Expected calorimeter jet performance of the sPHENIX detector

Virginia Bailey
University of Illinois Urbana-Champaign
on behalf of the sPHENIX collaboration

Quark Matter 2022 - the 29th International Conference
on Ultra-relativistic Nucleus-Nucleus Collisions
4-10 April 2022, Krakow, Poland
The sPHENIX detector at the Relativistic Heavy Ion Collider is designed to measure high transverse momentum probes of the quark-gluon plasma such as jets, which can offer insight into the small-scale structure of the QGP.

- **Tracking detector:**
  - MAPS-based Vertex Tracker (MVTX)
  - Intermediate Silicon Tracker (INTT)
  - Time Projection Chamber (TPC)

- **Superconducting Magnet**
  - 1.4T solenoid magnet

- **Calorimeter:**
  - Electromagnetic calorimeter
  - Inner hadronic calorimeter
  - Outer hadronic calorimeter

- **High rate DAQ and trigger systems**
  - 15 kHz trigger
Calorimeter jets in sPHENIX

**UE determined event-by-event**

\[
\frac{d^2 E_T}{d\eta d\phi} = \frac{dE_T}{d\eta} \left( 1 + 2 \sum_n \nu_n \cos (n (\phi - \Psi_n)) \right)
\]

Average energy density, excluding regions with jet candidates

Flow modulation: \(v_2, v_3, v_4\)


**Average energy density, excluding regions with jet candidates**

\[\langle \frac{p_{\text{rec}}}{p_{\text{true}}} \rangle \text{ (Before Calibration)}\]

\[\text{R} = 0.4\]

\[\text{R} = 0.2\]

sPHENIX MIE 2018

**Flow modulation: \(v_2, v_3, v_4\)**
Jet physics

- Jet measurements out to 70 GeV overlap with LHC measurements

- High stats also for photons (γ-jet measurements) charged hadrons (fragmentation functions, substructure)

- Large luminosity Au+Au in first year dijets, jet $v_2$

**Projected yields, 3 year run proposal**

<table>
<thead>
<tr>
<th>Year one</th>
<th>Species</th>
<th>$\sqrt{S_{NN}}$ [GeV]</th>
<th>Cryo Weeks</th>
<th>Physics Weeks</th>
<th>Rec. Lum.</th>
<th>Samp. Lum.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2023</td>
<td>Au+Au</td>
<td>200</td>
<td>24 (28)</td>
<td>9 (13)</td>
<td>3.7 (5.7) nb$^{-1}$</td>
<td>4.5 (6.9) nb$^{-1}$</td>
</tr>
</tbody>
</table>

**3 years**

<table>
<thead>
<tr>
<th>Signal</th>
<th>Au+Au 0-10% Counts</th>
<th>$p+p$ Counts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jets $p_T &gt; 20$ GeV</td>
<td>22 000 000</td>
<td>11 000 000</td>
</tr>
<tr>
<td>Jets $p_T &gt; 40$ GeV</td>
<td>65 000</td>
<td>31 000</td>
</tr>
<tr>
<td>Direct Photons $p_T &gt; 20$ GeV</td>
<td>47 000</td>
<td>5 800</td>
</tr>
<tr>
<td>Direct Photons $p_T &gt; 30$ GeV</td>
<td>2 400</td>
<td>290</td>
</tr>
<tr>
<td>Charged Hadrons $p_T &gt; 25$ GeV</td>
<td>4 300</td>
<td>4 100</td>
</tr>
</tbody>
</table>
Summary

• sPHENIX detector will provide:
  Full coverage electromagnetic and hadronic calorimetry
  High precision tracking
  Fast readout rate

• Design allows for:
  High statistics samples of hard probes (jets, photons, high $p_T$ charged hadrons)
  Full jet reconstruction $\rightarrow$ complimentary jet measurements to LHC

• Measurements will improve our understanding of small-scale behavior of the QGP

• Data taking to begin in Feb. 2023!

February 28, 2022