Overlap for $B^0 \to K^* \mu\mu$

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Physics Performance, Trigger and Stripping meeting

University of Zurich[UZH]

August 18, 2014

Outline

University of Zurich[UZH]

Yellow pages

Previous presentations:

- $B^0 \to K^* \mu\mu$ meeting: `https://indico.cern.ch/event/290864/contribution/0/material/slides/0.pdf`.
- $B^0 \to K^* \mu\mu$ meeting: `https://indico.cern.ch/event/290864/contribution/2/material/slides/1.pdf`.
- PPTS meeting: `https://indico.cern.ch/event/288654/contribution/2/material/slides/0.pdf`.

What we are trying to explain

In July we freeze the selection for $B^0 \to K^*\mu\mu$:
LHCb-INT-2013-058

- New selection is based on simplified BDT:(less variables, larger dataset)
- Modified vetoes for exclusive backgrounds
- Moved from Stripping 17 RECO12 $\to$ Stripping 20 RECO14.
- A question raised by Tom:
  - "What is the overlap for the new and old selection on the 2011 data sample?"
- By product: check any potential bias of events not common in both RECOs, check how well we can model this things in MC(needed for acceptance corrections),

Data comparison

Method 1:

Take old ntuples and match events using a unique numbers: event-number and run-number. Study the missing events from one data sample.

Advantages

- Comparing directly samples that we do our analysis on.

Disadvantages

- Different stripping.
- Not easy to disentangle different contributions.
- Event alignment problems(recovered).

Data samples used for studies:

- RECO12, Stripping 17, full selection, old BDT. Fixed sample.
- RECO14, Stripping 20, full selection.

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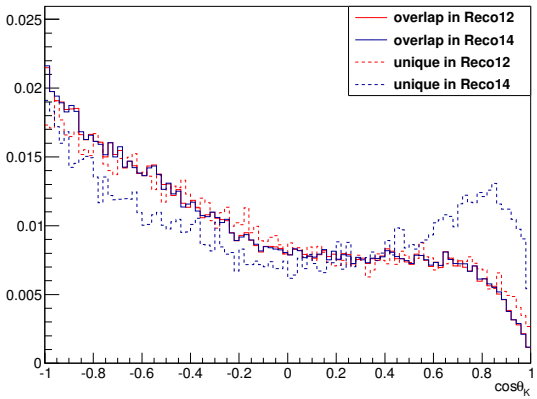
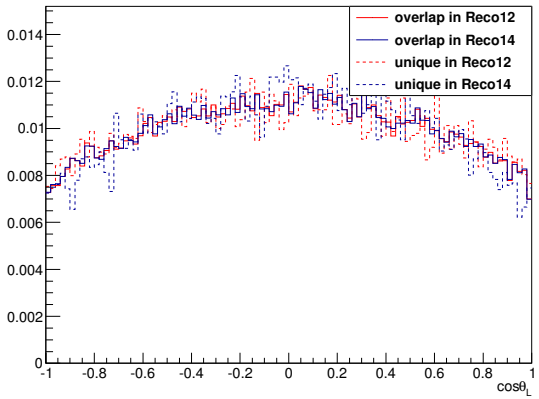
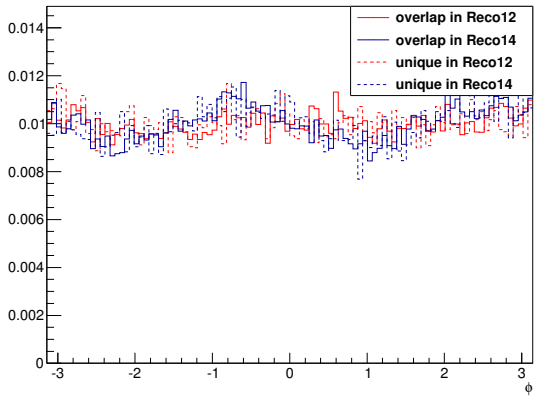
with BDT, signal region

$q^2[\mathrm{GeV}^2]$	N_{old}	N_{new}	N_{common}	$N_{\mathrm{old}}^{\mathrm{only}}$	$N_{\mathrm{new}}^{\mathrm{only}}$	$N_{\mathrm{common}}/N_{\mathrm{old}}[\%]$	$N_{\mathrm{common}}/N_{\mathrm{old}\cup\mathrm{new}}[\%]$
$[0.1, 2]$	162	156	105	57	51	64.8	49.3
$[2, 4]$	101	91	60	41	31	59.4	45.5
$[4, 6]$	111	107	66	45	41	59.5	43.4
$[6, 8]$	165	144	98	67	46	59.4	46.4
$(m_{J/\psi} \pm 0.05)^2$	102102	105000	77678	24424	27322	76.1	60.0
$[11, 12.5]$	88	110	63	25	47	71.6	46.7
$[15, 17]$	121	148	88	33	60	72.7	48.6
$[17, 19]$	79	109	59	20	50	74.7	45.7

Helicity angles in different RECO samples:







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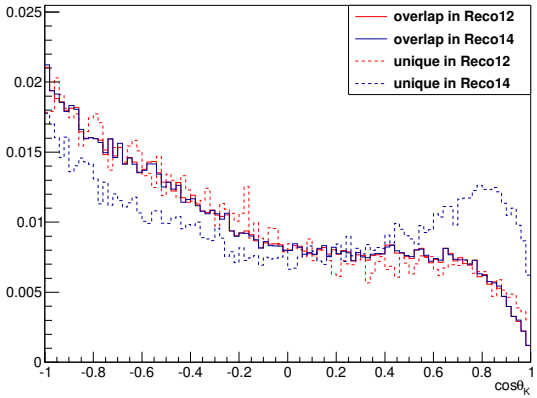
with BDT, background region

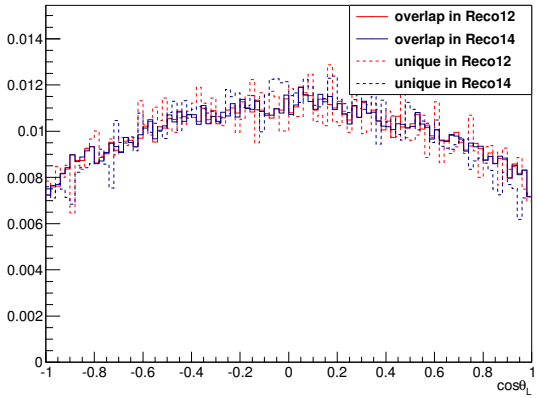
$q^2[\mathrm{GeV}^2]$	N_{old}	N_{new}	N_{common}	$N_{\mathrm{old}}^{\mathrm{only}}$	$N_{\mathrm{new}}^{\mathrm{only}}$	$N_{\mathrm{common}}/N_{\mathrm{old}}[\%]$	$N_{\mathrm{common}}/N_{\mathrm{old}\cup\mathrm{new}}[\%]$
$[0.1, 2]$	33	11	2	31	9	6.1	4.8
$[2, 4]$	50	25	10	40	15	20.0	15.4
$[4, 6]$	37	28	4	33	24	10.8	6.6
$[6, 8]$	32	32	7	25	25	21.9	12.3
$(m_{J/\psi} \pm 0.05)^2$	1751	1773	549	1202	1224	31.4	18.5
$[11, 12.5]$	35	25	9	26	16	25.7	17.6
$[15, 17]$	27	18	5	22	13	18.5	12.5
$[17, 19]$	27	15	1	26	14	3.7	2.4

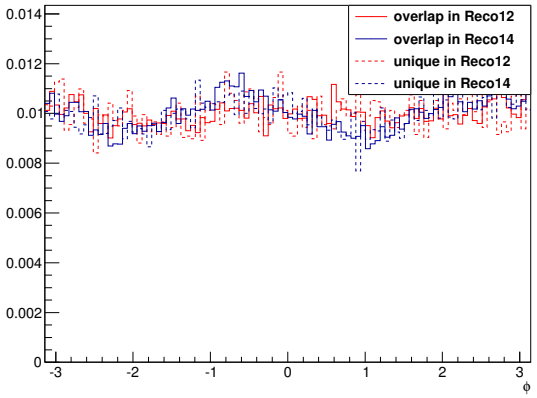
without BDT, signal region

$q^2[\mathrm{GeV}^2]$	N_{old}	N_{new}	N_{common}	$N_{\mathrm{old}}^{\mathrm{only}}$	$N_{\mathrm{new}}^{\mathrm{only}}$	$N_{\mathrm{common}}/N_{\mathrm{old}}[\%]$	$N_{\mathrm{common}}/N_{\mathrm{old}\cup\mathrm{new}}[\%]$
$[0.1, 2]$	162	320	119	43	201	73.5	32.8
$[2, 4]$	101	416	75	26	341	74.3	17.0
$[4, 6]$	111	409	78	33	331	70.3	17.6
$[6, 8]$	165	499	118	47	381	71.5	21.6
$(m_{J/\psi} \pm 0.05)^2$	102102	125084	83995	18107	41089	82.3	58.7
$[11, 12.5]$	88	359	69	19	290	78.4	18.3
$[15, 17]$	121	478	99	22	379	81.8	19.8
$[17, 19]$	79	377	65	14	312	82.3	16.6

Helicity angles in different RECO samples:







without BDT, background region

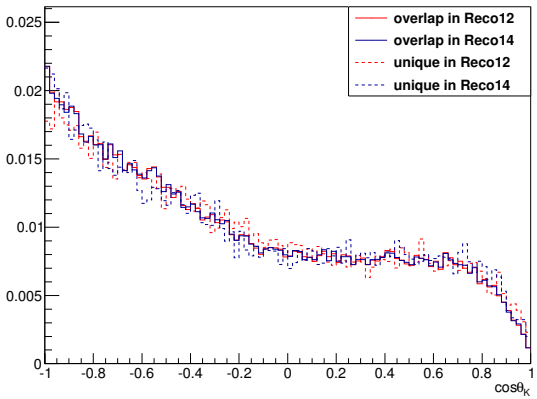
$q^2[\mathrm{GeV}^2]$	N_{old}	N_{new}	N_{common}	$N_{\mathrm{old}}^{\mathrm{only}}$	$N_{\mathrm{new}}^{\mathrm{only}}$	$N_{\mathrm{common}}/N_{\mathrm{old}}[\%]$	$N_{\mathrm{common}}/N_{\mathrm{old}\cup\mathrm{new}}[\%]$
$[0.1, 2]$	33	457	18	15	439	54.5	3.8
$[2, 4]$	50	643	33	17	610	66.0	5.0
$[4, 6]$	37	634	18	19	616	48.6	2.8
$[6, 8]$	32	650	21	11	629	65.6	3.2
$(m_{J/\psi} \pm 0.05)^2$	1751	7976	857	894	7119	48.9	9.7
$[11, 12.5]$	35	466	23	12	443	65.7	4.8
$[15, 17]$	27	603	16	11	587	59.3	2.6
$[17, 19]$	27	678	16	11	662	59.3	2.3

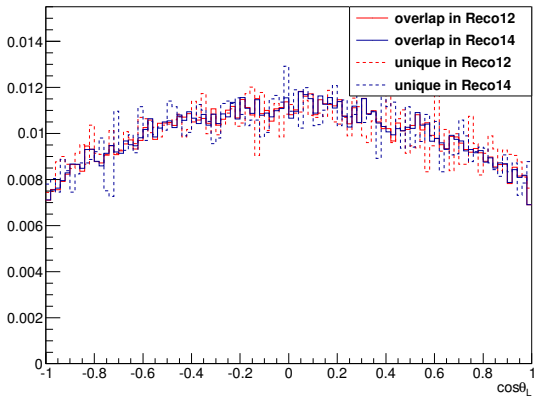
with BDT, $p_T > 250$MeV, signal region

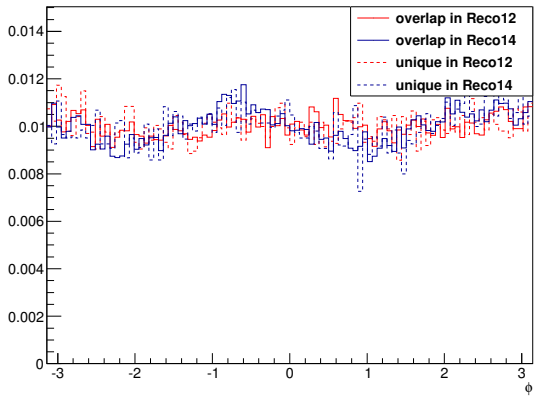
- p_T was inherit from CommonParticles in S17, removed in S20.

q^2[GeV^2]	N_{old}	N_{new}	N_{common}	$N_{\text{old}}^{\text{only}}$	$N_{\text{new}}^{\text{only}}$	$N_{\text{common}}/N_{\text{old}}$[%]	$N_{\text{common}}/N_{\text{old}\cup\text{new}}$[%]
$[0.1, 2]$	147	136	101	46	35	68.7	55.5
$[2, 4]$	89	79	59	30	20	66.3	54.1
$[4, 6]$	100	86	60	40	26	60.0	47.6
$[6, 8]$	143	117	92	51	25	64.3	54.8
$(m_{J/\psi} \pm 0.05)^2$	95946	95224	74711	21235	20513	77.9	64.2
$[11, 12.5]$	83	94	62	21	32	74.75	53.9
$[15, 17]$	112	121	83	29	38	74.1	55.3
$[17, 19]$	73	84	58	15	26	79.5	58.6

Helicity angles in different RECO samples:







with BDT, $p_T > 250$MeV, background region

- p_T was inherit from CommonParticles in S17, removed in S20.

$q^2[\mathrm{GeV}^2]$	N_{old}	N_{new}	N_{common}	$N_{\mathrm{old}}^{\mathrm{only}}$	$N_{\mathrm{new}}^{\mathrm{only}}$	$N_{\mathrm{common}}/N_{\mathrm{old}}[\%]$	$N_{\mathrm{common}}/N_{\mathrm{old}\cup\mathrm{new}}[\%]$
$[0.1, 2]$	31	4	2	29	2	6.5	6.1
$[2, 4]$	46	16	8	38	8	17.4	14.8
$[4, 6]$	34	15	4	30	11	11.82	8.9
$[6, 8]$	29	17	7	22	10	24.1	17.9
$(m_{J/\psi} \pm 0.05)^2$	1420	1138	522	898	616	36.8	25.6
$[11, 12.5]$	31	14	9	22	5	29.0	25.0
$[15, 17]$	25	12	5	20	7	20.0	15.6
$[17, 19]$	25	7	1	24	6	4.0	3.2

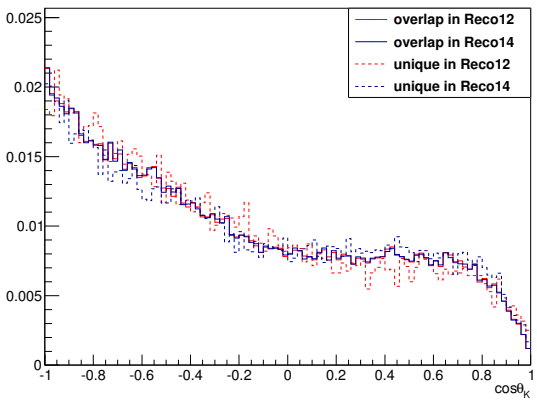
without BDT, $p_T > 250$ MeV, signal region

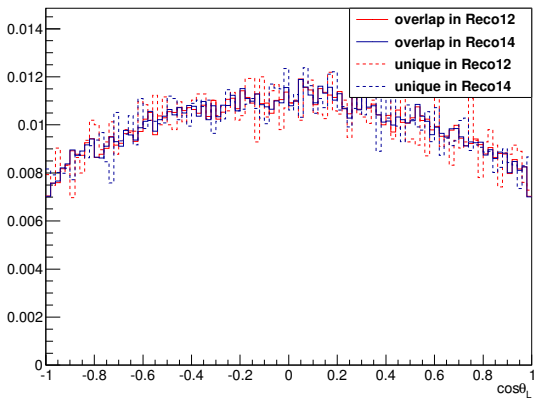
- p_T was inherit from CommonParticles in S17, removed in S20.

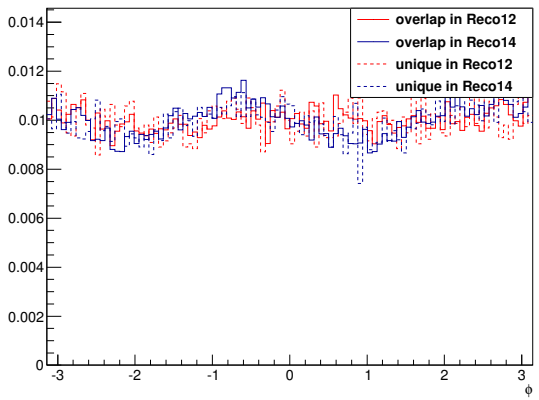
q^2[GeV^2]	N_{old}	N_{new}	N_{common}	$N_{\text{old}}^{\text{only}}$	$N_{\text{new}}^{\text{only}}$	$N_{\text{common}}/N_{\text{old}}$[%]	$N_{\text{common}}/N_{\text{old}\cup\text{new}}$[%]
$[0.1, 2]$	147	215	113	34	102	76.9	45.4
$[2, 4]$	89	211	70	19	141	78.7	30.4
$[4, 6]$	100	209	71	29	138	71.0	29.8
$[6, 8]$	143	284	109	34	175	76.2	34.3
$(m_{J/\psi} \pm 0.05)^2$	95946	110137	80481	15465	29656	83.9	64.1
$[11, 12.5]$	83	209	68	15	141	81.9	30.4
$[15, 17]$	112	268	92	20	176	82.1	31.9
$[17, 19]$	73	187	63	10	124	86.3	32.0

- q^2 trend is worrying. Can suggests kinematic dependence?

Helicity angles in different RECO samples:





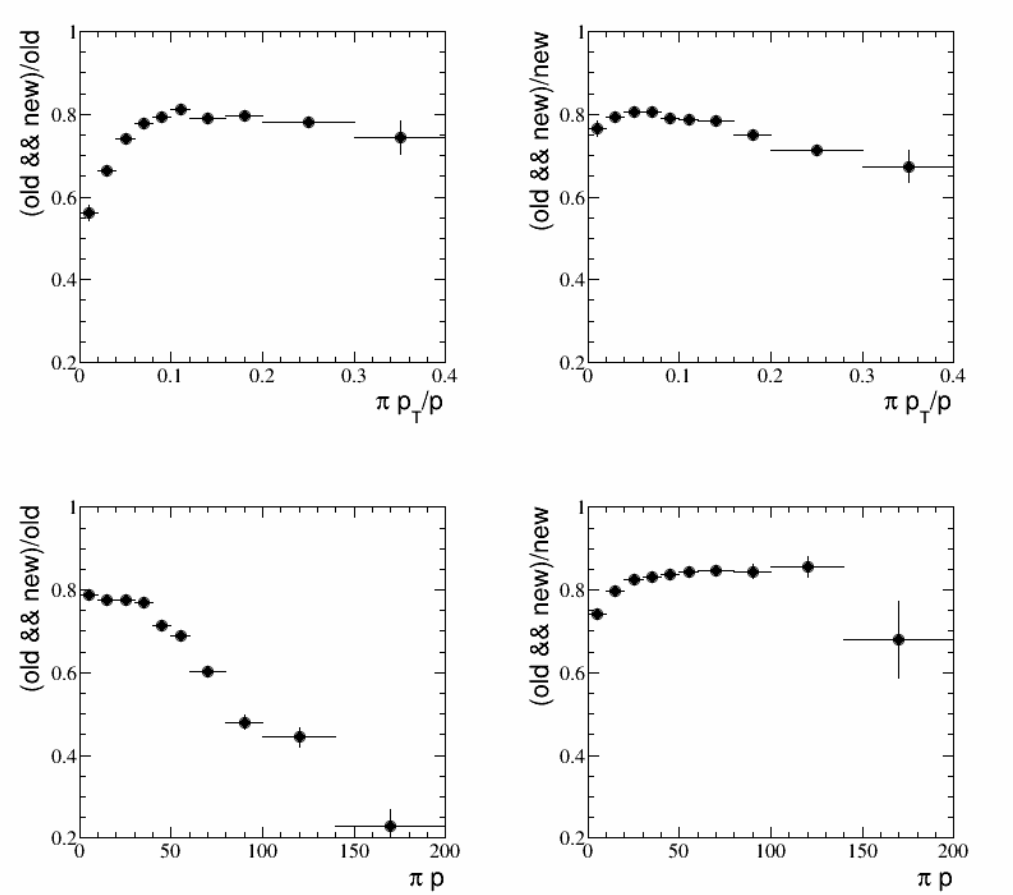


without BDT, $p_T > 250$ MeV, background region

- p_T was inherit from CommonParticles in S17, removed in S20.

$q^2[\mathrm{GeV}^2]$	N_{old}	N_{new}	N_{common}	$N_{\mathrm{old}}^{\mathrm{only}}$	$N_{\mathrm{new}}^{\mathrm{only}}$	$N_{\mathrm{common}}/N_{\mathrm{old}}[\%]$	$N_{\mathrm{common}}/N_{\mathrm{old}\cup\mathrm{new}}[\%]$
$[0.1, 2]$	31	233	18	13	215	58.1	7.3
$[2, 4]$	46	295	31	15	264	67.4	10.0
$[4, 6]$	34	294	17	17	277	50.0	5.5
$[6, 8]$	29	344	20	9	324	69.0	5.7
$(m_{J/\psi} \pm 0.05)^2$	1420	4037	802	618	3235	56.5	17.2
$[11, 12.5]$	31	258	20	11	238	64.5	7.4
$[15, 17]$	25	288	15	10	273	60.0	5.0
$[17, 19]$	25	301	12	13	289	48.0	3.8

Kinematics comparison



- Clear lack of high p_T tracks in RECO 14
- Still investigating.
- Check, effects are independent of polarity.

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MC comparison

Method 2: MC comparison

- Simulate MC for:B $\rightarrow$ K$^*\mu\mu$ PHSP, B $\rightarrow$ K$^*\mu\mu$ SM and B $\rightarrow$ K*J/ψ
- Using the same chain: Gauss $\rightarrow$ Boole $\rightarrow$ Moore
- The same files are run through two different Brunel versions (one for RECO12 other for RECO14).
- After this you have two sets of dsts that are easy to compare.

Advantages

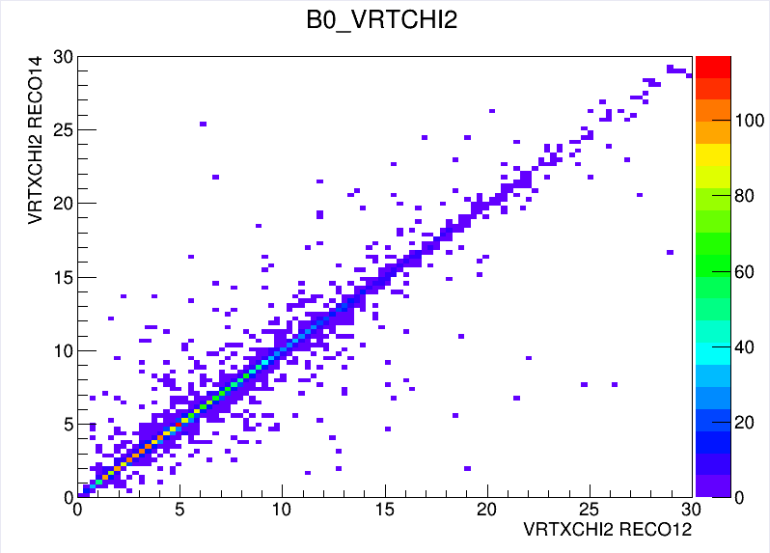
- Clean way to compare(no backgrounds).
- Can check every step.
- No alignment of events problem.

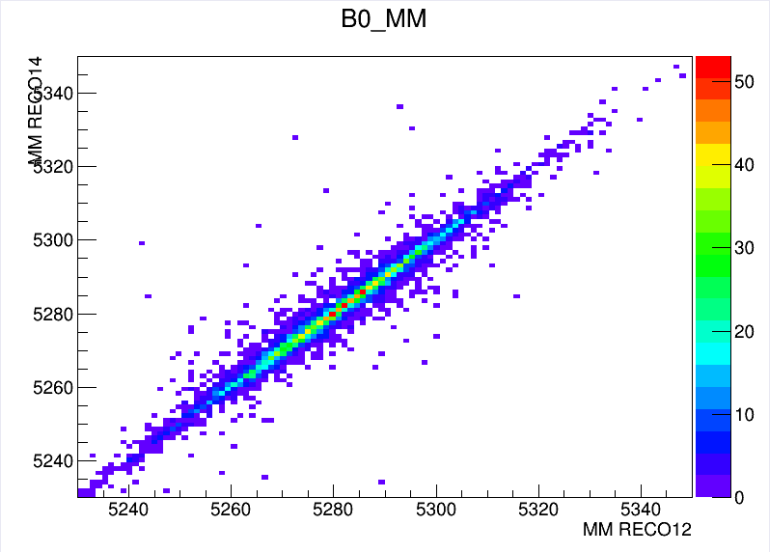
Disadvantages

- Perfect detector alignment.
- DATA/MC difference.
- Need to repeat each step in 2011 analysis.

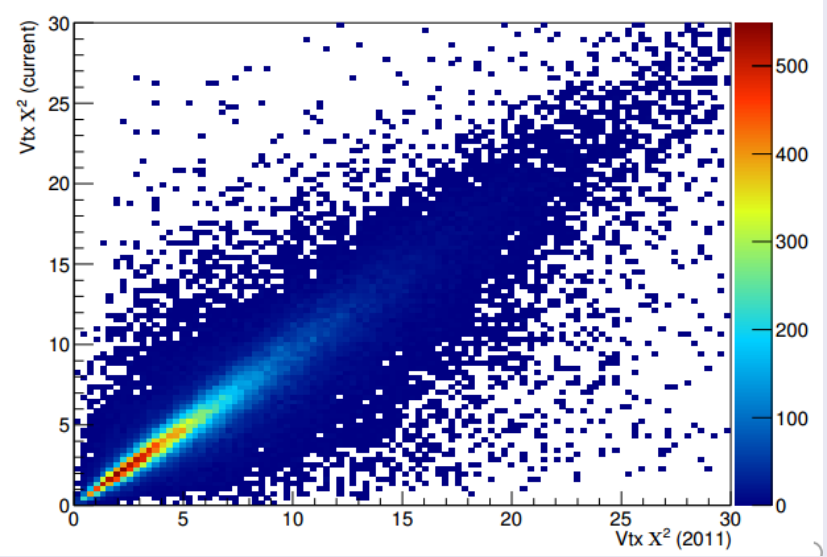
MC Results $B^0 \to K^* J/\psi$

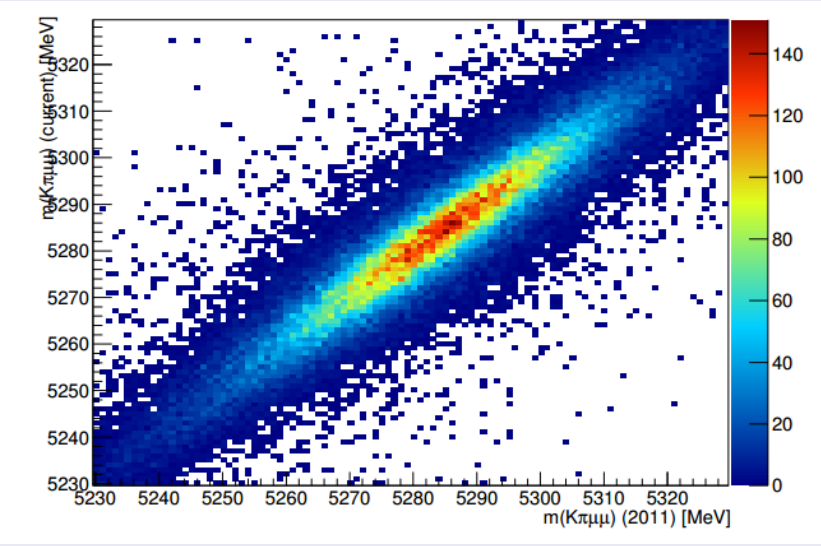
MC





DATA





MC Results $B^0 \to K^* J/\psi$ RECO

Legend:

$RY =$ RECO Y.

No selection just truth matching.

Comparison(NEW vs OLD)	FOM	eff [%]
R14 vs R12	$(OLD \&\& NEW)/(OLD \| NEW)$	90.1
R14 vs R12	$(OLD \&\& NEW)/(OLD)$	95.0
R14 vs R12	$(OLD \&\& NEW)/(NEW)$	94.6

MC Results $B^0 \to K^* J/\psi$

Legend:

$SXRY =$ Stripping X, RECO Y.

Comparison(NEW vs OLD)	FOM	eff [%]
S20R14 vs S17R12	$(OLD \&\& NEW)/(OLD \| NEW)$	81.1
S20R14 vs S17R12	$(OLD \&\& NEW)/(OLD)$	88.2
S20R14 vs S17R14	$(OLD \&\& NEW)/(OLD \| NEW)$	94.7
S20R14 vs S17R14	$(OLD \&\& NEW)/(OLD)$	95.4
S17R14 vs S17R12	$(OLD \&\& NEW)/(OLD \| NEW)$	84.5
S17R14 vs S17R12	$(OLD \&\& NEW)/(OLD)$	92.0
S20R12 vs S17R12	$(OLD \&\& NEW)/(OLD \| NEW)$	90.0
S20R12 vs S17R12	$(OLD \&\& NEW)/(OLD)$	90.0

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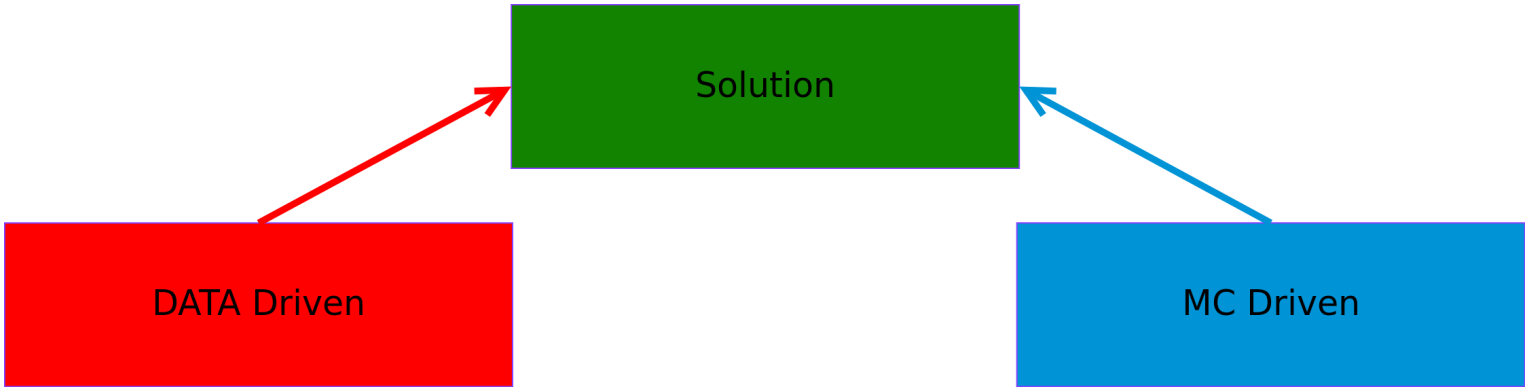
Summary

- The overlap in data is about 64% when we have the BDT applied and the cuts aligned.
- The BDTs contain different variables and do not select the same events. The overlap for the old sample increases from 78 to 84% when turning off the BDT in the new sample.
- Without any selection, the MC predicts an overlap of 95%.

Mille viae ducunt homines per sacula solutio



- We are getting closer. We need to match 88% (MC) with 83% (DATA).
- To meet at common point we need to recover the old selection and BDT(work in progress).
- p_T mystery remains to be solved.
- Applying an aligned selection (with no BDT), this comes down to 81%. We know that there is not a complete correlation in e.g. IP χ^2 between a track reconstructed in RECO 12 and 14, which explains this difference.

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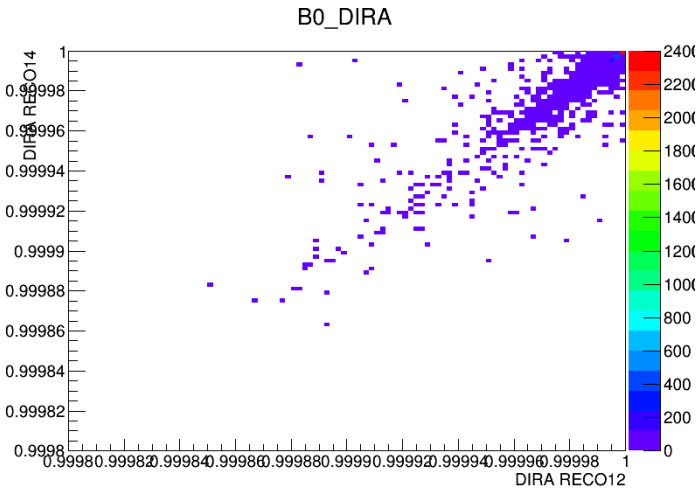
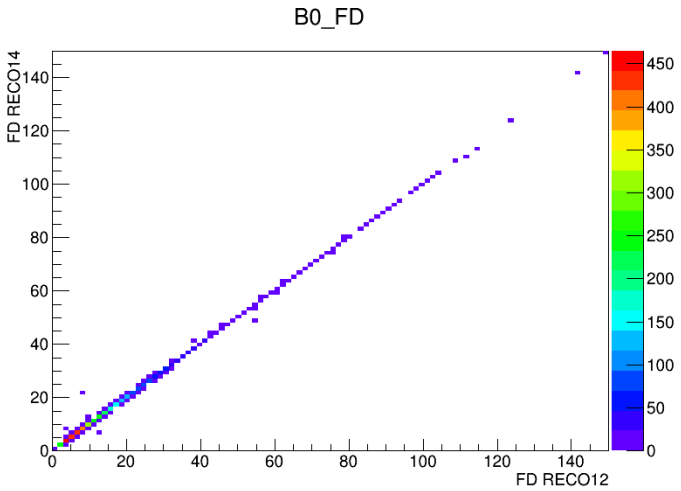
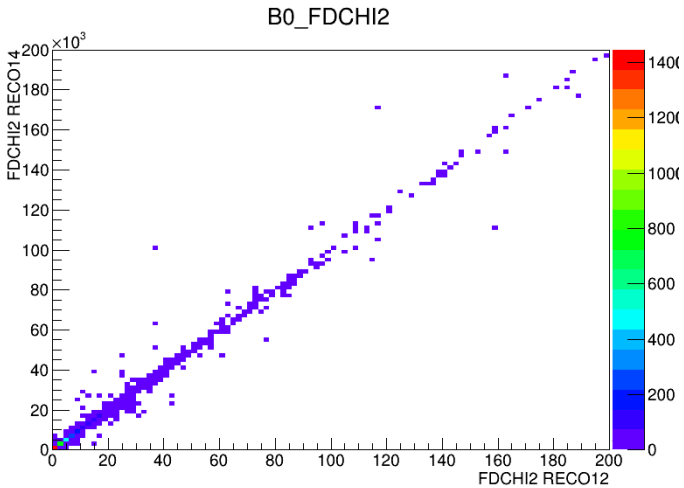
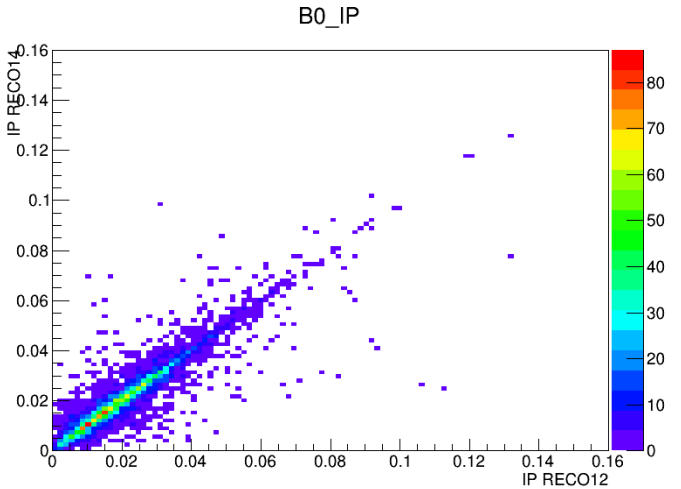
Backup

Results/Plots B^0

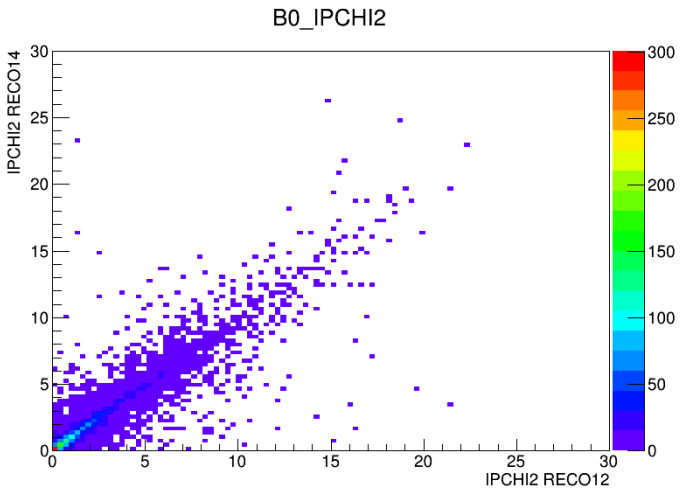


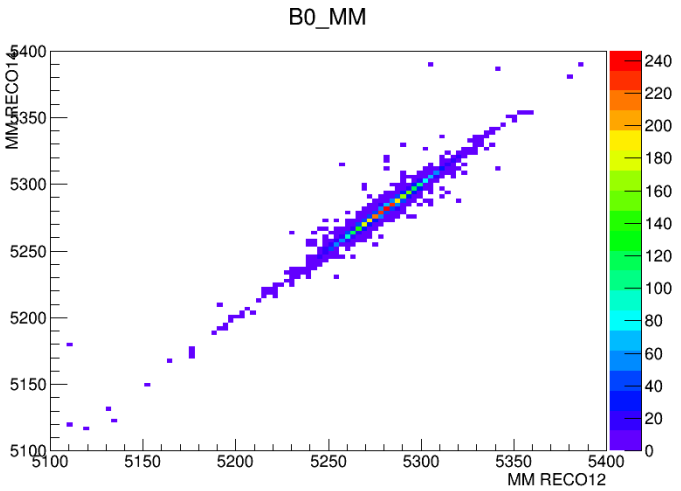


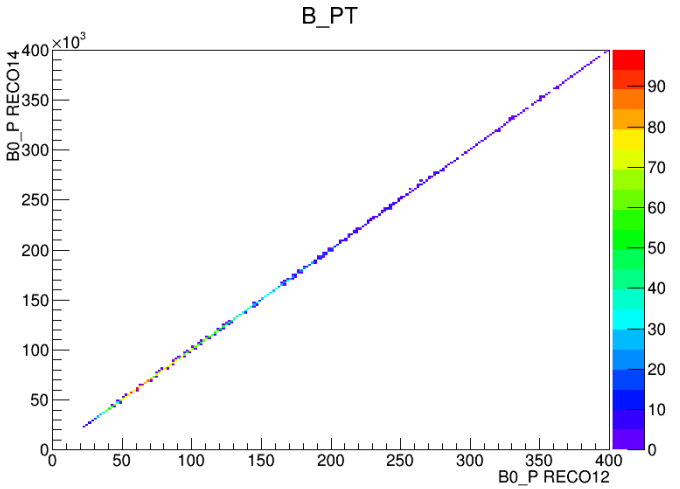


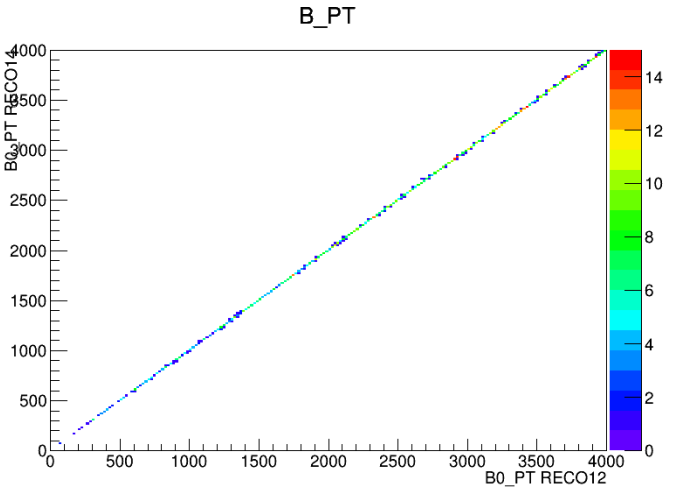


Results/Plots B^0









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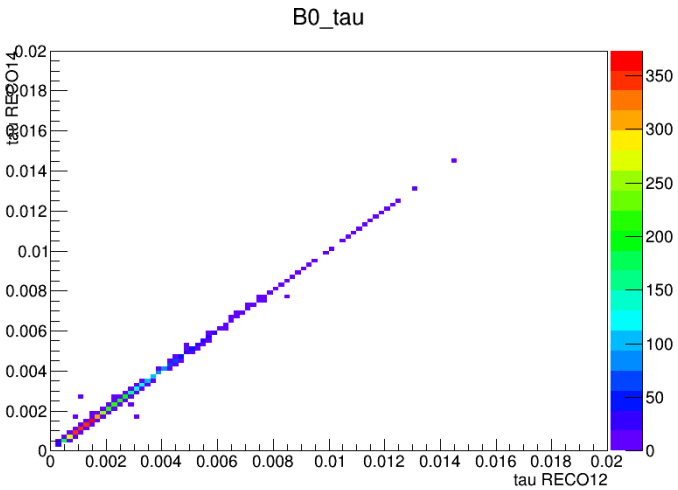
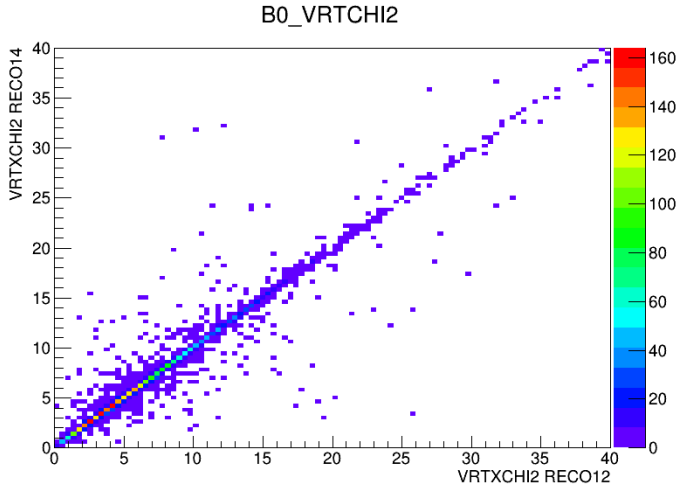
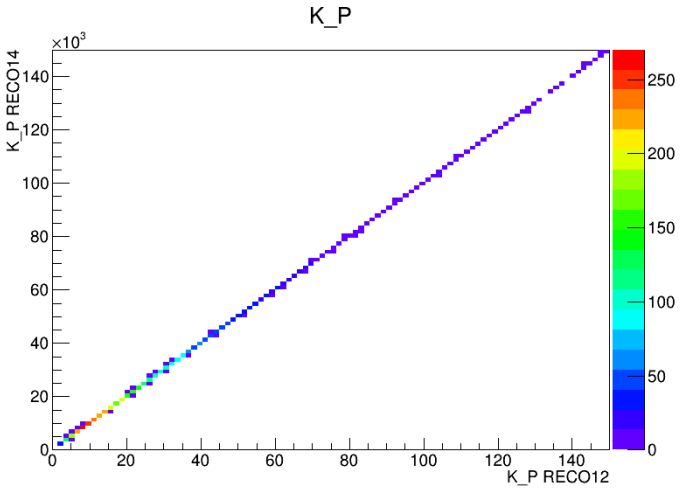
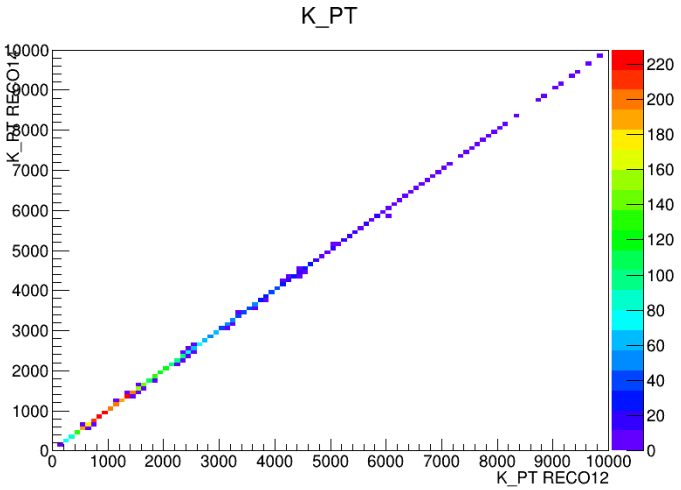
Results/Plots B^0

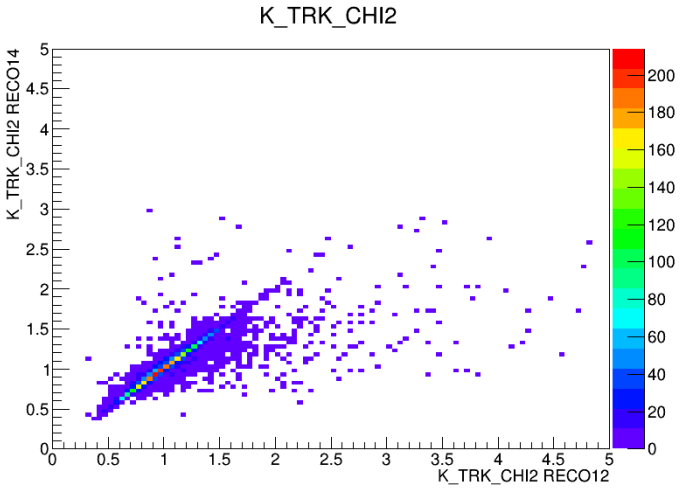




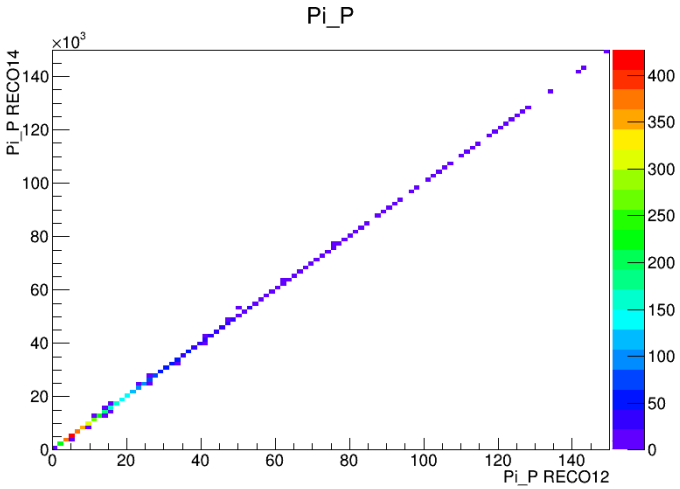
Results/Plots K

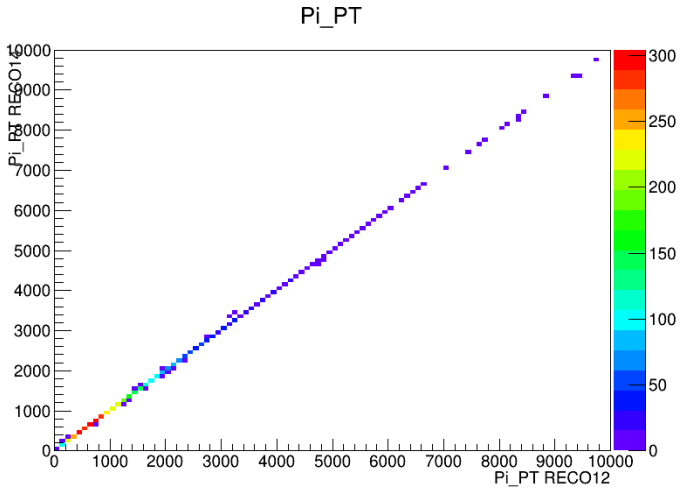


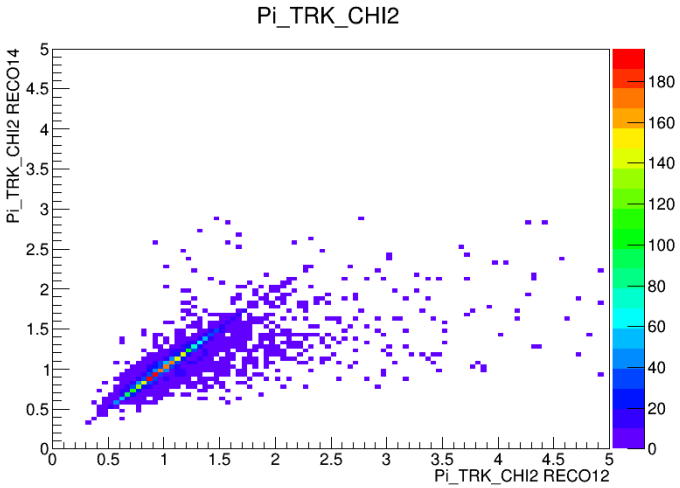




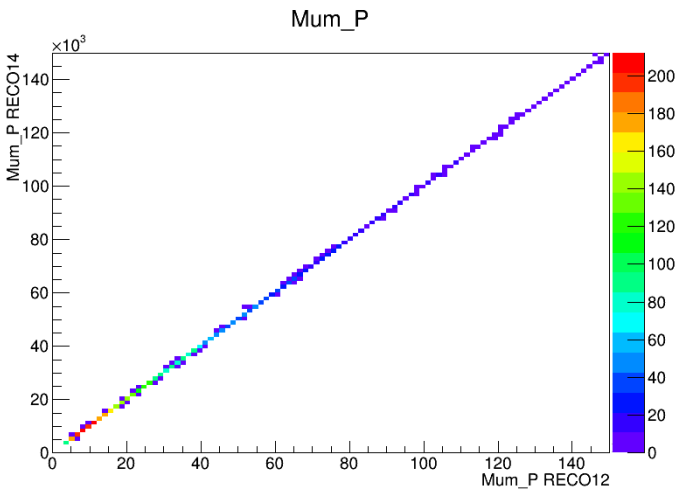
Results/Plots π

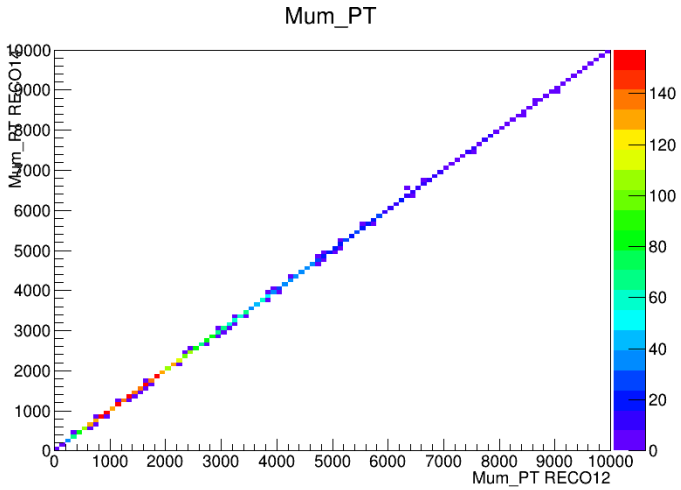


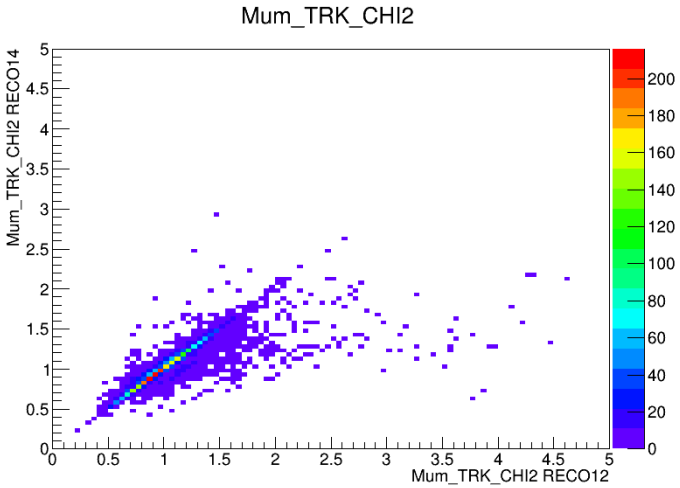




Results/Plots μ^-







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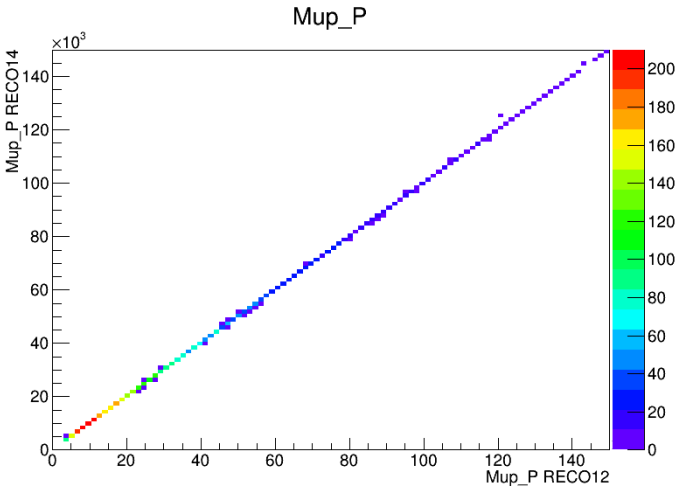
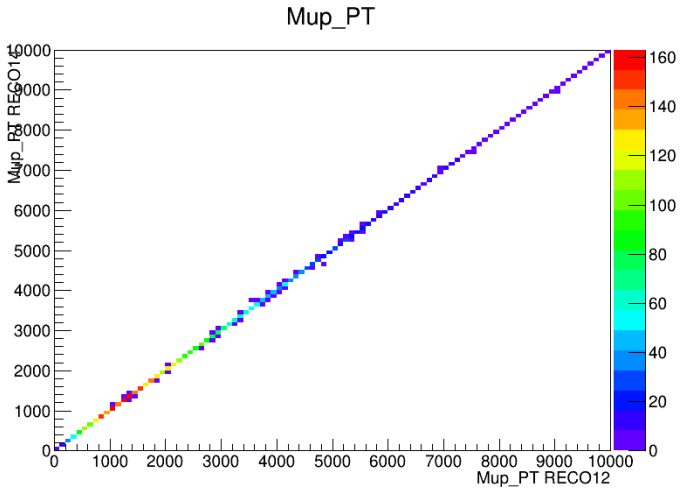
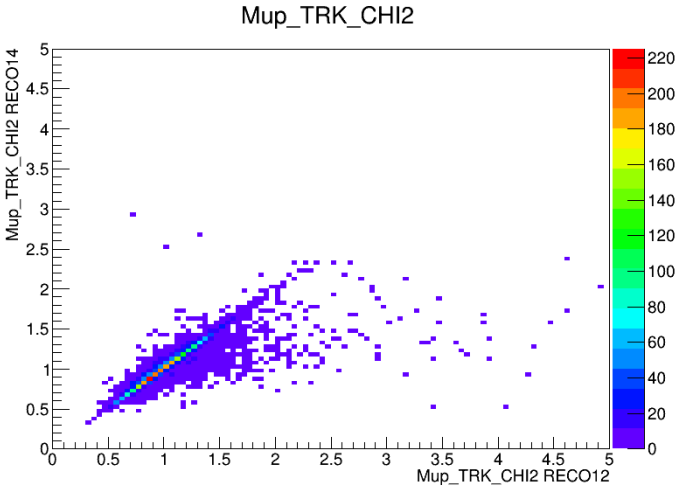
Results/Plots μ^+







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