RLOI #9

HIGH P_T PHOTONS, CHARGED PARTICLES AND JETS AT RHIC

R. Bellwied, P. Braun-Munzinger, G. David, B. Hong, R. McGrath,
J. Stachel, N. Xu, Y.C. Zhang, M. Zou
State University of Stony Brook, Stony Brook, New York

C. Woody
Brookhaven National Laboratory, Upton, New York

P. DeYoung, P. Gonthier, P. Jolivette
Hope College, Holland, Michigan

R. Arjaeinejad, J. Cole, M. Drigert, D. Struttmann
Idaho National Engineering Laboratory, Idaho Falls, Idaho

S.Y. Lee
Indiana University

T. Cormier, H. Dejbakhsh, S. Dutta, Q. Li, W. Trzaska
Texas A&M University

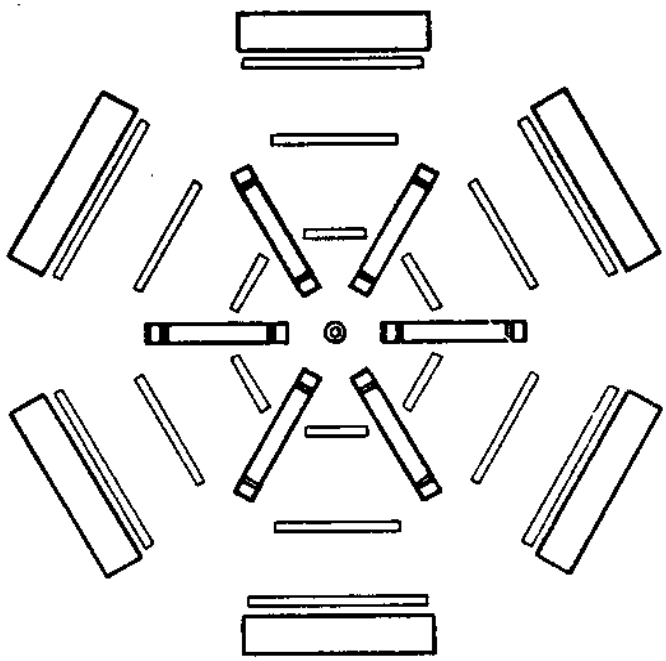
T. Hemmick
Yale University

1. INTRODUCTION

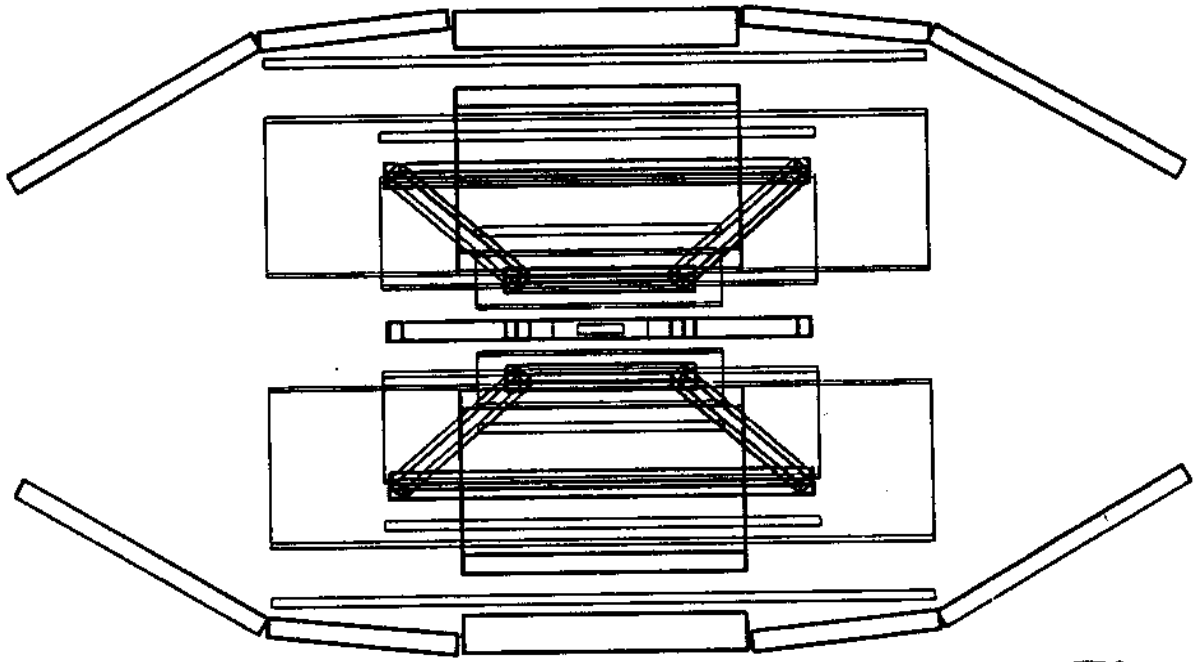
We intend to develop a proposal for the investigation of high p_T photons, charged particles and jets at one of the intersection regions of RHIC. Our approach is motivated by the observation, outlined in section two, that physical processes likely to take place at RHIC can conveniently be classified according to the transverse momentum of produced particles. At very high p_T (p_T > 6 GeV/c), corresponding to very short distance and time scales, hard scattering from the initial phase of the collision will dominate. Barring unforseeable surprises, these processes should be calculable using QCD perturbation theory. At RHIC luminosities, only direct photons will be a clean probe of these hard collisions; dilepton pairs at such large p_T values or masses will be produced at very low rates and high p_T charged hadron and jet production may be influenced[1] by the hadronic/quark-gluon medium surrounding the production point. At intermediate p_T values (1 < p_T < 6 GeV/c) one starts to probe distance and time scales where the perturbative (temperature T=0) approach is no longer applicable. Here, dileptons and photons from the hot initial phase of the (hopefully produced) quark-gluon plasma (QGP) should be observable and will provide a direct measurement of the initial temperature of the QGP. At low values of p_T (< 1 GeV/c) soft processes from the later stages of the collision will dominate. Obviously, the division into the above three regions is somewhat arbitrary. It is taken from theoretical estimates, and we will adopt it here as a guideline for designing the experiment. While in the following we will stay with the division made above, we are aware that it is approximate and it will become clear below that, for the present purpose, it is inconsequential where the exact boundaries are.

We plan to develop a detector in which charged particle multiplicity and transverse electromagnetic energy production of dominantly soft particles are measured to determine the event characteristics (degree of centrality, entropy, unusual fluctuations in space/rapidity, etc.). In conjunction with measurement of these global observables we plan to measure, for p_T > 1 GeV/c, photons and, for m_{ee}> 2.5 GeV and all values of p_T, dielectron pairs as detailed probes of the QGP. In addition, measurement of J/Ψ cross sections as a function of p_T is expected to yield information on the possible suppression of such bound states in the QGP. For very high p_T values, where perturbative QCD should be applicable, the direct photon measurement will provide a strong test of the theory. There measurements will also provide important and new information on gluon structure functions and their possible modification in the nuclear medium. Furthermore, correlation of these photons with the corresponding (away-side) jet will furnish experimental information on the possible quenching of jets in the QGP or hadronic matter formed in the collision.

Since much value is placed on establishing a connection tó a region where perturbative QCD can be applied the experiment will be designed to cover the whole range of projectile-target combinations available from RHIC, i.e. from p-p to p-nucleus to nucleus-nucleus collisions for the heaviest projectiles and for the highest luminosities forseeable for p-p as well as Au-Au collisions.



(a)



(b)

Fig.7