RHICf status

Takashi Sako

(ISEE/KMI Nagoya University)

RHICf Japan meeting

Tuesday, 4 April

13:00 → 13:30 **Summary of the status**
Speaker: Takashi Sako (Nagoya University (JP))
RHICf_mtg_sako_s... RHICf_mtg_sako_s...

13:30 → 14:15 **DAQ: status and TODO**
Speakers: Hiroaki Menjo (Nagoya University (JP)) , Mr. Kenta Sato
20170404_DAQstat...

14:15 → 14:45 **Slow control, event display, polarization analysis: status and TODO**
Speakers: Mr. Junsang Park , Mr. Minho Kim
rhicfnagoya_20170...

14:45 → 15:05 break

15:05 → 15:25 **Correlation with STAR: status and TODO**
Speaker: Mana Ueno (Nagoya University (JP))
20170405_rhicf_co...

15:25 → 15:45 **Front Counter: status and TODO**
Speaker: Takashi Sako (Nagoya University (JP))
RHICf_mtg_sako_F... RHICf_mtg_sako_F...

15:45 → 16:35 **Discussions for preparation and operation**

18:20 → 20:20 Dinner

Wednesday, 5 April

09:00 → 09:40 **Introduction to the spin physics**
Speaker: Dr. itaru nakagawa (RIKEN)
CollabMeeting_RHI... CollabMeeting_RHI...

09:40 → 10:10 **MC simulation: status and TODO**
Speaker: Mr. Takuya Suzuki
rhicf-sim_suzuki.pdf

10:10 → 10:50 **MC study on SSA and correlation**
Speaker: Mr. Minho Kim
rhicfnagoya_20170...

10:50 → 11:10 break

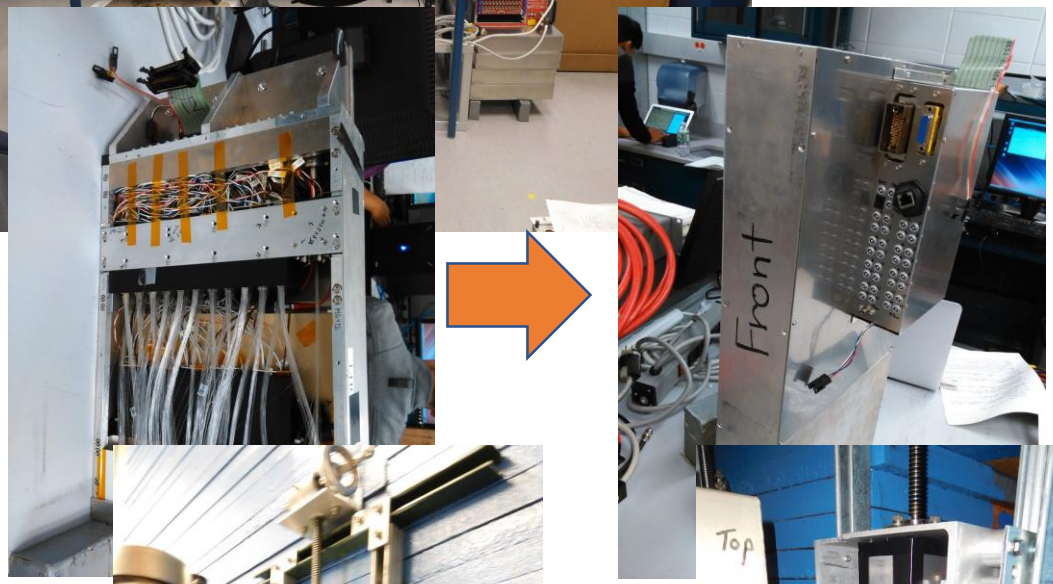
11:10 → 11:40 **Neutron analyses in LHCf Arm2**
Speaker: Eugenio Berti (Universita e INFN, Firenze (IT))
Neutron_RHICf_Me...

11:40 → 12:00 **Neutron analyses in LHCf Arm1**
Speakers: Mana Ueno (Nagoya University (JP)) , Qidong Zhou (Nagoya University (JP))
20170405_rhicf_co...

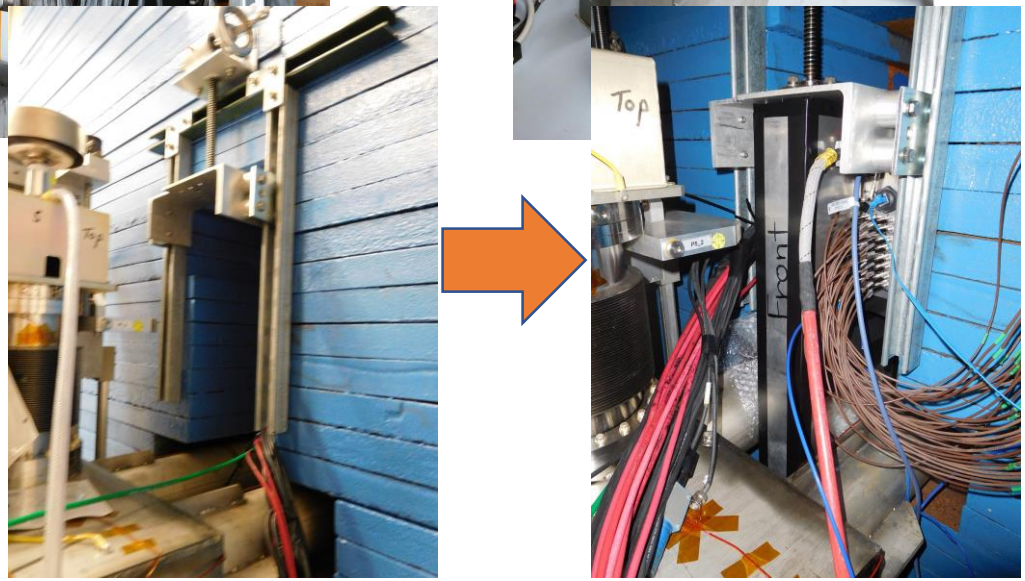
13:20 → 14:10 **Discussions on MC and analyses**

14:10 → 17:10 **Students' work and Staff discussions**

- LHCf detector and electronics arrived from CERN in June
- STAR group offered a lab space to set them up
- Makino woke up the detector

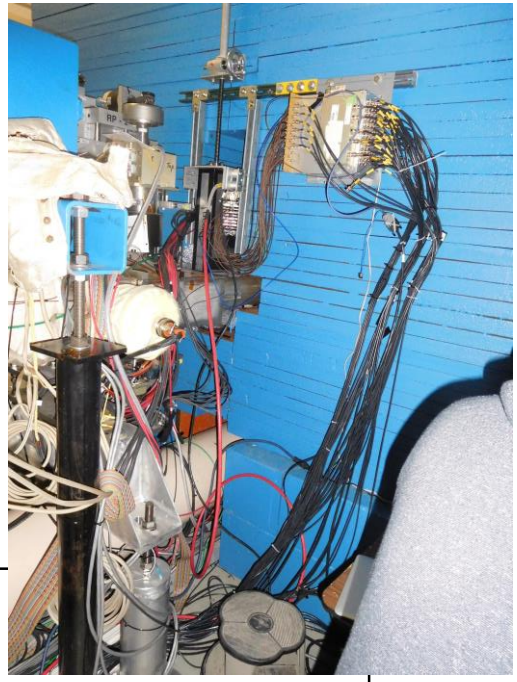


- Detector was modified to fit with the space at the STAR site



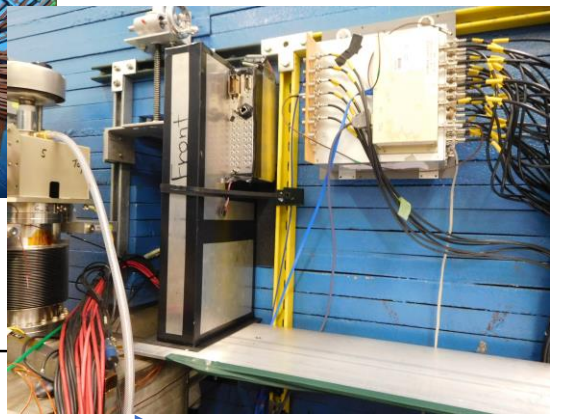
- Installation structure was constructed by STAR in August
- Detector was installed in November

Status @ RHIC



For physics

Current position

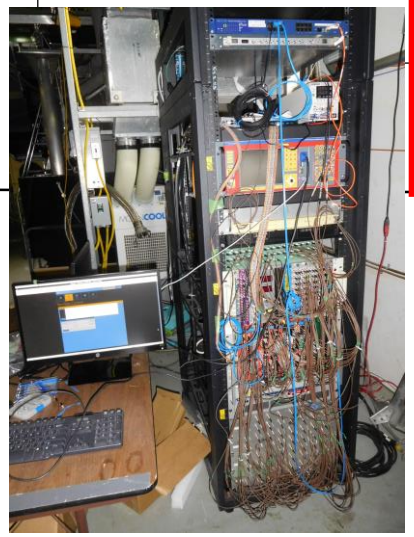


18m

STAR detector

DAQ electronics

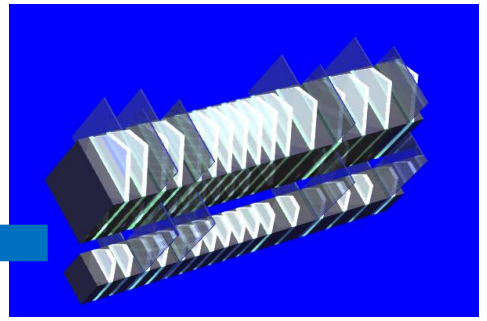
long cables



Rack room (server PCs)

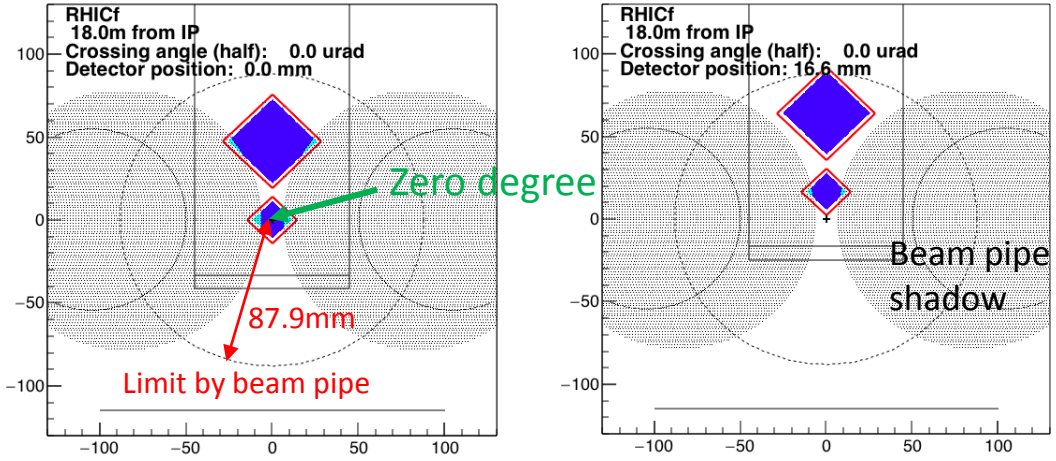
Control room

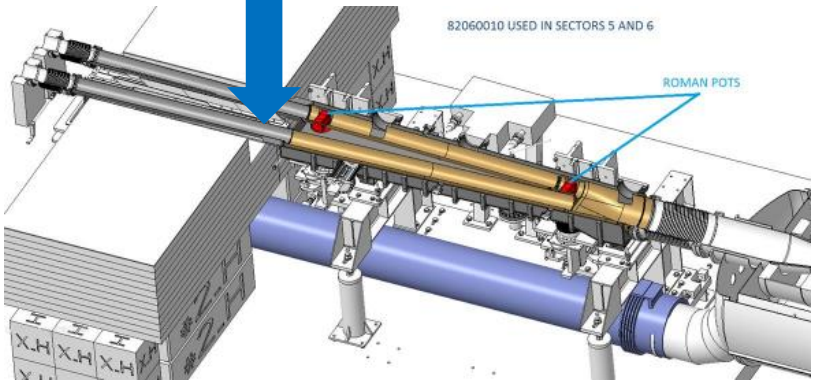
Compact double calorimeters
(20mmx20mm and 40mmx40mm)



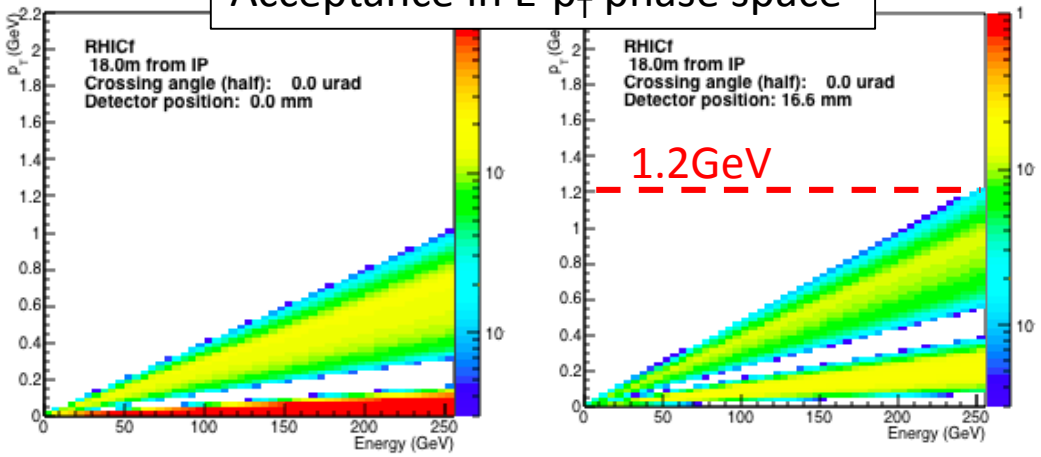
RHICf detector acceptance

Cross section view from IP





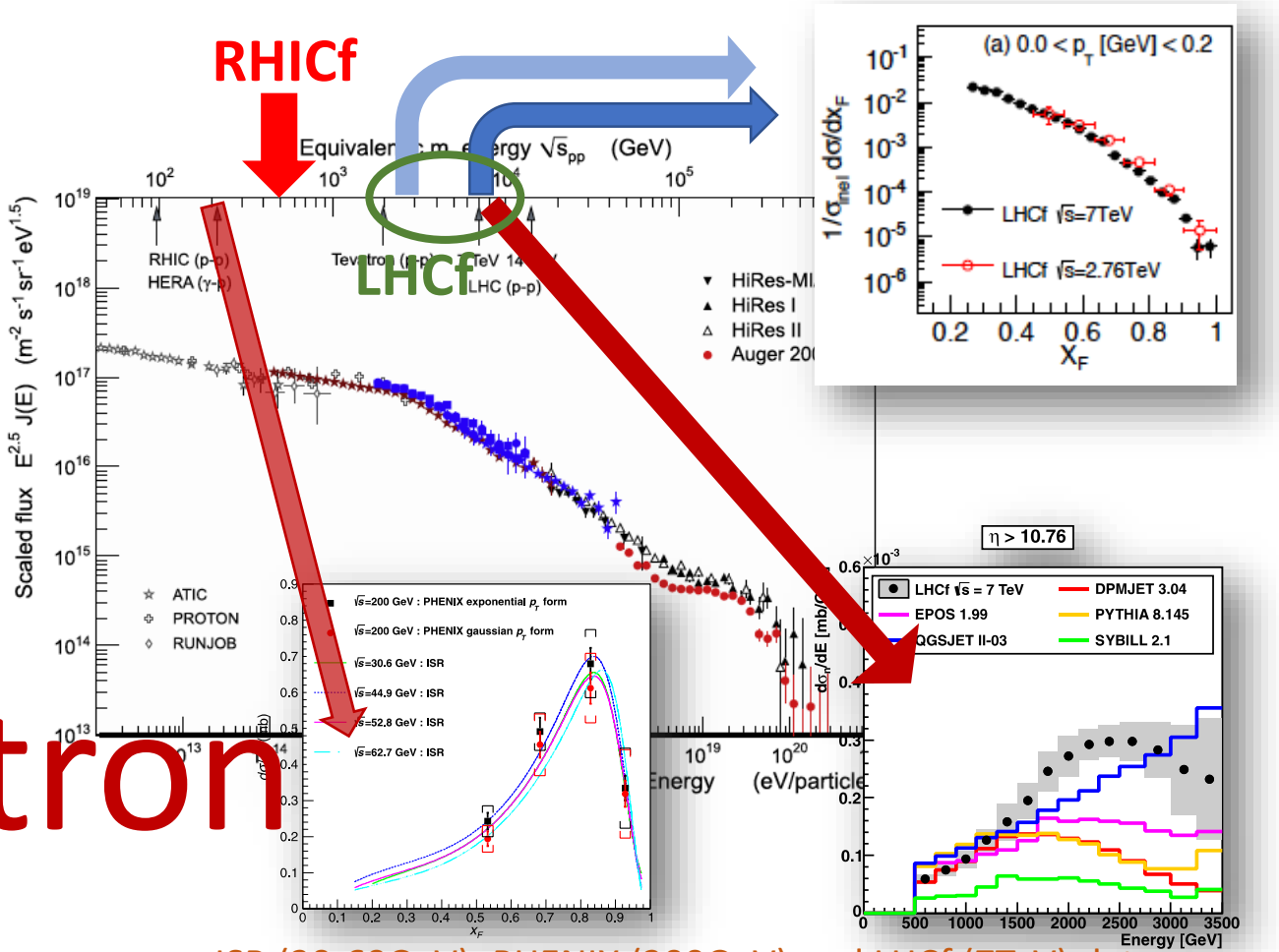
Acceptance in E-p_T phase space



- ✓ Widest and gapless p_T coverage is realized by moving the vertical detector position.
- ✓ Beam pipes obscure photons but not neutrons.

√s scaling, or breaking?

LHCf 2.76TeV and 7TeV data shows scaling of forward π^0

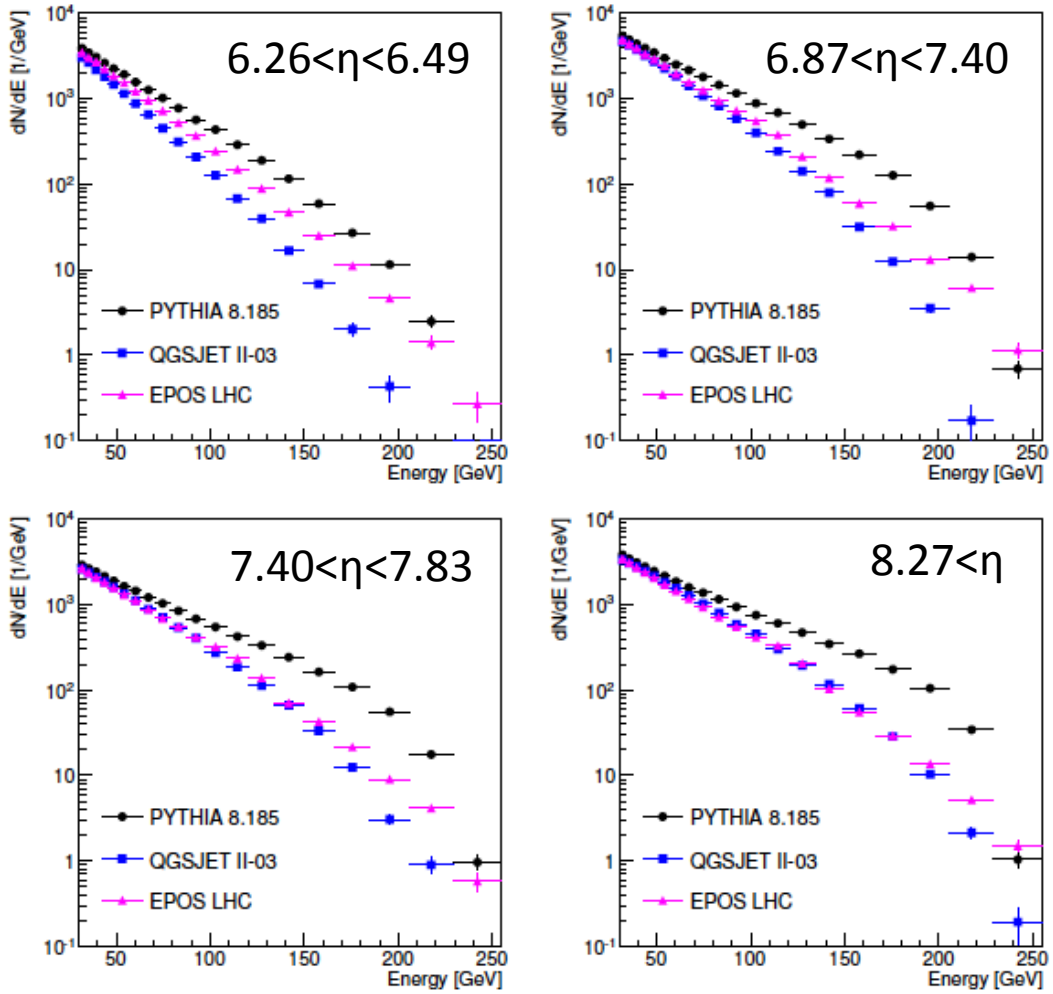


π^0

neutron

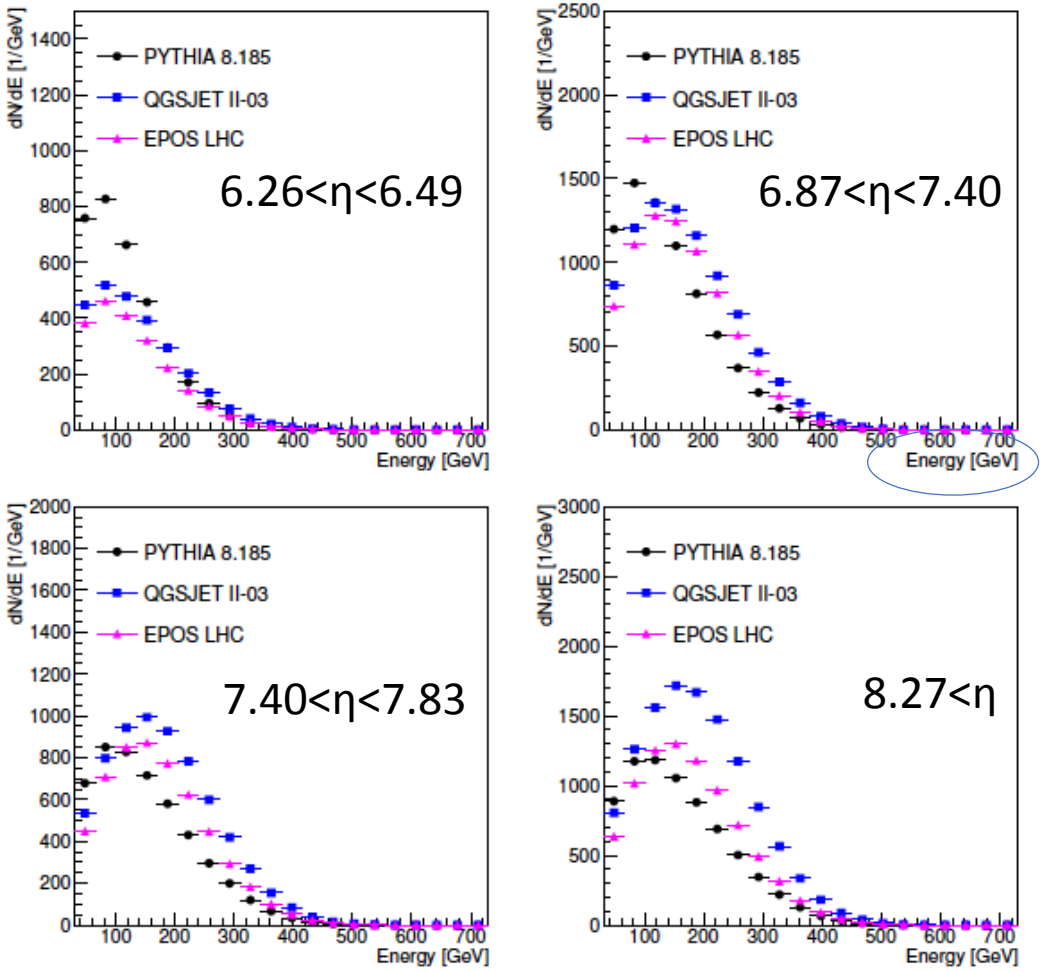
ISR (30-60GeV), PHENIX (200GeV) and LHCf (7TeV) data indicate scaling ***braking*** of forward neutrons

Expected Results (single photons)



- Photon spectra at 4 rapidity samples
- 12 hours statistics (12 nb^{-1} effective luminosity; 360nb^{-1} delivered)
- Statistical error is almost negligible except at the highest energy bins

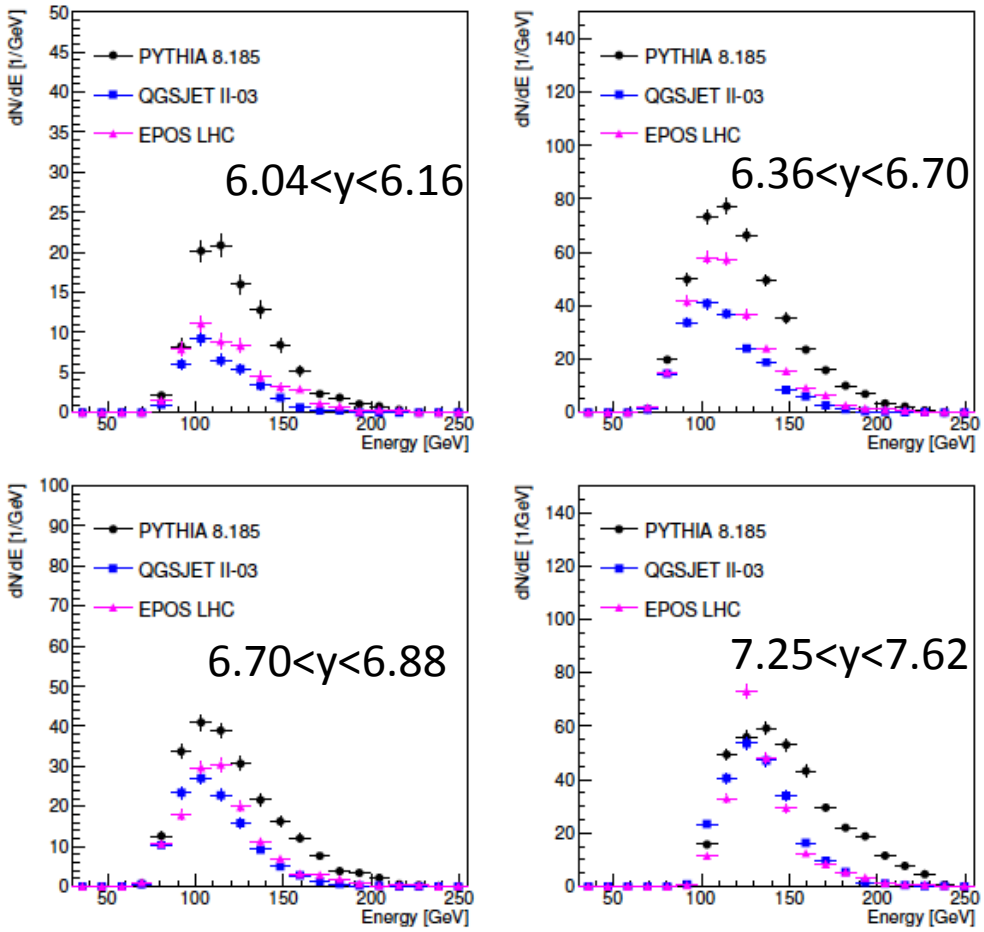
Expected Results (single neutrons)



measured energy (resolution folded)

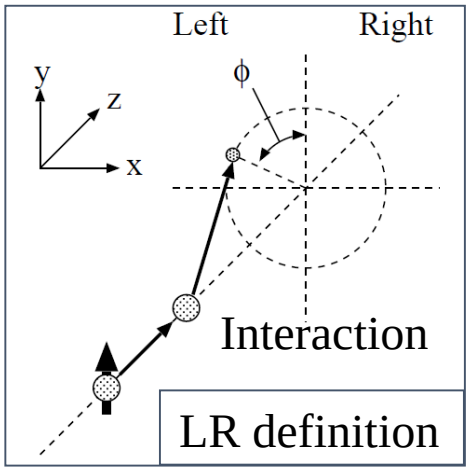
- Neutron spectra at 4 rapidity samples
- 12 hours statistics (12 nb^{-1} effective luminosity; 360nb^{-1} delivered)
- RHICf resolution taken into account, but ZDC joint analysis not considered
- Statistical error is almost negligible

Expected Results (π^0)



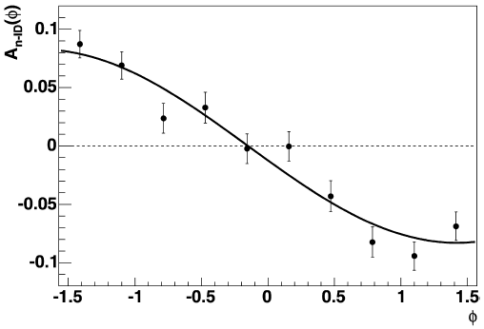
- π^0 spectra at 4 rapidity samples
- <60GeV not detectable due to large opening angle of γγ
- 24 min statistics (12 nb^{-1} effective luminosity; 12 nb^{-1} delivered)
- Statistical error will be negligible with a reasonable run time

SSA of forward neutron production

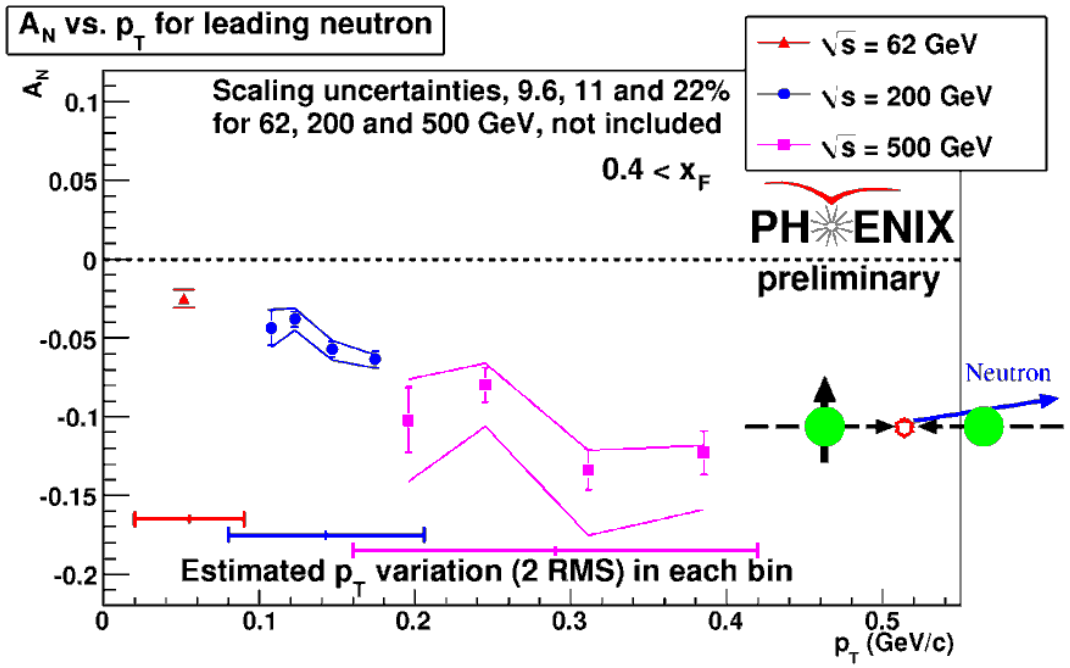


$$A_N \equiv \frac{d\sigma^{\uparrow} - d\sigma^{\downarrow}}{d\sigma^{\uparrow} + d\sigma^{\downarrow}} = \frac{\sigma_L^{\uparrow} - \sigma_R^{\uparrow}}{\sigma_L^{\uparrow} + \sigma_R^{\uparrow}}$$

$$A_N = \frac{1}{P} \cdot \varepsilon_N$$



Y. Fukao, et al.,
Phys. Lett. B 650 (2007) 325.



PHENIX, Journal of Phys. Conf. Ser., 295 (2011) 012097.

- Asymmetric production of forward neutron in polarized p-p collisions, A_N
- p_T dependence of A_N reported by PHENIX
  ,or √s dependence?
- For PHENIX low p_T was limited by the position resolution of ZDC, but RHICf can improve it.

Theoretical explanation

- Pion-a_1 interference: results
  - The data agree well with independence of energy
- The asymmetry has a sensitivity to presence of different mechanisms, e.g. Reggeon exchanges with spin-non-flip amplitude, even if they are small amplitudes

$$A_N \approx \frac{2\,\mathrm{Im}\left(fg^*\right)}{|f|^2 + |g|^2}$$

f : spin non-flip amplitude
g : spin flip amplitude

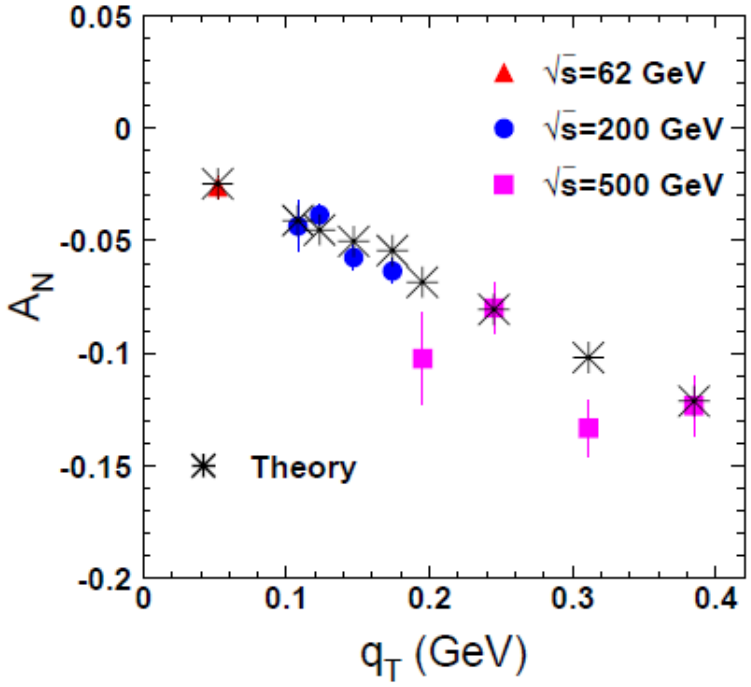
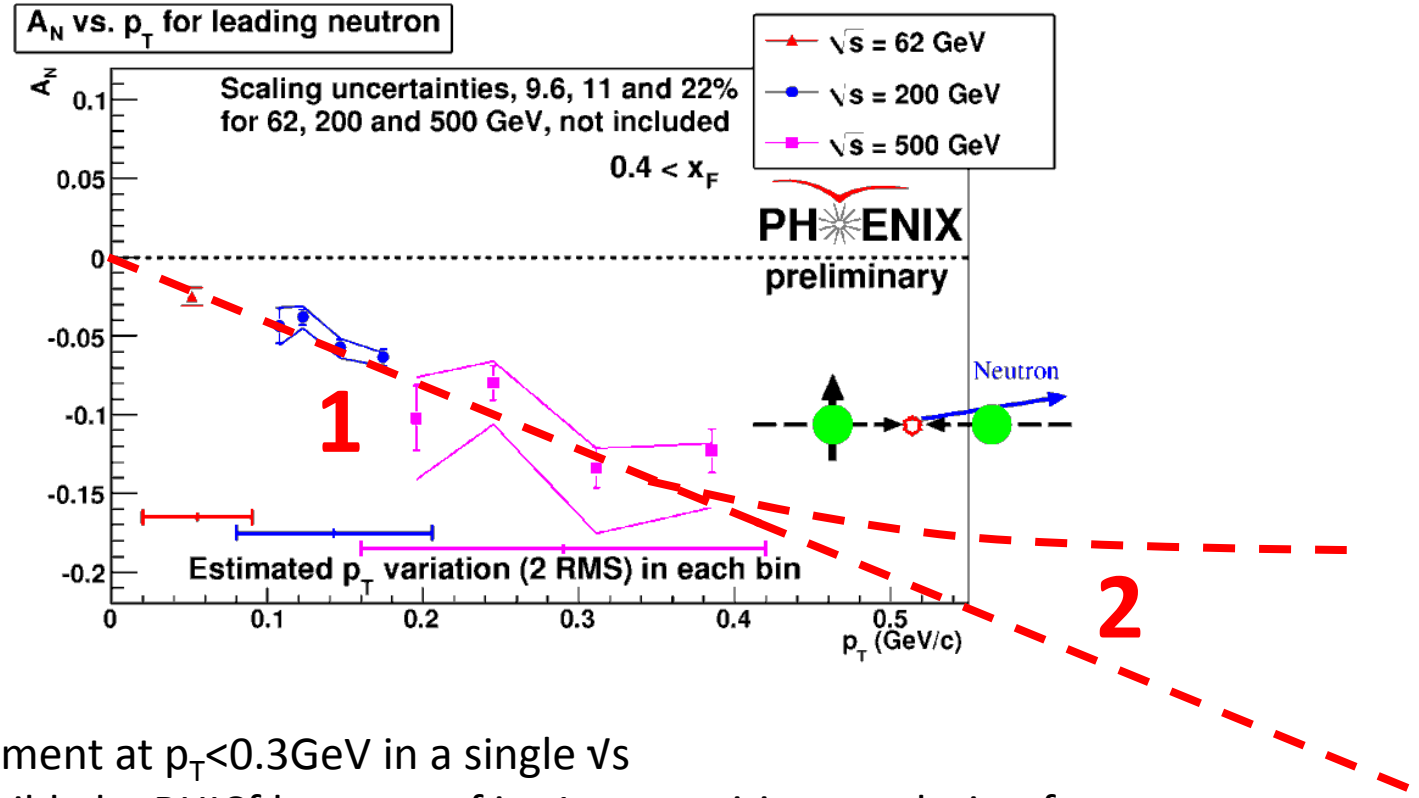


FIG. 1: (Color online) Single transverse spin asymmetry A_N in the reaction $pp \to nX$, measured at $\sqrt{s} = 62,\ 200,\ 500$ GeV [1] (preliminary data). The asterisks show the result of our calculation, Eq. (38), which was done point by point, since each experimental point has a specific value of z (see Table I).

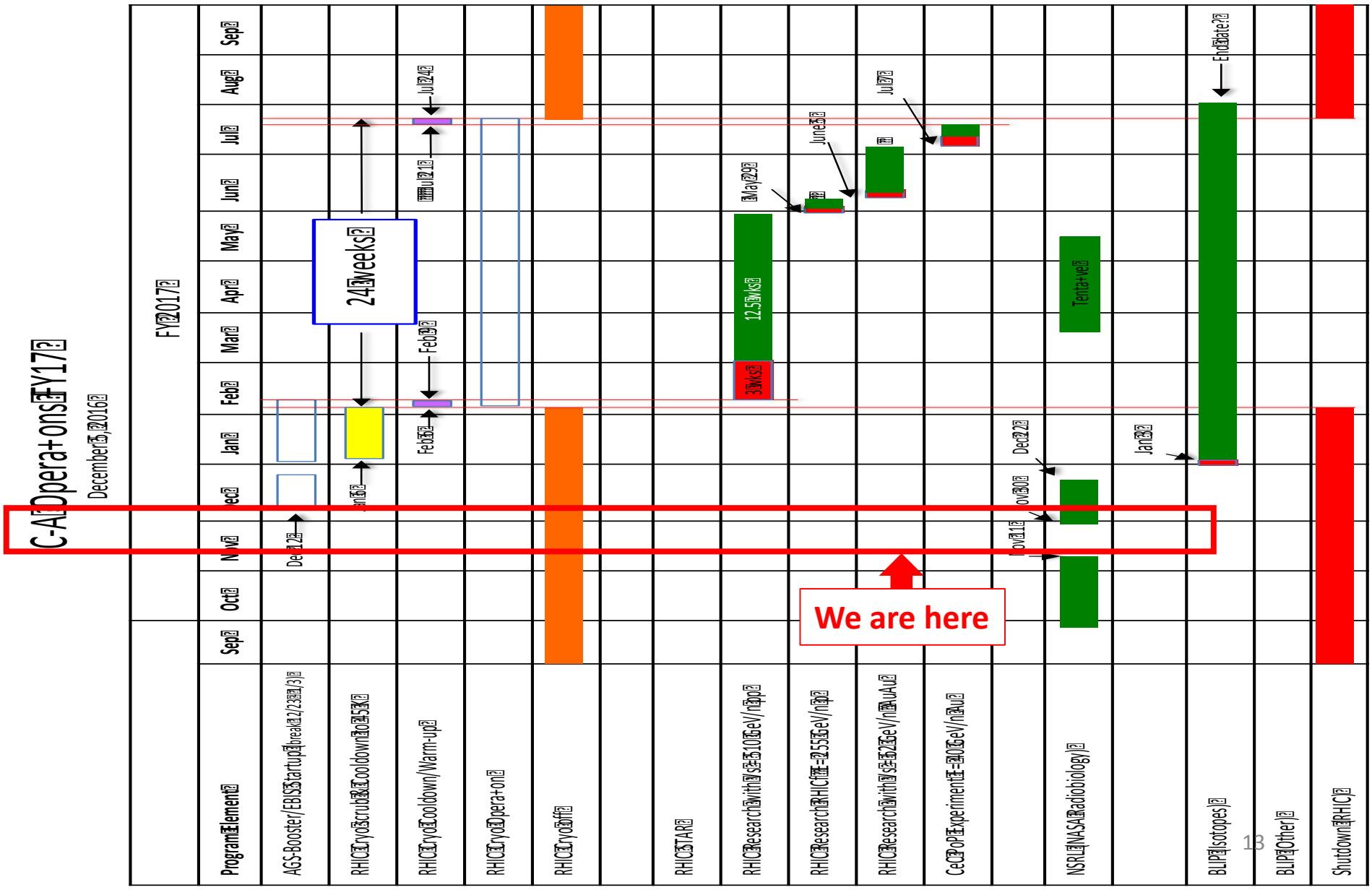
Kopeliovich, Potashnikova, Schmidt, Soffer: Phys. Rev. D 84 (2011) 114012.

SSA of forward neutron production



1. Measurement at p_T<0.3GeV in a single √s
   - possible by RHICf because of its 1mm position resolution for neutrons
2. Measurement at p_T>0.3GeV to know A_N evolution
   - possible by RHICf because of its wide p_T coverage required for cross section measurements

RHIC schedule



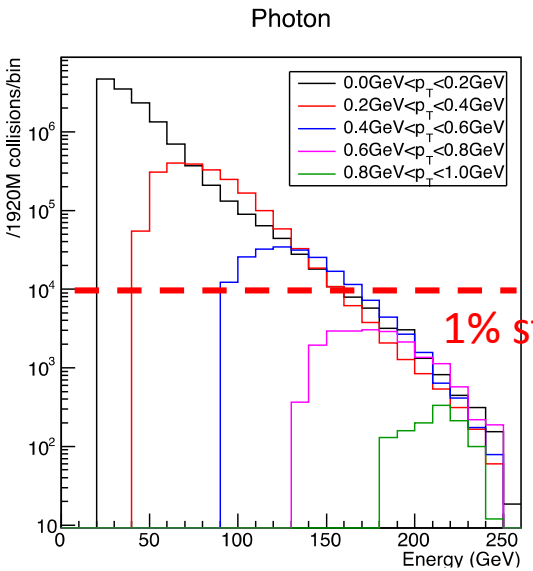
We are here

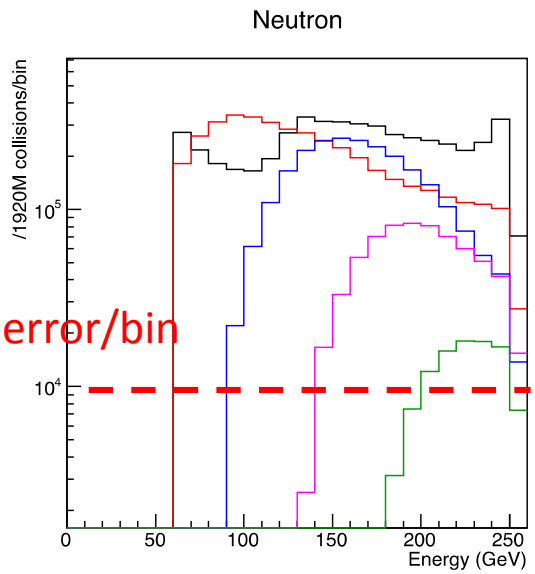
Agreement of “RHICf week”

- From 29 May to 5 June
- 2 days for beam setup
  - 1 day (1-3 shifts) for β^*=10m setup
  - 1 day for radial (horizontal) pol setup
- 2 days for physics data taking
  - Position scan (2-3 positions to be optimized)
  - Low pile-up run
  - High threshold run…
- Contingency
  - Installation/uninstallation included?

RHIC Beam Use Request 2016

Expected statistics in 12 hours

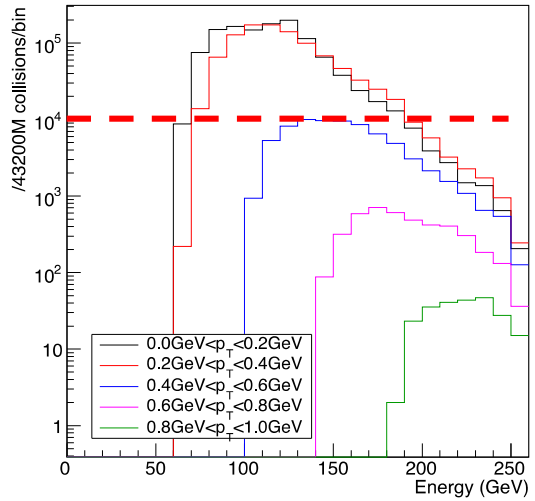




1% stat error/bin

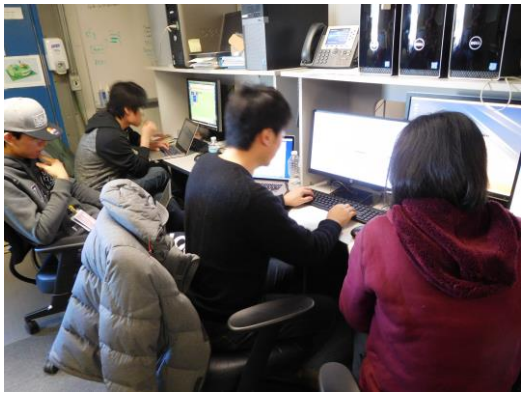
Neutron SSA

$p_T(GeV)$	N $(\times 10^3)$	δA
0.0–0.1	2,310	0.0013
0.1–0.2	2,570	0.0012
0.2–0.3	1,710	0.0015
0.3–0.4	2,190	0.0014
0.4–0.5	1,210	0.0018
0.5–0.6	1,130	0.0019
0.6–0.7	402	0.0032
0.7–0.8	260	0.0039
0.8–1.2	104	0.0062

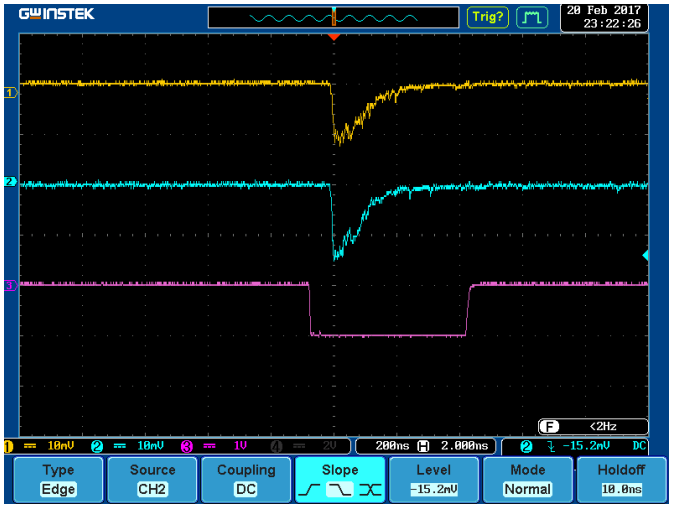


- ✓ DAQ speed, Type-I enhance trigger taken into account, but using the true information
- ✓ Special trigger for high energy EM shower is under preparation
- ✓ Luminosity error will be about 5%
- ✓ STAR will record events according to the RHICf trigger
  => Fruitful possibilities in joint analyses with central detectors, ZDC, roman pots,…

Recent status

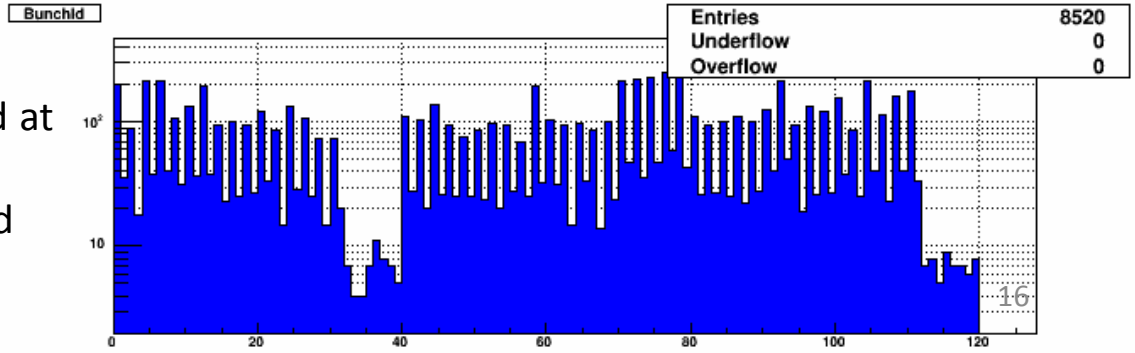


- RHIC starts first RUN2017 collision on 20-Feb
- RHICf observed shower signal (PMT coincidence) and tuned timing
- Common operation (RHICf triggers STAR) tested and common data successfully recorded at STAR (analysis of physics correlation on going)

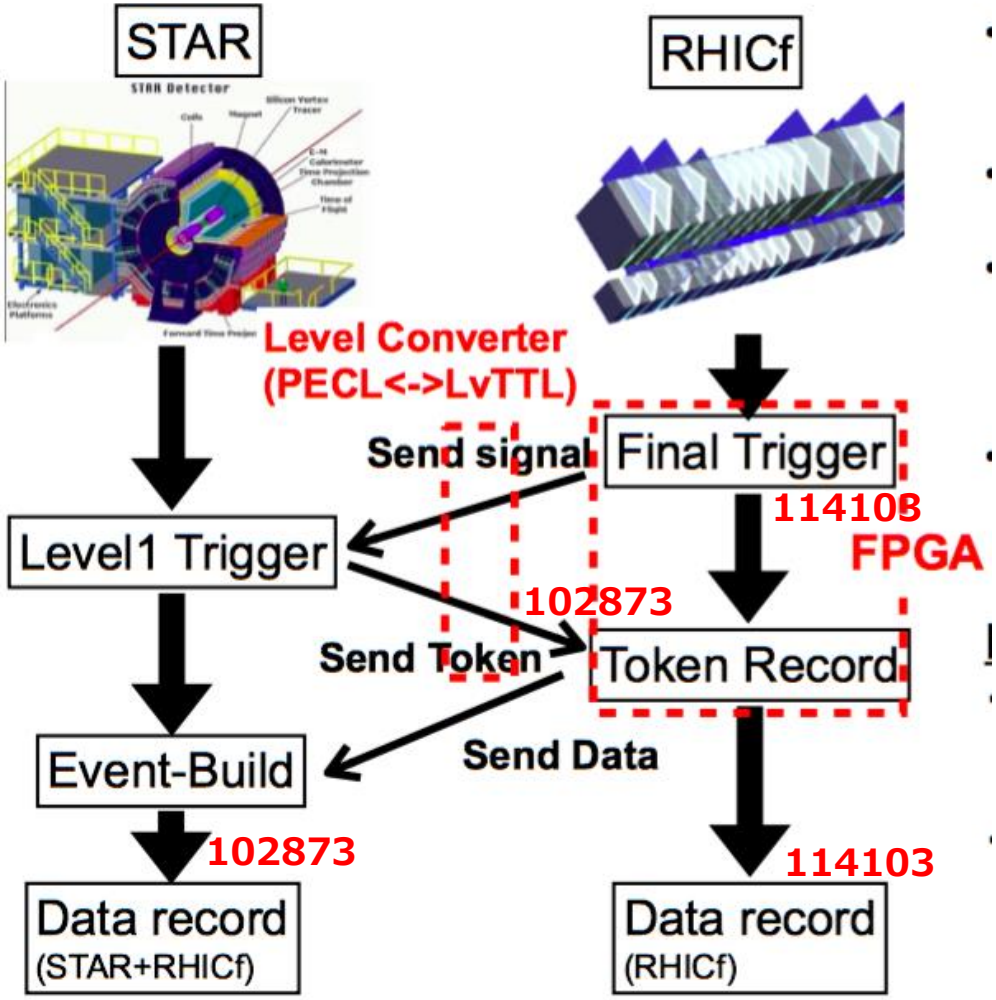


RHICf calorimeter PMT signals and ADC Gate after timing tuned

Bunch ID of RHICf trigger recorded at "STAR"
Two abort gaps correctly identified



STAR-RHICf common DAQ

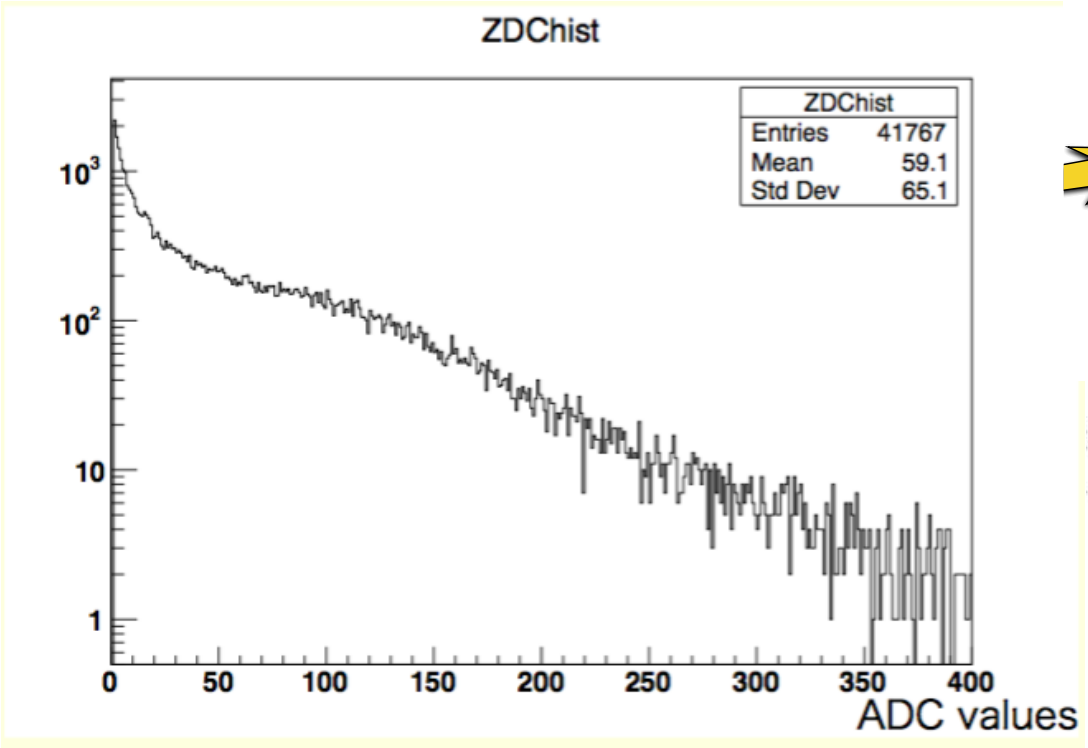


- In a common DAQ test

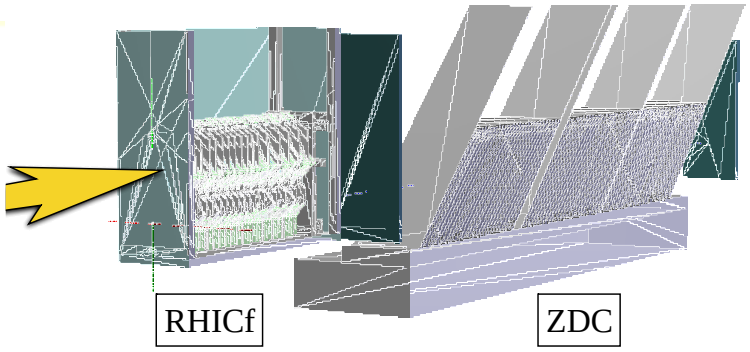
- LHCf sent 114,103 triggers to STAR
- LHCf recorded 114,103 events on own disk (of course!)
- STAR returned 102,873 answers to the RHICf trigger; 90% is not bad but why not 100% is issue to discuss.
- STAR recorded 103,873 events on their disk with STAR and RHICf data

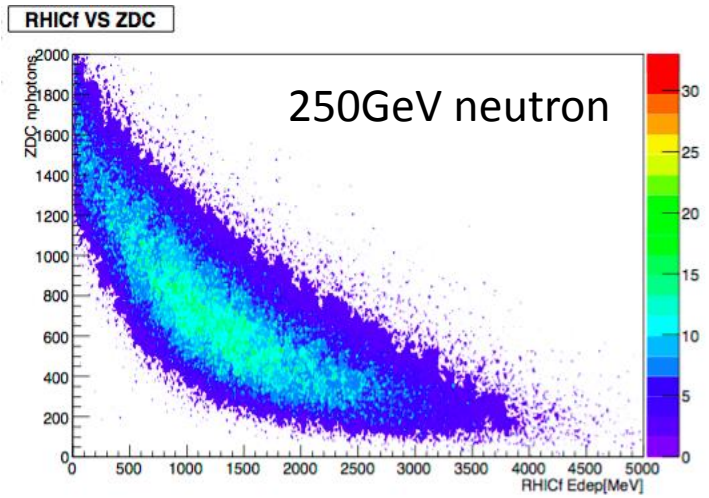
Tuned and analyzed by Zhou and Sato-ken

ZDC and RHICf



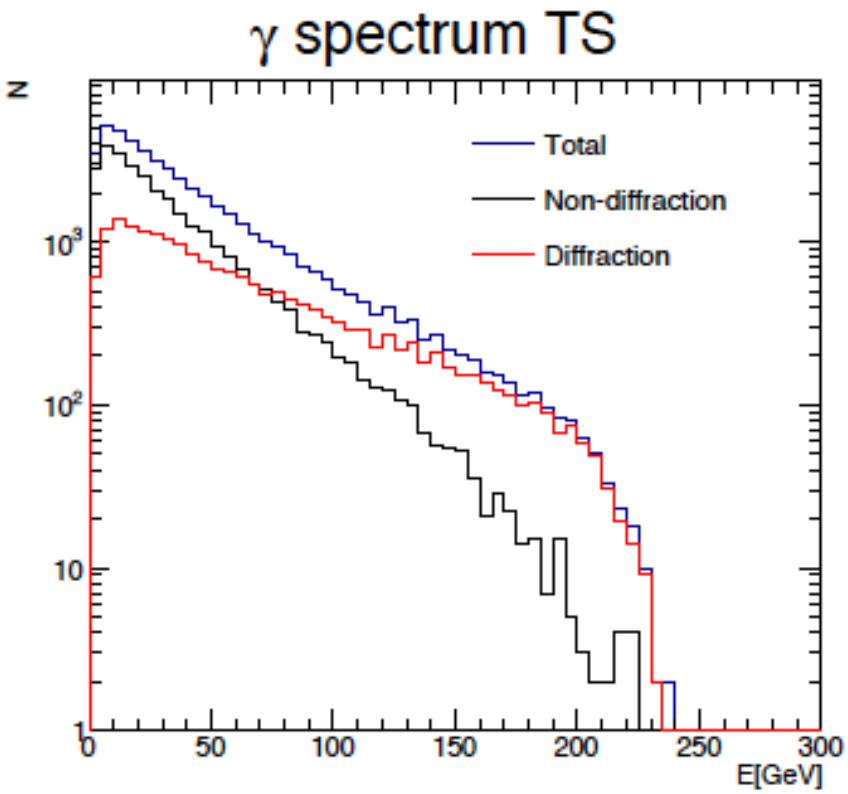
ZDC data triggered by RHICf
(analyzed by Ueno)

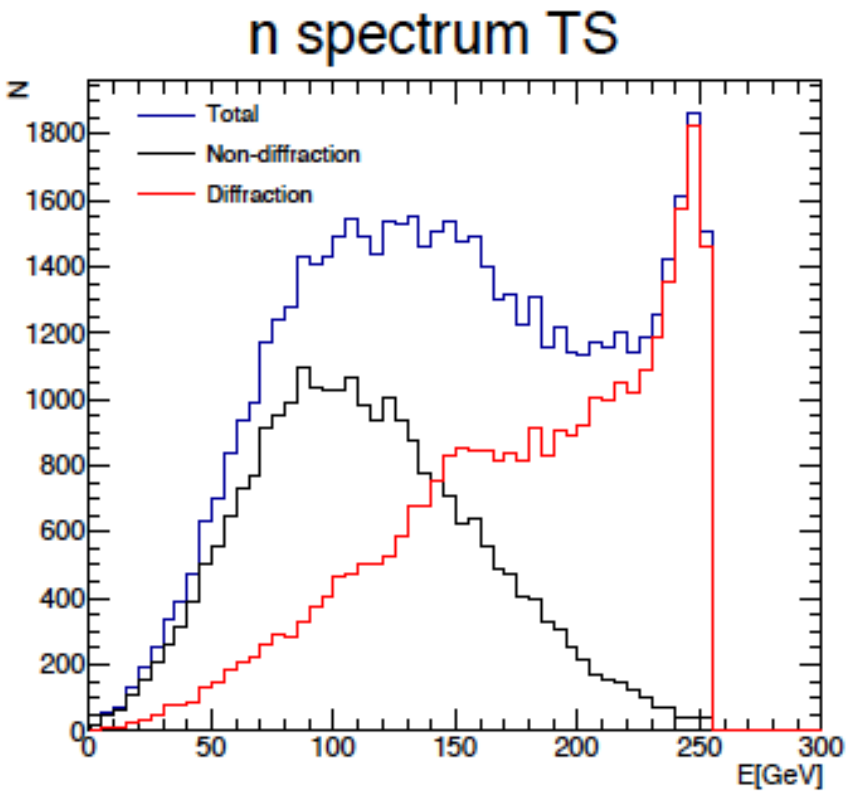




RHICf-ZDC correlation for hadronic shower
(calculated by Suzuki)

diffractive vs. non diffractive at η>8.2 with √s=510GeV p+p collisions





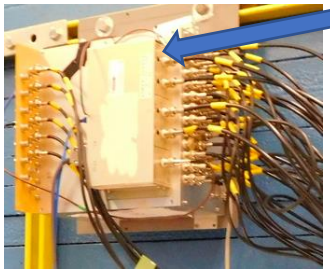
PYTHIA 8 simulation

BLUE: inclusive spectra expected by RHICf only

RED: diffractive only ("RHICf + no central track in STAR" will be similar => TBC)

BLACK: non diffractive ("RHICf + >=1 central track in STAR" => TBC)

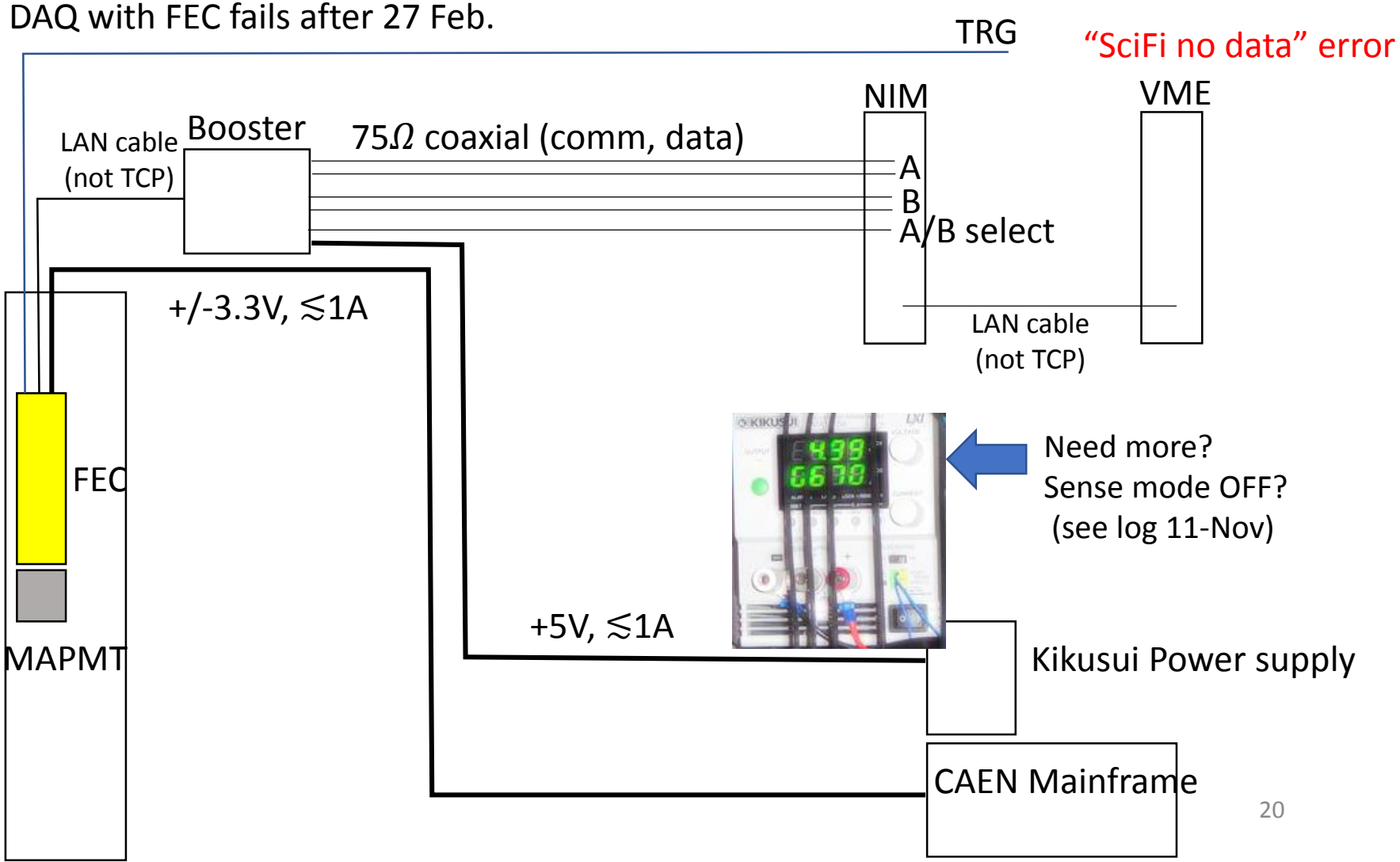
Are we ready? NO.



Booster on preamp

FEC trouble

- DAQ fine until 23 Feb.
- Clock trouble
- DAQ with FEC fails after 27 Feb.



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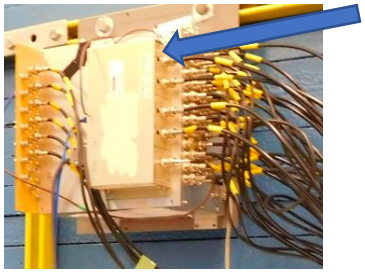

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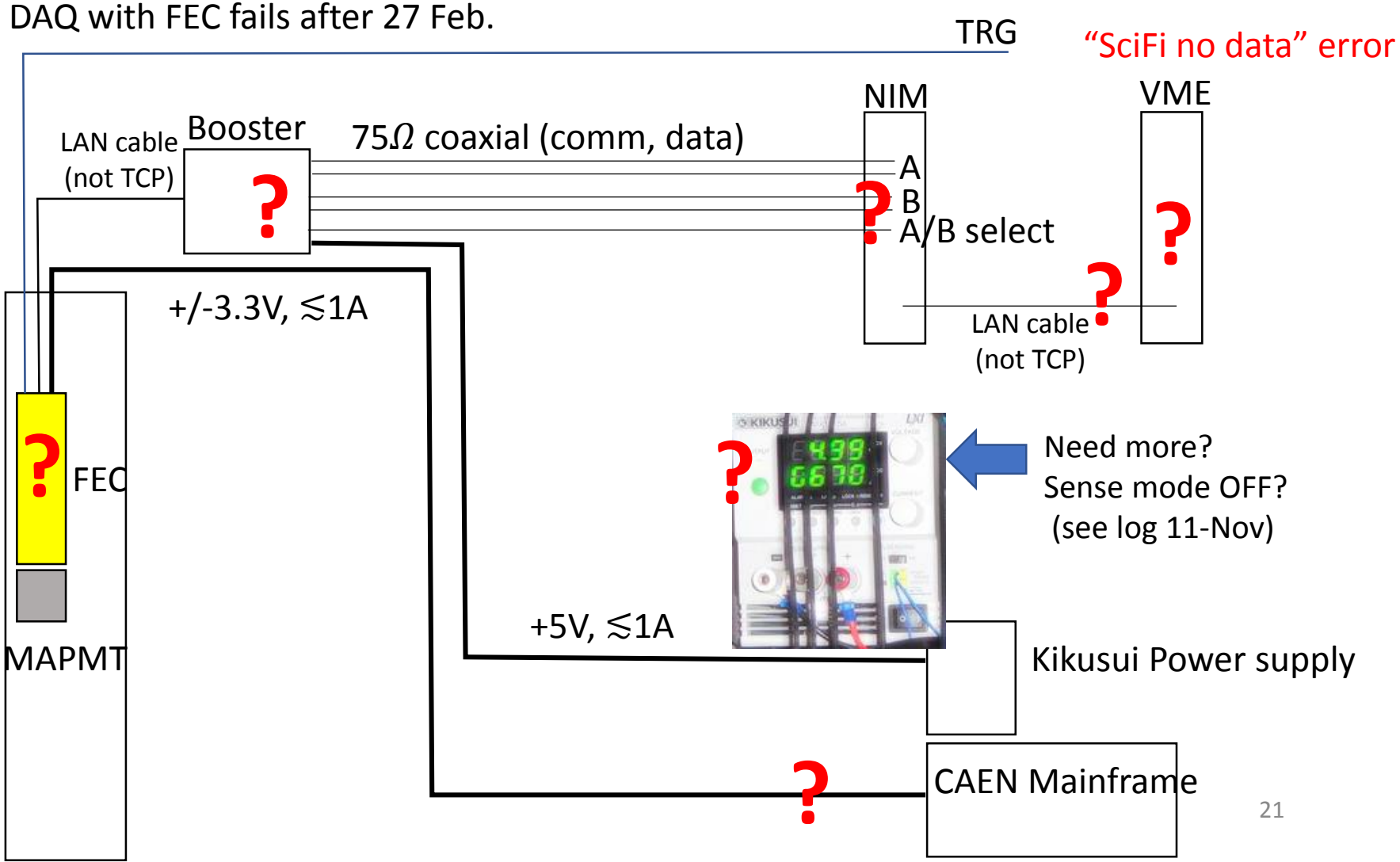

Summary

- RHICf is going to be ready for physics data taking in June (hope FEC problem will be solved soon)
- Members will return to the BNL from the next week and continue appearance until the last operation
- More software works; MC, quick analysis, slow control,…

E-mail this morning

Dear Sako,

I assume you are well aware of the uncertainties of the US budget situation as the US government is running on
a continuing resolution that expires at the end of April. It is based on the last year's spending levels agreed upon by Obama and Congress.
Due to the constraint, there is a high likelihood that the current RHIC running will end at the end of May (15 weeks run) rather than the until Jul 24th (24 weeks run).
In that case, there is a strong possibility that the RHICf run, originally scheduled to run for a week at the end of the current pp 510 GeV run,
will be significantly impacted, likely to be reduced to, say, ~2 days (not determined).
It would be an unfortunate situation, but it seems that we have to prepare a plan/strategy for the scenario.
There are some questions we have to know for planning and optimizing the rest of the run with various situations:

What would be highest priority and minimum requirement to deliver the physics
- Minimum running time / number of events to be collected
- Minimum beam condition:
Large beta-star
-What would be an impact in physics (resolution) running with the current optics (beta* ~1.5m)?
-Trade some running time for a beam setup?
Radial polarization
It seems obvious that transverse polarization is far less than optimal for the current RHICf detector setup.
-Would trade some running time for a radial polarization setup?
-Would a partial radial polarization would be acceptable?

In the worst budget scenario, there is even a possibility that run has to stop at the end of April with the potential "government shutdown'.
Also for that worst situation, I think RHICf should be ready to make a case why the RHICf run should be in the run and what would be the
minimum requirements for the physics.

Best Regards, JH