SOFT DILEPTONS ANALYSIS STATUS

ELECTRICAL CONDUCTIVITY
EXTRACTION PROCEDURE

TECHNISCHE UNIVERSITÄT DARMSTADT

Multi- analysis
2500A vs 200A field settings
Systematic cross-checks

↓

PHASE 1 – Clean Signal

Clean dilepton sample

PHASE 2 – Background Substraction

CB substraction

↓

PHASE 3 – Physics Background

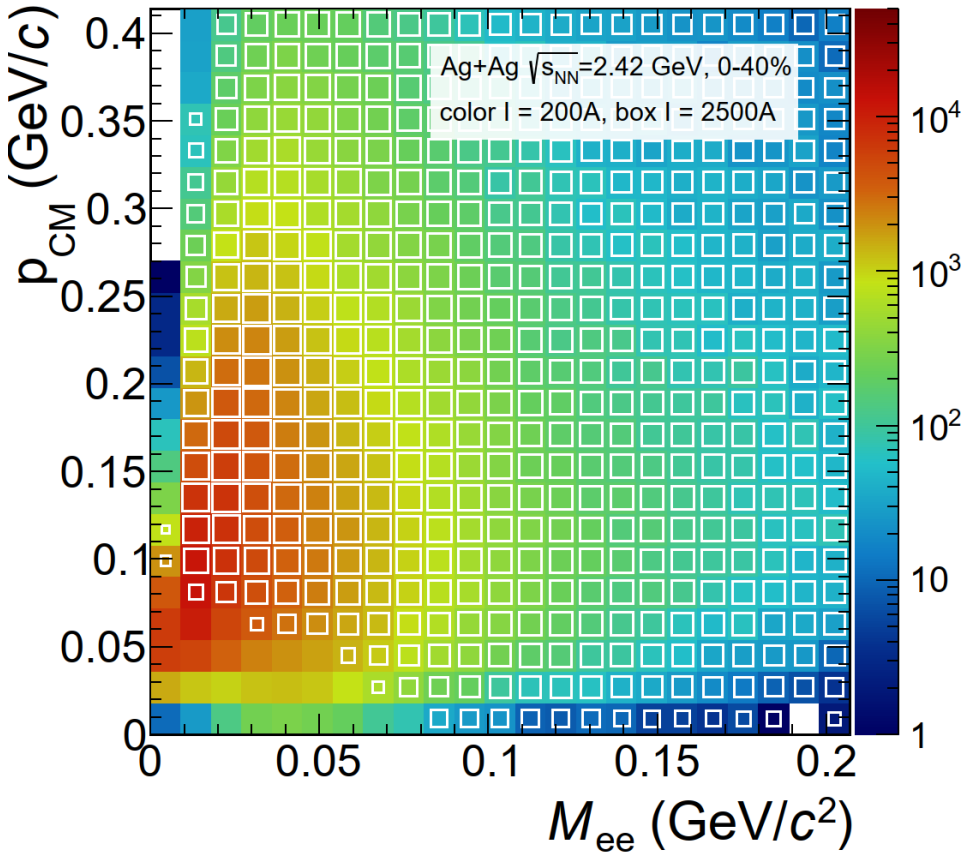
Hadronic cocktail simulation
π^0, η, ω – PLUTO input
Efficiency corrections

↓

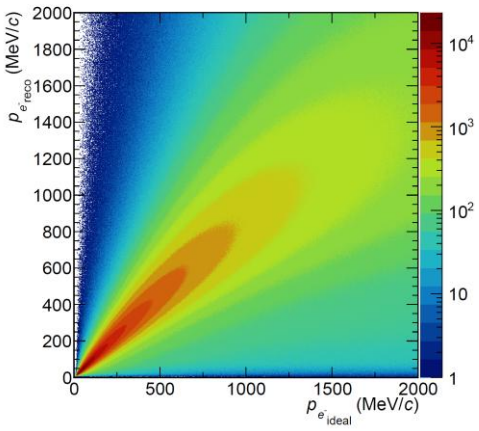
PHASE 4 – Excess extraction

Thermal radiation extraction

Signal e^+e^- spectra of raw counts
- Color: low-field
- White boxes: regular field



PREAMBLE



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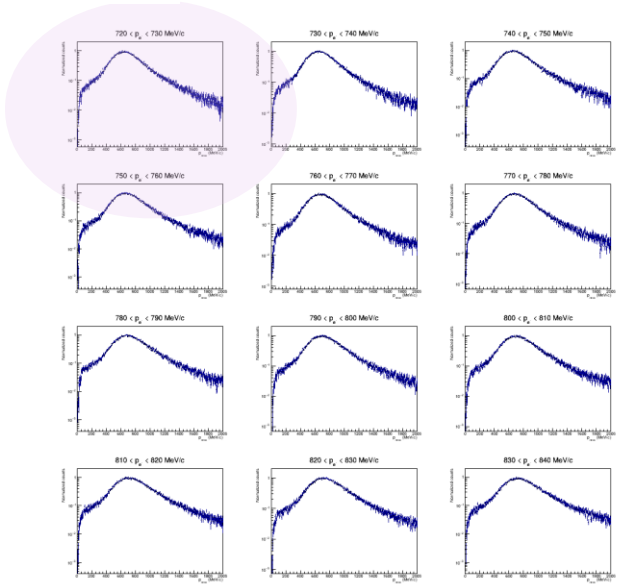
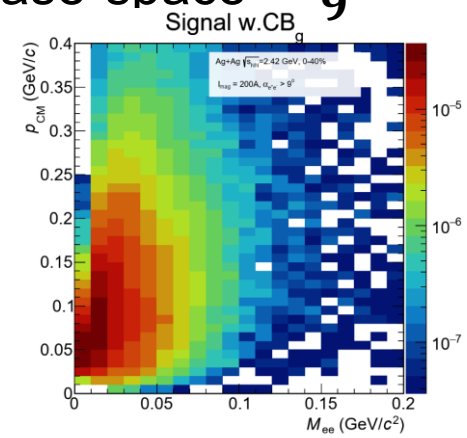
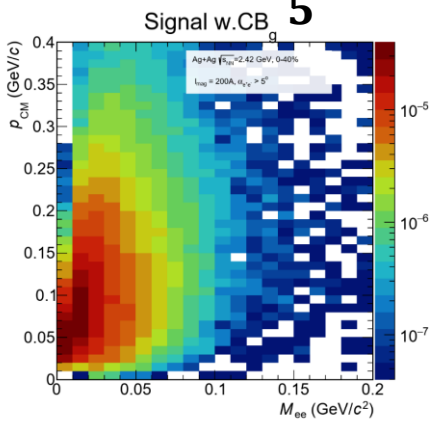
Signal selection :

1. Lower momentum selection studied
   - Upper momentum cut of 700 MeV/*c*
     - Due to momentum broadening of the smearing matrix
   - Lower momentum cut if 20 MeV/*c*
     - Good statistics, still
     - Preserves efficiency and achieve the σ_{el} limit



2. Checked the opening angle correlation
   - No impact on the phase-space

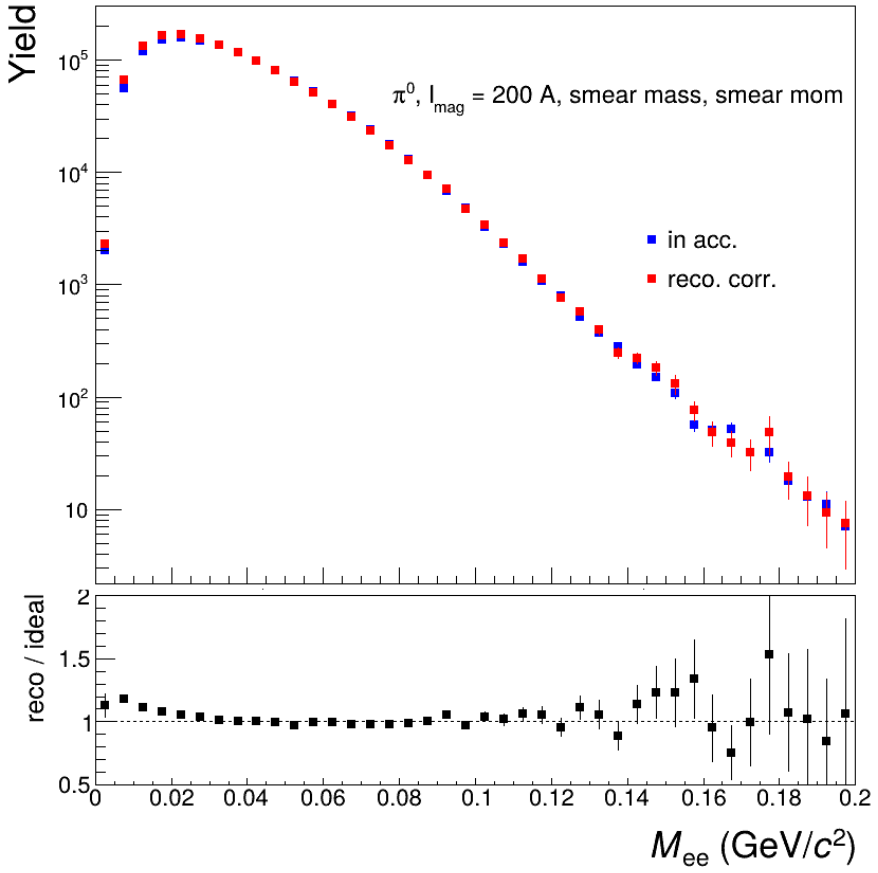


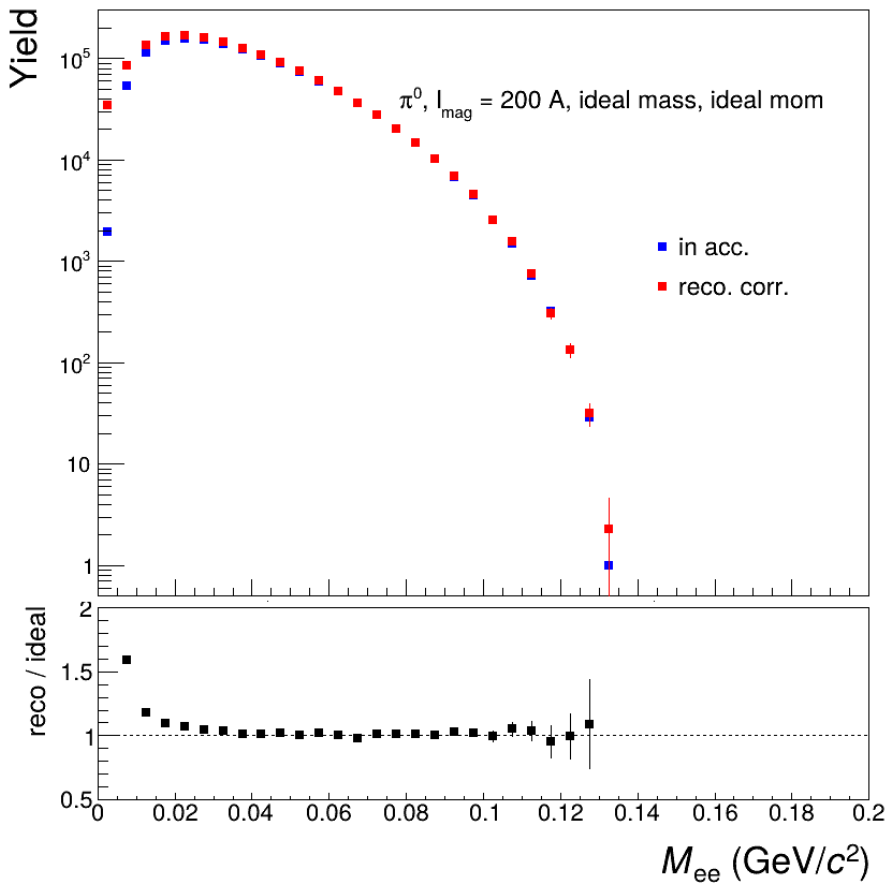


SYSTEMATIC CHECKS π^0

Smear Mom, Smear Pickup

- **White dileptons embedded to real events, enhanced from p = 0-1 GeV/c**





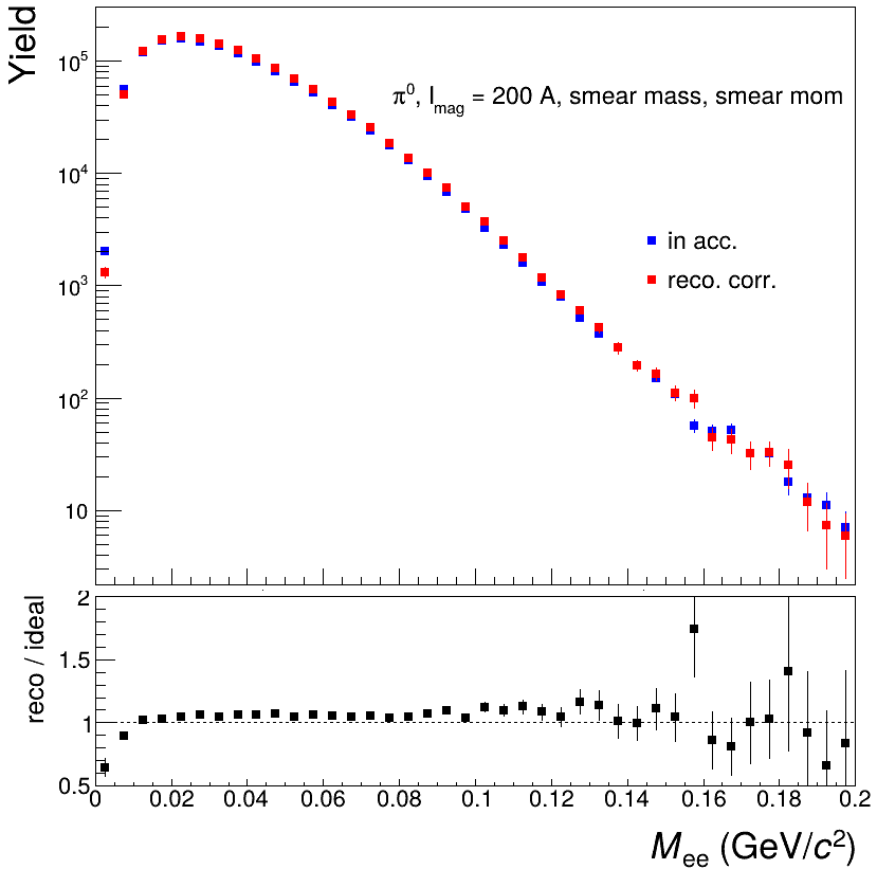
Solved issue

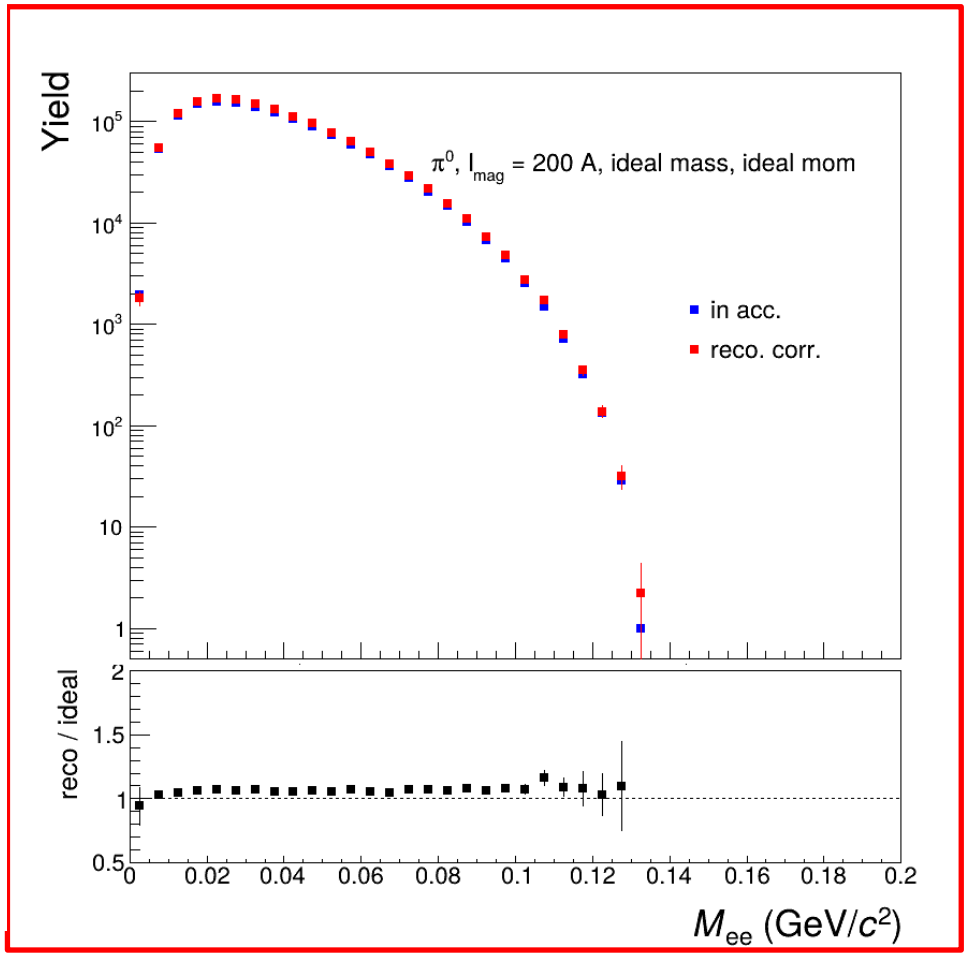
Reason:
Asymmetric cut in the loop over kine and cand

SYSTEMATIC CHECKS π^0

Ideal Mom, Ideal Pickup

- **White dileptons embedded to real events, enhanced from p = 0-1 GeV/c**





Solved issue

Reason:
Asymmetric cut in the loop over kine and cand

SIGNAL RECONSTRUCTION

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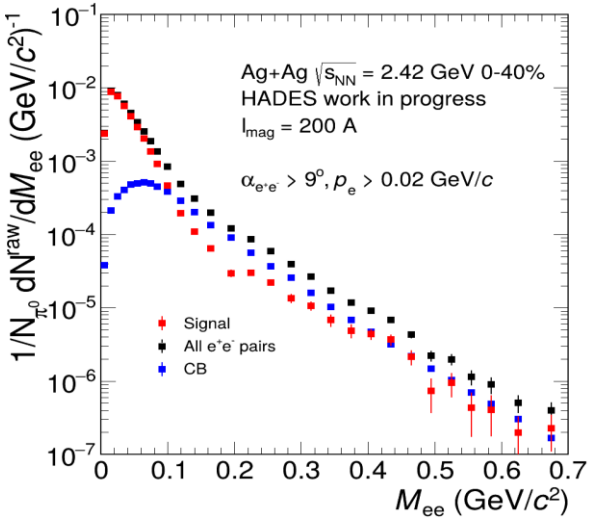
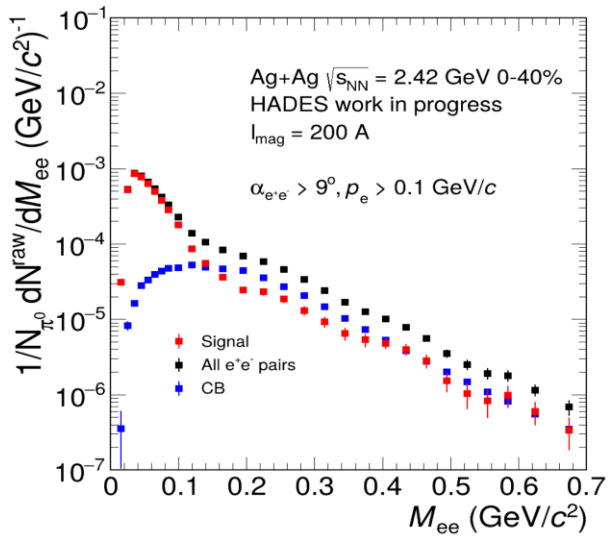
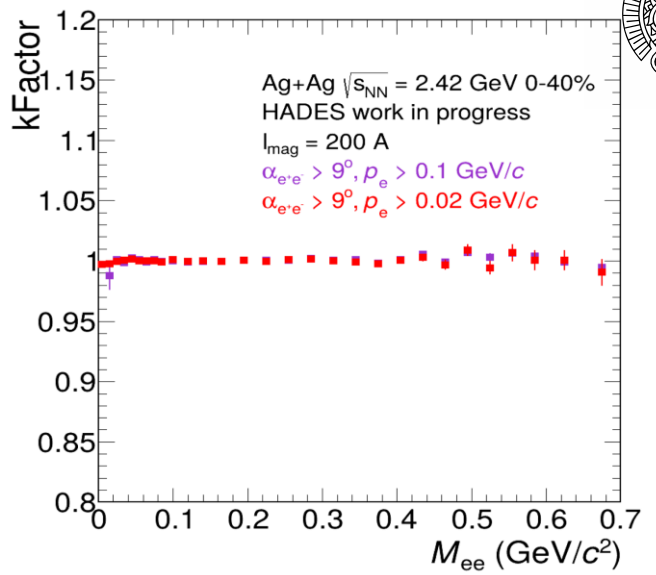
- Calculation of combinatorial background
  - Based on same event like-sign pairs and event-mixing

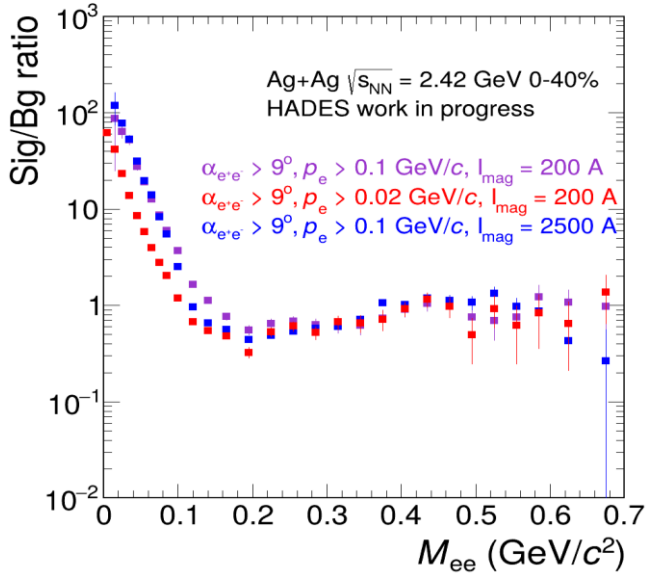
$$\frac{dN_{Signal}}{dM} = \frac{dN_{+-}}{dM} - 2k\sqrt{\frac{dN_{++}}{dM}\cdot\frac{dN_{--}}{dM}},\ k = \frac{N^{\pm}_{mix}}{2\sqrt{N^{++}_{mix}\cdot N^{--}_{mix}}}$$





raw signal counts	$p_e > 0.02\ GeV/c$	$p_e > 0.1\ GeV/c$
$M_{ee} < 0.13 GeV/c^2$	235k	30k
$M_{ee} > 0.13 GeV/c^2$	5.2k	3.9k





SIGNAL RECONSTRUCTION

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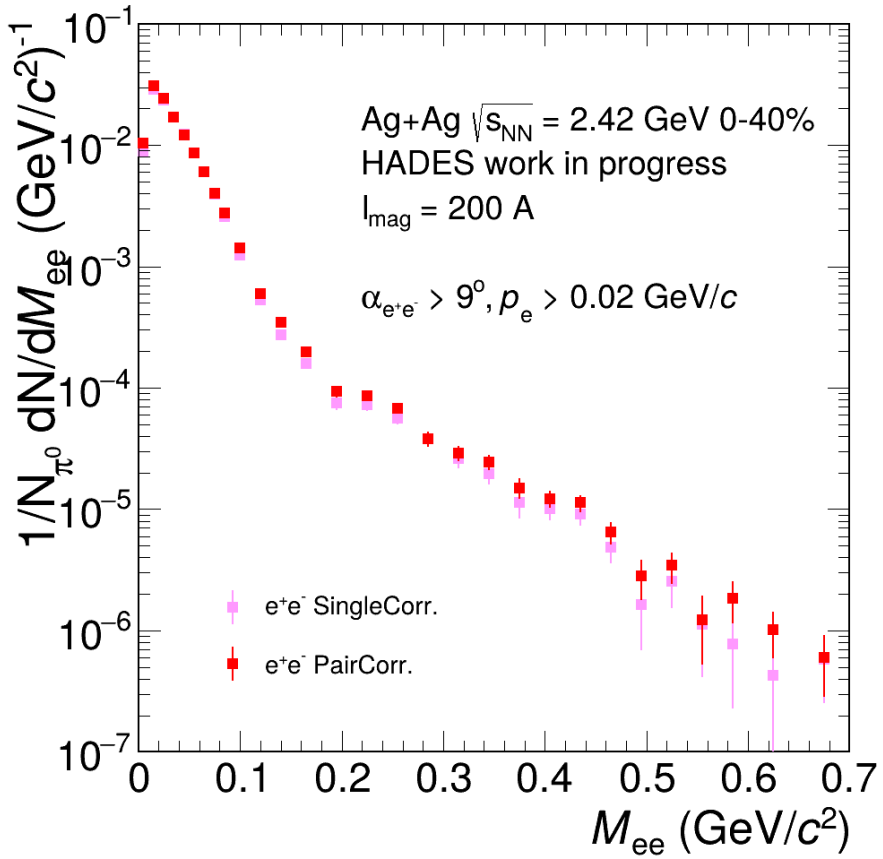
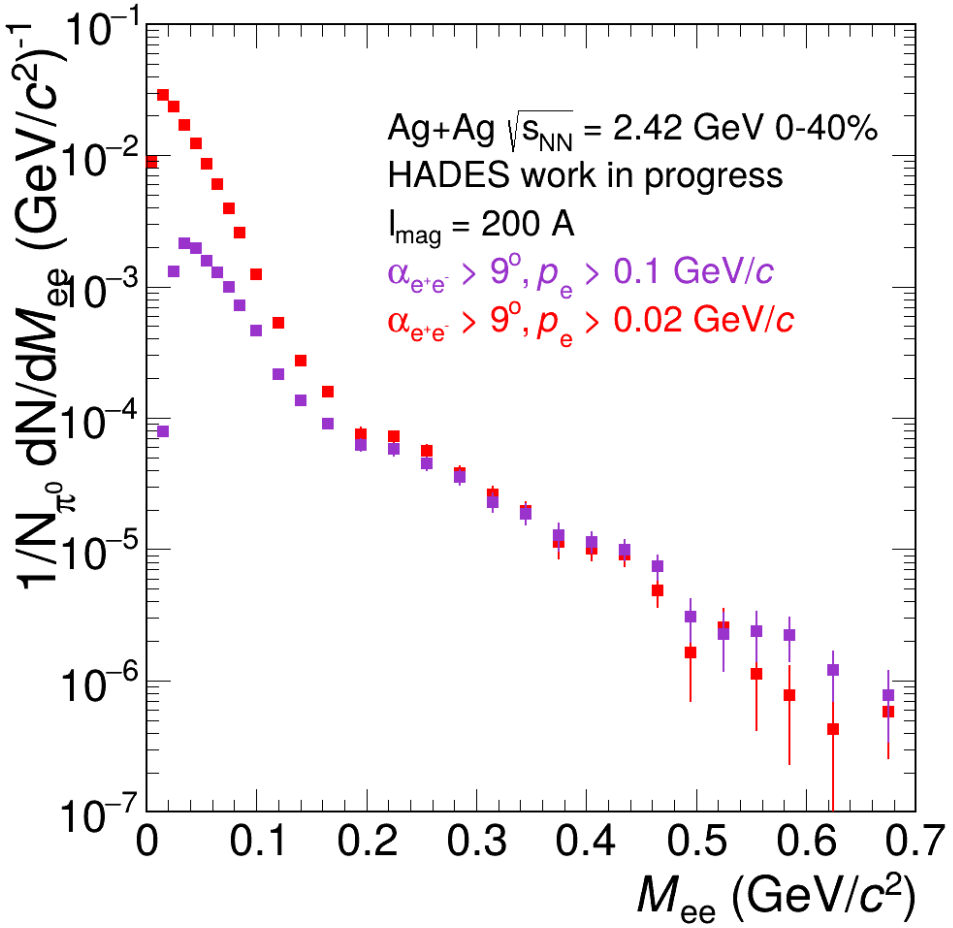
- Consistent results for single lepton and pair correction
- Data with low momentum consistent → Gain even more yield in the low mass region





SIGNAL RECONSTRUCTION

AgAg
1.23 AGeV
I_{mag} = 2500A

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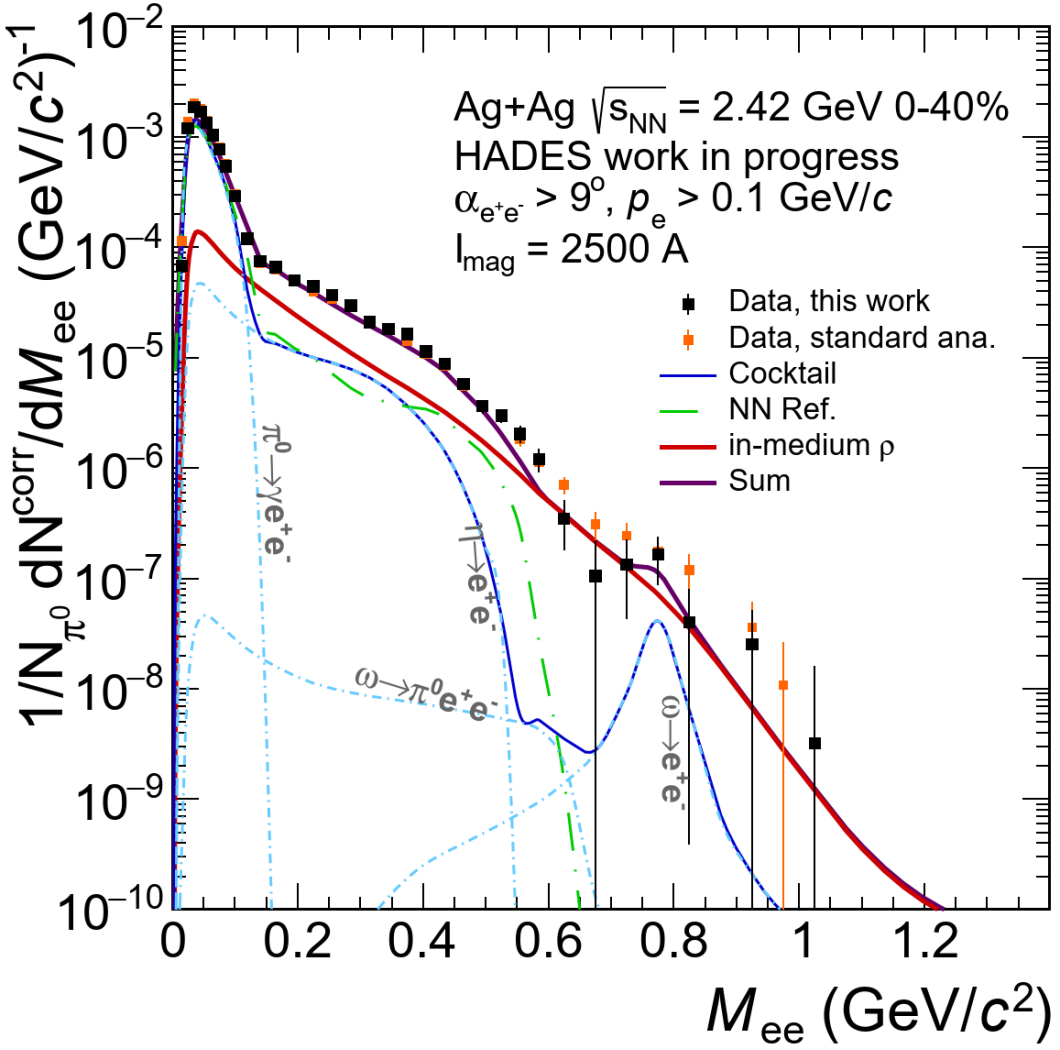
- High field analysis performed in the same way as low field
- Comparison with independent analysis resulting spectra agree within 5%
- Gives confidence for **going towards low field data**



SIGNAL RECONSTRUCTION

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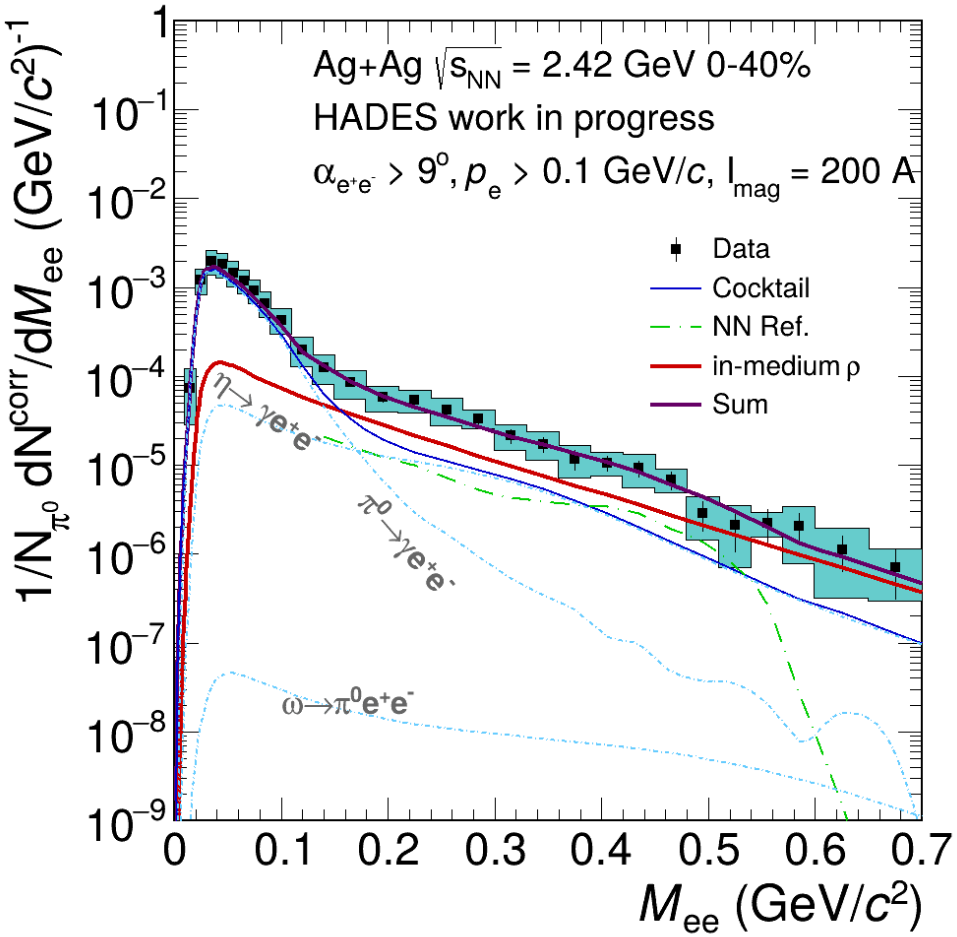
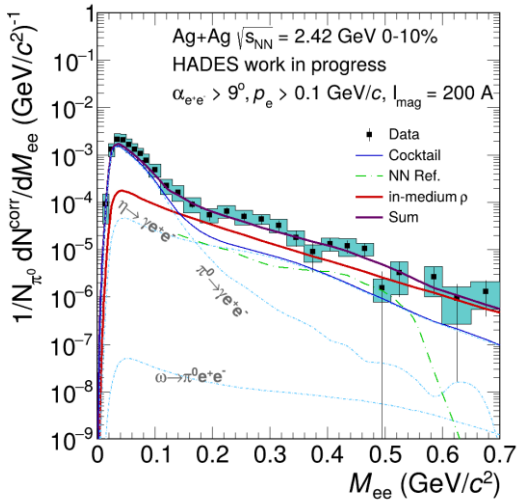
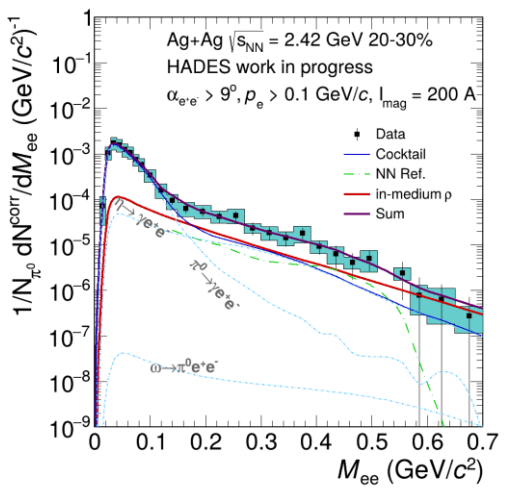
1.23 AGeV
I_{mag} = 200A

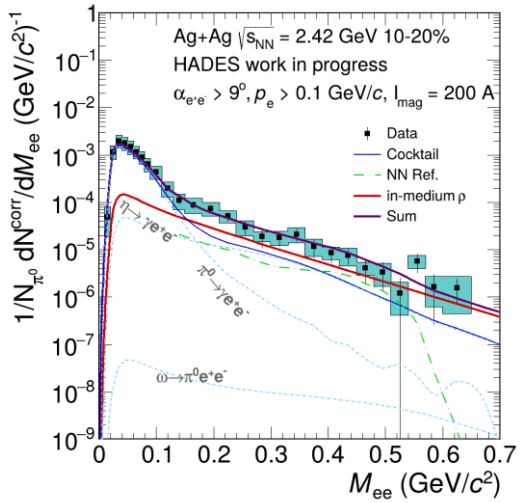
TECHNISCHE UNIVERSITÄT DARMSTADT

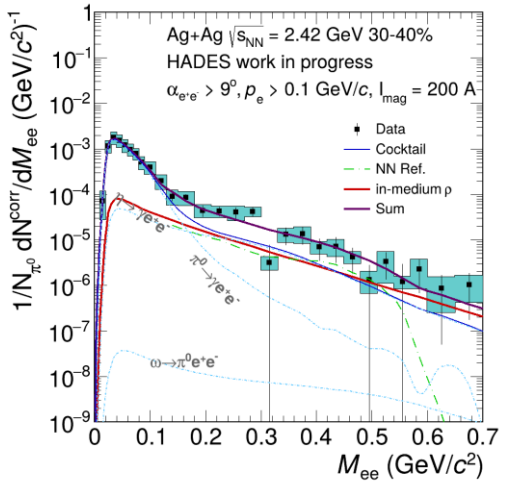
- Centrality dependence of the efficiency corrected data
- **Momentum cut of 0.1 GeV/*c***
- NN reference applied for M_{ee} > 0.13 GeV/c^2











Agreement between data and model calculations when in-medium *ρ* included

SIGNAL RECONSTRUCTION

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I_{mag} = 200A

TECHNISCHE UNIVERSITÄT DARMSTADT

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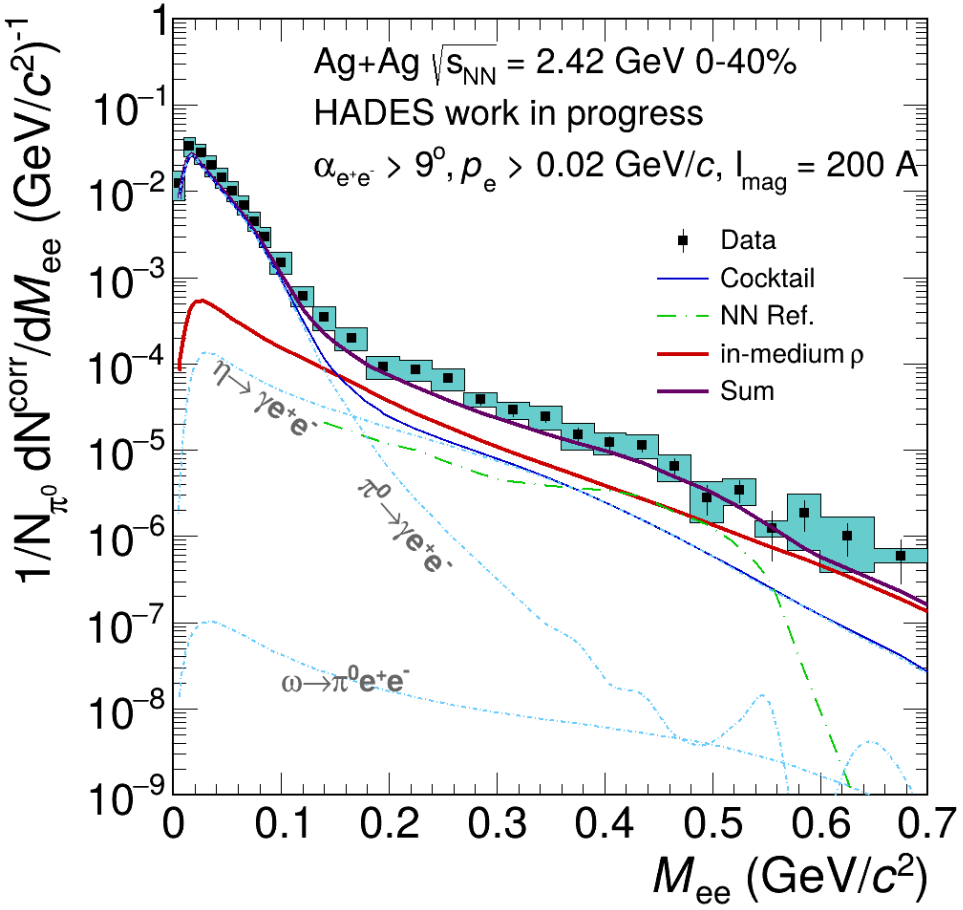
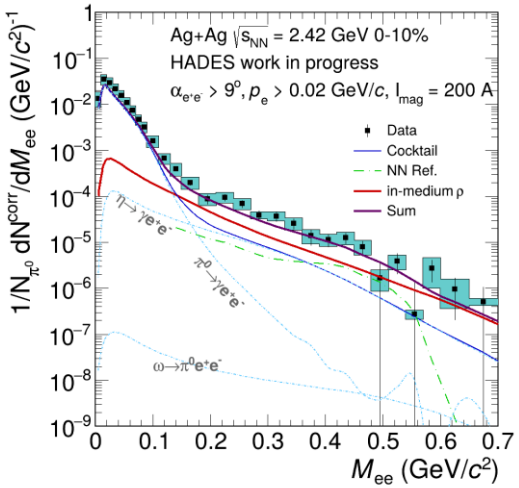
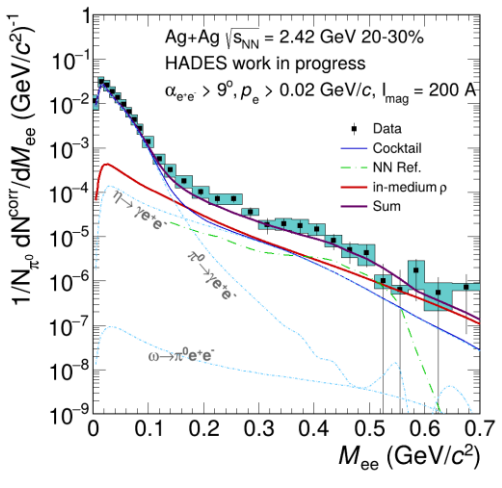
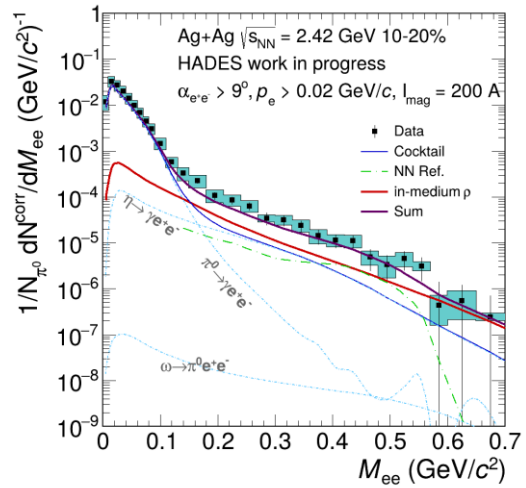
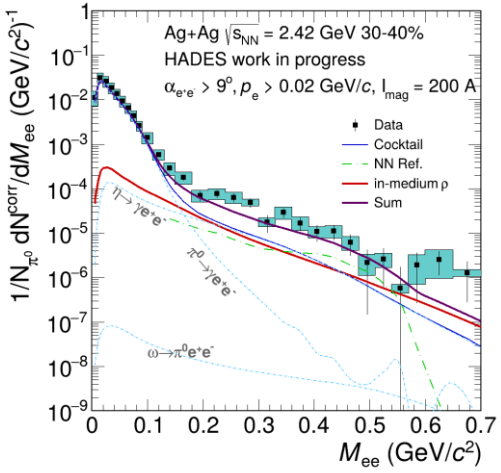










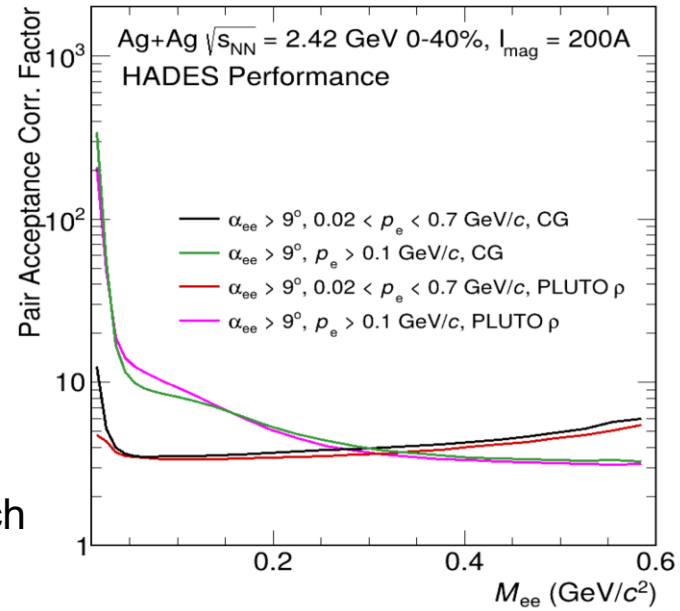
Agreement between data and model calculations when in-medium *ρ* included

EXCESS EXTRACTION

- Isolation of the excess by subtracting the experimentally measured:
  - NN reference
  - Freeze-out contributions

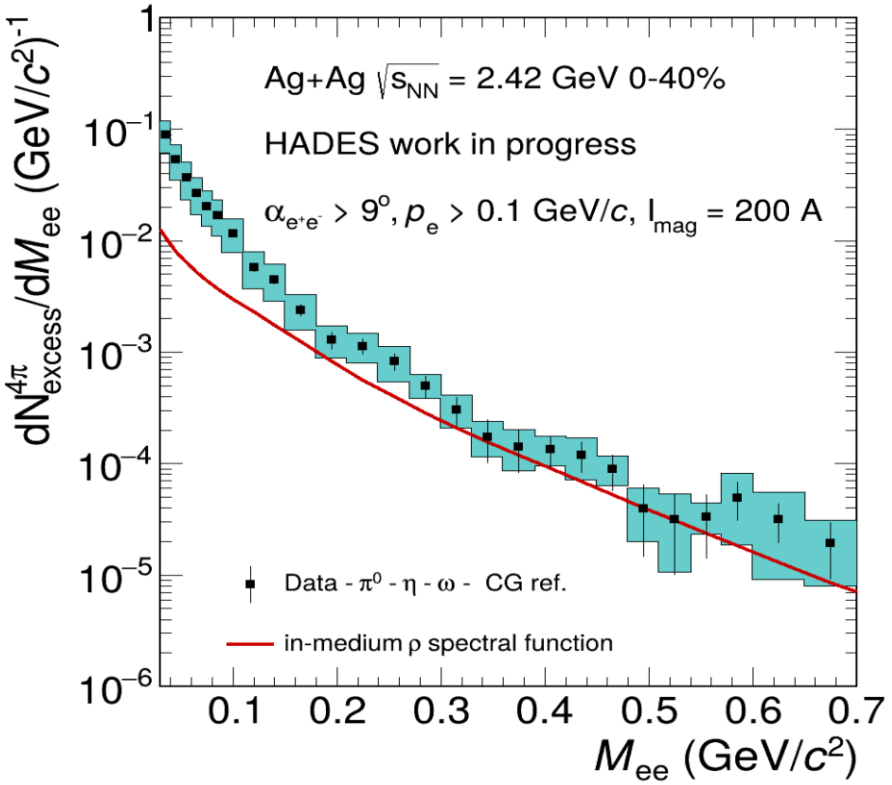
- Acceptance correction applied to pair spectra

- Uncertainties on acceptance correction factor calculated using different models



- Calculated acceptance factor
  → ρ generated with PLUTO event generator and coarse-grained approch

- Difference taken into systematics



PLUTO ρ : Fröhlich et al., PoS ACAT (2007) 076
CG: Seck et al., Phys. Lett. B 861 (2025) 139267
NA60 Collab. Phys. Lett. B 757 (2016) 437-444

EXCESS EXTRACTION

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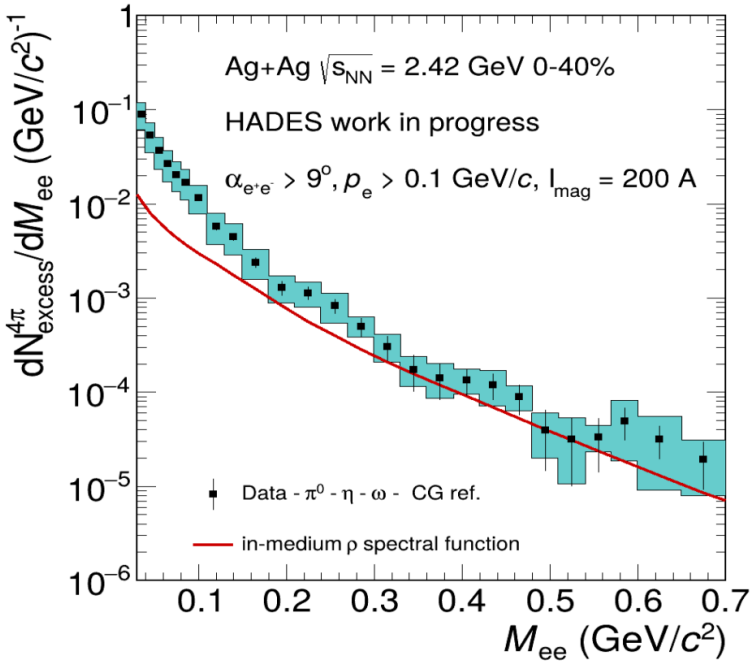
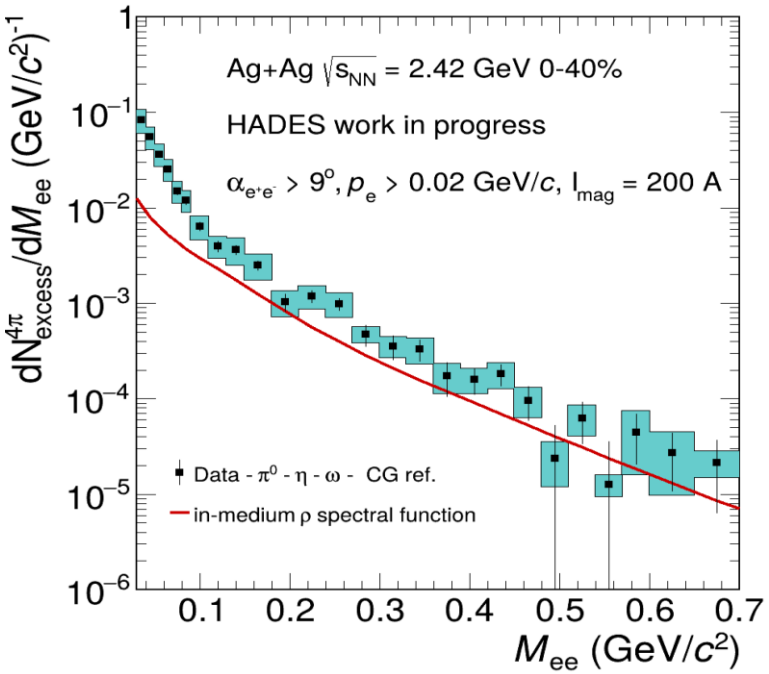
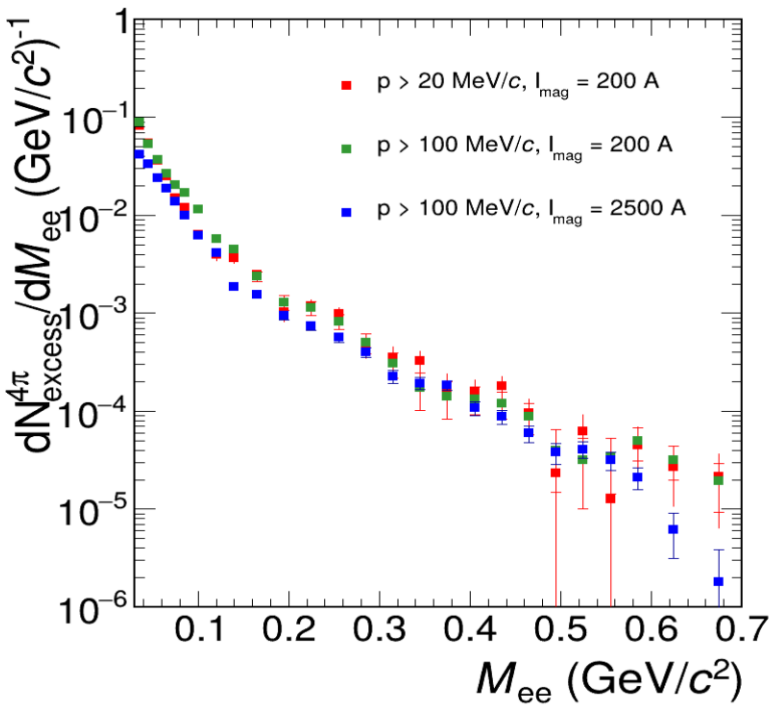
- Low-field 200A : **20MeV/*c*** vs. **100MeV/*c*** vs **2500A-100MeV/*c***
  - Good agreement for M > M_π







- More in-depth analysis need for the acceptance factor to understand the differences

EXCESS EXTRACTION SYSTEMATICS

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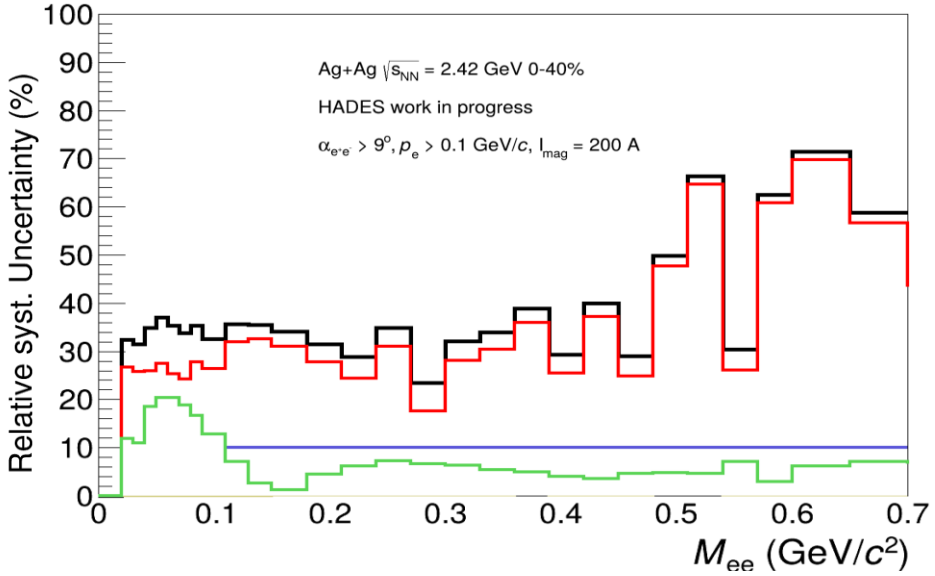
- Estimated bin by bin
- Systematic sources

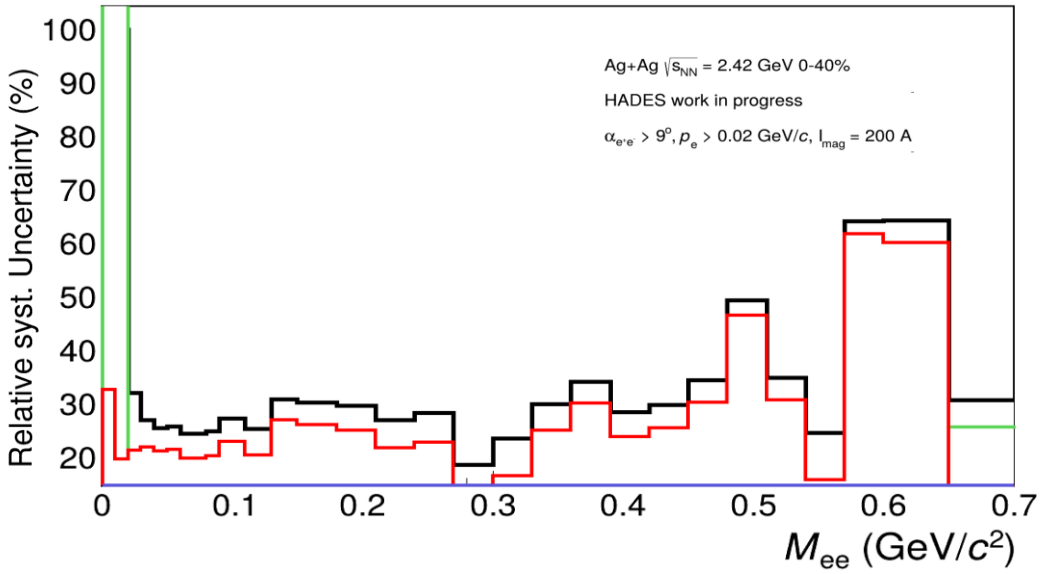
efficiency : based on consistency checks

acceptance : simulated acceptance factor difference between simulated CG ρ and PLUTO ρ

η substraction : 10%

normalisation of π^0 : 10%





OUTLOOK

TECHNISCHE UNIVERSITÄT DARMSTADT

- Next steps towards σ_{el} extraction

PHASE 4 – Excess extraction

Thermal radiation extraction

I_{mag} = 200A, low momentum cut

↓

PHASE 5 – p_{CM} dependence

Differential p_{CM} thermal spectra

↓

PHASE 6 – Electrical conductivity

Extrapolation to low-mass limit

↓

PHASE 7 – Theory comparison

OUTLOOK

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↓

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↓

PHASE 6 – Electrical conductivity

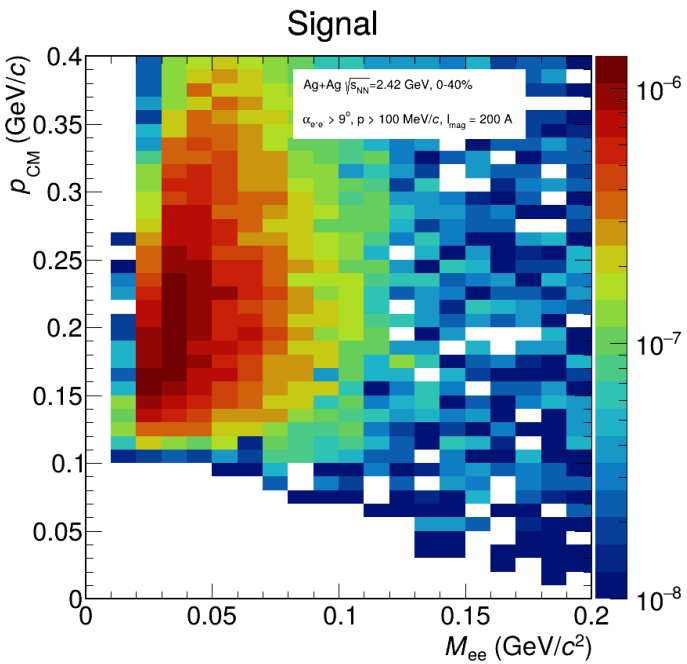
Extrapolation to low-mass limit

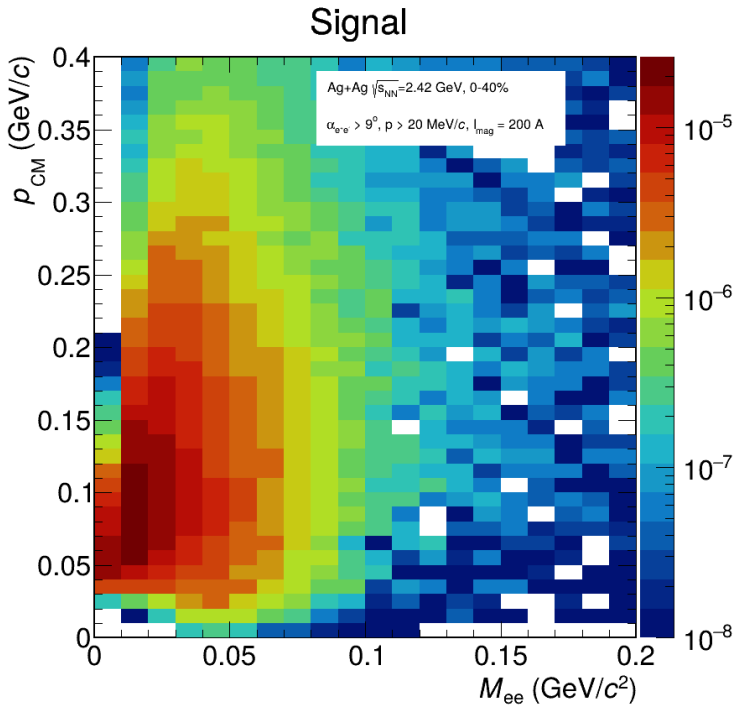
↓

PHASE 7 – Theory comparison

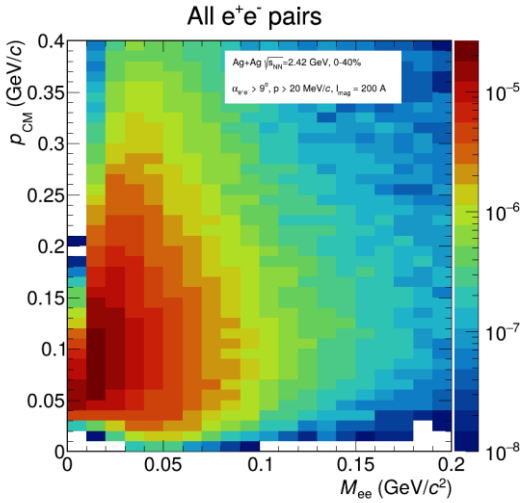
We are here now!

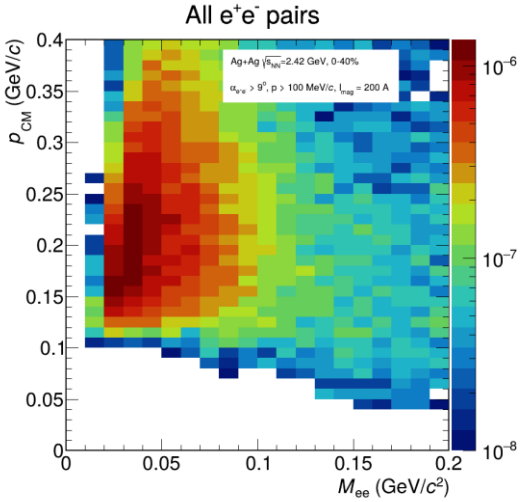
DIFFERENTIAL SPECTRA





- Signal corrected for the efficiency
- Clear advantage of low – momentum cut
- Better phase-space coverage, less extrapolation





DIFFERENTIAL SPECTRA

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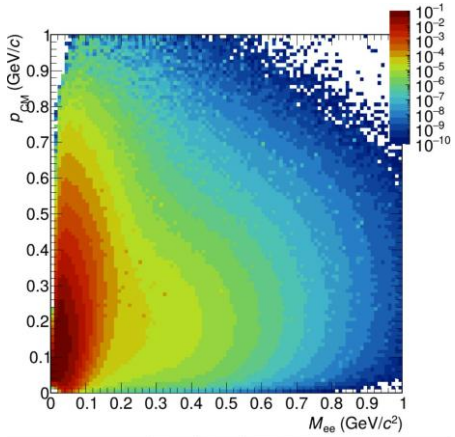
Outlook

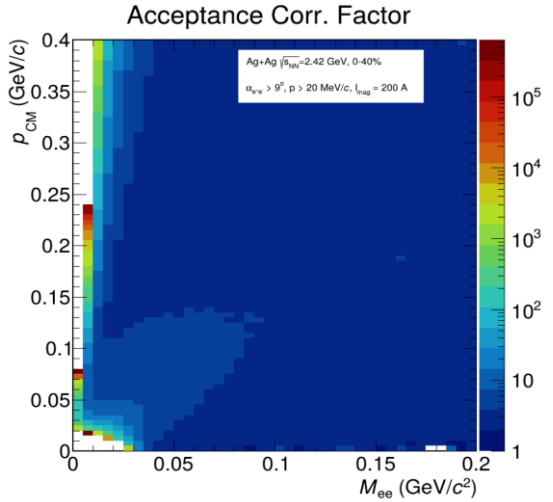
- Calculate the hadronic cocktail in 2D using the same inputs and efficiency corrections validated in the 1D analysis
- Subtract the cocktail from the differential signal spectra shown on the previous slide
- Subtract the GiBUU reference, benchmarked against the experimental data, tuned for 200A



- Apply the acceptance correction
  - Using the 2D acceptance correction factor calculated from the PLUTO ρ and CG `

- Cross-check consistency between the two momentum-cut settings in the overlapping p_{CM}
  - Already demonstrated for the 1D spectra

- Resulting differential excess will provide the p_{CM} binned thermal radiation spectra
  - Needed for phase 6, and the mass-extrapolated yield required to extract σ_{el}



SUMMARY

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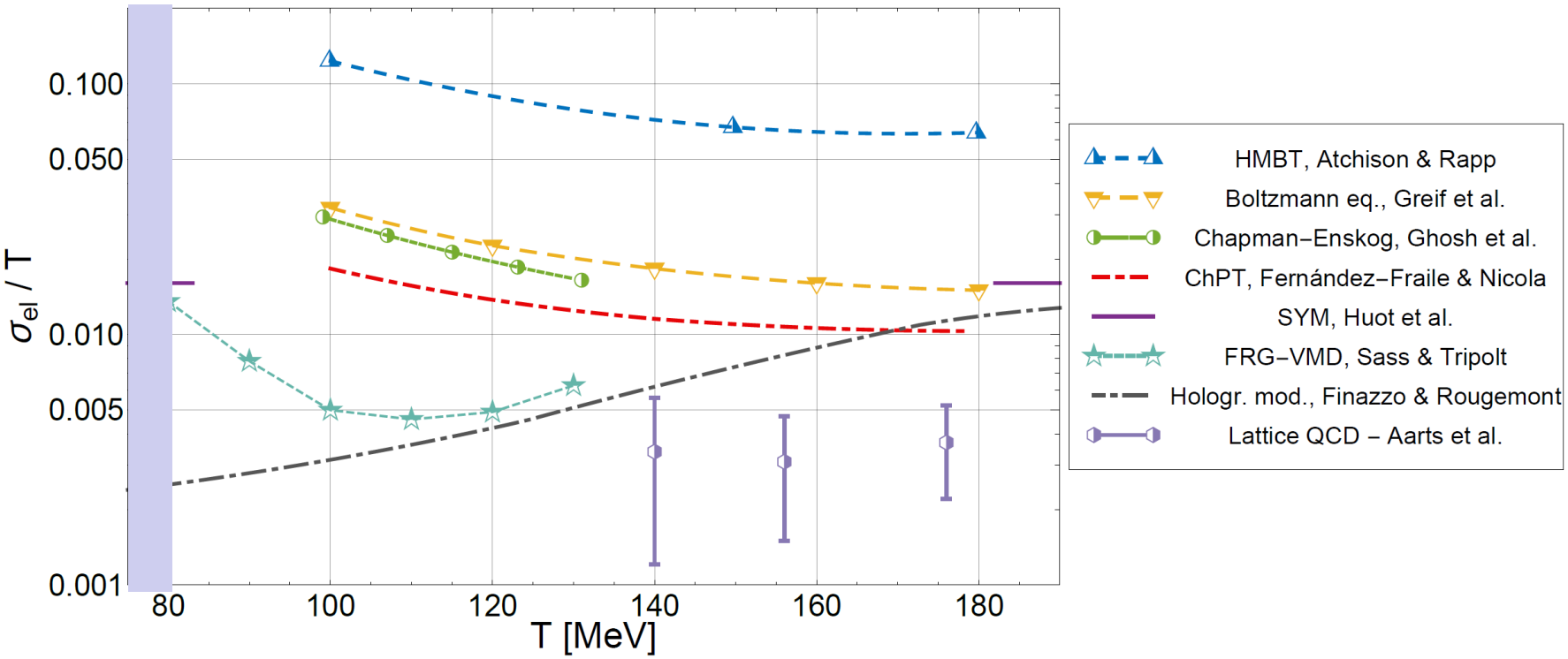
- ✓ Multi-differential analysis performed for two field strength settings
- ✓ Sample with a good purity, S/B ratio, and efficiency
- ✓ Low field setting analyzed under two settings of cuts
- ✓ Good control over the obtained yield with an upper momentum cut
- ✓ Excess radiation extracted for I_{mag} = 200 A , p < 0.1 GeV/*c* and p < 0.02 GeV/*c*
- ✓ 2D analysis on the way to extract the p_{CM} range to calculate electrical conductivity

HADES, possible extracted σ_{el}



F. Geurts, R.-A. Tripolt, Prog. Part. Nucl. Phys. 128 (2023) 104004

THANK YOU!