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The Necessity for the XTPC's

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History has taught us over and over again that in Hadron produced physics the recent important advances have occurred utilizing large solid angle (large rapidity - or psuedorapidity) coverage instruments.

The first very important example of this was Luis Alvarez bubble chamber program. Even though the bubble chamber was a slow-steam locomotive - type of device it was its essentially near 4π coverage that led to the unravelling of the elementary particle zoo phenomena, whereas the vary fast small solid angle counter systems could not accomplish this. The one exception was the $\Delta(1232)$ resonance and this was only possible because it stood alone with a Breit Wigner in its region, with very little background. Similarly later the J/Ψ and the upsilon were first seen with small angle telescopes as they essentially stood alone with huge narrow width signals.

One might argue that more limited solid angle coverage solenoidal detectors were very successful in the e^+e^- collider programs.

However there is an enormous difference in the physics capability of such detectors for e^+e^- collider experiments and hadron beam collider experiments.

In essence in e^+e^- colliders the theory is known well enough that what happens in the regions of solid angle not covered is often calculable or at least drastically constrained.

In hadron colliders this is not true in practice and therefore regardless of what one observes in a small solid angles region (for example η (psuedorapidity) = -1 to +1 for the STAR baseline TPC detector the theorists are free to use the unobserved regions to explain what happens in the observed region.

Although so far I have primarily discussed so called High Energy Physics Phenomena, this problem is even more relevant in heavy ion physics due to the enormous increase in complexity of the hadronic interactions.

The development of the large solid angle MPS I and MPS II fast drift chamber systems led to the following examples of important progress in the field.

1. The only viable Glueball candidates, namely the $g_T(2010)$, the $g_{T'}(2300)$ and $g_{T''}(2340)$ all with $I^GJ^{PC} = 0^+2^{++}$ were discovered. These are the only glueball candidates for

which all alternate explanations to date have been shown to be theoretically incorrect, do not fit the data or two or three of the above.[1] After two decades of intensive glueball investigations by many experimental groups all other glueball candidates have alternate explanations which have not been refuted.

2. A good deal of hadron spectroscopy has been investigated and clarified by these and other large solid angle hadron detectors. In addition it was found that prior glueball candidates appeared in the complex hadron produced spectroscopy and these large solid angle (rapidity coverage) detectors allowed successful analysis of the data.

The importance of establishing glueballs cannot be over emphasized since they are one of the two premier "Smoking Guns" required to establish non perturbative QCD – the "Achilles Heel" of the Standard Model.[1] The other Smoking Gun is the discovery of a Quark Gluon Plasma being searched for at the AGS, CERN, and RHIC.

As an important example I will use the case of the AGS E-810 which is similar to STAR in many basic concepts.

Although E-802 data had been used to conclude that there was substantial near complete stopping in Si - heavy target collisions at AGS, Guylassy and collaborators[2] had successfully used a model in regions outside the limited measured central rapidity region to draw the opposite conclusions, namely, that there was large nuclear transparency. It took the large solid angle (ie. rapidity coverage) of the E-810 TPC system[3] to convincingly contradict this and show indeed that there was large stopping.

The anomalously large Ξ^-/Λ observed by E-810[4] which first contradicted known cascade model predictions also was a result of the large rapidity coverage.

Horst Stökers' talk "From the AGS to RHIC" at the AGS/RHIC users June 14-15, at BNL.[5]

In an outstanding talk[5] at the AGS/RHIC users meeting Horst Stöcker raised the following point. It is listed on a transparency (attached) labelled – RHIC: Mid-Rapidity Baryons:

- Maximum baryons at $Y \sim 3$
- $\frac{\mu}{T} \approx 1 - 2 \rightarrow \frac{\rho}{\rho_0} \sim 3$
- Can RHIC afford:
  - 3 detectors at Y cm $= 0$
  - but
  - 0 detectors at Y cm $= 3$

Stöcker clearly implied that the answer to his question is no.

I believe the answer is definitely no – RHIC cannot afford to build three detectors at Y cm = 0, but 0 detectors at Y cm = 3.

Although Stöcker has only alluded to this one point in his talk, I believe (and have emphasized for some time) that there are many other points which will emerge as time goes by requiring as large a rapidity or psuedorapidity coverage as practical, Some examples are given elsewhere in this proposal for detection of plasma bubble production.

Therefore it is ill advised not to extend the psuedorapidity region of STAR by including the XTPC's in the baseline.

The real power of STAR is its ability to look for unusual single or classes of unusual single events. As soon as this happens in order to understand what has been observed in these unusual events (hopefully indicative of a Quark Gluon plasma), as well as to constrain the theorists from using these unexplored psuedorapidity regions to mundanely explain away the observed unusual events, we need the XTPC's.

These will extend the psuedorapidity range to as close to $\eta \approx \pm 5$ as possible. Since we expect to be able to obtain significant sign information from the radial TPC's for the particles in the region Horst Stöcker referred to, we expect to be able to separate out the protons and address his question.

However, even more importantly we will be able to address the many questions which will arise about the events we measure as "interesting" and provide constraints on their explanation. One could say why not wait for this upgrade for the future? The answer is that it is not resonable to spend so much money and effort on a detector and hobble its ability for crucial discoveries by leaving out coverage for a large psuedo rapidity range which will to a very high probability be crucial to understand what we observe in the present STAR baseline. This is especially so when its cost is a small fraction of the baseline detector cost.

Speaking for CCNY I would add that our group will take an active role in the appropriate aspects of building, testing, and providing software and physics analysis for the XTPC's in conjunction with the present baseline.

The exact role we play will of course be determined by detailed negotiations with our collaborators from BNL, U.C. Davis, MPI etc., and of course the degree of future funding available.

References

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[3] S.E. Eiseman *et al.* Phys. Lett. B292 (1992) 10–12.

[4] S.E. Eiseman *et al.* Phys. Lett. B325 (1994) 322–326.

[5] Horst Stöcker - From AGS to RHIC - Invited Talk at the AGS/RHIC Users Meeting, Brookhaven National Laboratory, June 14–15, 1994.