

Remarks on ep and eA Running with PHENIX & STAR

Thomas Ullrich

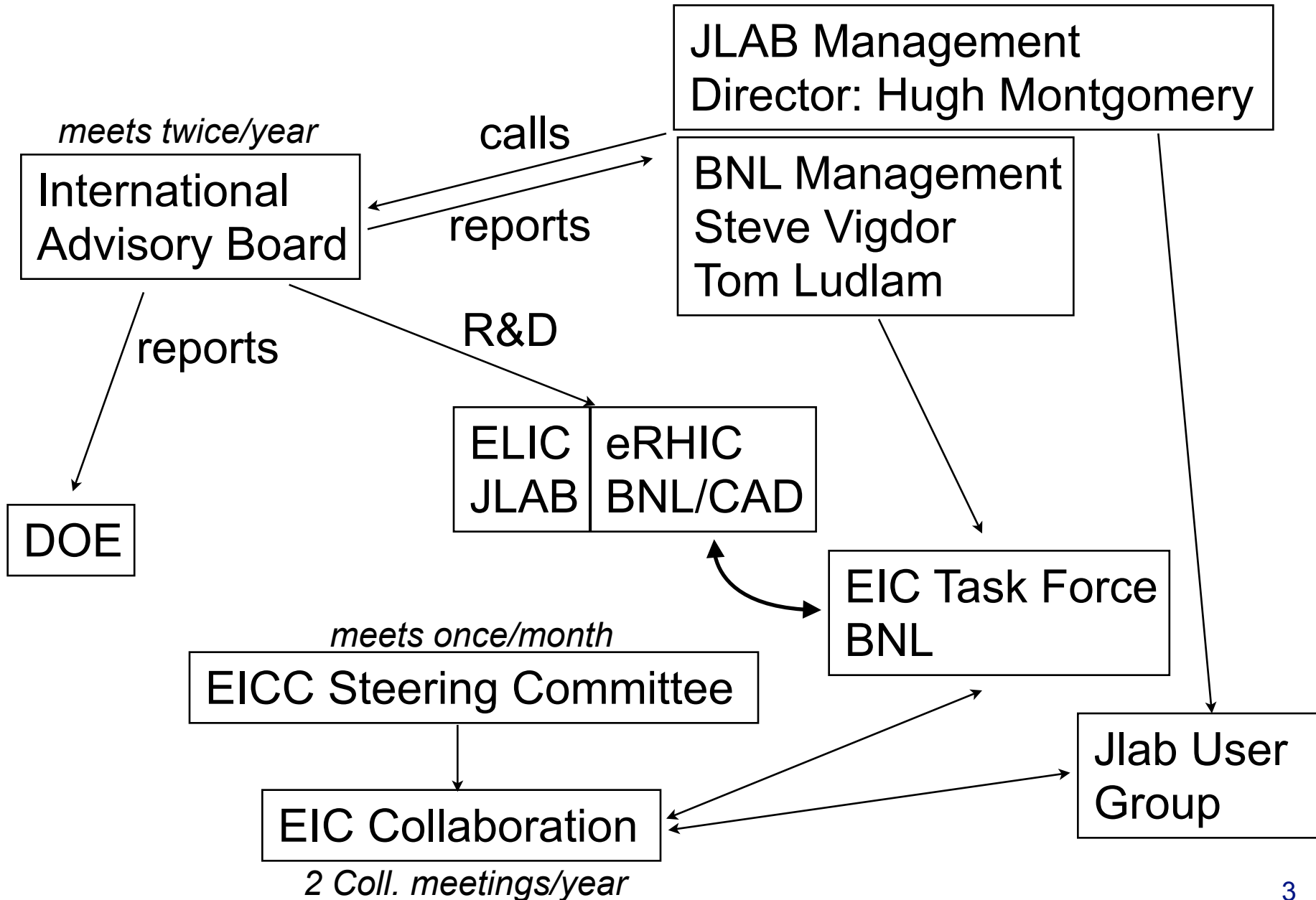
Meeting on ep and eA collision with RHIC detectors
Thursday, March 25, 2010

BNL

Decadal Plan - Steve's Charge

4) Any plans or interest your Collaboration has in adapting your detector or detector subsystems (or detector R&D) to study electron-nucleon and electron-ion collisions with an eventual eRHIC upgrade. This is relevant only near the end of the decade addressed here, but will be important for planning purposes. (We may well be forced by financial or environmental considerations, even for a first MeRHIC stage, to consider options in which acceleration of the electron beam is carried out around the RHIC tunnel, requiring some scheme for getting an electron beamline through or around PHENIX and STAR.! So it's worth considering if there is some way you could make use of the e-p

EIC Organization



Information on EIC

On the web:

EICC Home page: <http://web.mit.edu/eicc/>

CAD eRHIC Home Page: <http://www.bnl.gov/cad/eRHIC/>

Latest IAC Report:

http://skipper.physics.sunysb.edu/~abhay/EIC/2009/EICAC_November/EICAC-Nov09-Report.pdf

BNL Task Force:

https://wiki.bnl.gov/eic/index.php/Main_Page

Documents:

A White Paper Prepared for the NSAC LRP 2007, 24 April, 2007: http://web.mit.edu/eicc/DOCUMENTS/EIC_LRP-20070424.pdf

e+A White Paper, EIC Collaboration, 4 April, 2007:

http://web.mit.edu/eicc/DOCUMENTS/PositionPaper_eA-20070404.pdf

Staging of eRHIC - Original Idea

MeRHIC: Medium Energy eRHIC

- Both Accelerator and Detector are located at IP2 of RHIC
- 4 GeV e⁻ x 250 GeV p (63 GeV c.m.), $L \sim 10^{32}$ - $10^{33} \text{ cm}^{-2} \text{ s}^{-1}$
- 90% of hardware will be used for HE eRHIC

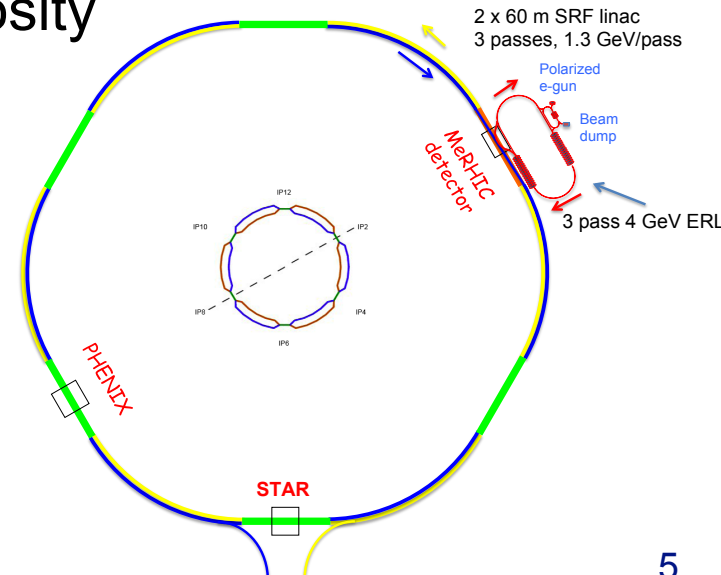
eRHIC: High energy and luminosity phase, inside RHIC tunnel

Full energy, nominal luminosity

- Polarized 20 GeV e⁻ x 325 GeV p, $L \sim 10^{33}$ - $10^{34} \text{ cm}^{-2} \text{ s}^{-1}$
- 30 GeV e⁻ x 120 GeV/n Au, $\sim 1/5$ of full luminosity
- and 20 GeV e⁻ x 120 GeV/n Au, full luminosity

eRHIC upgrades – if needed

- Higher luminosity
- Higher hadron energy



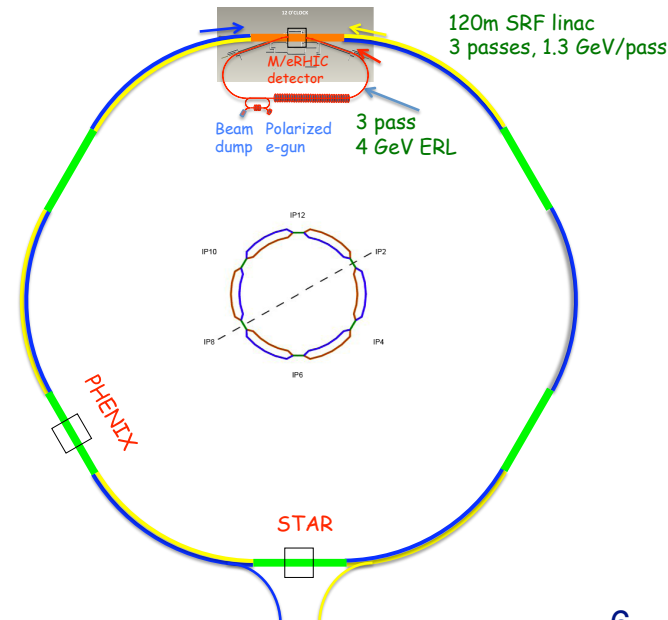
Latest Development

BNL design

- eRHIC cost estimate (2007): \$700M (\$100M det)
- MeRHIC cost estimate (2009 review): \$350 w/o det
 - ▶ includes secondary e-ring (as shown a slide earlier)

At a recent DOE visit, J. Simon-Gillo said that already MeRHIC is a ~billion \$ project (i.e. \$350M machine + \$250M detector + corrected for in-year future dollars), and that cost saving options must be explored.

- ▶ \$50 M cheaper to bring e around as in eRHIC design
 - allows for collision in PHENIX, STAR
 - not bound by 4 GeV ...
- EIC Task Force: disfavor 2 o'clock IR
- 12 o'clock allows to use same detector for



IAC Report

Main Task right now:

R&D money (LRP 2007 5 years x \$6 M) - what get's funded, what is needed (machine, detector, (common|JLAB|BNL))

On Physics Case:

One might indeed see two different routes of interests: one **looking for new phenomena in QCD at the highest energies** (in particular: saturation, the partonic content of heavy ions, initial states of the formation of quark gluon plasma in heavy ion collisions etc) **the other one aiming at a complete (three-dimensional) picture of the parton content of the proton**, asking primarily for **high luminosities** (maybe at not so high energies). [...]

In the view of some members of EICAC, this may leave two options to be explored in the near future: one of the two options has be favored, the other one disfavored. This will have serious consequences. [...]

IAC Report

Main Task right now:

R&D money (LRP 2007 5 years x \$6 M) - what get's funded, what is not

On Physics

One might think that the new phenomena saturation formation one aim is not so high. In the view of the other

MeRHIC is neither at the highest energies needed to truly probe saturation phenomena nor does it provide ultra-high luminosities for a complete 3D mapping as claimed ... (large Q^2 coverage = low-x reach as important)
There is however quite interesting physics that can be explored.

looking for the other parton maybe at options to be favored, one disfavored. This will have serious consequences. [...]

IAC Report

On Detectors:

It may therefore be wise to consider the possibility of **more than one interaction region to satisfy these different requirements**. This would also provide a natural way for different physics communities to group themselves. [...]

In a prioritized way, R&D suggested for the near term should begin to **address the following areas**:

- Low-mass vertex-tracker/tracker,
- TRD detector
- Particle identification at mid-rapidity for particles with momenta up to 4 GeV, e.g., using DIRC technology
- Low cost photon detection, e.g., SiPMs
- ion polarimeter

The ILC has worked out an organization to actively **include university groups** in the detector R&D which could be a good strategy also here to widen participation.

IAC Report

On Detectors:

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them

How does the next round of RHIC upgrades fit into this?

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up

In a pr
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begin to

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Info from Steve on MeRHIC & Charge #4

Steve's "optimistic" MeRHIC schedule would be **beam in 2020**

- CD0 in 2012, CD3 in 2015 (construction launch) - cannot be any earlier due to the FRIB funding profile
- ~ 18 month downtime for all of RHIC during this construction phase (somewhere between 2015-2020).
- It would be clear that there would be some re-direction of RHIC operations funding into construction funding.

We should assume there would be **one dedicated meRHIC** detector and then the same beam being available for STAR and/or PHENIX.

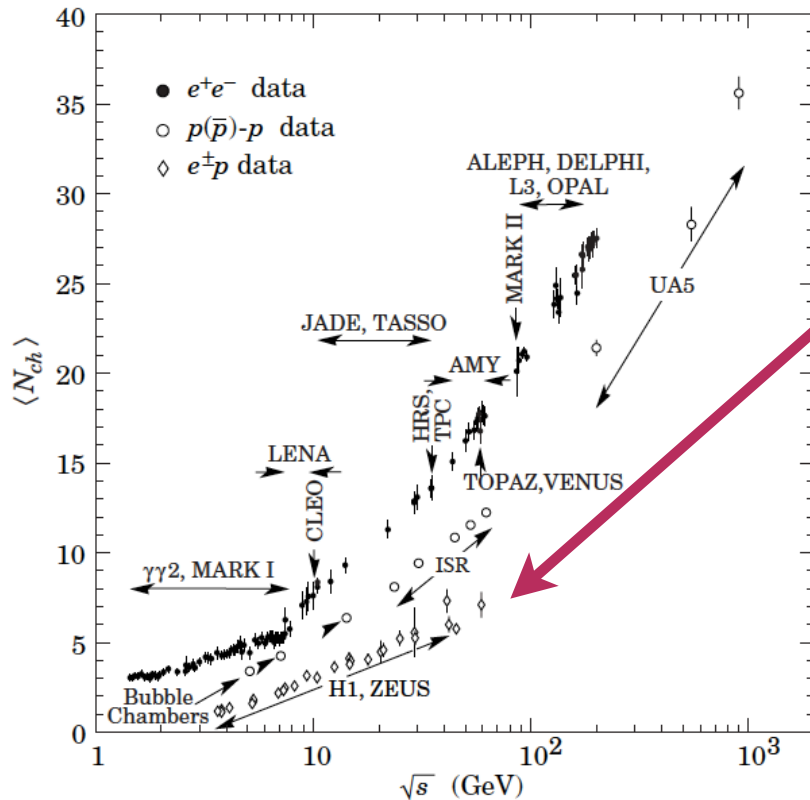
Steve said that an R&D connection would very valuable, even if the collaboration did not envision doing the actual e-p or e-A measurements in the upgraded detector.

Cost scope for possible upgrades:

~ same scale at the current mid-term upgrades (\$20M per experiment?). \$5M projects are very possible, and that \$20M would have to be transformative. Larger cost items would be difficult, but we have to make the case. He doesn't want to cut off thinking big processes (which he notes is having a revitalizing effect on the collaborations).

Some Parameters to Keep in Mind (I)

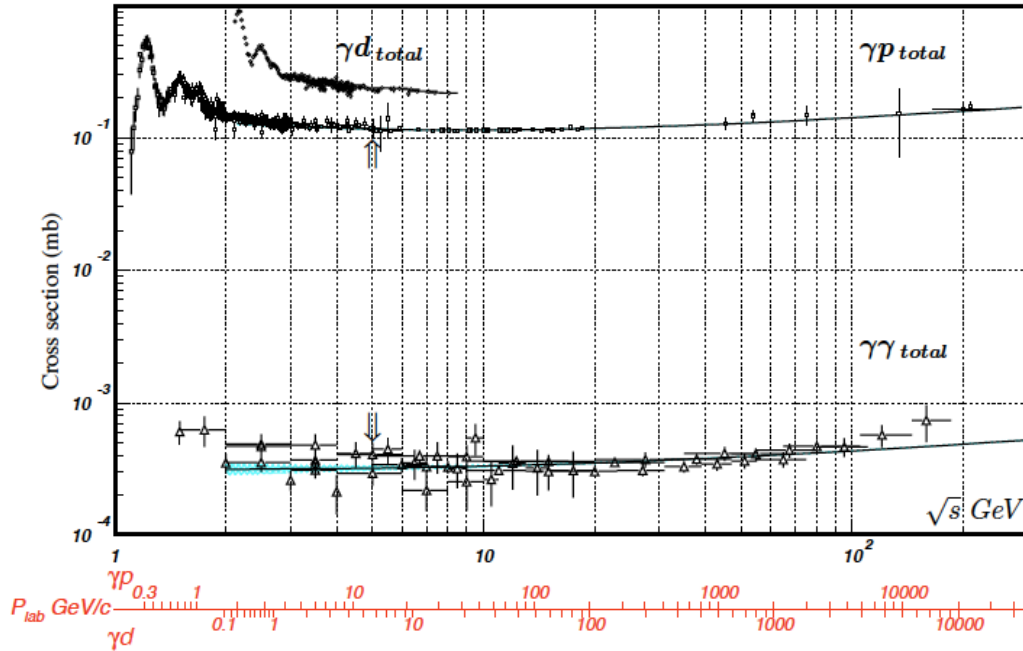
Beam Energy (GeV)		\sqrt{s} (GeV)	N_{ch} (4 π)
e	p, A		
4	100	40	6
4	250	63	7



Low multiplicity
 $N_{ch} \sim \log s$

Neither ep or eA
 pose a problem in terms of
 occupancy for RHIC detectors
 $N_{ch}(ep) \ll N_{ch}(eA) \leq N_{ch}(pA)$

Some Parameters to Keep in Mind (II)



$\sigma_{\gamma^*p} \sim 0.1 \text{ mb}$
 almost independent of
 \sqrt{s} in the (M)eRHIC
 range

For all Q^2 (!):
 $\sigma_{\gamma^*p} = \sigma_{ep}$

Realistic rate is lower
 by factor 10-100 (?)
 due to acceptance
 [Needs simulations]
 Should not be a
 problem for current
 DAQ/Trigger

Luminosity		Interaction rate for $\sigma = 0.1 \text{ mb}$
$(\text{cm}^{-2} \text{ s}^{-1})$	$(\text{mb}^{-1} \text{ s}^{-1})$	
10^{32}	100,000	10 kHz
10^{33}	1,000,000	100 kHz

Agenda for this meeting

- Introduction (TU) -- 10min
- eRHIC with eSTAR and ePHENIX Vladimir Litvinenko -- 30min
- ePHENIX Elke Aschenauer -- 20min
- Coffee Break
- eSTAR Jamie Dunlop -- 20min
- eRHIC/MeRHIC detector concepts Matt Lamont 20 min
- Discussion (1h)