Introduction: motivation and latest results

- Low mass region ($m_{\gamma\gamma} < m_{J/\psi}$):
  - virtual direct photons to understand thermodynamic properties of the quark-gluon plasma
  - chiral symmetry restoration via mass shape of vector mesons ($\rho$ / $\omega$ / $\phi$)
- Intermediate mass region ($m_{\rho} < m_{\omega} < m_{J/\psi}$):
  - heavy quarks (c/b) production
  - thermal radiation without blue-shift
  - coherent photo-production ($\gamma \gamma \rightarrow e^+e^-$)
- High mass region ($m_{\omega} < m_{J/\psi}$):
  - Drell-Yan process to study initial state effects

$$\gamma_{\text{direct}} = \gamma_{\text{all}} - \gamma_{\text{decay}}$$

- Huge backgrounds from $n^0 \rightarrow \gamma \gamma$ and $\eta \rightarrow \gamma \gamma$ for direct photons.
- One of the advantages of the virtual direct photon analysis is to exclude $n^0 \rightarrow e^+e^-$ by selecting $m_{\omega} > 140$ MeV/c$^2$.
- independent and complementary measurement to real direct photons

- Dielectron production through coherent photo-production in peripheral collisions reported by ALICE[1] and STAR[2].
- Excess at very low pair $p_T$ in the mass region of $1.1 < m_{ee} < 2.7$ GeV/c$^2$
- The excess yield with respect to hadronic cocktail is well described by photo-production models, but difference is found in the pair $p_T$ spectrum.

Data taking at high collision rate in 2018

- The high collision rate (~10 kHz) in 2018 to collect efficiently 0-10% and 30-50% centrality classes in Pb-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV.
  (On the contrary, the strategy in 2015 was to record minimum-bias events at a few kHz.)
- This led to out-of-bunch pileup events. (out-of-bunch pileup: collisions before/after the triggered bunch crossing in the readout time of detectors)
- The high charge-particle multiplicity in the TPC due to pileup events at the high collision rate.
- $-dE/dx$ in the TPC is mainly affected.

Events without pileup
- The maximum deviation is $-1 \sigma$ at the mid-rapidity.

Events with pileup
- The maximum deviation is $-2 \sigma$ at the mid-rapidity.
- Stronger rapidity dependence than clean events shown above.

ALICE apparatus and electron identification

- Trigger detector: V0 at forward and backward rapidity
- Tracking detectors at the central barrel:
  - Inner Tracking System (ITS) and Time Projection Chamber (TPC)
- Electron identification: ionizing energy loss in unit length $dE/dx$ in ITS, TPC and the time of flight measured by the TOF detector.
- The different subsystems have PID capabilities in different momentum regions.

\[ n_d = \frac{dE/dx}{dE/dx_{\text{max}}} = \frac{dE/dx}{dE/dx_{\text{max}}} \]

difference between measured and expected value of $dE/dx$ in units of standard deviation for each charged particle (e, $\pi$, K, p, $\mu$, etc.)

Dielectron invariant mass and future prospects

- UnLike Sign ($e^+e^-$ pairs): signal + background
  $$\text{ULS} = N_{\text{same}}$$
- Like Sign ($e^+e^-$ and $e^-e^-$ pairs): background
  $$\text{LS} = 2R \cdot \sqrt{N_{\text{same}} \cdot N_{\text{same}}}$$
- ULS - LS: signal
  $$R = 2 \cdot \sqrt{N_{\text{mix}} \cdot N_{\text{mix}}}$$
  (R: correction factor for acceptance)

The high statistics allows us to:
- reduce statistical fluctuations in the low mass region where virtual direct photon signals are expected.
- study $p_T$ and azimuthal angle $\phi$ differential yields.
- observe clear $J/\psi$ peak at 3.1 GeV/c$^2$.

Future prospects:
- Extract virtual direct photons in the low mass region.
- Extract dielectrons via photo-production in the intermediate mass region.