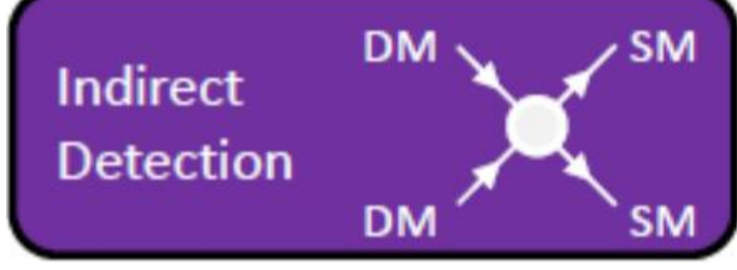


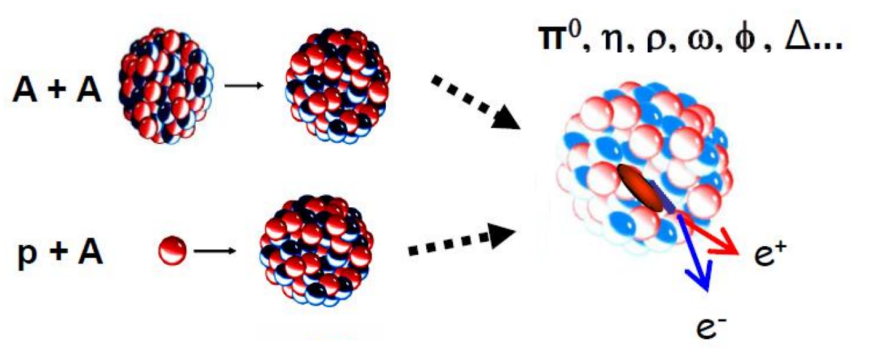
Motivation

- Possible dark photon (U-boson) observation by dilepton experiments
- Estimate the upper limit for the kinetic mixing parameter $\varepsilon^2(M_U)$ of the U-boson in dilepton spectra using the PHSD approach



Possible DM observation by dilepton experiments

- Dilepton spectra from SM sources in $p+p$, $p+A$, $A+A$ collisions are well studied by experiments from SIS to LHC energies
- Dark photon production by hadronic decays ($\pi^0, \eta, \Delta, \omega, \phi, K$)
- Possibility for an experimental observation of U-bosons by electromagnetic decays $U \rightarrow e^+e^-$ in heavy-ion experiments

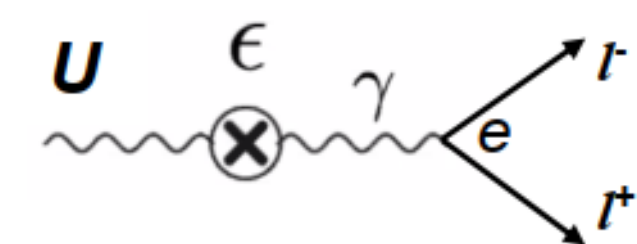


Dark Photon in vector portal

- The "vector" portal assumes the existence of a $U(1) - U(1)'$ gauge symmetry group mixing

$$\mathcal{L}_U = -\frac{1}{4}F'_{\mu\nu}F'^{\mu\nu} - \frac{1}{2}\frac{\varepsilon}{\cos\theta_W}B_{\mu\nu}F'^{\mu\nu} - \frac{1}{2}m_U^2 A'^{\mu}A'_{\mu}$$

- Due to the kinetic mixing the dark photon couples to the electromagnetic current with strength εe



$$\pi^0, \eta \rightarrow \gamma U$$

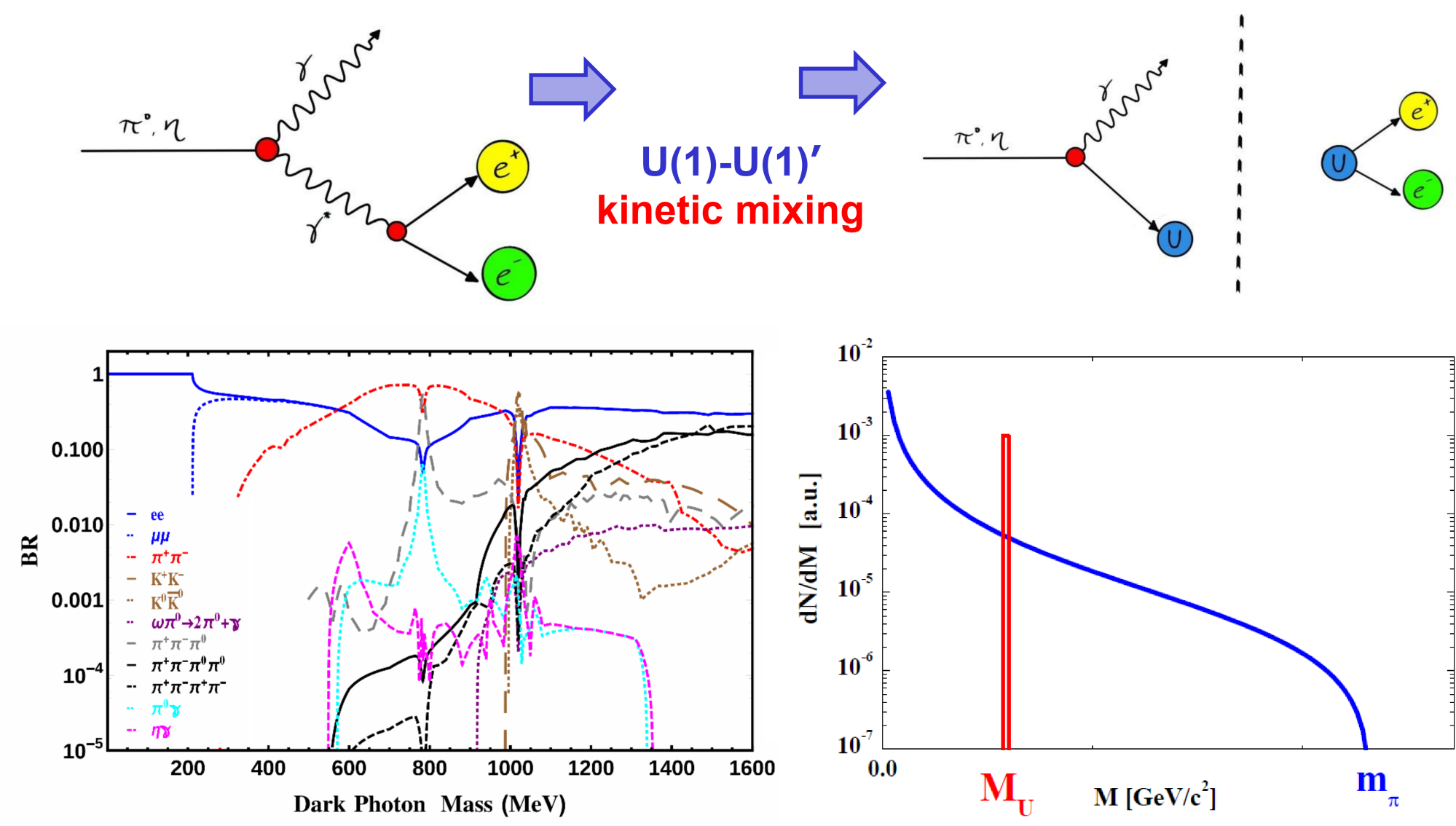
$$\Delta \rightarrow NU$$

$$\omega, \rho, \phi \rightarrow U$$

$$\omega \rightarrow \pi^0 U$$

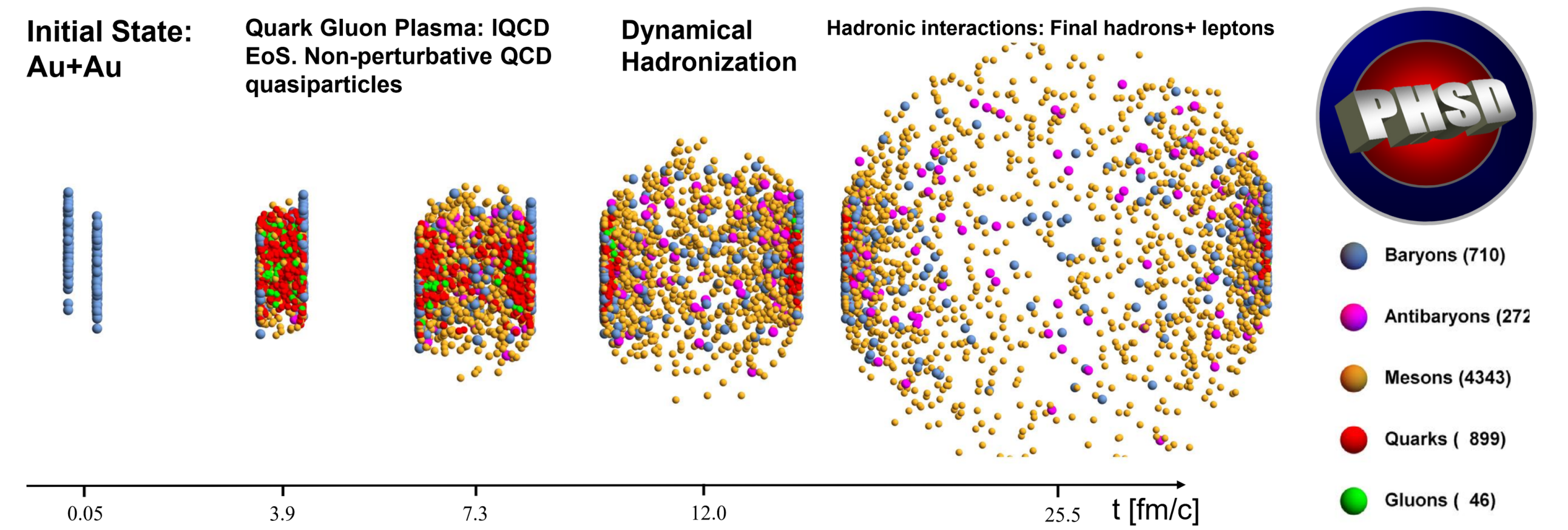
$$K^+ \rightarrow \pi^+ U$$

$$U \rightarrow e^+e^-$$



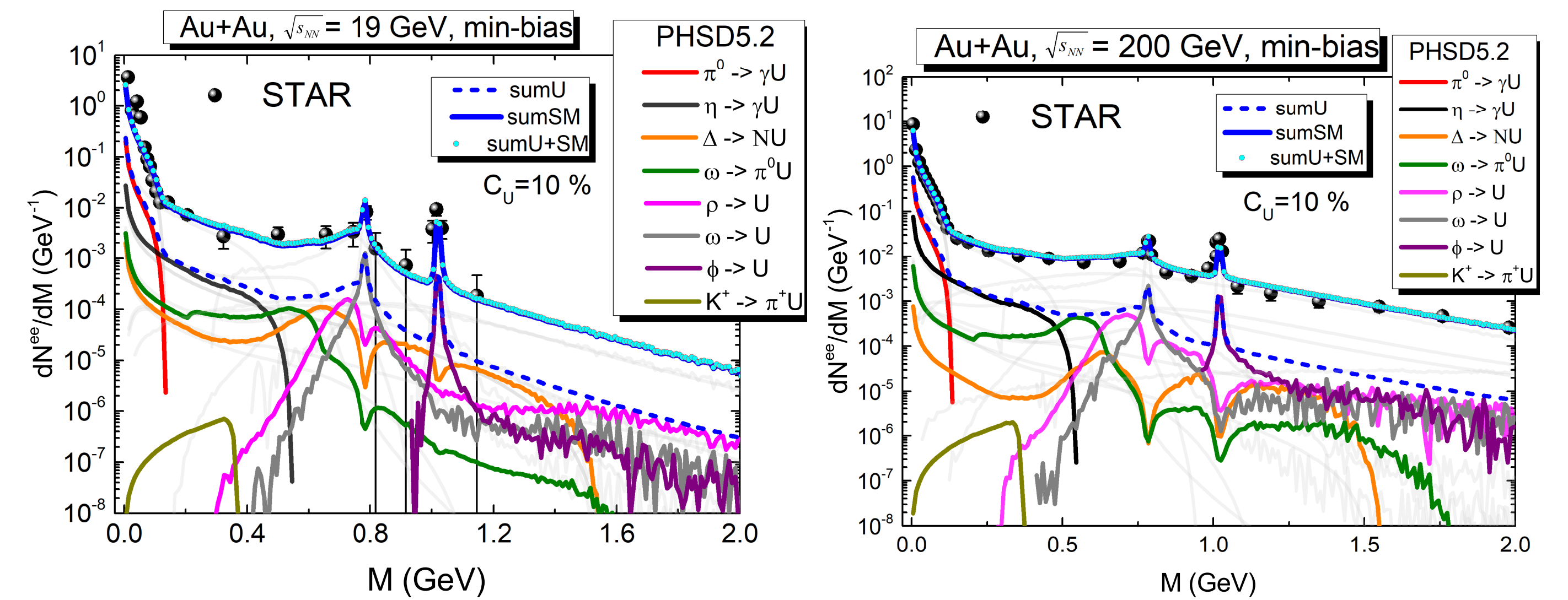
The PHSD transport approach

- Parton-Hadron-String Dynamics (PHSD)** is a non-equilibrium microscopic transport approach that incorporates hadronic as well as partonic degrees of freedom for the description of strongly-interacting matter created in heavy-ion collisions



Dilepton spectra from U-boson decays at RHIC energies

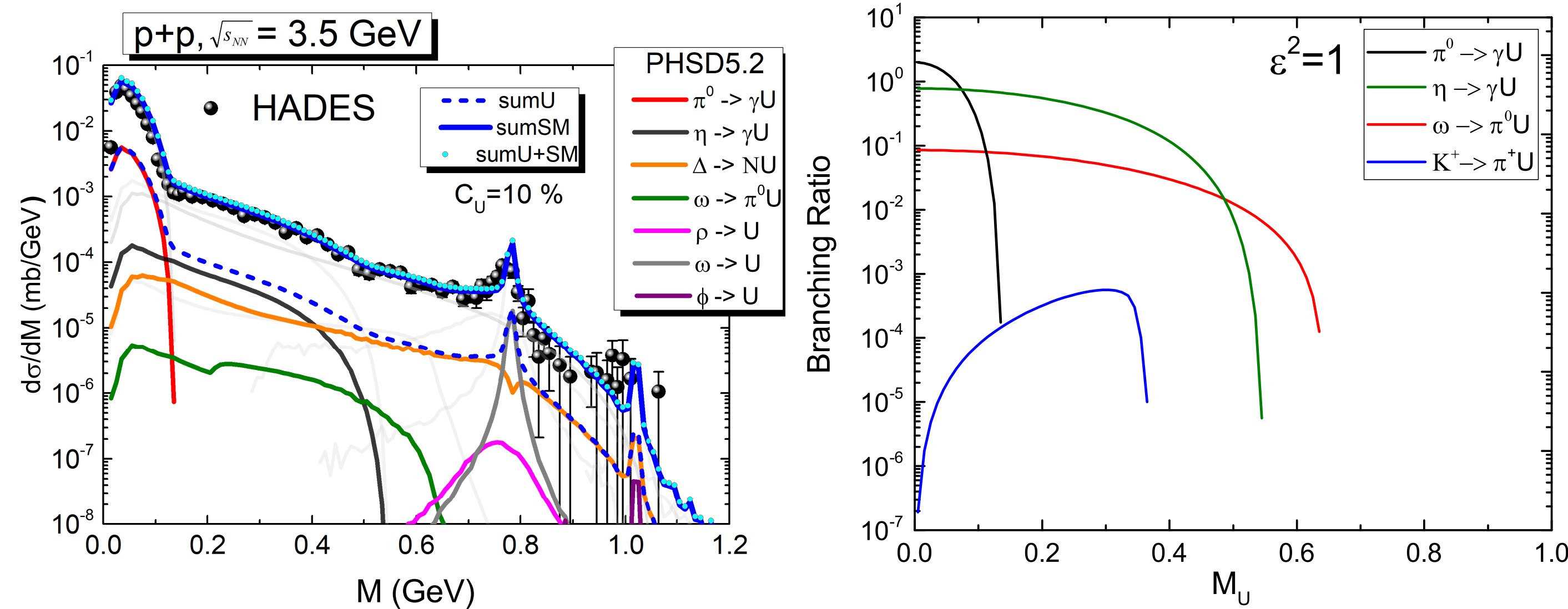
- Light gray backgrounds display SM decay channels



- Total dark photon and SM sum are still in good agreement with STAR data

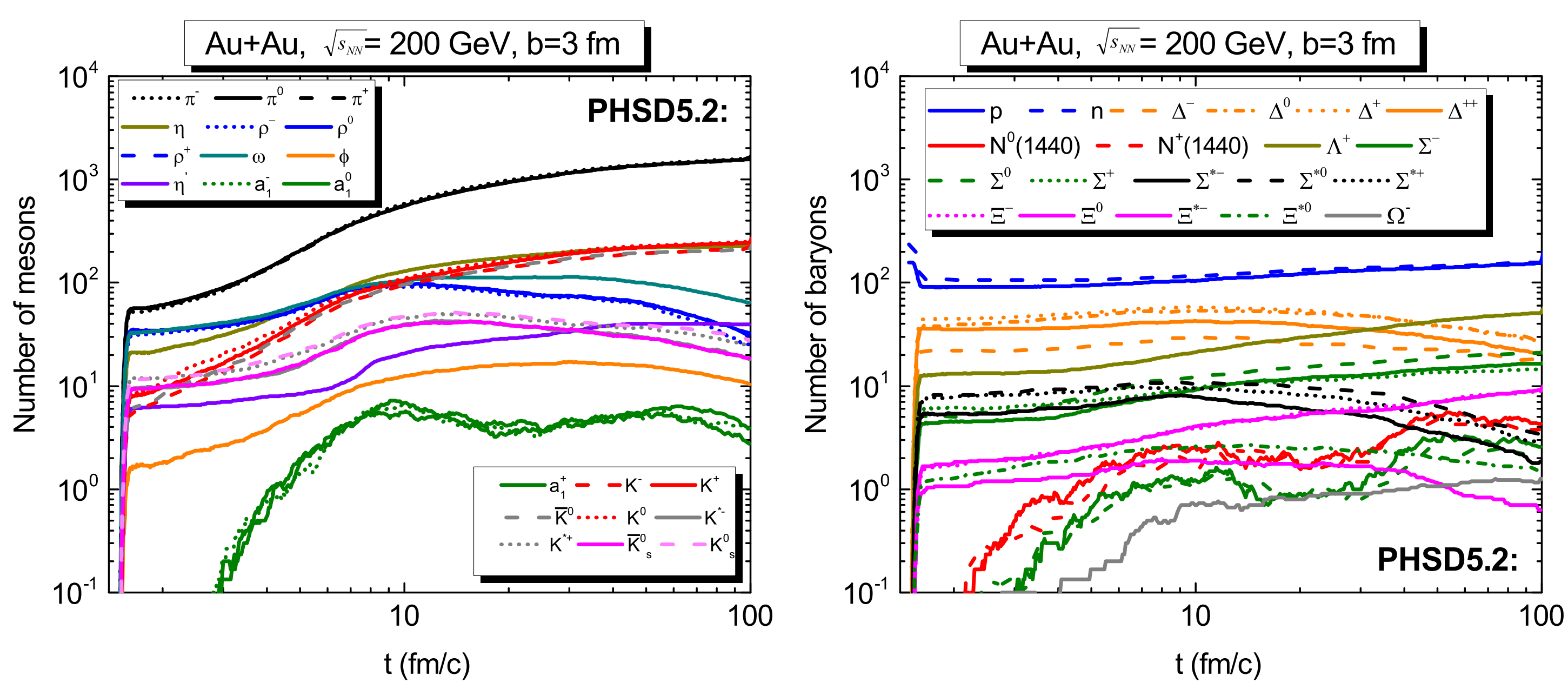
Dilepton spectra from U-boson decays at SIS18 energies

- Standard Model (SM) contributions are well described by the PHSD

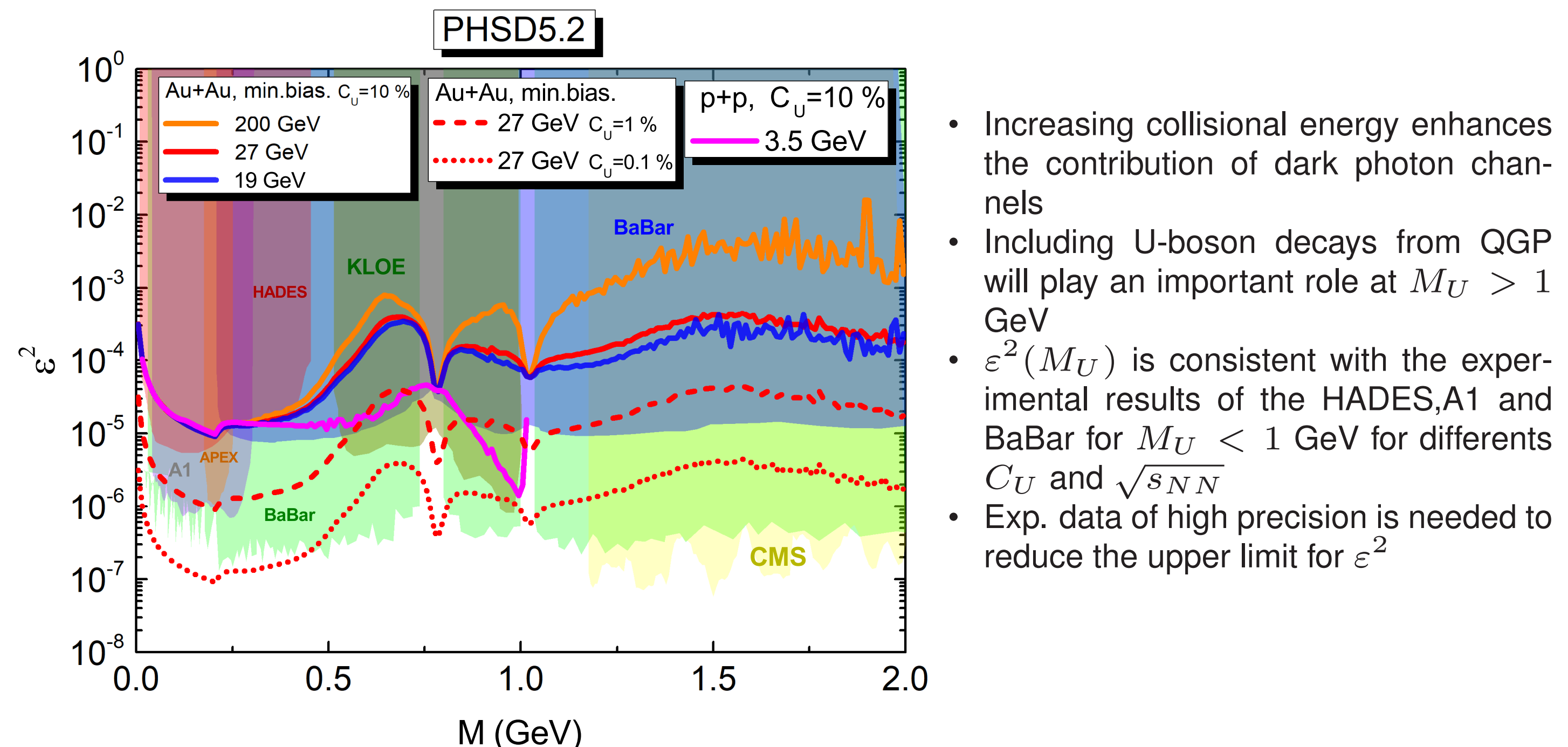
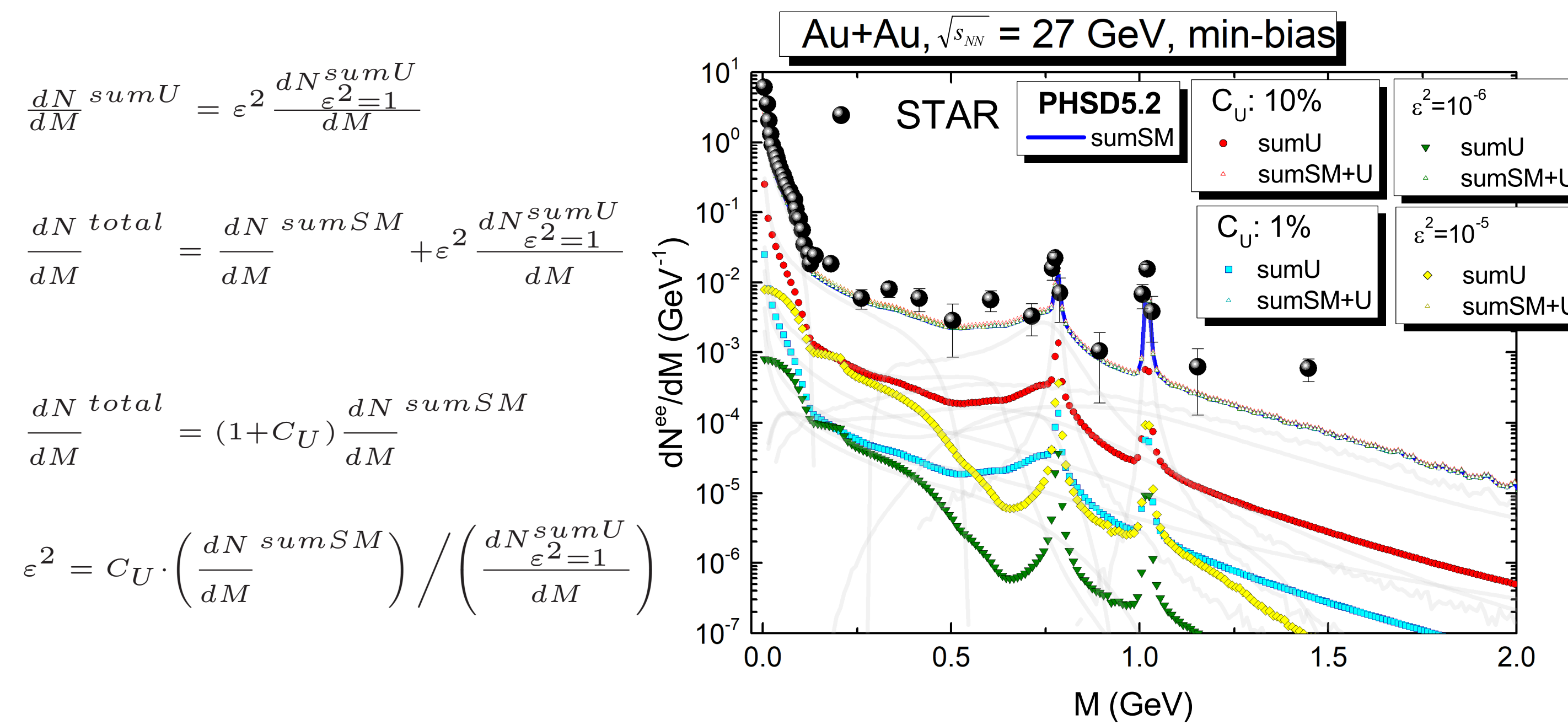


- The contributions from $U \rightarrow e^+e^-$ are added with an allowed surplus C_U of the total SM yield, the total sum is still in good agreement with experimental data

Number of particles in Au+Au collision



How to obtain theoretical constraints on $\varepsilon^2(M_U)$?



- Increasing collisional energy enhances the contribution of dark photon channels
- Including U-boson decays from QGP will play an important role at $M_U > 1$ GeV
- $\varepsilon^2(M_U)$ is consistent with the experimental results of the HADES, A1 and BaBar for $M_U < 1$ GeV for different C_U and $\sqrt{s_{NN}}$
- Exp. data of high precision is needed to reduce the upper limit for ε^2

Summary and Outlook

- We presented first microscopic transp. calculations, based on the PHSD approach, for the dilepton yield from the decay of U-bosons from $p+p$ and $A+A$ collisions from SIS18 up to RHIC energies
- Since dark photons are not observed in dilepton experiments so far, we can require that their contribution can not exceed some limit which would make them visible in experimental data
- Explore the axion portal and look for constraints in astrophysics and cosmology

KEY REFERENCES

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