# TRD Dielectron Performance Studies

**CBM PWG-DIL Meeting**

May 14th, 2021

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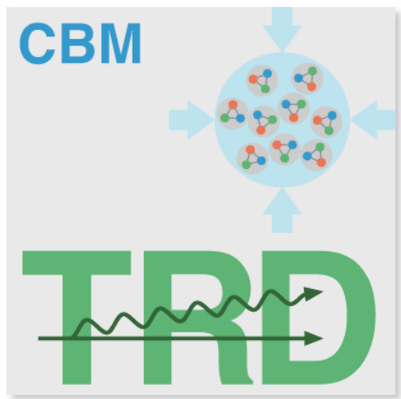
University of Frankfurt



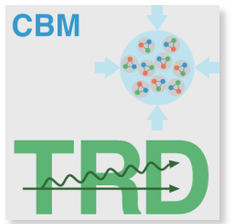








# Outline

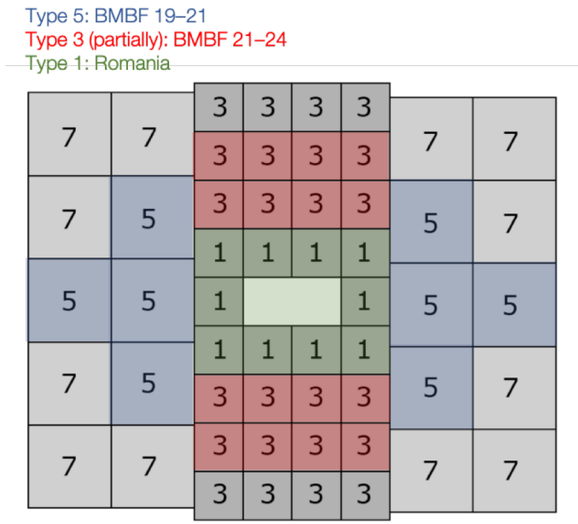



- Impact of a possibly reduced day-1 setup
- Optimization of layer spacing

# Module Construction Plan

- Planned module construction sequence
  - Frankfurt + Münster:
    Type-5 modules (BMBF funding 19–21)
    Type-3 modules, partially (BMBF funding 21–24)
    Type-7 modules (and rest of type-3 ?) in 24–25 (funding not yet applied for)
  - Bucharest:
    Type-1 (inner zone) as TRD-2D, see TDR-addendum
    (Rest if type-3 ?)

- Day-1 setup
  - Most reasonable sequence in terms of logistics and physics
  - Complete setup foreseen for 2025
  - Funding for 24–25 open
  - Alternative approach: Built layer-by-layer
    ⟹ Risk of reduced PID capability if only 3 layers ready

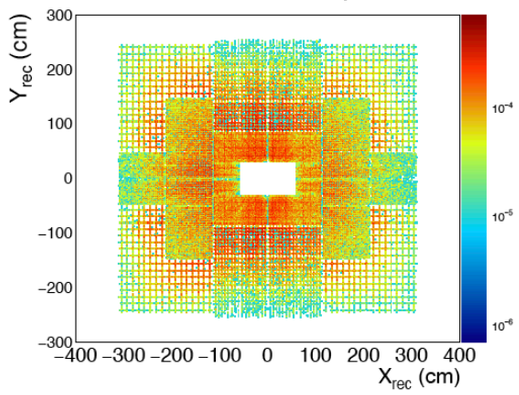


# Reduced Day-1 Setup

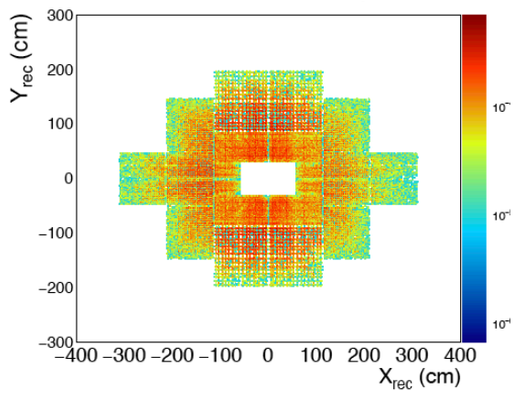
- Performance studies with reduced (2024) setup
  - Full PID performance, but reduced acceptance
  - Study of implications on di-electron performance by Etienne Bechtel

- Simulation input
  - Au+Au, 12A GeV, 0–5 %
  - $7 \cdot 10^7$ UrQMD evts.
    + LMVM cocktail ($\eta_D$, $\eta'$,$\omega_D$, $\omega$, $\phi$, $\rho^0$, $\Delta$)
    + thermal radiation (in-medium $\rho$ + QGP) (*)
  - Default SIS100 electron setup
  - Reduced acceptance modeled by discarding tracks in outer modules

Full Setup



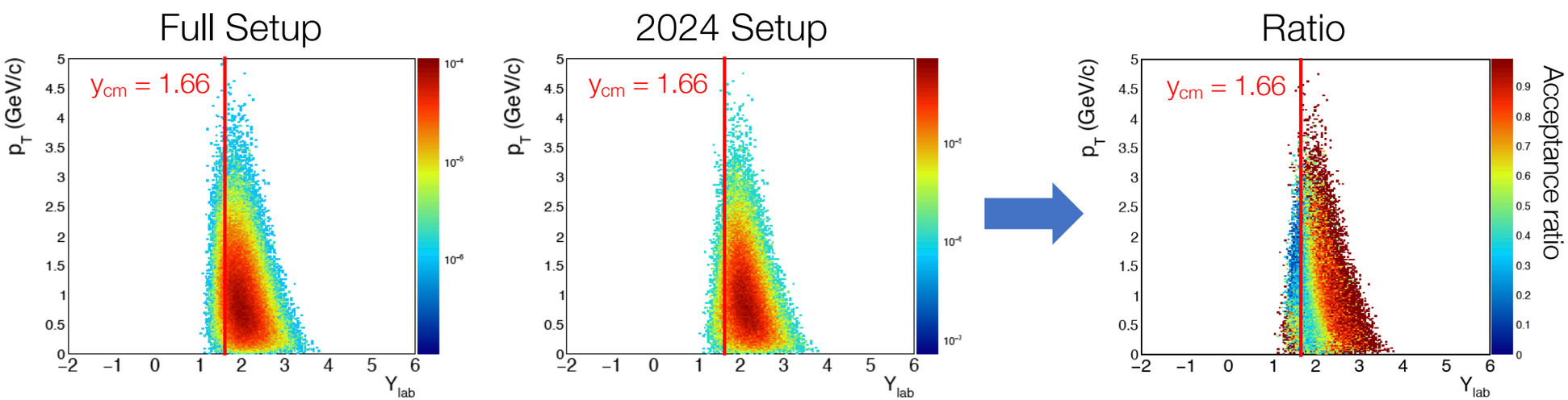

2024 Setup




(*) Input files and multiplicities, see: https://cbm-wiki.gsi.de/foswiki/bin/view/PWG/CbmDileptonInfoFiles

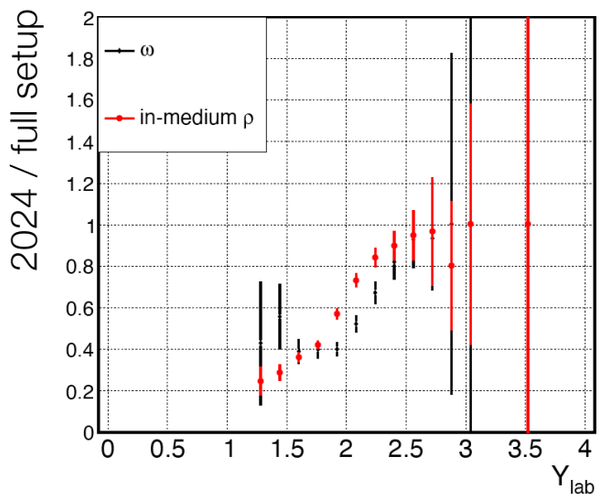
# Reduced Day-1 Setup

- Acceptance for di-electrons

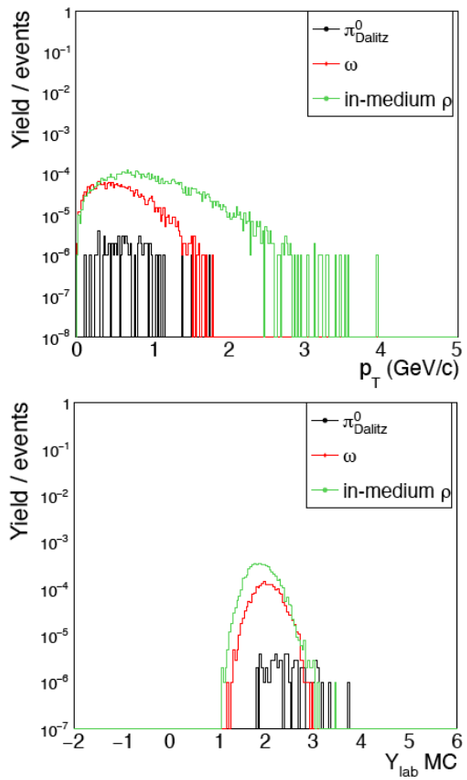


# Reduced Day-1 Setup

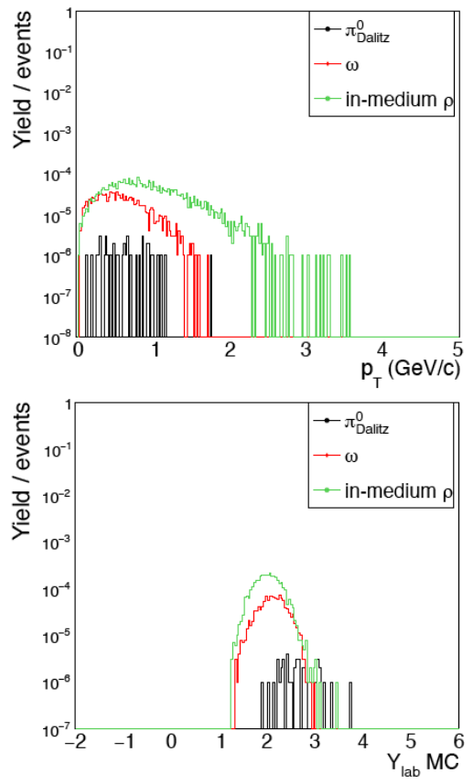
- Di-Electron performance
  - Signal distributions for $\pi^0_{Dalitz}$, ω and in-medium ρ
  - ~ 60 % reduction of total acceptance, mainly concentrated at mid-rapidity ($y_{lab} < 2$)




Full Setup



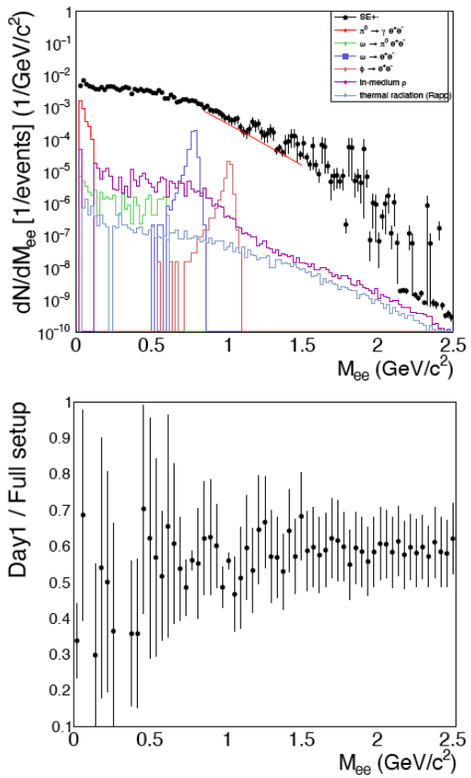

2024 Setup



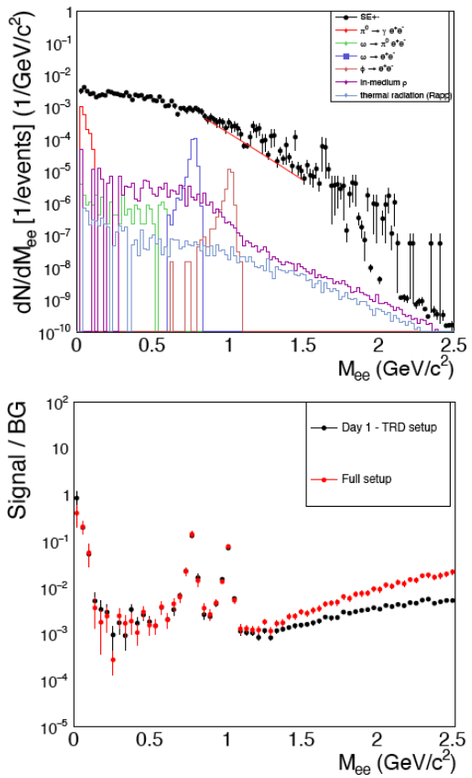
# Reduced Day-1 Setup

- Di-Electron performance
  - Full di-electron spectrum accessible
  - ~ 60 % reduction of total acceptance
  - Degradation of S/B-ratio at higher masses (Integrated factor ~ 2.5 at $M_{ee}$ > 2.0 GeV/$c^2$, less at forward rapidities)
  - Would require additional factor ~4 – 5 in statistics (less at forward rapidities)
    $\Longrightarrow$ ~ $5 \cdot 10^{10}$ central events
  - Analysis done with fixed PID cuts
    Factor 5 – 10 improvement in S/B with ML

Full Setup




2024 Setup

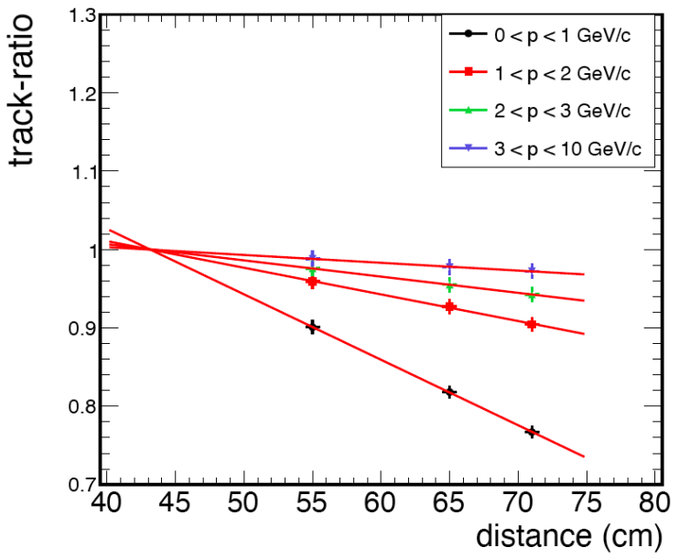


# Layer Spacing

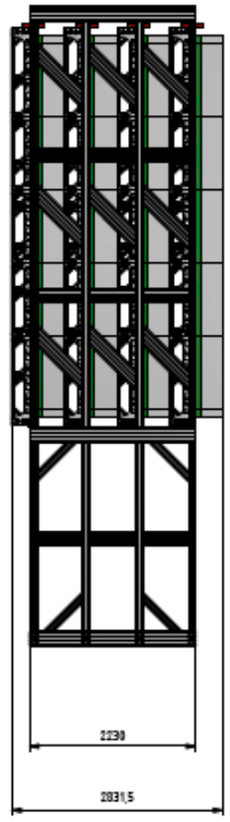
- TRD support structure (CDR version)
  - Increased layer *z*-spacing (45 cm ⟶ 71 cm, for 30 cm radiator)
  - Implications on physics performance

- Di-Electron performance
  - Au+Au, 12A GeV, 0 – 5 %,
    UrQMD + ω ⟶ $e^+ e^-$
  - Minor change in overall acceptance
  - Fraction of tracks with 4 points decreases
    Less prominent hat higher momenta

    ⟹ Deterioration of PID performance



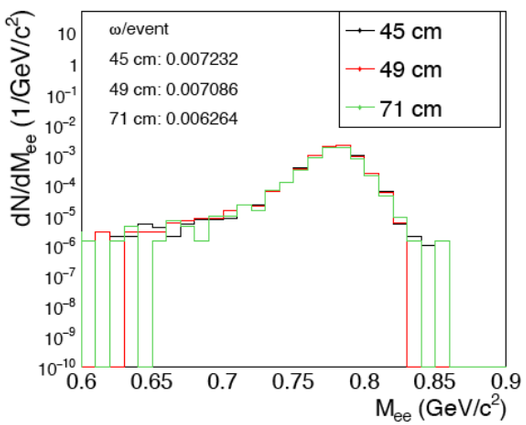

Side view

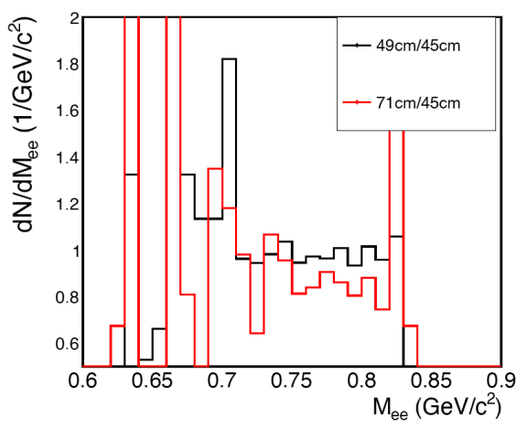


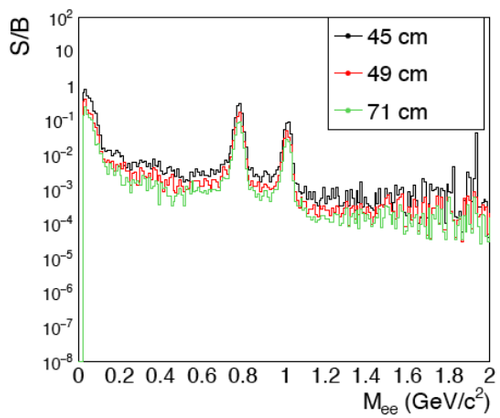
# Layer Spacing

- Options (currently under discussion)
  - Proposed design with 71 cm distance and accept PID deterioration
  - Integration of radiators in support structure of preceding layer
    ⟹ Pro: reduction of *z*-spacing to 49 cm possible
    ⟹ Con: Slightly (~ 2 % in area) smaller radiator required to fit between support structure

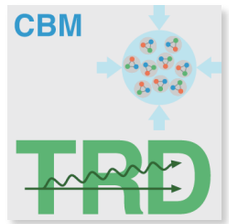
    Studies, modelling both effects, indicate better performance for 49 cm solution



# Conclusions




- Reduced day-1 setup
  - Type-7 and part of type-3 only after 2024
  - Reduced acceptance
    For ω and ρ: ~ 60 % integrated over all rapidities
    $\gtrsim$ 80 % for $y_{lab} > 2$
  - Increase of S/B-ratio for $M_{ee} > 2$ GeV/$c^2$ by ~ factor 2.5
  - Intermediate mass di-electrons still feasible
    Higher statistics required and/or reduced $y$-acceptance

- Layer spacing
  - Optimization of geometry on-going $\Longrightarrow$ radiator design and mounting structure
  - Find compromise between stability and physics performance
  - Submit design change request