SMI: News from ALICE

FAKT meeting, 26 Feb 2021

Michael Weber

ALICE at SMI

- **Fast Interaction Trigger:** Hannes Zmeskal, (Ken Suzuki), (Lukas Gruber)
  - Forward detector for ALICE 2 (Run 3 and 4) for event characterization and triggering
  - R&D, construction, and testing of components at SMI
  - Fully assembled in 2020 and ready for installation in 2021 (COVID delay)

- **Low-mass dileptons:** Michael Weber + NFG (ended in 2020)
  - **Photoproduction**: preliminary results in ***PoS LHCP2019 (2019) 164***
  - **Small systems**: published results in ***Phys. Rev. C 102, 055204***
  - **Heavy flavour (HF) hadrons**: Lise Meitner fellowship (Elisa Meninno, ended in 2020)
    - Published Λ_c results in ***https://arxiv.org/abs/2011.06078*** and ***https://arxiv.org/abs/2011.0607***
    - **Machine Learning** techniques for separation between HF and thermal dilepton sources
  - **Thermal radiation**: preparing for Run 3 and 4 and beyond
    → **ALICE 3** (***arXiv:1902.01211 [physics.ins-det]***): Letter of Intent planned for end of 2021

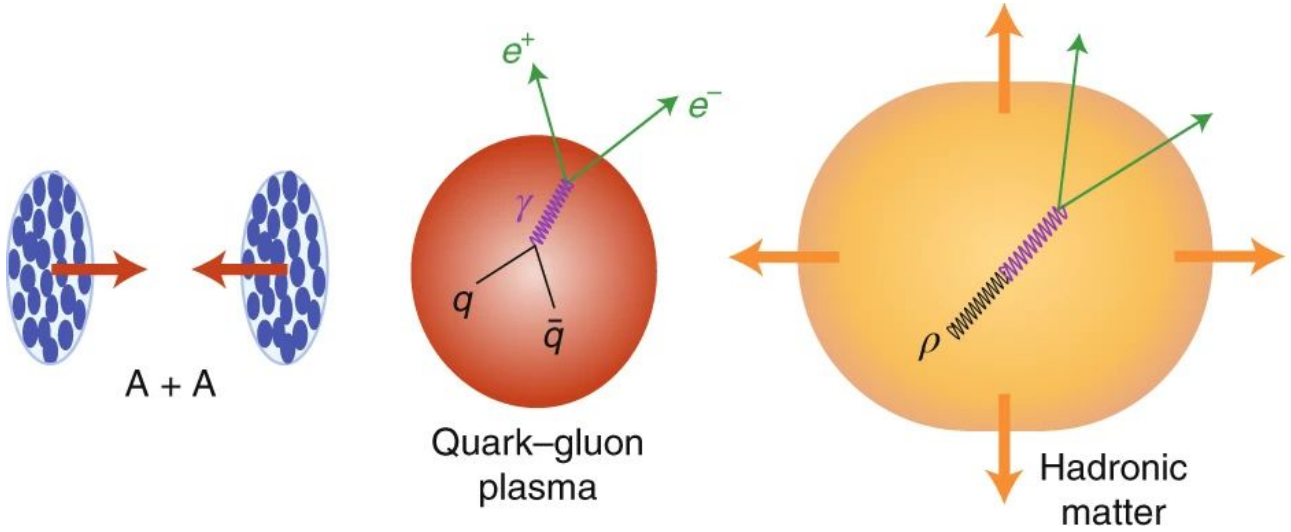
- **BSM physics:** Michael Weber, (Sebastian Lehner) + master student (with help of Marian Ivanov, GSI)
  - **Magnetic monopoles:** Algorithmic tracking of spallation products as calibration of high-energy signals

- **Interactions between hadrons containing strangeness :** Michael Weber + master student (with help of TU München team)
  - **p-Λ and Λ-Λ correlations:** complementary approach to “standard” methods at SMI

- **Central Exclusive production:** Paul Bühler + master students
  - **Preliminary results** for pion and kaon channels
  - Paul Bühler in the core team of the **ALICE analysis framework for ALICE in Run 3 and 4** (O^2)

More details (Backup)

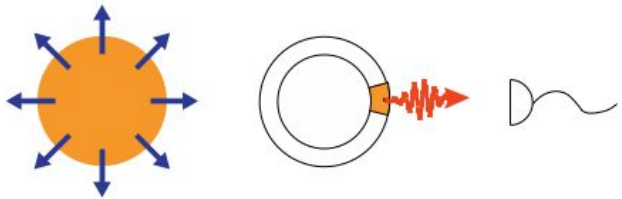
Thermal radiation from QCD matter



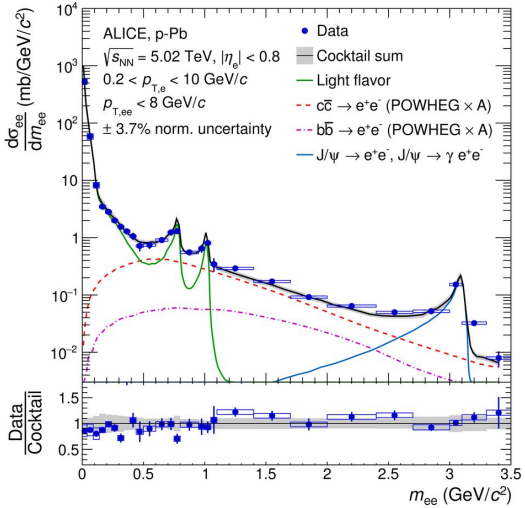
Degrees of freedom: *quarks, gluons* *hadrons*

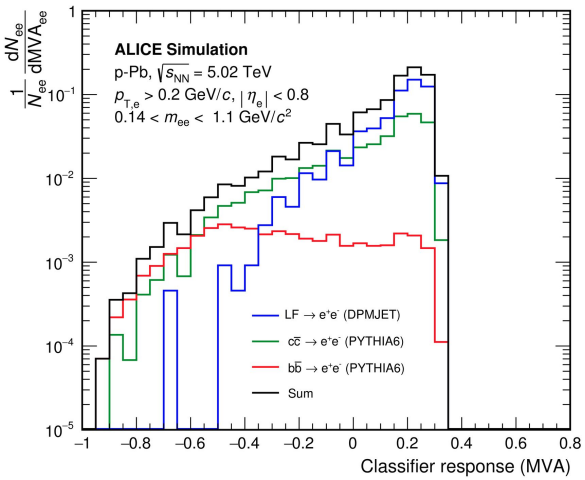
Strategy: measure dileptons (e^+e^- or $\mu^+\mu^-$ pairs)

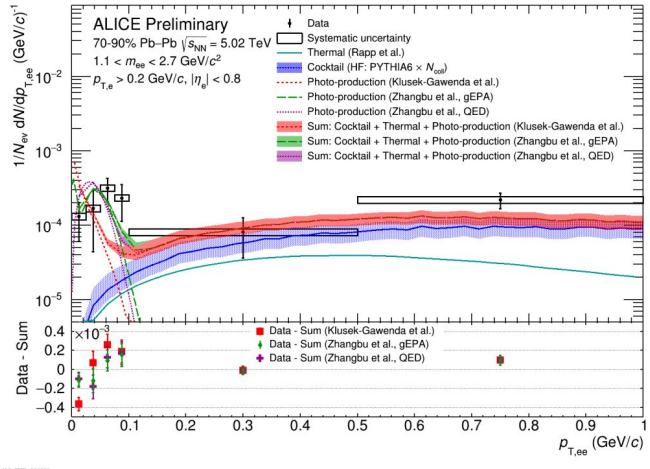
- Couple to EM current throughout the **full collision history**
- Very low interaction with QCD medium (**no strong interaction**)
- **Virtual photons:** invariant mass, no blue-shift of rapidly expanding system
- **Bonus:** Also sensitive to **BSM particle decays (dark photons)**



Low mass dileptons







p-Pb collisions

- Cold matter reference
- Light- and heavy flavour production
- Thermal radiation?
- **Paper published**

ALICE, Phys. Rev. C 102, 055204

Heavy flavours

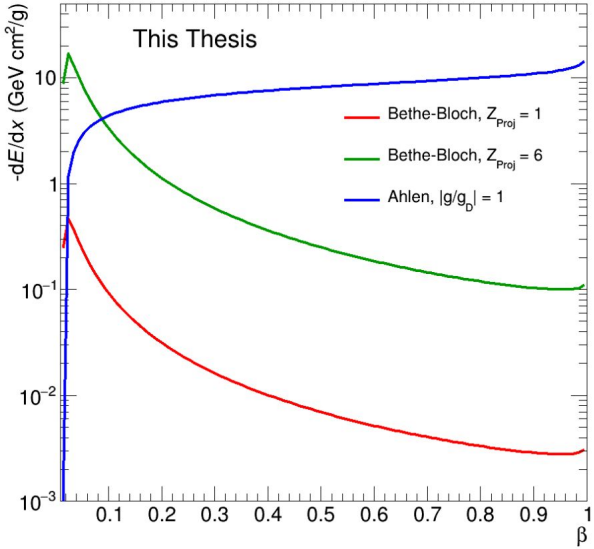
- Background for low mass dileptons (Machine Learning approach)
- Charm baryon production: **papers submitted**

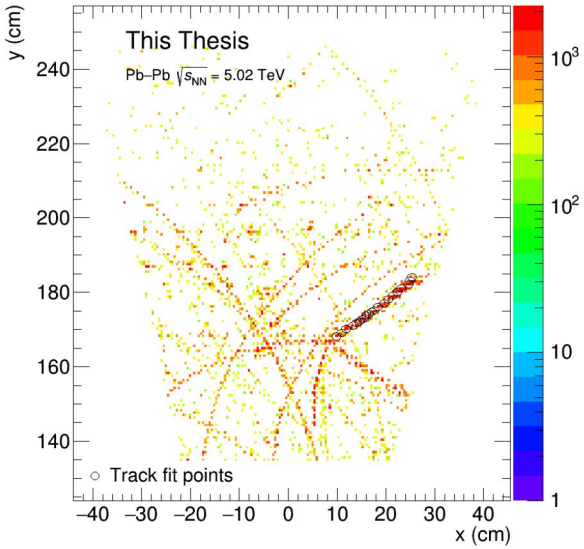
https://arxiv.org/abs/2011.06078
https://arxiv.org/abs/2011.06079

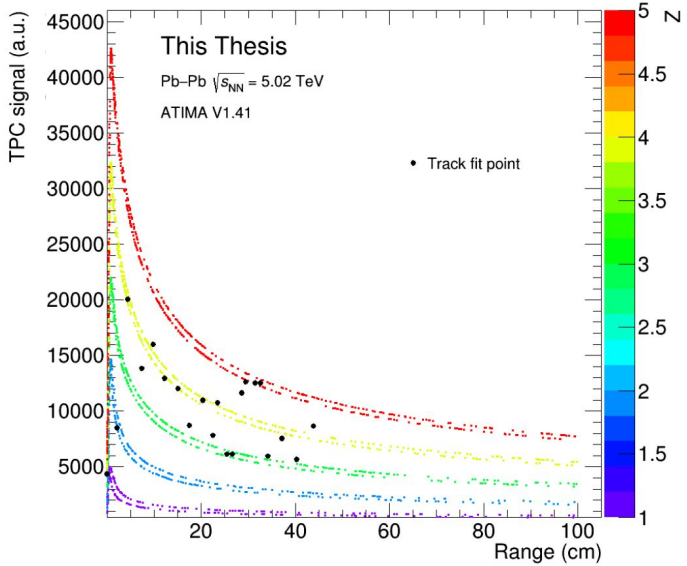
Pb-Pb collisions

- Photo-production and comparison to QED
- Magnetic field effects?
- ***Machine Learning for background suppression***

Magnetic monopoles



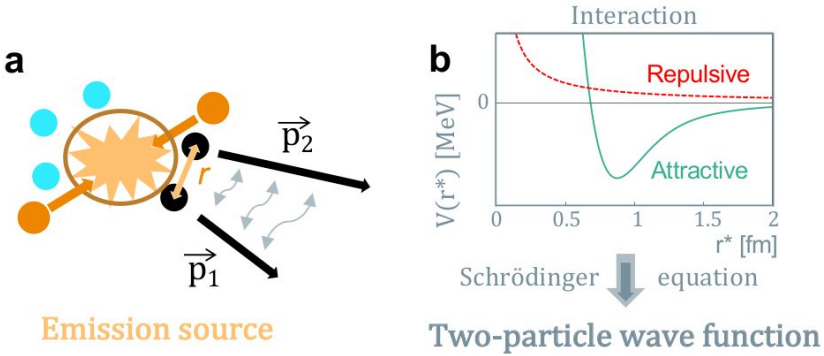




Search strategy in Pb-Pb collisions

- Monopoles: huge energy loss signal in ALICE TPC
- Similar dE/dx than in Bragg peak of heavy spallation fragments (Z=6)
  - Use to verify search strategy for highly ionizing particles
  - Found one Z=4 candidate for PhD thesis (manual analysis)
  - **Extend with algorithmic tracking of spallation products**
- **Then: Extract exclusion limits**

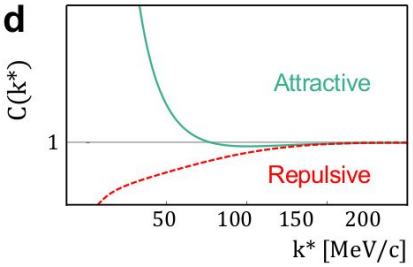
Hadron-hadron interactions

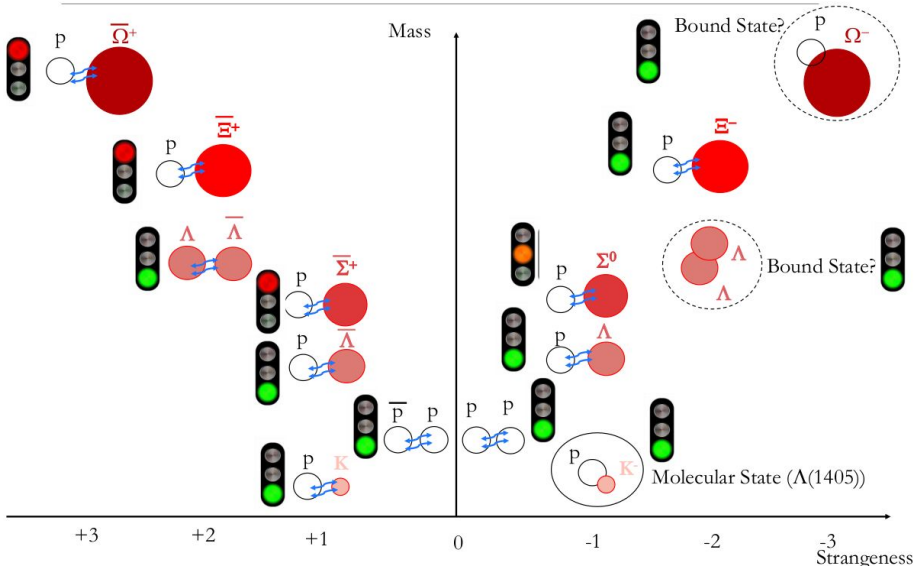


c

Correlation Function

$$C(k^*) = \int S(r^*) \left|\Psi(k^*, \vec{r^*})\right|^2 d^3r^* = \mathcal{N} \cdot \frac{N_{same}(k^*)}{N_{mixed}(k^*)}$$

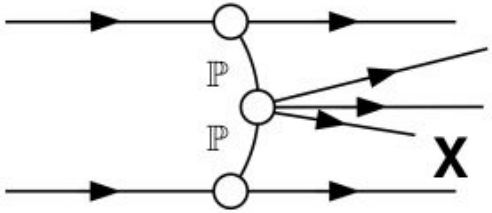


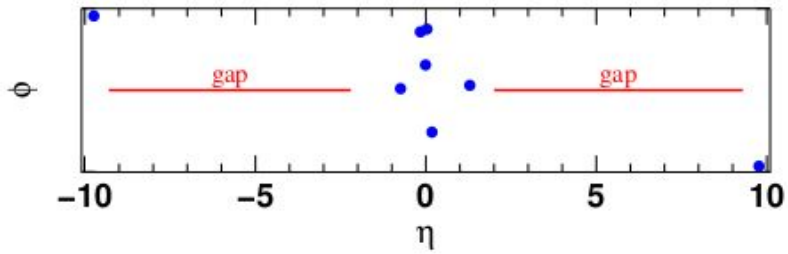


Correlation studies

- Direct connection to hadron interactions
- Initiated by TU Munich
- **Many unmeasured combinations still...**

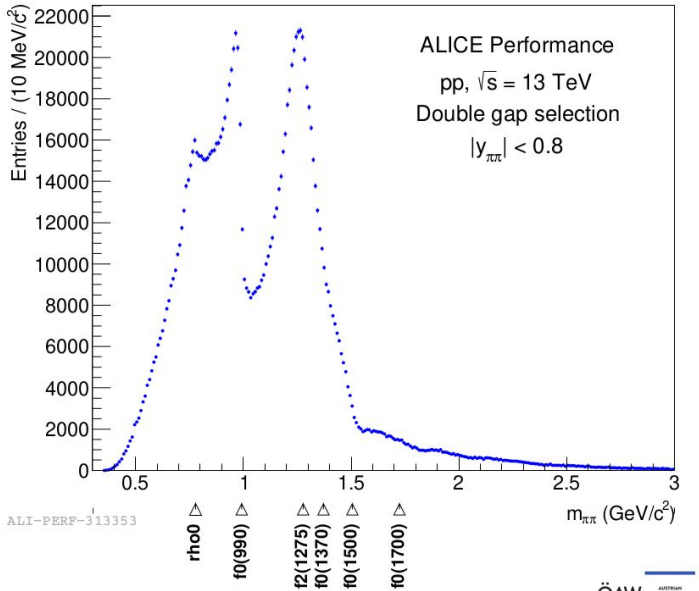
Hadron spectroscopy in diffractive events





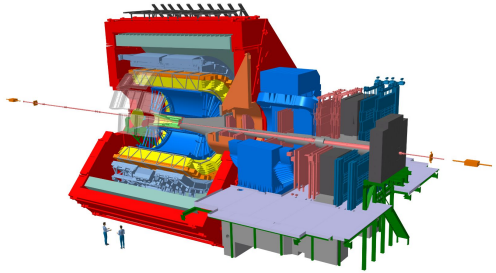
Central exclusive production in pp collisions

- Outgoing protons are not detected
- Event selection by event-topology - double-gap events
- Interested in X → [π + π − , K + K −]
- Invariant mass analysis (IVM) of 2-particle events



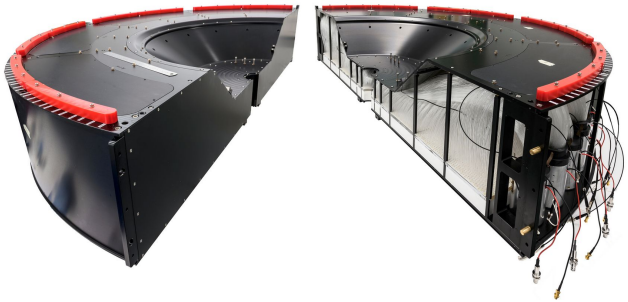
LHC and ALICE: beyond 2020

2019 — 2020 — 2021 — 2022 — 2023 — 2024 — 2025 — 2026 — 2027 — 2028 — 2029 — 2030 — 2040 — 2050

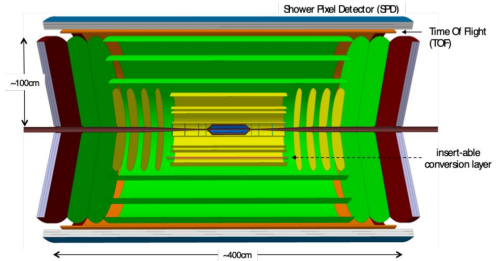


Major ALICE upgrade

New inner tracking system (ITS2)
TPC: MWPC -> GEM (contribution TUM)
Continuous readout
FIT: new event characterization detectors

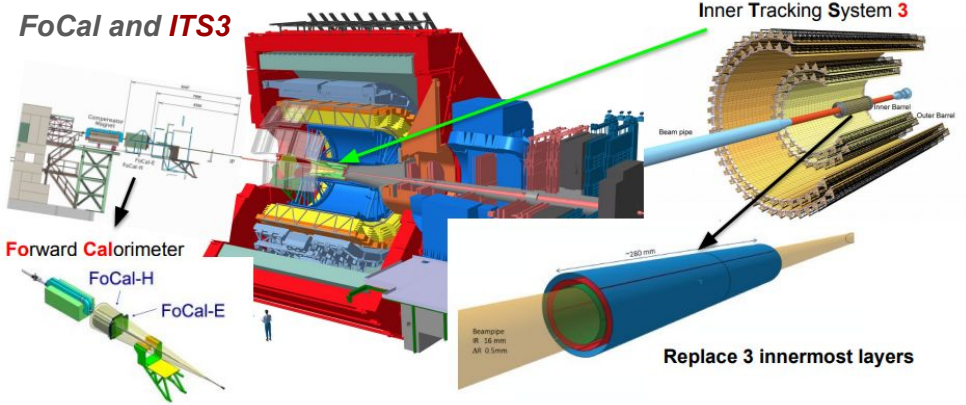


ALICE 3



[arXiv:1902.01211 [physics.ins-det]](arXiv:1902.01211 [physics.ins-det])

FoCal and ITS3



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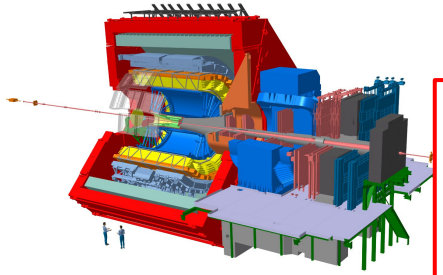

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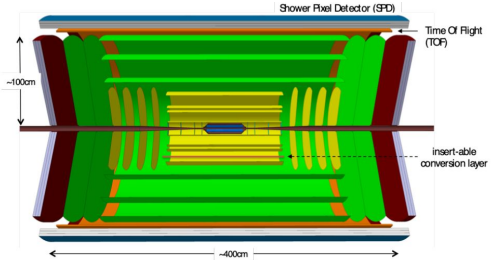
Continuous readout
FIT: new event characterization d

At SMI

- **FIT**: R&D, construction, and testing of components at SMI
- **Software**: core analysis developments
- Shaping **future heavy-ion program**
  - Performance studies for ALICE in **LHC Run 3 and 4**
  - Coordination of physics program for **ALICE 3** (Letter of Intent planned for 2021)

ALICE 3



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