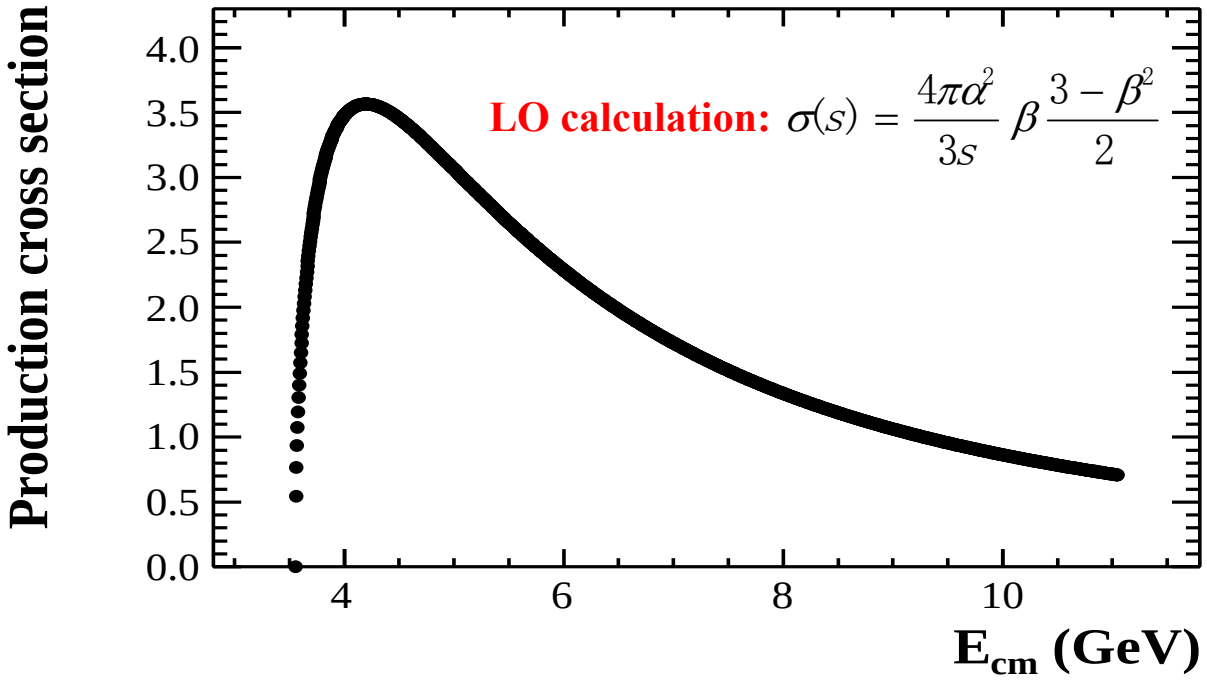
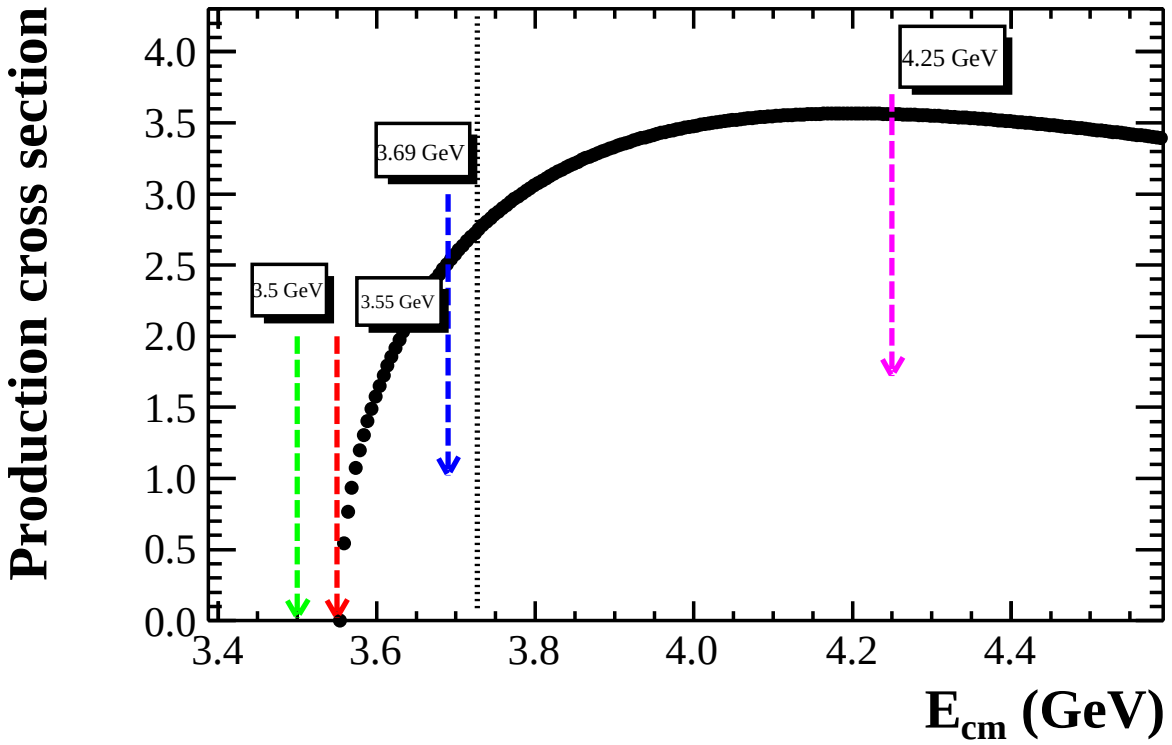
The lepton flavor violation study from $\tau \rightarrow \ell\ell\ell$

Tau pair production cross section



Tau pair production cross section



Analysis strategy

- Tag side:
  - $\tau^+ \rightarrow e^+ \upsilon_e \upsilon_\tau$
  - $\tau^+ \rightarrow \mu^+ \nu_\mu \nu_\tau$
  - $\tau^+ \rightarrow \pi^+ \nu_\tau$
- Signal side:
  - $\tau^- \rightarrow e^+ e^- e^-$
  - $\tau^- \rightarrow \mu^+ \mu^- \mu^-$
  - $\tau^- \rightarrow e^+ e^- \mu^-$
  - $\tau^- \rightarrow \mu^+ \mu^- e^-$
  - $\tau^- \rightarrow \mu^+ e^- e^-$
  - $\tau^- \rightarrow e^+ \mu^- \mu^-$

Final states:

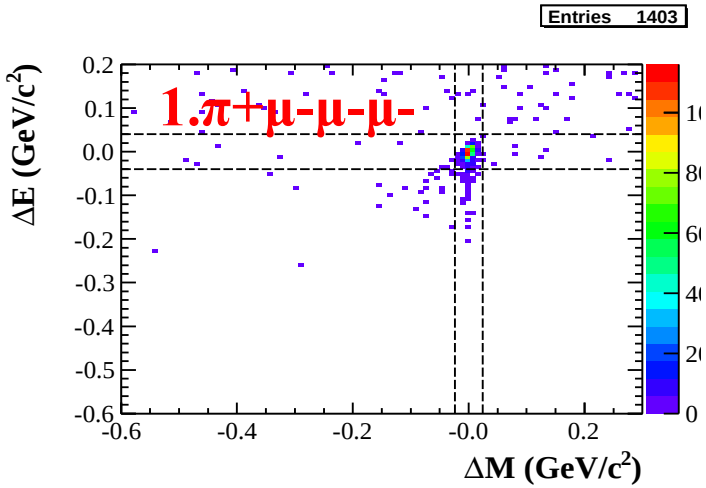
1.π+μ-μ-μ-	7. π+μ+μ-e-
2.π+e-e-e-	8.μ+μ+μ-e-
3.e+μ+μ-μ-	9.π+e-e-μ+
4.μ+e+e-e-	10.μ+μ+e-e-
5.π+e+e-μ-	11.π+μ-μ-e+
6.e+e+e-μ-	12.e+e+μ-μ-

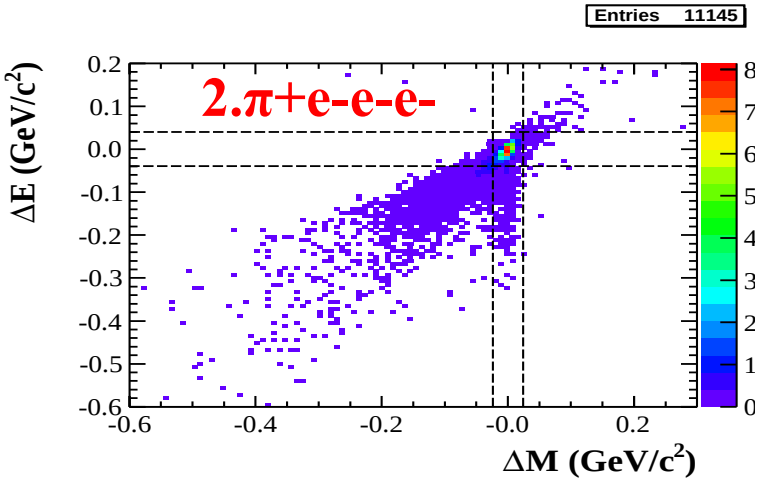
1. There are totally 18 mode, while the $e^+e^+e^-e^-$, $\mu^+\mu^+\mu^-\mu^-$, $e^+e^-\mu^+\mu^-$ are removed
2. mode 3 can be from $\tau^+ \rightarrow e^+ \upsilon_e \upsilon_{\tau,}$ $\tau^- \rightarrow \mu^+ \mu^- \mu^-$ or $\tau^+ \rightarrow \mu^+ \nu_\mu \nu_{\tau,}$ $\tau^- \rightarrow e^+ \mu^- \mu^-$ (mode 13)
3. mode 4 can be from $\tau^+ \rightarrow \mu^+ \nu_\mu \nu_{\tau,}$ $\tau^- \rightarrow e^+ e^- e^-$ or $\tau^+ \rightarrow e^+ \upsilon_e \upsilon_{\tau,}$ $\tau^- \rightarrow \mu^+ e^- e^-$ (mode 14)

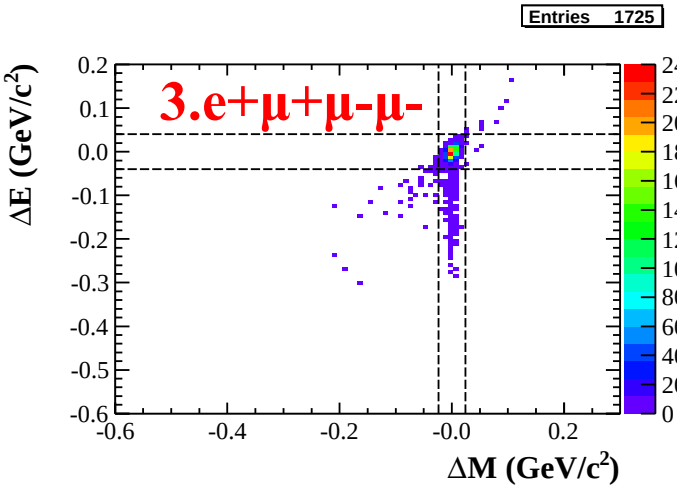
Event selection

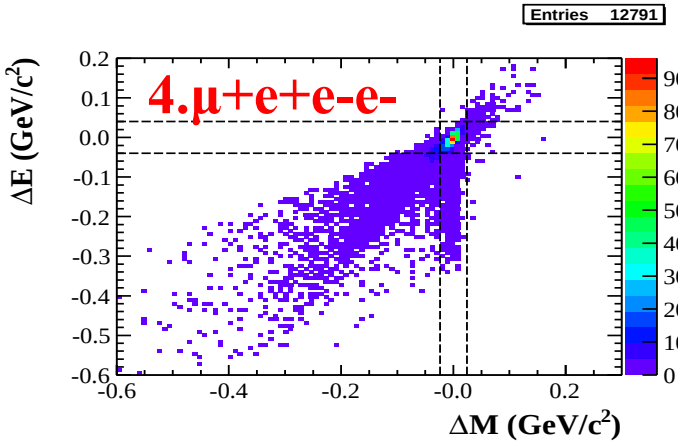
- Ngood=4, Ncharge=0;
- Neutral track: $E_{deposit}<0.5GeV$
- PID
  - muon: deposit energy<0.4GeV, hit layer in muc>1
  - electron: e/p>0.5
  - pion: probπ>probK && probπ>probp
- Mode match
  - if exist e^+e^- pairs, $|angle_{ee}|>10^o$, $|M_{ee}|>0.05GeV$
  - if more than one combination, select the one with minimum
    $$(M_{prong3}-M_\tau)^2/\sigma_{M\tau}+(E_{prong3}-E_\tau)^2/\sigma_{E\tau}$$
  - If the tag mode is π, require miss.$m^2<0.5GeV^2$
  - Angle between 1 prong to 3 prong $>175^o$
- Yield (ΔM, ΔE)

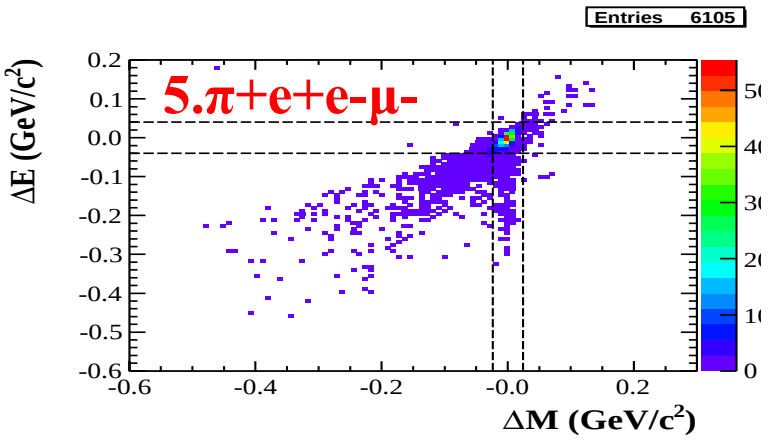
MC in (Δm, ΔE) plane (I)

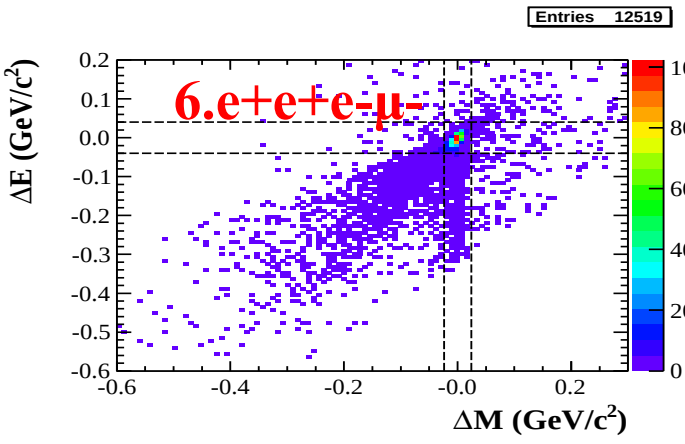




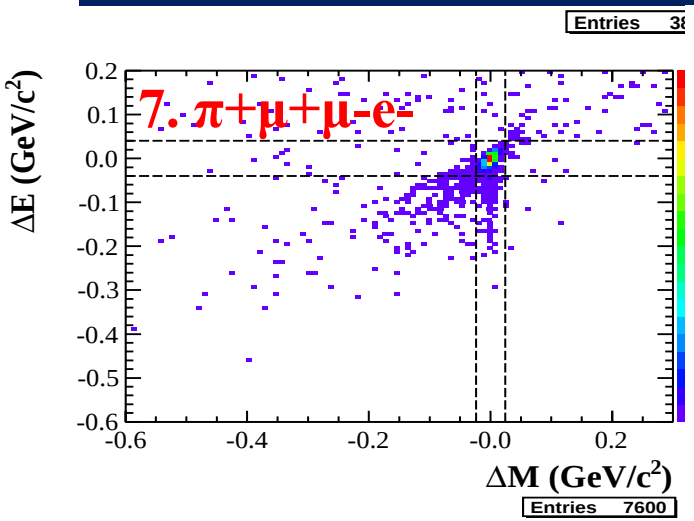


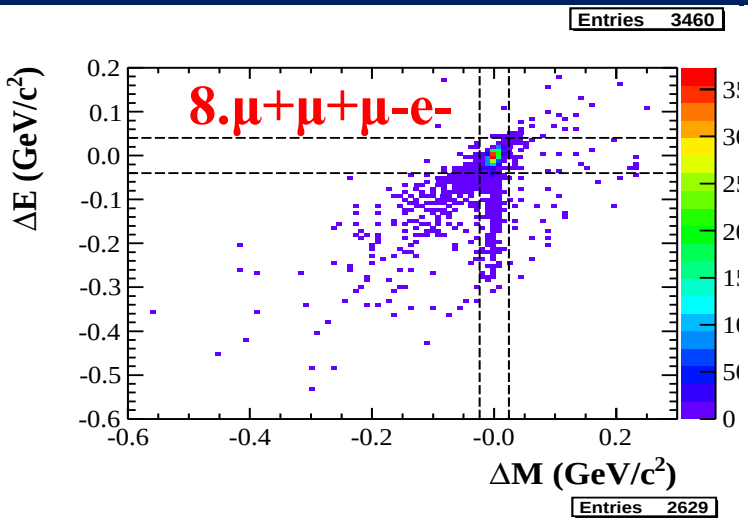


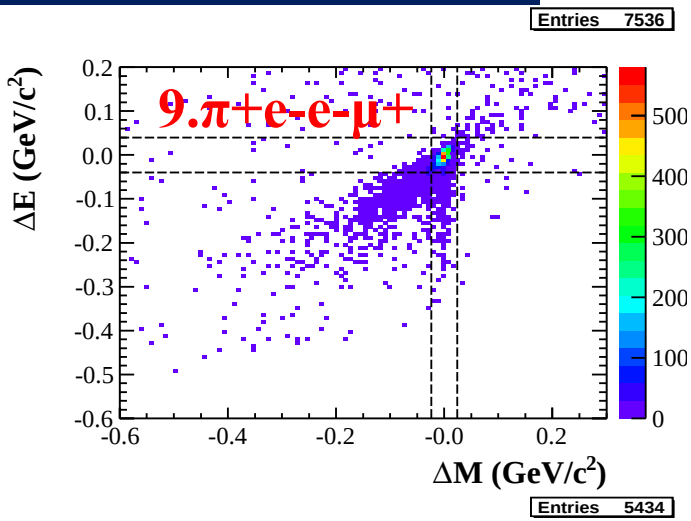


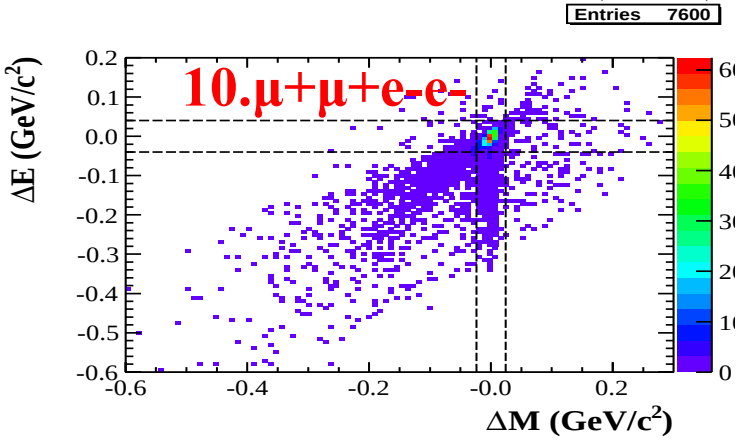


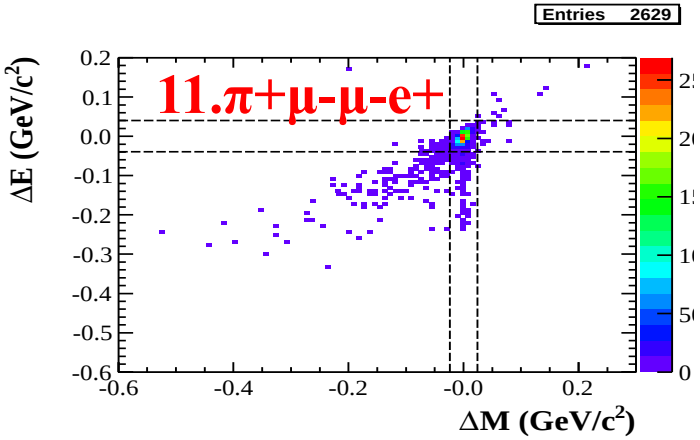
MC in (Δm, ΔE) plane (II)

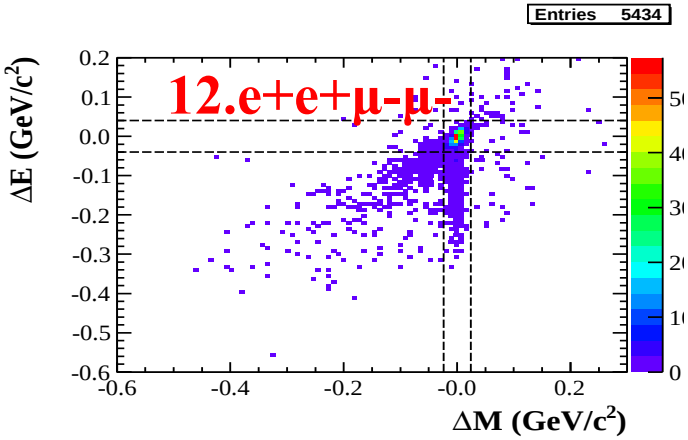




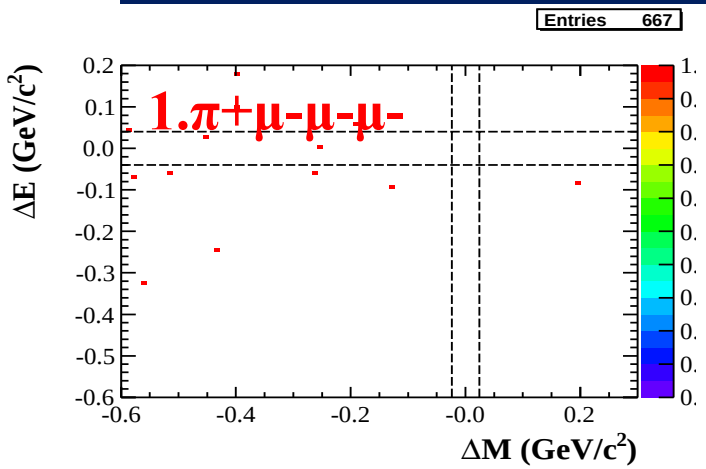


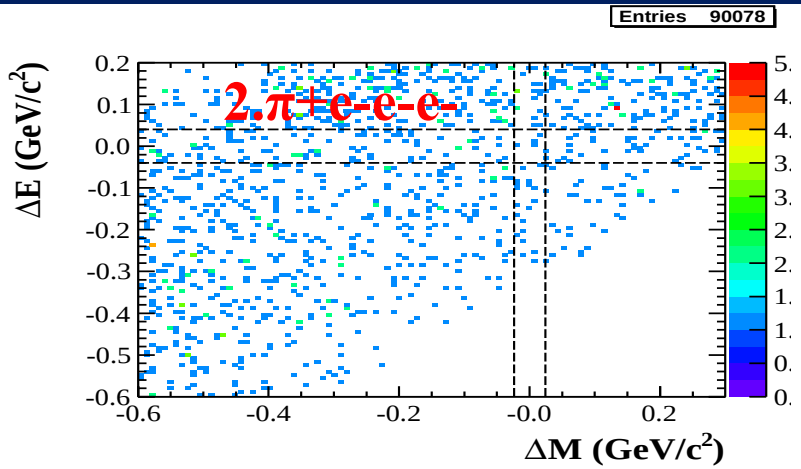


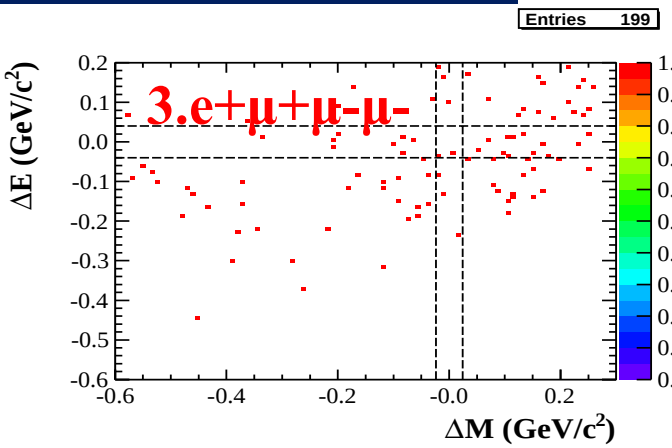


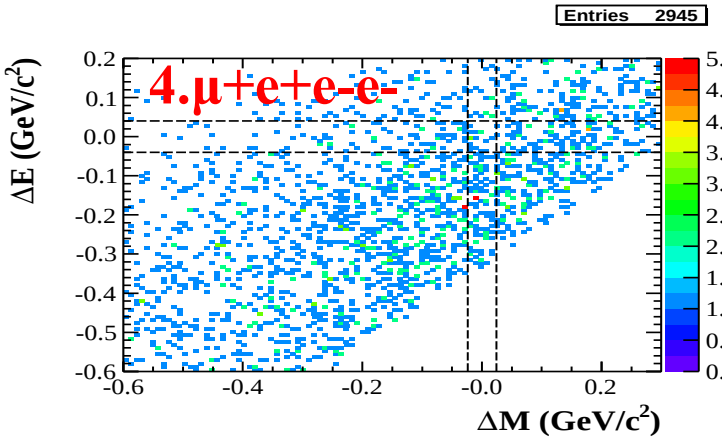


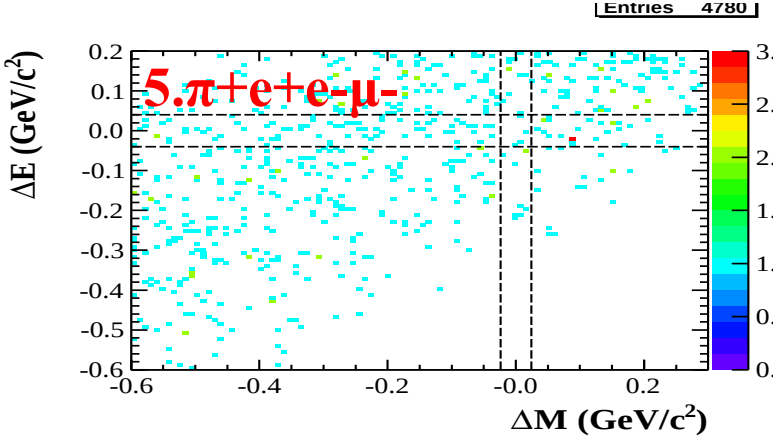
data in (Δm, ΔE) plane (I)

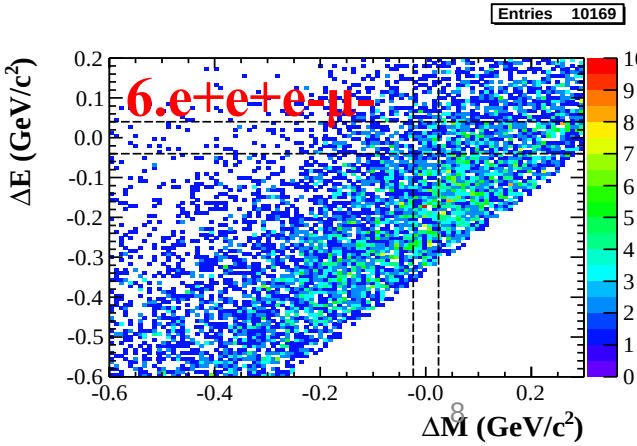




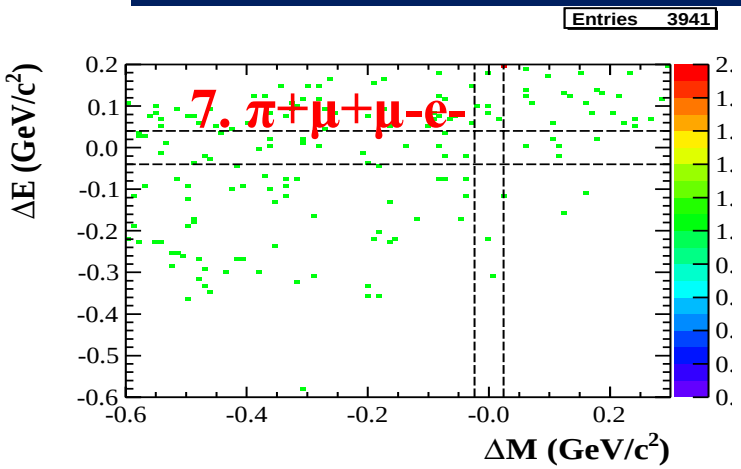


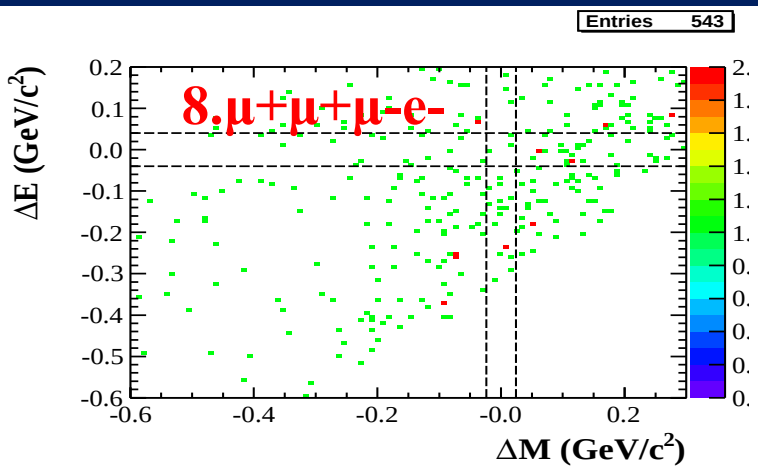


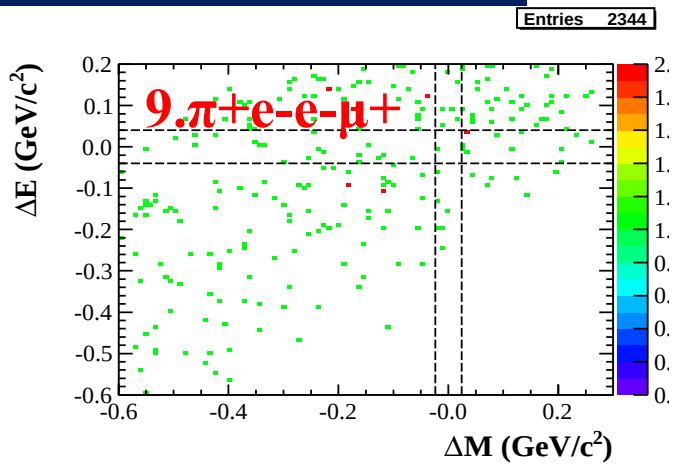


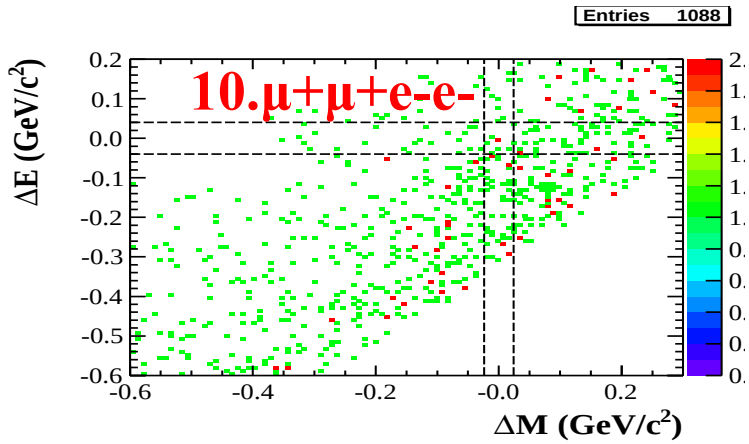


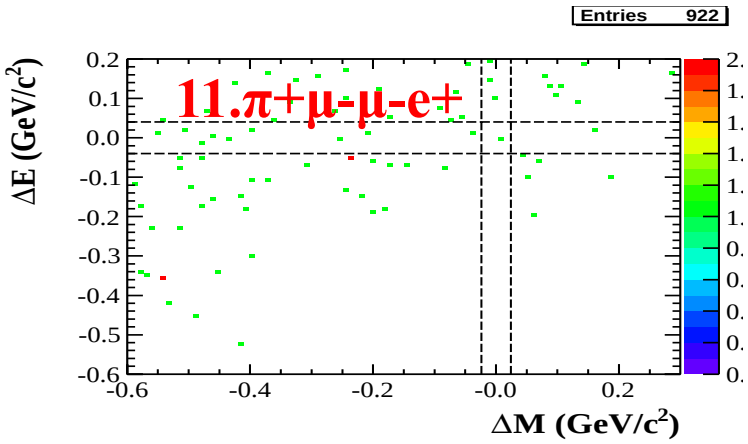
data in (Δm, ΔE) plane (II)

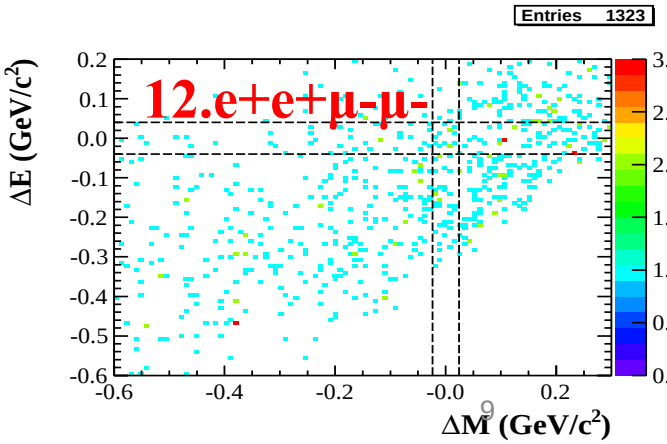












Summary (I)

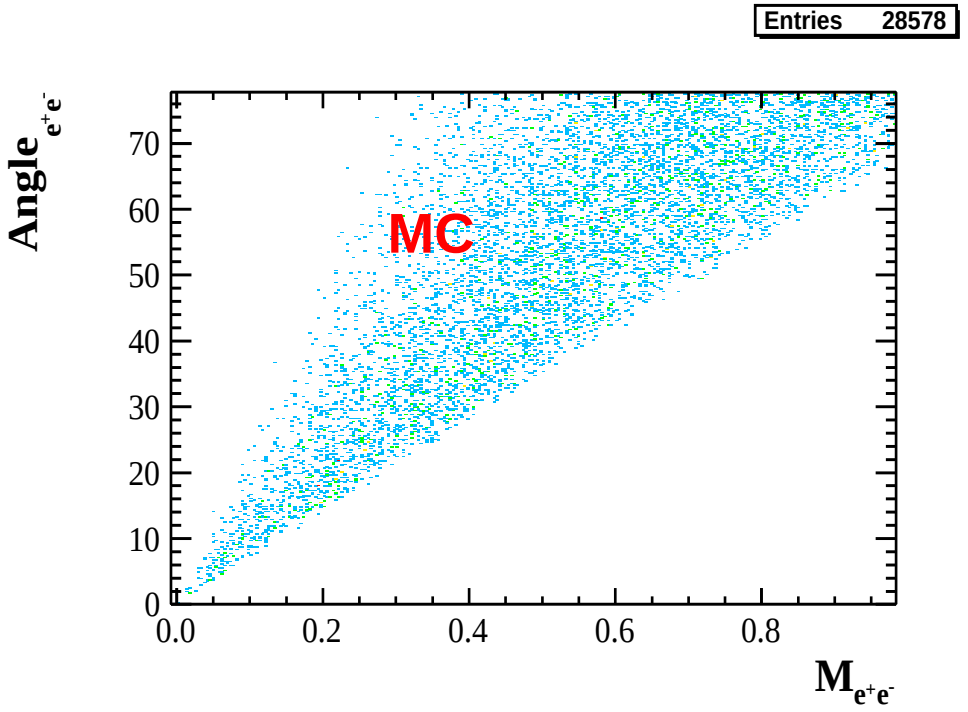
Mode	1.π+μ-μ-μ-	2.π+e-e-e-	3.e+μ+μ-μ-	4.μ+e+e-e-	5.π+e+e-μ-	6.e+e+e-μ-	7. π+μ+μ-e-
Efficiency	1.41%	14.31%	3.02%	15.32%	8.61%	16.28%	4.27%
ττ bkg	0	1.14	0.90	3.04	1.90	32.70	0
qqbar bkg	0.65	1.30	0.65	5.19	2.60	15.58	0
DD bkg	0	0	0	3	0	12	0
ISR bkg	0	0	0	2	1	3	1
Nobs	0	5	2	18	4	80	0

Mode	8.μ+μ+μ-e-	9.π+e-e-μ+	10.μ+μ+e-e-	11.π+μ-μ-e+	12.e+e+μ-μ-	13	14
Efficiency	5.18%	8.55%	9.81%	4.02%	8,24%	5.21%	16.44%
ττ bkg	0.76	1.14	0.38	0	3.42	0.38	11.0
qqbar bkg	2.60	0.65	4.55	0	0.65	0.65	4.55
DD bkg	1	0	0	0	4	1	10
ISR bkg	0	0	1	0	1	0	4
Nobs	3	1	7	1	13	1	26

Summary (II)

Mode	1.π+μ-μ-μ-	2.π+e-e-e-	3.e+μ+μ-μ-	4.μ+e+e-e-	5.π+e+e-μ-	6.e+e+e-μ-	7. π+μ+μ-e-
Efficiency	1.41%	14.31%	3.02%	15.32%	8.61%	16.28%	4.27%
N bkg	0.65	2.44	1.55	11.25	3.50	63.28	1
Nobs	0	5	2	18	4	80	0
Br(up limit)	~10-3	~10-4	~10-4	~10-5	~10-4	~10-5	~10-4

Mode	8.μ+μ+μ-e-	9.π+e-e-μ+	10.μ+μ+e-e-	11.π+μ-μ-e+	12.e+e+μ-μ-	13	14
Efficiency	5.18%	8.55%	9.81%	4.02%	8,24%	5.21%	16.44%
ISR bkg	4.36	1.79	5.93	0	9.07	2.03	25.55
Nobs	3	1	7	1	13	1	26
Br(up limit)	~10-4	~10-4	~10-4	~10-4	~10-4	~10-4	~10-5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30
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50
60
70
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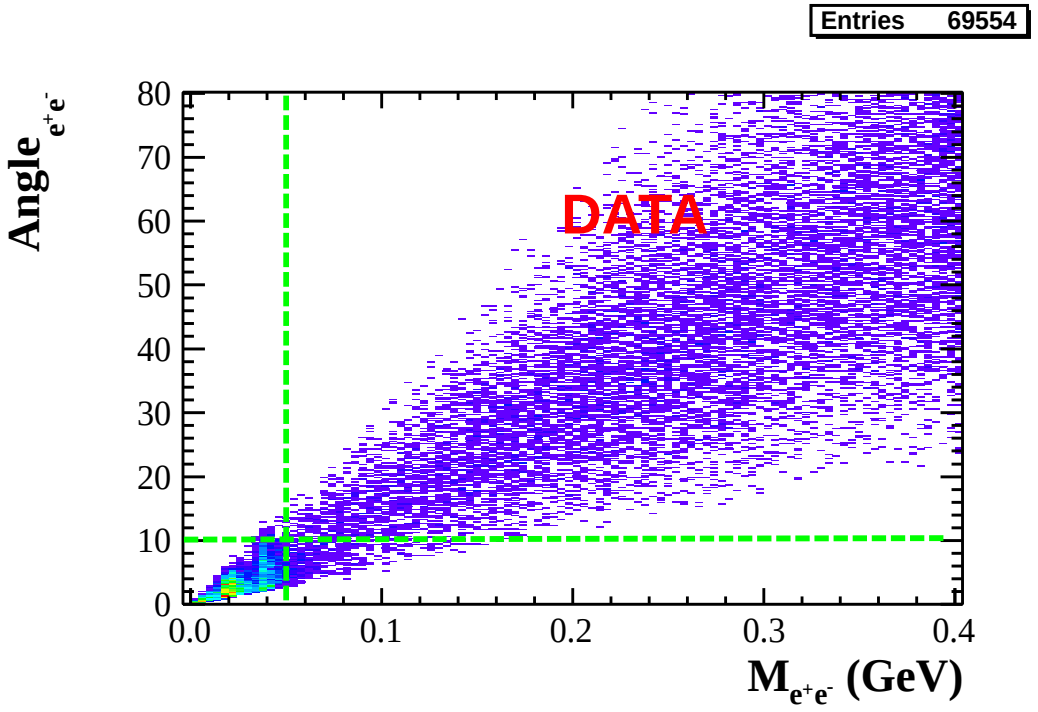
0.2
0.4
0.6
0.8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M e+e- (GeV)
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20
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40
50
60
70
80
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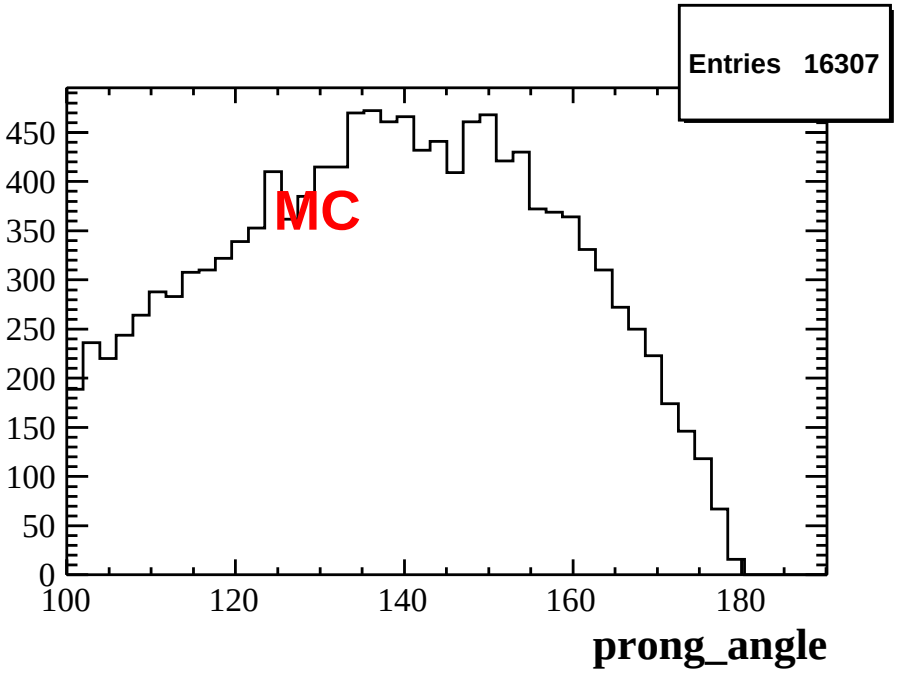
0.1
0.2
0.3
0.4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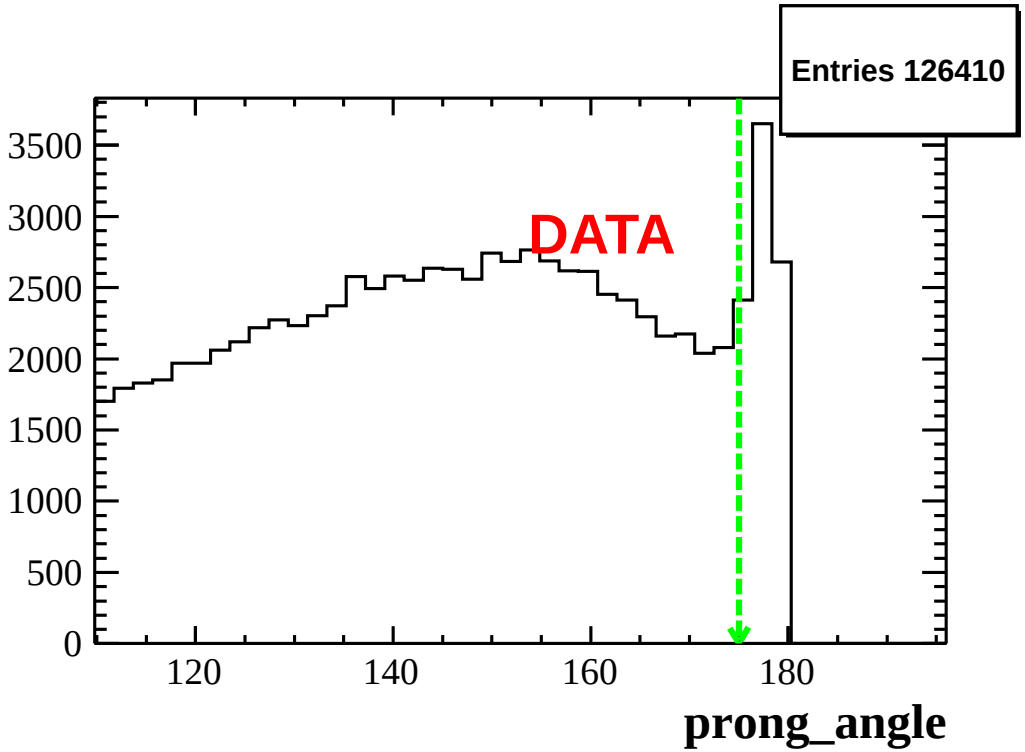
prong_angle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