Update on neutral meson and dielectron studies in BiBi@9.46

V. Riabov

Outline

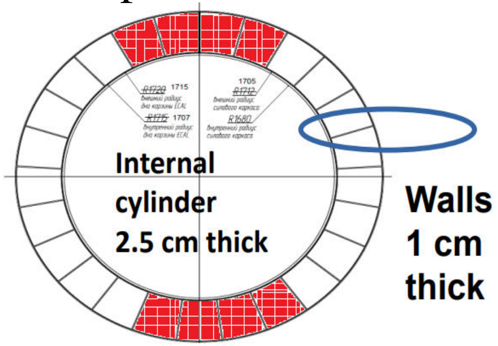
- Update on the ECAL efficiency with a limited acceptance
  - ✓ for neutral mesons
  - ✓ for (di)electrons
- S/B vs. significance for dielectrons

ECAL acceptance

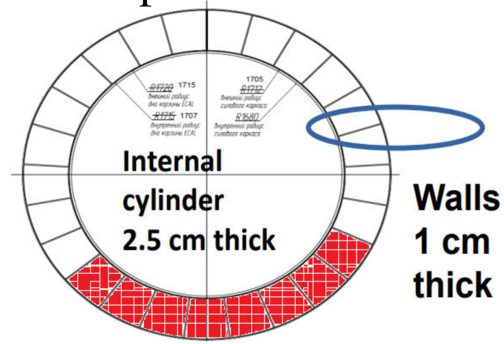
ECAL geometry, last meeting

- Full configuration: (25 sectors in azimuth with full pseudorapidity coverage; 25 half-sectors)
- Realistic configuration: 8 full sectors, 8/25 = 0.32 of the full acceptance
- At the last meeting we discussed the following two options:

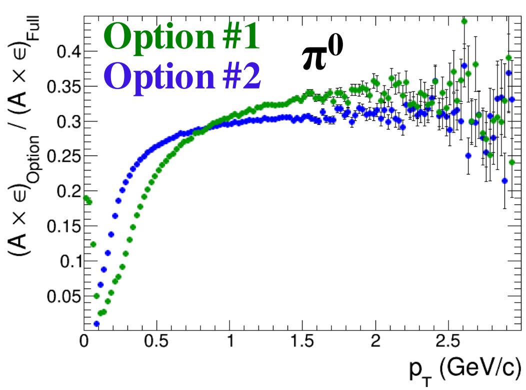
Option #1

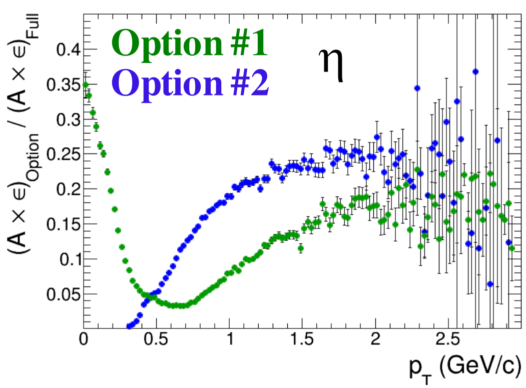


Option #2



- Two options are not ideal for the neutral meson measurements



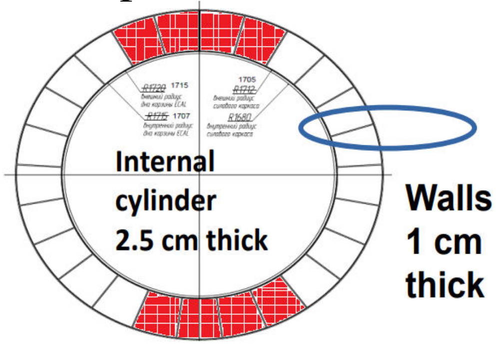


Either zero acceptance at low p_T (p_T < 100 MeV/c for π0; p_T < 300 MeV/c for η) or small efficiency at intermediate p_T

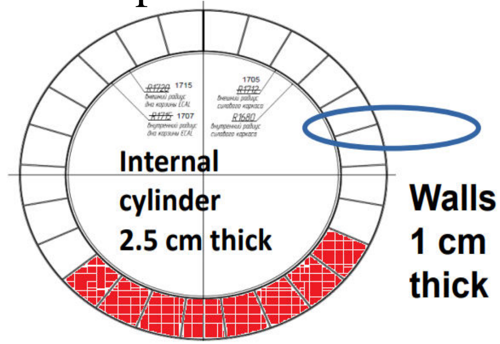
ECAL geometry, today

- Full configuration: (25 sectors in azimuth with full pseudorapidity coverage; 25 half-sectors)
- Increased number of variants:

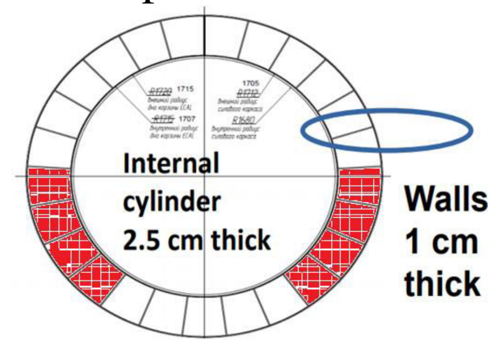
Option #1



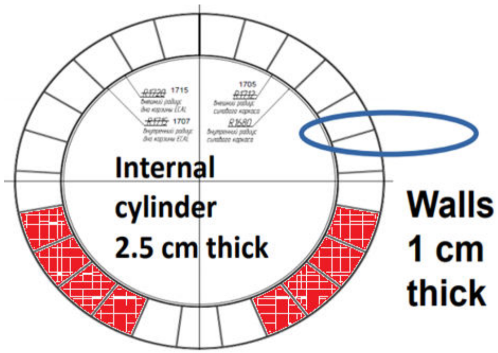
Option #2



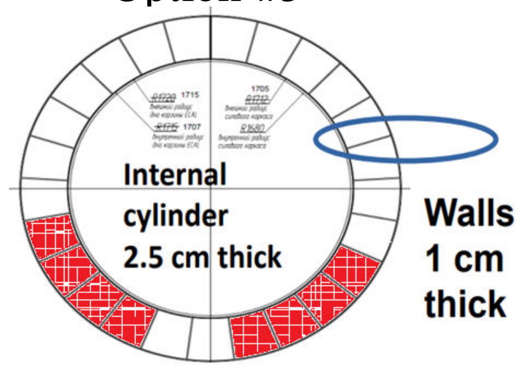
Option #3



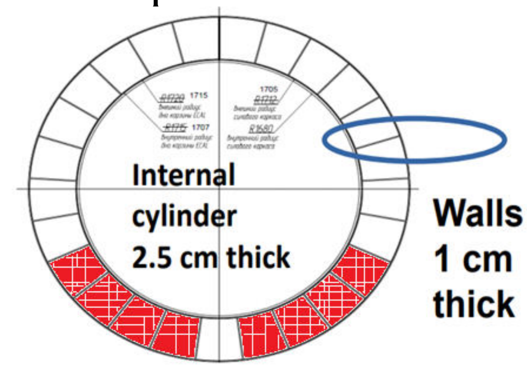
Option #4



Option #5

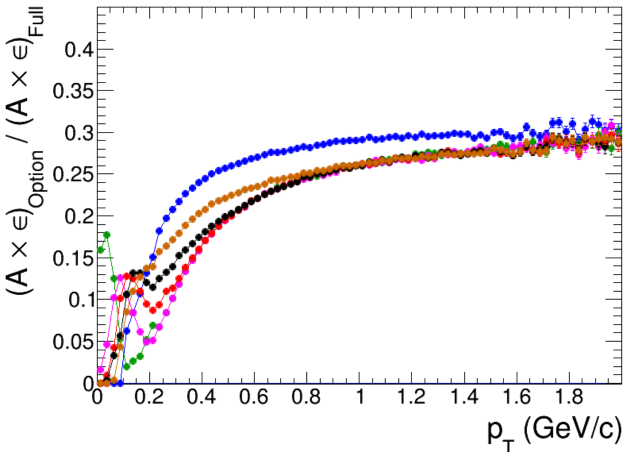


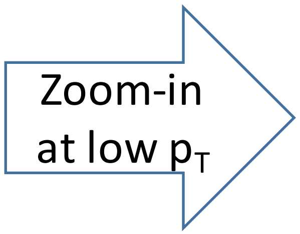
Option #6

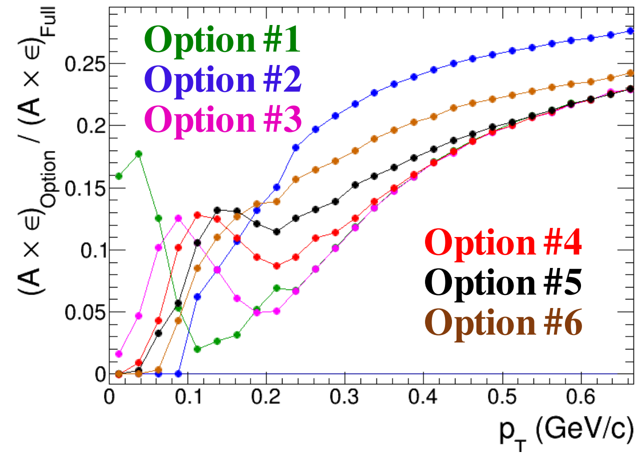


Efficiencies for π^0 and η

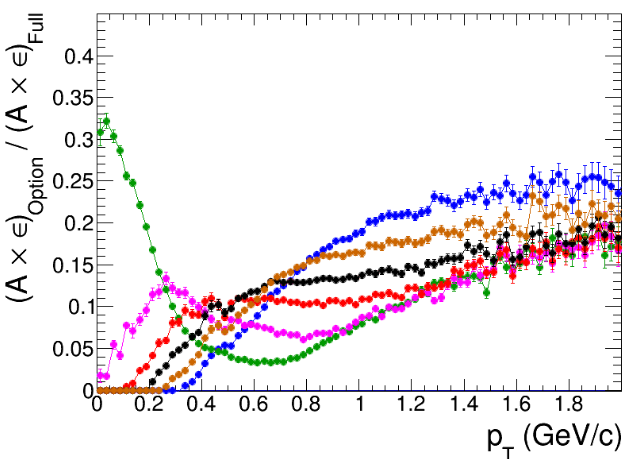
- π^0 fractional efficiencies: BiBi@9.46, realistic vertex distribution

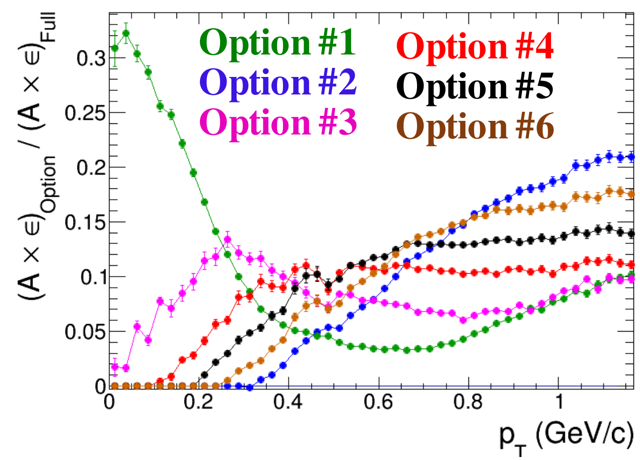






- η fractional efficiencies: BiBi@9.46, realistic vertex distribution

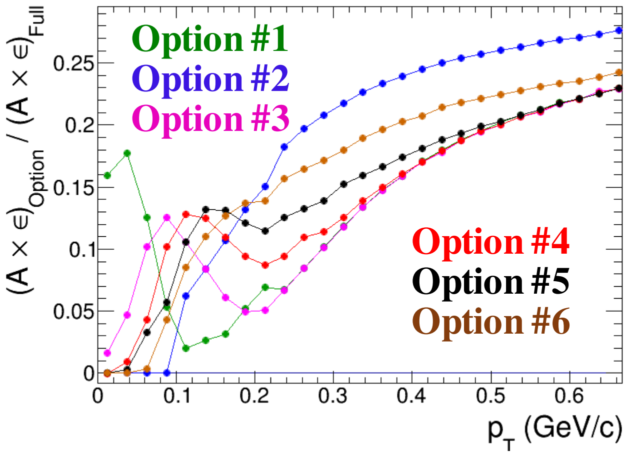


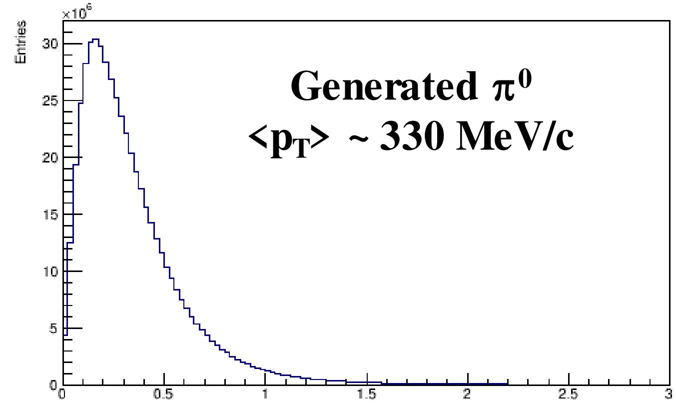


- Loss of efficiency is >> than just a geometrical factor of 0.32, especially at p_T < 1-2 GeV
- Option #1 shows strong p_T dependence of efficiency
- Option #2 has zero efficiency for π^0 (η) at p_T < 100 (300) MeV/c

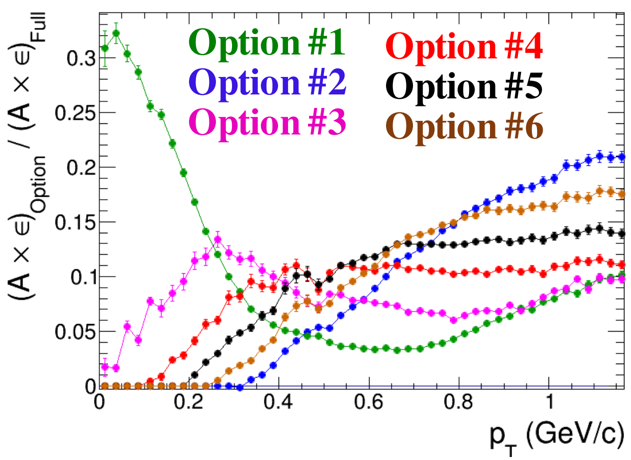
Sampling fraction for π^0 and η

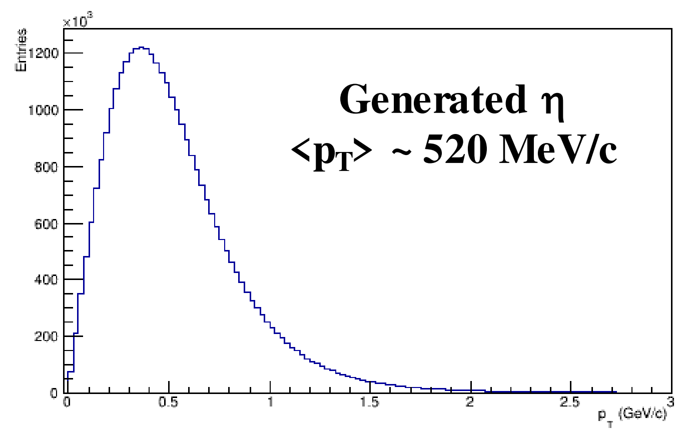
- π^0 fractional efficiencies: UrQMD, BiBi@9.46, realistic vertex distribution





- η fractional efficiencies: BiBi@9.46, realistic vertex distribution



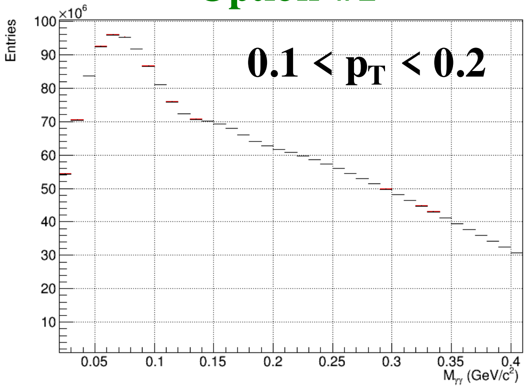


- Options #4 and #5 are the most balanced for neutral meson measurements:
  - ✓ open up acceptance at low p_T, down to ~ 50 MeV/c for π^0 and ~ 150-200 MeV/c for η
  - ✓ moderate efficiency at intermediate p_T

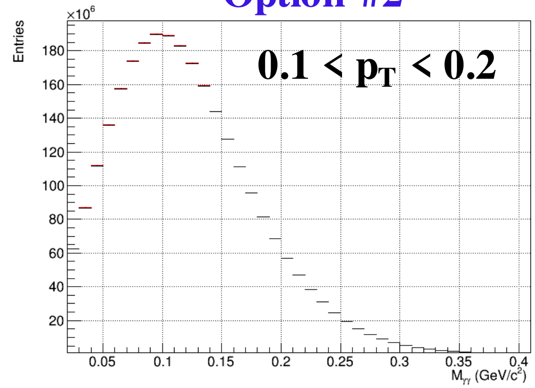
Reconstructed peaks, π^0

- π^0 fractional efficiencies: UrQMD, 10M minbias BiBi@9.46, realistic vertex distribution
- Same statistics for all options

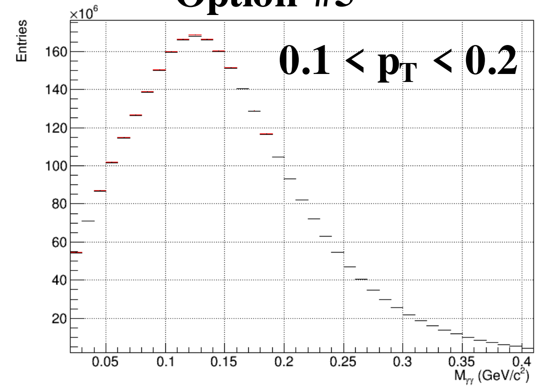
Option #1

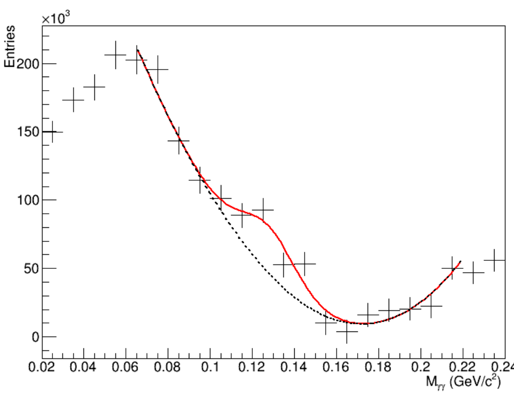


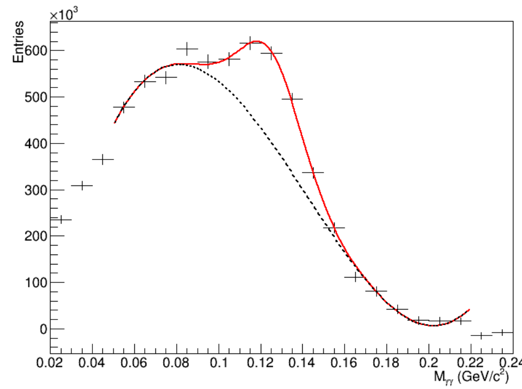
Option #2

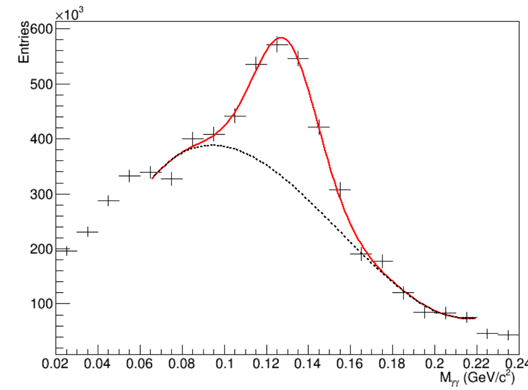


Option #5







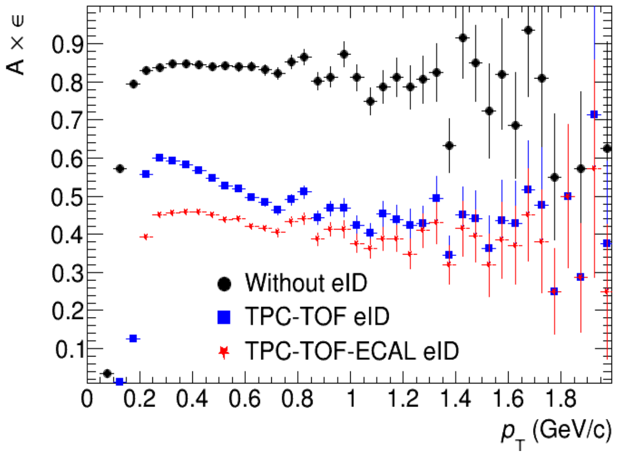


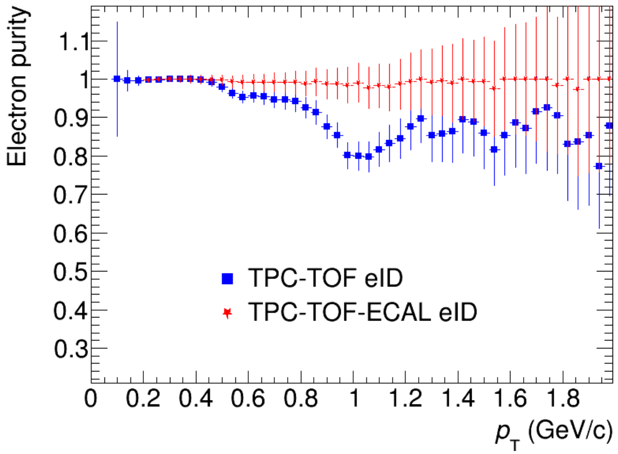
- Options #4 #5 provide better signal significance at p_T ~ 100 MeV/c

Dielectrons vs. ECAL acceptance

- ECAL is used to identify tracks that are matched to the ECAL clusters (E/p, time-of-flight)
- ECAL acceptance does not affect the (di)electron efficiency, only purity & efficiency

✓ 10 M minbias BiBi@9.45 (UrMQD v.3.4) events, **noID**, **TPC&TOF** or **TPC&TOF&ECAL**

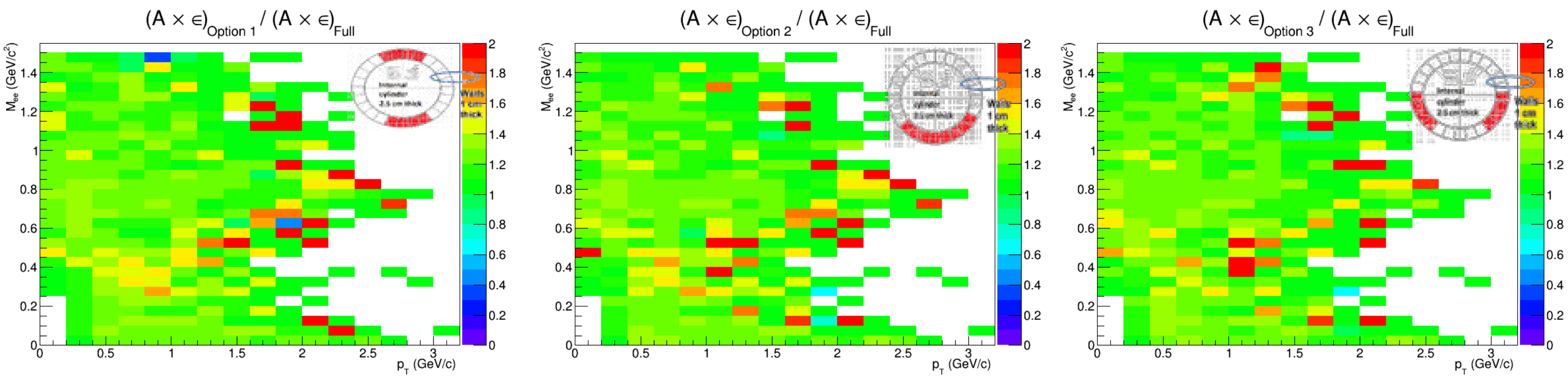




- Lets see what happens with (di)electrons when ECAL is used to identify electrons at p_T > 200 MeV/c

Acceptance for dielectrons, p_T^{ee} > 200 MeV/c

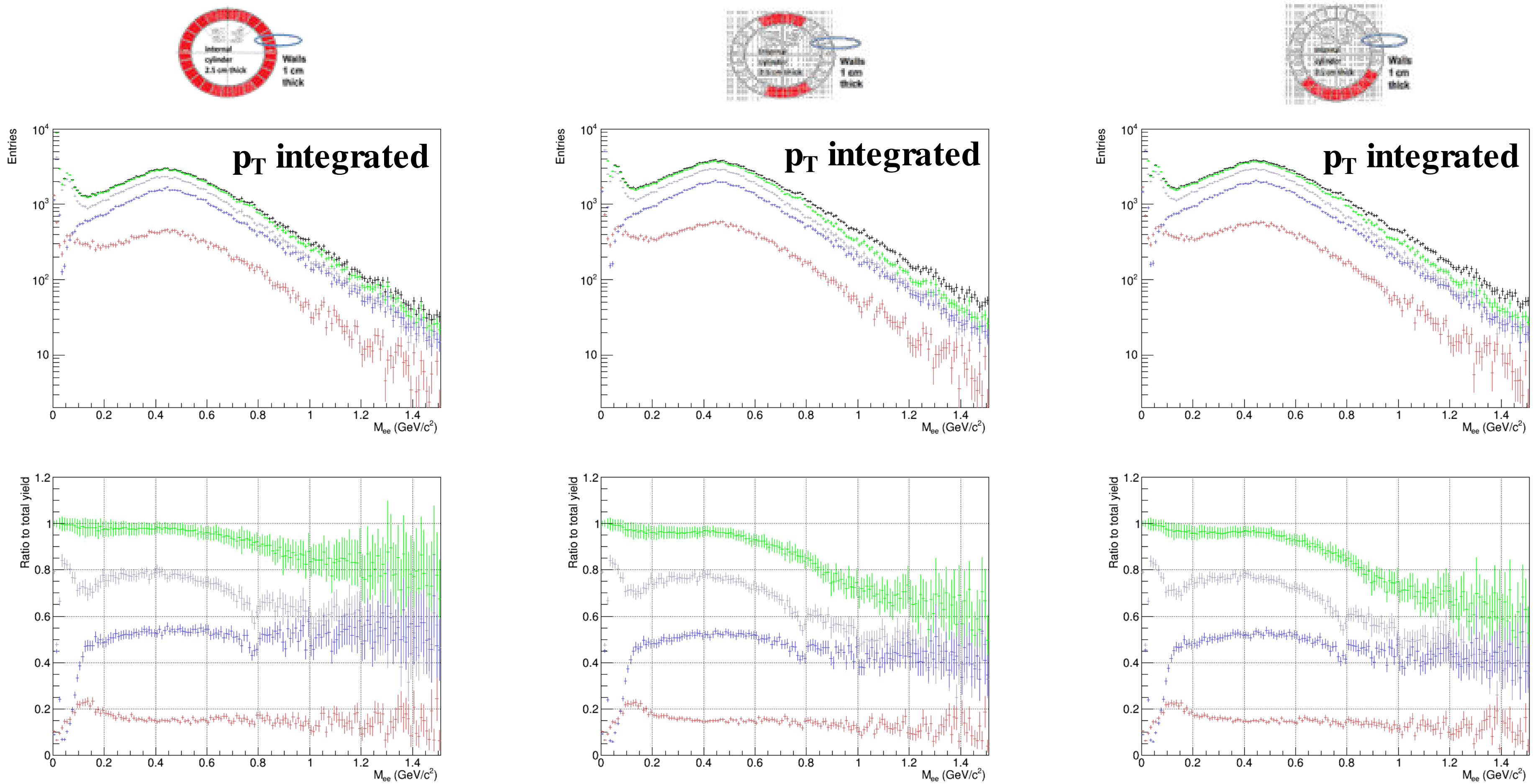
- Fractional yields: UrQMD, BiBi@9.46, smeared vertex, $p_T^{single\ e\pm}$ > 200 MeV/c



- Fractional yields increase since ECAL reduces efficiency at low p_T^e and cleans-up hadron contamination at high p_T^e
- No obvious difference between the Options #1,2,3 (4-6)

Acceptance for dielectrons, p_T^{ee} > 200 MeV/c

- M_{ee} yields: UrQMD, BiBi@9.46, smeared vertex, $p_T^{single\ e\pm}$ > 200 MeV/c



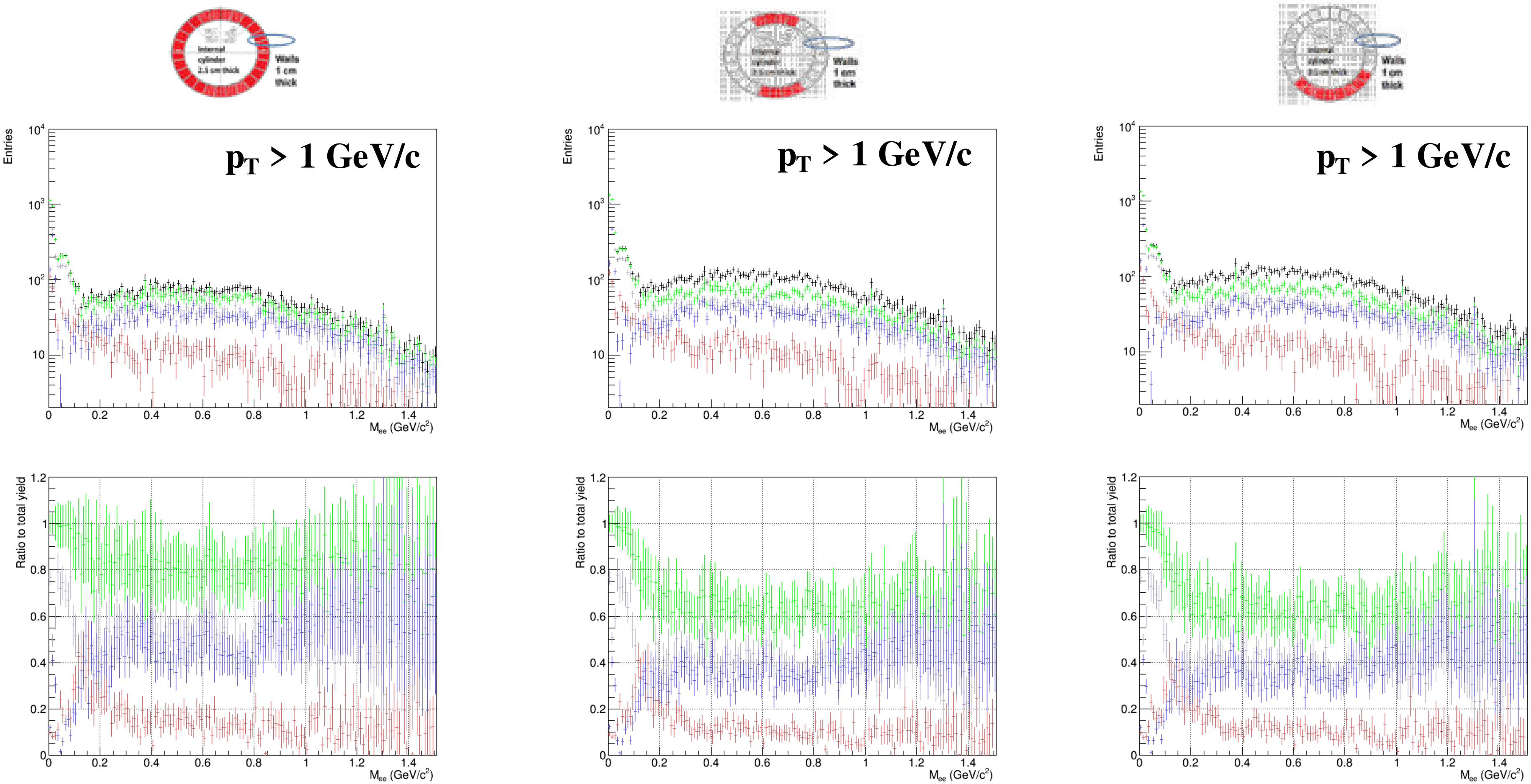
M_{ee} measured/reconstructed with eID in the TPC&TOF&ECAL;

M_{ee} true electrons: among them M_{ee} with π^0 Dalitz, M_{ee} with conversion, M_{ee} with η Dalitz

- No obvious difference between the Options #1,2 (3-6)

Acceptance for dielectrons, p_T^{ee} > 200 MeV/c

- M_{ee} yields: UrQMD, BiBi@9.46, smeared vertex, $p_T^{single\ e\pm}$ > 200 MeV/c



M_{ee} measured/reconstructed with eID in the TPC&TOF&ECAL;
M_{ee} true electrons: among them M_{ee} with π^0 Dalitz, M_{ee} with conversion, M_{ee} with η Dalitz

- No obvious difference between the Options #1,2 (3-6)

Summary

- Options # 4,5 look most promising for neutral mesons → day-1 measurements
- Do not observe any difference between the Options for dielectron measurements

S/B for dielectrons

S/B, comparison with previous results

AZ

VR

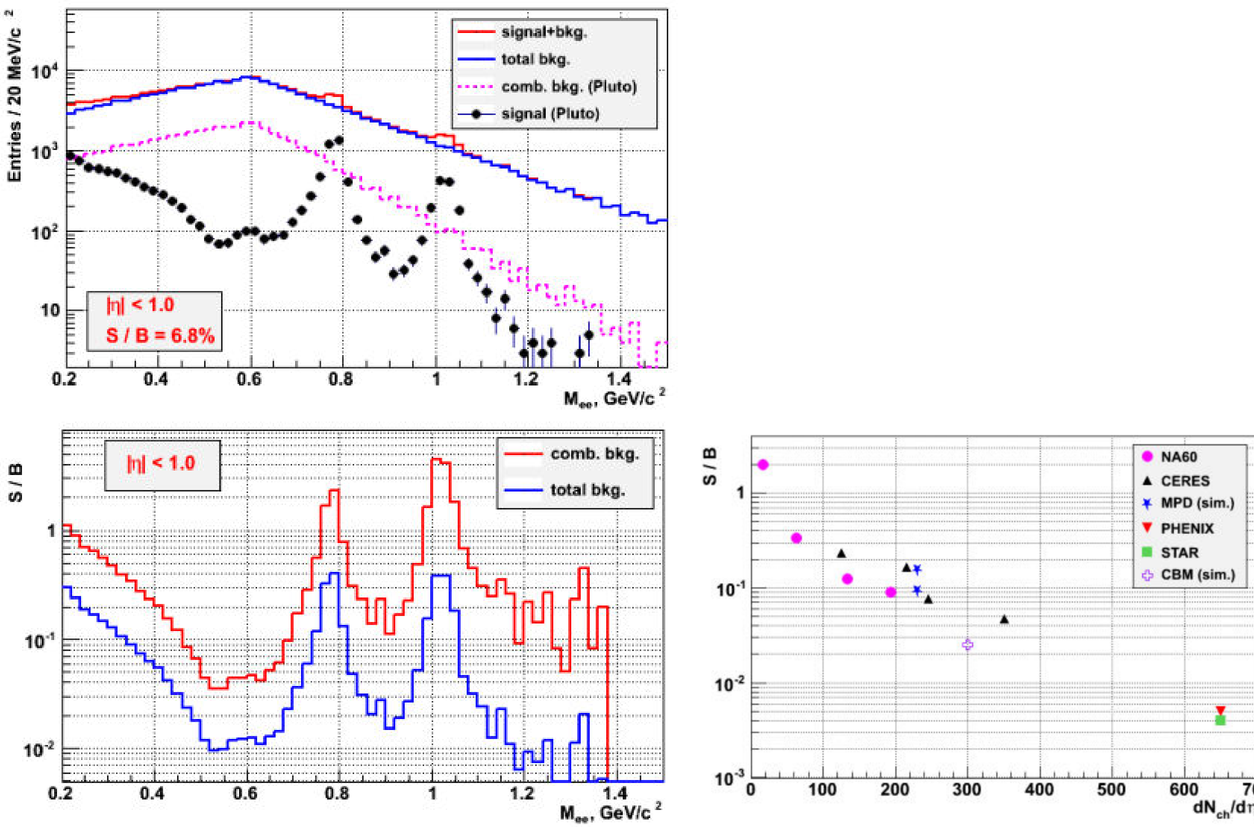
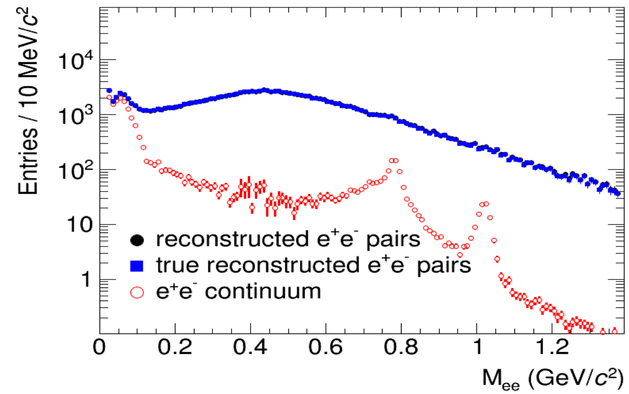
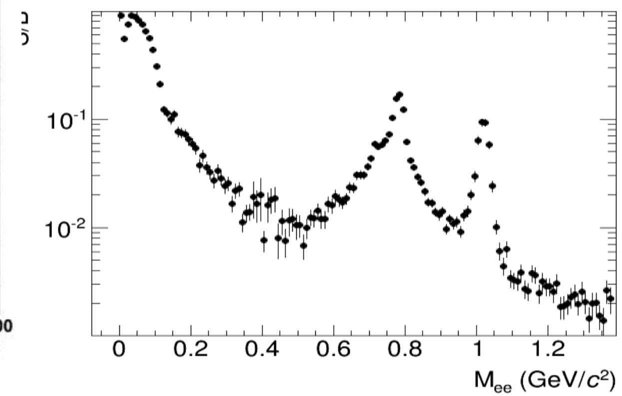


Figure 15: Reconstructed invariant mass of electron-positron pairs and signal-to-background ratios in invariant mass bins. Also shown are the integrated signal-to-background ratios for invariant mass values of 0.2-1.5 GeV/c^2.



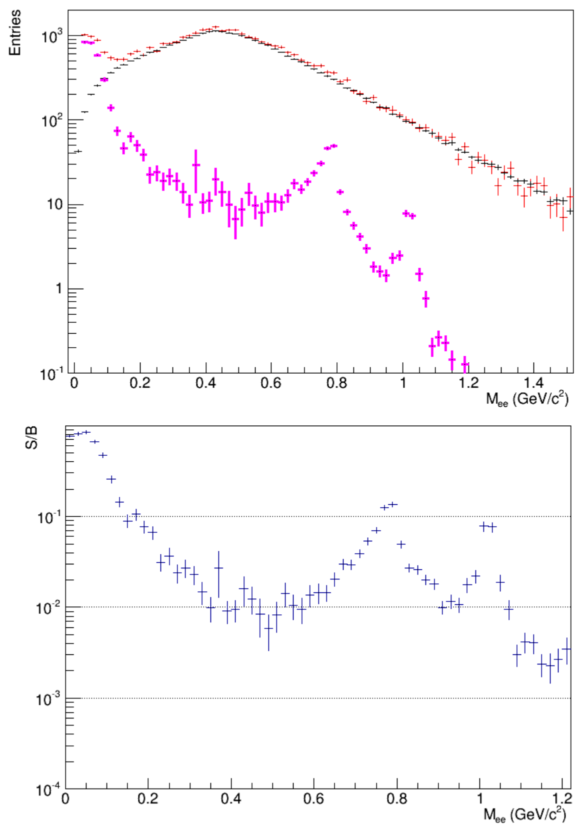


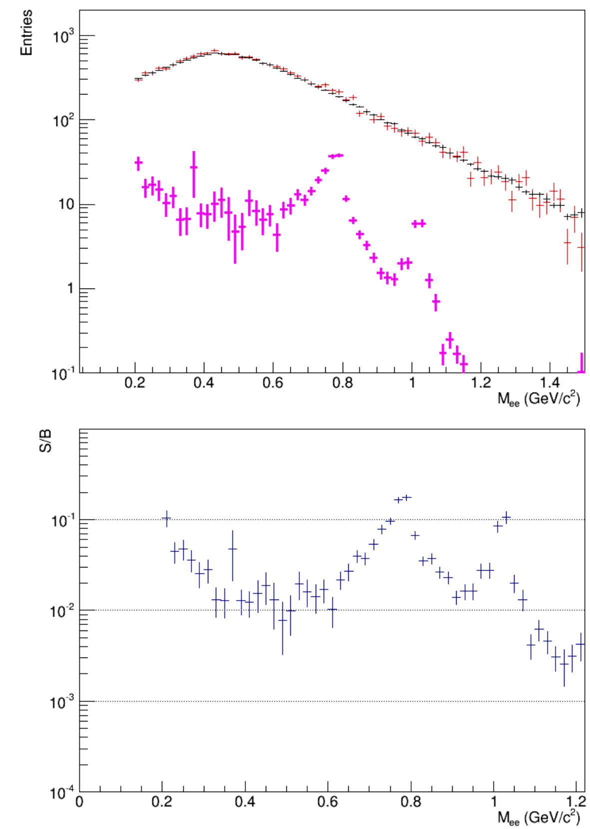
Detector acceptance $\|\eta\|$	$\|\Delta\eta_{e^+e^-}\|$	Signal	S/B, %	S/B, % (R_{pipe} = 20 cm)
< 1.0	-	13025	6.8	10.7
< 0.5	-	3754	10.1	12.7
< 1.2	< 1.0	14198	8.2	13.2
< 1.2	< 0.5	8616	9.4	15.7
< 1.2	< 0.25	4531	9.6	16.8

- Previous analysis reports better S/B ratio:
  - ✓ AZ: S/B = 0.068 for 0.2-1.5 GeV/c^2
  - ✓ VR: S/B ~ 0.022 for 0.2-1.5 GeV/c^2

S/B, different cuts: M_{pair}

- **M_{pair} > 0.2 GeV/c**: tag and reject all electron track candidates that form a pair with M_{ee} < 0.2 GeV/c with any other electron track candidate in the event





S/B in 0.2-1.5: 0.0228562
================================
Omega (s/sqrt(b)): 2.45081
Phi (s/sqrt(b)): 1.01321
LMR (s/sqrt(b)): 0.469486
================================

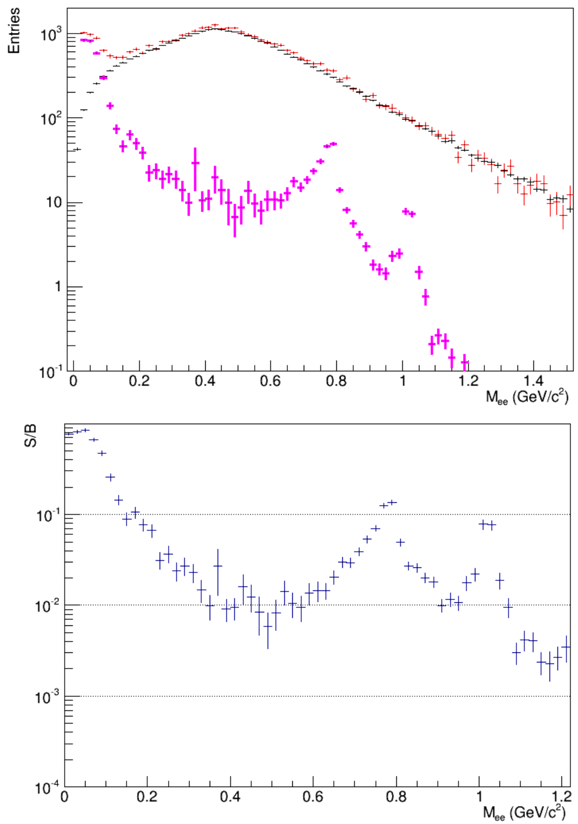
S/B ratio improved by 35%,

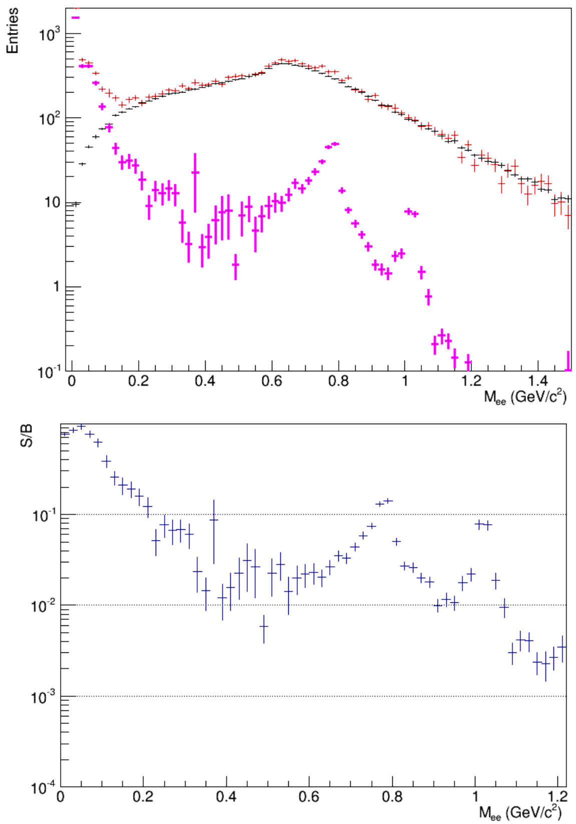
but signal significance have not changed

S/B in 0.2-1.5: 0.0310112
================================
Omega (s/sqrt(b)): 2.49616
Phi (s/sqrt(b)): 0.98441
LMR (s/sqrt(b)): 0.463362
================================

S/B, different cuts: asymmetry

- $\sqrt{p_T^{e-} p_T^{e+}} > 0.3$: a low-$p_T$ electron must pair only with a high-p_T electron





S/B in 0.2-1.5: 0.0228562
================================
Omega (s/sqrt(b)): 2.45081
Phi (s/sqrt(b)): 1.01321
LMR (s/sqrt(b)): 0.469486
================================

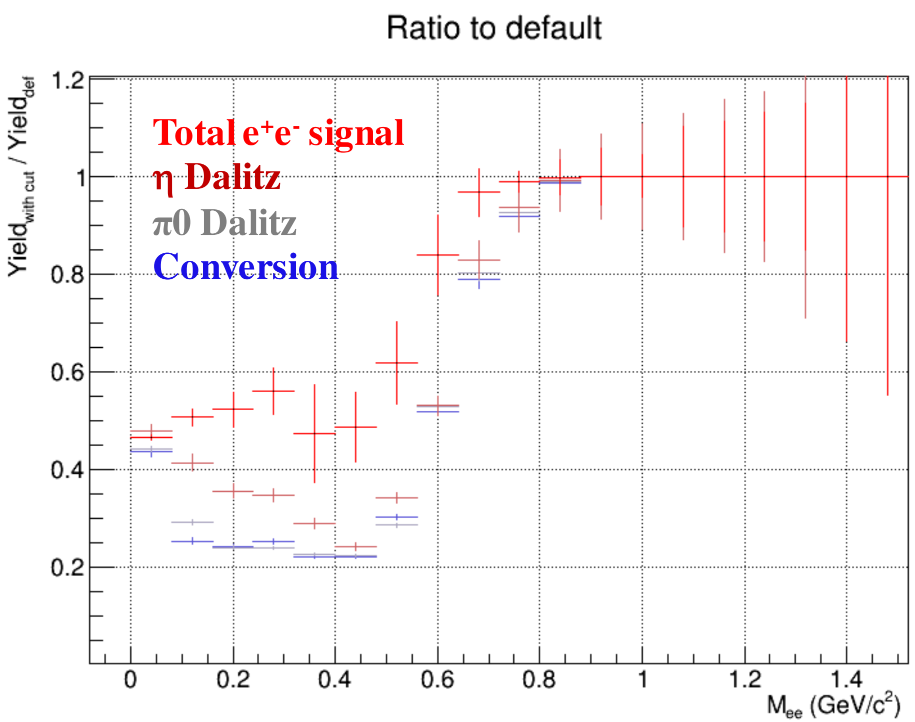
S/B ratio improved by 69%,

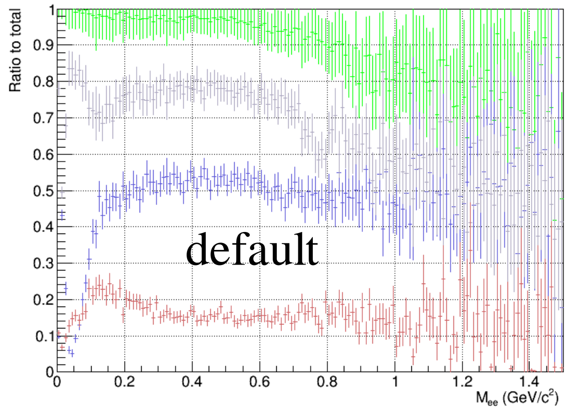
but signal significance have not changed

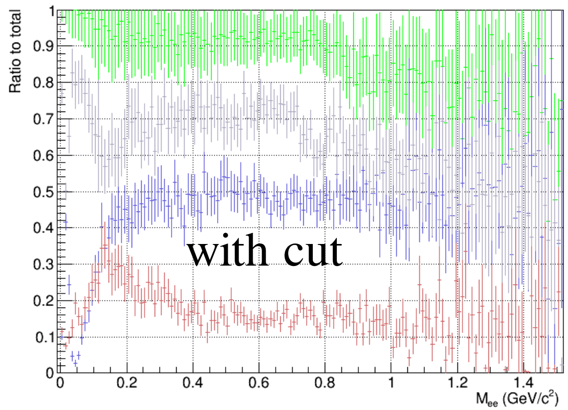
S/B in 0.2-1.5: 0.0386114
================================
Omega (s/sqrt(b)): 2.48839
Phi (s/sqrt(b)): 1.01321
LMR (s/sqrt(b)): 0.47154
================================

S/B, different cuts: asymmetry

- $\sqrt{p_T^{e-} p_T^{e+}} > 0.3$: a low-$p_T$ electron must pair only with a high-p_T electron



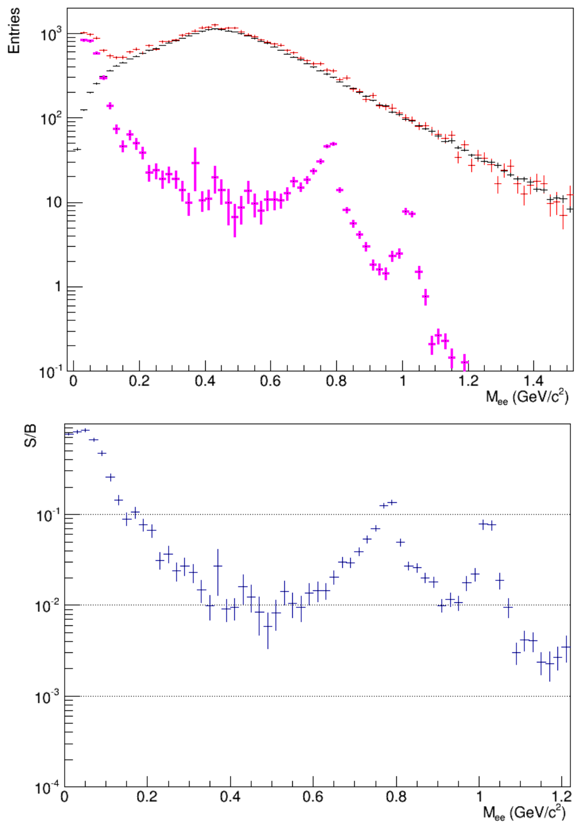


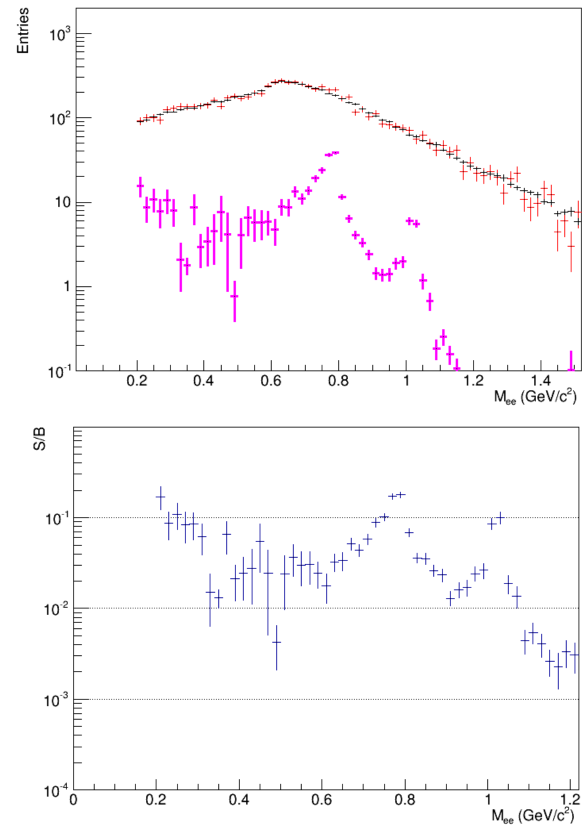


- The cut rejects ~ 50% of the total signal, 60% of e-η, 75% of e-π^0 and e-conversion pairs
- Redistribution of pairs for from different sources at low masses

S/B, different cuts: M_{pair} && asymmetry

- M_{pair} > 0.2 GeV/c && $\sqrt{p_T^{e-} p_T^{e+}} > 0.3$





S/B in 0.2-1.5: 0.0228562

==============================

Omega (s/sqrt(b)): 2.45081

Phi (s/sqrt(b)): 1.01321

LMR (s/sqrt(b)): 0.469486

==============================

S/B ratio improved by 212%,

but signal significance have not changed

S/B in 0.2-1.5: 0.0494519

==============================

Omega (s/sqrt(b)): 2.5189

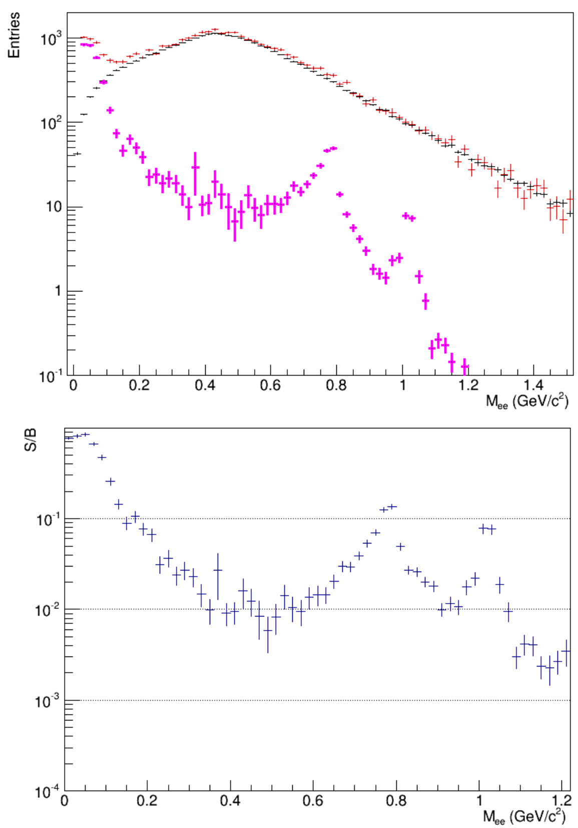
Phi (s/sqrt(b)): 0.959773

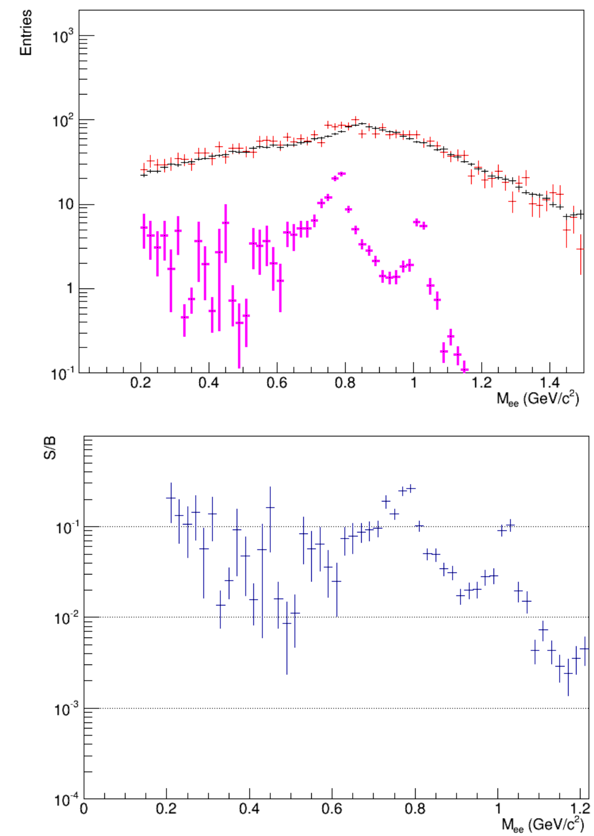
LMR (s/sqrt(b)): 0.452017

==============================

S/B, different cuts: going to extremes

- **M_{pair} > 0.2 GeV/c** && $\sqrt{p_T^{e-} p_T^{e+}} > 0.4$





S/B in 0.2-1.5: 0.0228562
==============================
Omega (s/sqrt(b)): 2.45081
Phi (s/sqrt(b)): 1.01321
LMR (s/sqrt(b)): 0.469486
==============================

S/B ratio improved by x 3,

but signal significance have not changed or even decreased →

S/B in 0.2-1.5: 0.067297 → as in previous ANA
==============================
Omega (s/sqrt(b)): 2.33164
Phi (s/sqrt(b)): 0.993915
LMR (s/sqrt(b)): 0.436604
==============================

Summary for comparison

- S/B can be maid many factors larger with the specific analysis cuts
- Larger S/B ratio does not mean better signal extraction.
- Focus is on optimization of the signal significance !!!