Selection Update

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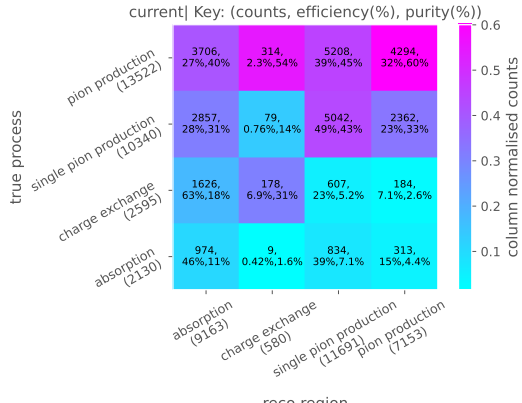
- Current selection is not great.
- regions were defined by the number of $\pi^{\pm}$ and π^{0} reconstructed

	$\pi^{\pm}$	π^{0}
abs	0	0
cex	0	1
spip	1	0
pip	>1	≥ 0
	>0	1

- previous slides here, where I started by improving the absorption region
- found that a γ veto and loose $\pi^{\pm}$ and γ definition can improve absorption identification.
- try to use these concepts to improve the other regions



particle selections

- strict particle selection to select PFOs with high purity. Useful when we need to positively ID objects
- loose particle selection to select PFOs with high efficiency. Useful to veto objects

loose γ
$(\chi^2/ndf)_p > 61.2$
track score < 0.45
nHits > 31
$d < 114$
$b < 80$

strict γ
$(\chi^2/ndf)_p > 61.2$
track score < 0.45
nHits > 80
$3 < d < 90$
$b < 20$

loose $\pi^{\pm}$
$(\chi^2/ndf)_p > 61.2$
track score > 0.39
median $dE/dX < 6.3$

strict $\pi^{\pm}$
$(\chi^2/ndf)_p > 61.2$
track score ≥ 0.5
nHits > 20
$0.5 <$ median $dE/dX < 2.8$

π^0
strict $\gamma = 2$
$50 < m_{\gamma\gamma} < 250$
$10 < \theta < 80$

- $(\chi^2/ndf)_p$ is a PID metric to identify protons, used to exclude protons in all my selections
- d is distance from PFO start position to beam end position
- b is impact parameter of PFO wrt the beam end position
- Note that strict particles are a subset of the loose particles
- see backups for the cut tables and plots for the selections

Updated region definitions

- re-define regions using new objects
- exclude events where we are less confident e.g. events with only 1 loose $\pi^{\pm}$ are removed

	loose $\pi^{\pm}$	loose γ	$\pi^{\pm}$	γ	π^0
abs	0	0	0	0	-
cex	0	0	0	2	1
spip	0	0	1	0	-
pip	-	-	>1	-	-
	-	-	>0	2	1
	-	-	-	>2	-
	-	>2	-	-	-

all other events are removed

- dashed lines represent categories which are ignored
- found three different selections increasing in signal purity.

different region selections

High purity

	loose $\pi^{\pm}$	loose γ	$\pi^{\pm}$	γ	π^0
abs	0	0	0	0	-
cex	0	0	0	2	1
spip	0	0	1	0	-
pip	-	-	>1	-	-
	-	-	>0	2	1
	-	-	-	>2	-
	-	>2	-	-	-

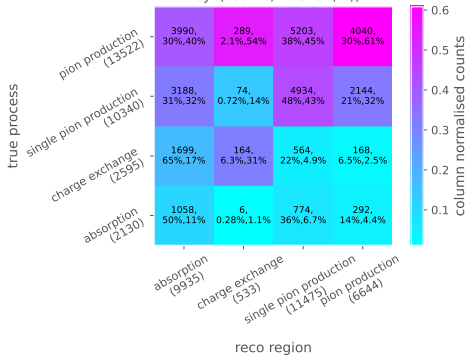
Moderate efficiency

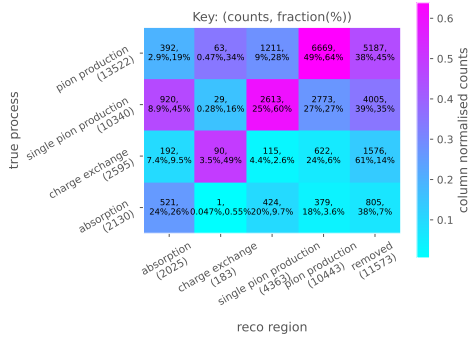
	loose $\pi^{\pm}$	loose γ	$\pi^{\pm}$	γ	π^0
abs	0	0	0	0	-
cex	0	0	0	2	1
	0	0	0	1	-
spip	-	0	1	0	-
pip	-	-	>1	-	-
	-	-	>0	2	1
	-	-	-	>2	-
	-	>2	-	-	-

High efficiency

	loose $\pi^{\pm}$	loose γ	$\pi^{\pm}$	γ	π^0
abs	-	-	0	0	-
cex	0	0	0	2	1
	0	0	0	1	-
spip	-	-	1	0	-
pip	>0	>0	>0	>0	-
	1	-	0	1	0
	-	>1	0	-	0
	>0	<3	0	-	0

High purity

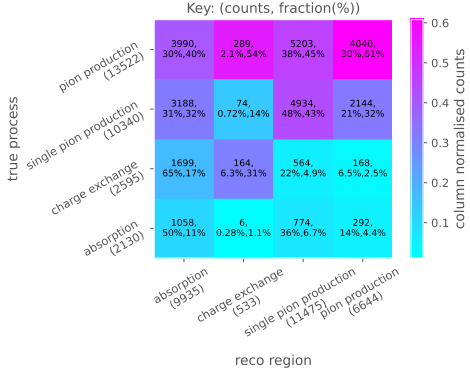


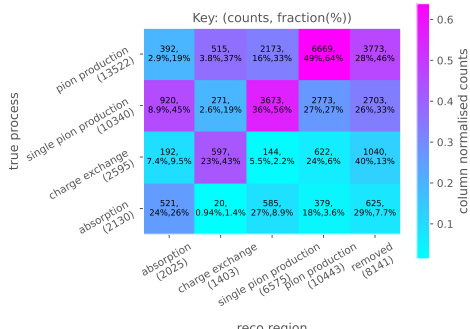


	loose $\pi^{\pm}$	loose γ	$\pi^{\pm}$	γ	π^0
abs	-	-	0	-	0
cex	-	-	0	-	1
spip	-	-	1	-	0
pip	-	-	>1	-	≥ 0
	-	-	>0	-	1

	loose $\pi^{\pm}$	loose γ	$\pi^{\pm}$	γ	π^0
abs	0	0	0	0	-
cex	0	0	0	2	1
spip	0	0	1	0	-
pip	-	-	>1	-	-
	-	-	>0	2	1
	-	-	-	>2	-
	-	>2	-	-	-

Moderate efficiency

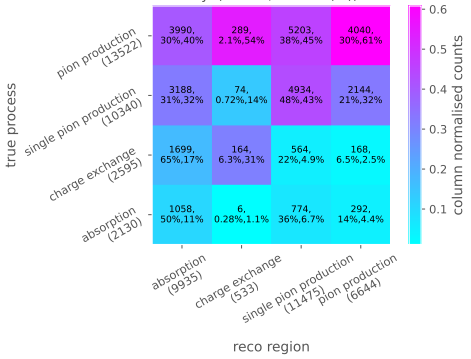


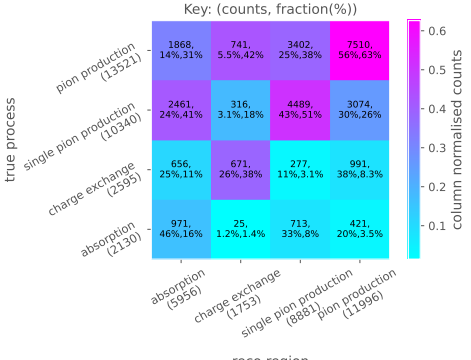


	loose $\pi^{\pm}$	loose γ	$\pi^{\pm}$	γ	π^0
abs	-	-	0	-	0
cex	-	-	0	-	1
spip	-	-	1	-	0
pip	-	-	>1	-	$\geq$ 0
	-	-	>0	-	1

	loose $\pi^{\pm}$	loose γ	$\pi^{\pm}$	γ	π^0
abs	0	0	0	0	-
cex	0	0	0	2	1
	0	0	0	1	-
spip	-	0	1	0	-
pip	-	-	>1	-	-
	-	-	>0	2	1
	-	-	-	>2	-
	-	>2	-	-	-

High efficiency





	loose $\pi^{\pm}$	loose γ	$\pi^{\pm}$	γ	π^0
abs	-	-	0	-	0
cex	-	-	0	-	1
spip	-	-	1	-	0
pip	-	-	>1	-	≥ 0
	-	-	>0	-	1

	loose $\pi^{\pm}$	loose γ	$\pi^{\pm}$	γ	π^0
abs	-	-	0	0	-
cex	0	0	0	2	1
	0	0	0	1	-
spip	-	-	1	0	-
pip	>0	>0	>0	>0	-
	1	-	0	1	0
	-	>1	0	-	0
	>0	<3	0	-	0

Performance metrics

- quantify the performance of a selection

$$pe = p \times e = \frac{N_s^r}{N^r} \times \frac{N_s^r}{N_s} \tag{1}$$

- N^r is number of events in a region
- N_s^r is number of signal events in a region
- N_s is the number of true events which pass the beam particle selection

Comparing selections

High purity

	loose $\pi^{\pm}$	loose γ	$\pi^{\pm}$	γ	π^0
abs	0	0	0	0	-
cex	0	0	0	2	1
spip	0	0	1	0	-
pip	-	-	>1	-	-
	-	-	>0	2	1
	-	-	-	>2	-
	-	>2	-	-	-

	pe
abs	0.063
cex	0.017
spip	0.15
pip	0.31

Moderate efficiency

	loose $\pi^{\pm}$	loose γ	$\pi^{\pm}$	γ	π^0
abs	0	0	0	0	-
cex	0	0	0	2	1
	0	0	0	1	-
spip	-	0	1	0	-
pip	-	-	>1	-	-
	-	-	>0	2	1
	-	-	-	>2	-
	-	>2	-	-	-

	pe
abs	0.063
cex	0.098
spip	0.20
pip	0.31

High efficiency

	loose $\pi^{\pm}$	loose γ	$\pi^{\pm}$	γ	π^0
abs	-	-	0	0	-
cex	0	0	0	2	1
	0	0	0	1	-
spip	-	-	1	0	-
pip	>0	>0	>0	>0	-
	1	-	0	1	0
	-	>1	0	-	0
	>0	<3	0	-	0

	pe
abs	0.074
cex	0.099
spip	0.22
pip	0.35

Normalisation cross check

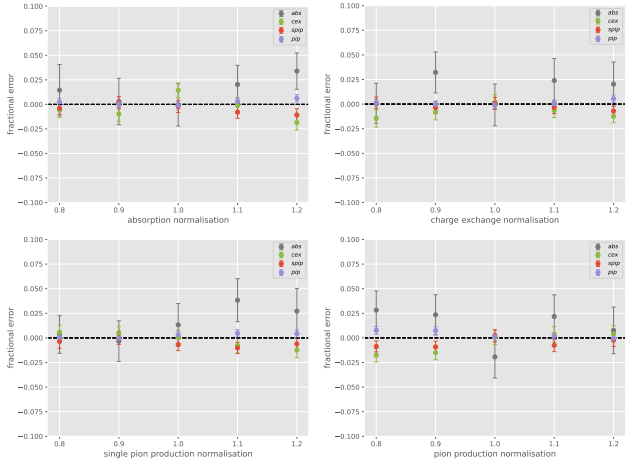
- normalisation cross check calculates the inaccuracy in the fitted values, compare fit inaccuracy to performance metric for each selection.
- fit cross check:
  1. generate toy template (fixed)
  2. generate toy data, for normalisations between 0.8 and 1.2
  3. perform fit, calculate inaccuracy for each POI μ_s:

$$N_s^{pred} = \mu_s^{fit} \sum_c \lambda_{cs}; \ \Delta N_s^{pred} = \Delta\mu_s^{fit} \sum_c \lambda_{cs} \tag{2}$$

$$f_s = \frac{N_s^{pred} - N_s^{true}}{N_s^{true}}; \ \Delta f_s = \frac{\Delta N_s^{pred}}{N_s^{true}} \tag{3}$$

  4. repeat 3 times, calculate average f_s and Δf_s

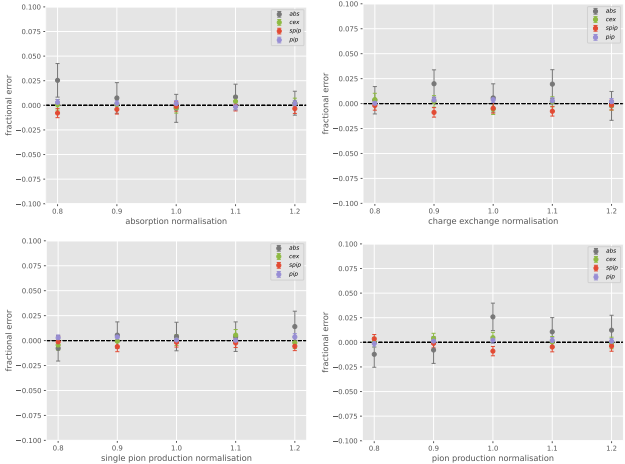
High efficiency



	pe
abs	0.074
cex	0.099
spip	0.22
pip	0.35

	abs(%)	**cex(%)**	**spip(%)**	**pip(%)**
abs	3.4 ± 2	1.9 ± 0.8	1.1 ± 0.6	0.6 ± 0.4
spip	3.8 ± 2	1.2 ± 0.7	1.0 ± 0.7	0.5 ± 0.4
pip	2.8 ± 2	1.8 ± 0.7	0.9 ± 0.6	0.8 ± 0.4
cex	3.2 ± 2	1.5 ± 0.9	0.7 ± 0.6	0.5 ± 0.4

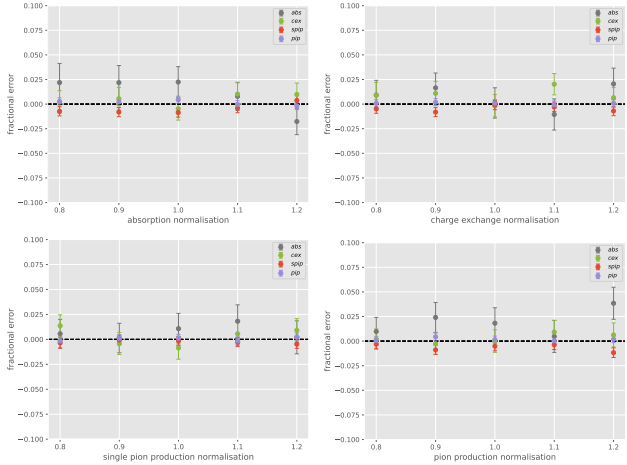
Moderate efficiency



	pe
abs	0.063
cex	0.098
spip	0.20
pip	0.31

	abs(%)	**cex(%)**	**spip(%)**	**pip(%)**
abs	2.5 ± 2	0.4 ± 0.5	0.8 ± 0.5	0.3 ± 0.3
spip	1.4 ± 1	0.6 ± 0.5	0.6 ± 0.5	0.4 ± 0.3
pip	2.6 ± 1	0.5 ± 0.5	0.9 ± 0.5	0.2 ± 0.3
cex	2.0 ± 1	0.6 ± 0.6	0.9 ± 0.5	0.4 ± 0.3

High purity

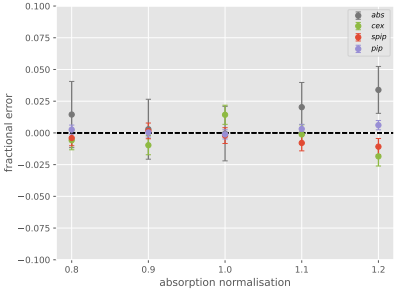


	pe
abs	0.063
cex	0.017
spip	0.15
pip	0.31

	abs(%)	**cex(%)**	**spip(%)**	**pip(%)**
abs	2.2 ± 2	1.0 ± 1	0.9 ± 0.5	0.4 ± 0.4
spip	1.8 ± 1	1.4 ± 1	0.5 ± 0.5	0.2 ± 0.4
pip	3.8 ± 2	0.9 ± 1	1.2 ± 0.5	0.4 ± 0.4
cex	2.1 ± 2	2.0 ± 1	0.8 ± 0.5	0.2 ± 0.4

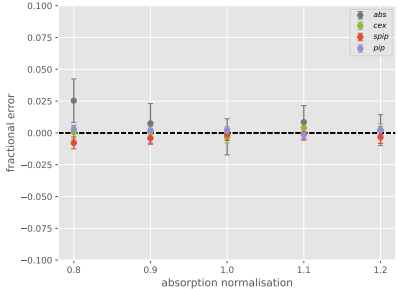
Comparing absorption normalisation test

high efficiency



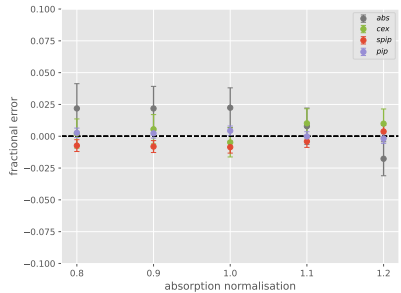
	pe
abs	0.074
cex	0.099
spip	0.22
pip	0.35

moderate efficiency



	pe
abs	0.063
cex	0.098
spip	0.20
pip	0.31

high purity



	pe
abs	0.063
cex	0.017
spip	0.15
pip	0.31

Comparing cross check summary tables

high efficiency

	abs(%)	cex(%)	spip(%)	pip(%)
abs	3.4 ± 2	1.9 ± 0.8	1.1 ± 0.6	0.6 ± 0.4
spip	3.8 ± 2	1.2 ± 0.7	1.0 ± 0.7	0.5 ± 0.4
pip	2.8 ± 2	1.8 ± 0.7	0.9 ± 0.6	0.8 ± 0.4
cex	3.2 ± 2	1.5 ± 0.9	0.7 ± 0.6	0.5 ± 0.4

	pe
abs	0.074
cex	0.099
spip	0.22
pip	0.35

moderate efficiency

	abs(%)	cex(%)	spip(%)	pip(%)
abs	2.5 ± 2	0.4 ± 0.5	0.8 ± 0.5	0.3 ± 0.3
spip	1.4 ± 1	0.6 ± 0.5	0.6 ± 0.5	0.4 ± 0.3
pip	2.6 ± 1	0.5 ± 0.5	0.9 ± 0.5	0.2 ± 0.3
cex	2.0 ± 1	0.6 ± 0.6	0.9 ± 0.5	0.4 ± 0.3

	pe
abs	0.063
cex	0.098
spip	0.20
pip	0.31

high purity

	abs(%)	cex(%)	spip(%)	pip(%)
abs	2.2 ± 2	1.0 ± 1	0.9 ± 0.5	0.4 ± 0.4
spip	1.8 ± 1	1.4 ± 1	0.5 ± 0.5	0.2 ± 0.4
pip	3.8 ± 2	0.9 ± 1	1.2 ± 0.5	0.4 ± 0.4
cex	2.1 ± 2	2.0 ± 1	0.8 ± 0.5	0.2 ± 0.4

	pe
abs	0.063
cex	0.017
spip	0.15
pip	0.31

Summary

- three different options for region identification found
- all options are an improvement from the original region identification
- found that region identification with high efficiency has the best *pe*
- fit cross check showed moderate efficiency selection has (slightly) better fit predictions
- analysis favours higher purity selections, but if template statistics are too low, model predictions can become more inaccurate
- use moderate efficiency region identification for analysis.

Backup

cutflow tables: loose photon

Name	Remaining PFOs	$\pi^{\pm}$	$\pi^{\pm}$:2nd	γ:2nd	γ:beam π^0	γ:other π^0	e^-	e^+	p	other	$\mu^{\pm}$
Beam particle selection	101562	18689	9853	1054	16218	7379	201	2450	36338	1455	7925
Chi2ProtonSelection	70531	17306	9030	832	15233	6983	190	2224	10692	453	7588
TrackScoreCut	30712	2114	2241	751	13972	6322	176	1952	1164	61	1959
NHitsCut	26462	1596	1495	325	13222	6036	145	1586	599	20	1438
BeamParticleDistanceCut	24072	1554	1371	194	12916	5377	87	1250	579	19	725
BeamParticleIPCut	23578	1549	1339	181	12800	5204	81	1189	574	19	642

Name	Remaining PFOs	$\pi^{\pm}$	$\pi^{\pm}$:2nd	γ:2nd	γ:beam π^0	γ:other π^0	e^-	e^+	p	other	$\mu^{\pm}$
Beam particle selection	1.000000	0.184016	0.097015	0.010378	0.159686	0.072655	0.001979	0.024123	0.357791	0.014326	0.078031
Chi2ProtonSelection	1.000000	0.245367	0.128029	0.011796	0.215976	0.099006	0.002694	0.031532	0.151593	0.006423	0.107584
TrackScoreCut	1.000000	0.068833	0.072968	0.024453	0.454936	0.205848	0.005731	0.063558	0.037900	0.001986	0.063786
NHitsCut	1.000000	0.060313	0.056496	0.012282	0.499660	0.228101	0.005480	0.059935	0.022636	0.000756	0.054342
BeamParticleDistanceCut	1.000000	0.064556	0.056954	0.008059	0.536557	0.223372	0.003614	0.051928	0.024053	0.000789	0.030118
BeamParticleIPCut	1.000000	0.065697	0.056790	0.007677	0.542879	0.220714	0.003435	0.050428	0.024345	0.000806	0.027229

Name	Remaining PFOs	$\pi^{\pm}$	$\pi^{\pm}$:2nd	γ:2nd	γ:beam π^0	γ:other π^0	e^-	e^+	p	other	$\mu^{\pm}$
Beam particle selection	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
Chi2ProtonSelection	0.694462	0.925999	0.916472	0.789374	0.939265	0.946334	0.945274	0.907755	0.294237	0.311340	0.957476
TrackScoreCut	0.302397	0.113115	0.227443	0.712524	0.861512	0.856756	0.875622	0.796735	0.032033	0.041924	0.247192
NHitsCut	0.260550	0.085398	0.151730	0.308349	0.815267	0.817997	0.721393	0.647347	0.016484	0.013746	0.181451
BeamParticleDistanceCut	0.237018	0.083151	0.139145	0.184061	0.796399	0.728690	0.432836	0.510204	0.015934	0.013058	0.091483
BeamParticleIPCut	0.232154	0.082883	0.135898	0.171727	0.789247	0.705245	0.402985	0.485306	0.015796	0.013058	0.081009

cutflow tables: loose pi

Name	Remaining PFOs	$\pi^{\pm}$	$\pi^{\pm}$:2nd	γ:2nd	γ:beam π^0	γ:other π^0	e^-	e^+	p	other	$\mu^{\pm}$
Beam particle selection	101562	18689	9853	1054	16218	7379	201	2450	36338	1455	7925
Chi2ProtonSelection	70531	17306	9030	832	15233	6983	190	2224	10692	453	7588
TrackScoreCut	41831	15651	7038	109	1791	923	23	370	9765	405	5756
PiPlusSelection	40987	15579	6998	105	1755	917	22	360	9131	372	5748

Name	Remaining PFOs	$\pi^{\pm}$	$\pi^{\pm}$:2nd	γ:2nd	γ:beam π^0	γ:other π^0	e^-	e^+	p	other	$\mu^{\pm}$
Beam particle selection	1.000000	0.184016	0.097015	0.010378	0.159686	0.072655	0.001979	0.024123	0.357791	0.014326	0.078031
Chi2ProtonSelection	1.000000	0.245367	0.128029	0.011796	0.215976	0.099006	0.002694	0.031532	0.151593	0.006423	0.107584
TrackScoreCut	1.000000	0.374148	0.168248	0.002606	0.042815	0.022065	0.000550	0.008845	0.233439	0.009682	0.137601
PiPlusSelection	1.000000	0.380096	0.170737	0.002562	0.042818	0.022373	0.000537	0.008783	0.222778	0.009076	0.140240

Name	Remaining PFOs	$\pi^{\pm}$	$\pi^{\pm}$:2nd	γ:2nd	γ:beam π^0	γ:other π^0	e^-	e^+	p	other	$\mu^{\pm}$
Beam particle selection	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
Chi2ProtonSelection	0.694462	0.925999	0.916472	0.789374	0.939265	0.946334	0.945274	0.907755	0.294237	0.311340	0.957476
TrackScoreCut	0.411876	0.837444	0.714300	0.103416	0.110433	0.125085	0.114428	0.151020	0.268727	0.278351	0.726309
PiPlusSelection	0.403566	0.833592	0.710241	0.099620	0.108213	0.124272	0.109453	0.146939	0.251280	0.255670	0.725300

cutflow tables: pi

Name	Remaining PFOs	$\pi^{\pm}$	$\pi^{\pm}$:2nd	γ:2nd	γ:beam π^0	γ:other π^0	e^-	e^+	p	other	$\mu^{\pm}$
Beam particle selection	101562	18689	9853	1054	16218	7379	201	2450	36338	1455	7925
Chi2ProtonSelection	70531	17306	9030	832	15233	6983	190	2224	10692	453	7588
TrackScoreCut	38122	14749	6540	67	931	471	11	206	9292	377	5478
NHitsCut	36560	14484	6385	20	856	452	6	181	8395	327	5454
PiPlusSelection	27762	12273	5222	15	493	321	3	114	4221	205	4895

Name	Remaining PFOs	$\pi^{\pm}$	$\pi^{\pm}$:2nd	γ:2nd	γ:beam π^0	γ:other π^0	e^-	e^+	p	other	$\mu^{\pm}$
Beam particle selection	1.000000	0.184016	0.097015	0.010378	0.159686	0.072655	0.001979	0.024123	0.357791	0.014326	0.078031
Chi2ProtonSelection	1.000000	0.245367	0.128029	0.011796	0.215976	0.099006	0.002694	0.031532	0.151593	0.006423	0.107584
TrackScoreCut	1.000000	0.386889	0.171554	0.001758	0.024422	0.012355	0.000289	0.005404	0.243744	0.009889	0.143697
NHitsCut	1.000000	0.396171	0.174644	0.000547	0.023414	0.012363	0.000164	0.004951	0.229623	0.008944	0.149179
PiPlusSelection	1.000000	0.442079	0.188099	0.000540	0.017758	0.011563	0.000108	0.004106	0.152042	0.007384	0.176320

Name	Remaining PFOs	$\pi^{\pm}$	$\pi^{\pm}$:2nd	γ:2nd	γ:beam π^0	γ:other π^0	e^-	e^+	p	other	$\mu^{\pm}$
Beam particle selection	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
Chi2ProtonSelection	0.694462	0.925999	0.916472	0.789374	0.939265	0.946334	0.945274	0.907755	0.294237	0.311340	0.957476
TrackScoreCut	0.375357	0.789181	0.663757	0.063567	0.057405	0.063830	0.054726	0.084082	0.255710	0.259107	0.691230
NHitsCut	0.359977	0.775001	0.648026	0.018975	0.052781	0.061255	0.029851	0.073878	0.231025	0.224742	0.688202
PiPlusSelection	0.273350	0.656696	0.529991	0.014231	0.030398	0.043502	0.014925	0.046531	0.116159	0.140893	0.617666

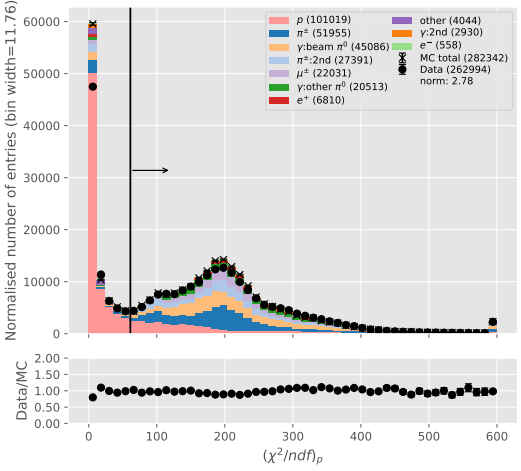
cutflow tables: photon

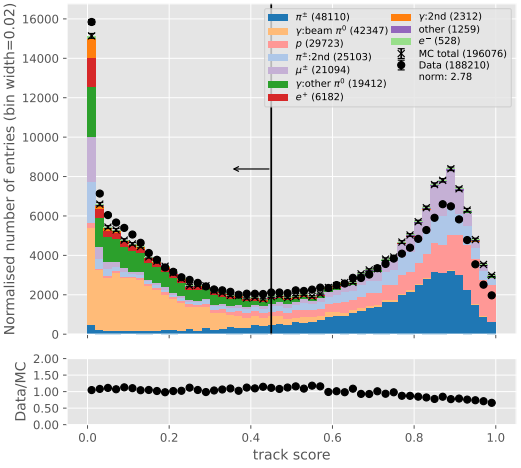
Name	Remaining PFOs	$\pi^{\pm}$	$\pi^{\pm}$:2nd	γ:2nd	γ:beam π^0	γ:other π^0	e^-	e^+	p	other	$\mu^{\pm}$
Beam particle selection	101562	18689	9853	1054	16218	7379	201	2450	36338	1455	7925
Chi2ProtonSelection	70531	17306	9030	832	15233	6983	190	2224	10692	453	7588
TrackScoreCut	30712	2114	2241	751	13972	6322	176	1952	1164	61	1959
NHitsCut	17170	759	435	114	10138	4424	71	470	200	10	549
BeamParticleDistanceCut	14176	401	305	70	9155	3532	43	313	116	3	238
BeamParticleIPCut	11104	370	229	49	7680	2361	35	196	92	3	89

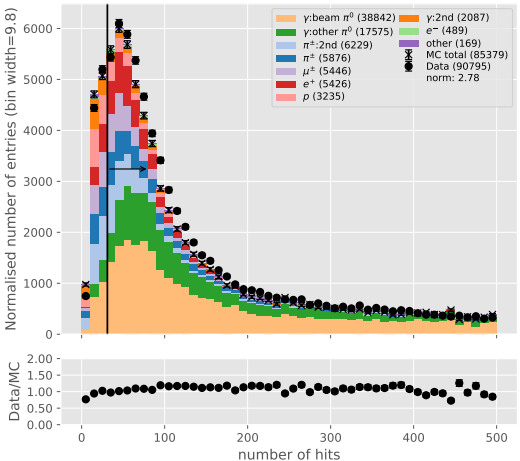
Name	Remaining PFOs	$\pi^{\pm}$	$\pi^{\pm}$:2nd	γ:2nd	γ:beam π^0	γ:other π^0	e^-	e^+	p	other	$\mu^{\pm}$
Beam particle selection	1.000000	0.184016	0.097015	0.010378	0.159686	0.072655	0.001979	0.024123	0.357791	0.014326	0.078031
Chi2ProtonSelection	1.000000	0.245367	0.128029	0.011796	0.215976	0.099006	0.002694	0.031532	0.151593	0.006423	0.107584
TrackScoreCut	1.000000	0.068833	0.072968	0.024453	0.454936	0.205848	0.005731	0.063558	0.037900	0.001986	0.063786
NHitsCut	1.000000	0.044205	0.025335	0.006639	0.590448	0.257659	0.004135	0.027373	0.011648	0.000582	0.031974
BeamParticleDistanceCut	1.000000	0.028287	0.021515	0.004938	0.645810	0.249153	0.003033	0.022080	0.008183	0.000212	0.016789
BeamParticleIPCut	1.000000	0.033321	0.020623	0.004413	0.691643	0.212626	0.003152	0.017651	0.008285	0.000270	0.008015

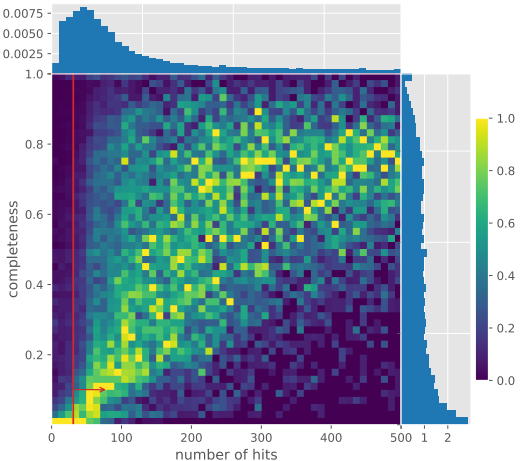
Name	Remaining PFOs	$\pi^{\pm}$	$\pi^{\pm}$:2nd	γ:2nd	γ:beam π^0	γ:other π^0	e^-	e^+	p	other	$\mu^{\pm}$
Beam particle selection	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
Chi2ProtonSelection	0.694462	0.925999	0.916472	0.789374	0.939265	0.946334	0.945274	0.907755	0.294237	0.311340	0.957476
TrackScoreCut	0.302397	0.113115	0.227443	0.712524	0.861512	0.856756	0.875622	0.796735	0.032033	0.041924	0.247192
NHitsCut	0.169059	0.040612	0.044149	0.108159	0.625108	0.599539	0.353234	0.191837	0.005504	0.006873	0.069274
BeamParticleDistanceCut	0.139580	0.021456	0.030955	0.066414	0.564496	0.478656	0.213930	0.127755	0.003192	0.002062	0.030032
BeamParticleIPCut	0.109332	0.019798	0.023242	0.046490	0.473548	0.319962	0.174129	0.080000	0.002532	0.002062	0.011230

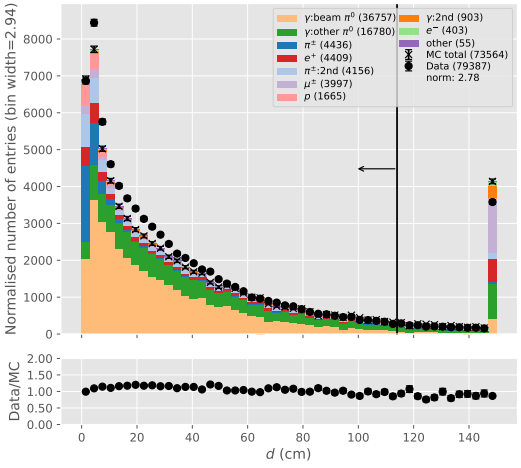
Loose photon selection

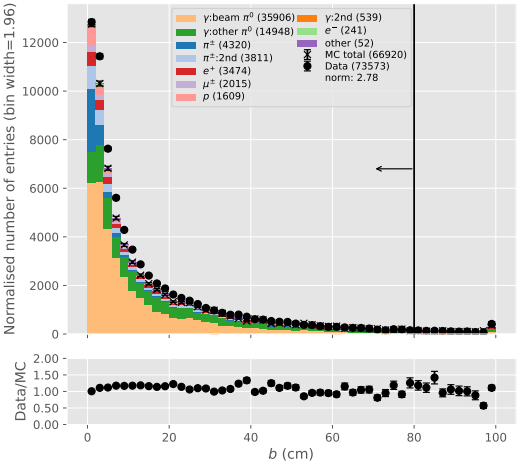

Normalised number of entries (bin width=11.76)
p (101019)
π± (51955)
γ:beam π0 (45086)
π±:2nd (27391)
μ± (22031)
γ:other π0 (20513)
e+ (6810)
other (4044)
γ:2nd (2930)
e− (558)
MC total (282342)
Data (262994)
norm: 2.78
Data/MC
(χ2/ndf)p

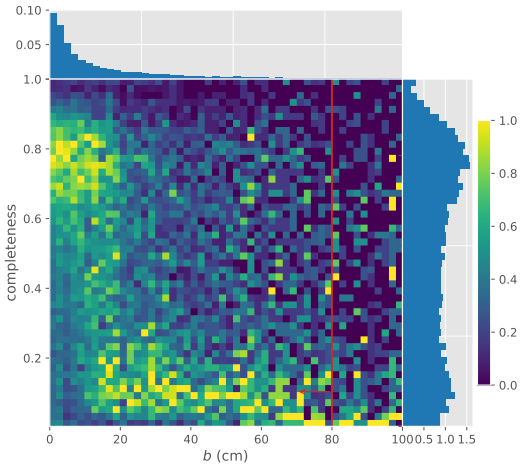

Normalised number of entries (bin width=0.02)
π± (48110)
γ:beam π0 (42347)
p (29723)
π±:2nd (25103)
μ± (21094)
γ:other π0 (19412)
e+ (6182)
γ:2nd (2312)
other (1259)
e− (528)
MC total (196076)
Data (188210)
norm: 2.78
Data/MC
track score


γ:beam π⁰ (38842)
γ:other π⁰ (17575)
π±:2nd (6229)
π± (5876)
μ± (5446)
e+ (5426)
p (3235)
γ:2nd (2087)
e− (489)
other (169)
MC total (85379)
Data (90795)
norm: 2.78
Normalised number of entries (bin width=9.8)
Data/MC
number of hits

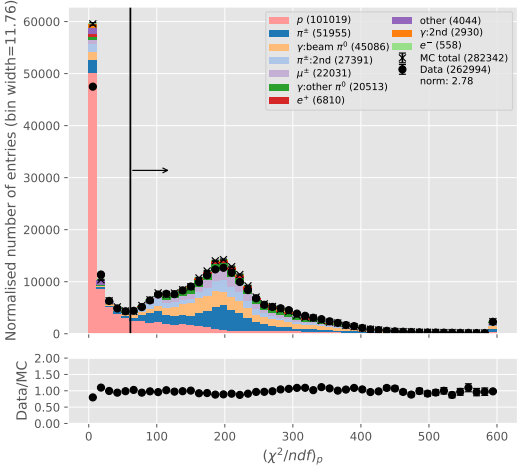

completeness
number of hits

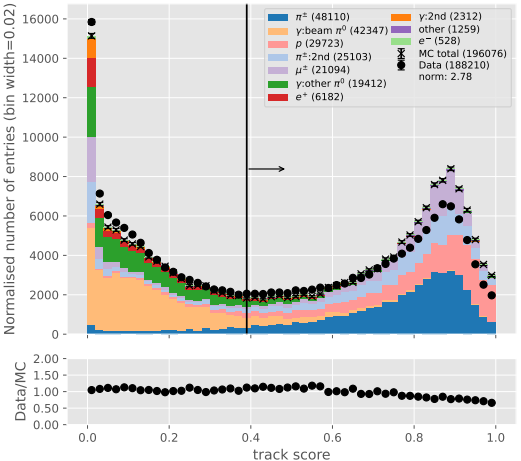

Normalised number of entries (bin width=2.94)
γ:beam π⁰ (36757)
γ:other π⁰ (16780)
π± (4436)
e⁺ (4409)
π±:2nd (4156)
μ± (3997)
p (1665)
γ:2nd (903)
e⁻ (403)
other (55)
MC total (73564)
Data (79387)
norm: 2.78
Data/MC
d (cm)

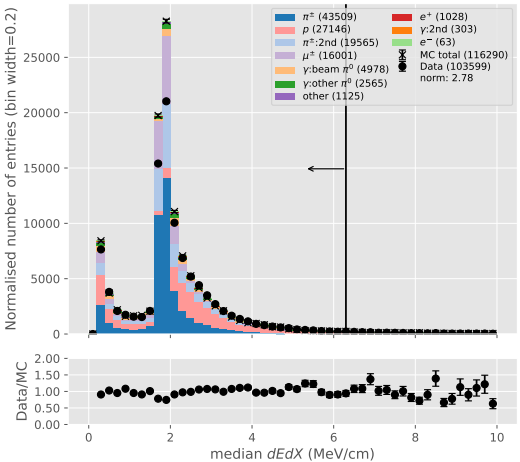

Normalised number of entries (bin width=1.96)
γ:beam π⁰ (35906)
γ:other π⁰ (14948)
π± (4320)
π±:2nd (3811)
e⁺ (3474)
μ± (2015)
p (1609)
γ:2nd (539)
e⁻ (241)
other (52)
MC total (66920)
Data (73573)
norm: 2.78
Data/MC
b (cm)


0.10
0.05
1.0
0.8
0.6
0.4
0.2
completeness
0
20
40
60
80
100
0.5
1.0
1.5
b (cm)
1.0
0.8
0.6
0.4
0.2
0.0

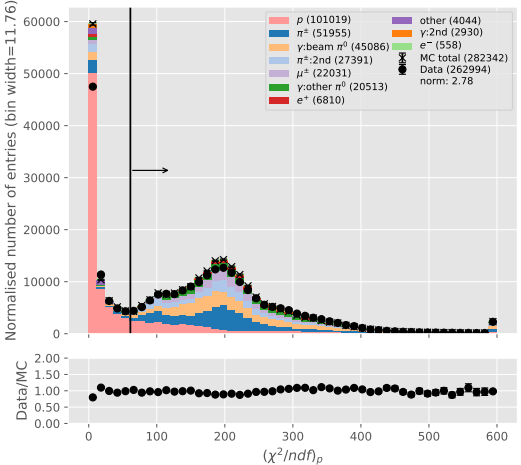
Loose pion selection

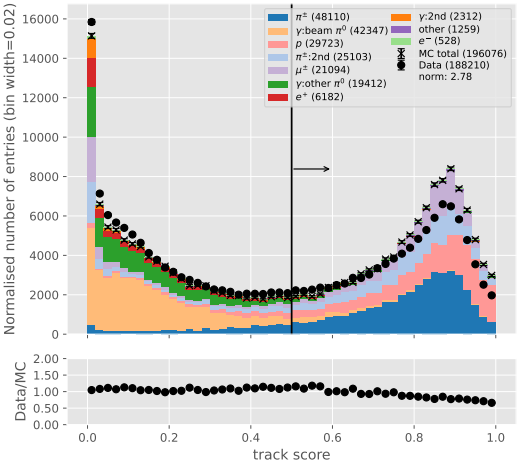

Normalised number of entries (bin width=11.76)
p (101019)
π± (51955)
γ:beam π0 (45086)
π±:2nd (27391)
μ± (22031)
γ:other π0 (20513)
e+ (6810)
other (4044)
γ:2nd (2930)
e− (558)
MC total (282342)
Data (262994)
norm: 2.78
Data/MC
(χ2/ndf)p

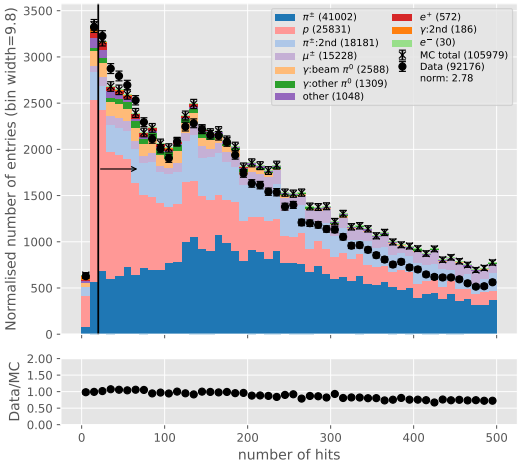

Normalised number of entries (bin width=0.02)
π± (48110)
γ:beam π0 (42347)
p (29723)
π±:2nd (25103)
μ± (21094)
γ:other π0 (19412)
e+ (6182)
γ:2nd (2312)
other (1259)
e− (528)
MC total (196076)
Data (188210)
norm: 2.78
Data/MC
track score

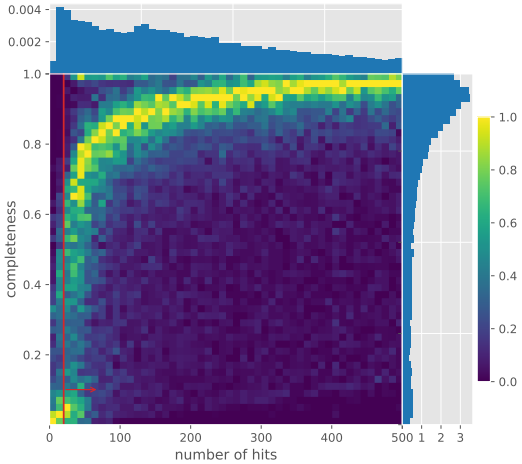

$\pi^{\pm}$ (43509)
p (27146)
$\pi^{\pm}$:2nd (19565)
$\mu^{\pm}$ (16001)
γ:beam π^0 (4978)
γ:other π^0 (2565)
other (1125)
e^+ (1028)
γ:2nd (303)
e^- (63)
MC total (116290)
Data (103599)
norm: 2.78
Normalised number of entries (bin width=0.2)
Data/MC
median $dEdX$ (MeV/cm)

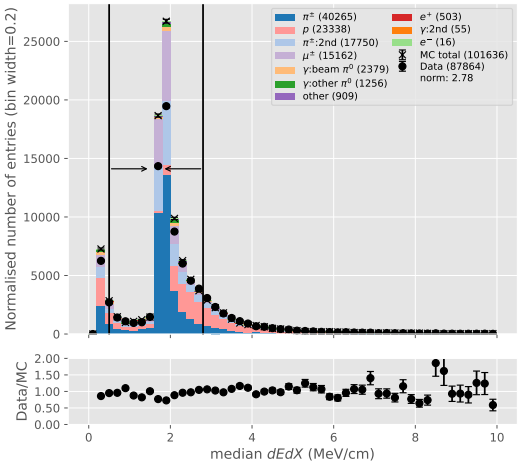
Strict pion selection


Normalised number of entries (bin width=11.76)
p (101019)
π± (51955)
γ:beam π0 (45086)
π±:2nd (27391)
μ± (22031)
γ:other π0 (20513)
e+ (6810)
other (4044)
γ:2nd (2930)
e− (558)
MC total (282342)
Data (262994)
norm: 2.78
Data/MC
(χ2/ndf)p

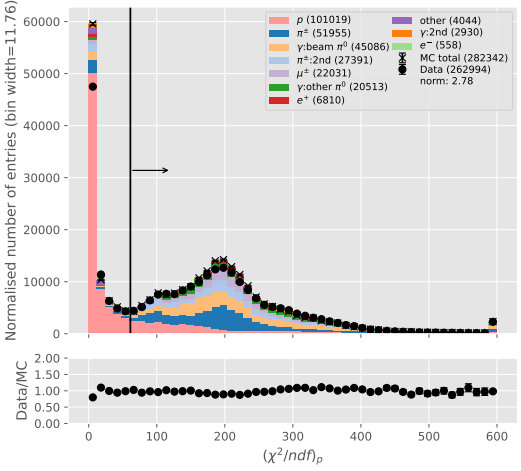

Normalised number of entries (bin width=0.02)
π± (48110)
γ:beam π0 (42347)
p (29723)
π±:2nd (25103)
μ± (21094)
γ:other π0 (19412)
e+ (6182)
γ:2nd (2312)
other (1259)
e− (528)
MC total (196076)
Data (188210)
norm: 2.78
Data/MC
track score

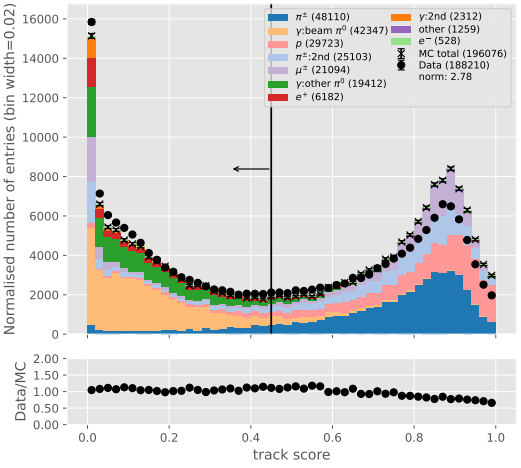

Normalised number of entries (bin width=9.8)
$\pi^{\pm}$ (41002)
p (25831)
$\pi^{\pm}$:2nd (18181)
$\mu^{\pm}$ (15228)
γ:beam π^0 (2588)
γ:other π^0 (1309)
other (1048)
e^+ (572)
γ:2nd (186)
e^- (30)
MC total (105979)
Data (92176)
norm: 2.78
Data/MC
number of hits

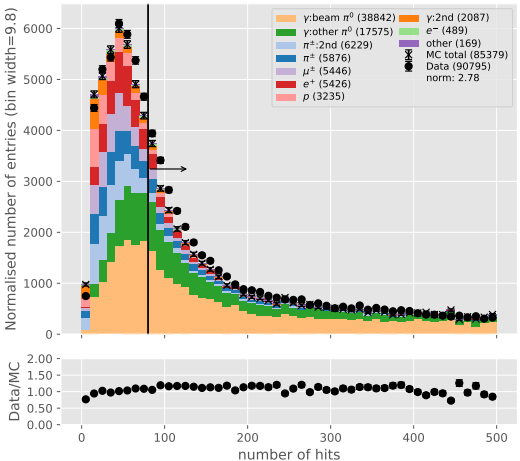

completeness
number of hits

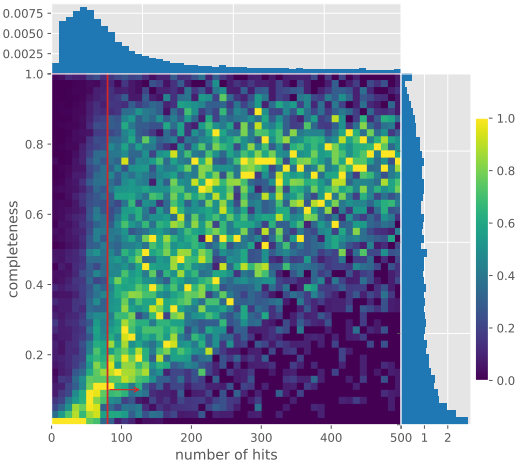

$\pi^{\pm}$ (40265)
p (23338)
$\pi^{\pm}$:2nd (17750)
$\mu^{\pm}$ (15162)
γ:beam π^0 (2379)
γ:other π^0 (1256)
other (909)
e^+ (503)
γ:2nd (55)
e^- (16)
MC total (101636)
Data (87864)
norm: 2.78
Normalised number of entries (bin width=0.2)
Data/MC
median $dEdX$ (MeV/cm)

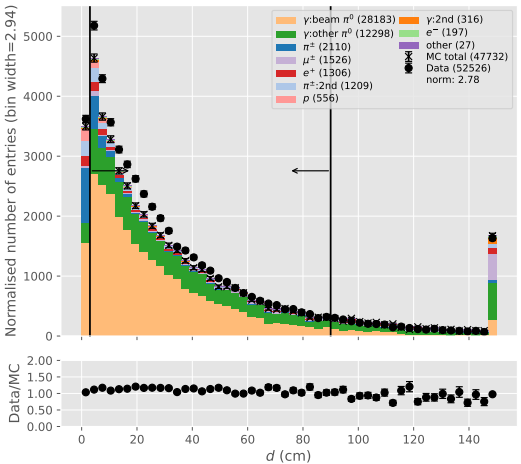
Strict photon selection

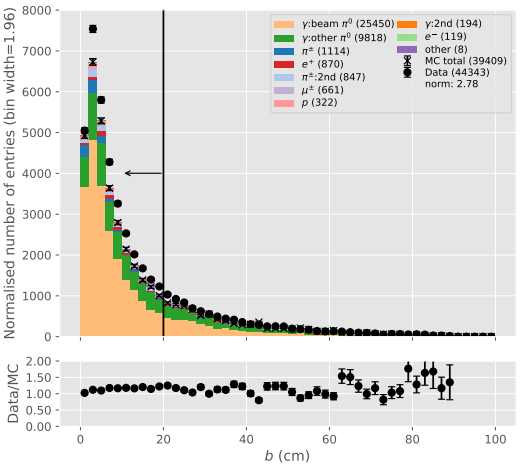

Normalised number of entries (bin width=11.76)
p (101019)
π± (51955)
γ:beam π0 (45086)
π±:2nd (27391)
μ± (22031)
γ:other π0 (20513)
e+ (6810)
other (4044)
γ:2nd (2930)
e− (558)
MC total (282342)
Data (262994)
norm: 2.78
Data/MC
(χ2/ndf)p

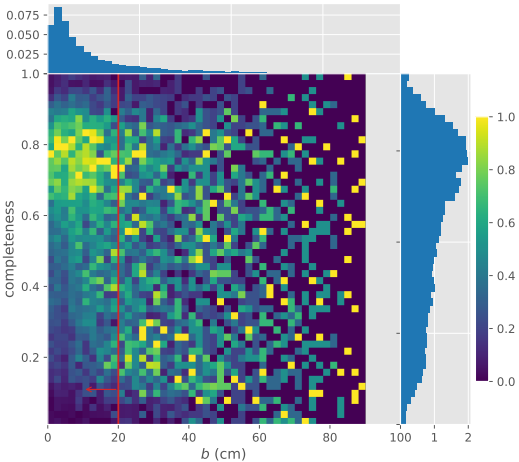

Normalised number of entries (bin width=0.02)
π± (48110)
γ:beam π0 (42347)
p (29723)
π±:2nd (25103)
μ± (21094)
γ:other π0 (19412)
e+ (6182)
γ:2nd (2312)
other (1259)
e− (528)
MC total (196076)
Data (188210)
norm: 2.78
Data/MC
track score


γ:beam π⁰ (38842)
γ:other π⁰ (17575)
π±:2nd (6229)
π± (5876)
μ± (5446)
e+ (5426)
p (3235)
γ:2nd (2087)
e− (489)
other (169)
MC total (85379)
Data (90795)
norm: 2.78
Normalised number of entries (bin width=9.8)
Data/MC
number of hits

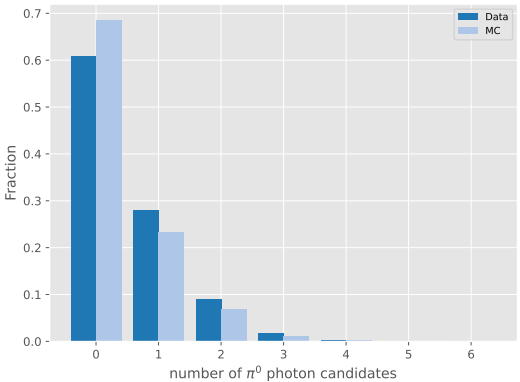

completeness
number of hits

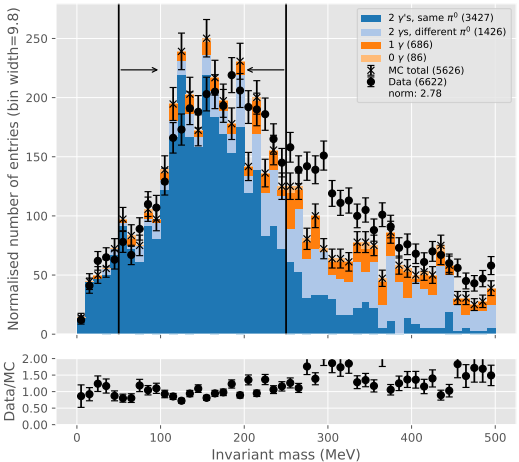

Normalised number of entries (bin width=2.94)
γ:beam π⁰ (28183)
γ:other π⁰ (12298)
π± (2110)
μ± (1526)
e⁺ (1306)
π±:2nd (1209)
p (556)
γ:2nd (316)
e⁻ (197)
other (27)
MC total (47732)
Data (52526)
norm: 2.78
Data/MC
d (cm)

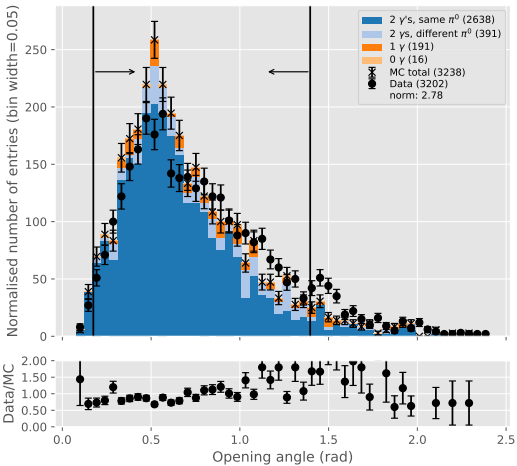

Normalised number of entries (bin width=1.96)
γ:beam π⁰ (25450)
γ:other π⁰ (9818)
π± (1114)
e⁺ (870)
π±:2nd (847)
μ± (661)
p (322)
γ:2nd (194)
e⁻ (119)
other (8)
MC total (39409)
Data (44343)
norm: 2.78
Data/MC
b (cm)


0.075
0.050
0.025
1.0
0.8
0.6
0.4
0.2
completeness
0
20
40
60
80
100
b (cm)
1
2
1.0
0.8
0.6
0.4
0.2
0.0

π^0 selection


Data
MC
Fraction
number of π^0 photon candidates


2 γ's, same π^0 (3427)
2 γs, different π^0 (1426)
1 γ (686)
0 γ (86)
MC total (5626)
Data (6622)
norm: 2.78
Normalised number of entries (bin width=9.8)
Data/MC
Invariant mass (MeV)


2 γ's, same π⁰ (2638)
2 γs, different π⁰ (391)
1 γ (191)
0 γ (16)
MC total (3238)
Data (3202)
norm: 2.78
Normalised number of entries (bin width=0.05)
Data/MC
Opening angle (rad)