Run 12 RHIC Machine/Experiments Meeting

24 Apr 2012

Agenda:

- Status reports
- Other business

Run 12 Plan based on 20 weeks cryo operation
23 week schedule based on 4/10/12 Vigdor guidance

- **17 Jan, Begin cool-down to 4.5K**
- **20 Jan, Cool-down to 4.5K in Blue and Yellow Ring complete, begin magnet setup**
- **21-28 Jan, pp injection setup**
- **28 Jan-3 Feb, LLRF, Ramp and store setup, begin 8 hr/night for experiments**
- **3-10 Feb, 1 week ramp-up with 8 hrs/night for experiments**
- **10 Feb, with store # 16397, begin *4 weeks pp physics* with further ramp-up**
- **16 Feb, 24/7 stores begin**
- **12 (Monday) March, end 4.4 weeks √s = 200 GeV pp, begin ½ week setup for √s = 510 GeV pp**
- **16 March, begin 5 week pp physics (machine only) √s = 510 GeV**
- **17/18 March, STAR/PHENIX physics start with longitudal polarization**
- 18 April (Wednesday 1300), end physics begin pp beam development/APEX
- 19 April (Thursday, 0800), end 4.9 week pp physics run at √s = 510 GeV

Uranium-Uranium/Cu-Au/Au-Au plan (subject to change)

STAR request for ~2 day √s = 5 GeV/n AuAu development run is pending

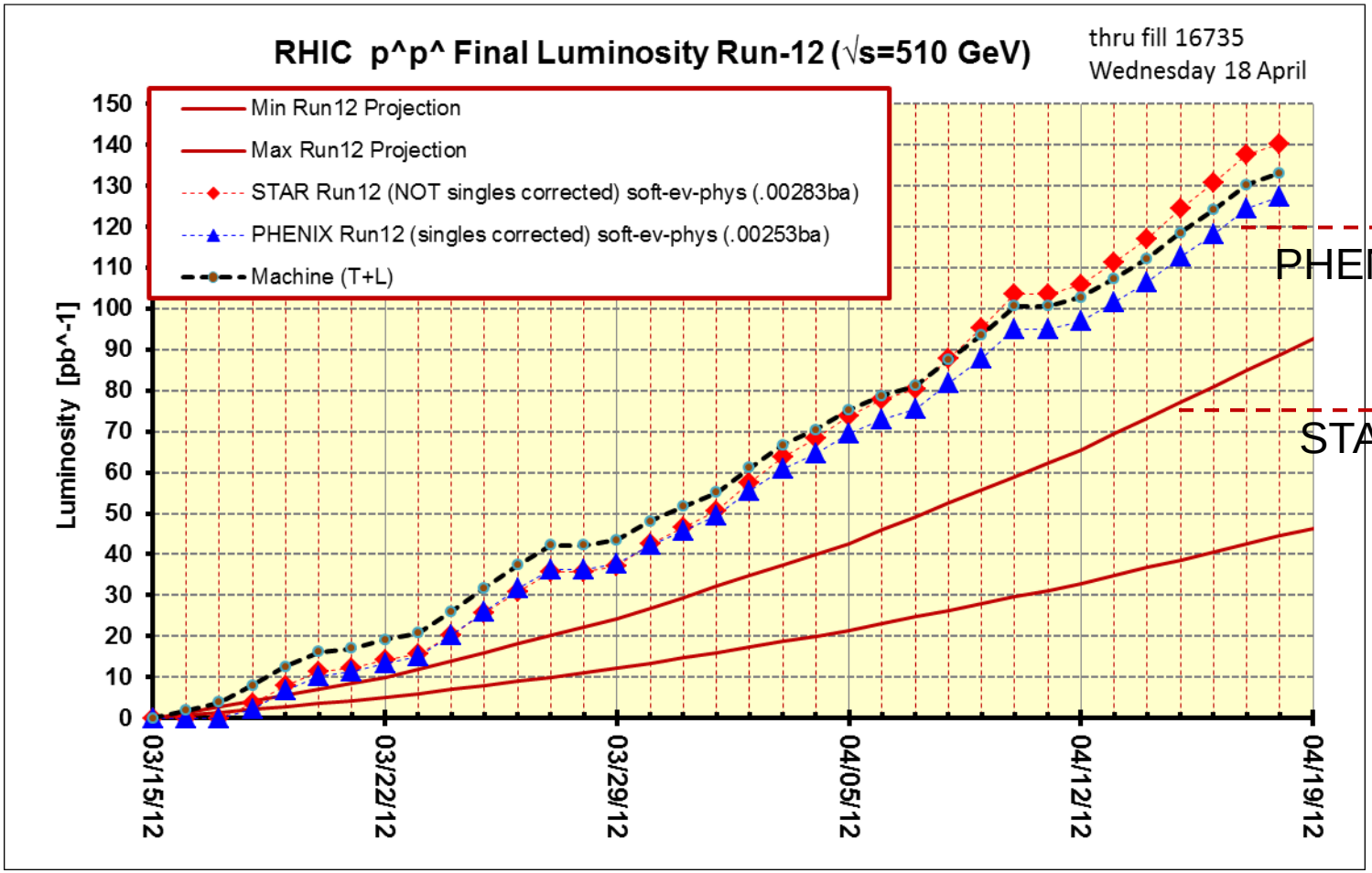
- 19 April (Thursday), begin 1 week setup for UU
- 22 April (evening) first overnight stores for experiments

Today – 24 April

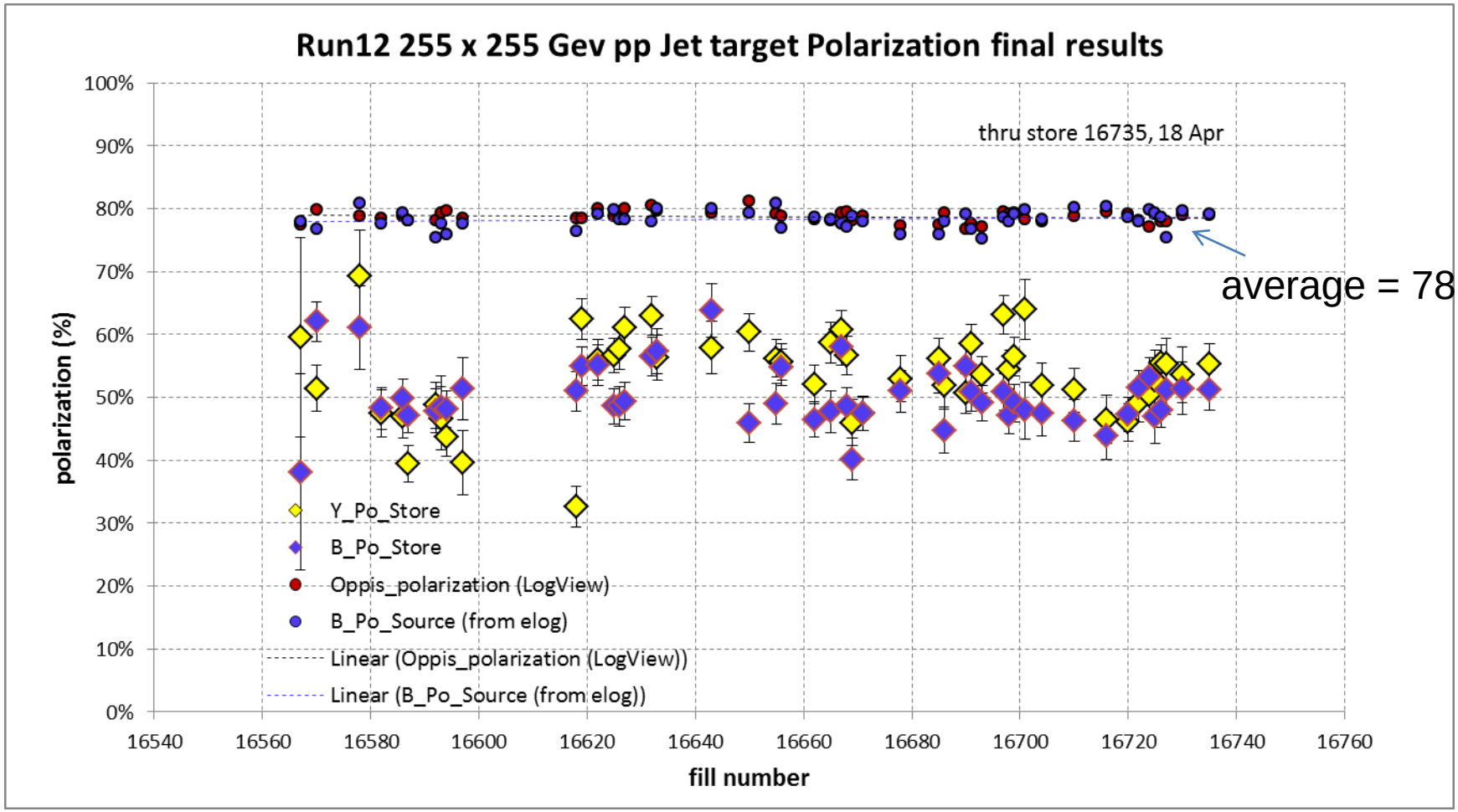
- 26 April (Thursday), begin ***3 week UU physics run***
- 17 May (Thursday) **end 3 week √s = 193 GeV/n UU run, begin setup for √s = 200 GeV/n CuAu**
- 19 May (Saturday – my ambitious estimate) begin CuAu physics run
- 20-25 May: IPAC
- 25 June (Monday), **end 5.3 week √s = 200 GeV/n CuAu run**, begin cryo warm-up
- 28 June, cryo warm-up complete (23.3 cryo-weeks)

Total Physics Weeks = 17.6

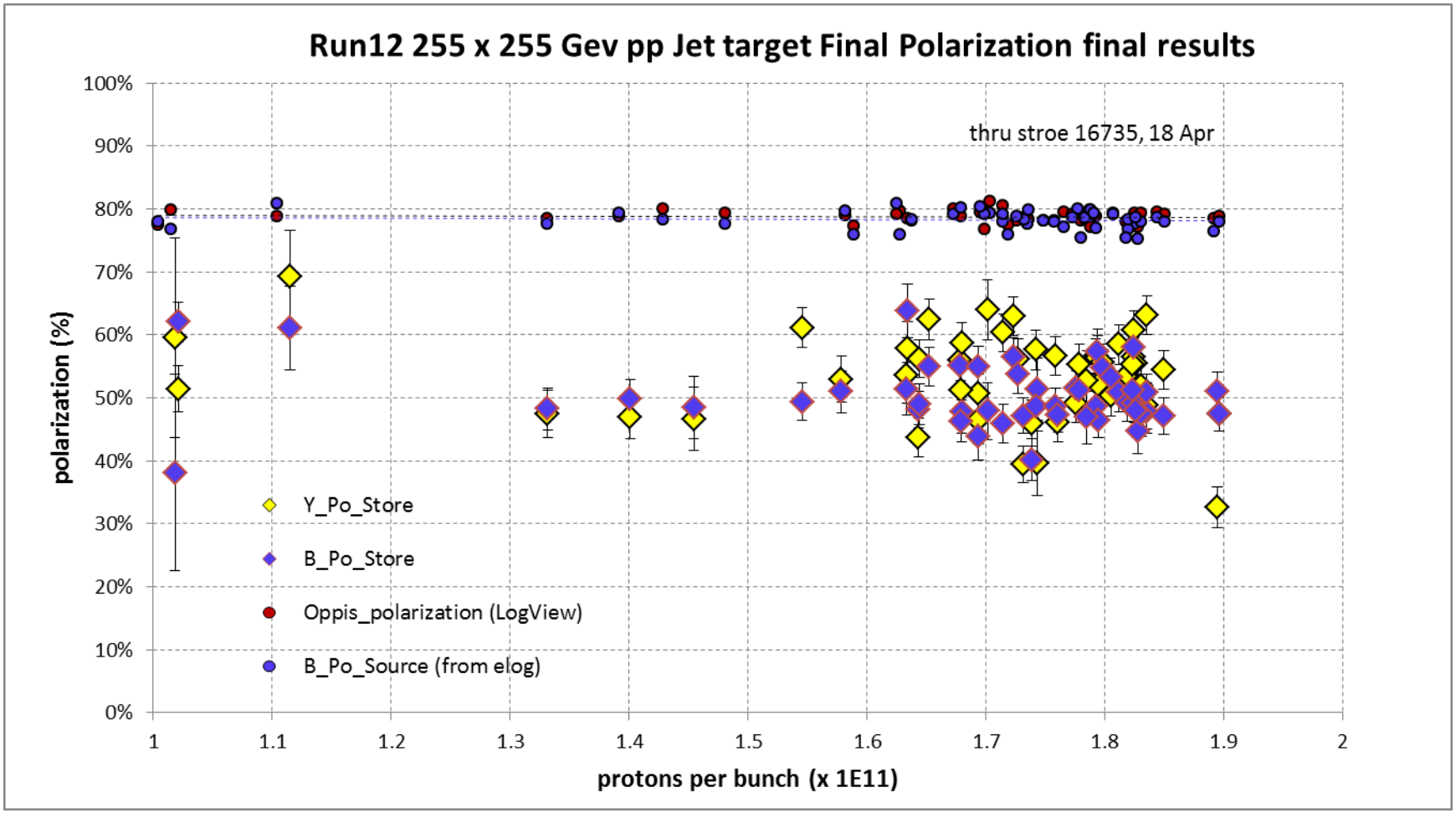
Thru final store, 16735, 18 Apr

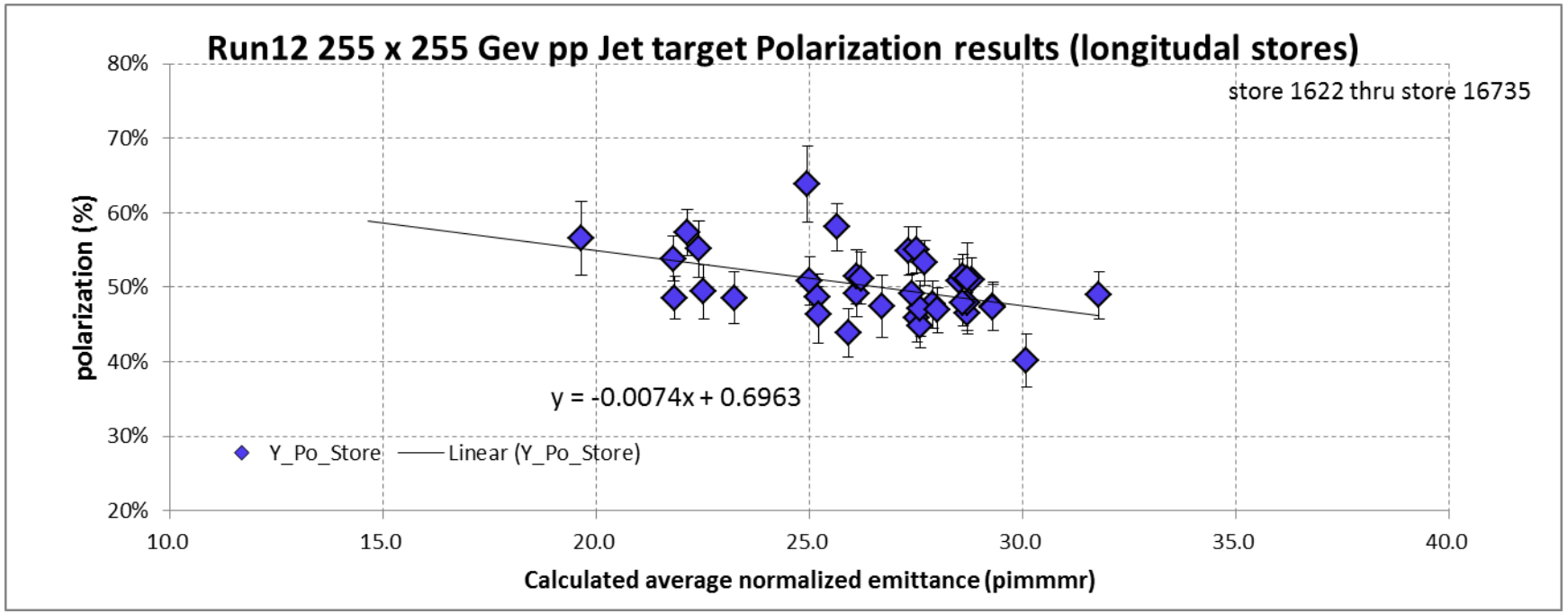


Blue beam at injection jet target result = ? %



Blue weighted average = 50.3% ± 0.5%
Yellow weighted average = 53.4% ± 0.5%


Run12 255 x 255 Gev pp Jet target Final Polarization final results
thru stroe 16735, 18 Apr
polarization (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2
protons per bunch (x 1E11)
Y_Po_Store
B_Po_Store
Oppis_polarization (LogView)
B_Po_Source (from elog)


Run12 255 x 255 Gev pp Jet target Polarization results (longitudal stores)
store 1622 thru store 16735
polarization (%)
80%
70%
60%
50%
40%
30%
20%
y = -0.0074x + 0.6963
Y_Po_Store
Linear (Y_Po_Store)
10.0
15.0
20.0
25.0
30.0
35.0
40.0
Calculated average normalized emittance (pimmmr)

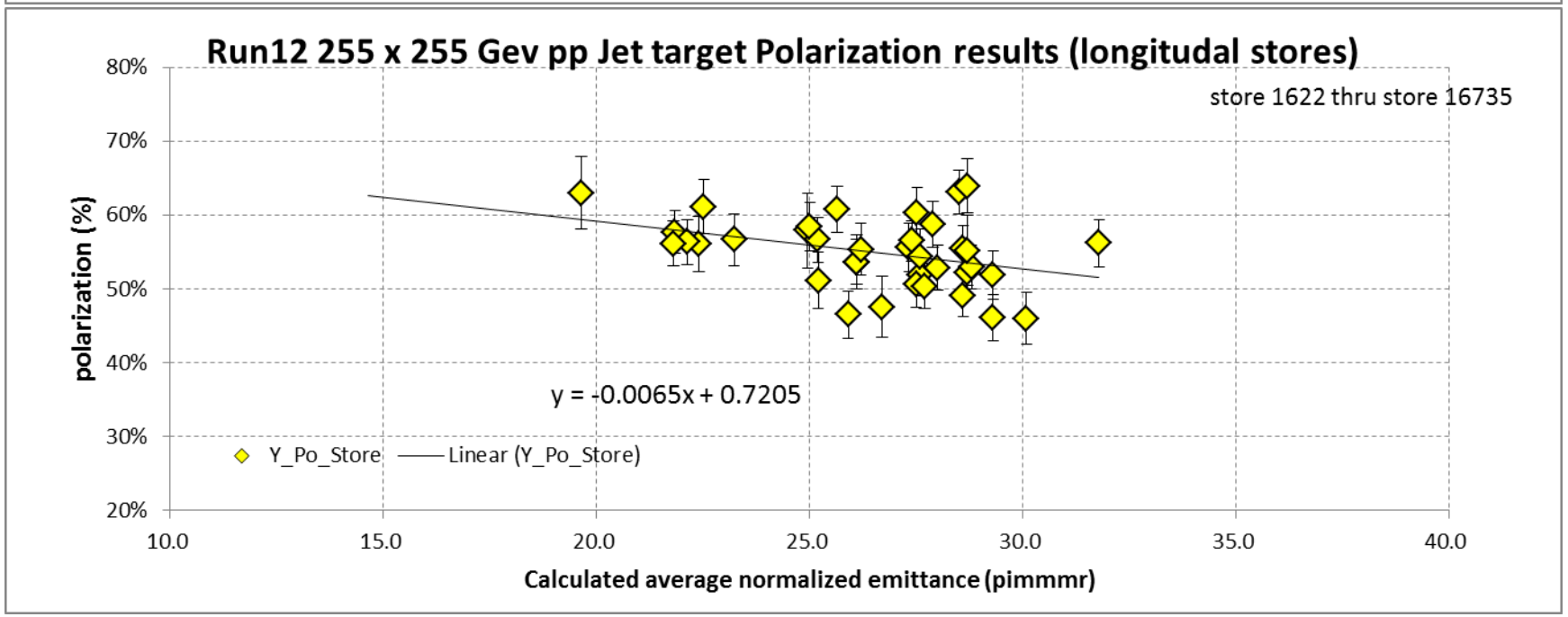

Run12 255 x 255 Gev pp Jet target Polarization results (longitudal stores)
store 1622 thru store 16735
polarization (%)
80%
70%
60%
50%
40%
30%
20%
y = -0.0065x + 0.7205
Y_Po_Store
Linear (Y_Po_Store)
10.0
15.0
20.0
25.0
30.0
35.0
40.0
Calculated average normalized emittance (pimmmr)

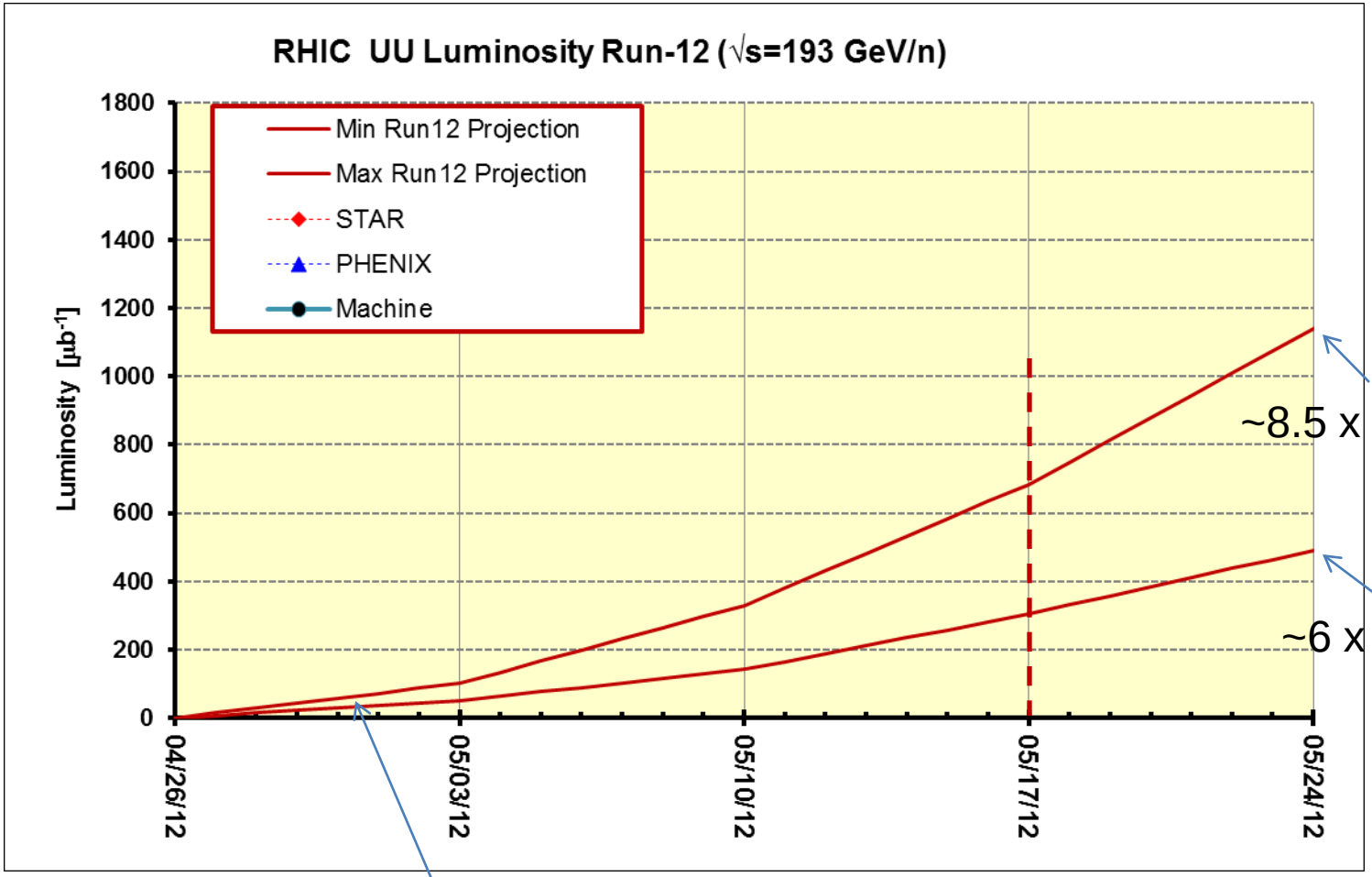
Table 2: Maximum luminosities that can be reached after a sufficiently long running period. For ion operation numbers are given for a beam energy of 100 GeV/nucleon. For polarized proton operation the beam energy is stated.

Mode	No of colliding bunches	Ions/bunch [10^9]	β^* [m]	Emittance [μm]	L_{peak} [$cm^{-2}s^{-1}$]	$L_{store\ avg}$ [$cm^{-2}s^{-1}$]	L_{week}
U-U	111	0.85	0.75	15-10	20×10^{26}	14×10^{26}	0.5 nb^{-1}
Au-Au	111	1.3	0.75	15-10	50×10^{26}	35×10^{26}	1.1 nb^{-1}
Cu-Cu	68	6.0	0.75	15-20	8×10^{28}	5×10^{28}	16 nb^{-1}
Cu-Au	111	4.0Cu/1.3Au	0.85	15-20	1.7×10^{28}	1.0×10^{28}	3.1 nb^{-1}
d-Au	111	110d/1.1Au	0.85	18-30	30×10^{28}	18×10^{28}	60 nb^{-1}
p↑-p↑* 100 GeV	107	135	0.85	15-20	50×10^{30}	30×10^{30}	10 pb^{-1}
p↑-p↑* 250 GeV	107	165	0.6	20-25	200×10^{30}	120×10^{30}	40 pb^{-1}

* We expect that an intensity-averaged store polarization P of up to about 60%, as measured by the H jet, can be reached at 100 GeV. At 250 GeV we expect the polarization P to reach about 55%. In Run-11 PHENIX had 107 and STAR 102 colliding bunches.

Minimum goal after *4 weeks of physics operations* for UU in RHIC
→ 6 x 10^8 ions/bunch with above U-U parameters

Best to date = 2 x 10^8 ions/bunch

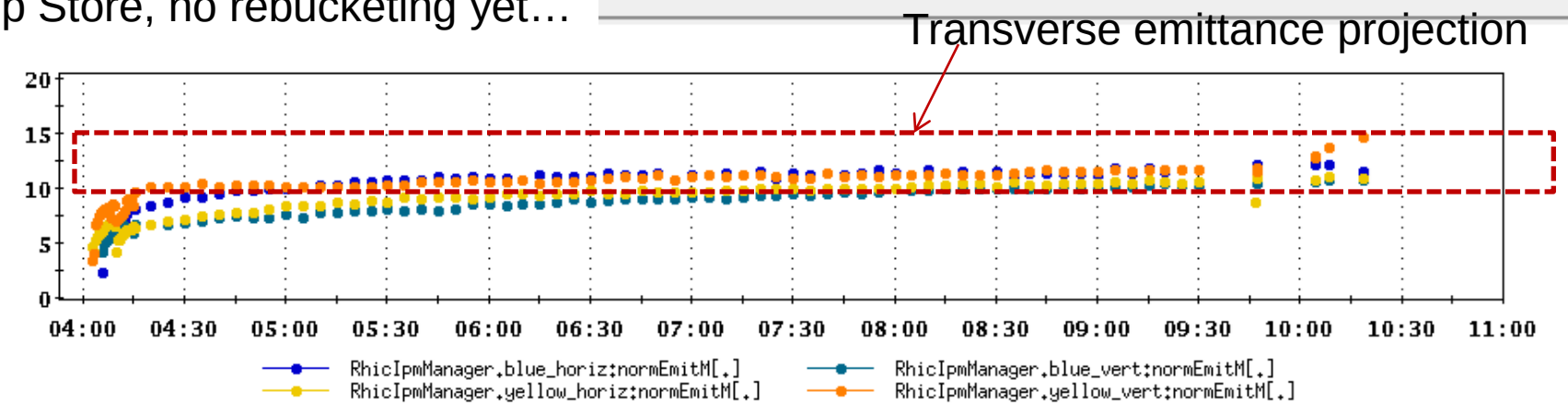


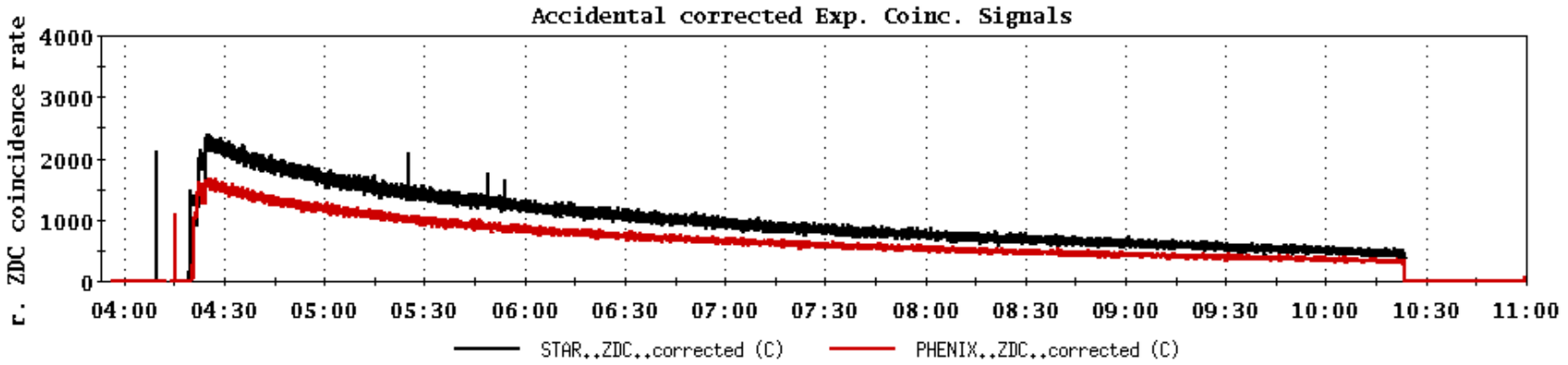
~8.5 x 10^8 ions/bunch

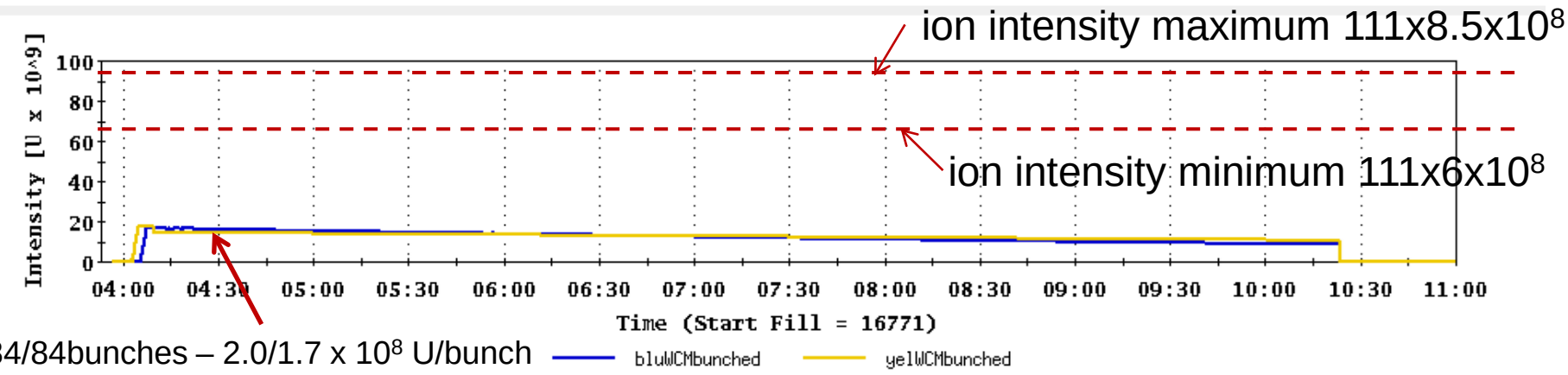
~6 x 10^8 ions/bunch

~3 x 10^8 ions/bunch

Setup Store, no rebucketing yet…







Other Slides

Where we are with Uranium (From K. Zeno)

Into the booster 8 x 10^8 in 4 bunches

These are then combined into one bunch

Booster extraction 6.5 x 10^8 / bunch

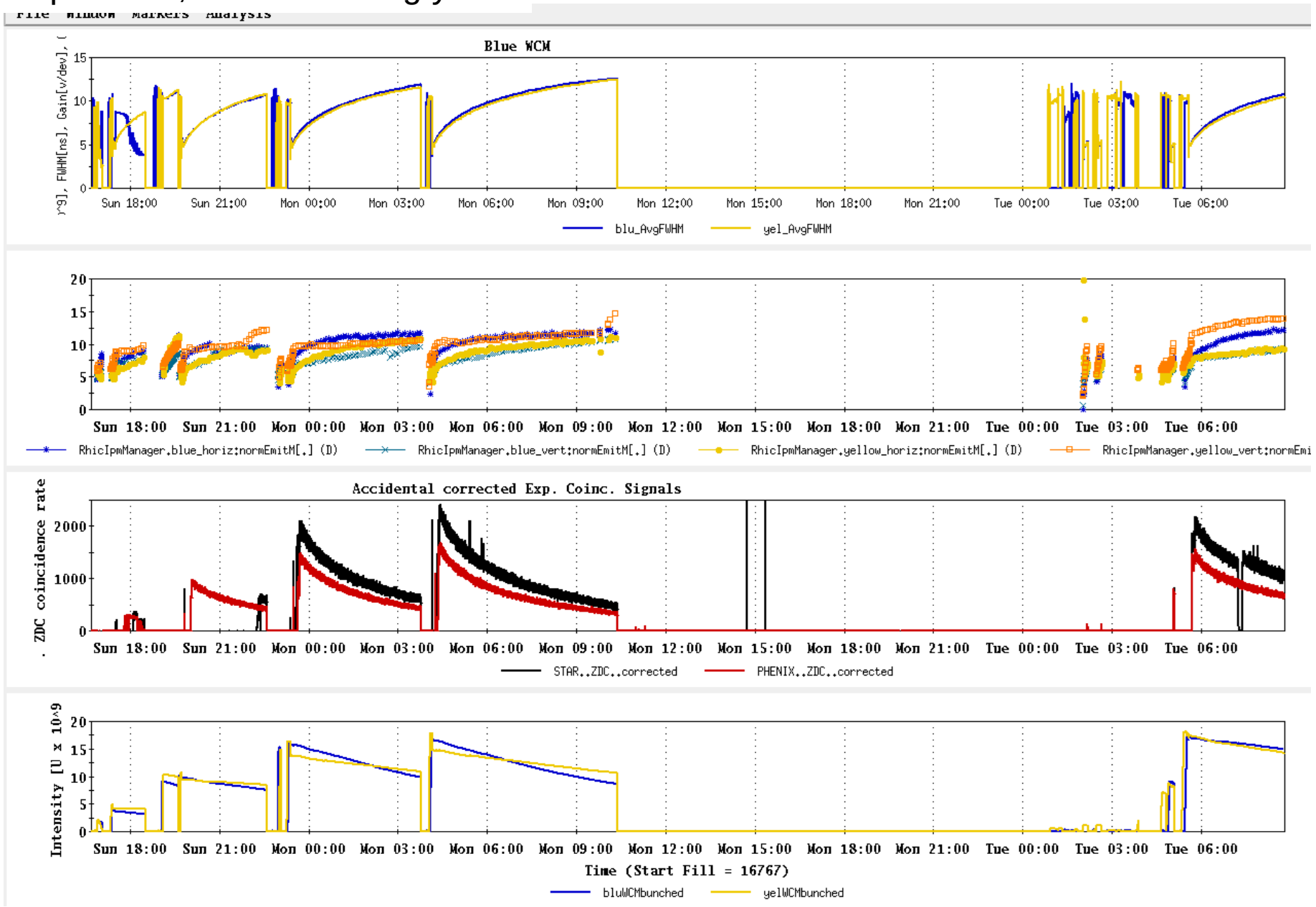
30% efficiency into the AGS

AGS extraction is at 2 x 10^8 / bunch

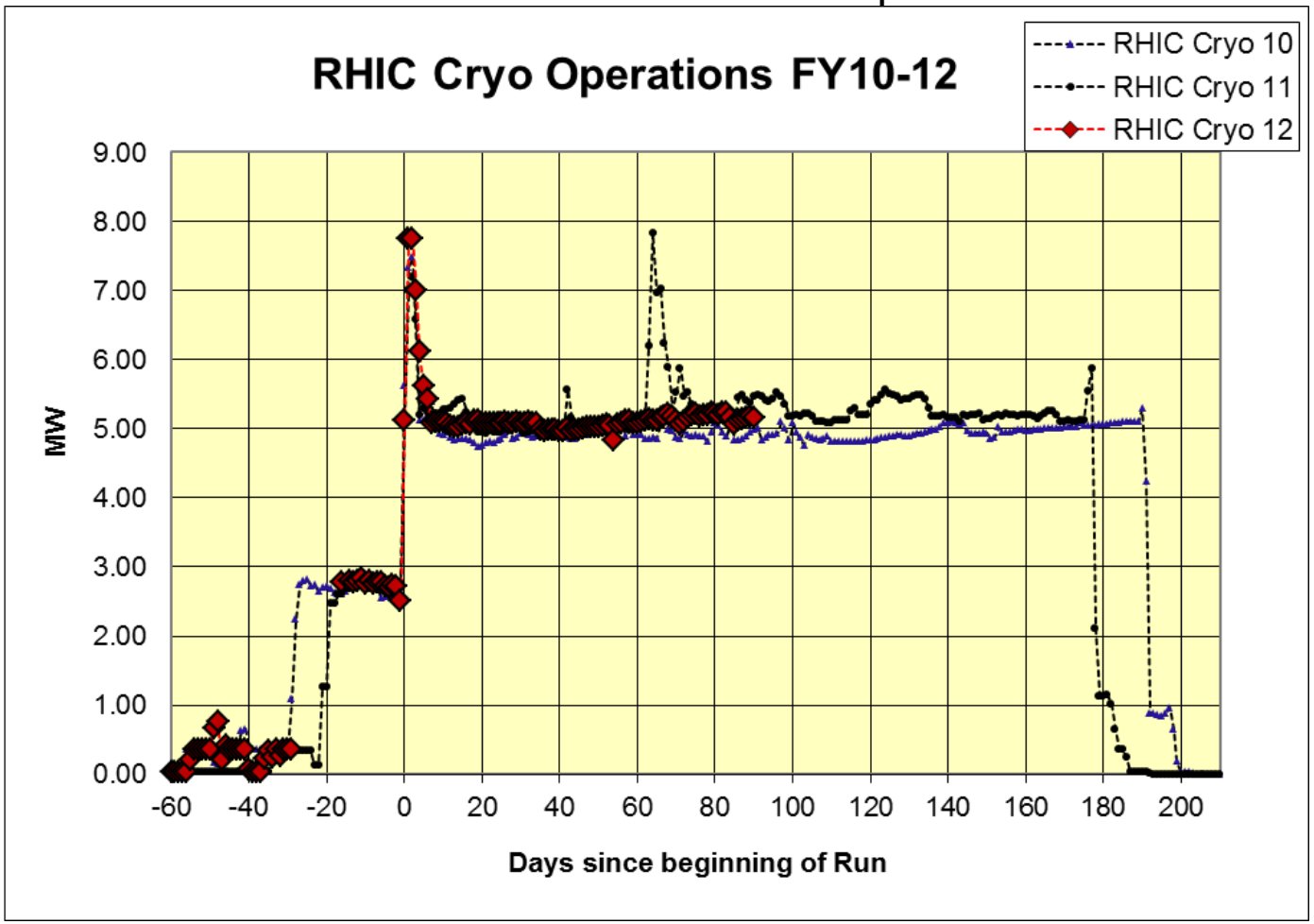
Desired (Wolfram) ~ 7 x 10^8 / bunch

>>> 6 x 10^8 / bunch in RHIC

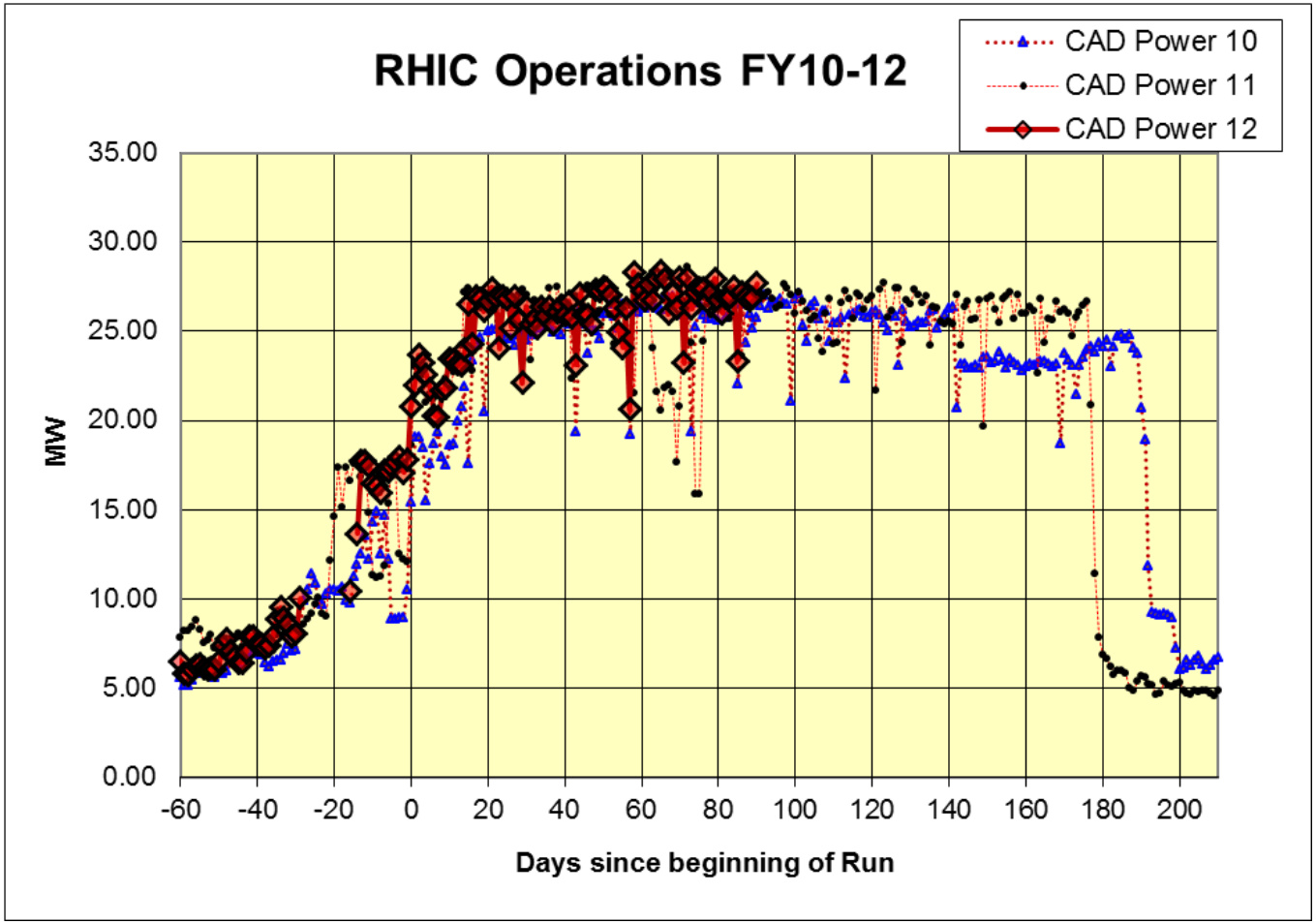
Setup Stores, no rebucketing yet… √s = 193 GeV/n UU – stores 16769 through 16775

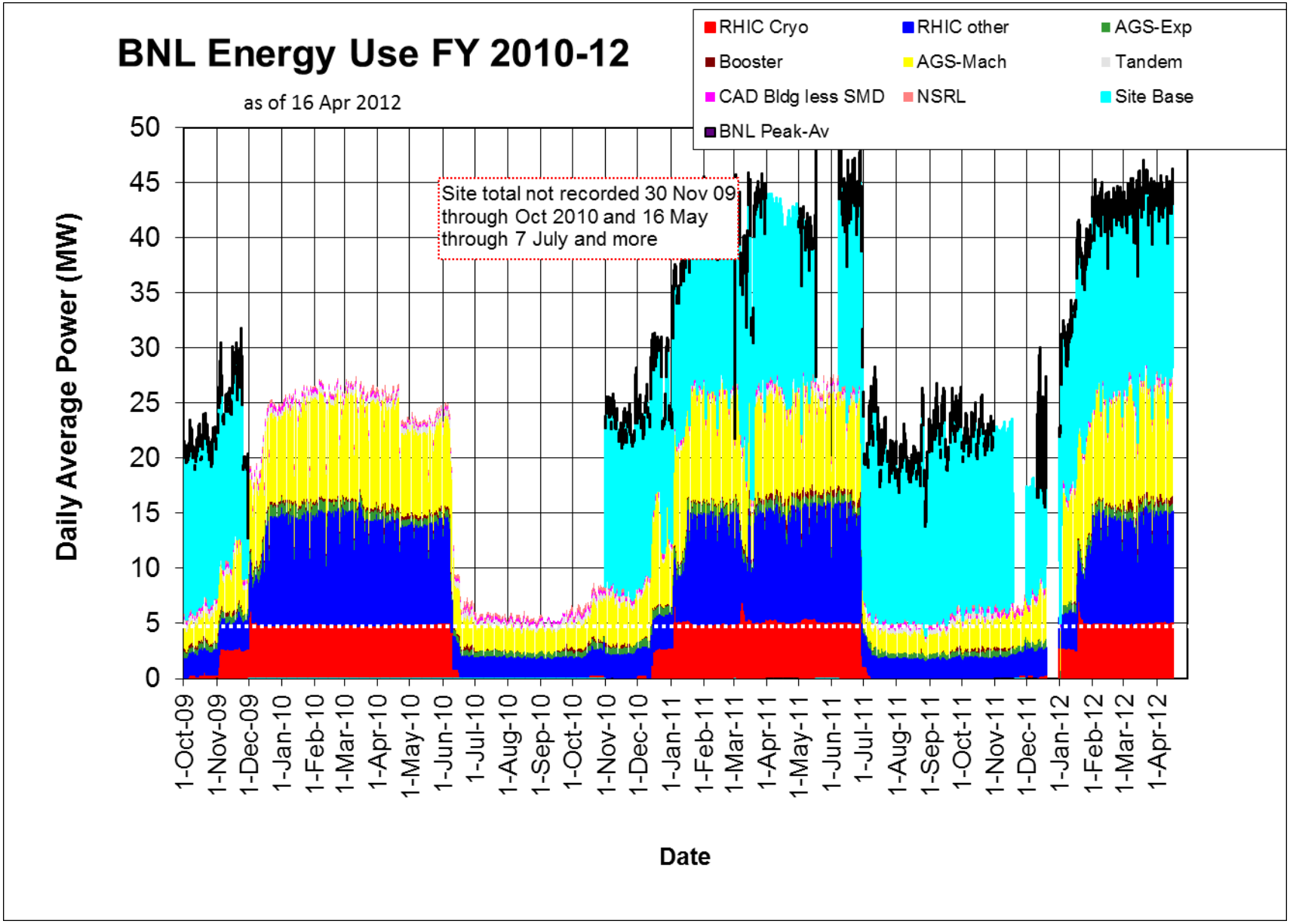


As of 16 Apr 2012

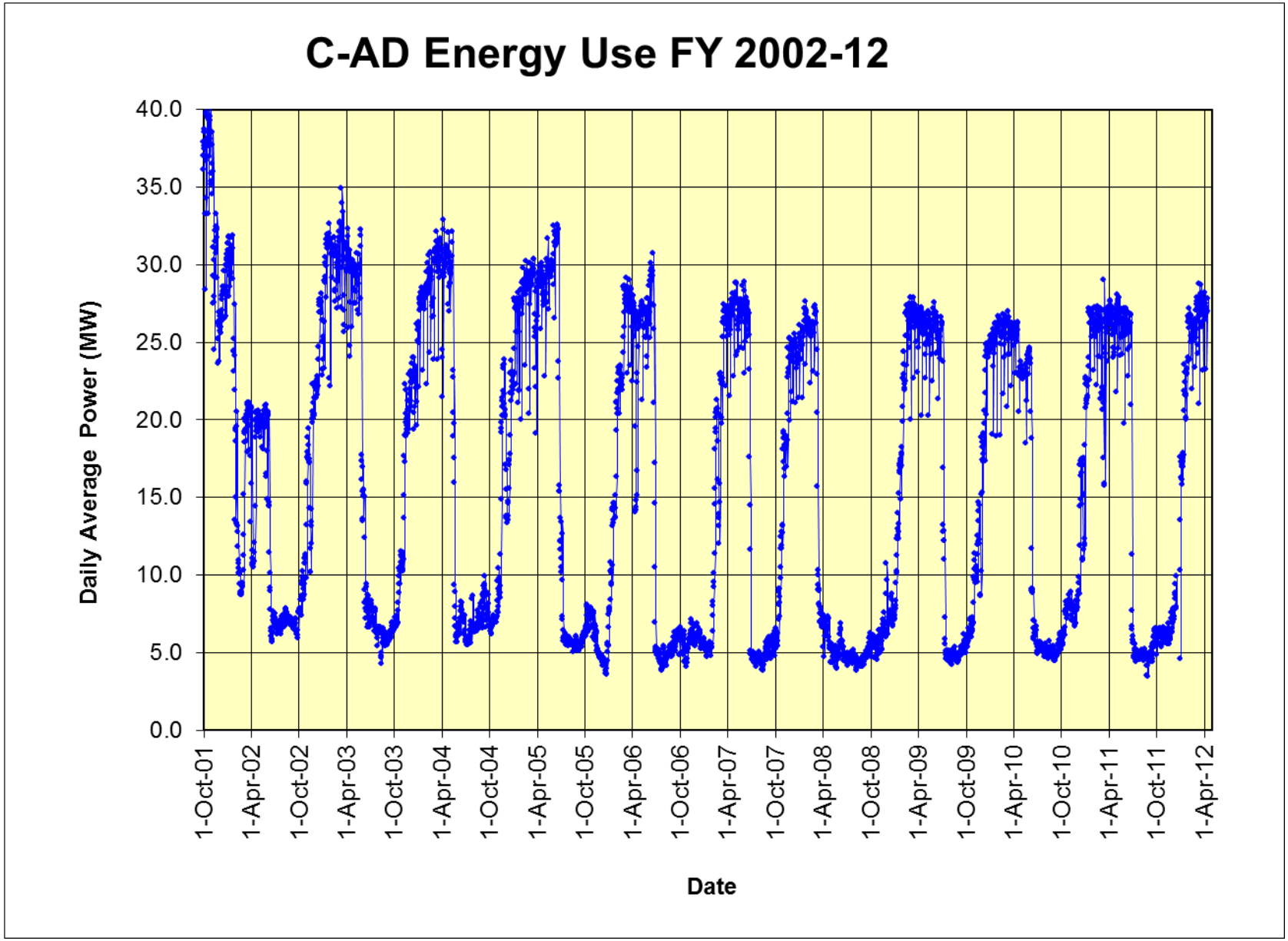


As of 16 Apr 2012

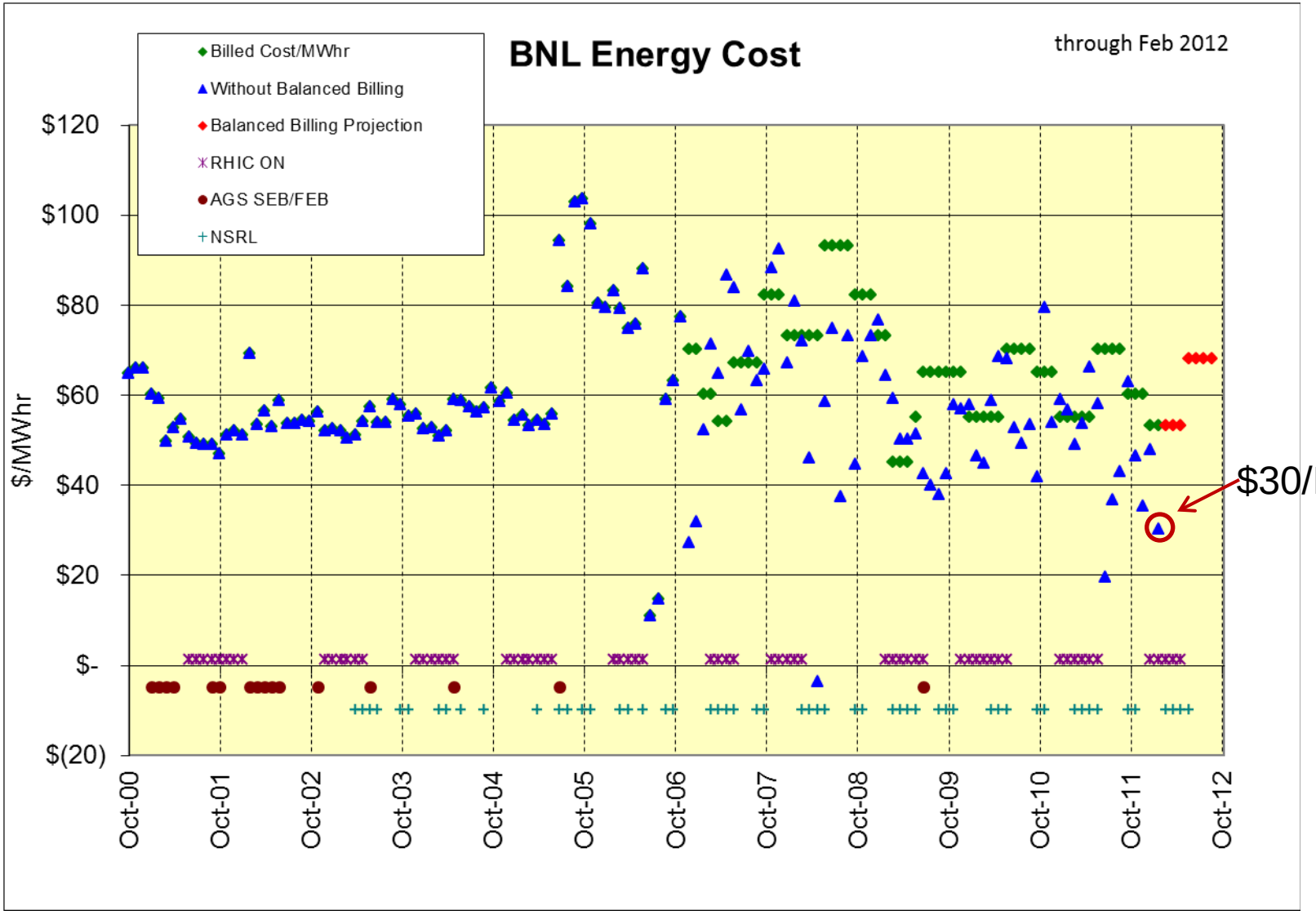


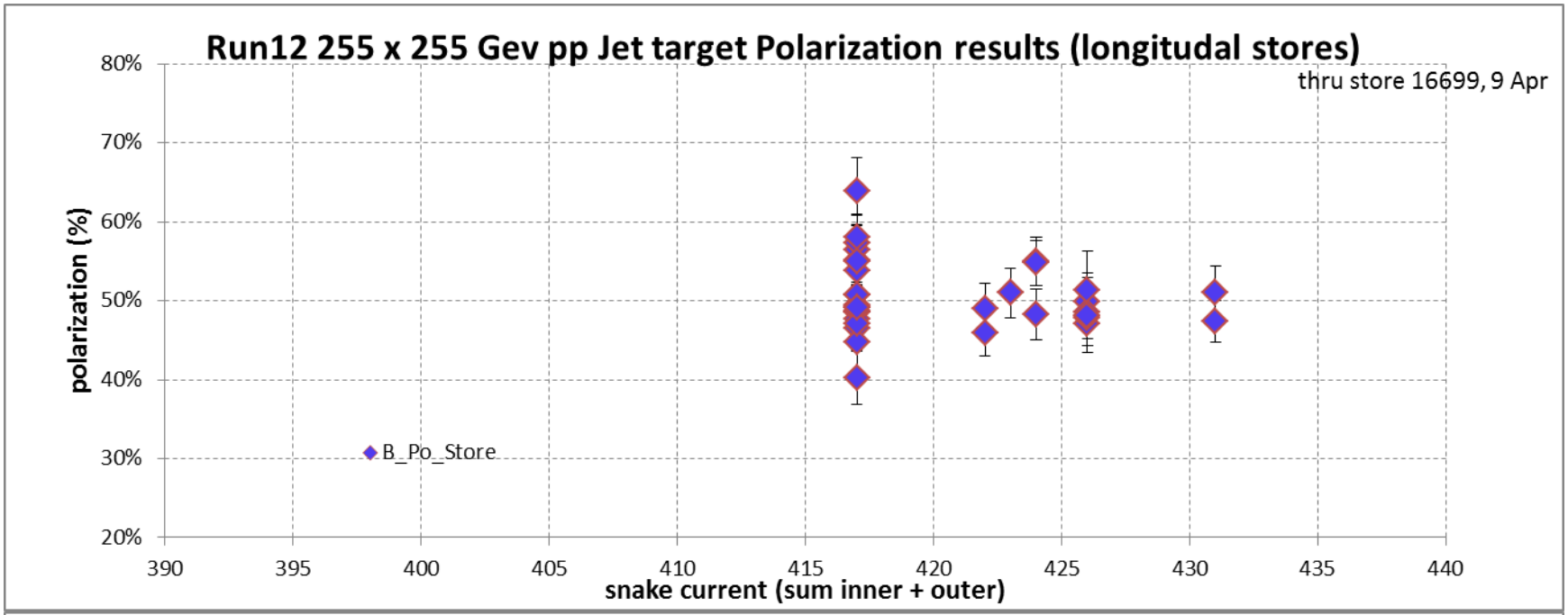

BNL Energy Use FY 2010-12
as of 16 Apr 2012
RHIC Cryo
RHIC other
AGS-Exp
Booster
AGS-Mach
Tandem
CAD Bldg less SMD
NSRL
Site Base
BNL Peak-Av
Site total not recorded 30 Nov 09 through Oct 2010 and 16 May through 7 July and more
Daily Average Power (MW)
0
5
10
15
20
25
30
35
40
45
50
1-Oct-09
1-Nov-09
1-Dec-09
1-Jan-10
1-Feb-10
1-Mar-10
1-Apr-10
1-May-10
1-Jun-10
1-Jul-10
1-Aug-10
1-Sep-10
1-Oct-10
1-Nov-10
1-Dec-10
1-Jan-11
1-Feb-11
1-Mar-11
1-Apr-11
1-May-11
1-Jun-11
1-Jul-11
1-Aug-11
1-Sep-11
1-Oct-11
1-Nov-11
1-Dec-11
1-Jan-12
1-Feb-12
1-Mar-12
1-Apr-12
Date

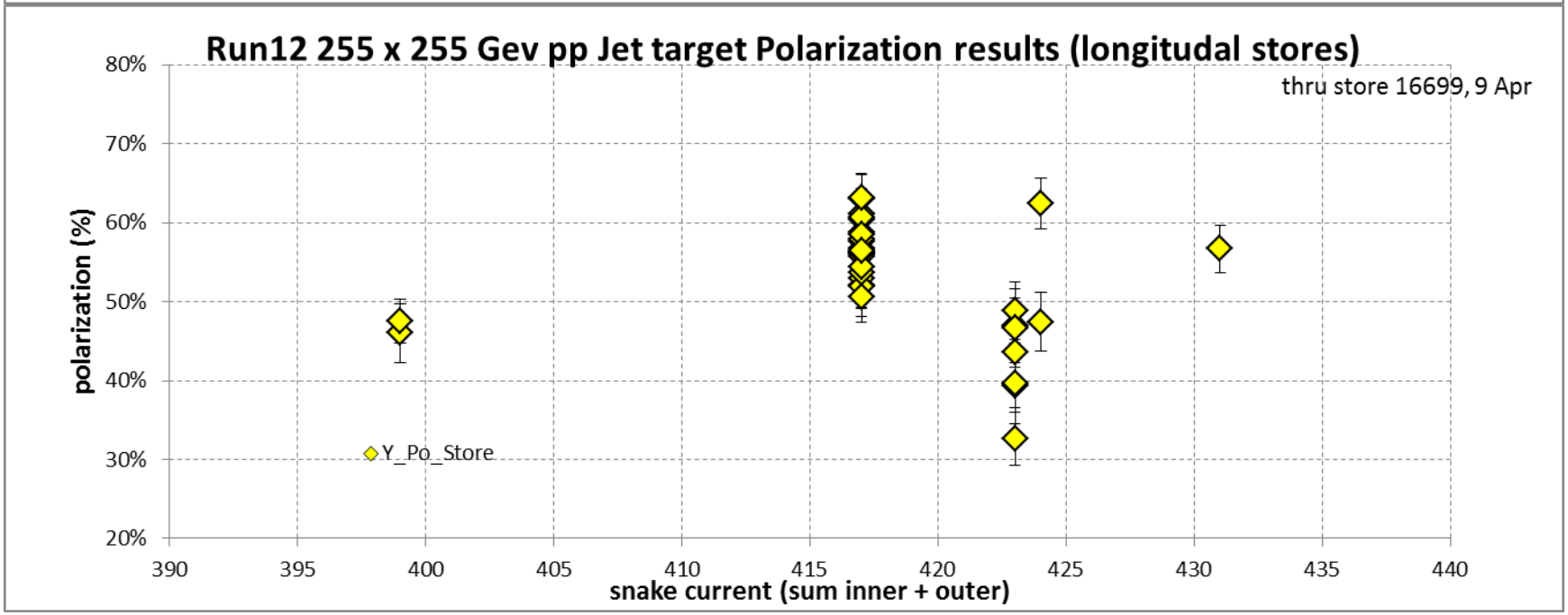
As of 16 Apr 2012



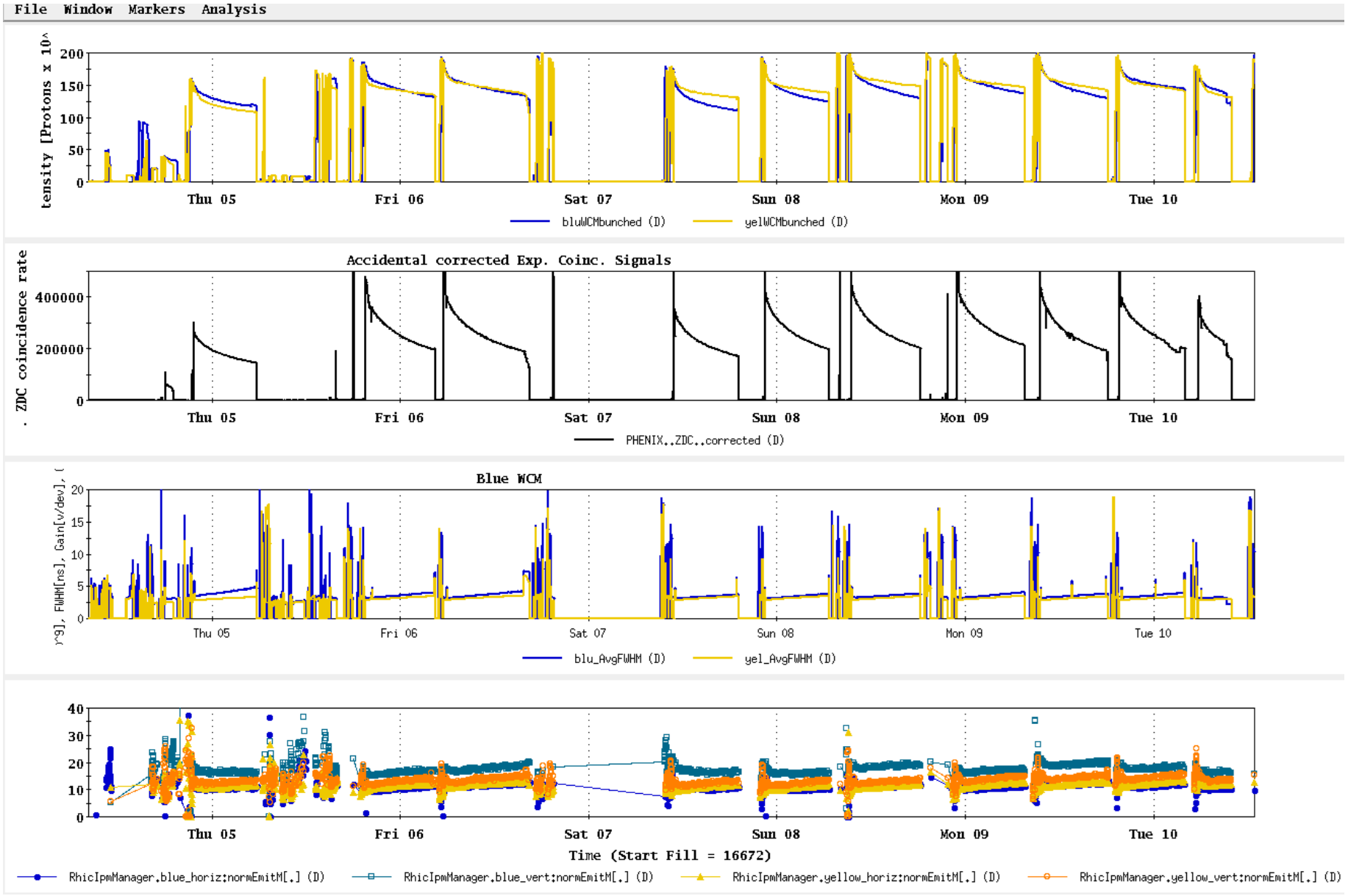
$ in BNL Balanced Billing Bank for FY12 (through Feb) = +$1,825K




Run12 255 x 255 Gev pp Jet target Polarization results (longitudal stores)
thru store 16699, 9 Apr
polarization (%)
80%
70%
60%
50%
40%
30%
20%
B_Po_Store
390
395
400
405
410
415
420
425
430
435
440
snake current (sum inner + outer)


Run12 255 x 255 Gev pp Jet target Polarization results (longitudal stores)
thru store 16699, 9 Apr
polarization (%)
80%
70%
60%
50%
40%
30%
20%
Y_Po_Store
390
395
400
405
410
415
420
425
430
435
440
snake current (sum inner + outer)

4 Apr – 10 Apr stores

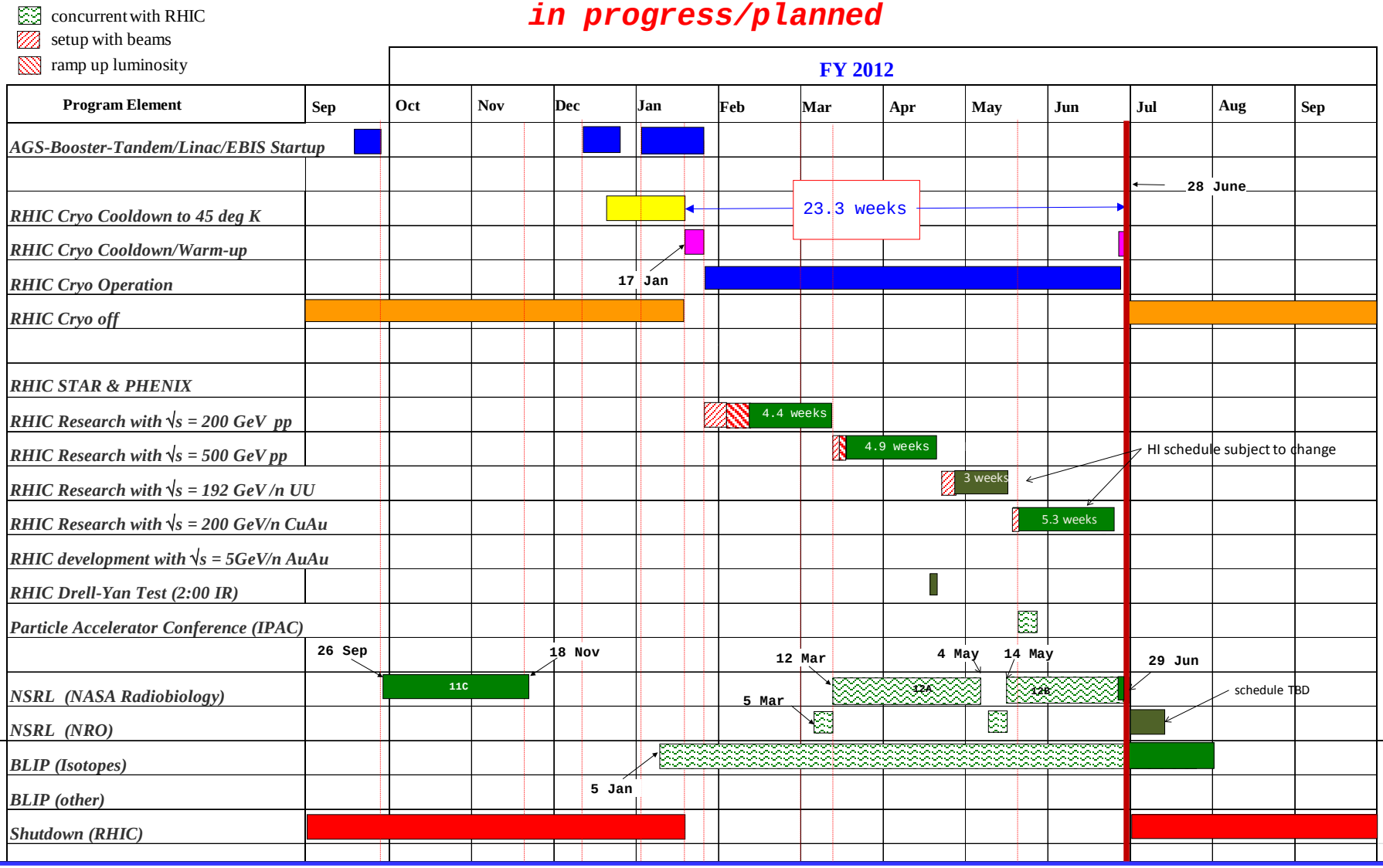


http://www.bnl.gov/cad/esfd

24 Apr 12

C-A Operations-FY12

in progress/planned



Run 12, $\sqrt{s}$ = 510 GeV polarized proton run – experiment goals

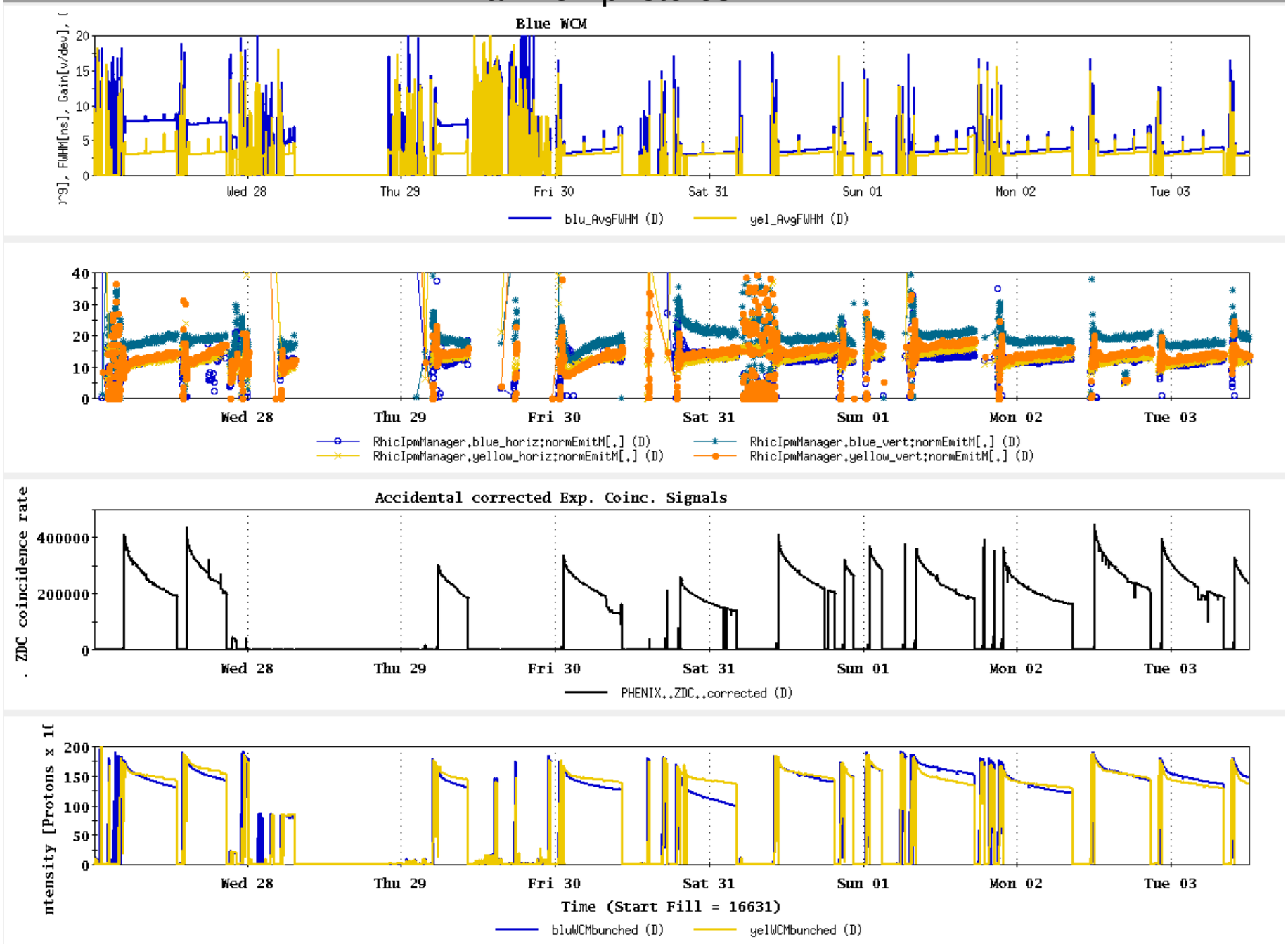
STAR Goal for 5 weeks longitudal polarization (50% polarization):

- Sampled Luminosity = 45 pb^{-1} with 50% polarization
- Delivered Luminosity = 75 pb^{-1}

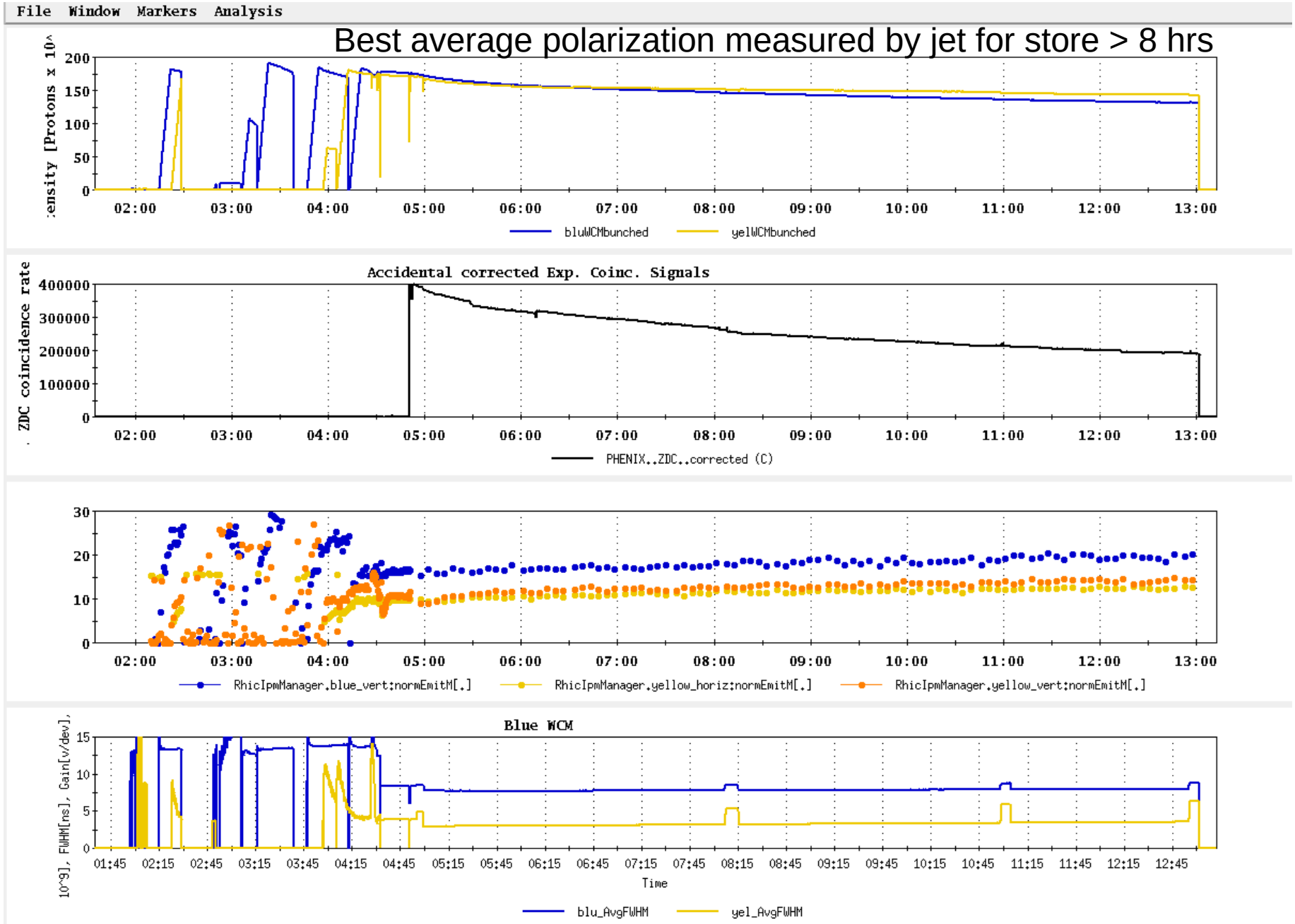
PHENIX Goal for 5 weeks longitudal polarization (50% polarization):

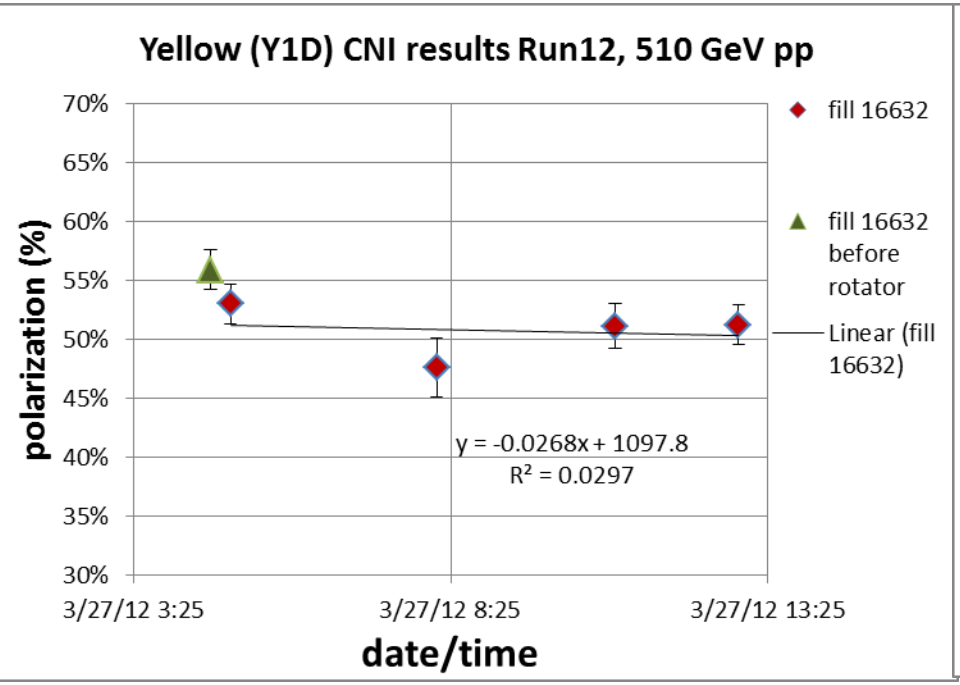
- Sampled Luminosity = 30 pb^{-1} with |z| <30 cm
  = 10 pb^{-1} with |z| <10 cm
- Delivered Luminosity = ~~75~~ pb^{-1} changed to 120 pb^{-1}, 3/29/12, Ed O'Brien email

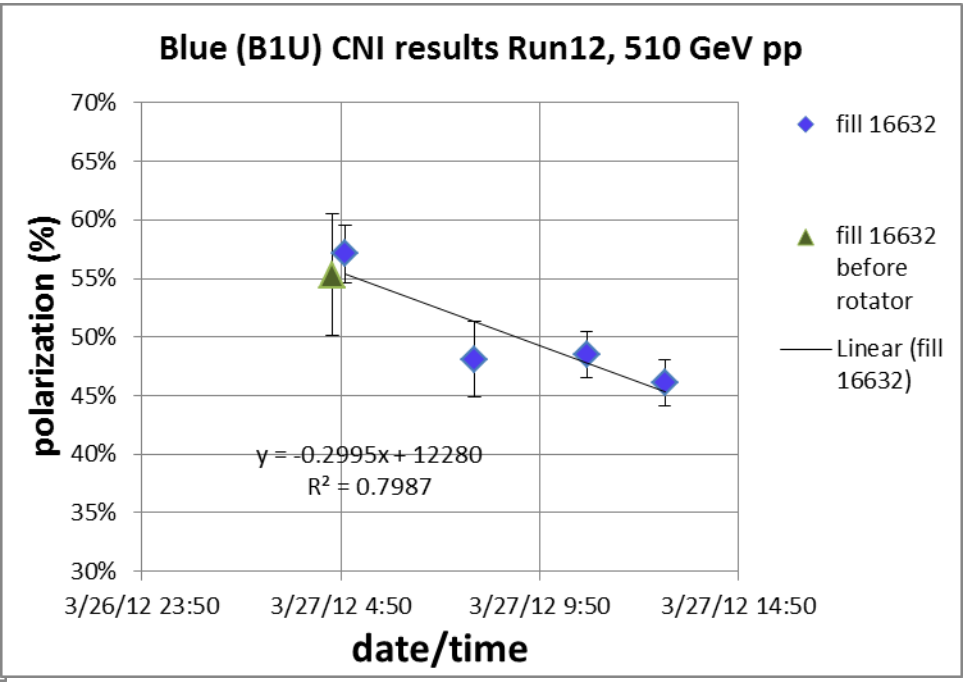
27 Mar – 3 Apr stores

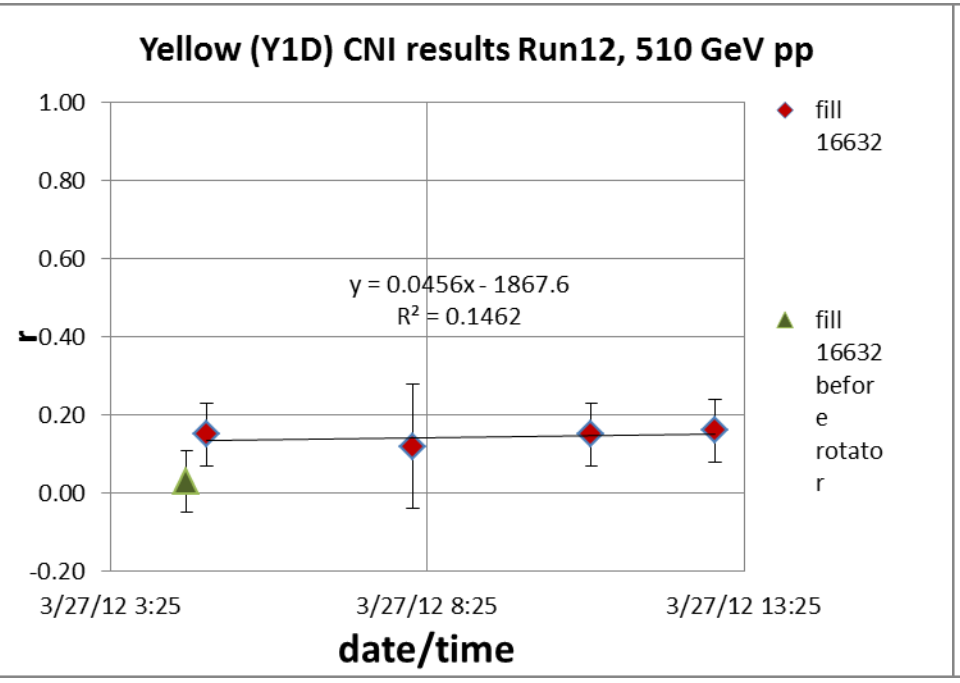


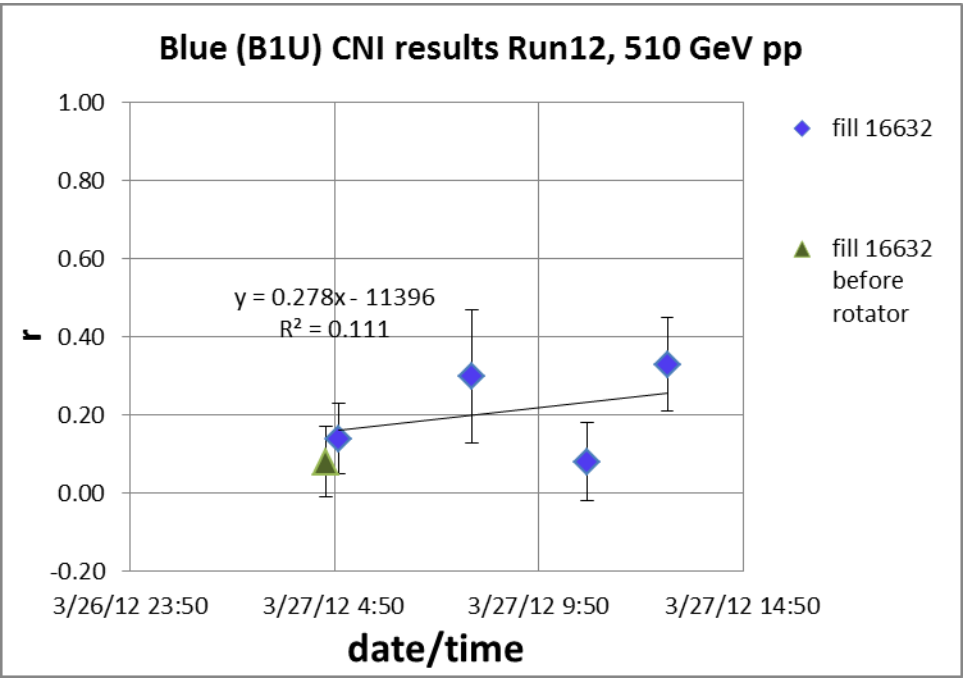
Store 16632, Blue jet = 56.5 +/- 3.0; Yellow jet = 63.0 +/- 3.1




Yellow (Y1D) CNI results Run12, 510 GeV pp
polarization (%)
70%
65%
60%
55%
50%
45%
40%
35%
30%
3/27/12 3:25
3/27/12 8:25
3/27/12 13:25
date/time
fill 16632
fill 16632 before rotator
Linear (fill 16632)
y = -0.0268x + 1097.8
R² = 0.0297

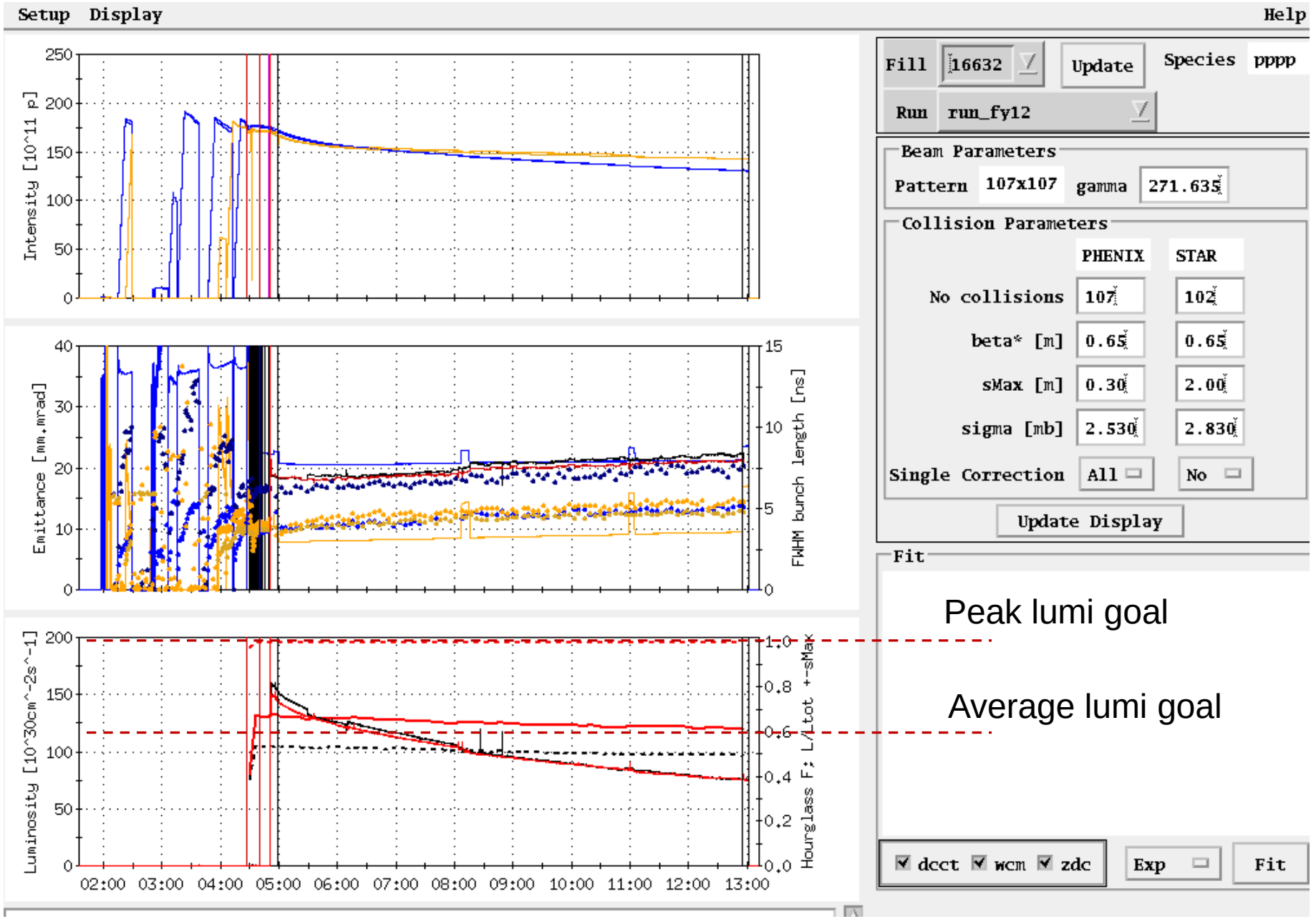

Blue (B1U) CNI results Run12, 510 GeV pp
polarization (%)
70%
65%
60%
55%
50%
45%
40%
35%
30%
3/26/12 23:50
3/27/12 4:50
3/27/12 9:50
3/27/12 14:50
date/time
fill 16632
fill 16632 before rotator
Linear (fill 16632)
y = -0.2995x + 12280
R² = 0.7987


Yellow (Y1D) CNI results Run12, 510 GeV pp
r
1.00
0.80
0.60
0.40
0.20
0.00
-0.20
3/27/12 3:25
3/27/12 8:25
3/27/12 13:25
date/time
fill 16632
fill 16632 before rotator
y = 0.0456x - 1867.6
R² = 0.1462


Blue (B1U) CNI results Run12, 510 GeV pp
r
1.00
0.80
0.60
0.40
0.20
0.00
-0.20
3/26/12 23:50
3/27/12 4:50
3/27/12 9:50
3/27/12 14:50
date/time
fill 16632
fill 16632 before rotator
y = 0.278x - 11396
R² = 0.111

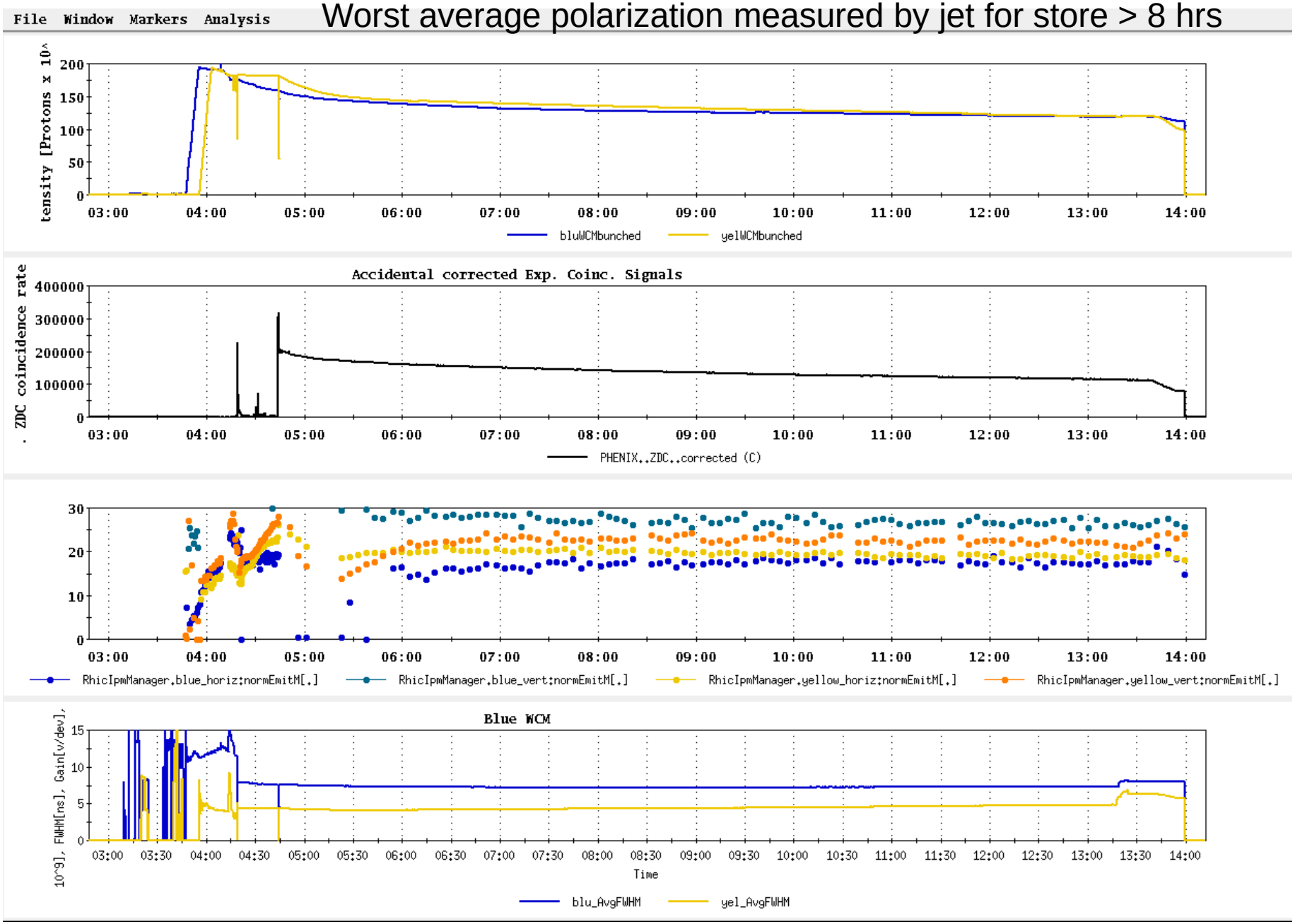
Store 16632

Best average polarization measured by jet for store > 8 hrs



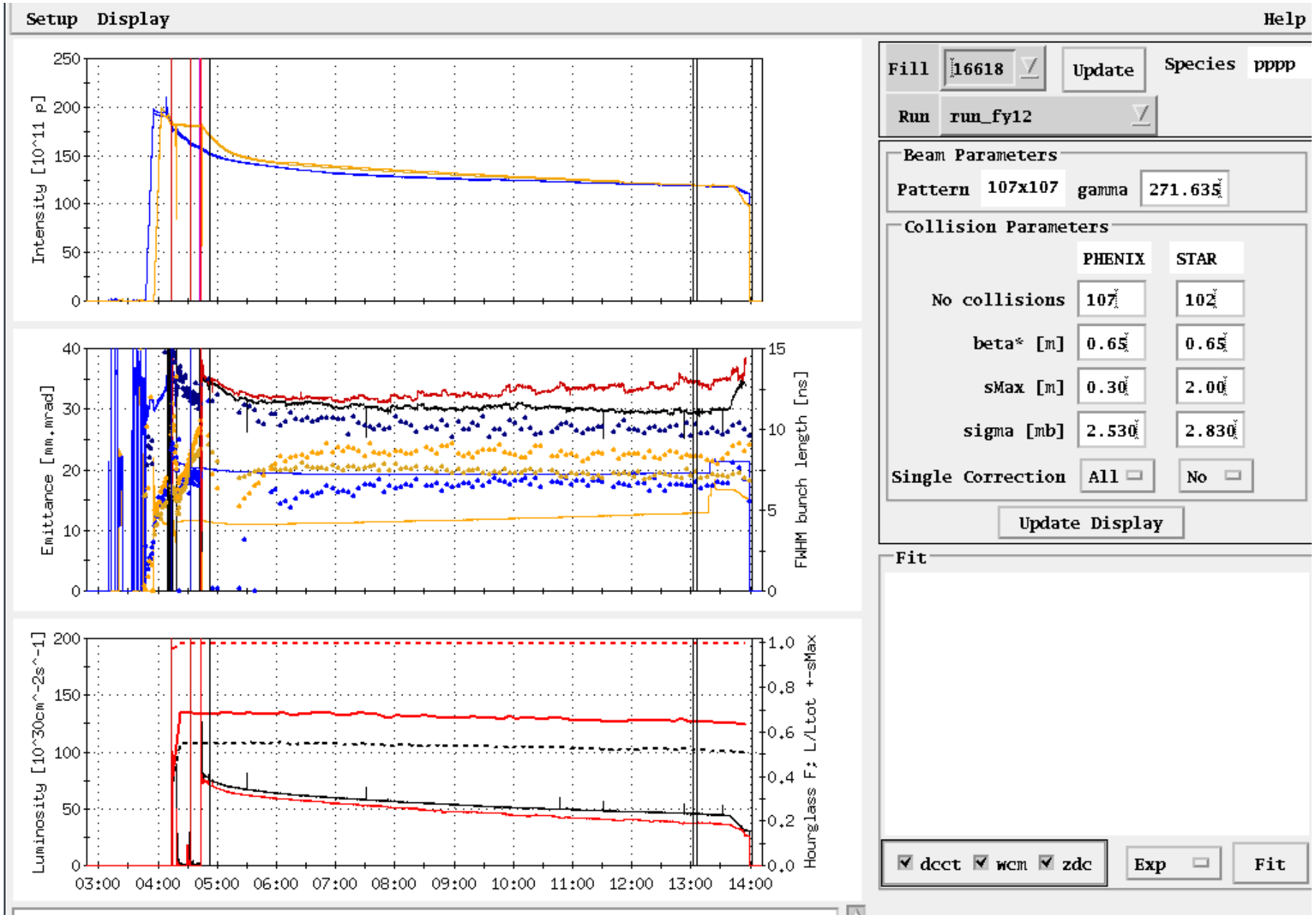
Store 16618, Blue jet = 51.0 +/- 3.2; Yellow jet = 32.6 +/- 3.3

Worst average polarization measured by jet for store > 8 hrs



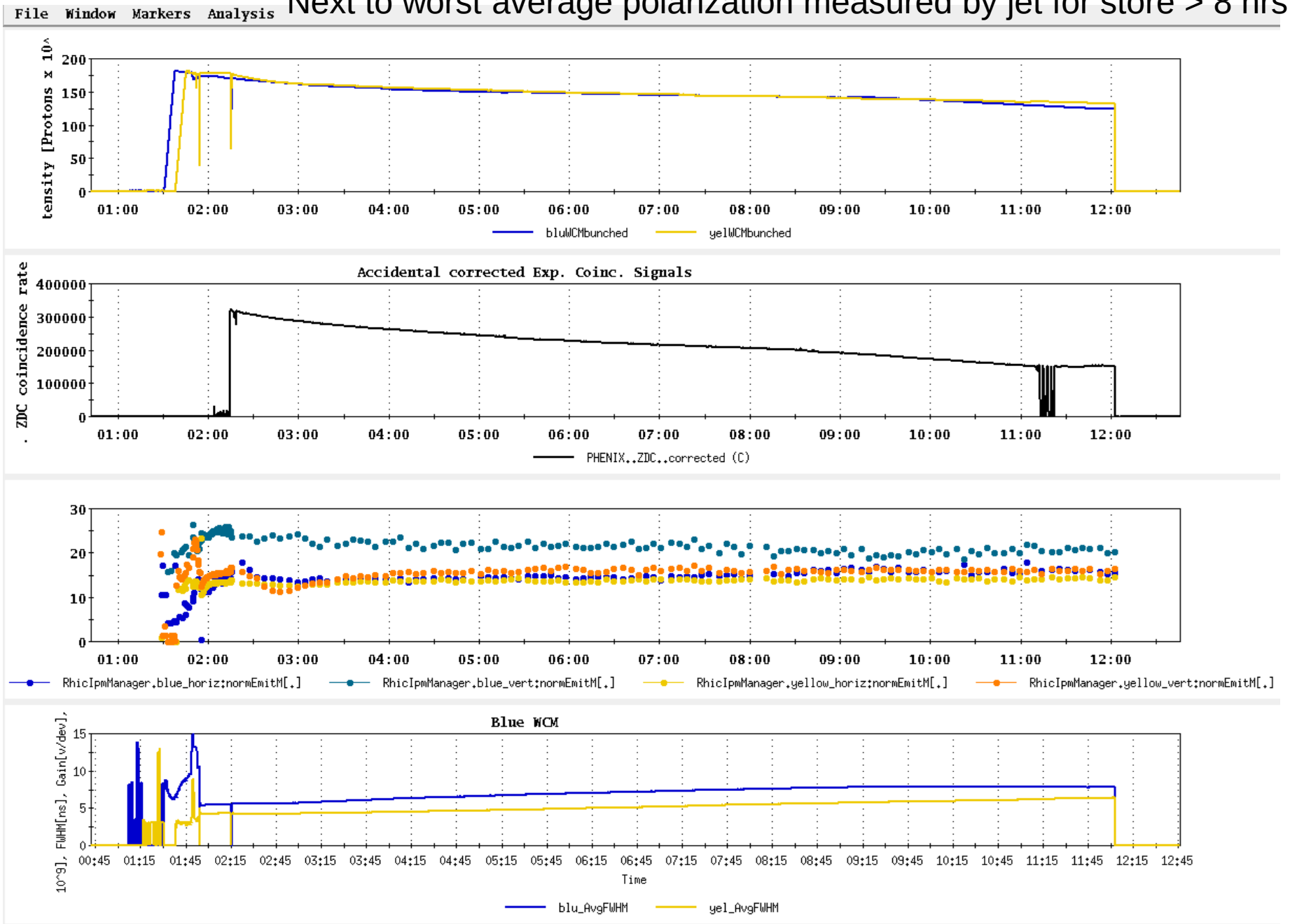
Store 16618

Worst average polarization measured by jet for store > 8 hrs

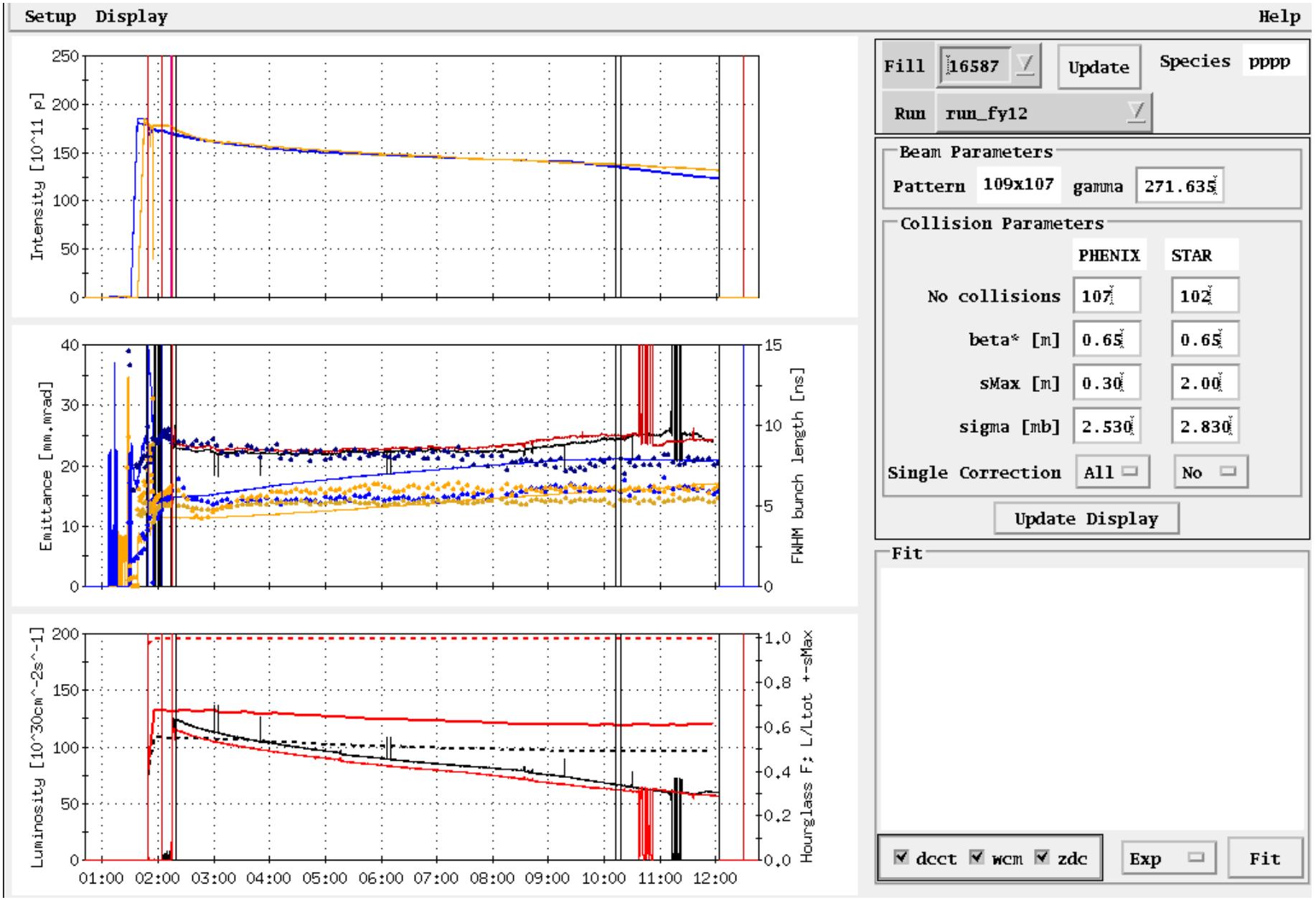


Store 16587, Blue jet = 47.2 +/- 2.8; Yellow jet = 39.4 +/- 2.9

Next to worst average polarization measured by jet for store > 8 hrs

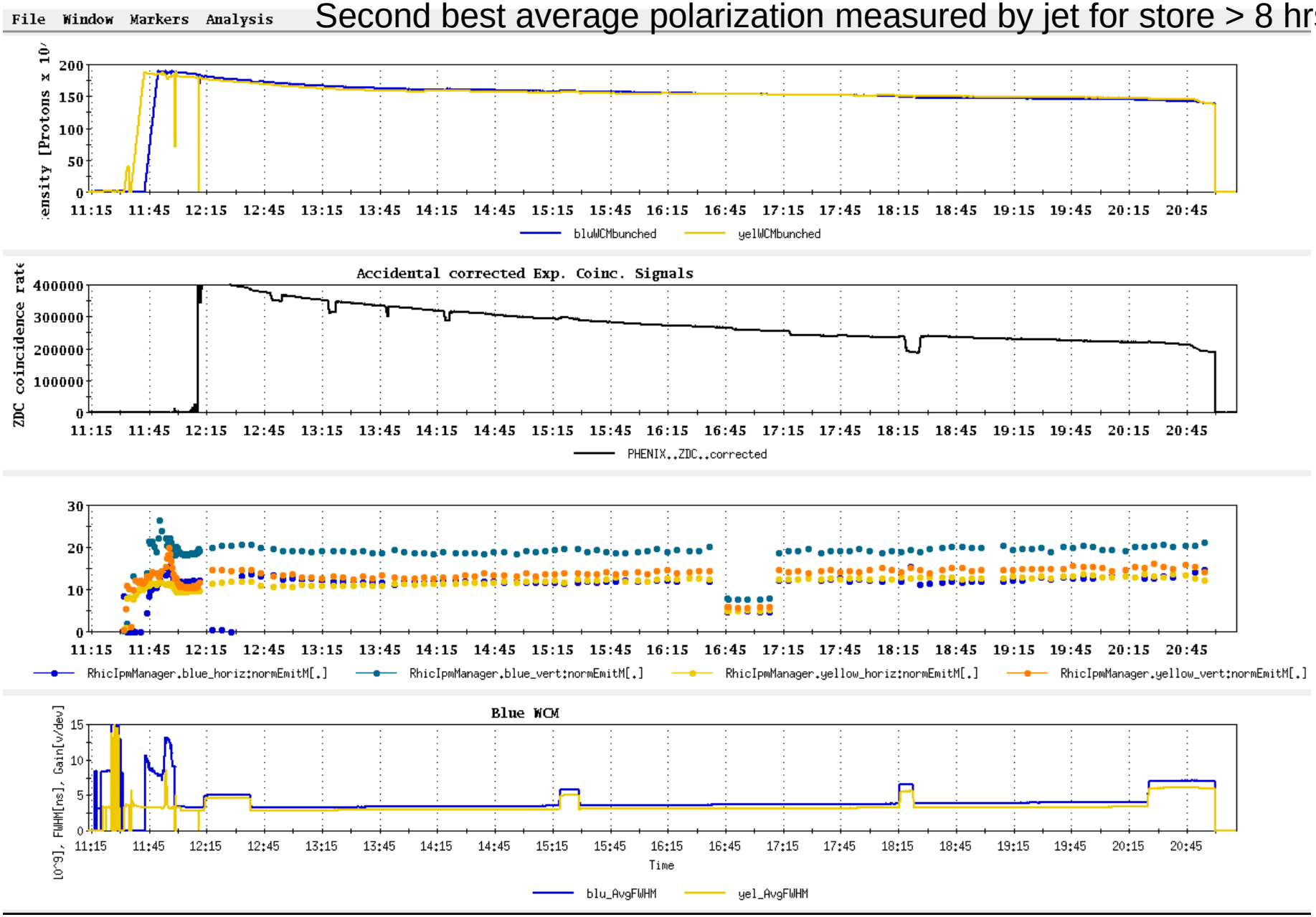


Store 16587 Next to worst average polarization measured by jet for store > 8 hrs

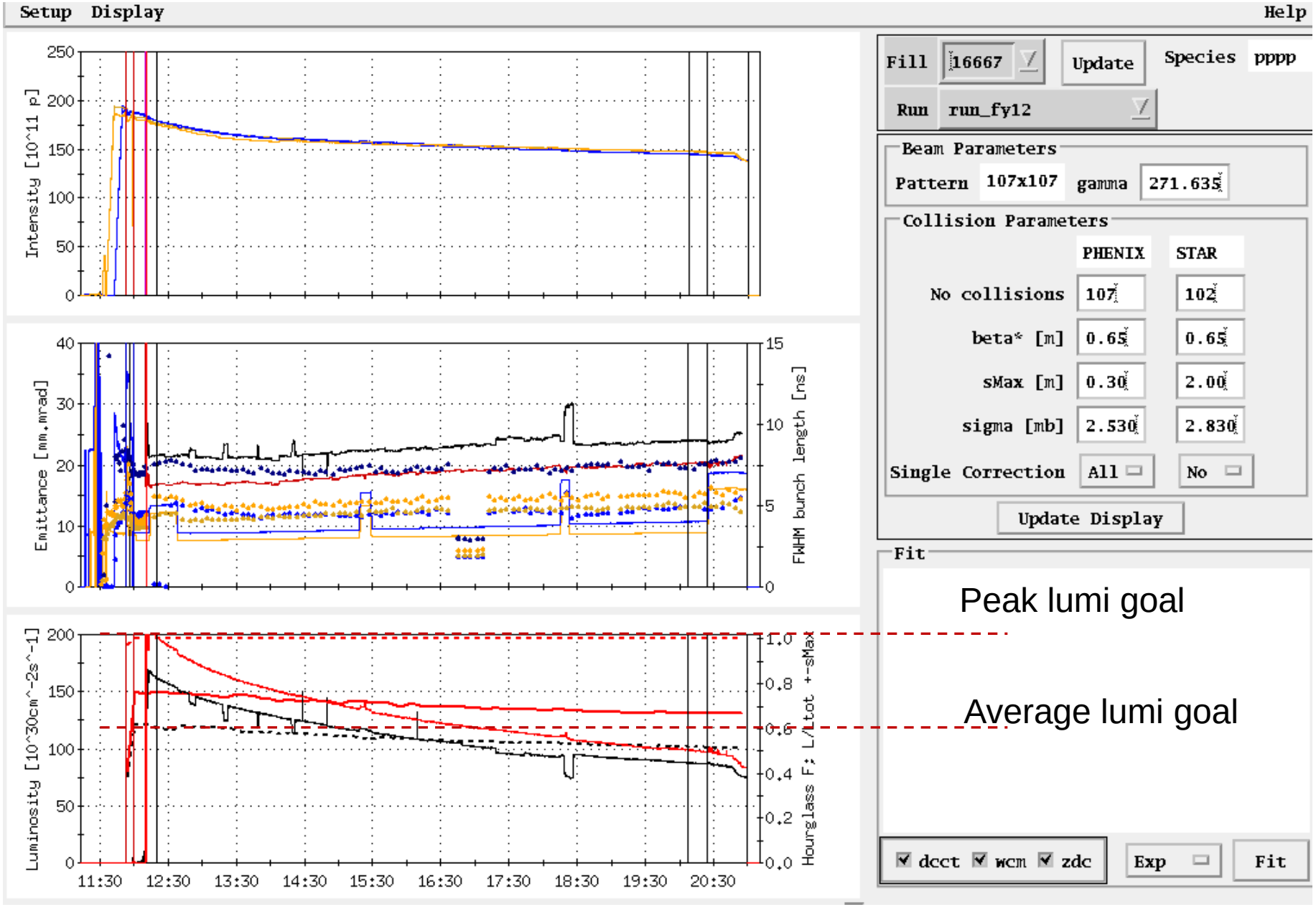


Store 16667, Blue jet = 58.1 +/- 2.9; Yellow jet = 60.7 +/- 3.1

Second best average polarization measured by jet for store > 8 hrs



Store 16667 Second best average polarization measured by jet for store > 8 hrs



Store 16632, 3/27/12

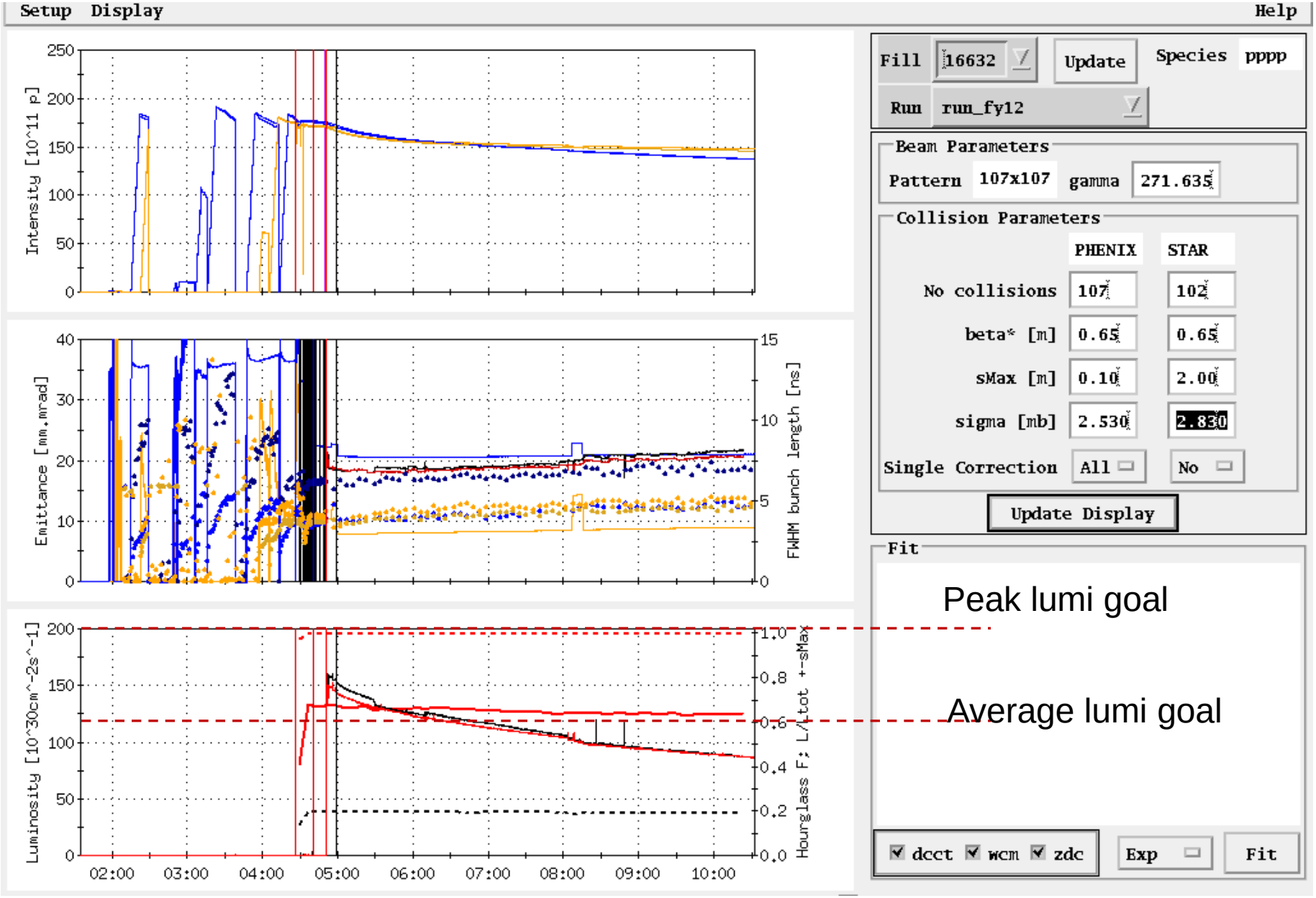
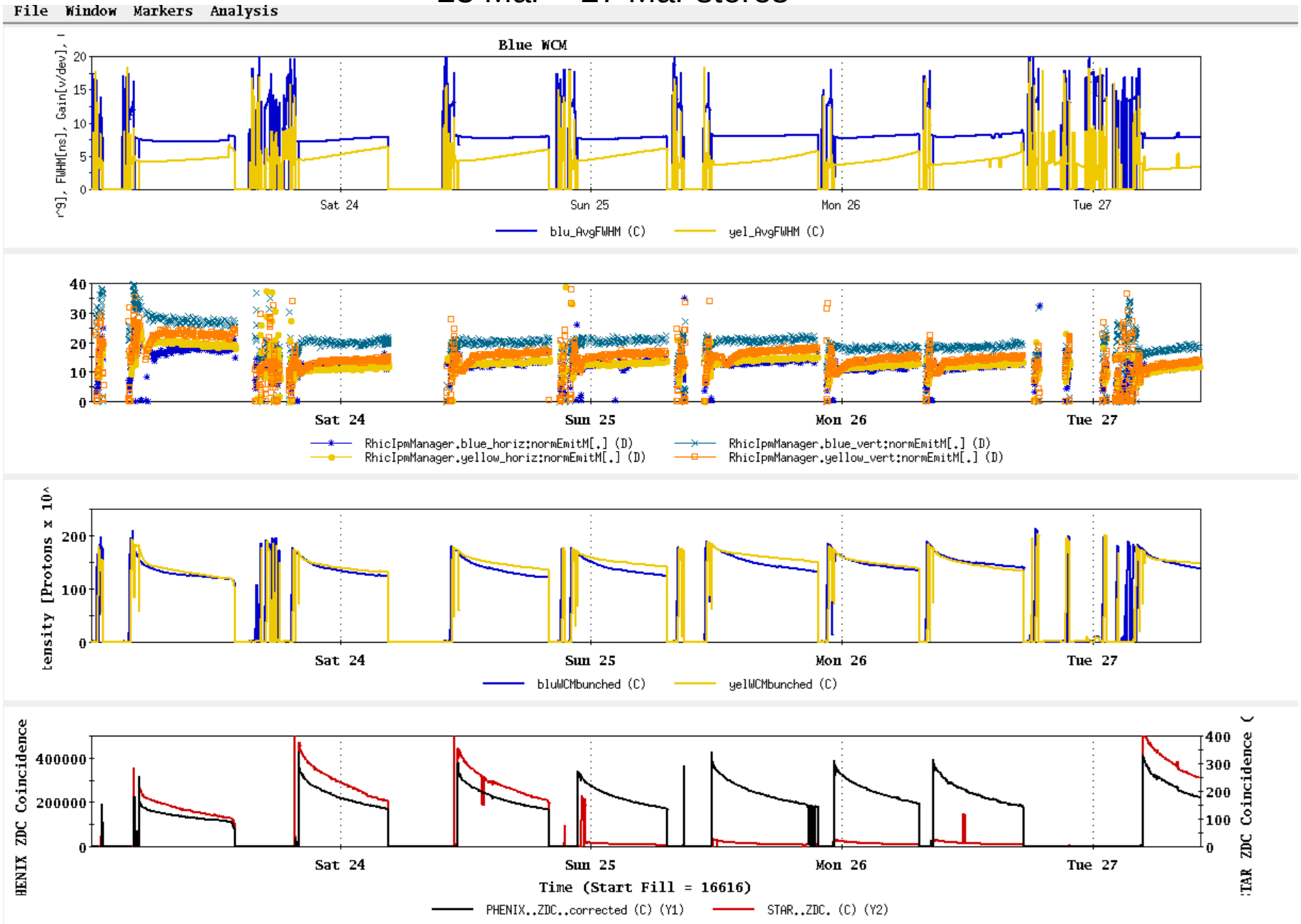
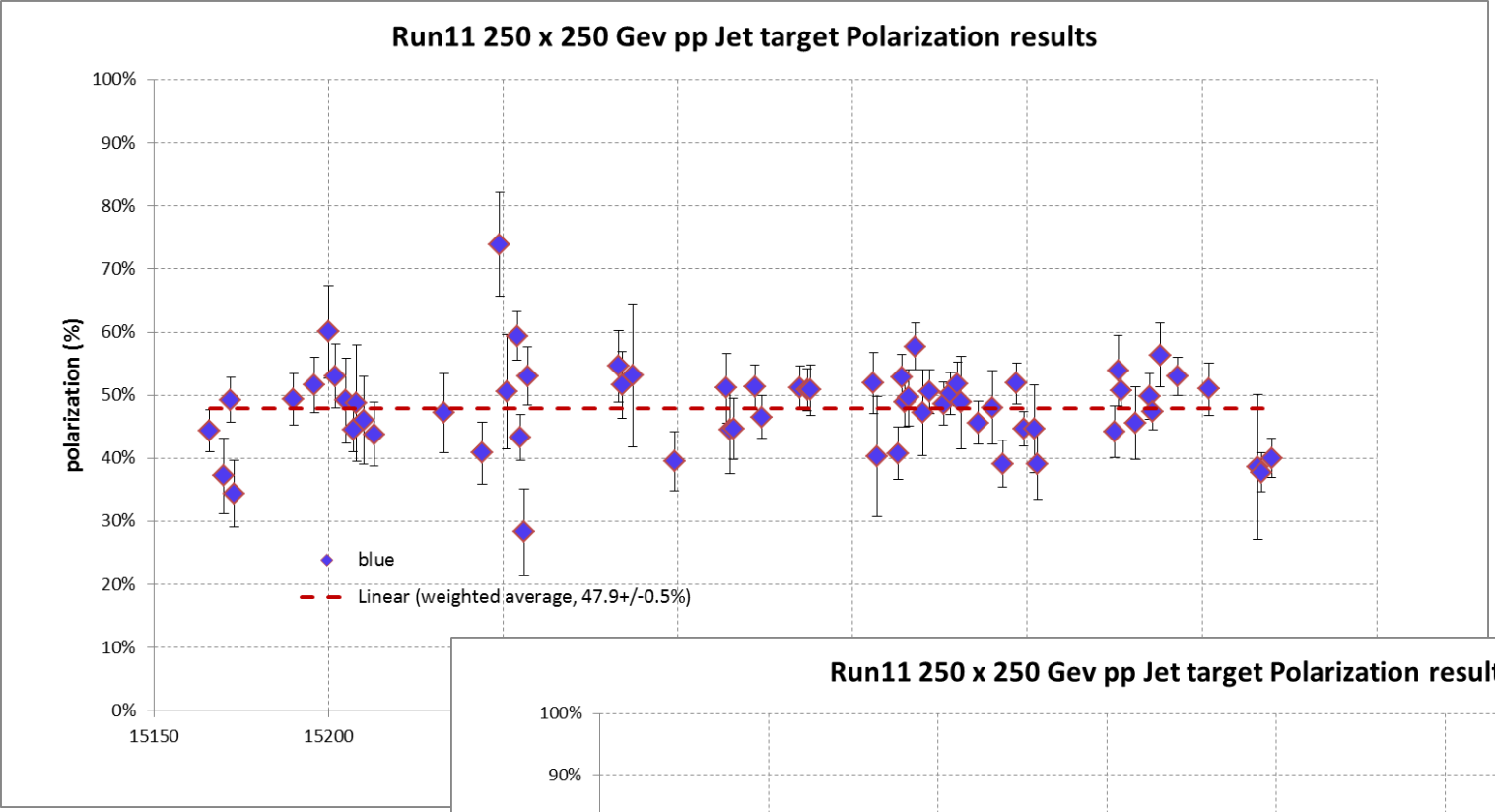
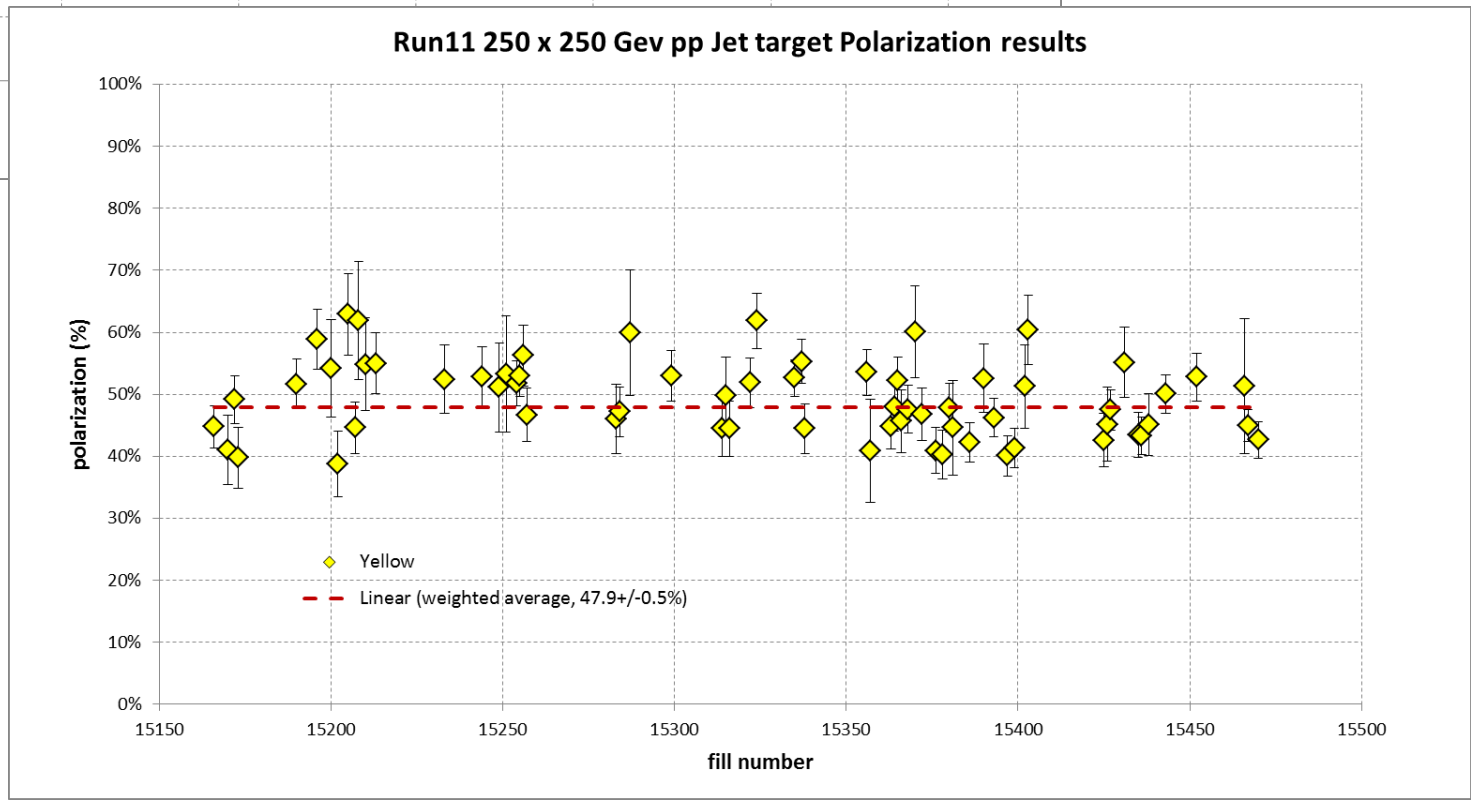


Table2: Max lumi parameters: 1.65x10^{9}/bunch, 0.6 β*, 20-25 mmmr emitt → peak = 200x10^{30} cm^{-2}s^{-1}

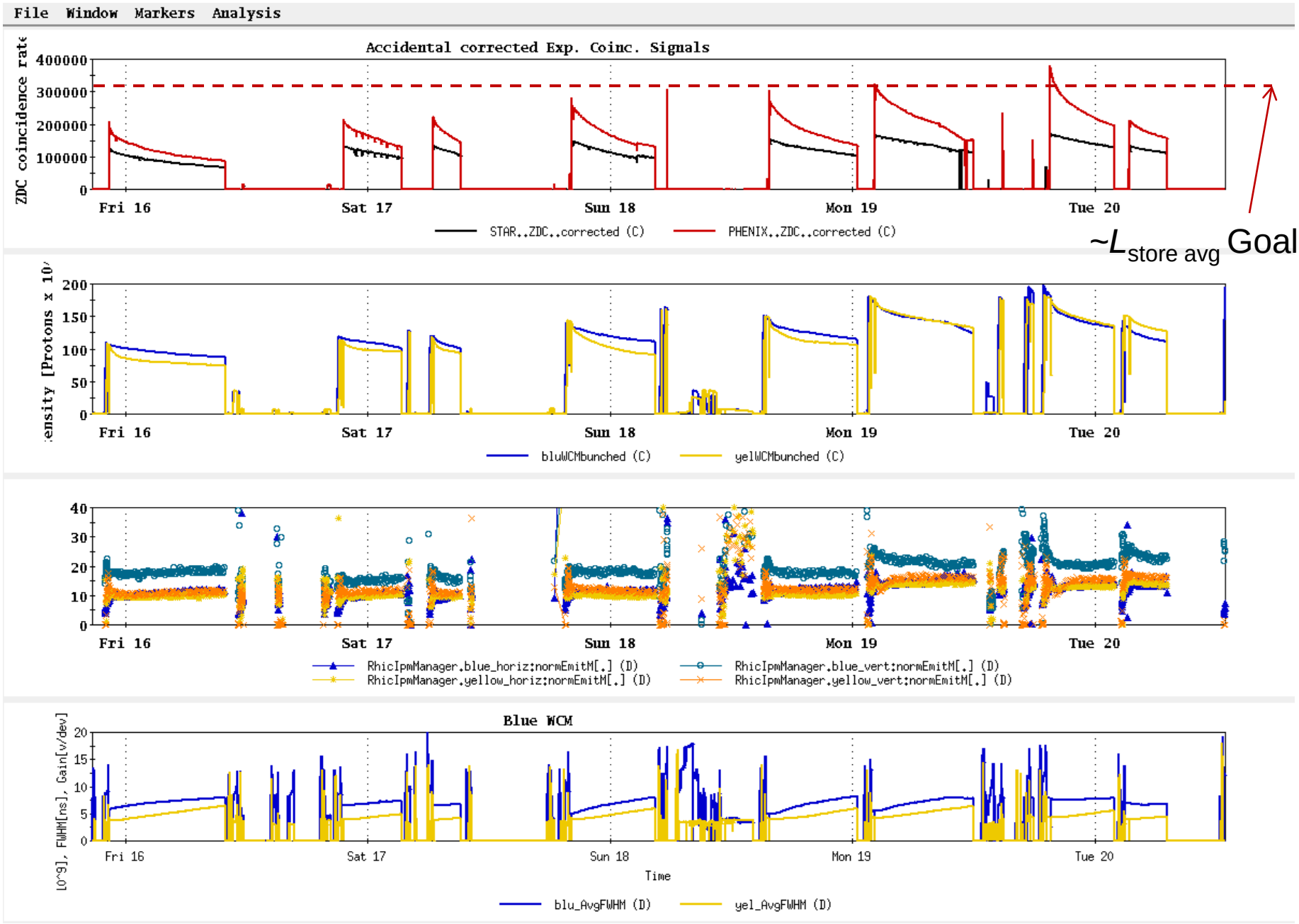
23 Mar – 27 Mar stores



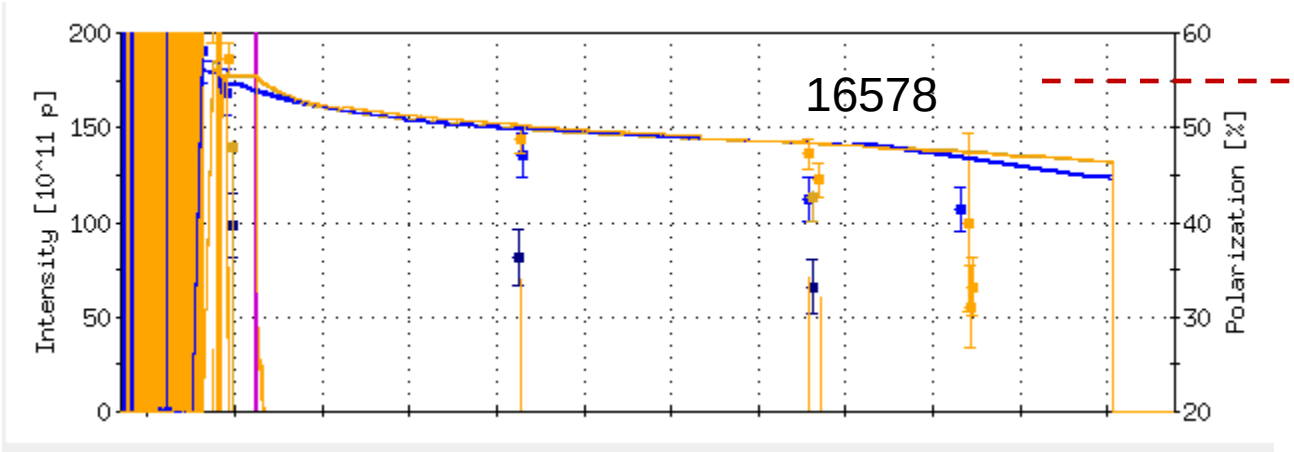

Run11 250 x 250 Gev pp Jet target Polarization results
polarization (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
15150
15200
blue
Linear (weighted average, 47.9+/-0.5%)

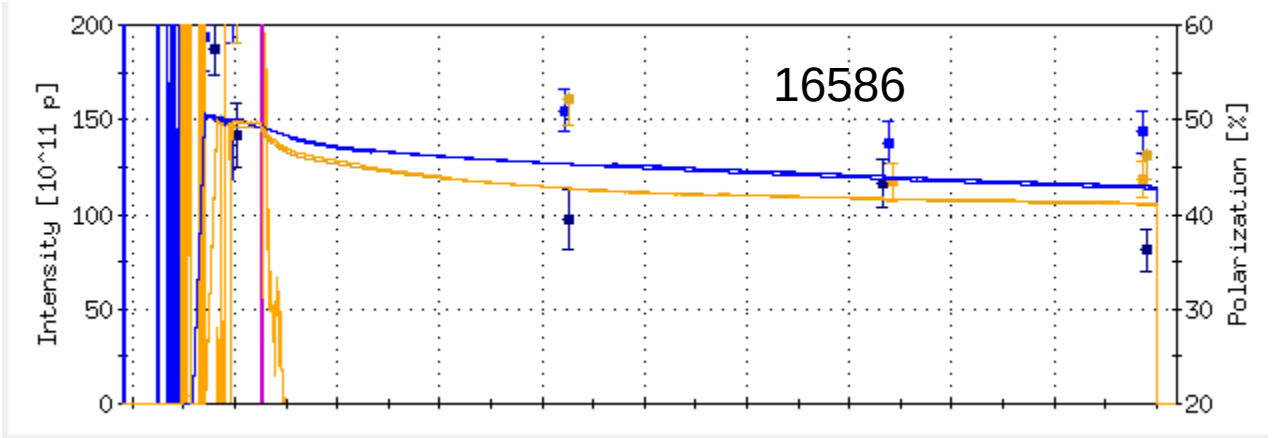

Run11 250 x 250 Gev pp Jet target Polarization results
polarization (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
15150
15200
15250
15300
15350
15400
15450
15500
fill number
Yellow
Linear (weighted average, 47.9+/-0.5%)

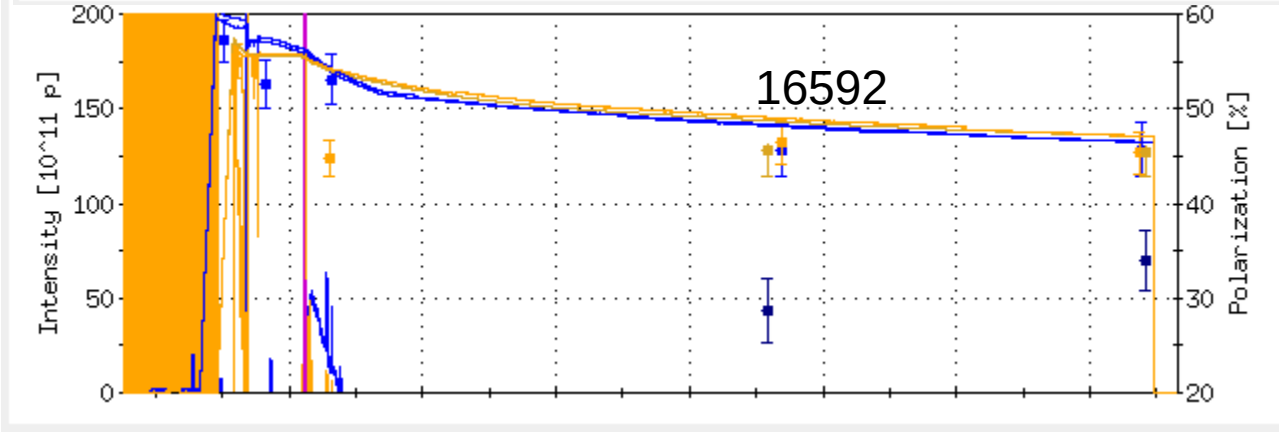
All “physics” stores beginning with16570, 15 March



From “StoreAnalysis” program in “StartUp”







Expectation for 5 weeks physics:
45-95 pb^{-1} delivered luminosity with 45-50% polarization

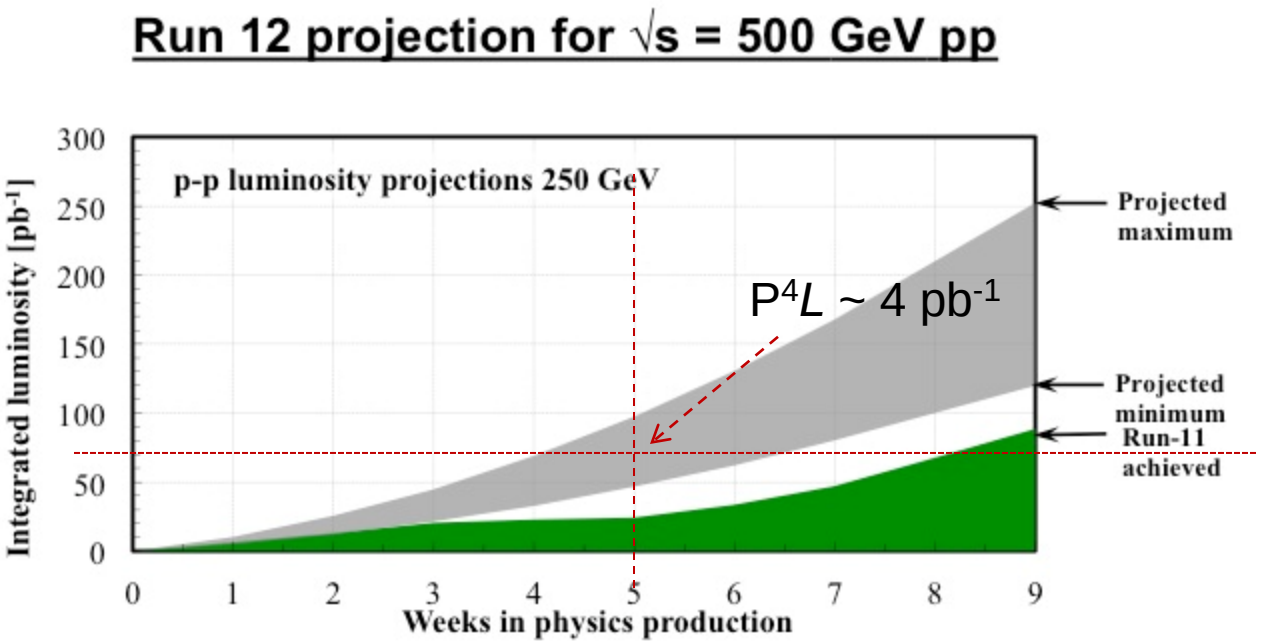
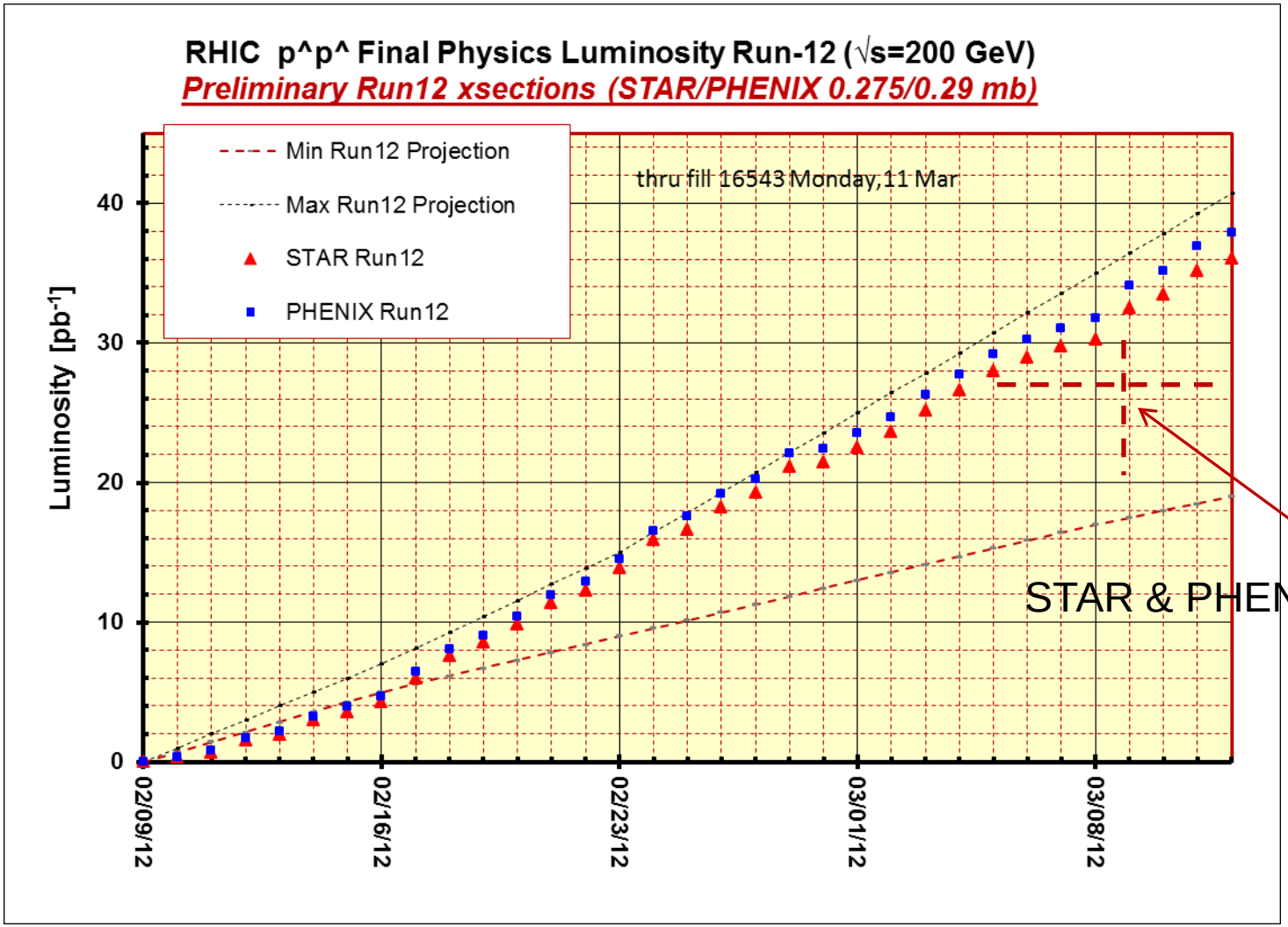
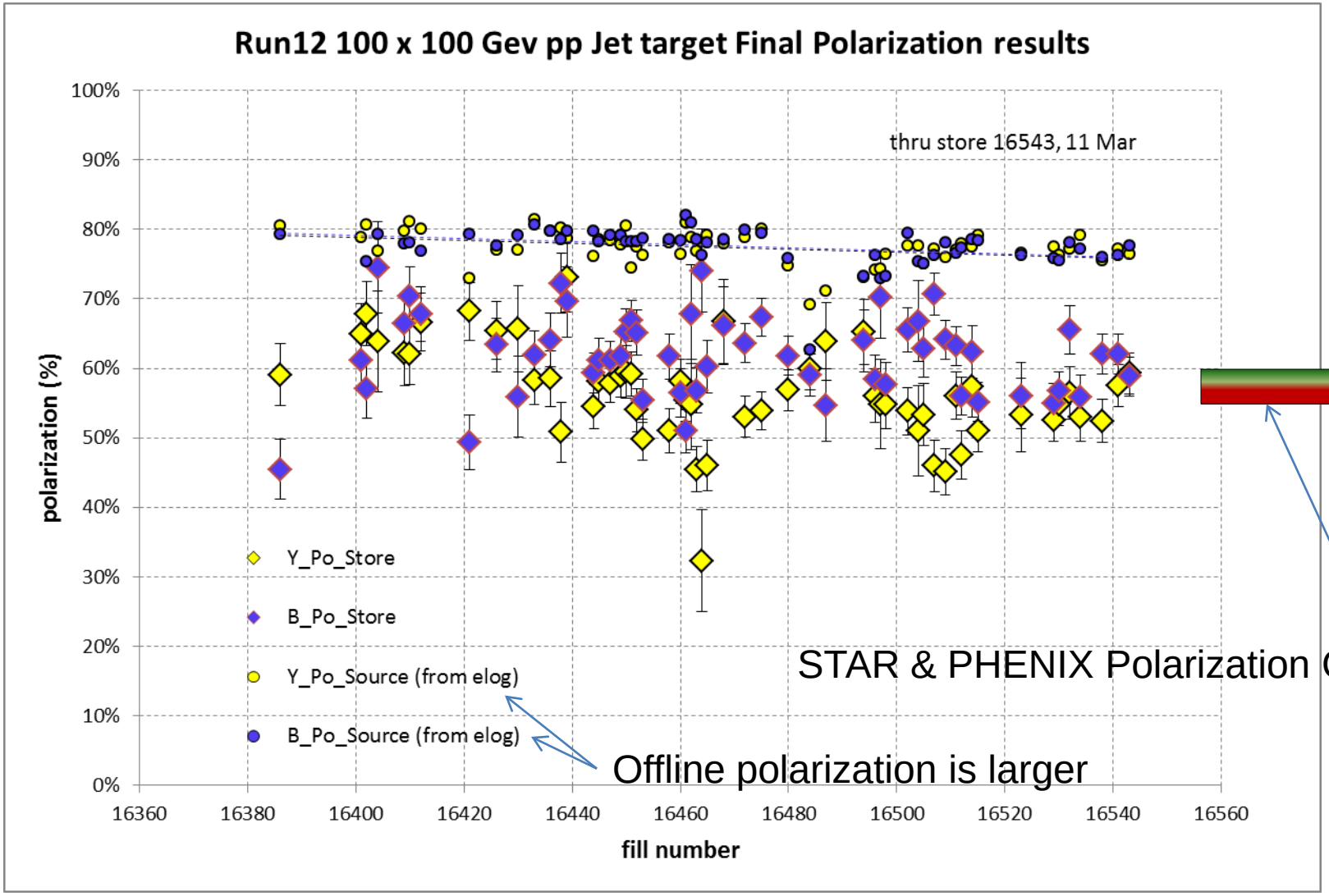


Figure 4: Projected minimum and maximum integrated luminosities for polarized proton collisions at 250 GeV beam energy, assuming linear weekly luminosity ramp-up in 8 weeks. An average store polarization between 45 and 50% is expected.

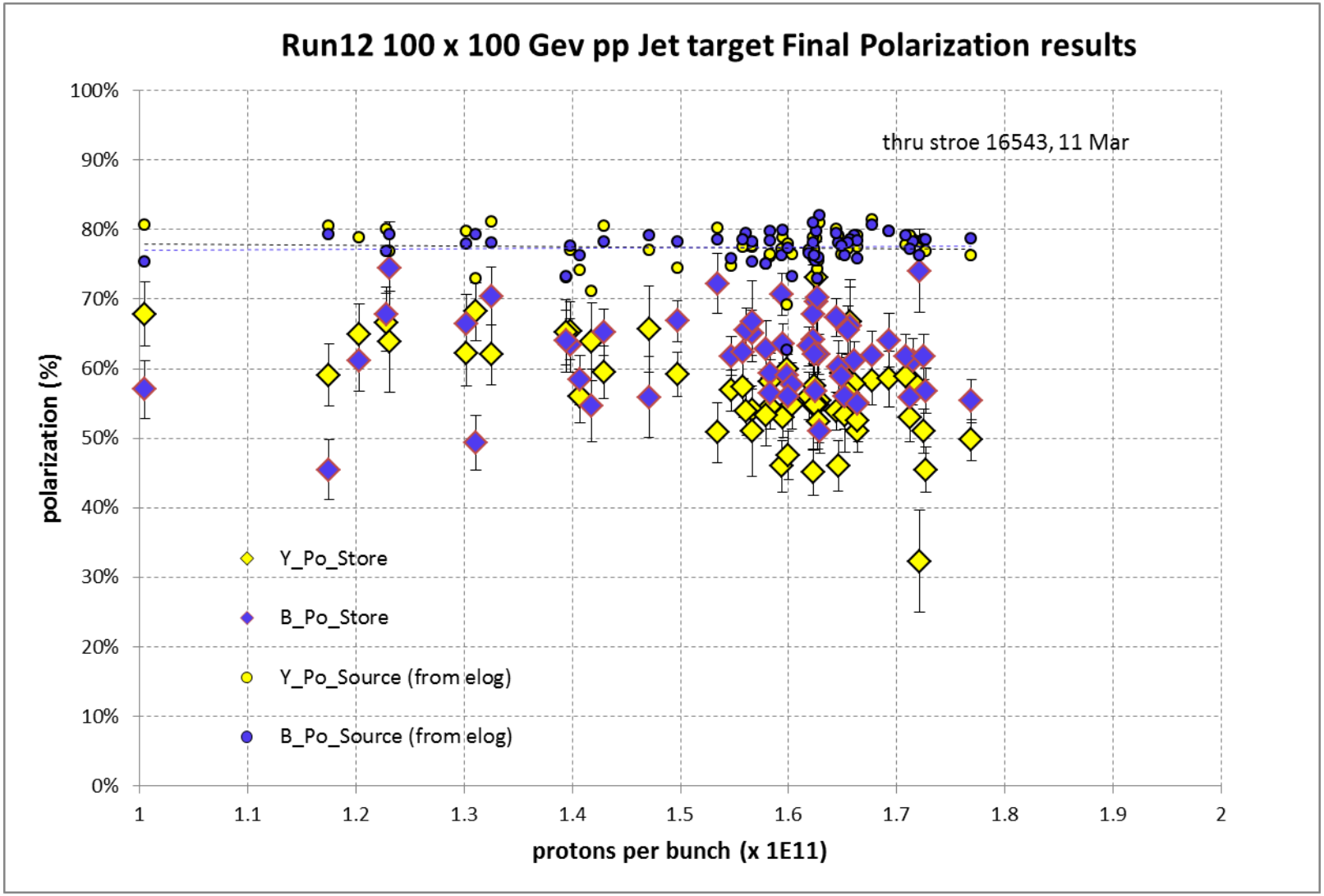
From Fischer et. Al. "RHIC Collider Projections (FY 2012 – FY 2016)"
14 October 2011

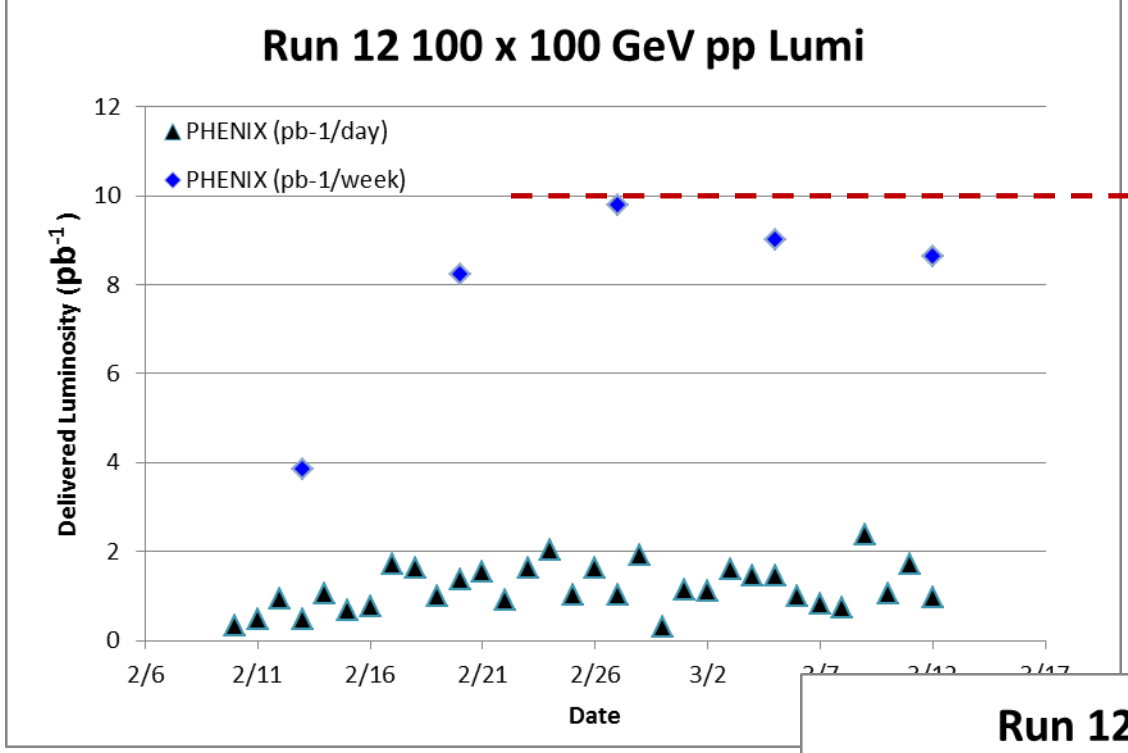

RHIC p^p^ Final Physics Luminosity Run-12 (√s=200 GeV)
Preliminary Run12 xsections (STAR/PHENIX 0.275/0.29 mb)
Min Run12 Projection
Max Run12 Projection
STAR Run12
PHENIX Run12
thru fill 16543 Monday,11 Mar
Luminosity [pb-1]
0
10
20
30
40
02/09/12
02/16/12
02/23/12
03/01/12
03/08/12
STAR & PHENIX Goal



Blue Jet weighted average = 61.2% ± 0.5%;
Yellow Jet weighted average = 55.8% ± 0.5%;

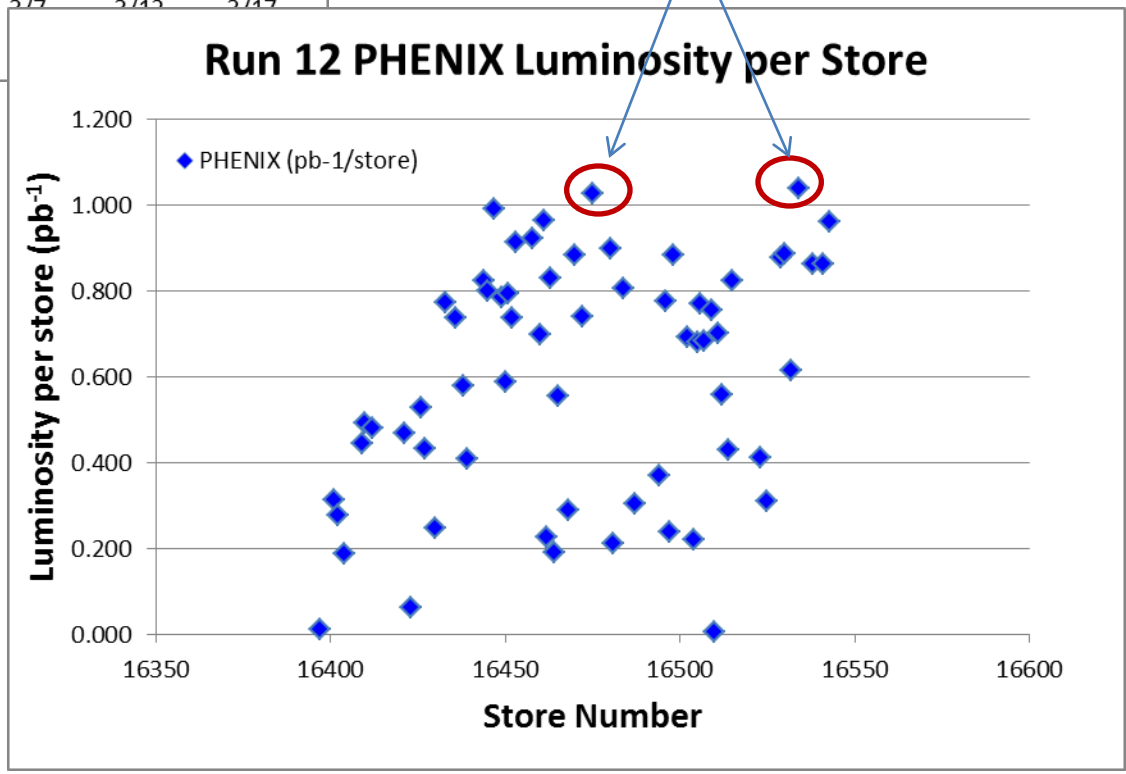
source blue average = 77.5% → **20% lost**
source yellow average = 77.4% → **28% lost**

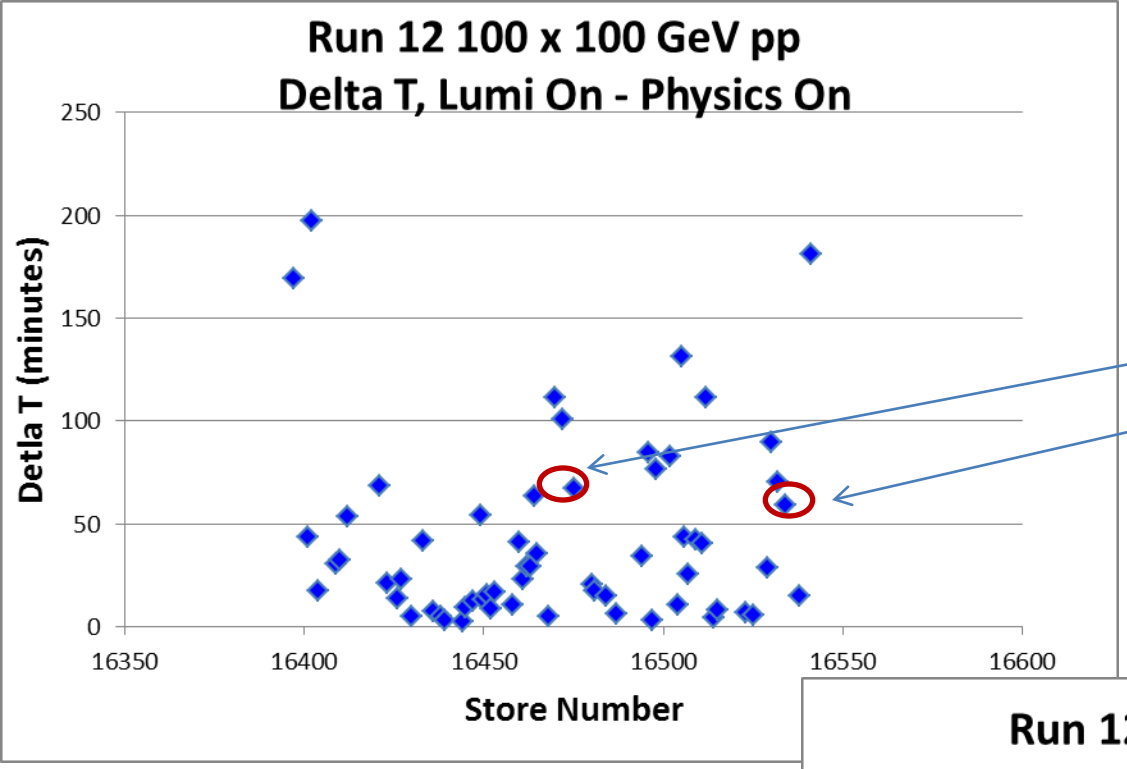

Run12 100 x 100 Gev pp Jet target Final Polarization results
thru stroe 16543, 11 Mar
polarization (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2
protons per bunch (x 1E11)
Y_Po_Store
B_Po_Store
Y_Po_Source (from elog)
B_Po_Source (from elog)



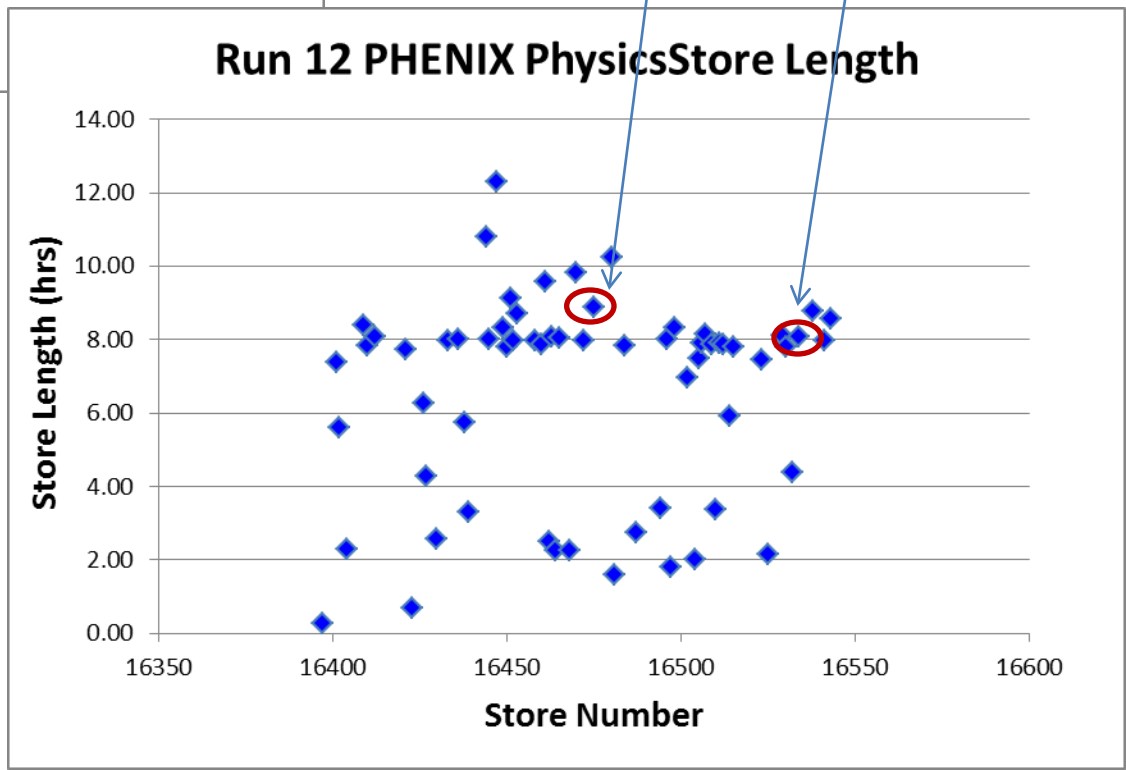
Target (max projection)

Best stores, 16475 and 16534

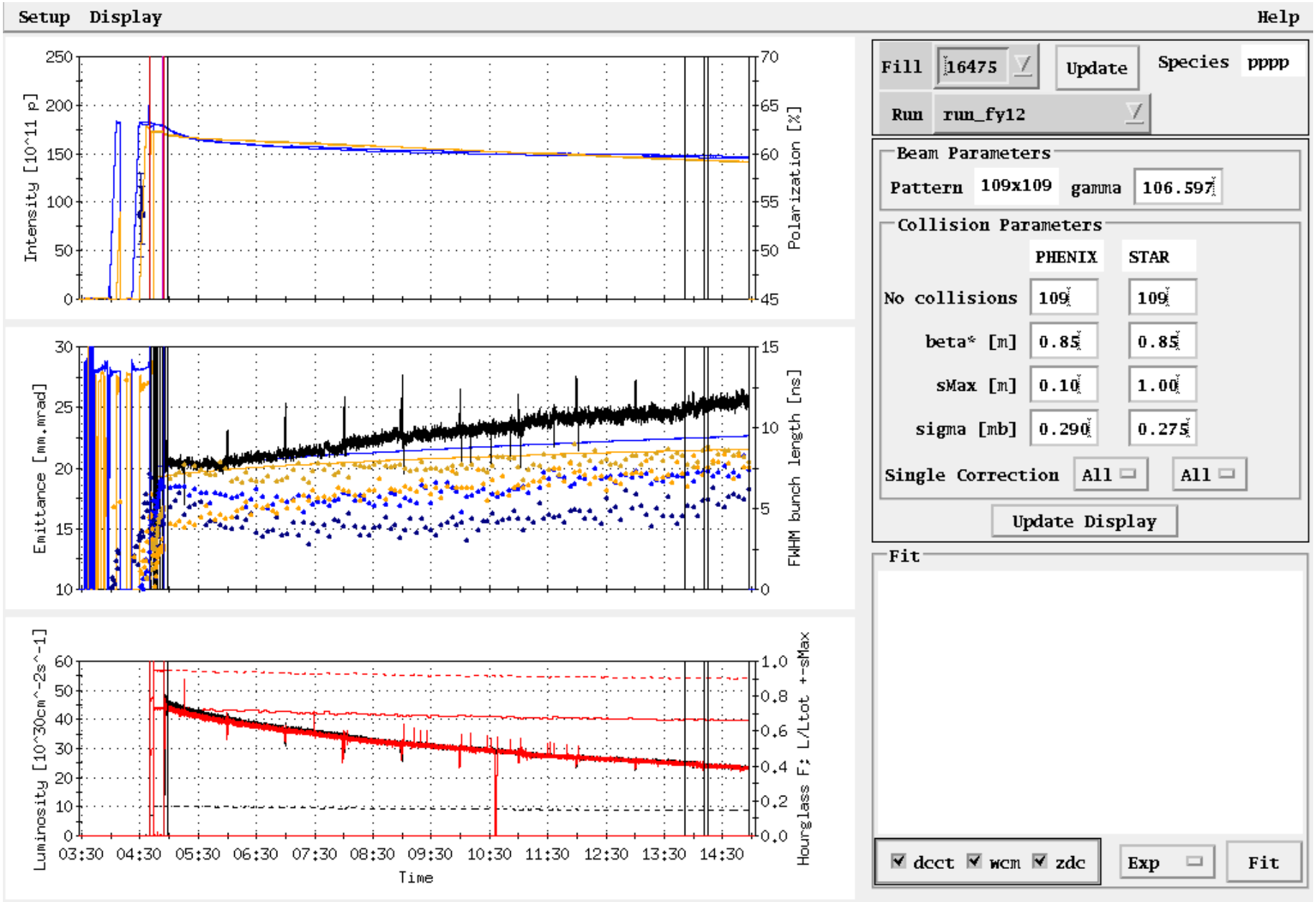




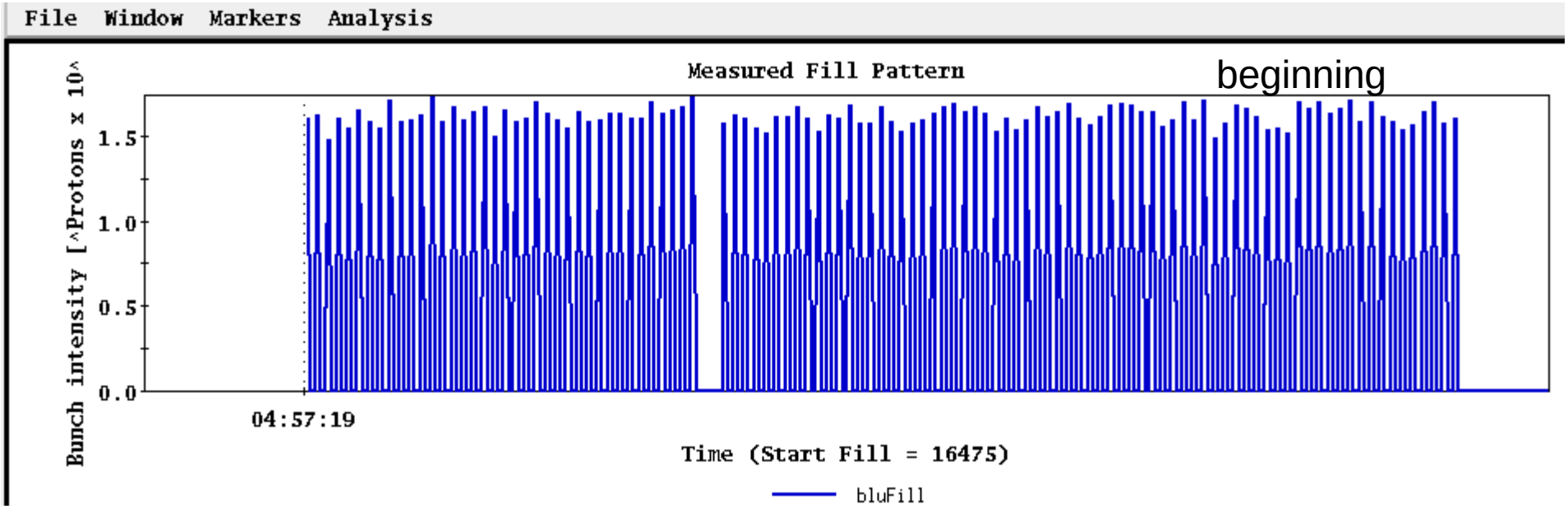
Best stores, 16475 and 16534

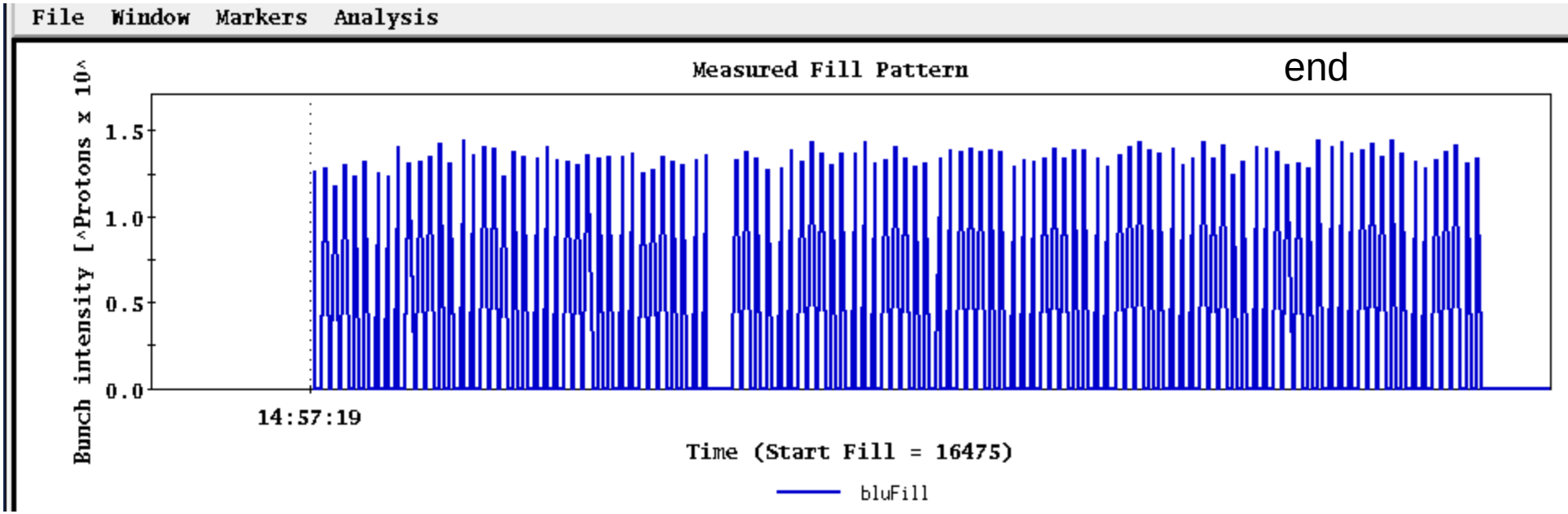


Fill 16475, 27 Feb, 8.9 hours physics store (10 hour Lumi on Store), PHENIX 1.03 pb^{-1}

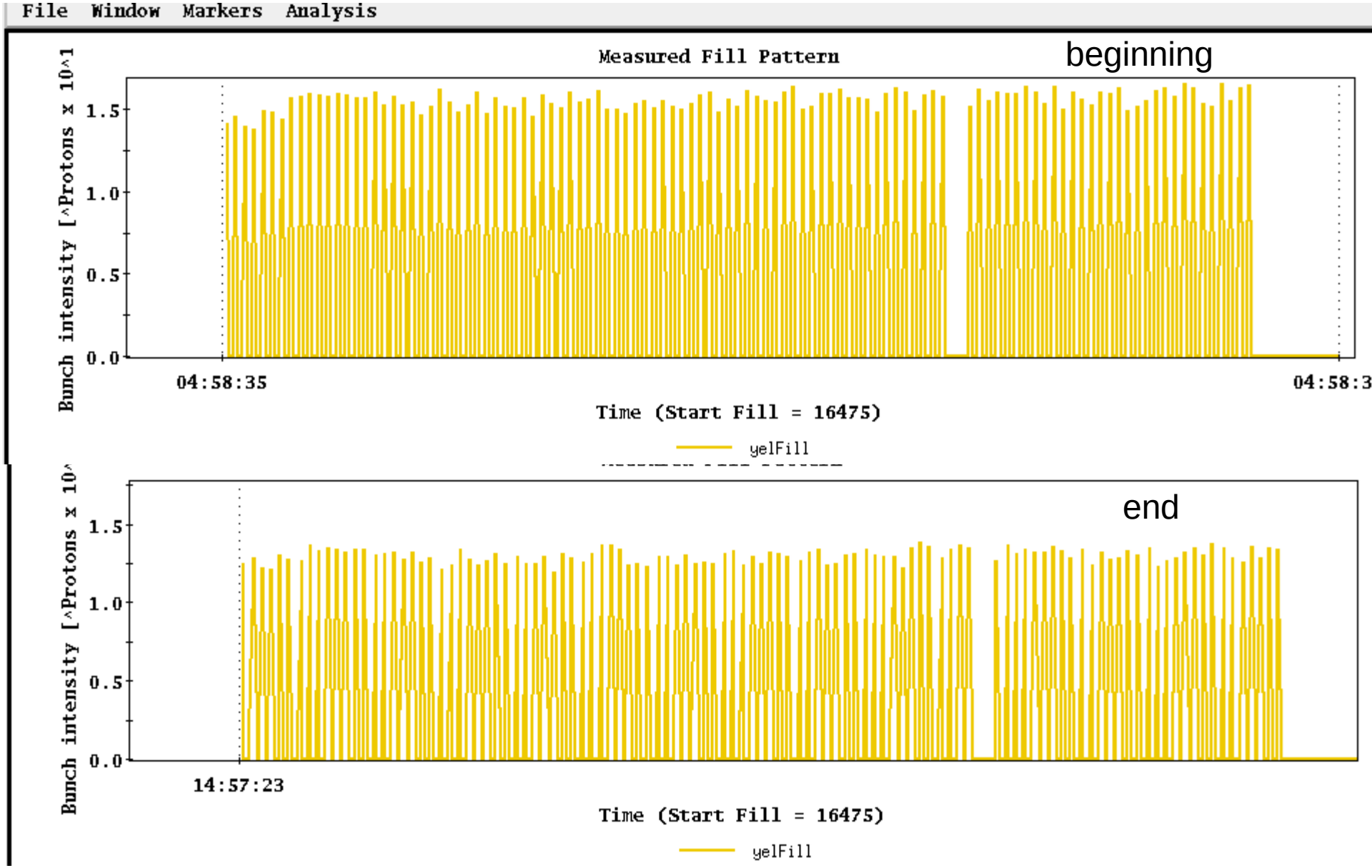


Fill 16475, 27 Feb, 8.9 hours physics store (10 hour Lumi on Store), PHENIX 1.03 pb^{-1}

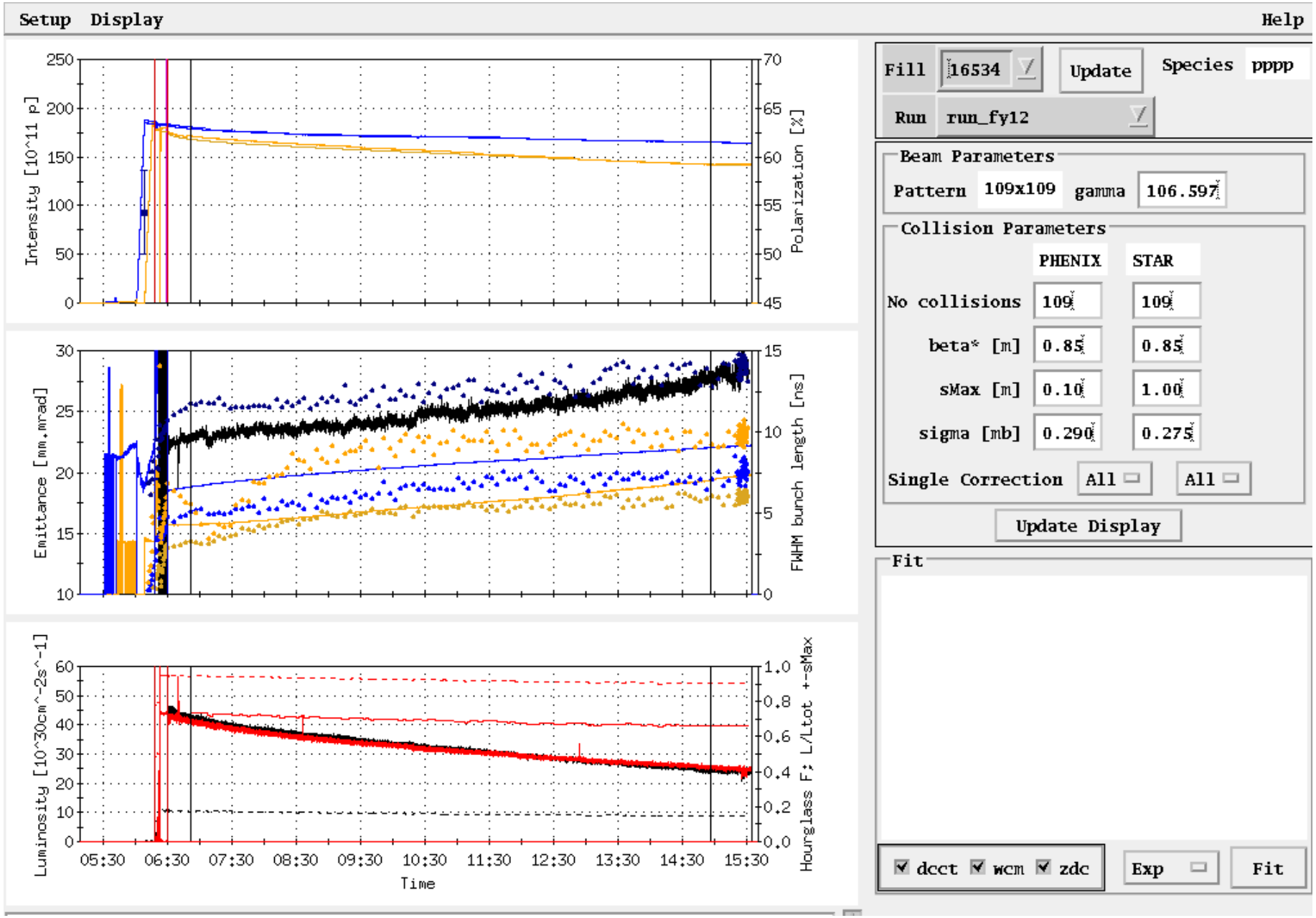




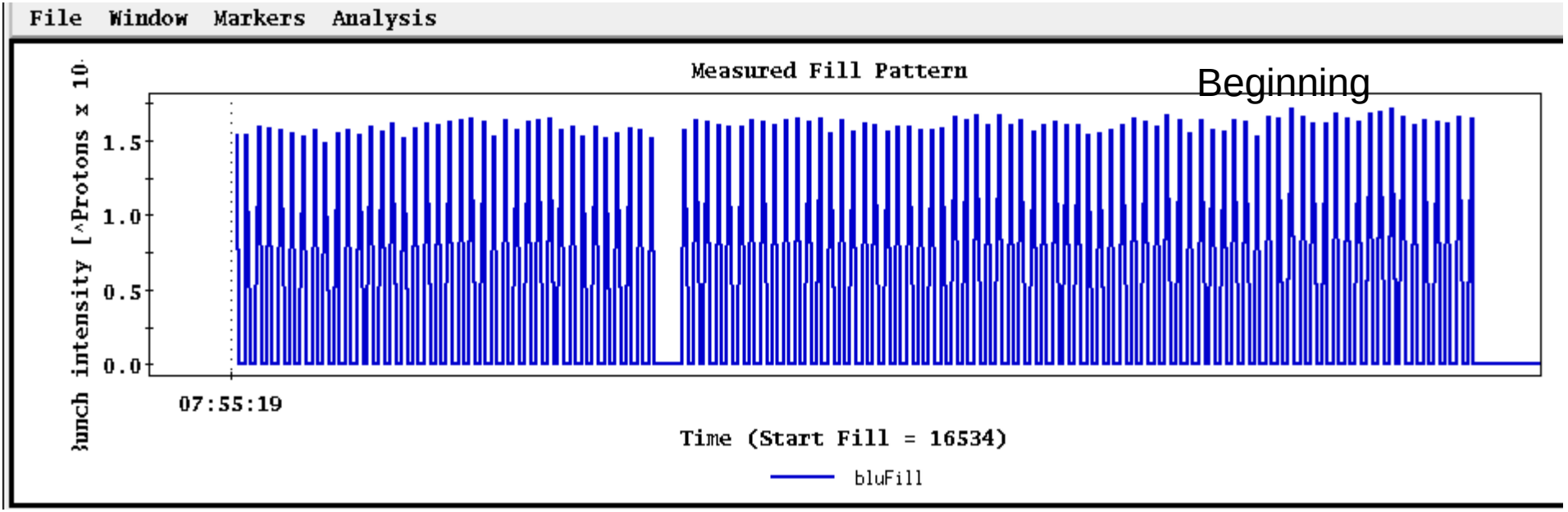
Fill 16475, 27 Feb, 8.9 hours physics store (10 hour Lumi on Store), PHENIX 1.03 pb^{-1}

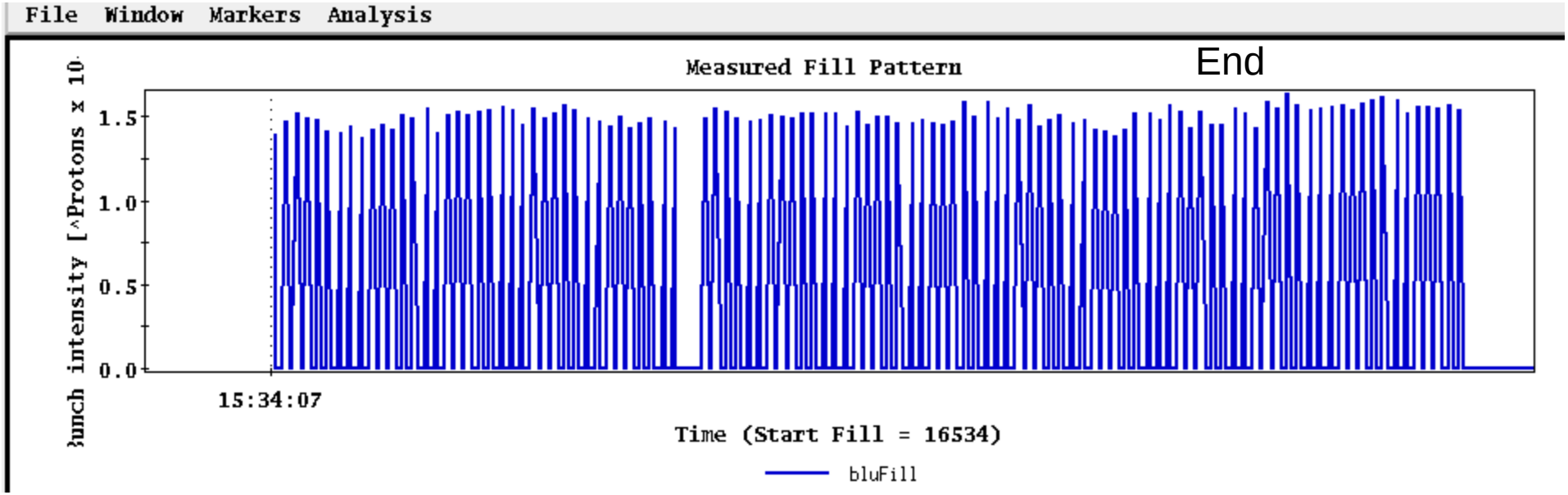


Fill 16534, 9 Mar, 8.1 hours physics store (9.1 hr Lumi on store), PHENIX 1.04 pb^{-1}

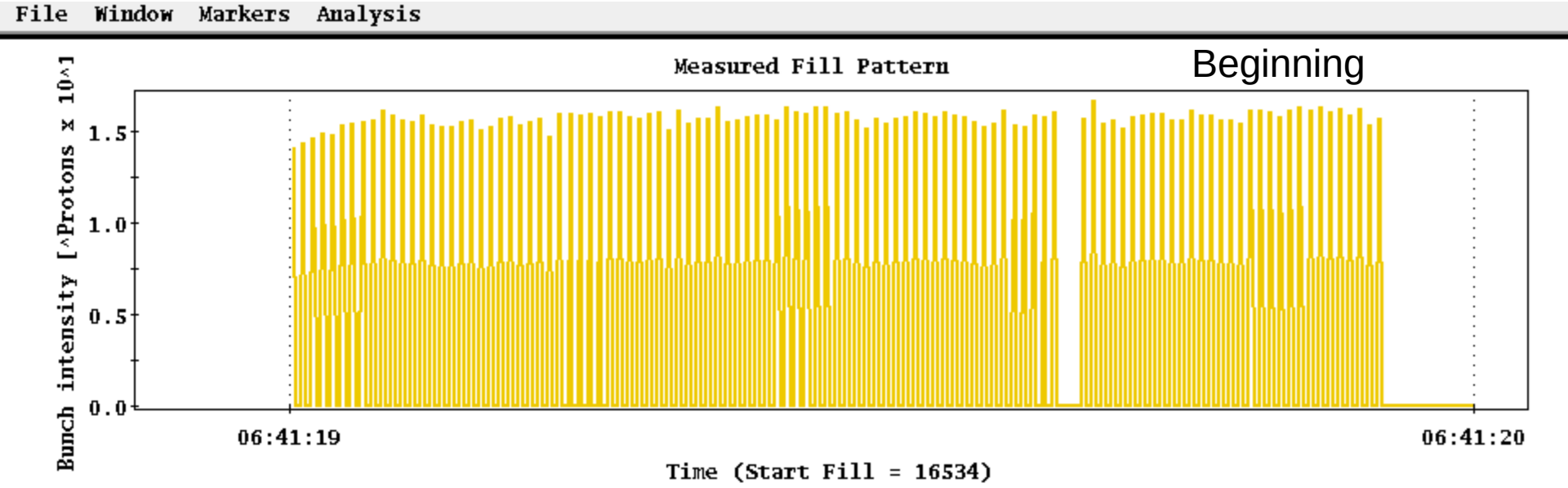


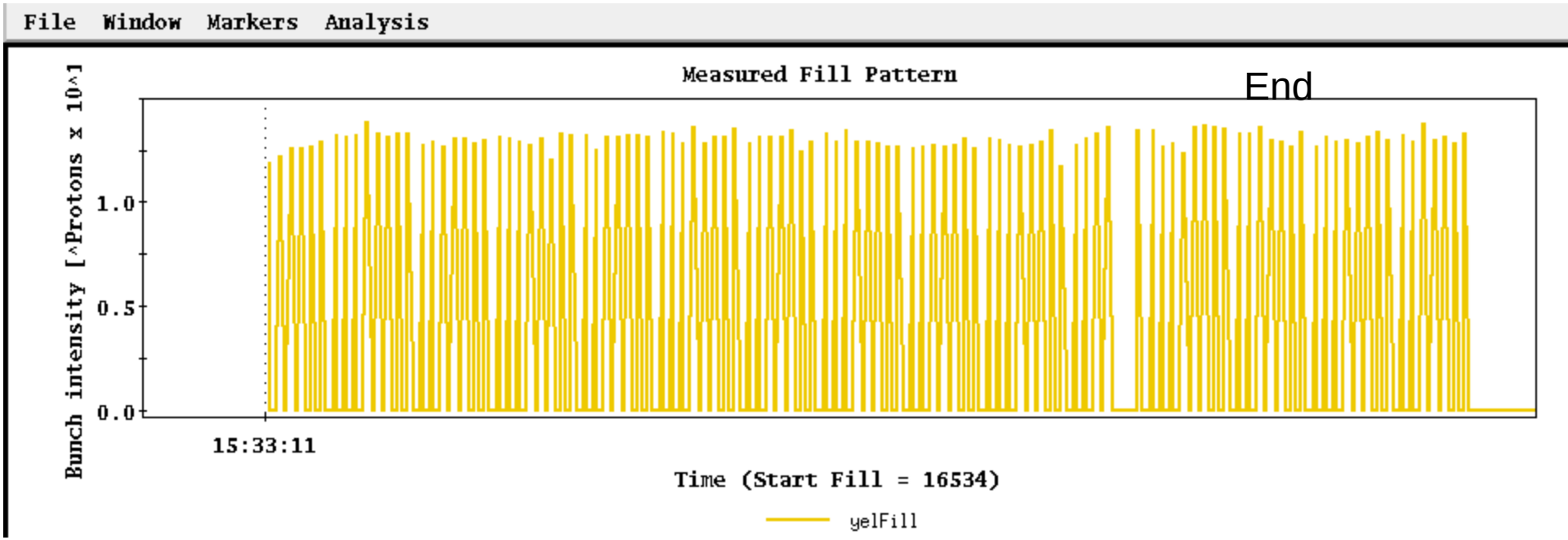
Fill 16534, 9 Mar, 8.1 hours physics store (9.1 hr Lumi on store), PHENIX 1.04 pb^{-1}

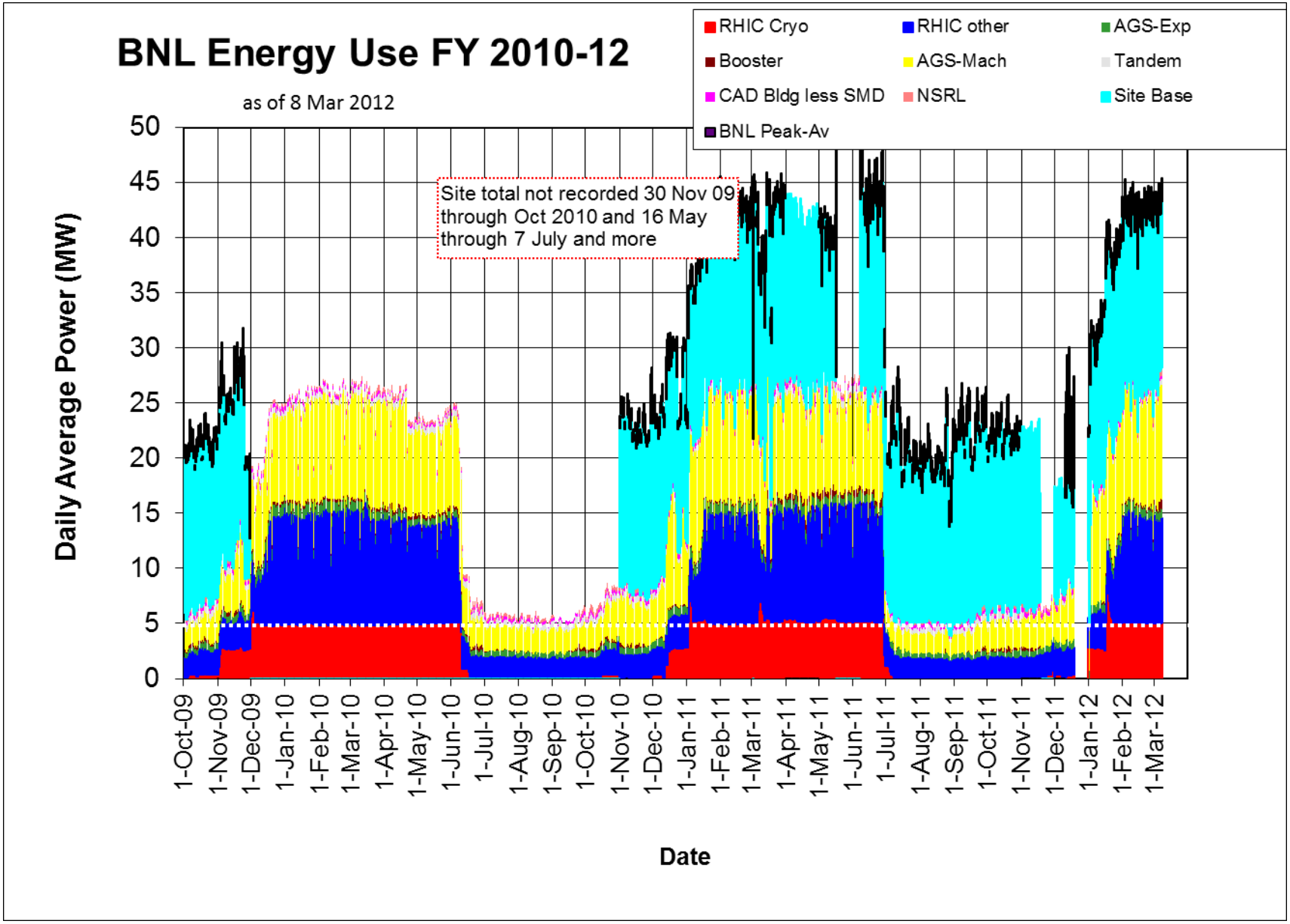




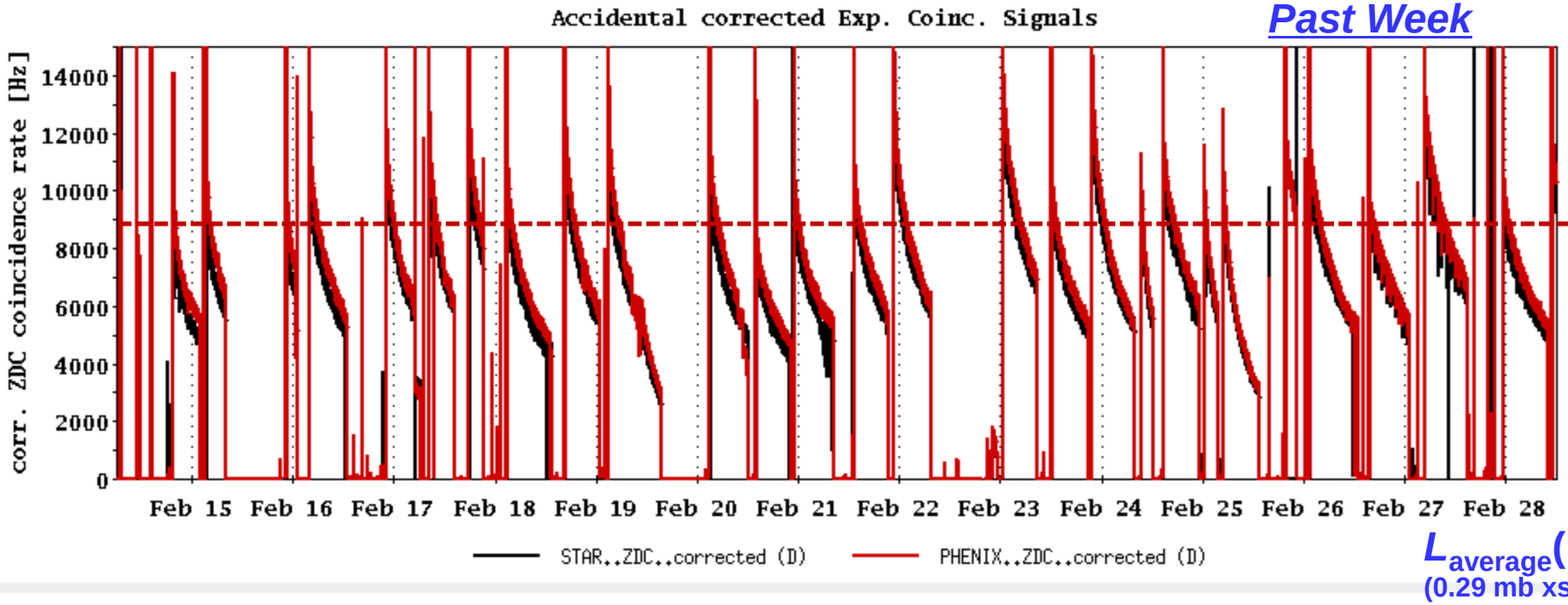
Fill 16534, 9 Mar, 8.1 hours physics store (9.1 hr Lumi on store), PHENIX 1.04 pb^{-1}





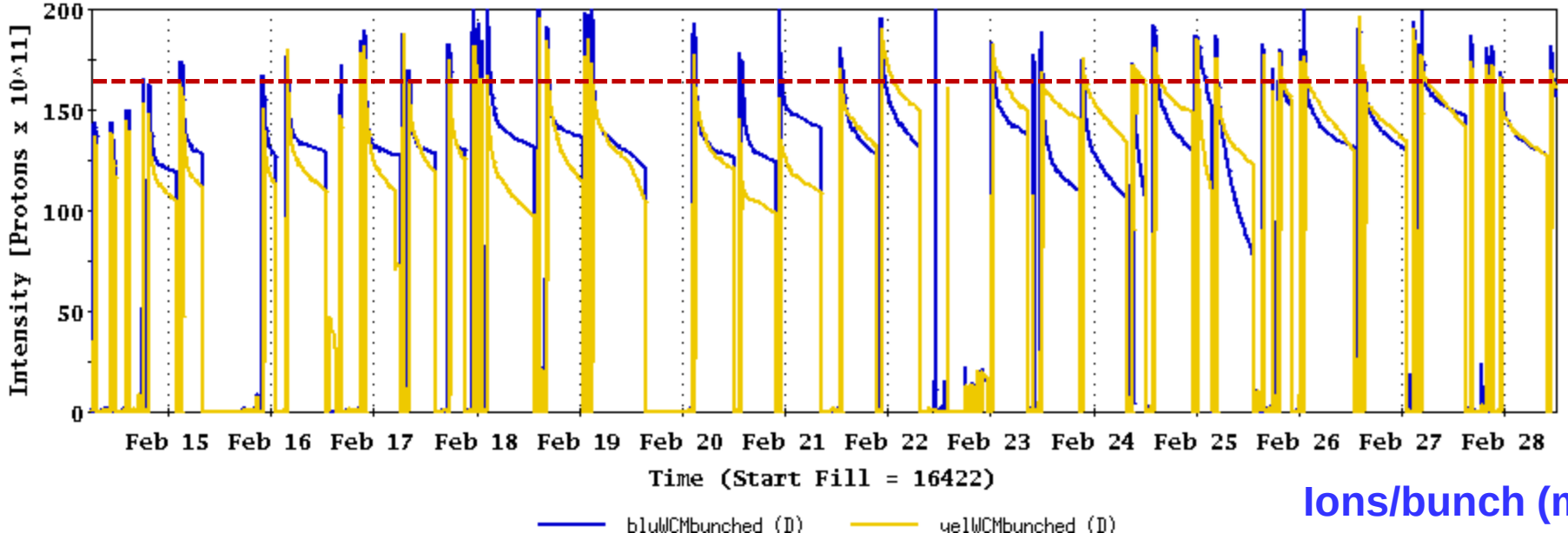

BNL Energy Use FY 2010-12
as of 8 Mar 2012
RHIC Cryo
RHIC other
AGS-Exp
Booster
AGS-Mach
Tandem
CAD Bldg less SMD
NSRL
Site Base
BNL Peak-Av
Site total not recorded 30 Nov 09 through Oct 2010 and 16 May through 7 July and more
Daily Average Power (MW)
0
5
10
15
20
25
30
35
40
45
50
1-Oct-09
1-Nov-09
1-Dec-09
1-Jan-10
1-Feb-10
1-Mar-10
1-Apr-10
1-May-10
1-Jun-10
1-Jul-10
1-Aug-10
1-Sep-10
1-Oct-10
1-Nov-10
1-Dec-10
1-Jan-11
1-Feb-11
1-Mar-11
1-Apr-11
1-May-11
1-Jun-11
1-Jul-11
1-Aug-11
1-Sep-11
1-Oct-11
1-Nov-11
1-Dec-11
1-Jan-12
1-Feb-12
1-Mar-12
Date

File Window Markers Analysis

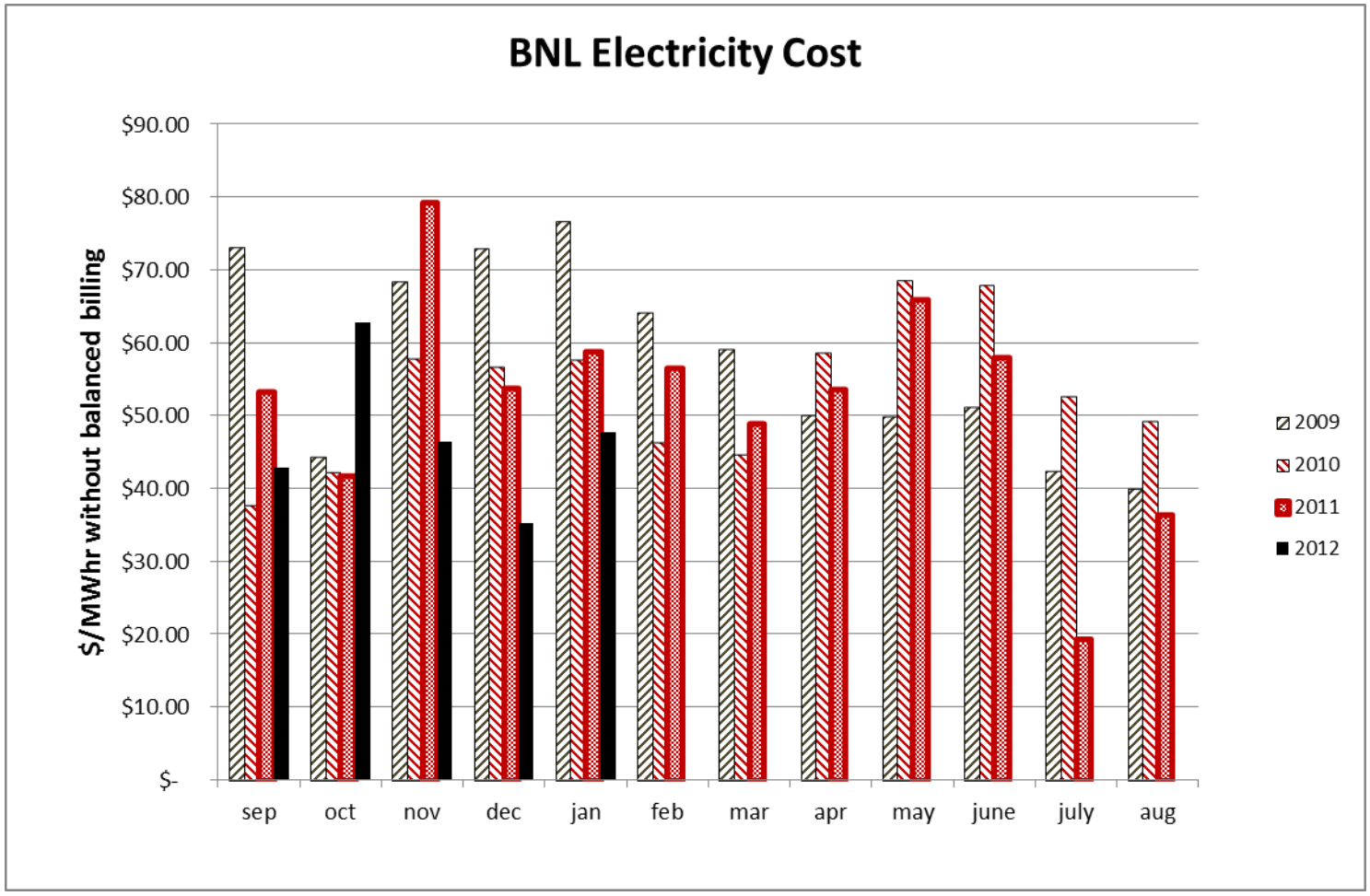


Past Week

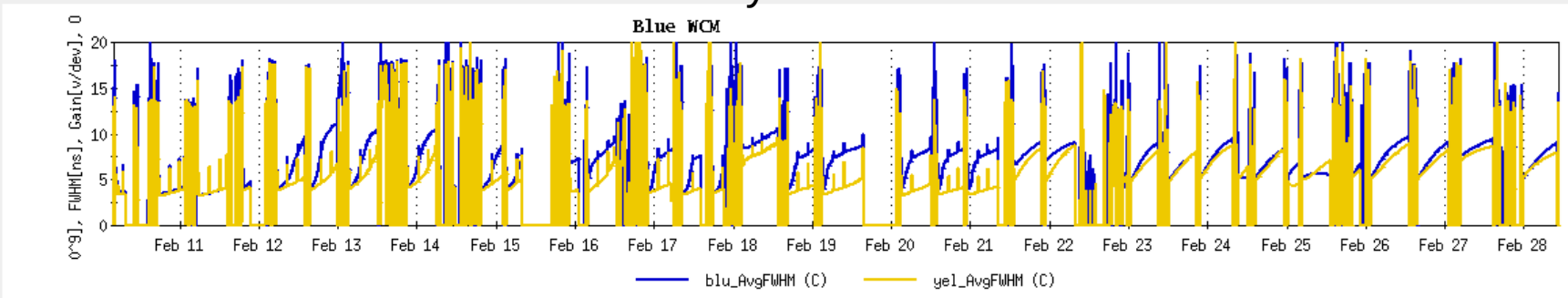
$L_{average}$(ma
(0.29 mb xsect

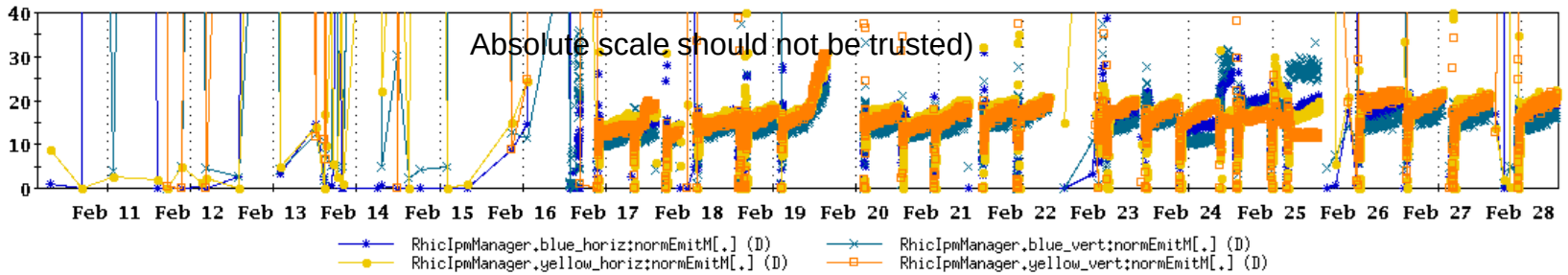


Ions/bunch (ma

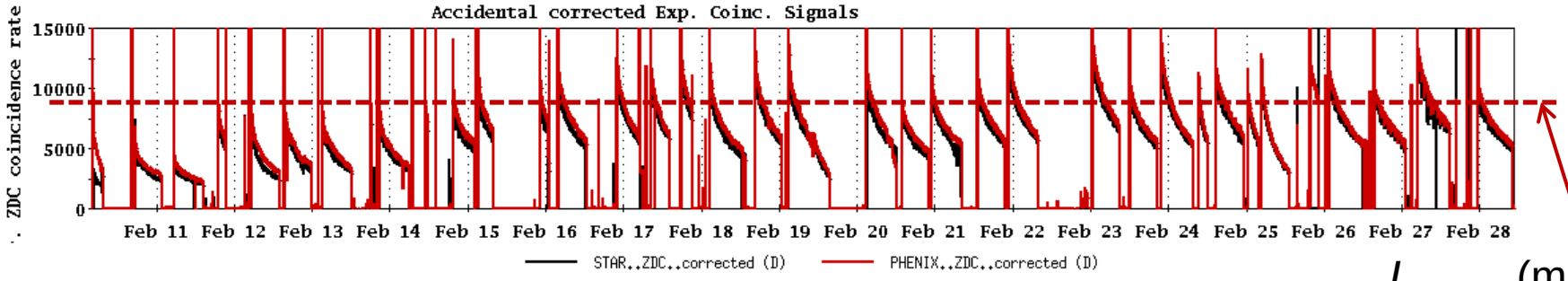

BNL Electricity Cost
$/MWhr without balanced billing
$90.00
$80.00
$70.00
$60.00
$50.00
$40.00
$30.00
$20.00
$10.00
$-
sep
oct
nov
dec
jan
feb
mar
apr
may
june
july
aug
2009
2010
2011
2012

Run 12 Physics Stores to 28 Feb

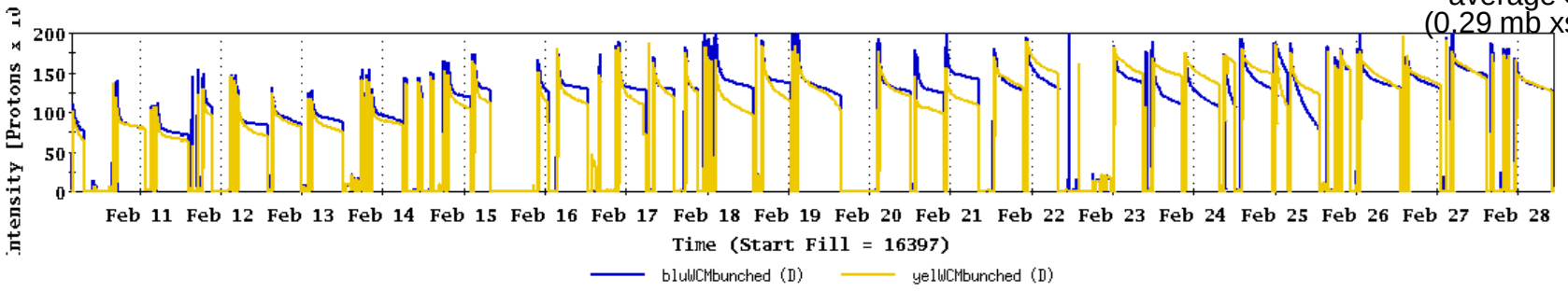




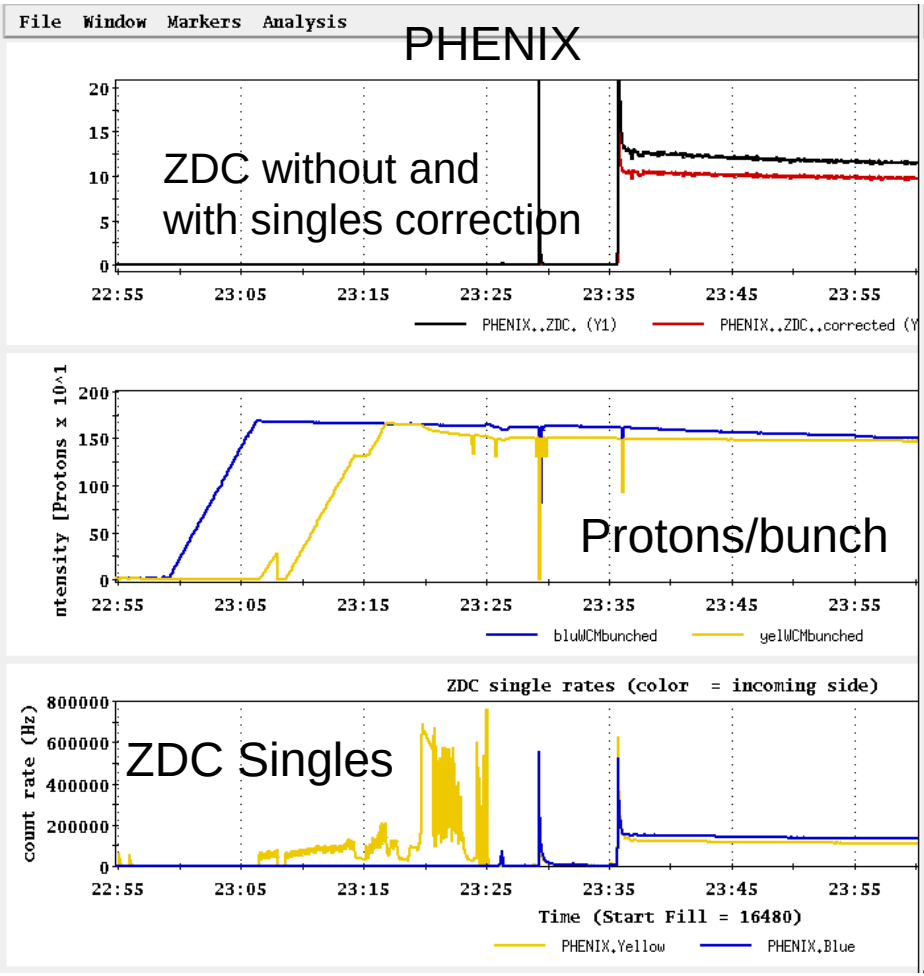
Absolute scale should not be trusted)

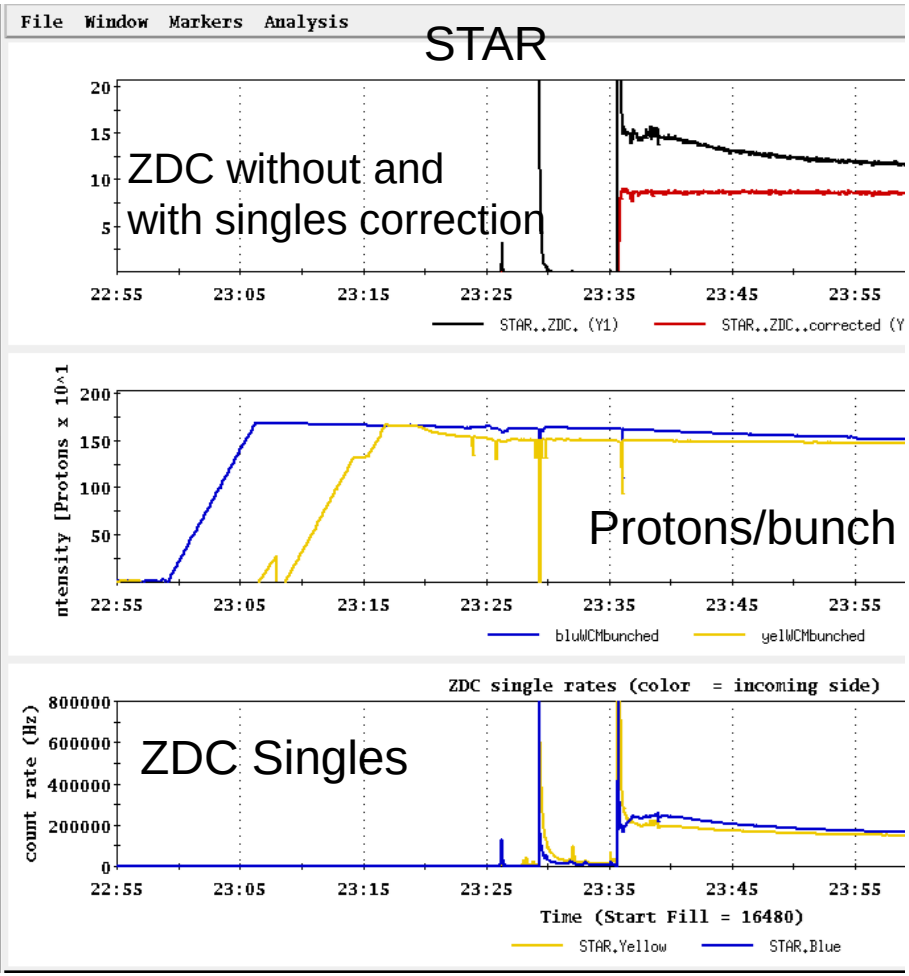


$L_{average}$(max)
(0.29 mb xsection)

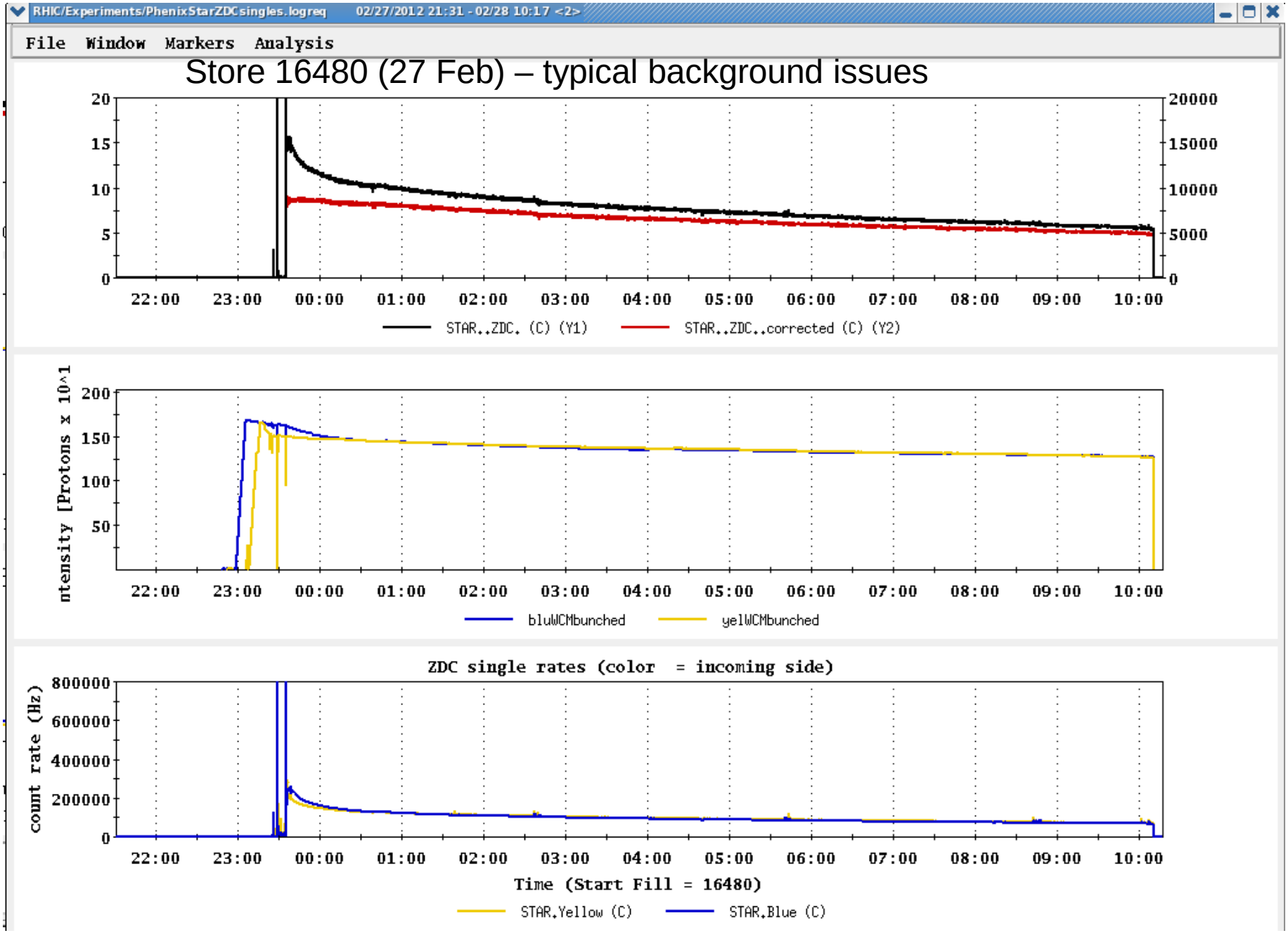


Store 16480 (27 Feb) – typical background issues

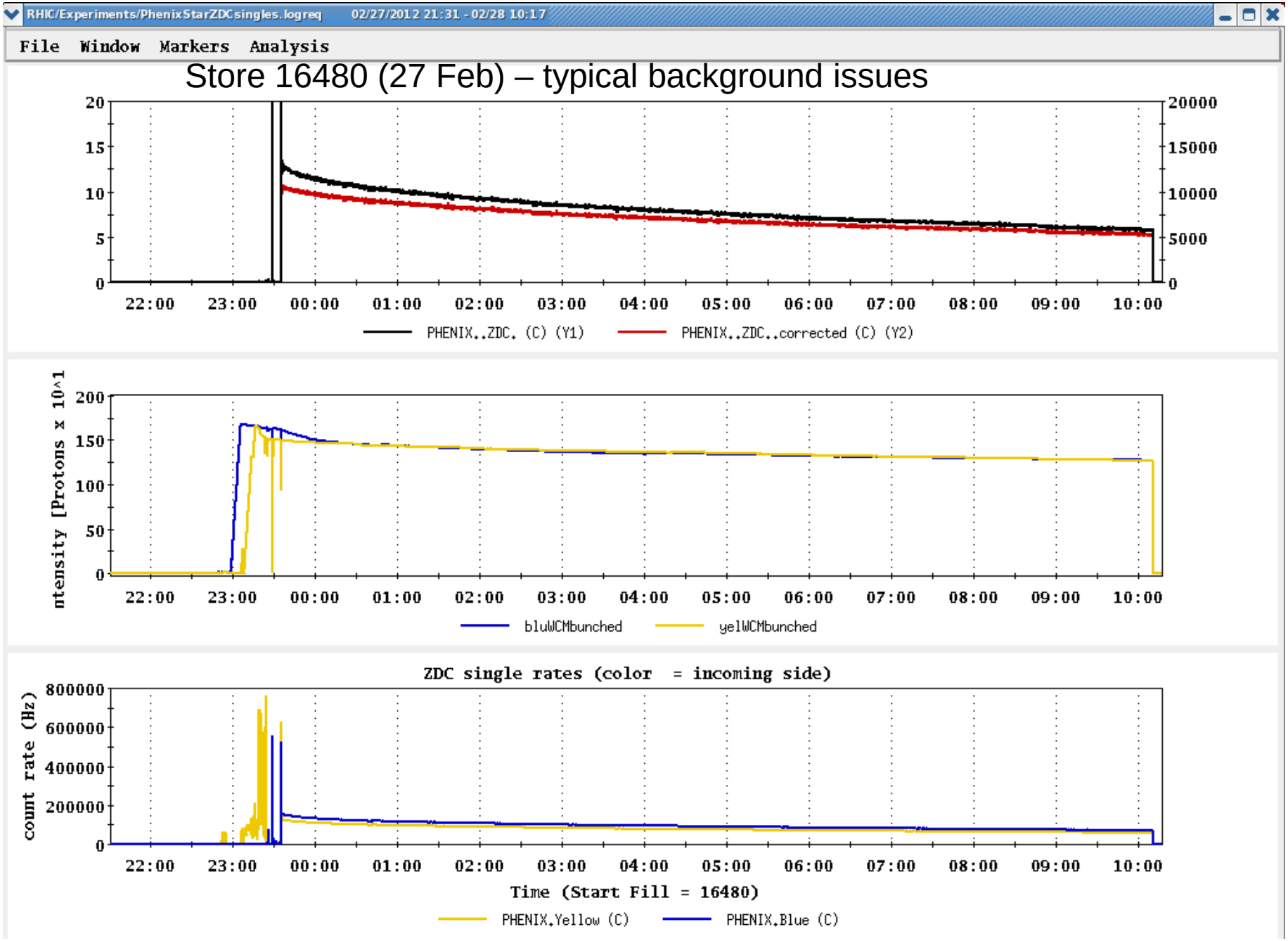




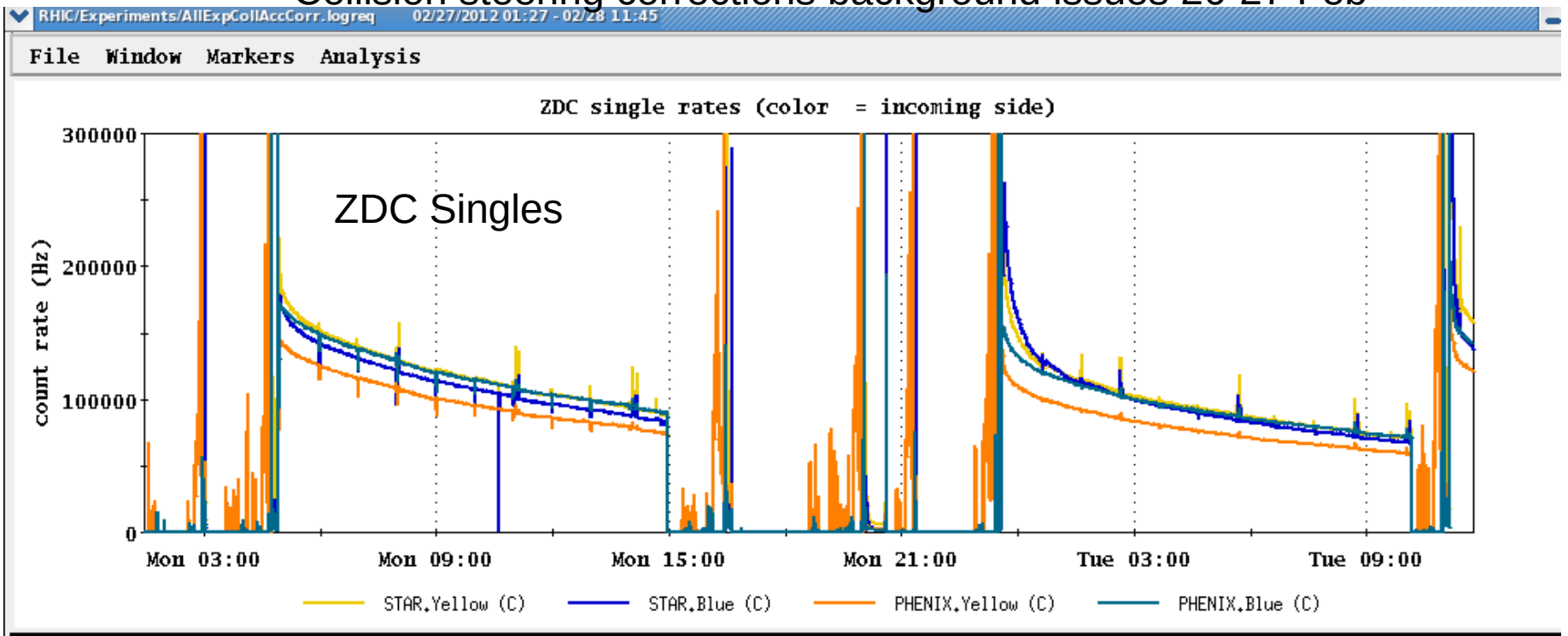
Store 16480 (27 Feb) – typical background issues

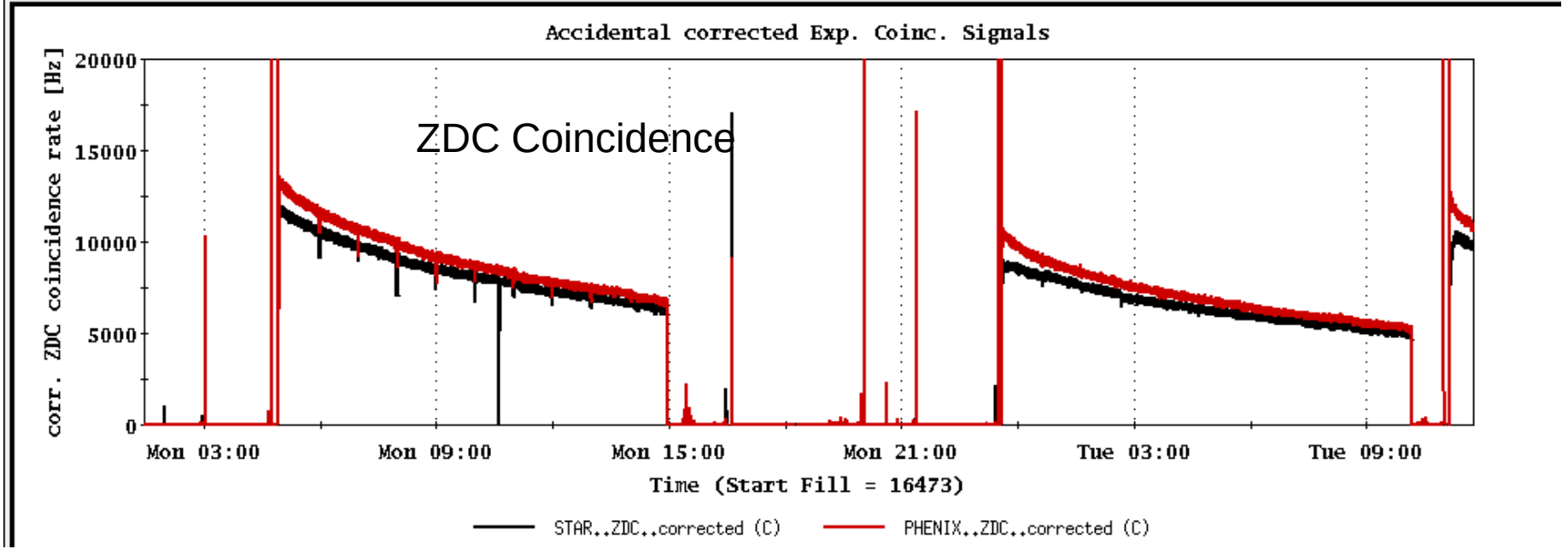


Store 16480 (27 Feb) – typical background issues

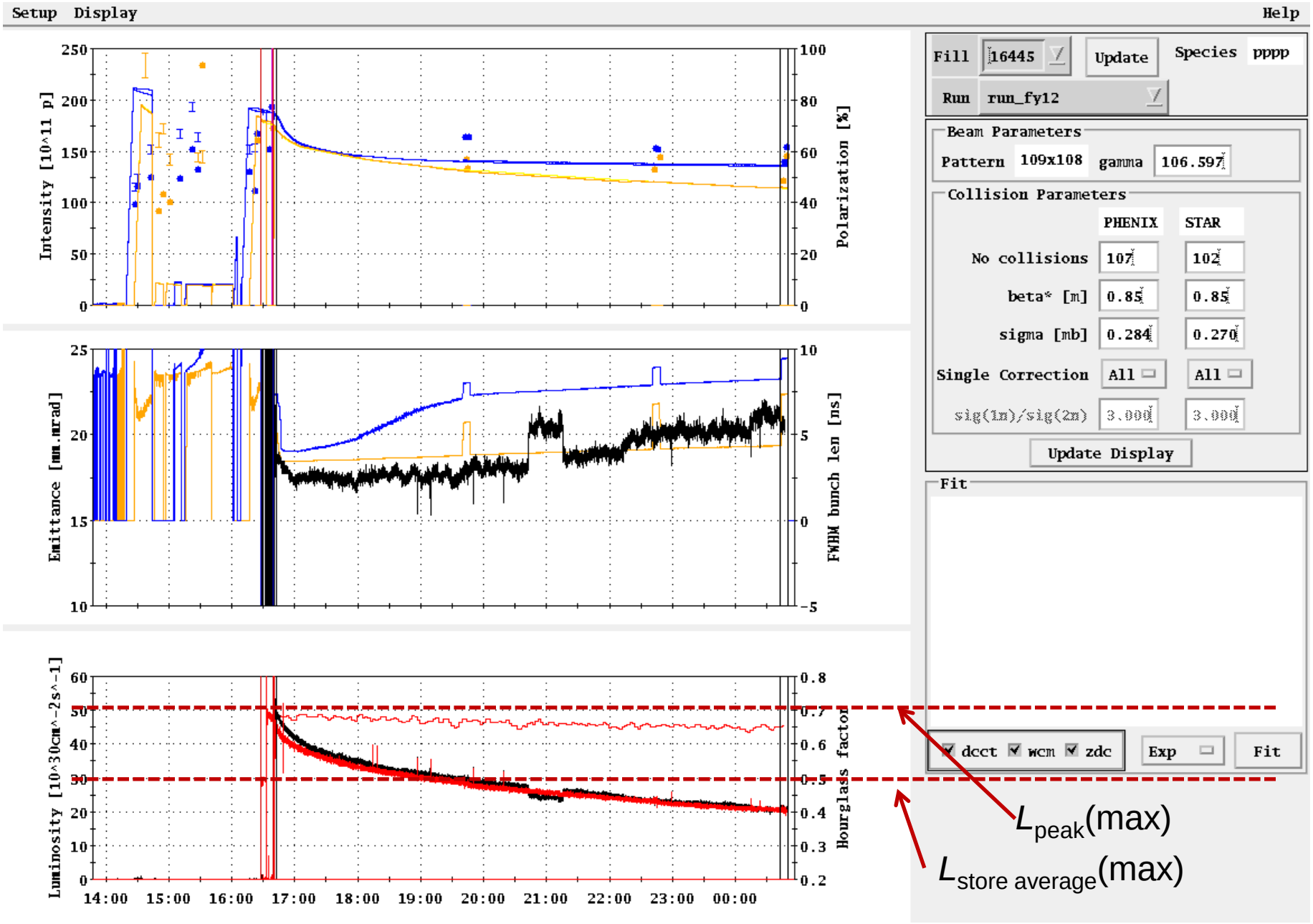


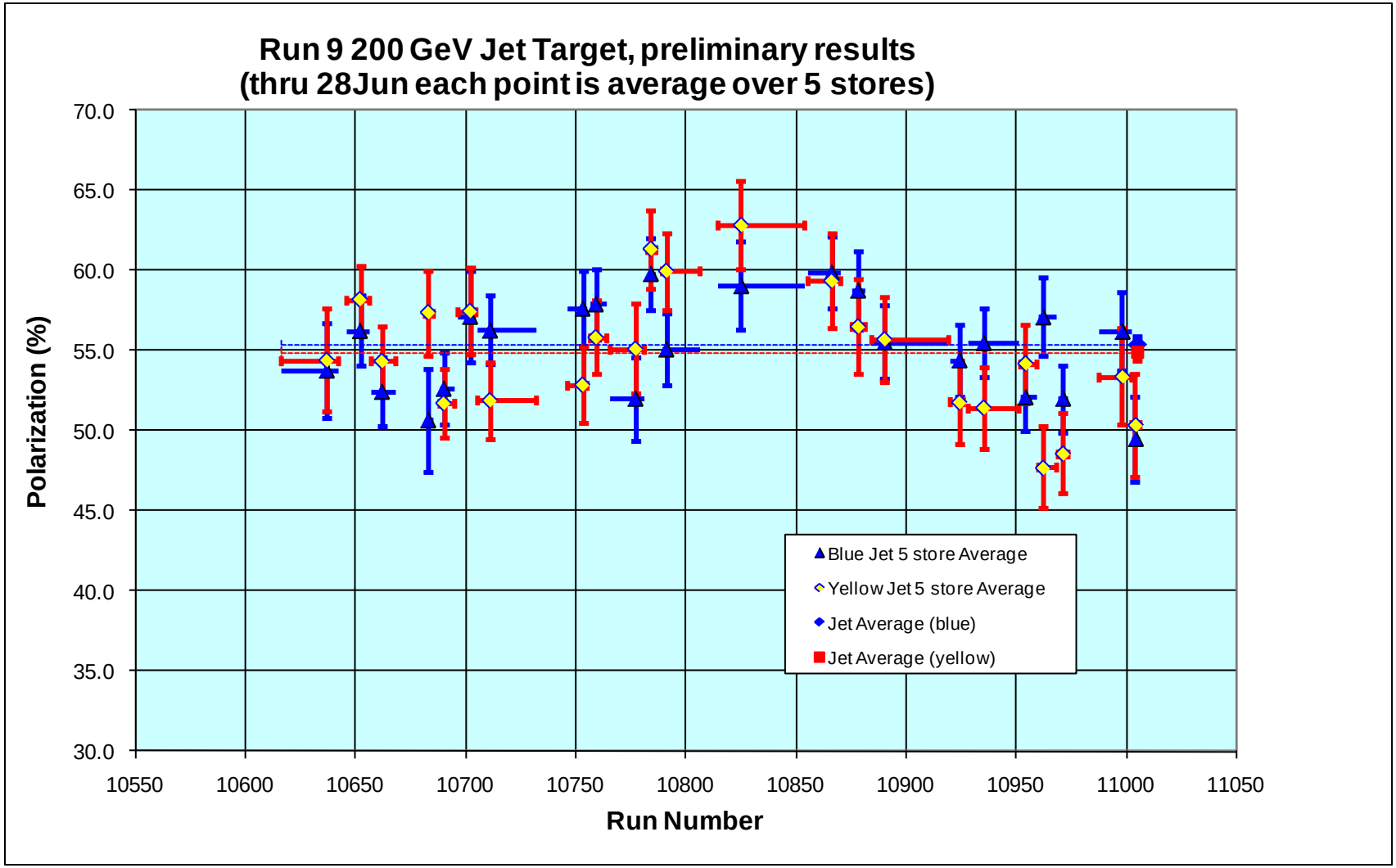
Collision steering corrections background issues 26-27 Feb





Example -- Store 16445, Sat Feb 18





Blue Jet weighted average = 55.4 ± 0.5

Yellow Jet weighted average = 54.9 ± 0.5

Run 12 projection for √s = 200 GeV pp

STAR Goal: 27 pb-1 delivered with 55-60 % polarization
PHENIX Goal: 27 pb-1 delivered with 55-60 % polarization

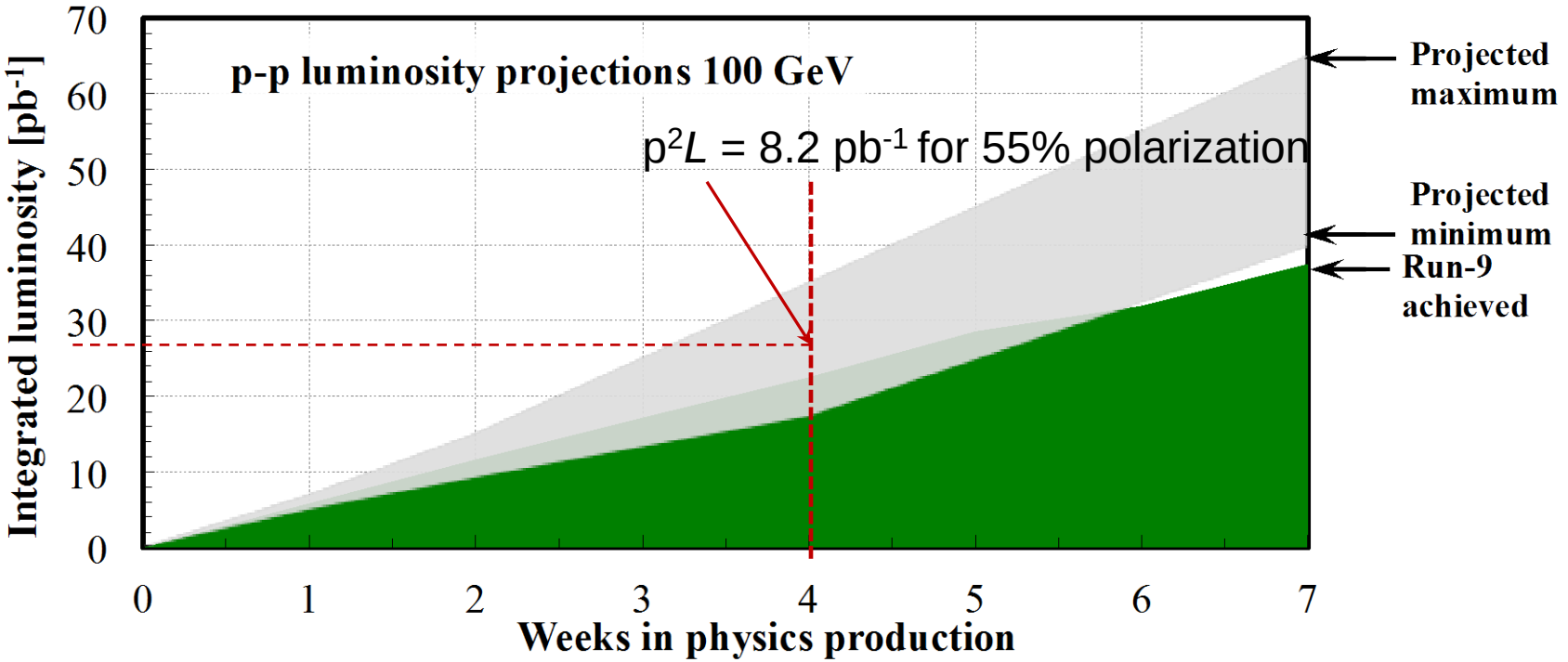
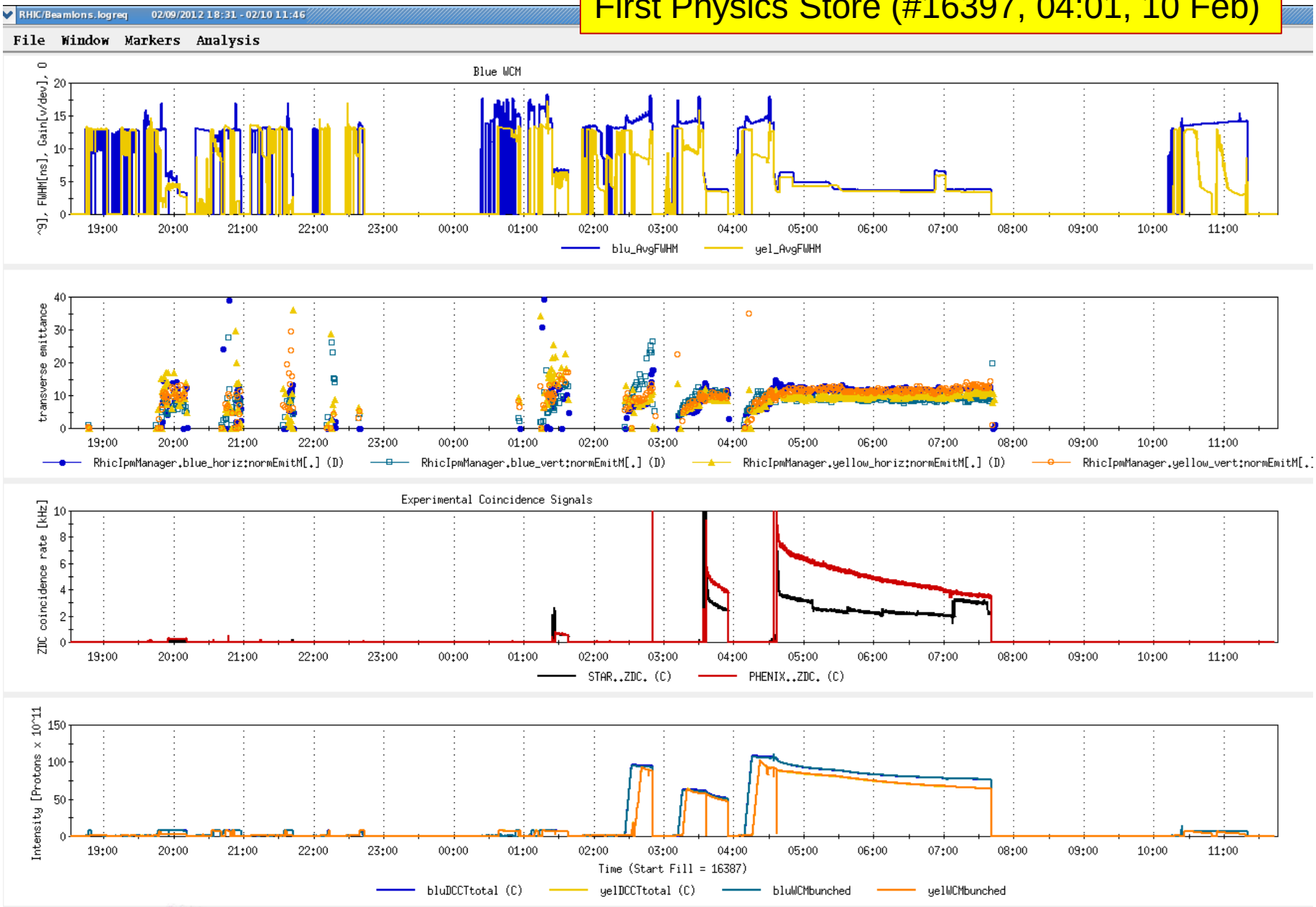


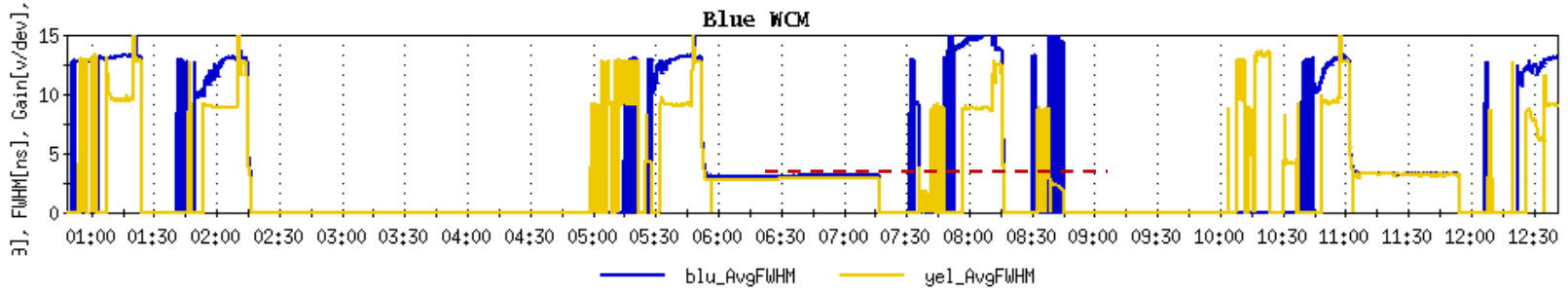
Figure 3: Projected minimum and maximum integrated luminosities for polarized proton collisions at 100 GeV beam energy, assuming a linear weekly luminosity ramp-up in 4 weeks. An average store polarization between 50 and 60% is expected.

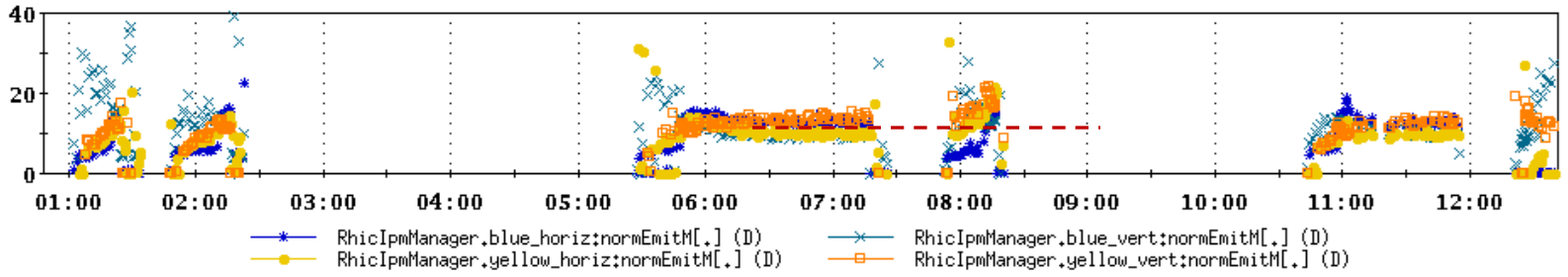
From Fischer et. Al. "RHIC Collider Projections (FY 2012 – FY 2016)"
14 October 2011

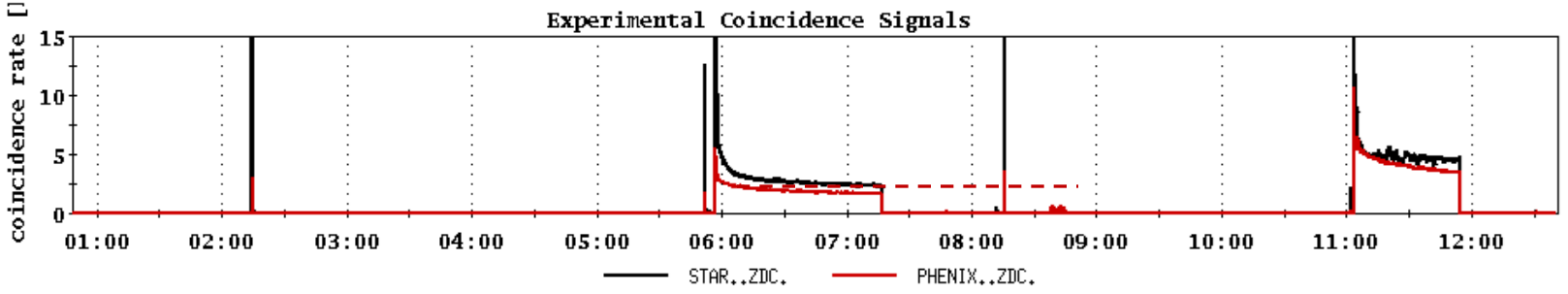
First Physics Store (#16397, 04:01, 10 Feb)

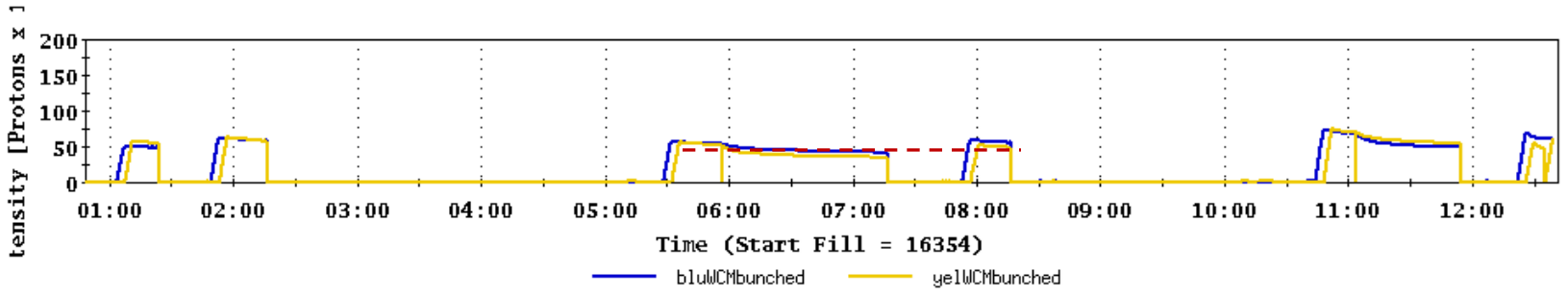


Today, 7 Feb 2012

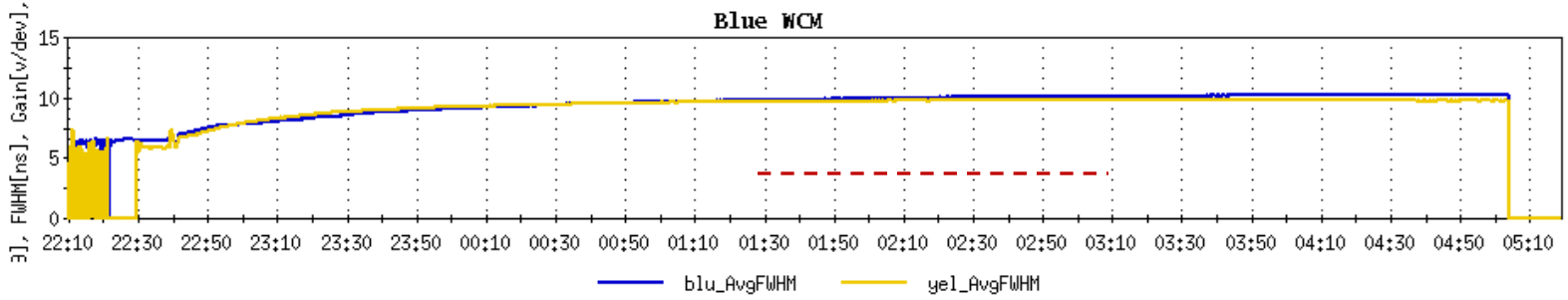


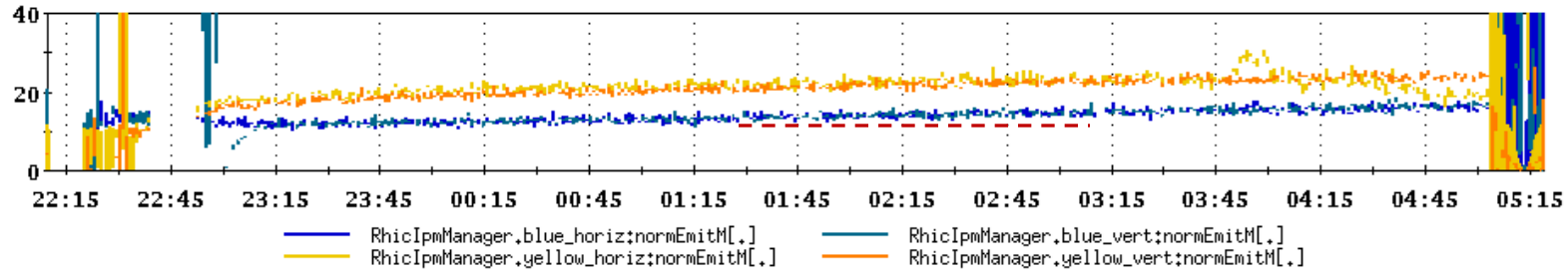


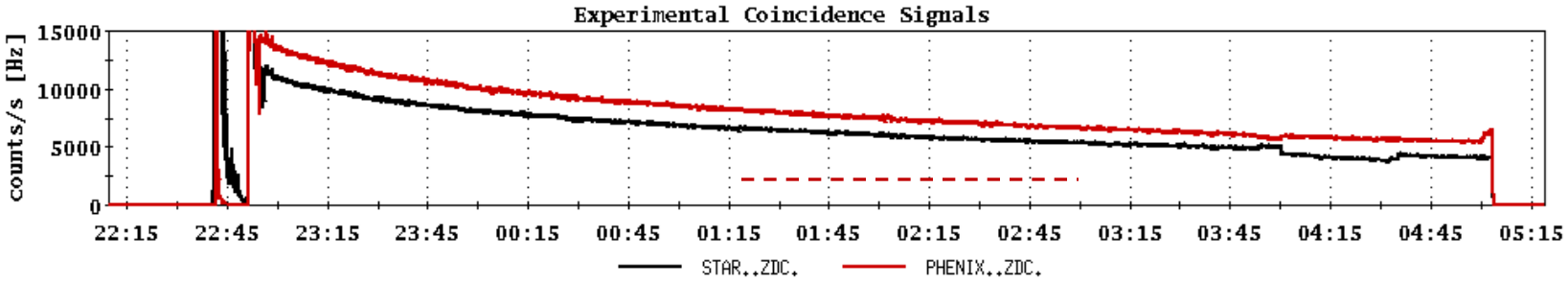


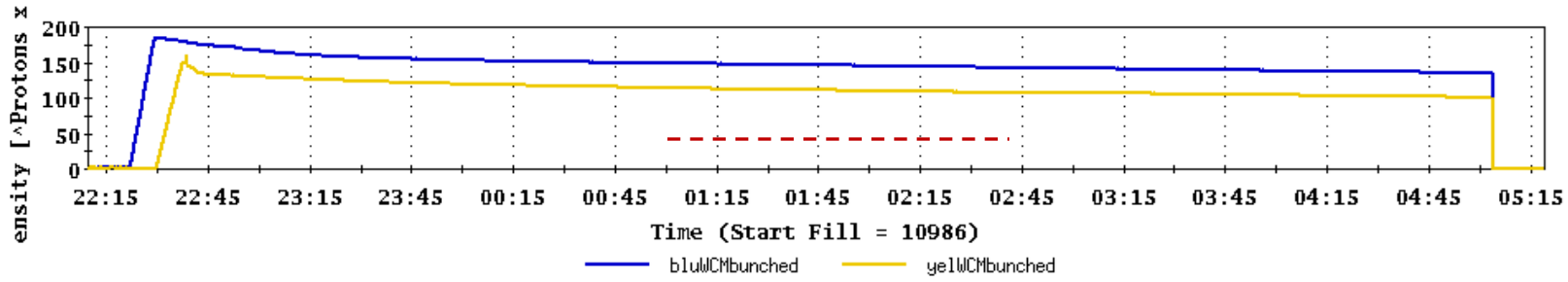


Typical Store from Run 9, 100 x 100 GeV pp





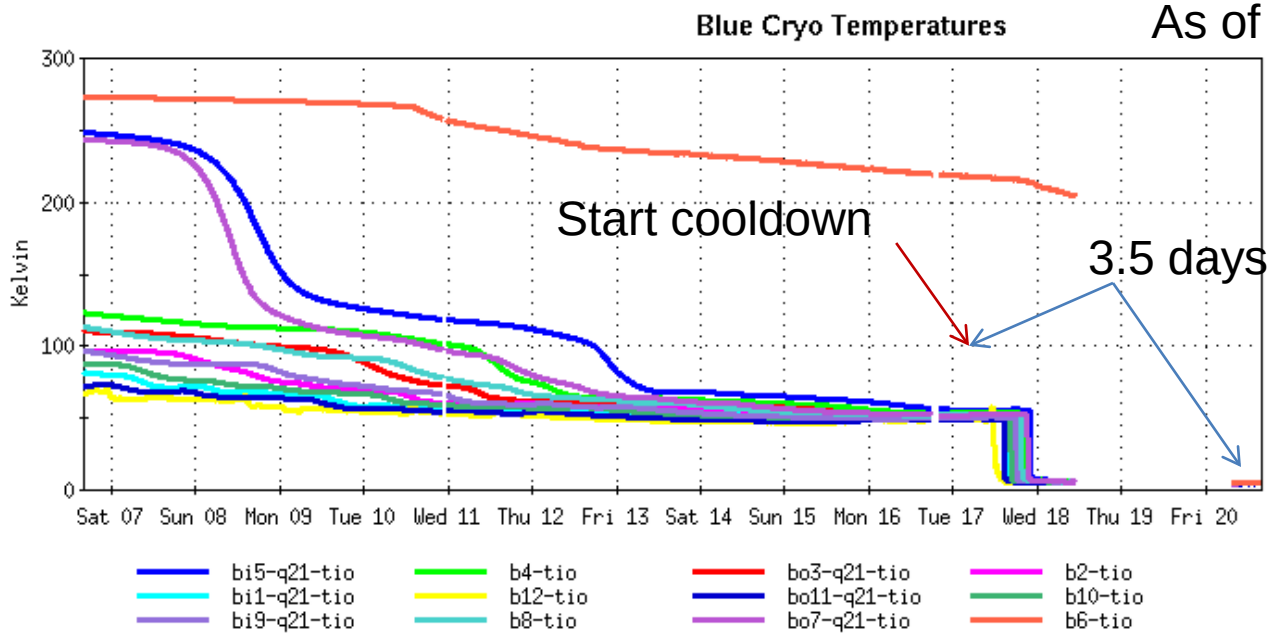


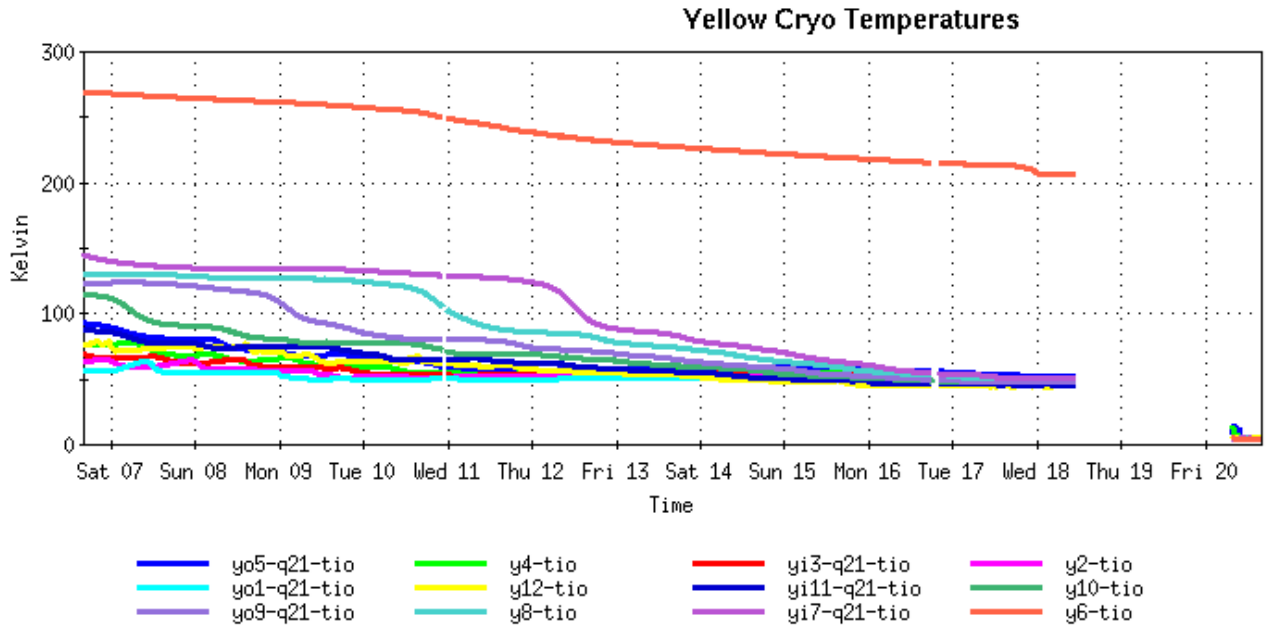


Ring Summary (1 day) Sector Plots (1 day) Sector Plots (14 days)

File Window Markers Analysis

As of 16:18 hrs 20 Jan





Recommendations following the June 6-8, 2011 PAC

For Run 12 the PAC recommends the following (*in order of priority*):

- 5 weeks of running with polarized proton collisions at 200 GeV.
- 7 weeks of running with polarized proton collisions at 500 GeV.
- 5 weeks of running with Cu+Au collisions at 200 GeV.
- 3 weeks of running with U+U collisions at 193 GeV.

For Run13 the PAC recommends the following (*not* in order of priority):

- 12 weeks of running with polarized proton collisions at 500 GeV.
- 5 week of running with polarized proton collisions at 200 GeV.
- 7 weeks of running with Au+Au collisions at full energy.

D.L. November 23, 2011 update

Cryo Issue

Our helium supplier no longer able to meet our peek demand of 4 trailers in a one week period. They can give us one trailer a week starting on December 31st, so we expect to have all the helium we need, on time, but we will have to store most of it in the dewars outside 1006B. This will result in our 4K cooldown being a little less stable and predictable than it has been for the past few years when we received all of the helium at 1005R over a short period of time. Because of this, I expect the 4K cooldown will take a least one additional day.

Cryogenic System Cooldown Projection based on Full Compressor Power Starting on January 17, 2012

.5 to 1 MW – Nov 23, 2011 through Dec 18, 2011 (temporary peaks up to 2 MW)

Scrub of RHIC rings and cryo plant, 14 atm pressure test of blue sextants 2/3 and 8/9 M-lines. Main compressor testing and scrub.

2.8 MW – Dec 19, 2011 through Jan 16, 2012

12/19/11	Start 45K cooldown of cryo plant
12/20/11	Start 45K wave in both RHIC rings
12/31/11	First liquid helium delivery, 1006B
01/07/12	Second liquid helium delivery, 1006B
01/14/12	Third liquid helium delivery, 1005R

6 to 8 MW – Jan 17, 2012 through Jan 22, 2012

01/17/12	Start 4K wave in Blue ring, Hi potting (3 days)
01/20/12	Estimate blue ring cold and stable, soak complete, ready for magnet powering.
01/20/12	Start 4K wave in Yellow ring, Hi potting (3 days)
01/21/12	Fourth liquid helium delivery
01/23/12	Estimate yellow ring cold and stable, soak complete, ready for magnet powering.

5 MW starting on Jan 23, 2012

01/23/12	Start T7 turbine

FY2012

Sept billed at $70/MWhr actual cost $42.86 -- $438K added to bank

Oct billed at $60/MWhr actual cost $62.80 -- $45.5K withdrawn from bank

FY2012 Bank Total = $392,563

FY2012 Electric Rates			FY11 Rates
Month	Original $/kWh	Revised $/kWh	As Billed $/kWh
Oct-11	0.060		0.065
Nov-11	0.060		0.065
Dec-11	0.060		0.065
Jan-12	0.053		0.055
Feb-12	0.053		0.055
Mar-12	0.053		0.055
Apr-12	0.053		0.055
May-12	0.053		0.055
Jun-12	0.068		0.070
Jul-12	0.068		0.070
Aug-12	0.068		0.070
Sep-12	0.068		0.070

From Fischer et. al. "RHIC Collider Projections (FY 2012 – FY 2016)"
14 October 2011

Cool-down from 50 K to 4 K	1 week	
Set-up mode 1 (p↑-p↑ at 100 GeV)	1 week	(no dedicated time for experiments)
Ramp-up mode 1	2 week	(8 h/night for experiments)
Data taking mode 1 with further ramp-up	5 weeks	
Set-up mode 2 (p↑-p↑ at 250 GeV)	½ week	(no dedicated time for experiments)
Ramp-up mode 2	1 week	(8 h/night for experiments)
Data taking mode 2 with further ramp-up	7 weeks	
Set-up mode 3 (U-U at 100 GeV/nucleon)	1 week	(no dedicated time for experiments)
Data taking mode 3 with further ramp-up	3 weeks	
Warm-up	½ week	

Run 12 projection for √s = 500 GeV pp

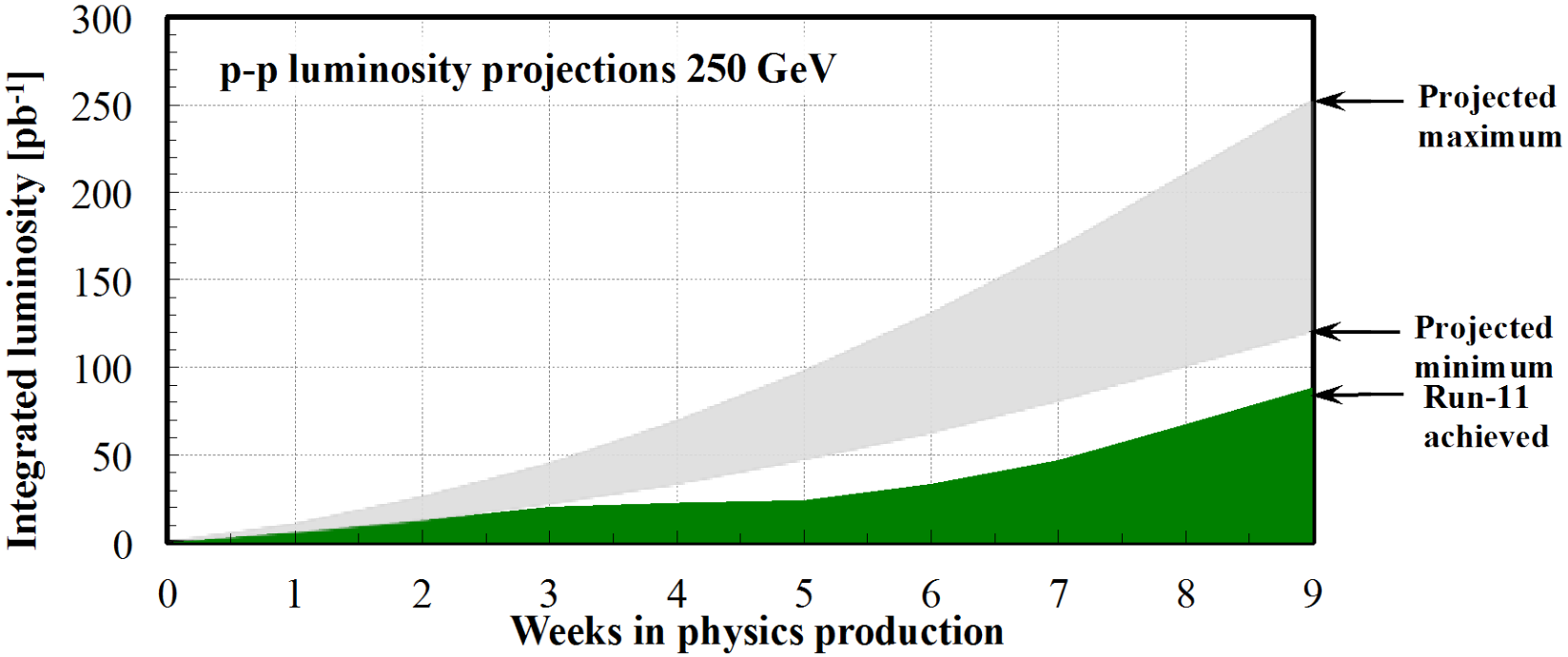


Figure 4: Projected minimum and maximum integrated luminosities for polarized proton collisions at 250 GeV beam energy, assuming linear weekly luminosity ramp-up in 8 weeks. An average store polarization between 45 and 50% is expected.

From Fischer et. Al. "RHIC Collider Projections (FY 2012 – FY 2016)"
14 October 2011

Run 12 projection for √s = 193 GeV/n UU

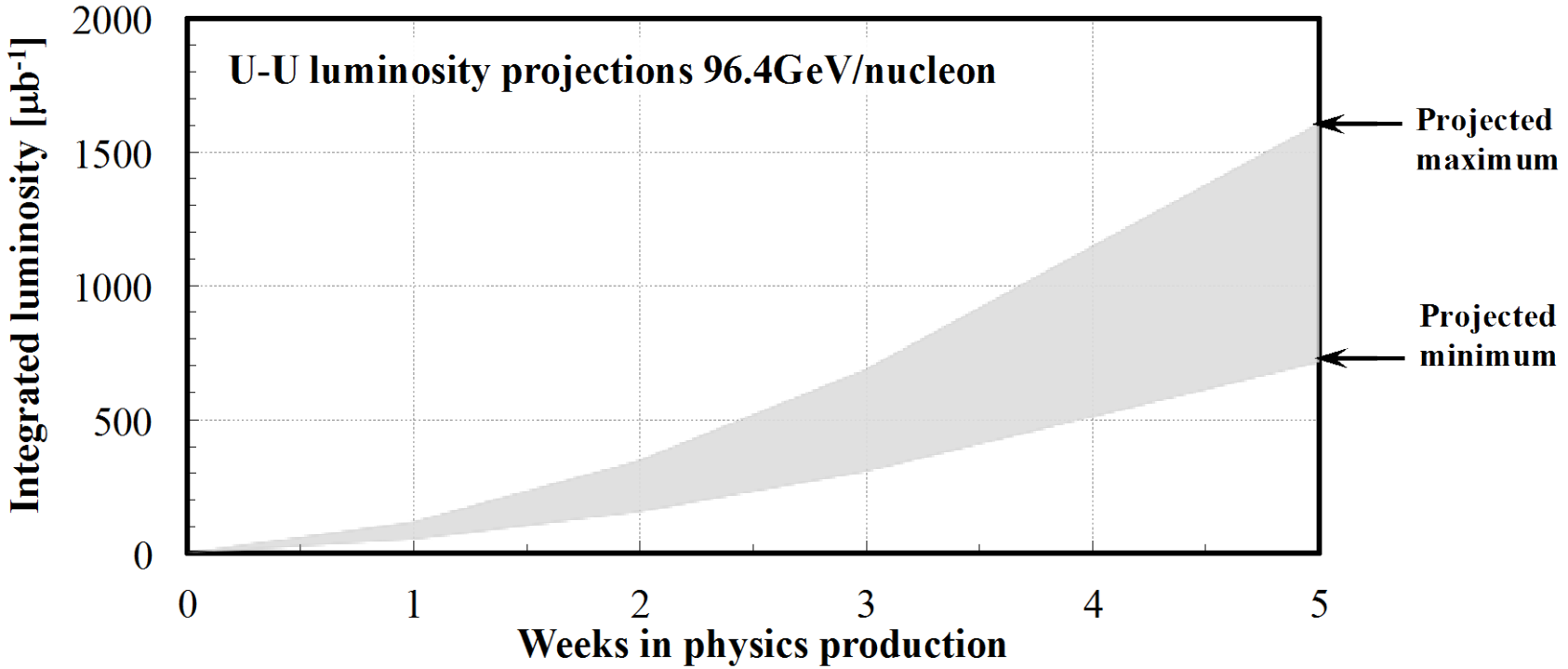


Figure 5: Projected minimum and maximum integrated luminosities for uranium-uranium at 96.4 GeV/nucleon, assuming linear weekly luminosity ramp-up in 48 weeks.

From Fischer et. Al. "RHIC Collider Projections (FY 2012 – FY 2016)"
14 October 2011

Run 12 projection for √s = 200 GeV/n CuAu

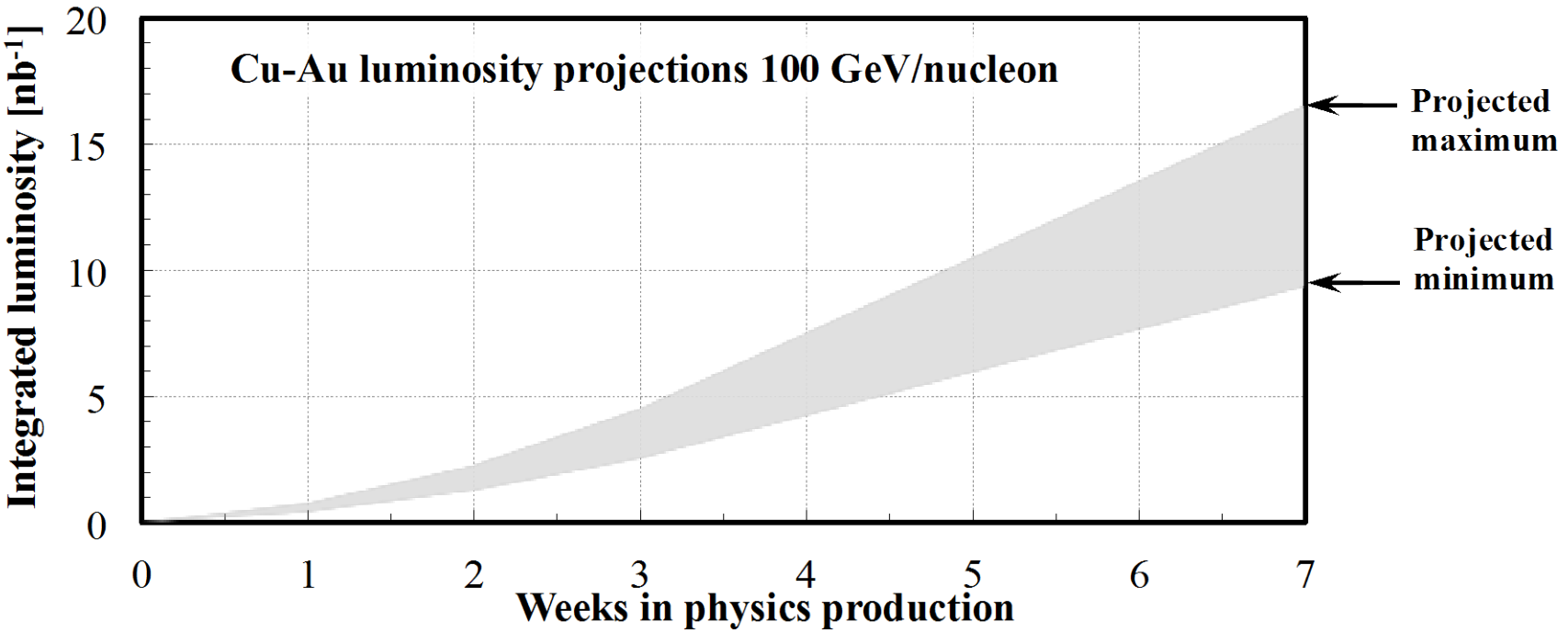


Figure 6: Projected minimum and maximum integrated luminosities for copper-gold collisions at 100 GeV/nucleon beam energy, assuming linear weekly luminosity ramp-up in 4 weeks.

From Fischer et. Al. "RHIC Collider Projections (FY 2012 – FY 2016)"
14 October 2011