Update on the μ-trigger & NCC Forward upgrade

Richard Seto-UCR

DC-Upgrades Meeting

BNL Sep 8, 2004

Progress

- Got green light for 2 CDR's
- Mu-trig-design decisions (tree)
- Funding – beginnings of plan
- New Collaborators
- most recent communication with FSi folks (LANL)
  - Santa-Fe meeting
  - RKS/Naohito made a visit to LANL Sep 2-3

EC/DC/PM letter – reader's digest version

- We got the green light for CDR(s)
  2 CDR's : μ-trigger and NCC
- Work with FSi (LANL), consider GEM also
- Muon trigger
  - look at possible benefits of displaced vertex measurements
  - looking into possibility that it can trigger at RHIC 2 heavy ions
  - looking into possibility that it solves the pattern recognition problem
  - Choose a technology
  - be ready by FY 07/08
- NCC
  - combined charged tracking and calorimeter measurements?- optimize
  - Make sure it can take high occupancies
  - money!
  - Consider Hera B Calorimeter

The proposed detectors
a reminder and status

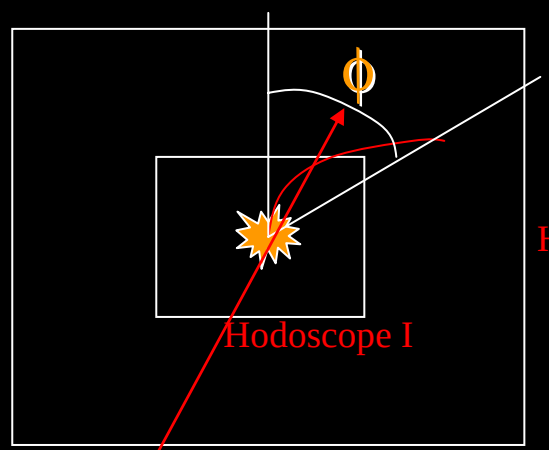
status μ-trigger

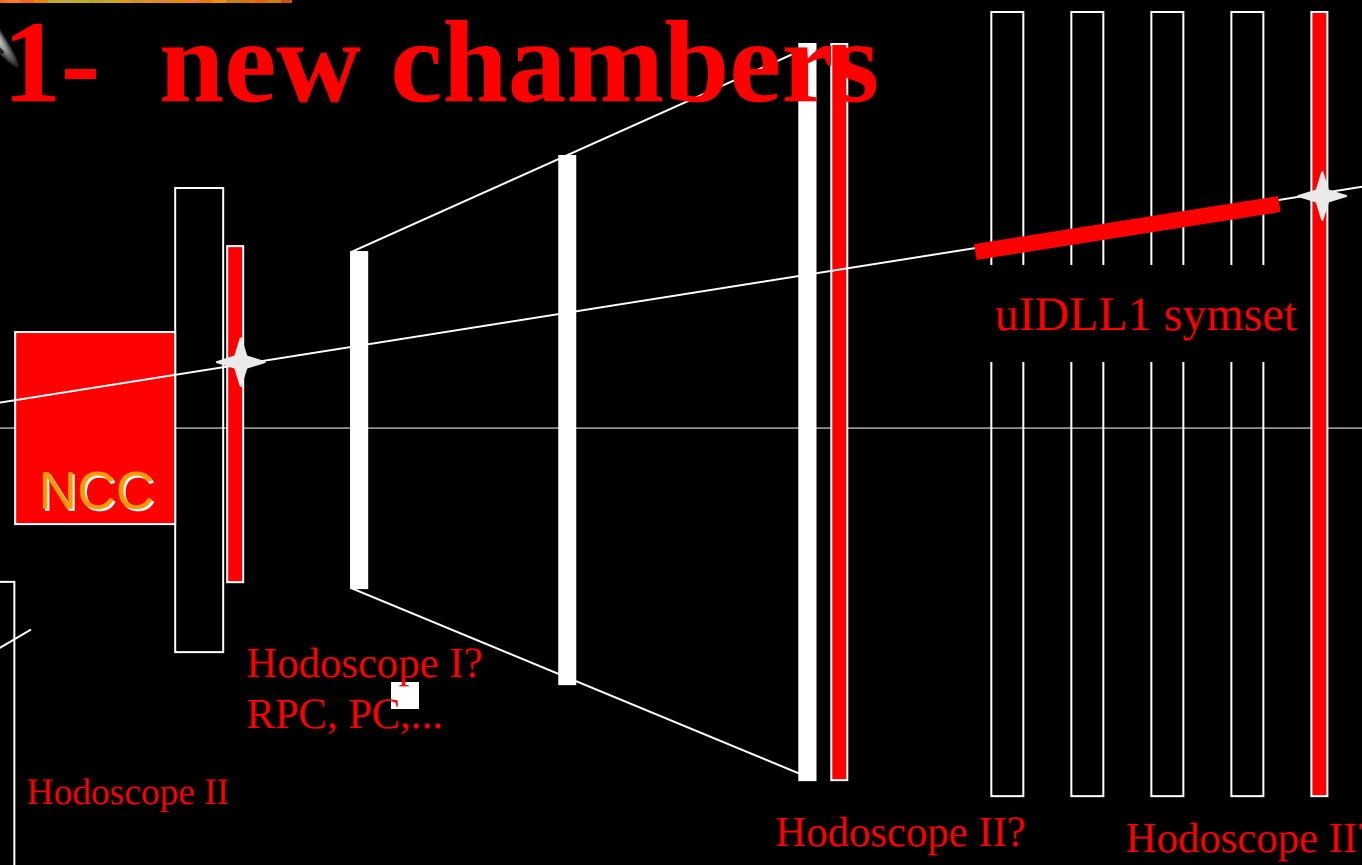
- Purpose
  - LVL-1 trigger for W physics (the driving factor)
    - Need factor of 10^5 at RHIC II pp (x4)
  - Trigger for heavy ions – upsilon etc
  - help with pattern recognition
- 2 technologies possible
  - new trigger chambers (RPC, PC)
  - replace μ-Tr electronics

Idea 1- new chambers

Single muons

p=4-10GeV/c





do look-up among pc1-tile/pc2-tile/symset then radial

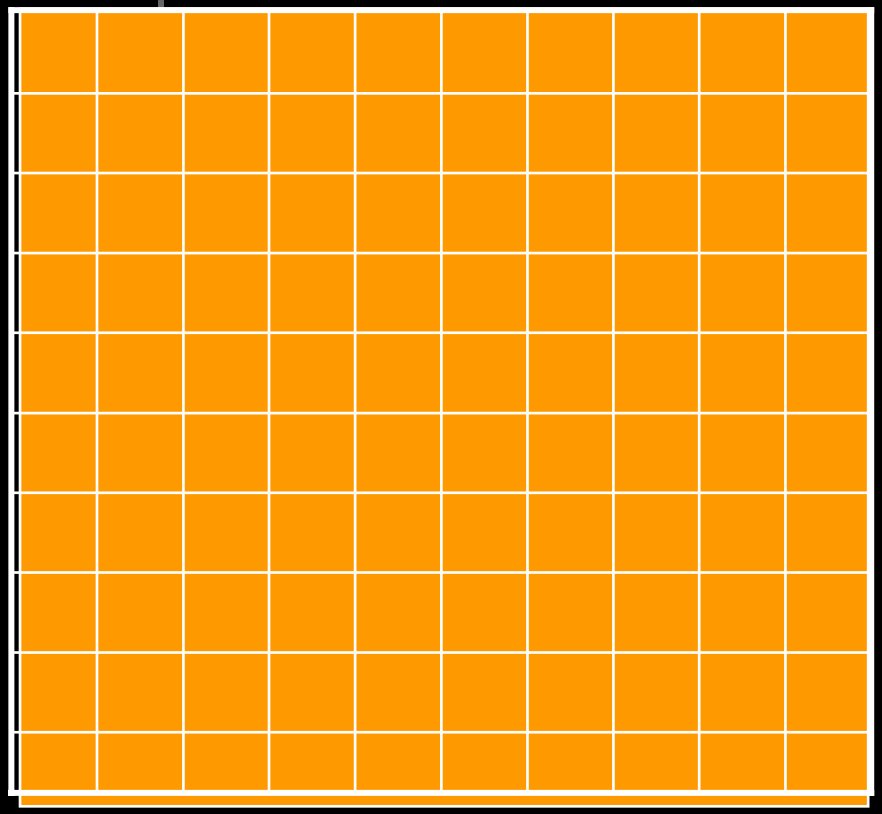
PC1 is in front of station #1. Radial pads + 10 cm Tile size
PC2 in 2 possible places. Radial pads+ 30 cm tile size PC2

double chambers for redundancy??

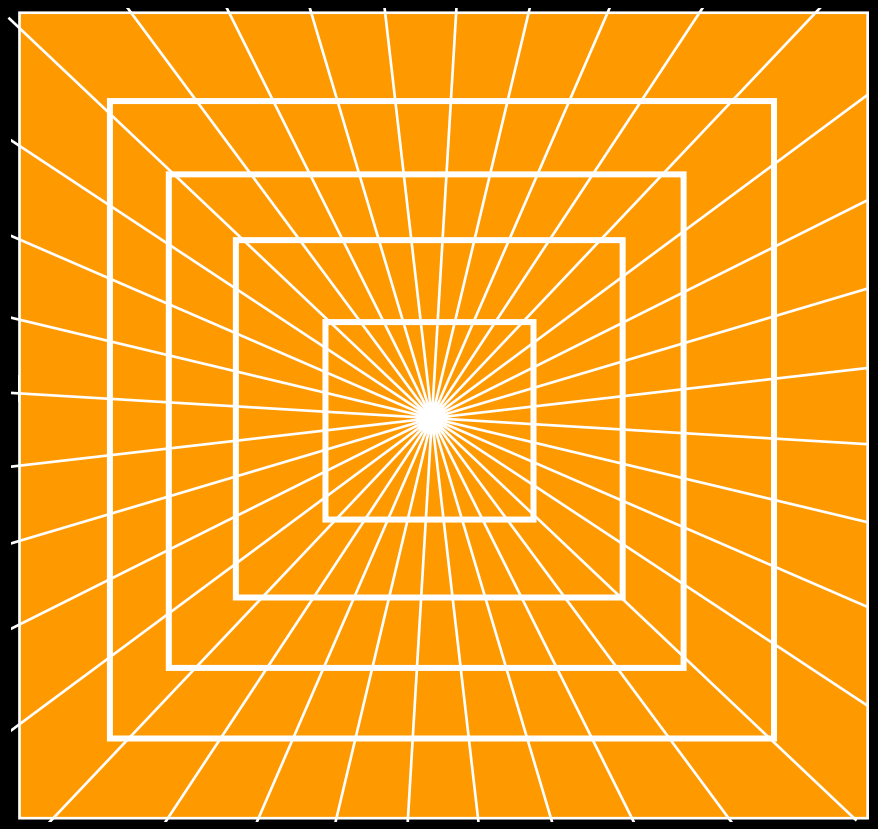
δ(ϕ) deg	<1	<2	<3	<4	<5	<6	<7	<8	<9	<10
eff	87%	90%	91%	91%	91%	92%	92%	92%	92% 6	92%
rej	85000	34000	12142	7727	6296	5000	3542	3091	2881	2464

RPC/PC segmentation

tiles

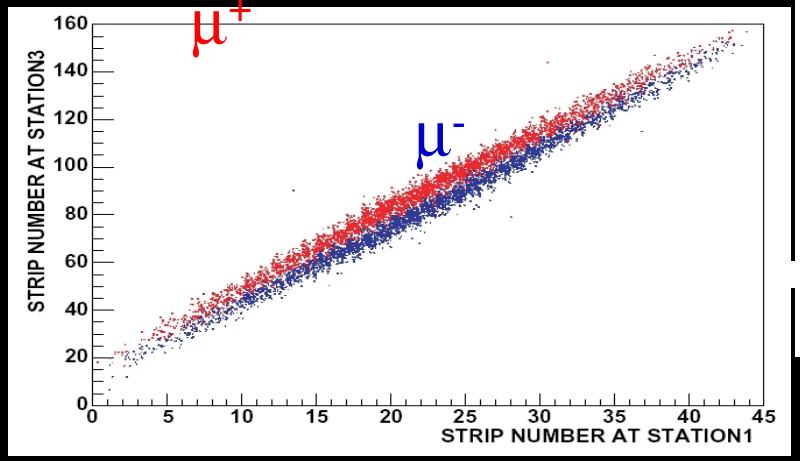


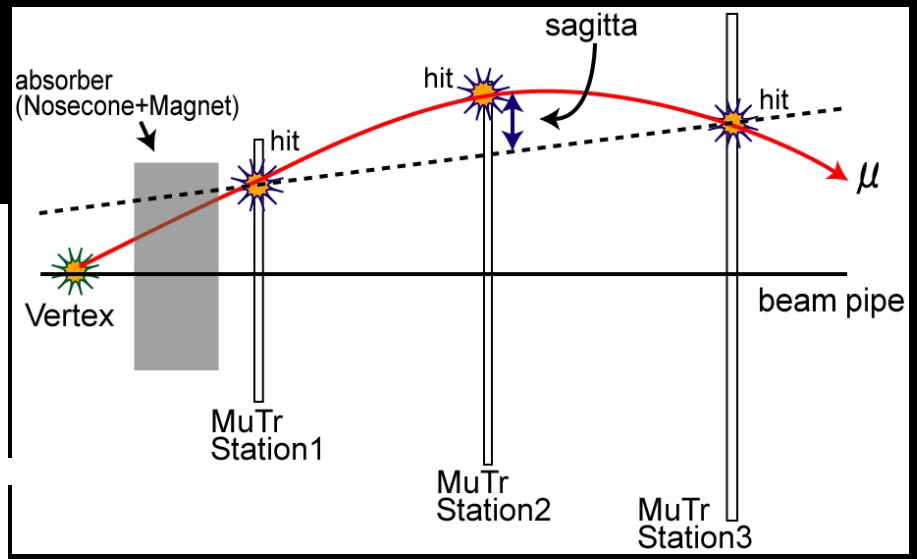
radial segmentation



- 2 sides, one side tiles, one side radial segmentation ???
- Exact segmentation scheme is subject to change (90K PC channels available)
- maybe more, maybe less segments – but you get the idea

idea-2 Tracking Trigger: MuTrLL1+MuIDLL1





	str<=1	str<=2	str<=3
Rej	23700	10900	7180

Full PISA simulation including trigger processors

Result from Kazuya – good eff

μ trigger technology

- DECISION: by Sep 13 Naohito/Matthias will agree on a trigger technology which will satisfy the requirements of W physics
  - This is the primary criteria in choosing a technology-
    - note: additional information may come from NCC for W physics
- Criteria-Performance for triggering:

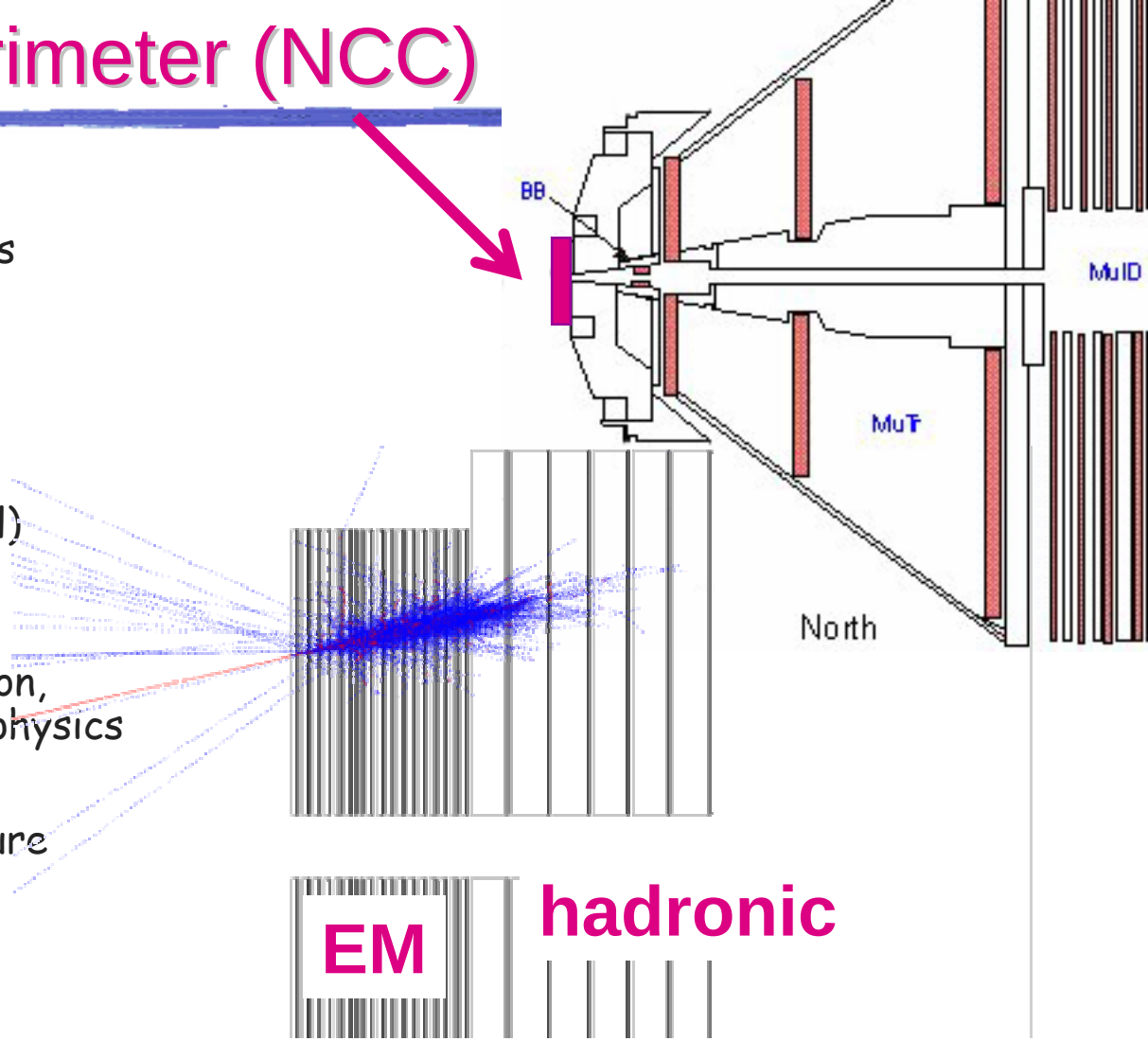
1) rejection for W in pp, heavy vector mesons in AA, open charm/bottom in pp and AA.
   - simulation for AA – wei timescale<1mo
2) Stability against collisions related backgrounds: decays into muons, combinatorial background from spectator fragments showering of the beampipe or material close to the beam pipe.
   - shielding help noise? kazuya and wei, yajun timescale<1mo
     - use pisa to do this – fragments – check with kazuya for fragments
3) Beam related backgrounds: hardron punch through, neutrons, decay-muons, incoming vs outgoing beam background.
   - background from beam – incoming -finish Scint test – run4 (wei check this)
     - mars to pisa Vasily< 1mo
     - DECISION made: one plane or more of fast device – i.e. RPC
4) Can trigger info be passed on to LL1 within one clock tick?
   - design – 2 beam clocks to lvl1 (fast hardware) RPC OK
   - measure for Cathode – timescale< 1 month
5) "Noise" rate (in absence of any physics signal) in the trigger.
   - Noise – RPC – measure or send email Matthias– few days- Answer by next week

μ trigger technology-continued

- Tracking Issues
  - Is it necessary to improve the pattern recognition in AA? (YES-Vince) How can this be best done?
    - muTr resolution vs splitting of a trigger signal at the front end (ASD may fix this for cathode)
  - This is a more difficult problem
    - needs expertise from muon tracking person (wei to visit LANL – Melynda/Pat/…)
    - may increase cost- what is needed is probably theta resolution
- Integration issues
  - How long does it take to upgrade muTr FEE; can this be done during a regular shutdown? How can the installation of new decidcated trigger counters be integrated with the running schedule?
    - 2 shutdowns
  - How to solve integration issues for possible RPCs upstream of muTr magnet, downstream of muTr magnet or downstream of muID in gap 5?
    - Need to talk to Pete etc
  - Do we have a scheme in which we can combine the LL1 information for muId/muTr/RPC within the time budget for a level 1 decision?
    - John says at first order its OK [see John's slides~ 25 clock ticks OK, probably have 10 available since 15 are used]
  - Coordination with PHENIX muon group. There may be pretty strong oppinions on which solution is preferrable.

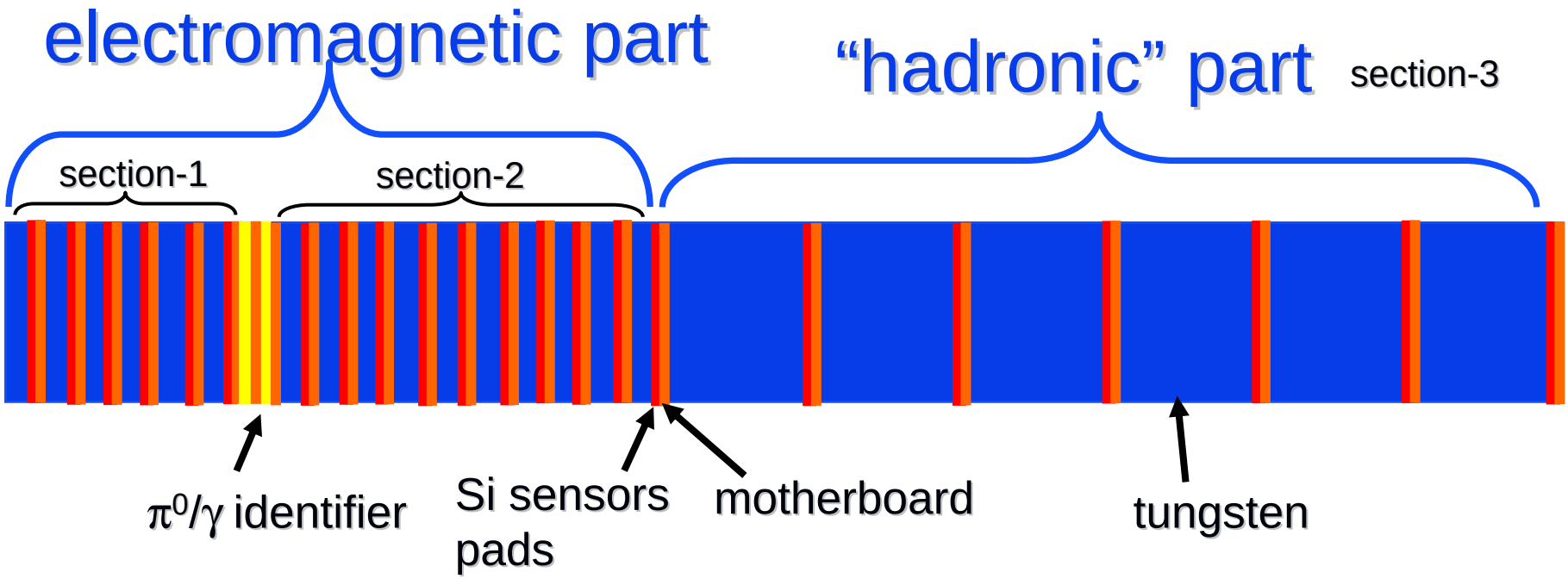
Nose cone calorimeter (NCC)

- Purpose
  - » Photons, electrons, Jets
- *AA*
  - » onium Physics
  - » Jet Tomography
  - » charm measurements
  - » possibly low pt (thermal) photons
- *pA*
  - » Gluon Structure Function, shadowing, Saturation physics
- pp (spin)
  - » Polarized Gluon Structure Function
  - » W isolation



- ***Requirements***
  - » **good $\gamma/\pi 0$ separation**
  - » **good position resolution**
  - » **e/photon PID vs. hadron**
  - » **isolation for γ, μ, e**
  - » **reasonable E-M energy resolution**
  - » **reasonable jet measurements**
  - » **triggering capability**

longitudinal segmentation

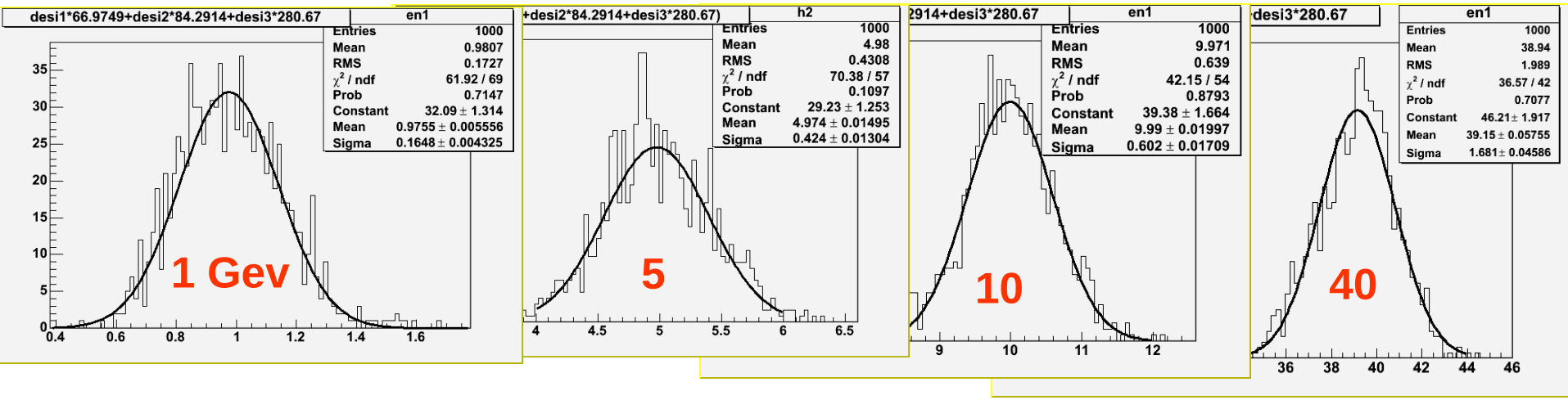


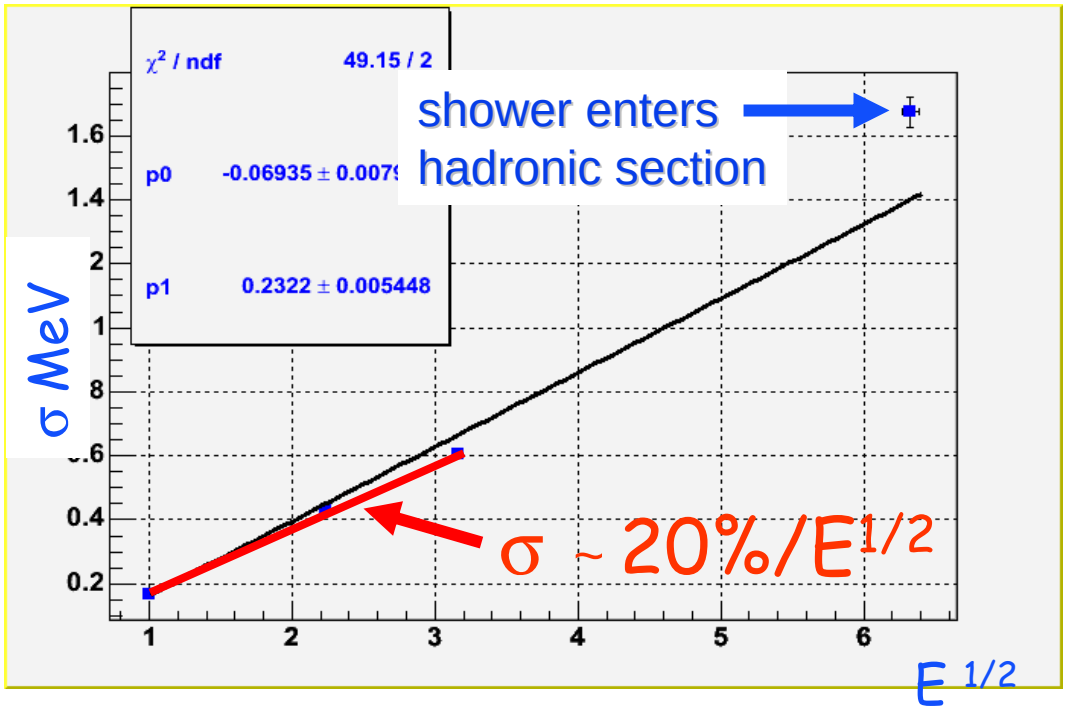
- Electromagnetic
  - » 16 layers of W 2.5 mm thick ➔ $10X_0$
  - » Si 1.5 cm x1.5 cm pads
- π^0/γ identifier
  - » 2 layers Si , 1.9 mm x 6 cm strips
  - » after $4.3X_0$
- Hadronic
  - » 6 layers W16.6 mm thick
  - » Si 1.5 cm x 1.5 cm pads
  - » Total (em+had) $40X_0$ 1.5 λ_0

- read out in 3 longitudinal sections
- Mollierre radius~1.3 cm
- EM Energy resolution ~ $20\%/\sqrt{E}$
- Hadronic Energy res ~ $100\%/\sqrt{E}$ (?)
- 2 γ "2 track resolution" ~ 4mm (?)

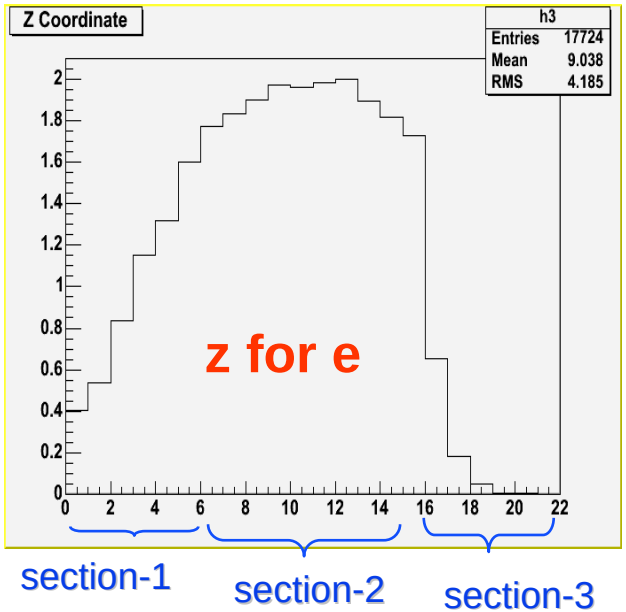
- X_0(tungsten)=3.5mm
- λ_0=9.5 cm

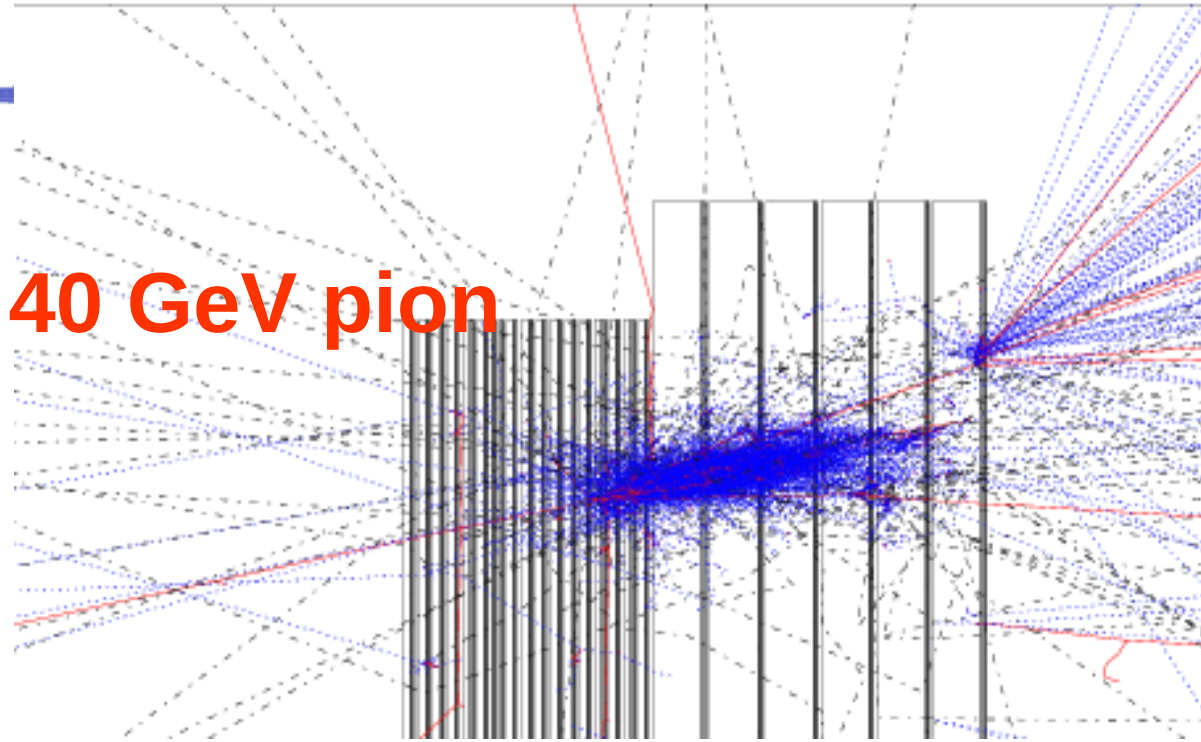
EM Energy Resolution

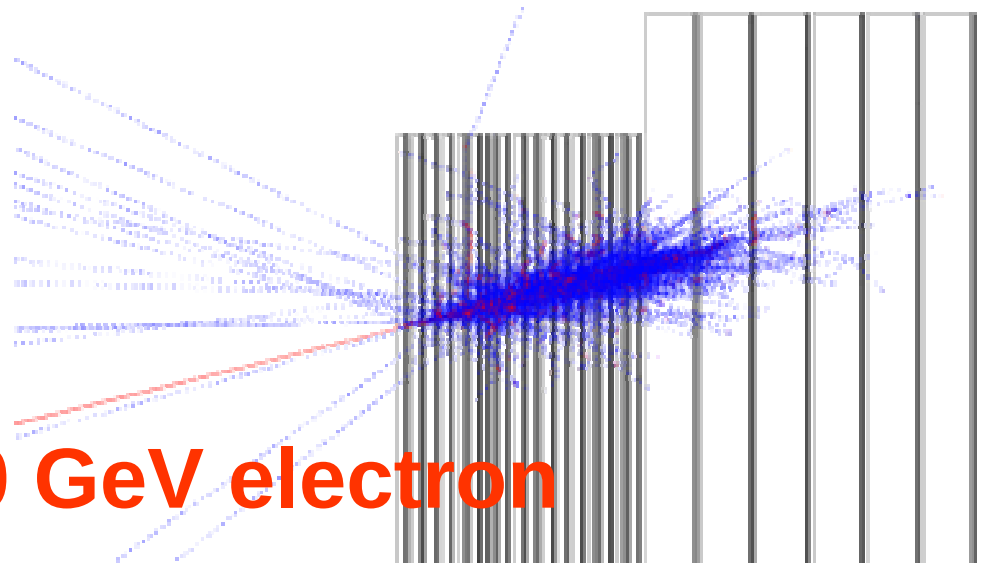




Separating e,π







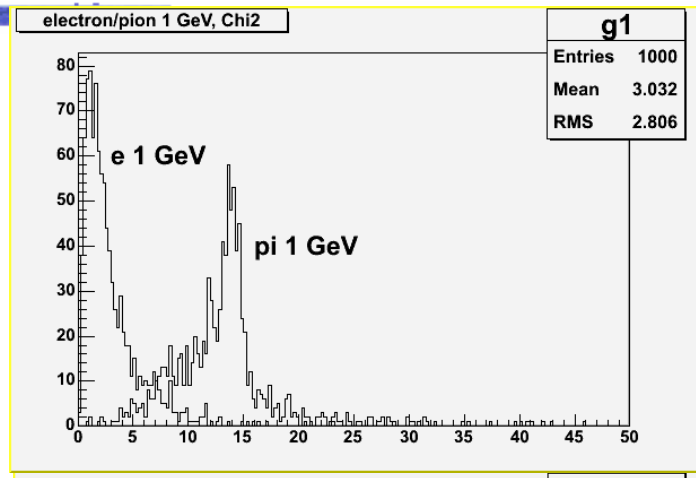
First try at e/π separation

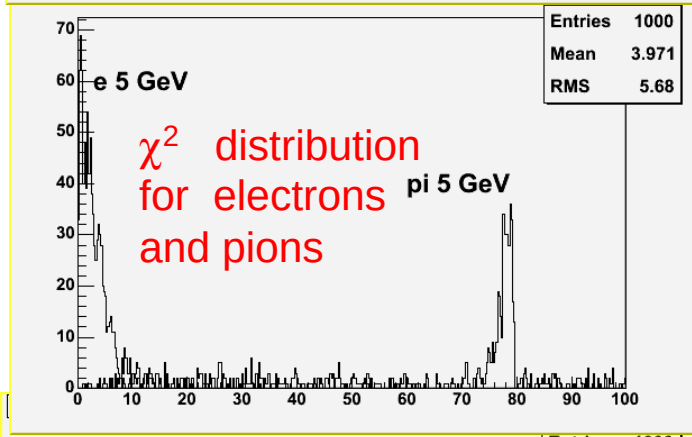
- Use only 3 longitudinal segments
- χ^2 Estimator for NCC

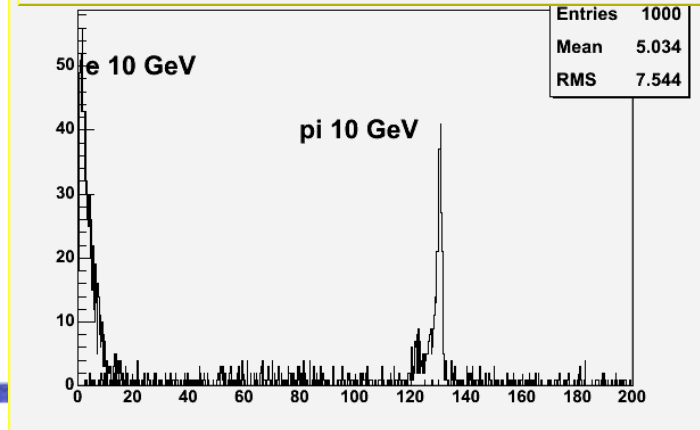
  $\Sigma_i \; (e_i - \langle e_i \rangle)^2 / rms^2 \quad i = 1, 3$

- Electron selection /projections in %

χ^2 cut	5.0	7.5	10.0
1GeV	83.2/100	93.3/99.1	97.4/78.0
5GeV	78.1/100	88.9/100	93.1/100
10GeV	76.2/100	87.1/100	92.2/100
20GeV	79.5/100	88.1/100	91.9/100
40GeV	76.7/100	85.1/100	89.8/100



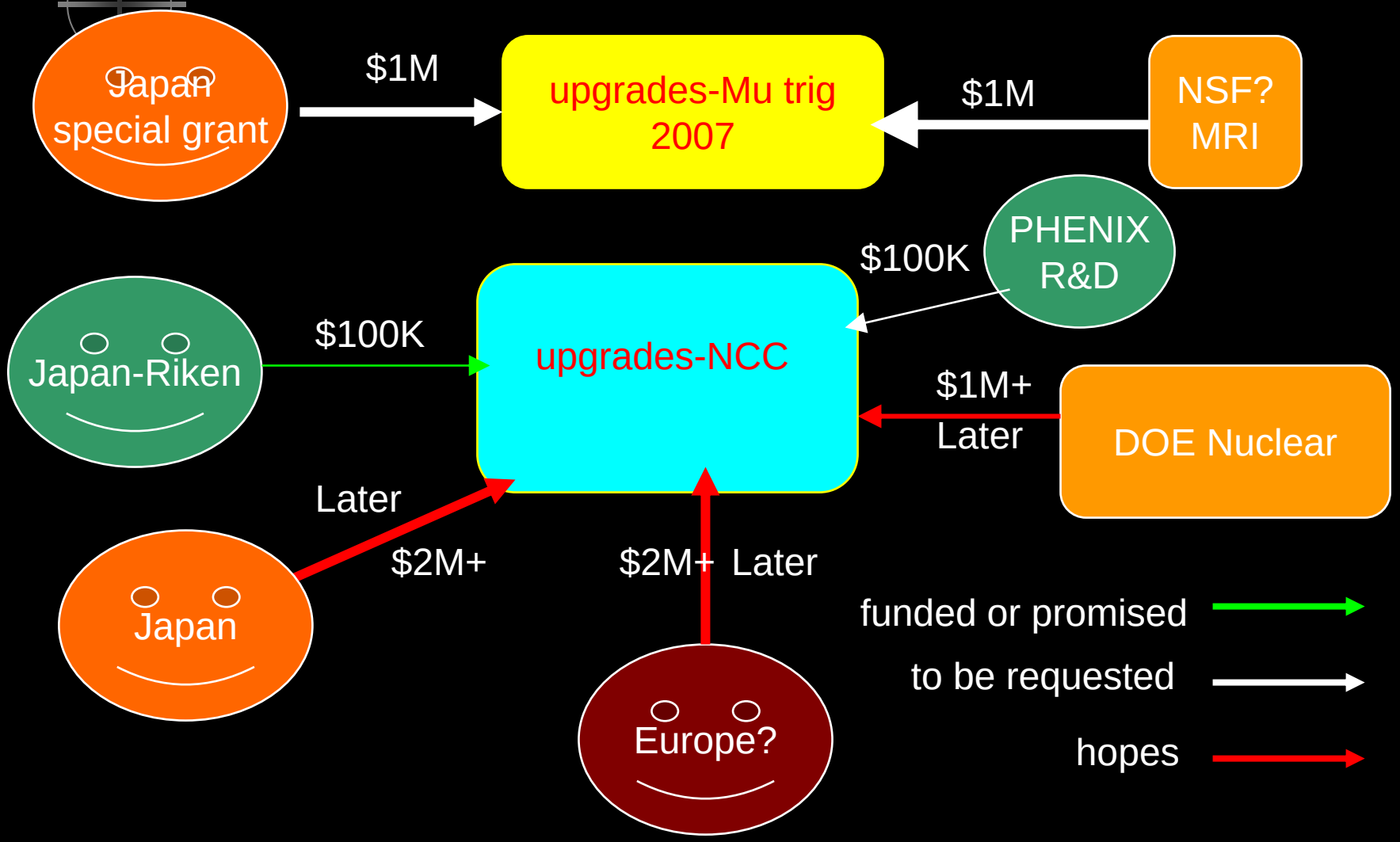




costs

- Mu trig (to solve W trigger problem)
  - RPC – $900K
  - cathode readout
    - 9K channels ~ $1M
  - Bottom line
    - either scheme or hybrid costs ~$1M
    - To solve pattern rec may double this just from increase in channels
- NCC
  - 1 side - $3M, Both sides $5M, incl gamma/pi0

Decision: strawman for funding



RKS note – discussion (a tough one which took most of the time) included Hideto – hence the green lin
Astushi will be the point person for these funds

NCC - schedule

- plan – to have 1 NCC in by 2008 (as in LOI)
  - 2004 – R and D ($100K-Riken, $100K-PHENIX)
  - 2005- prototype in (1 year from now)
  - 2006 –mid-year Funding in place for 1 NCC
    - $3M + = $1M+:NSF, $1.5M+:Japan, 0.5M+:DOE
    - Application for NSF funding Jan 2006 (ready by Oct 2005)
  - 2006 – Prototype 2 (full prototype)
  - 2008 – NCC 1 w/$\pi^0\gamma$ operational

  - 2007- midyear Funding in place for NCC 2
    - $2M Europe, Japan, DOE
  - 2009 – NCC 2 operational

Possible collaborators

- Czech Republic -NCC– Prague folks (Finger - Charles U, Tech U of Prague, Czech Acad Sci)
  - Applying for Money from Czech govt for cooperative work with US institutions (UIUC-NSF ~100K/yr from Czech Rep-4yrs) ■
- Arranging meeting at Trieste spin meeting
  - Bradamante/Vacchi etc
- Bejiing- Yajun Mao(μ-trig)
  - Major expertise with RPC's – provided them for CMS ($600m^2$)
  - Visit by Barbara, Matthias and Yasuyuki

Beijing University

- Man power for RPC R&D
  - 3 faculty+ 2 students
    - Yajun Mao – Previous Riken-μID person - Beijing
    - Yan Lin Ye – Head of CMS trigger group at Beijing (dean of school of physics)
- Tentative Schedule for involvement
  - Middle of Sep: Finish the design and the detailed drawings of the prototype
  - End of Oct: Finish the assembling of the prototypes
  - End of Nov: Preliminary study with the prototypes
    - (efficiency, time resolution, dark current, plateau, etc)
  - End of Dec: More detailed study with the prototype & Rough estimation of the cost if mass production in Beijing

RKS/NS visit to LANL coordination between FSi and μ trig/NCC

- J/ψ resolution
- μ pattern recognition
- μ-trig with detached vertex
- charged particle veto for NCC
- Jet reconstruction
- …

- General comment – a good meeting – lanl folks (Melynda/Pat/Dave/Mike…) willing to get involved with simulations etc

Highlights of the lanl meeting: NCC

- effect on J/psi resolution
  - Vasily from 150 to 200 MeV
  - They suggest that that Vasily come out to visit LANL with Pat, Melynda and others - both to get the code running in the right configuration and teach them about the NCC simulations.
  - front tracking will fix the problem. Resolution should be better than it is now.
  - Problems
    - matching between tracks in front of the NCC and the Mu-tracker. Dave has some software for this.
      - need additional points in NCC?
    - Timing of FSi and NCC installation
    - Can γ/π + GEM help? [Axel?]

Highlights of the lanl meeting: μ-Trig

- RF needed at RHIC 2 pp is ~ 10^5 !!
- Pattern recognition
  - want 2D space points at either/both the mu-tracker 1 and 3
  - communication between Wei and Melynda needed. Wei to visit LANL for a few days?
- μ-Trig Scheme
  - Mu-tracker electronics upgrade scheme
    - NS wants sagita at LVL-1
      - momentum from a 3 point sagita measured after the magnet
      - momentum cut is independent of the multiple scattering in the magnet/NCC
        - more robust
      - Possible to have online di-muon mass (e.g. for high, very low mass pairs)
    - Pat suggested signal be split right at the chamber using transformers.
      - rest of the mu-tracker electronics – unchanged – raise HV a little
      - more cables
  - Possible (Cadillac) solution
    - RPC/PC at stations 1 and 3. Read out mu-tracker 2