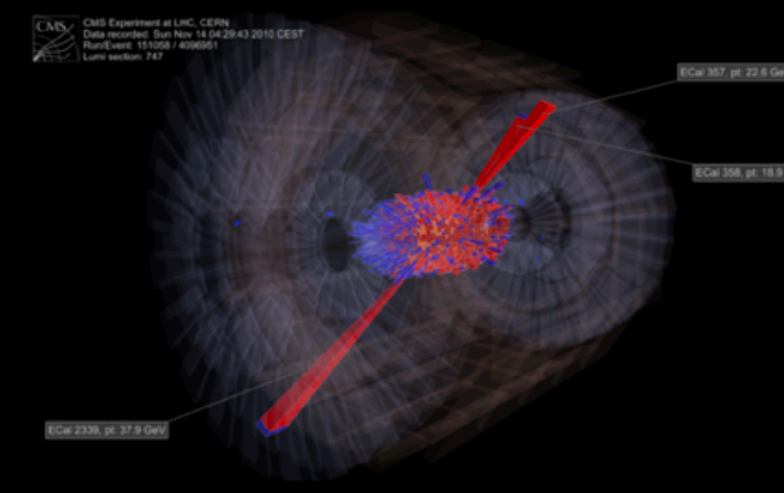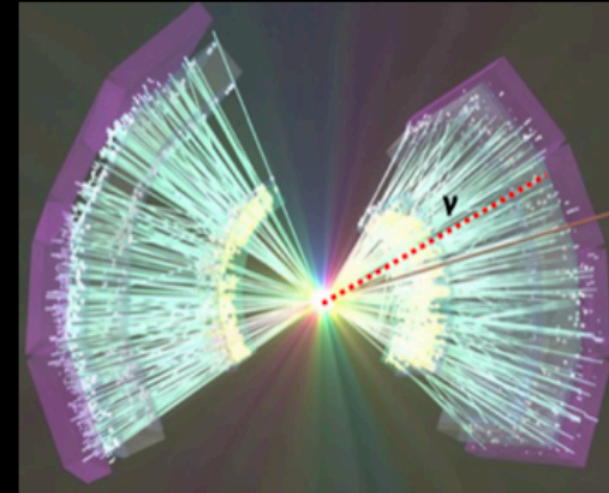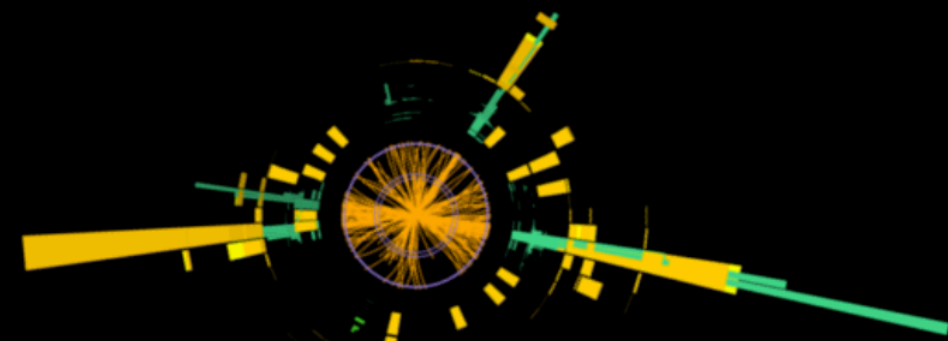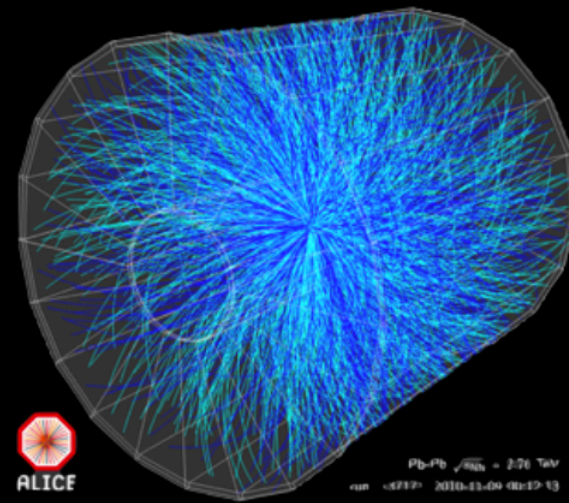# QUARK GLUON PLASMA WG

Members: Lipei Du, Hendrik Roch, Syed Afrid Jahan, Peter Jacob, Abhijit Majumder, Chun Shen

**Chun Shen**

# THE BIG PICTURE



**MULTIMESSENGER CHARACTERIZATION OF QUARK-GLUON PLASMA**

**Experimental Measurements**
Spectra, anisotropic flow
$v_n$. flow correlations
Jets and heavy-quarks
$J/\psi$ and $\Upsilon$ suppression
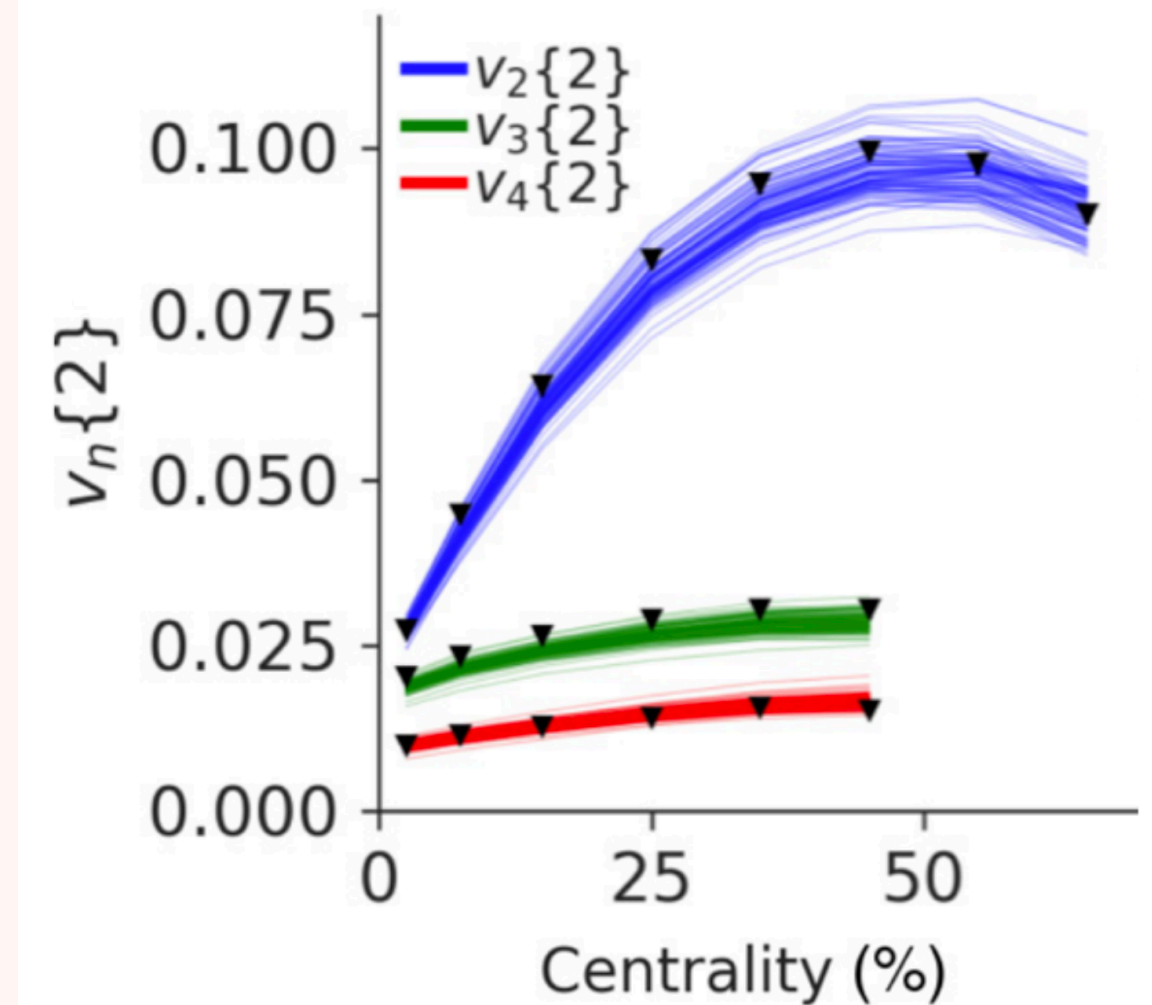Photons and dileptons

**Theoretical Modeling**

JETSCAPE

Bayesian Inference

**QGP Properties**
Shear and bulk viscosities $\eta, \zeta$
$\langle T^{xy}(x,t)T^{xy}(0,0)\rangle$

Energy-momentum transport
$\hat{q}, \hat{e}, \hat{e}_2$ $\langle F_a^{i+}(x^-)F_{ai}^+(0)\rangle$

Color screening
$\langle F_a^{i0}(x,0)F_{ai}^0(0,0)\rangle$

Electromagnetic emissivity
$\langle j^\mu(x,t)j^\nu(0,0)\rangle$

inaccessible from first principles

Anisotropic flow coefficients

$v_2\{2\}$
$v_3\{2\}$
$v_4\{2\}$

Nuclear modification factor

PbPb 5.02 TeV Posterior
Data from CMS
JETSCAPE
0-10% Centrality
30-50% Centrality
Median
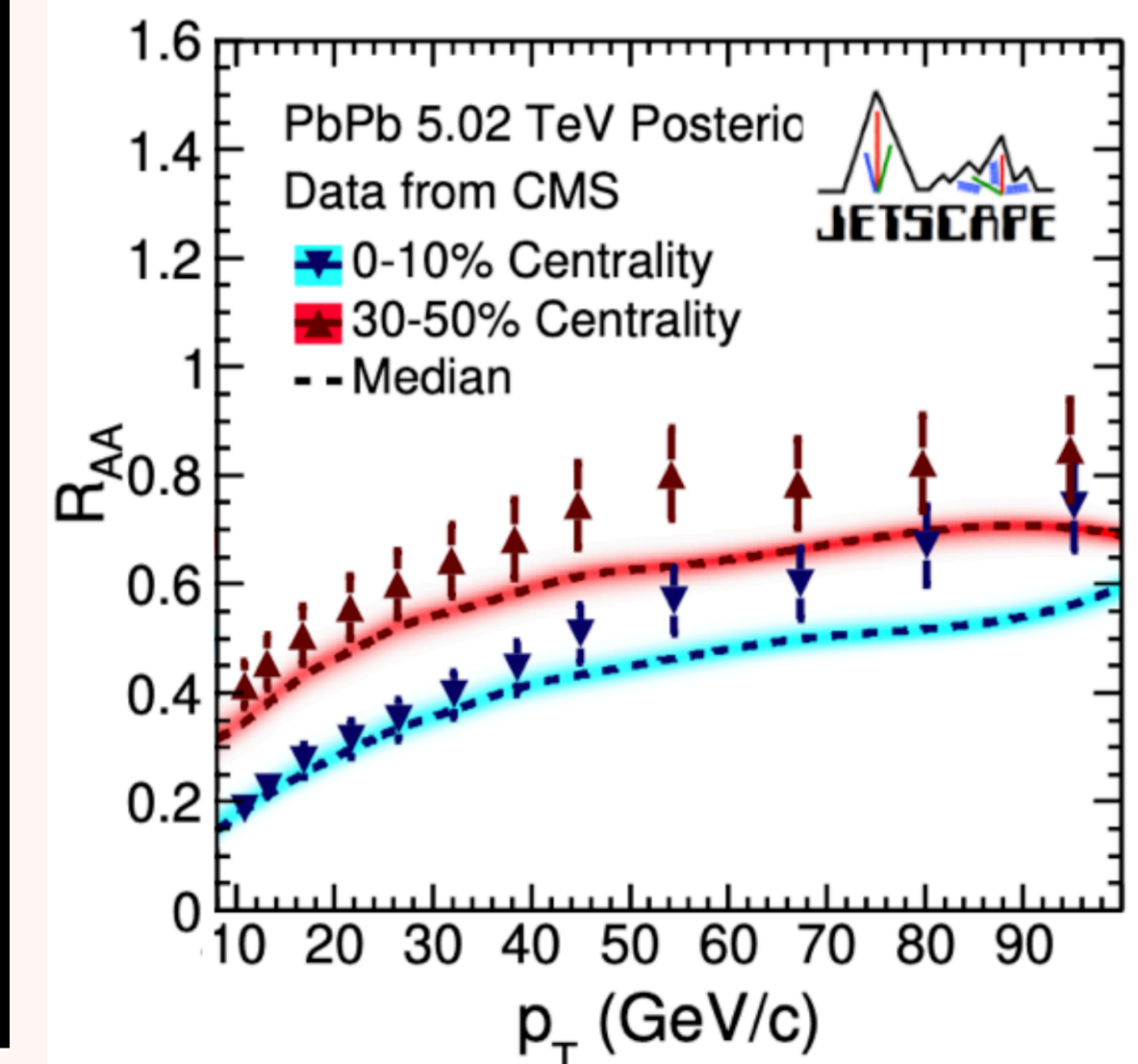
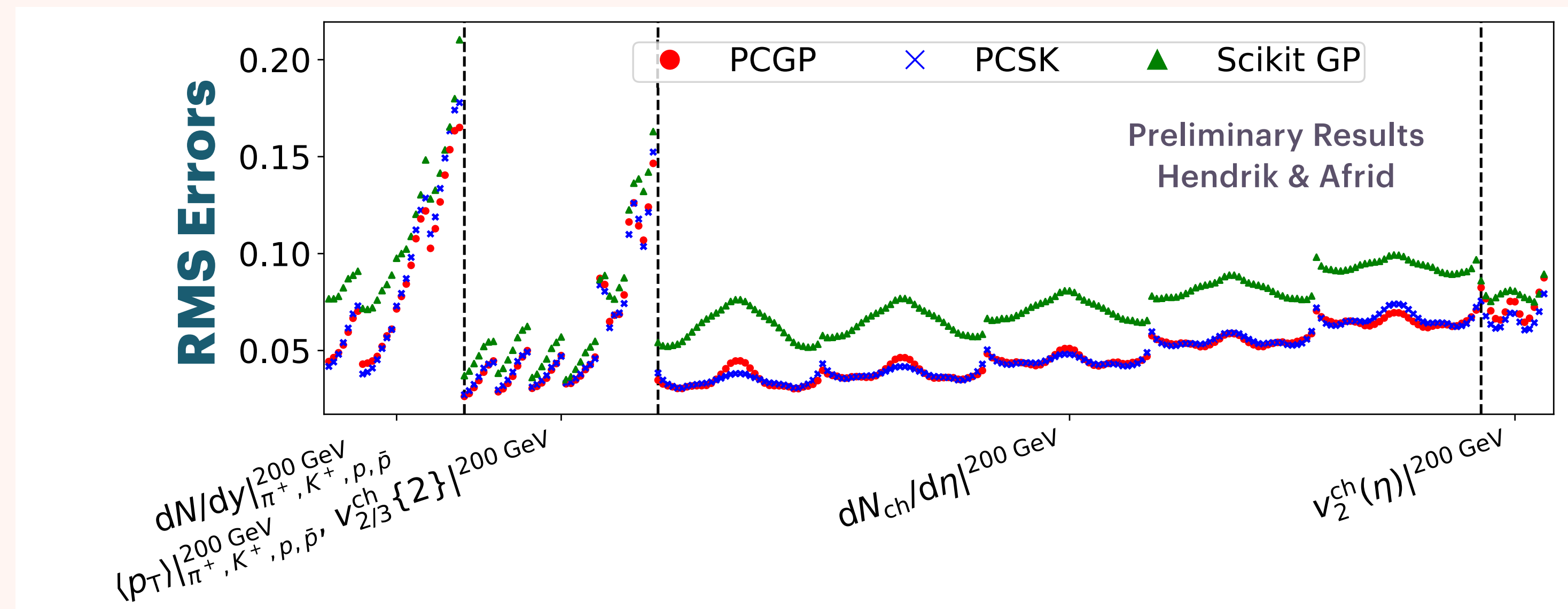# THE QGP PROJECT GOALS

> **Perform a joint Bayesian Inference study with soft and hard observables on QGP properties**

> > **Build the first multi-messenger Bayesian Inference study in heavy-ion physics**

> > **Quantify tomographic probes' constraints on QGP dynamics**

> > **Resolve tension between simulations and measurements in high $p_T$ hadron and jet $v_2$**

# THE PROJECT'S ROADMAP

> **Perform a pilot physics study with the JETSCAPE 3.6.1 framework**

> > **Identify key model parameters that are sensitive to soft and/or hard observables**

> > **Build the scientific case for applying computational resources**

> > **Code verification/improvements before large-scale simulations**

> **Incorporate the previous Bayesian posterior distributions in the model training design**

> **Explore transfer learning applications with the pre-trained model emulators in the soft and hard sectors from JETSCAPE**

# SIDE PROJECTS

> **Comparing different model emulators for (3+1)D QGP simulations**

> **Incorporate products from the BAND Collaboration**



Legend: ● PCGP   × PCSK   ▲ Scikit GP

Preliminary Results
Hendrik & Afrid

Y-axis: RMS Errors (0.05, 0.10, 0.15, 0.20)

X-axis labels: $dN/dy|_{\pi^+,K^+,p,\bar{p}}^{200\ GeV}$, $(p_T)|_{\pi^+,K^+,p,\bar{p}}^{200\ GeV}$, $v_{2/3}^{ch}\{2\}|^{200\ GeV}$, $dN_{ch}/d\eta|^{200\ GeV}$, $v_2^{ch}(\eta)|^{200\ GeV}$

> **Try out Simon's framework with transfer learning techniques**