

Influence of the choice of initial values of track parameters on track fitting in SpdRoot

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Generation of events

- SpdRoot: branch **geometry-update-spring-2023**
- Inner tracker: DSSD
- Artificial sample was generated:
 - Pions: isotropical, $p = 0 \dots 5$ GeV/c (with step 0.05 GeV/c),
 $Z_{\text{primary vertex}} = 0$.

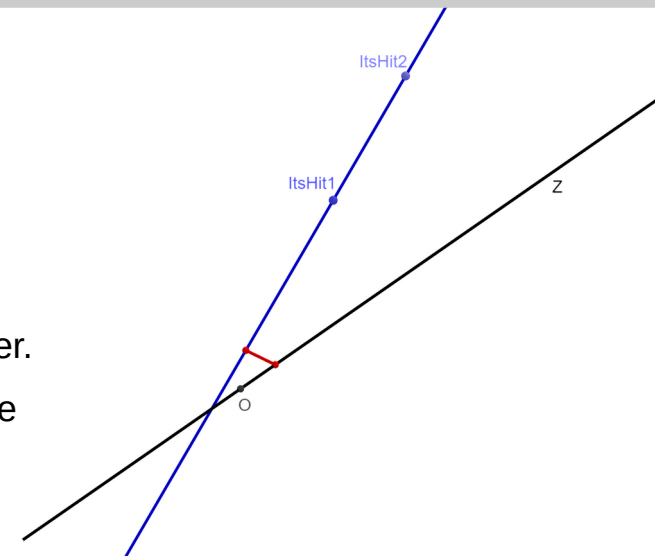
Reconstruction

- Ideal track finding.
- The only requirement for a particle to be accepted as a track (in SpdMCTracksFinder) was total **N hits ≥ 3** .
- The corrected function for the drift radius calculation is used (see [my talk at SPD Physics Weekly Meeting, Sep 19, 2023](#)).
- **Here we compare two procedures of assigning initial values for track fitting:**
 - 1) One that is currently coded in SpdRoot;
 - 2) Another, which sets initial values = MC values.

Currently used initialisation procedure

First method (fStartSeedMethod == 1)

- Method `SpdTrackFitterGF::DefineStartParameters()`
- $|p| = 1 \pm 0.05$ GeV/c (uniformly distributed)
- Momentum direction is defined from the first 2 hits in the inner tracker.
- As the vertex is taken some point on the segment connecting points of closest approach of z axis and the line passing through the first 2 hits in the inner tracker.
- If this procedure fails (for example, if there is no hits in ITS), then fallbacks to the second method.



Second method (fStartSeedMethod == 0)

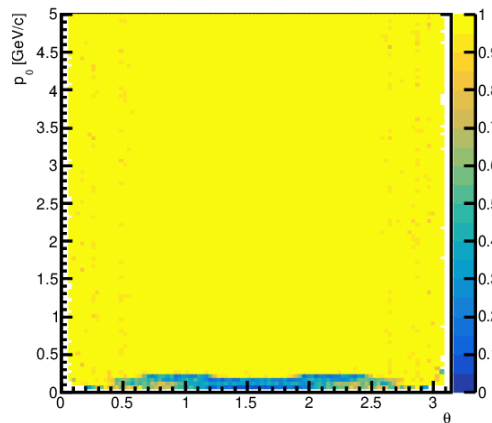
- Methods `SpdTrackFitterGF::SmearStartMom()`, `SpdTrackFitterGF::SmearStartVertex()`

		<i>Init. value</i>	<i>Smearing</i>
Momentum	$ p $	1 GeV/c	uniform, ± 0.1 GeV/c
	θ	0°	gaussian, $\sigma = 3^\circ$
	φ	0°	gaussian, $\sigma = 1^\circ$
Vertex	x	0	uniform, ± 0.5 cm
	y	0	uniform, ± 0.5 cm
	z	0	uniform, ± 0.5 cm

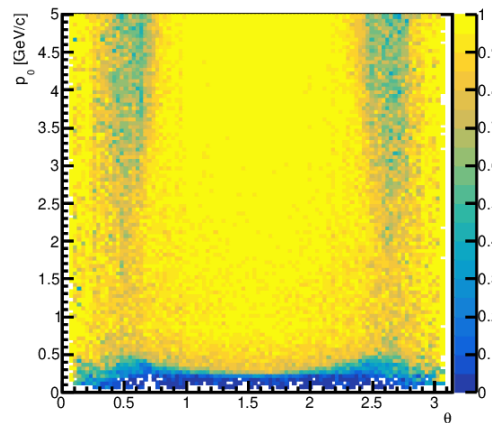
Efficiency of track quality cuts. Pions, $0 < p_0 < 5 \text{ GeV}/c$, $Z_{\text{prim.vtx.}} = 0$.

current
initialisation
procedure

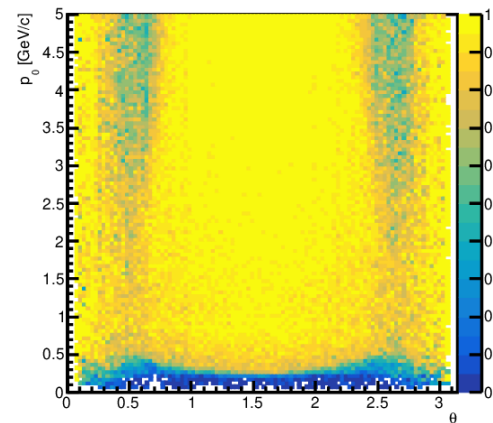
efficiency [!HasErrorMesg()]



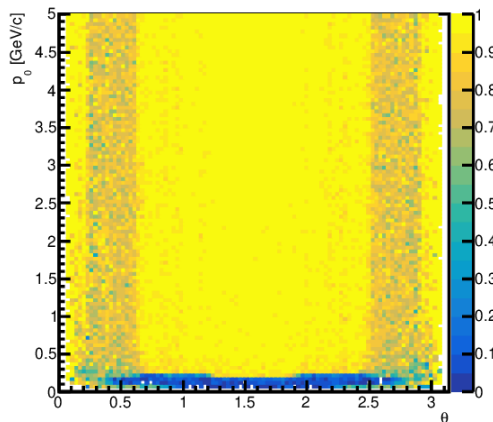
efficiency [fConvergencyGF = 1]



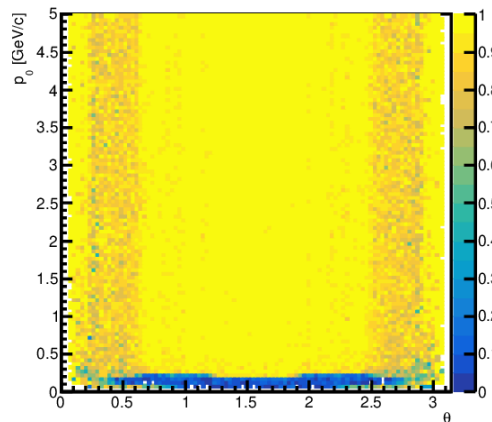
efficiency [fConvergencyGF = ±1]



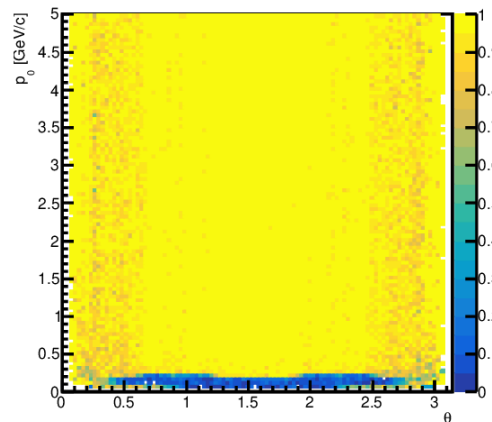
efficiency [$\chi^2/\text{ndf} < 2$]



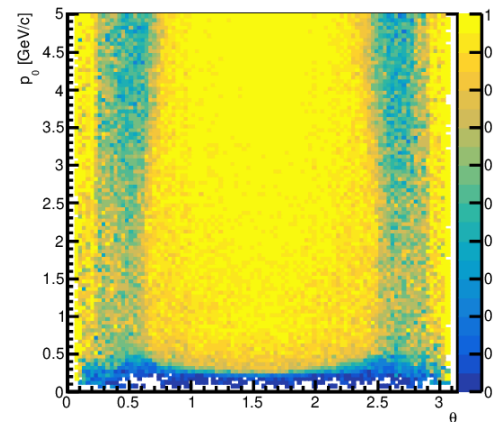
efficiency [$\chi^2/\text{ndf} < 4$]



efficiency [$\chi^2/\text{ndf} < 10$]



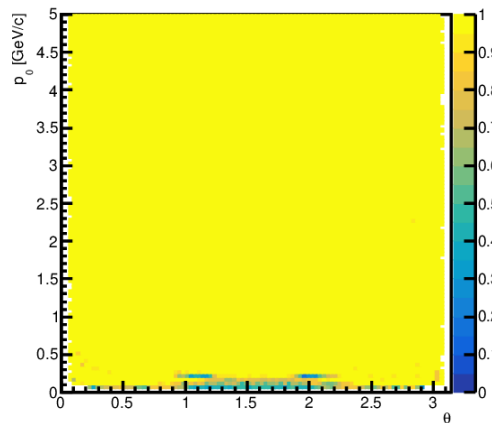
efficiency [all cuts]



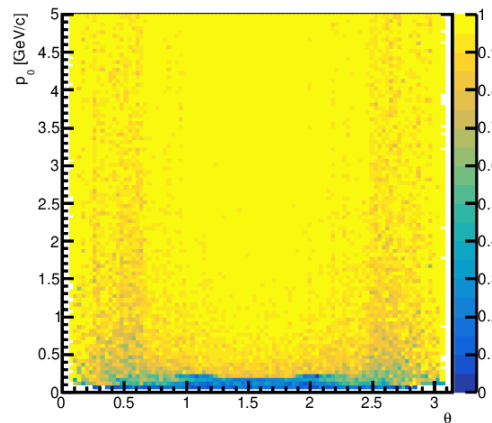
Efficiency of track quality cuts. Pions, $0 < p_0 < 5 \text{ GeV}/c$, $Z_{\text{prim.vtx.}} = 0$.

initial values
from MC

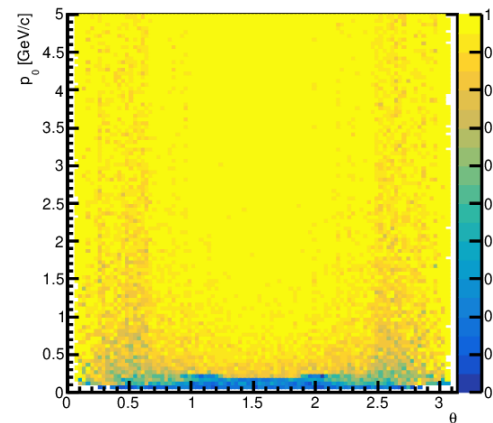
efficiency [!HasErrorMesg()]



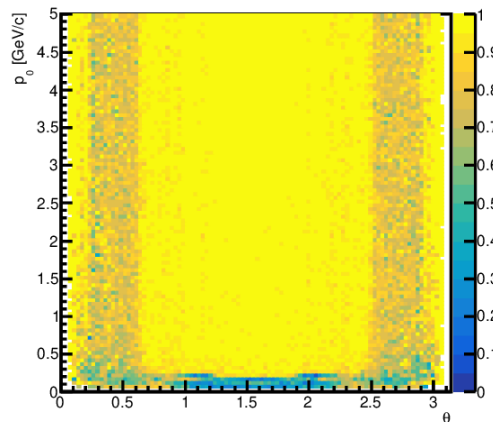
efficiency [fConvergencyGF = 1]



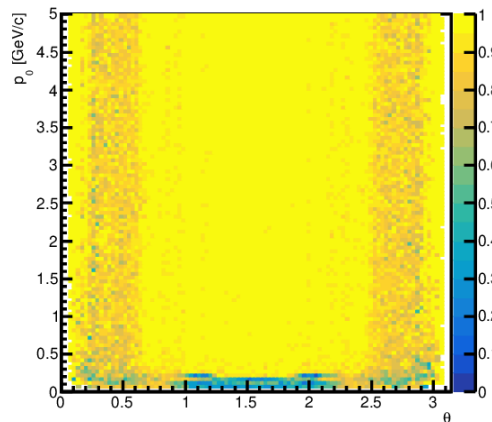
efficiency [fConvergencyGF = ±1]



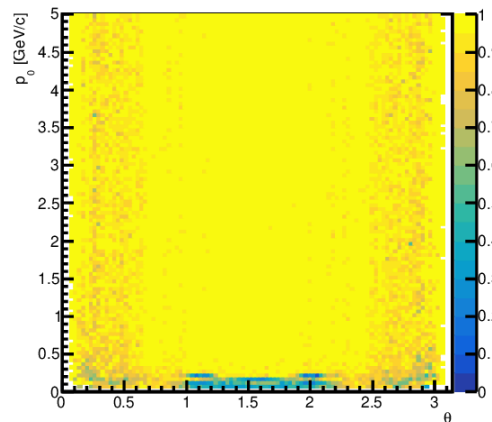
efficiency [$\chi^2/\text{ndf} < 2$]



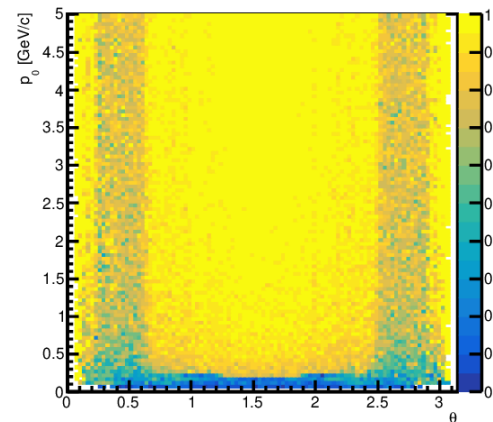
efficiency [$\chi^2/\text{ndf} < 4$]



efficiency [$\chi^2/\text{ndf} < 10$]

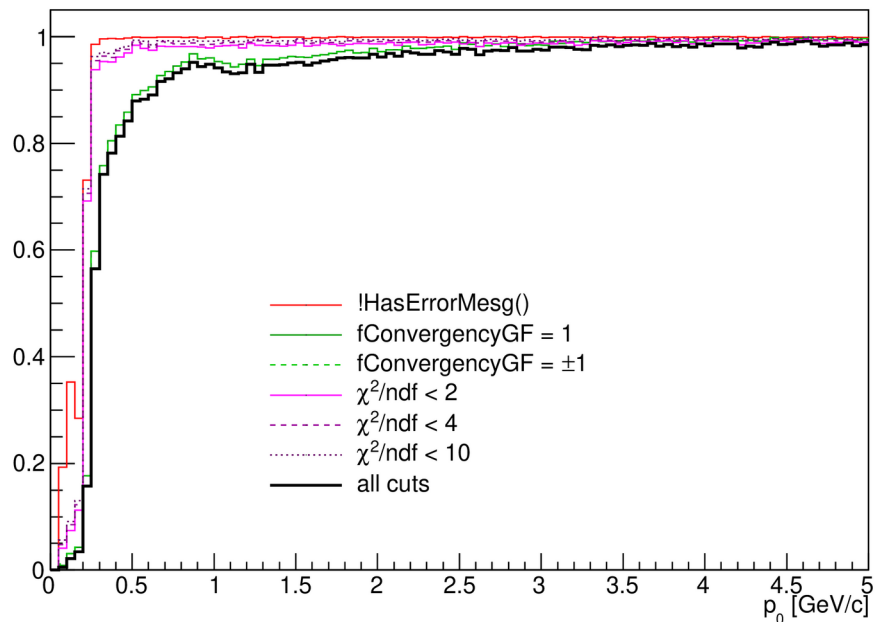


efficiency [all cuts]



Efficiency of track quality cuts. Pions, $0 < p_0 < 5 \text{ GeV}/c$, $Z_{\text{prim.vtx.}} = 0$.

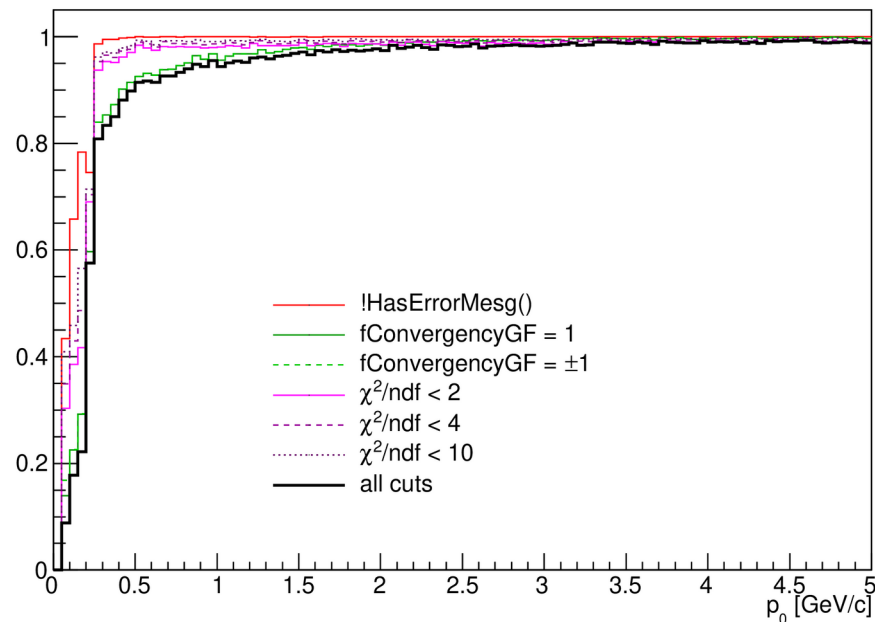
$60^\circ < \theta < 120^\circ$



current initialisation procedure



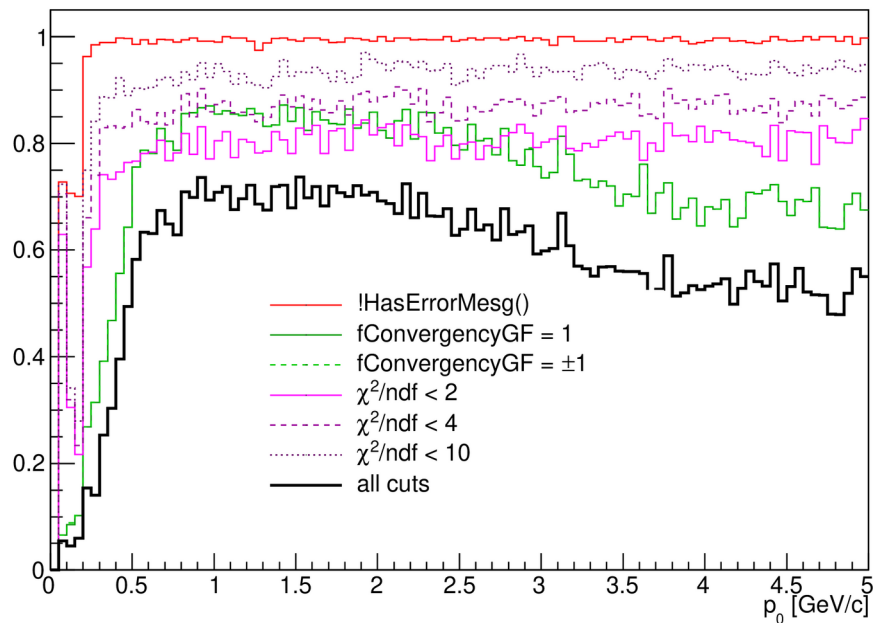
$60^\circ < \theta < 120^\circ$



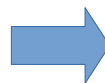
initial values from MC

Efficiency of track quality cuts. Pions, $0 < p_0 < 5 \text{ GeV}/c$, $Z_{\text{prim.vtx.}} = 0$.

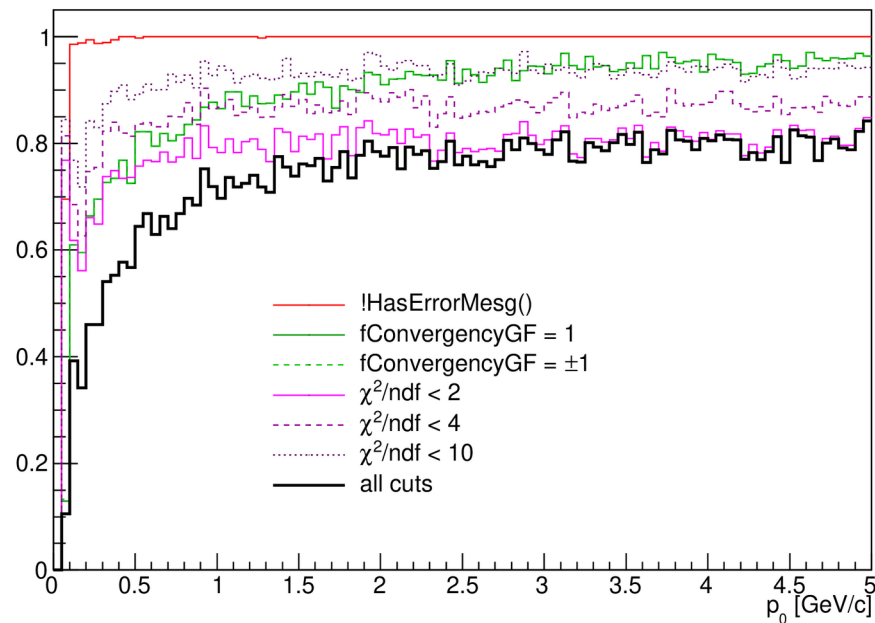
$13^\circ < \theta < 36^\circ$



current initialisation procedure

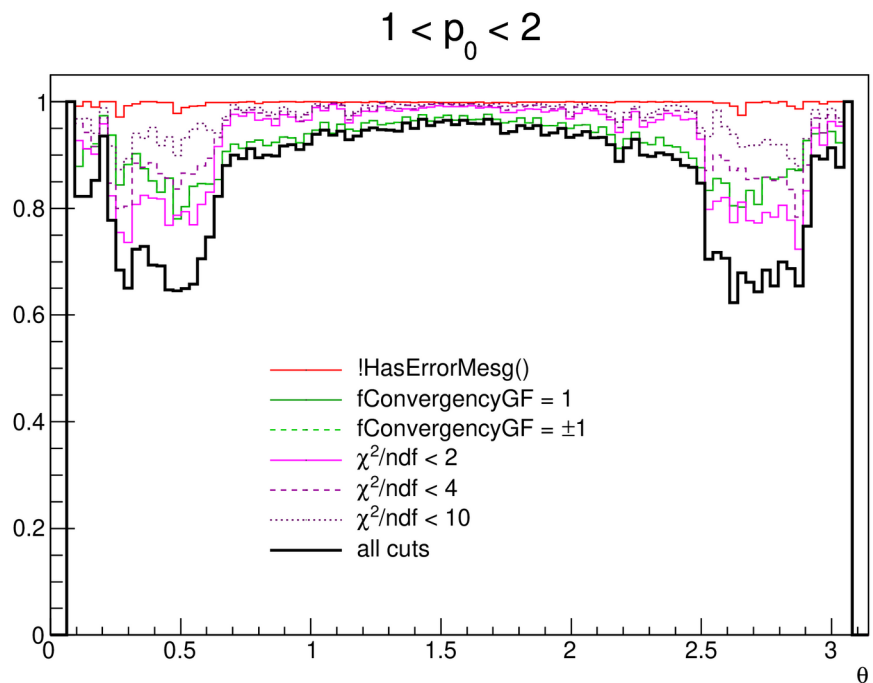


$13^\circ < \theta < 36^\circ$

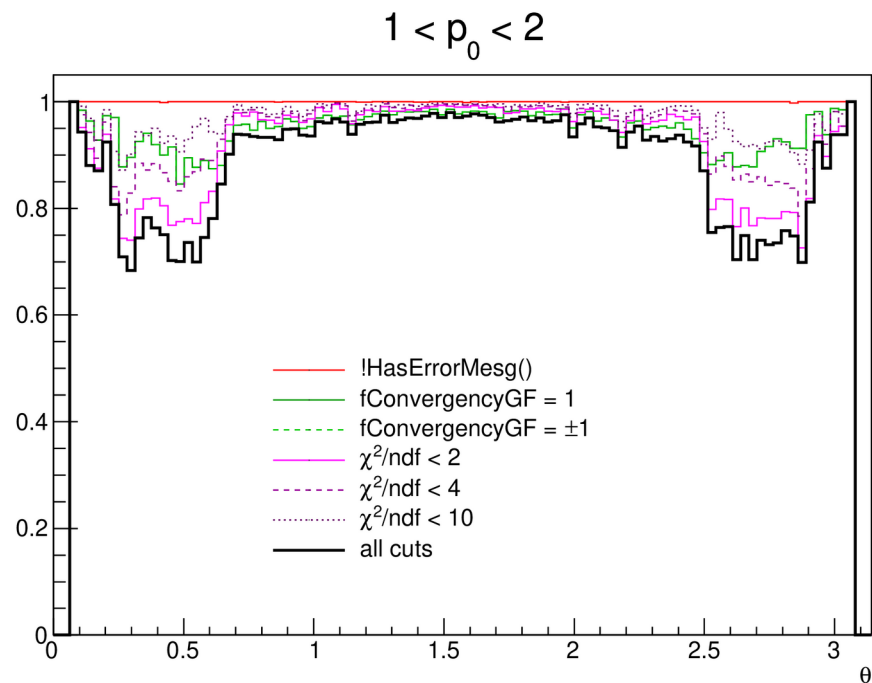


initial values from MC

Efficiency of track quality cuts. Pions, $1 < p_0 < 2 \text{ GeV}/c$, $Z_{\text{prim.vtx.}} = 0$.

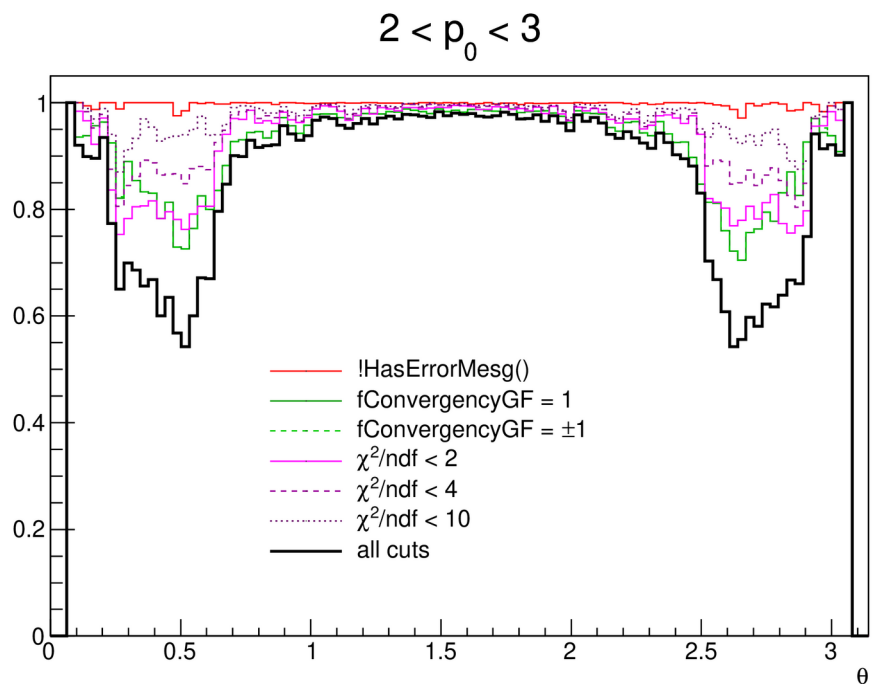


current initialisation procedure

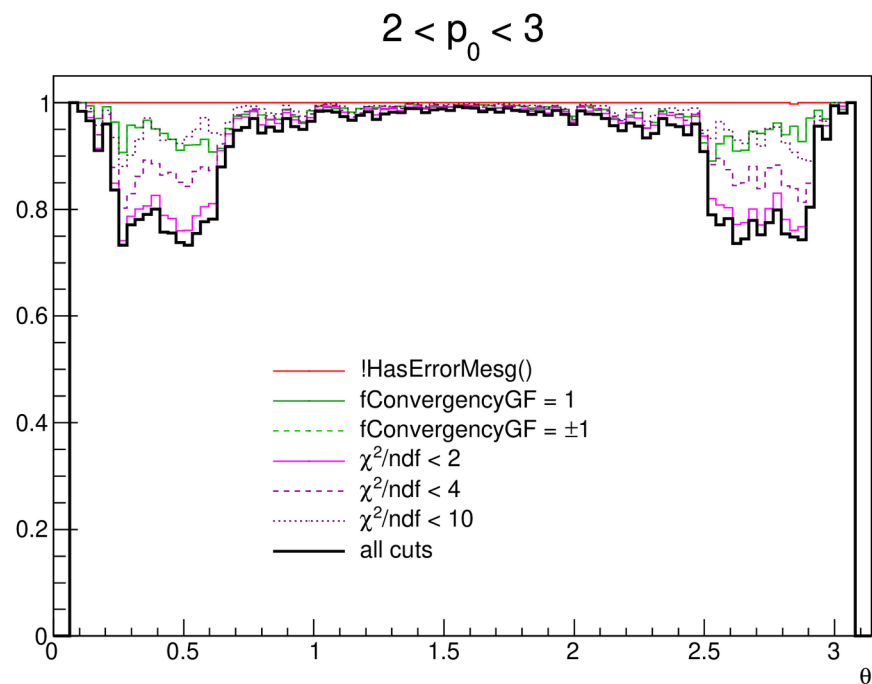


initial values from MC

Efficiency of track quality cuts. Pions, $2 < p_0 < 3 \text{ GeV}/c$, $Z_{\text{prim.vtx.}} = 0$.

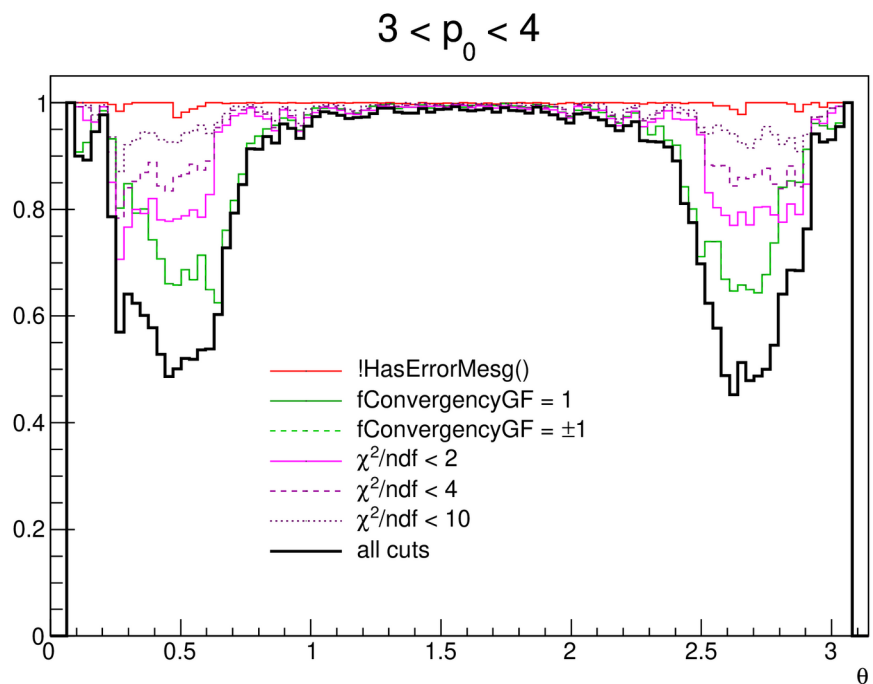


current initialisation procedure

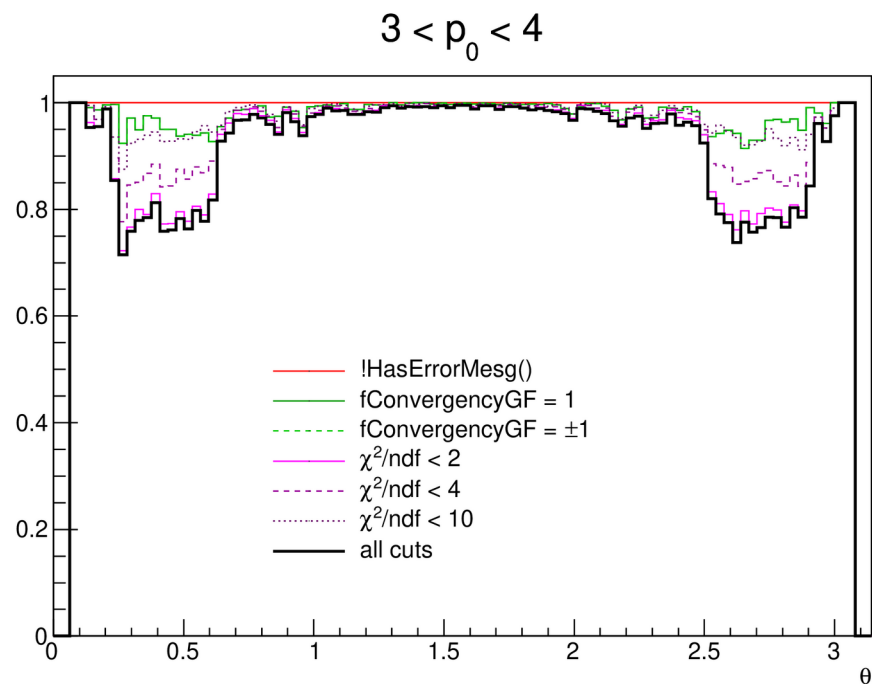


initial values from MC

Efficiency of track quality cuts. Pions, $3 < p_0 < 4 \text{ GeV}/c$, $Z_{\text{prim.vtx.}} = 0$.

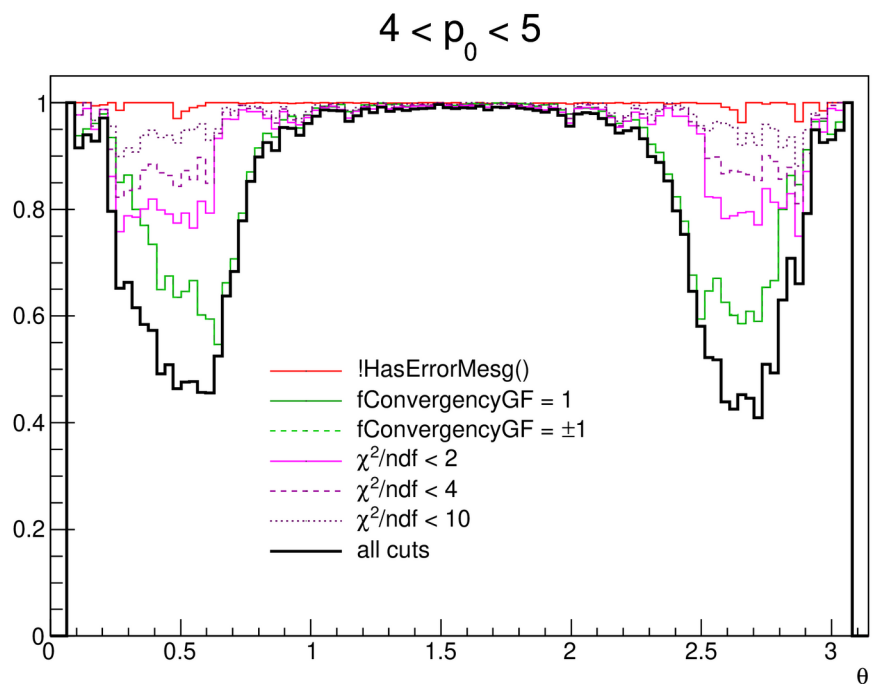


current initialisation procedure

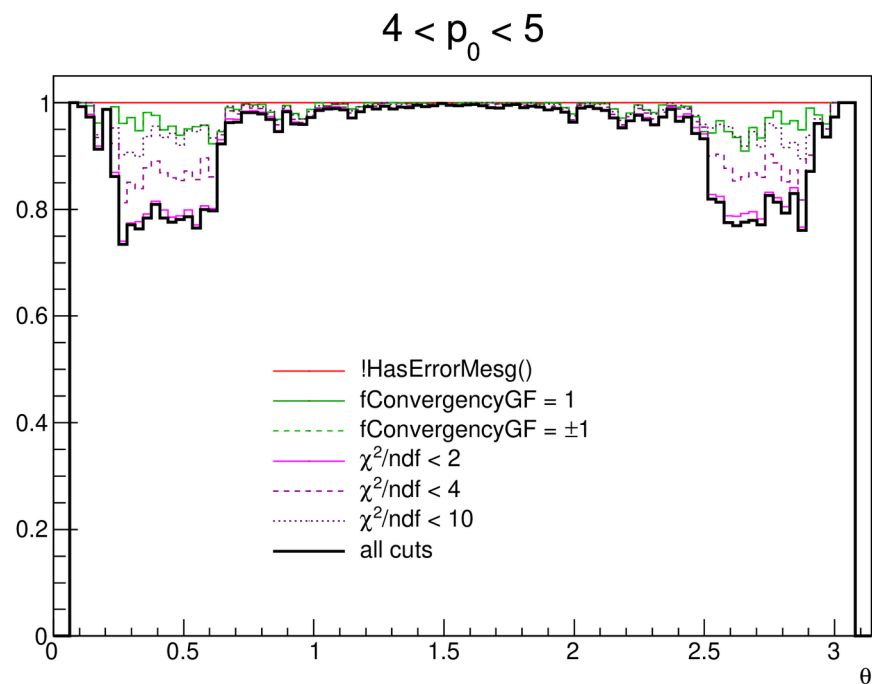


initial values from MC

Efficiency of track quality cuts. Pions, $4 < p_0 < 5 \text{ GeV}/c$, $Z_{\text{prim.vtx.}} = 0$.



current initialisation procedure

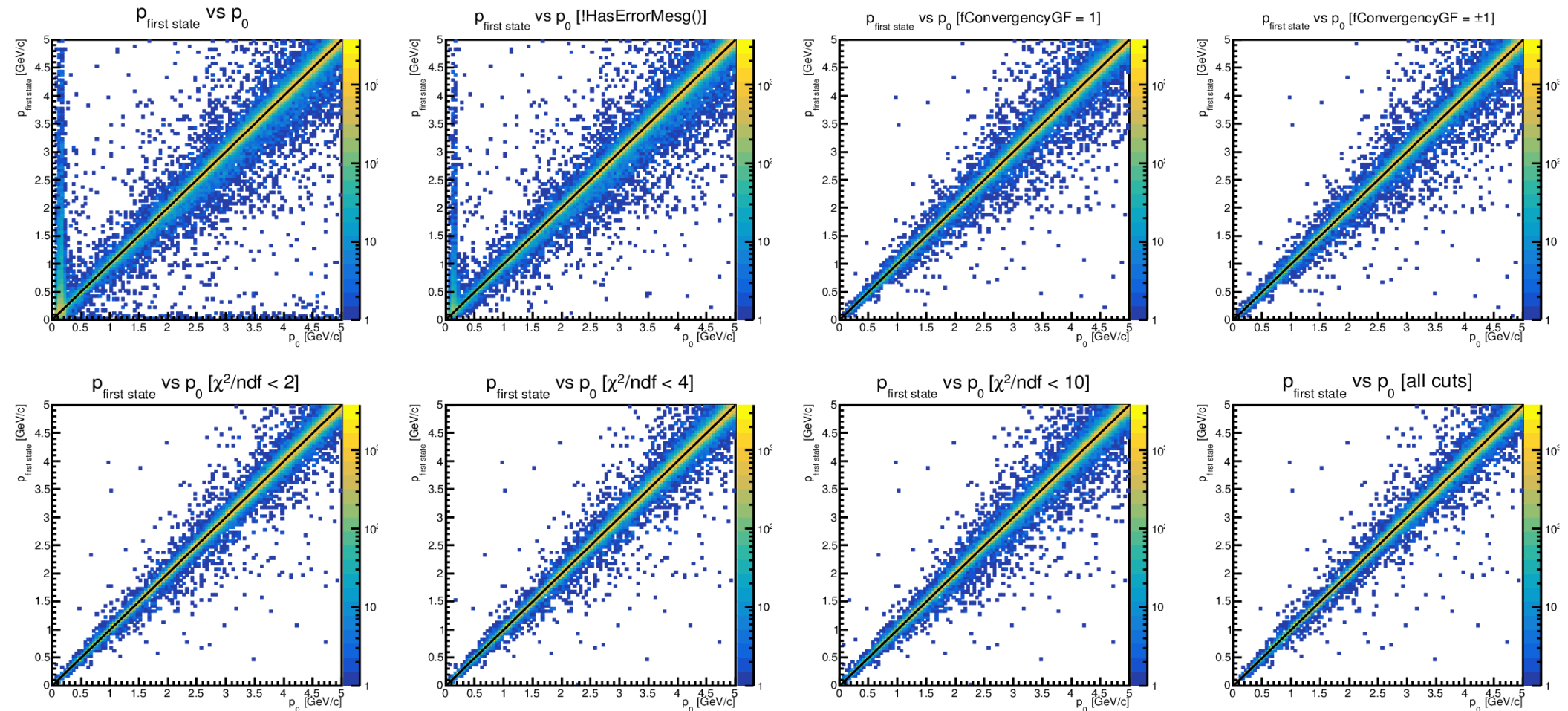


initial values from MC

current
initialisation
procedure

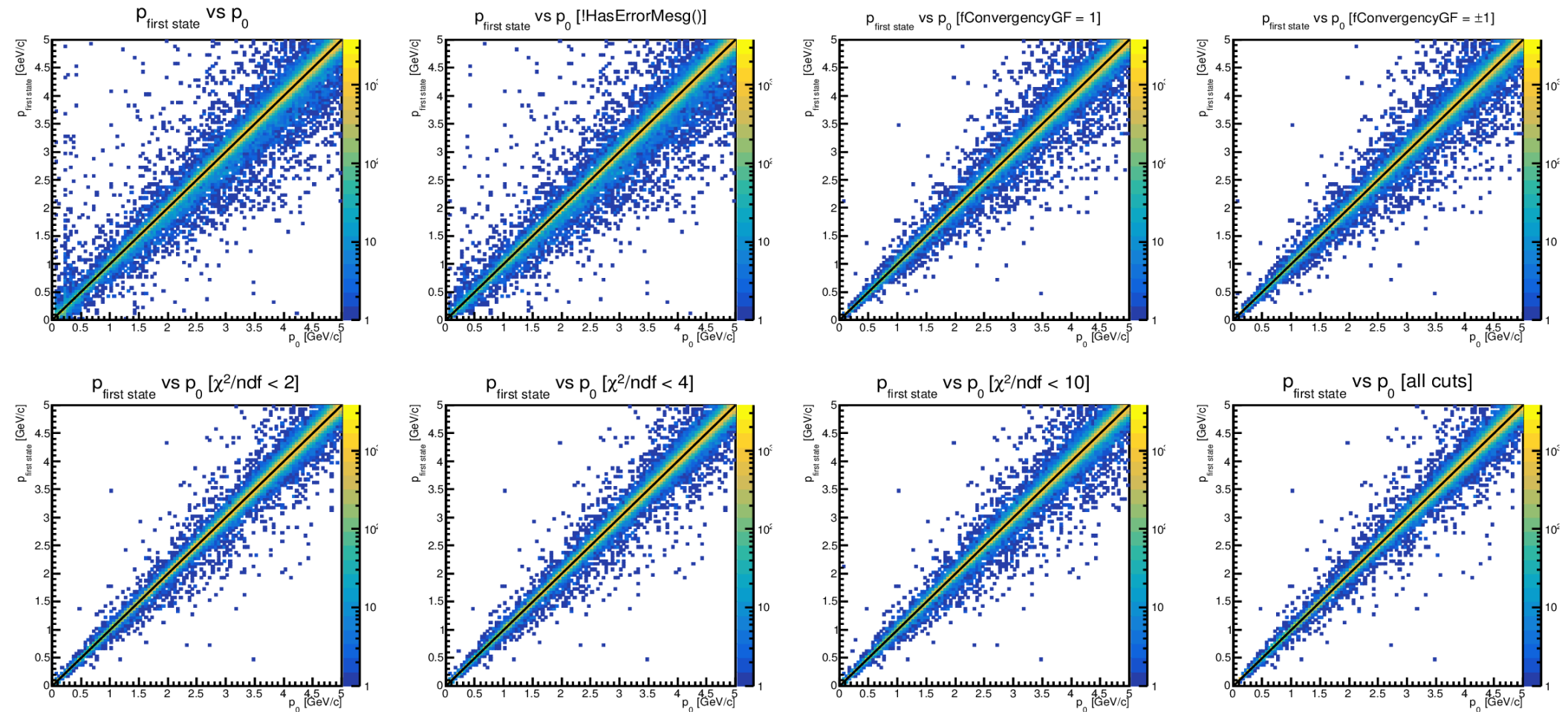
Reconstructed momentum vs true momentum.

Pions, $0 < p_0 < 5 \text{ GeV}/c$, $Z_{\text{prim.vtx.}} = 0$.



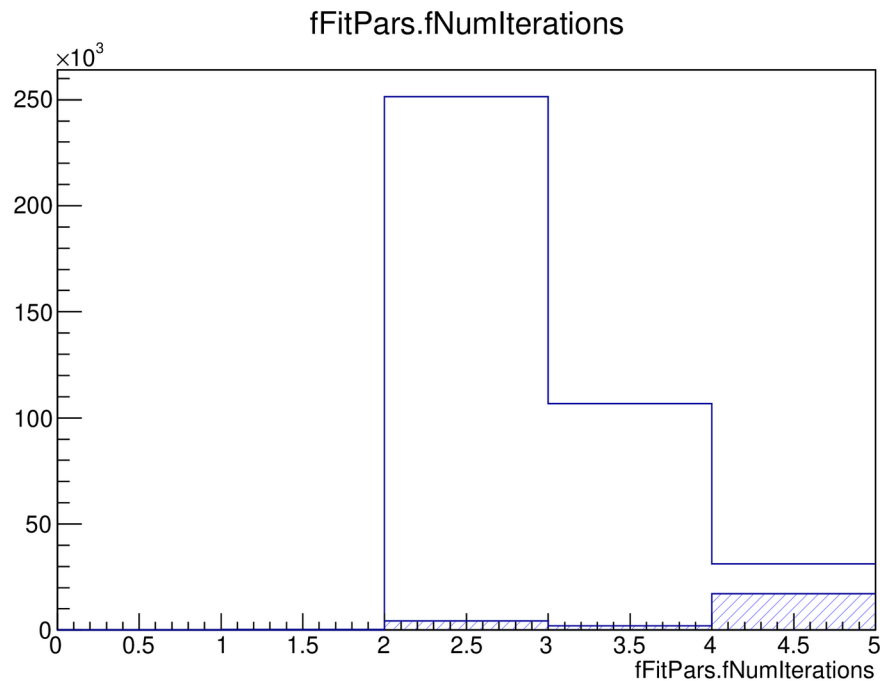
initial values
from MC

Reconstructed momentum vs true momentum. Pions, $0 < p_0 < 5 \text{ GeV}/c$, $Z_{\text{prim.vtx.}} = 0$.

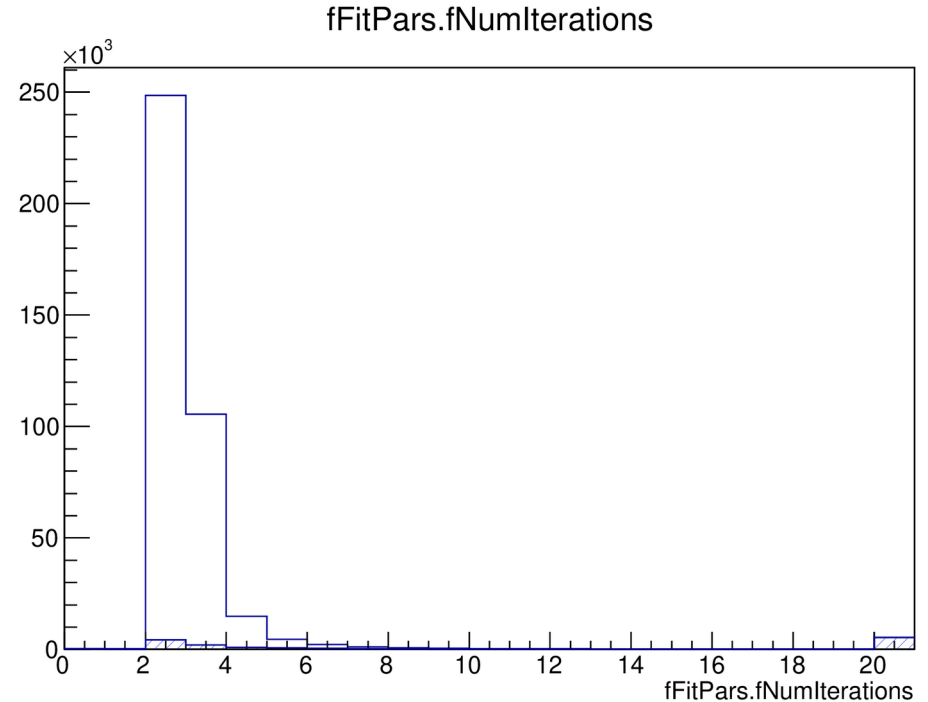


Number of iterations. Pions, $0 < p_0 < 5 \text{ GeV}/c$, $Z_{\text{prim.vtx.}} = 0$.

- Also I tried to increase max number of iterations of the fitter.



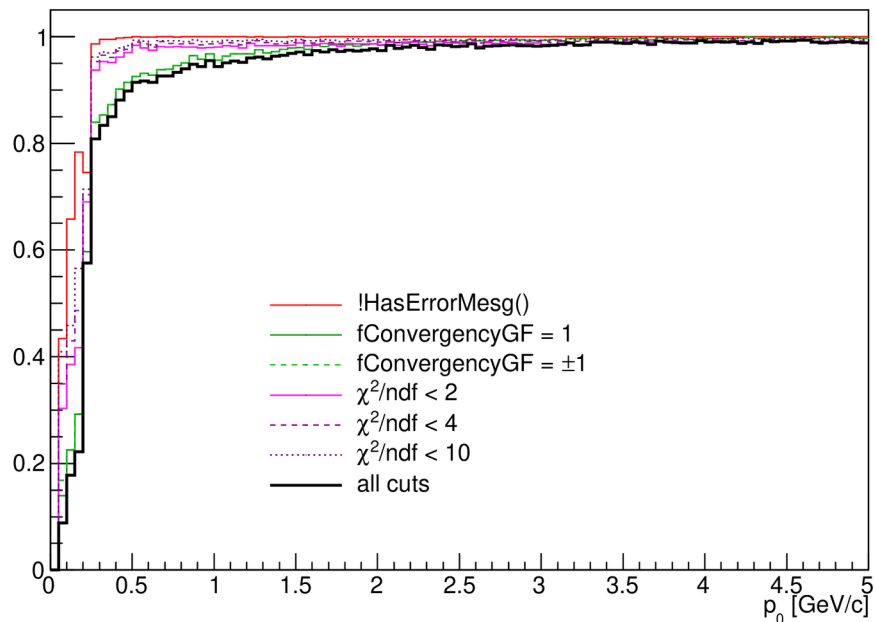
initial values from MC
max 4 iterations (default)



initial values from MC
max 20 iterations

Efficiency of track quality cuts. Pions, $0 < p_0 < 5 \text{ GeV}/c$, $Z_{\text{prim.vtx.}} = 0$.

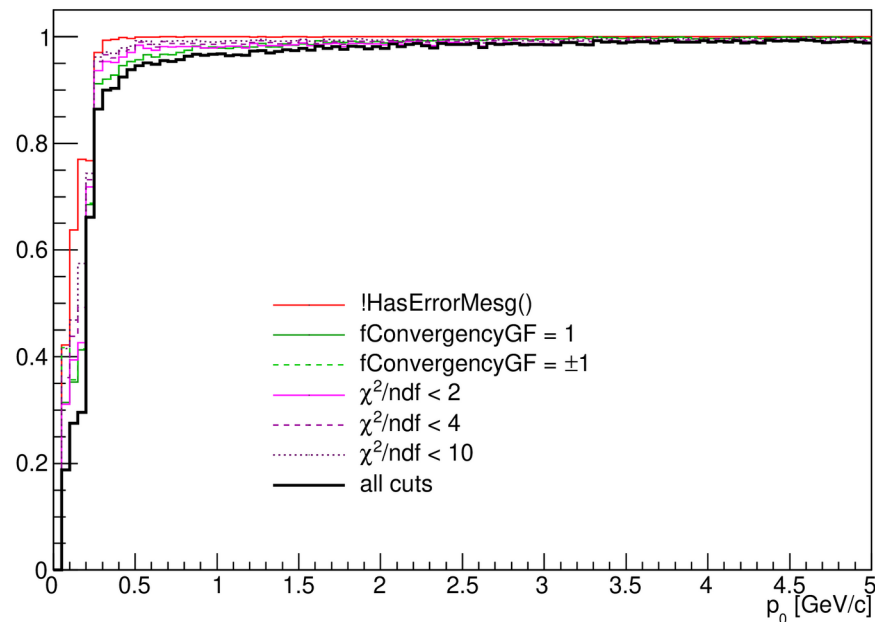
$60^\circ < \theta < 120^\circ$



initial values from MC
max 4 iterations



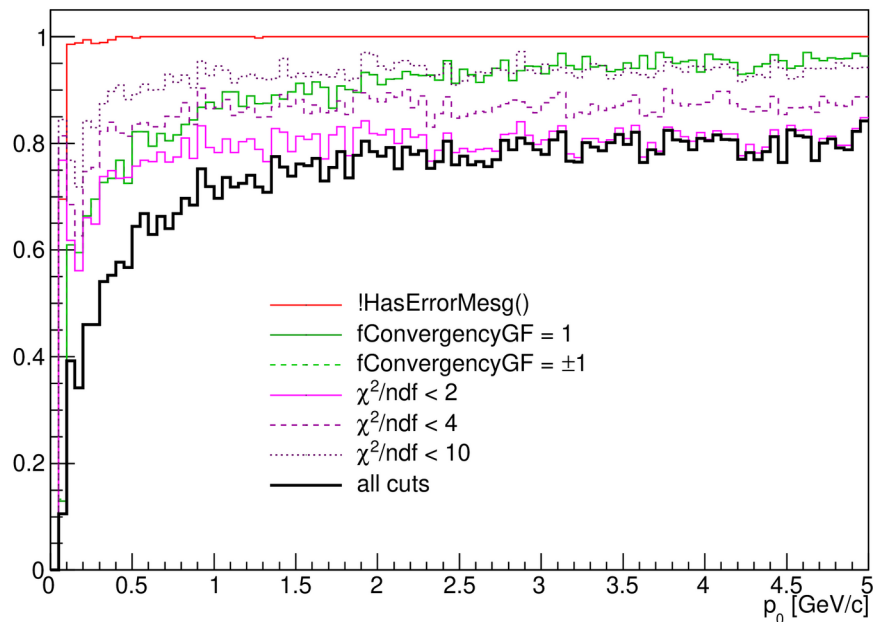
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initial values from MC
max 20 iterations

Efficiency of track quality cuts. Pions, $0 < p_0 < 5 \text{ GeV}/c$, $Z_{\text{prim.vtx.}} = 0$.

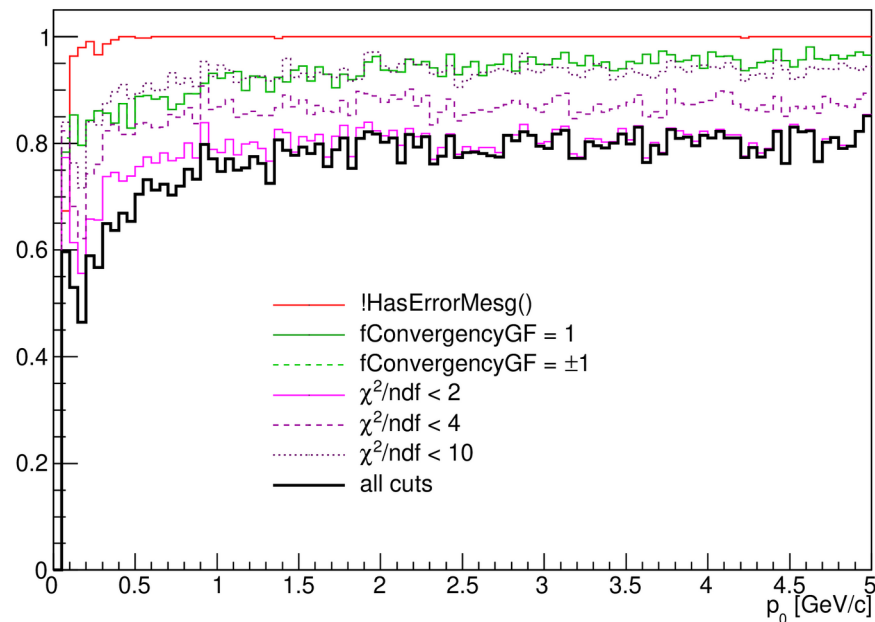
$13^\circ < \theta < 36^\circ$



initial values from MC
max 4 iterations



$13^\circ < \theta < 36^\circ$



initial values from MC
max 20 iterations

Conclusions

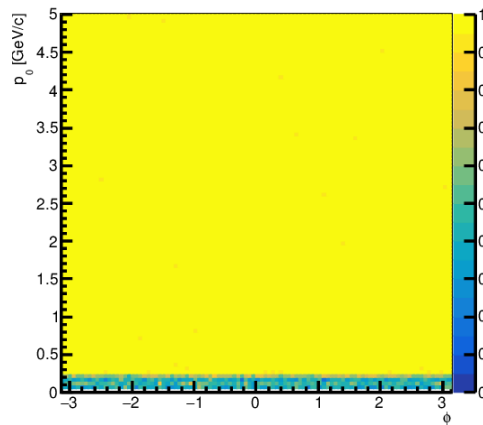
- Problem with convergency at high momenta was caused by a bad choice of initial track parameters.
- **We need a better initialisation procedure!**
- χ^2/ndf distribution is little affected by changing the initialisation procedure → the problem is somewhere else.

additional slides

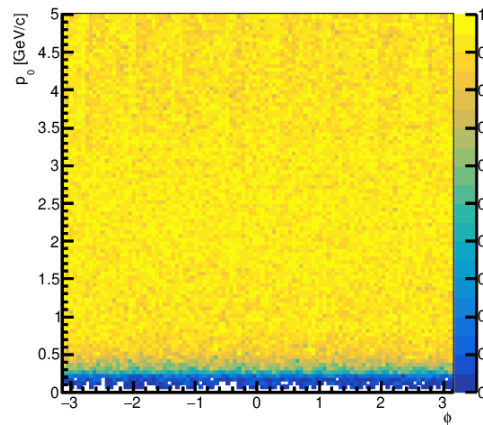
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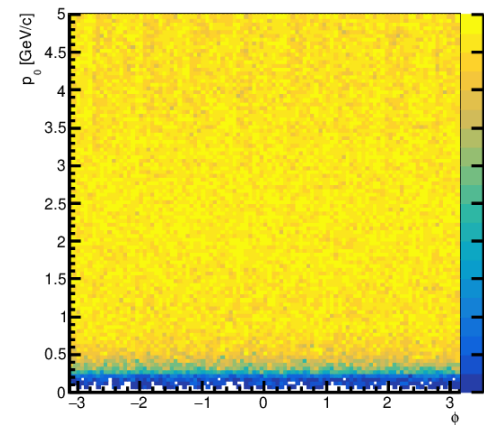
efficiency [!HasErrorMesg()]



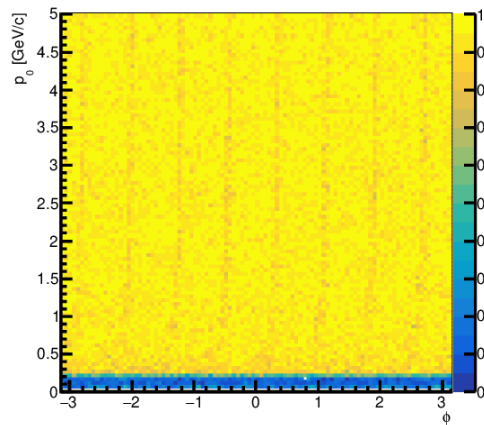
efficiency [fConvergenceGF = 1]



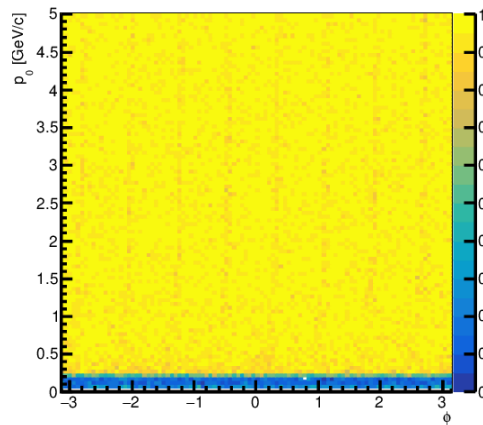
efficiency [fConvergenceGF = ±1]



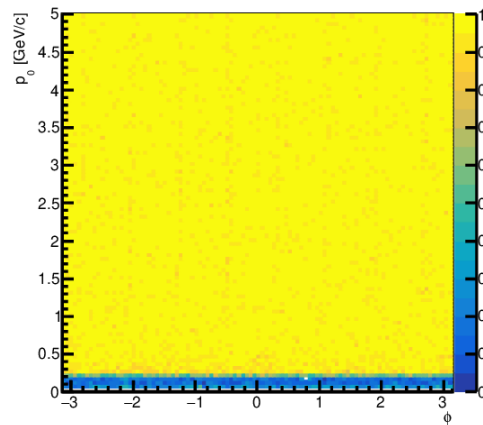
efficiency [$\chi^2/\text{ndf} < 2$]



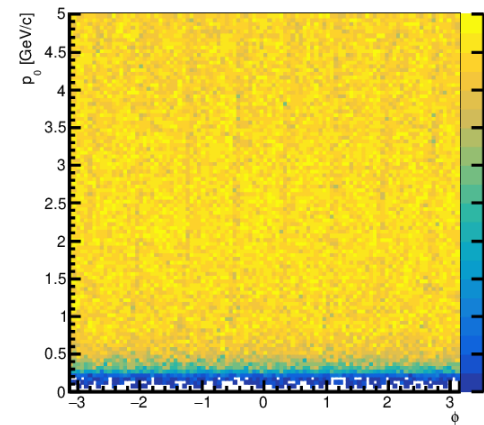
efficiency [$\chi^2/\text{ndf} < 4$]



efficiency [$\chi^2/\text{ndf} < 10$]



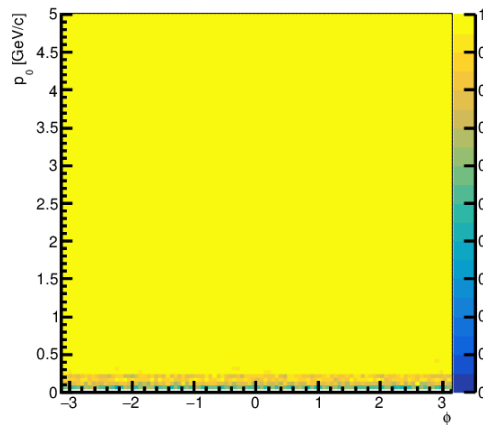
efficiency [all cuts]



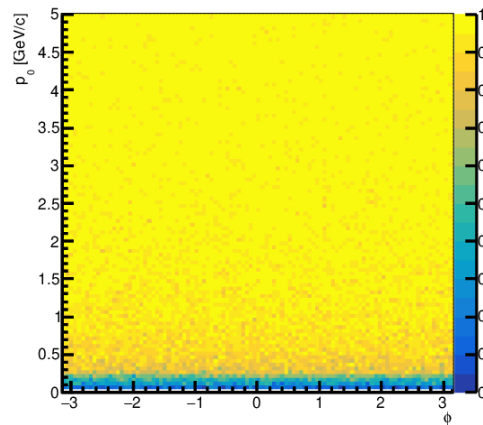
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initial values
from MC

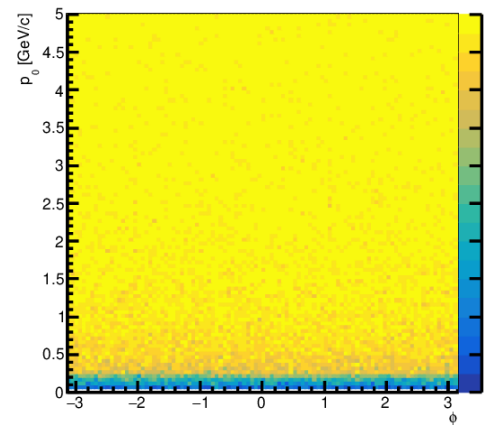
efficiency [!HasErrorMesg()]



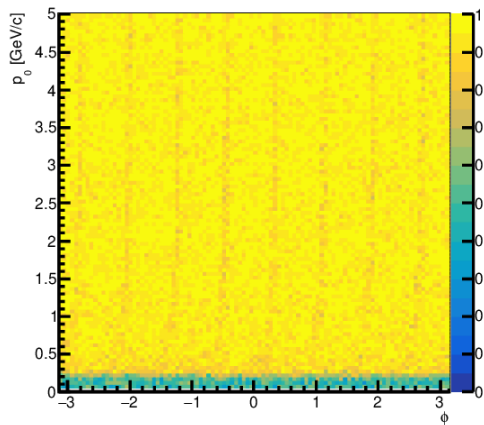
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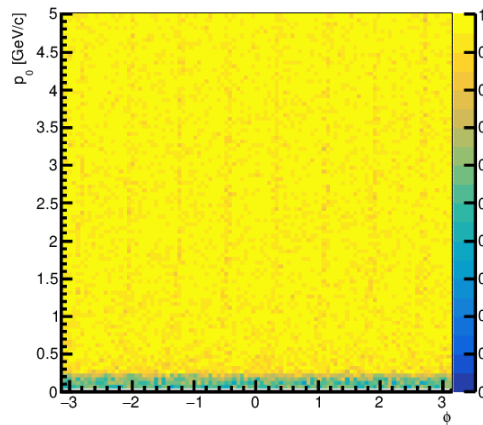
efficiency [fConvergencyGF = ±1]



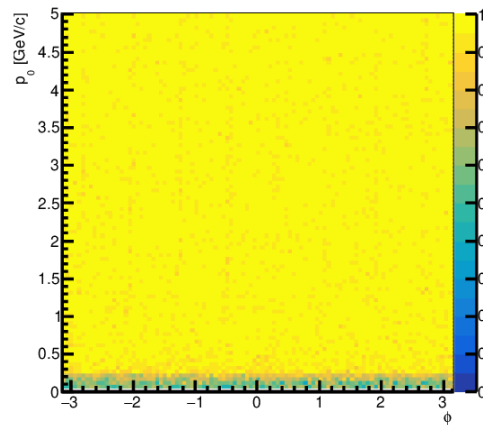
efficiency [$\chi^2/\text{ndf} < 2$]



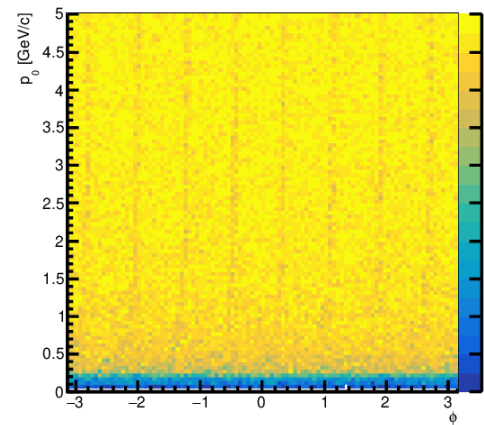
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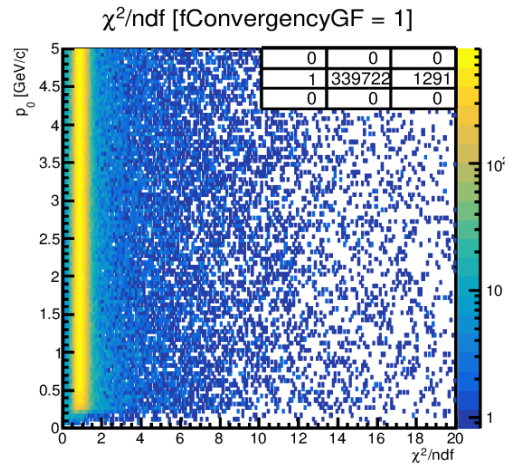
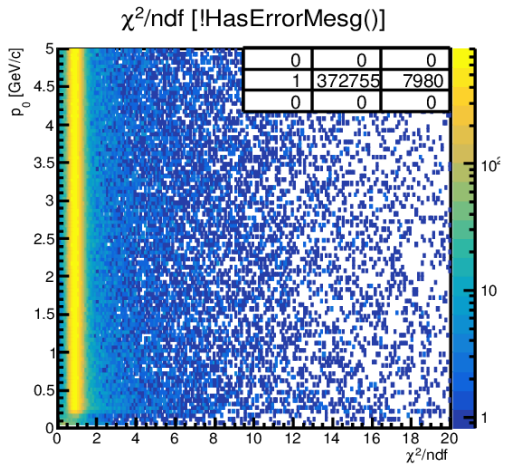
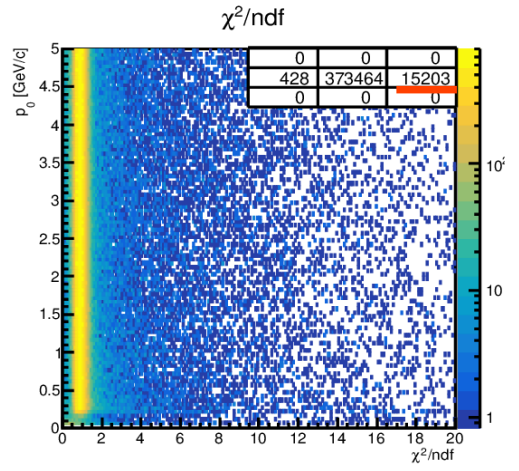
efficiency [$\chi^2/\text{ndf} < 10$]



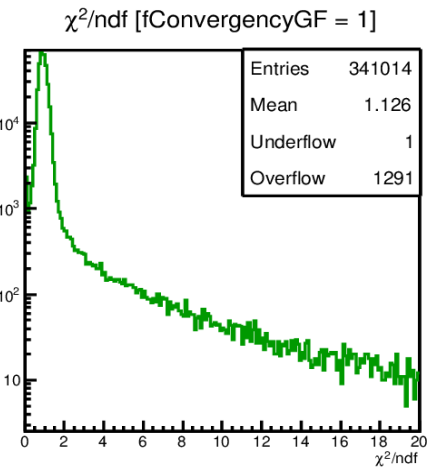
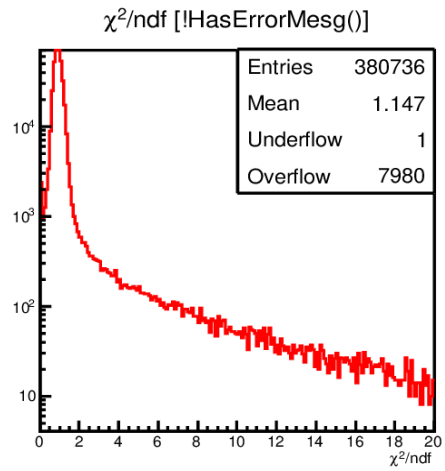
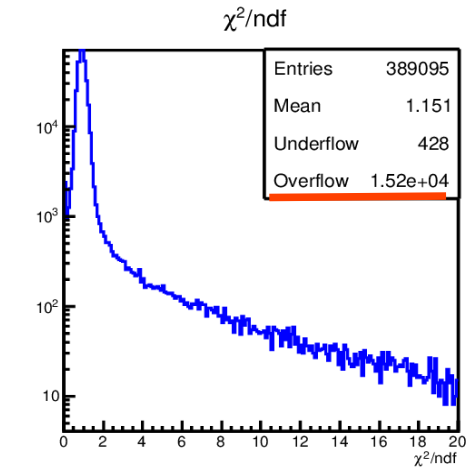
efficiency [all cuts]



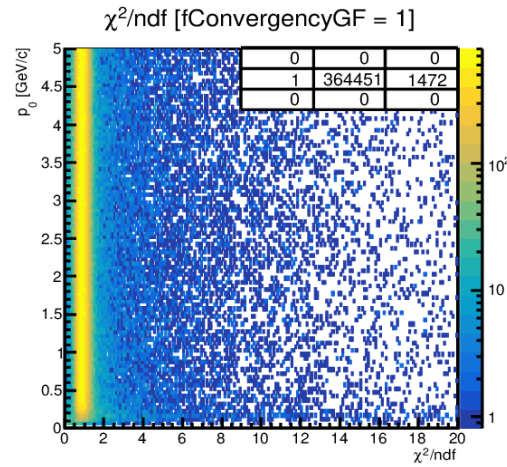
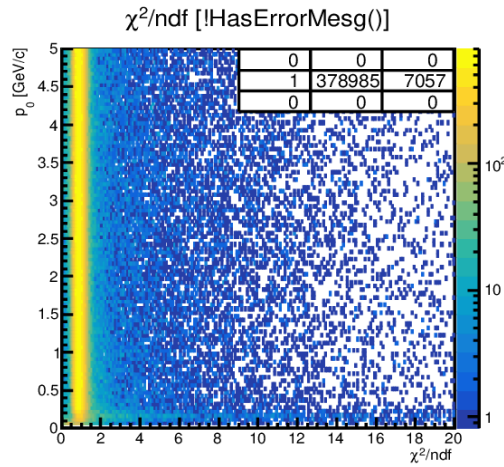
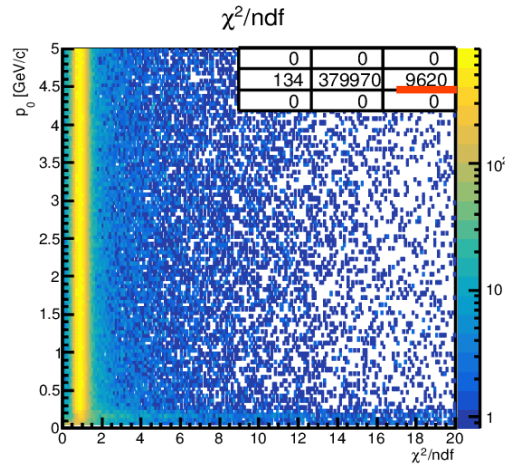
χ^2/ndf distribution. Pions, $0 < p_0 < 5 \text{ GeV}/c$, $Z_{\text{prim.vtx.}} = 0$.



current
initialisation
procedure



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initial values
from MC

