account $\sim 4\%$ of MB events inside 3σ range around D^0 peak

D⁰ vs MB

MB ~40 mb and D⁰ production ~20 mkm

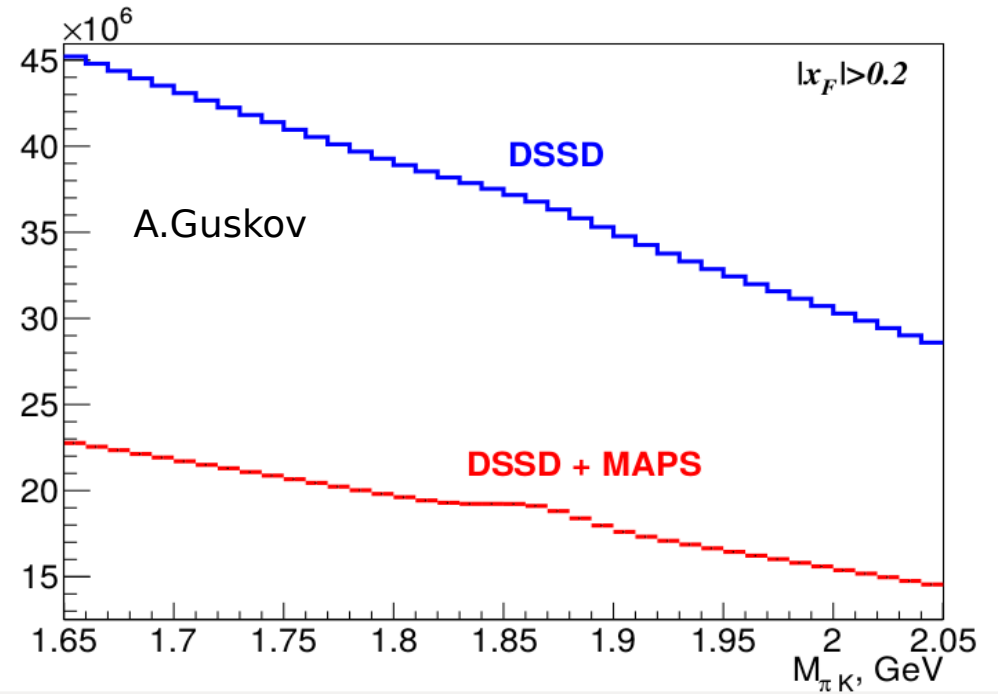
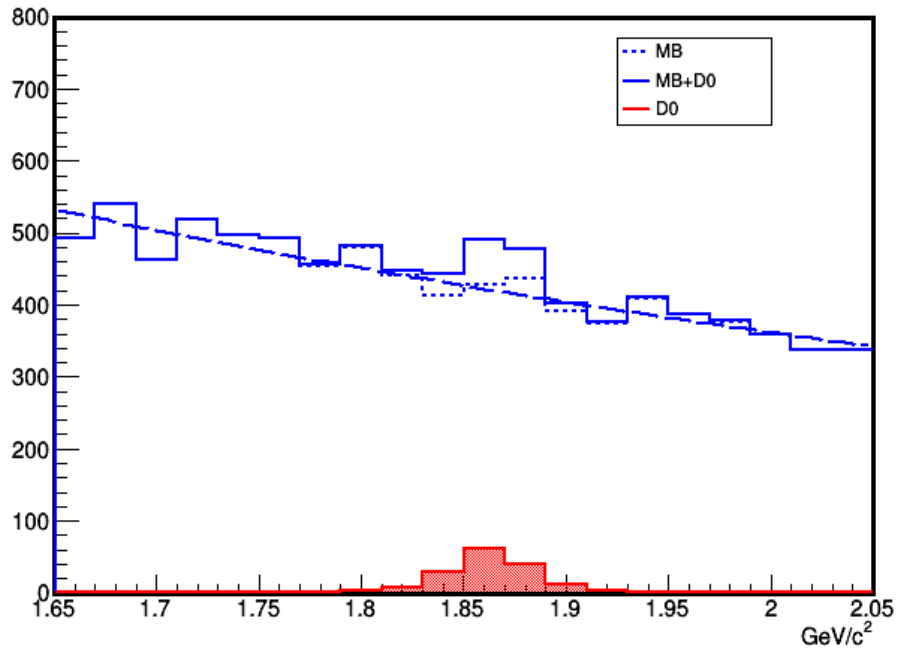
2*10³ MB events and only 1 D⁰ event

5*10⁴ MB events and only 1 D⁰ event with $D^0 \rightarrow K^- \pi^+$ decay mode (3.9%)

	tot	0<p<1.4	1.4<p<2.7	p>2.7	
v0					
1+2+3+4+5 =>	2.6*10 ³	4.4*10 ³	1.9*10 ³	1.0*10 ³	per 1 D ⁰ event
+3*σ =>	~100	~180	~76	~40	per 1 D ⁰ event
v3					
1+2+3+4+5 =>	1.5*10 ³	2.8*10 ³	1.2*10 ³	3.8*10 ²	per 1 D ⁰ event
+3*σ =>	~60	~110	~50	~15.4	per 1 D ⁰ event

D0 vs MB Pythia6

Invariant mass ($K^- \pi^+$)



Plan

1. increase statistics
2. use TMVA technique (Analysis of Boosted Decision Trees)
3. check $D^{*+} \rightarrow D^0 \pi$ channel