2012 Heavy Ion Schedule

Run 12 Plan based on 20 weeks cryo operation
–an example 20 week schedule based on Vincent's pp start-up plan*
Note physics weeks for 250 pp and HI are still to be determined

* http://www.cadops.bnl.gov/AGS/Operations/OpsWiki/index.php/RHIC_Setup:_Polarized_Protons

- **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**
- ***Today – 28 Feb***
- 9 March, end 4 week √s = 200 GeV pp run, begin ½ week setup for √s = 500 GeV pp
- 13 March, begin 1 week ramp-up to √s = 500 GeV with 8 hrs/night for experiments
- 20 March, begin ***5 week pp physics*** run at √s = 500 GeV
- 24 April, end 5 week pp physics run at √s = 500 GeV

If Uranium or Cu-Au…

- 24 April, begin 1 week setup for UU or CuAu (no overnight stores for experiments)
- 1 May, begin ***4.5 week UU or CuAu physics run***
- 20-25 May: IPAC
- 2 June end 4.5 week UU or CuAu physics run
- 2 June, begin cryo warm-up
- 5 June, cryo warm-up complete (20.0 cryo-weeks)

Total Physics Weeks = 13.5

Lattices in Previous Runs

	units	design	Run-2	Run-4	enhanced design	Run-7	Run-10	Run-11
Energy	GeV	100	100	100	100	100	100	100
No of bunches	...	55	55	45	111	103	111	111
Ions/bunch	10^9	1.0	0.6	1.1	1.0	1.1	1.1	1.5
β* (IP6, IP8)	m	2.0	1.0	1.0	1.0	0.8	0.7	0.7
Peak luminosity	$10^{26}cm^{-2}s^{-1}$	9	4	15	30	30	40	50
Avg. store luminosity	$10^{26}cm^{-2}s^{-1}$	2	1.5	5	8	12	20	30
Luminosity per week	μb^{-1}/week	50	24	160	300	380	650	1000
Run length	weeks (physics)	--	15.9	12	--	12.8	10.9	6.4
Time in store	% of calendar time		26	53		49	53	

IBS lattice used in 2008, 2010, 2011 ion runs.
The merit of IBS lattice is:

1) transverse IBS growth time suppression,
2) easier to obtain lower beta* with current RHIC PS connections.

With IBS lattices, we observed larger beam loss due to momentum aperture limitation during RF re-bucketing and in the store, especially with transverse cooling on.

Momentum Aperture Limitation

Early beam loss: reduced momentum aperture increases the beam loss during the RF re-bucketing.

Beam loss in store: transverse cooling increases the longitudinal IBS growth rates, As an result, large momentum deviation particles will leak out of the RF buckets and migrate to adjacent satellite buckets. If the momentum aperture is not big enough, they will be lost in transverse plane.

With extra transverse cooling power, **using IBS lattice to reduce the transverse IBS emittance growth is not so critical** as to improve the momentum aperture to increase beam lifetime.

One example:

direct comparison between 2007 and 2011 runs with only longitudinal cooling.

(No direct comparison between 2007 and 2011 with transverse cooling.)

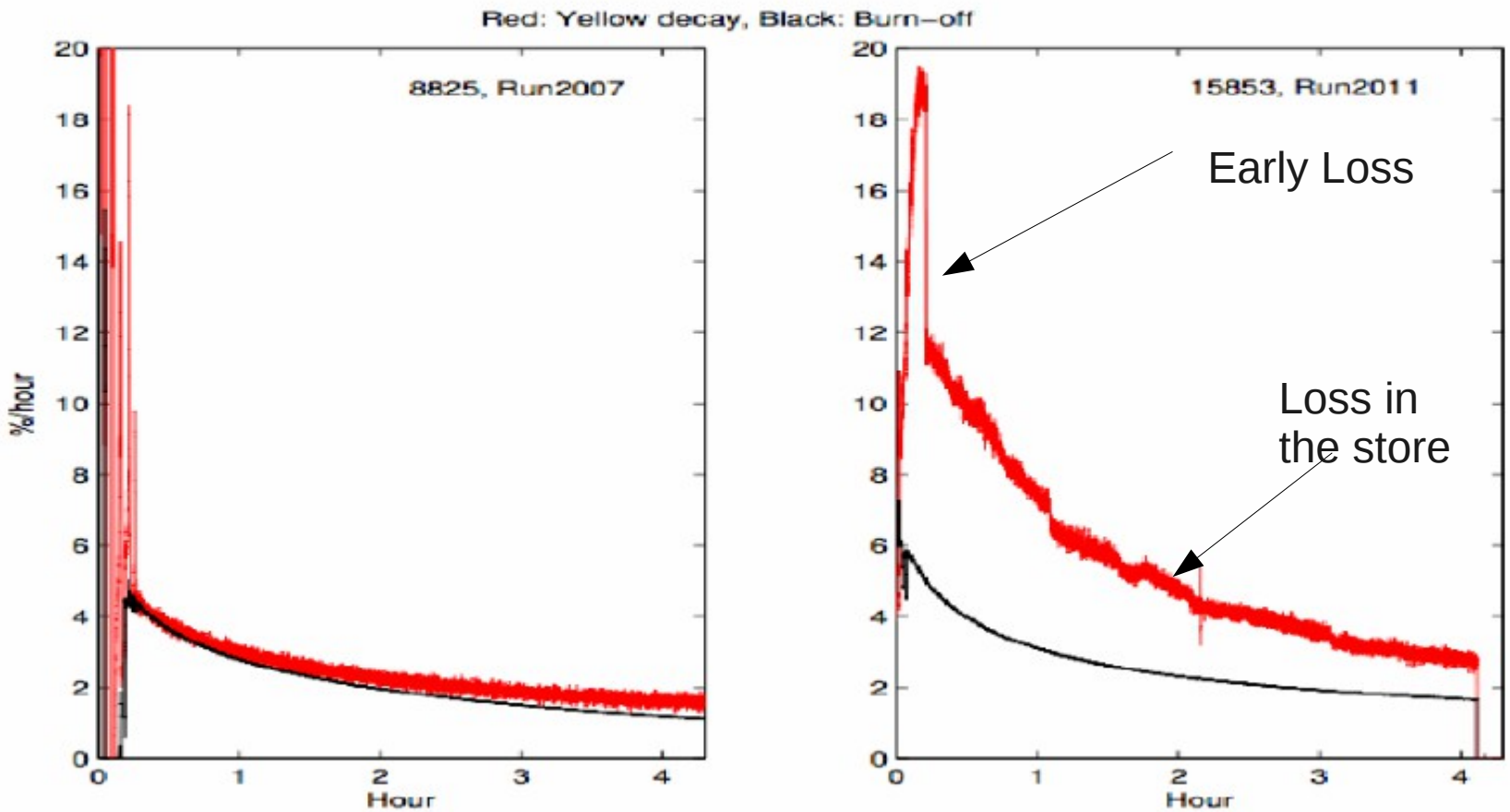
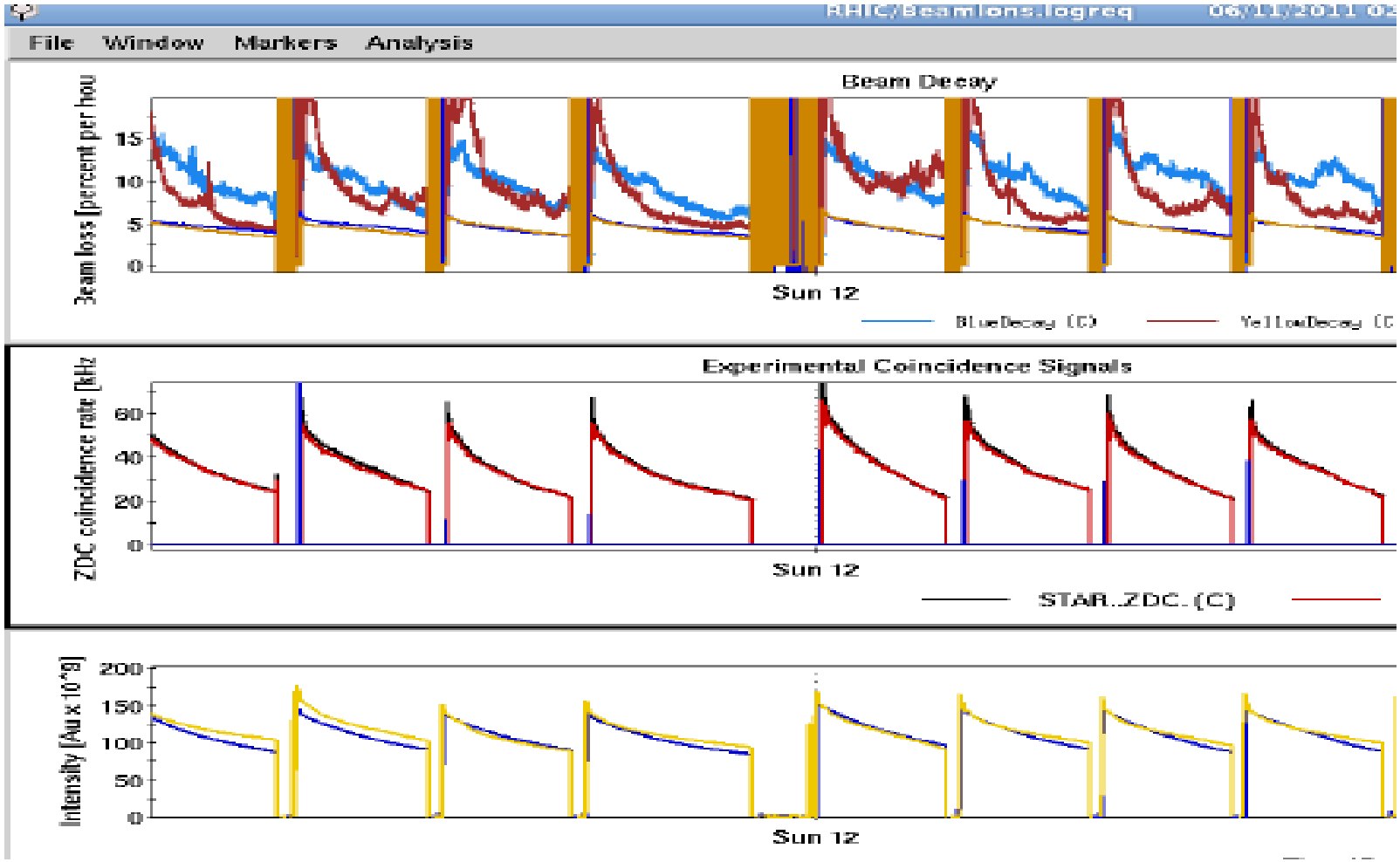


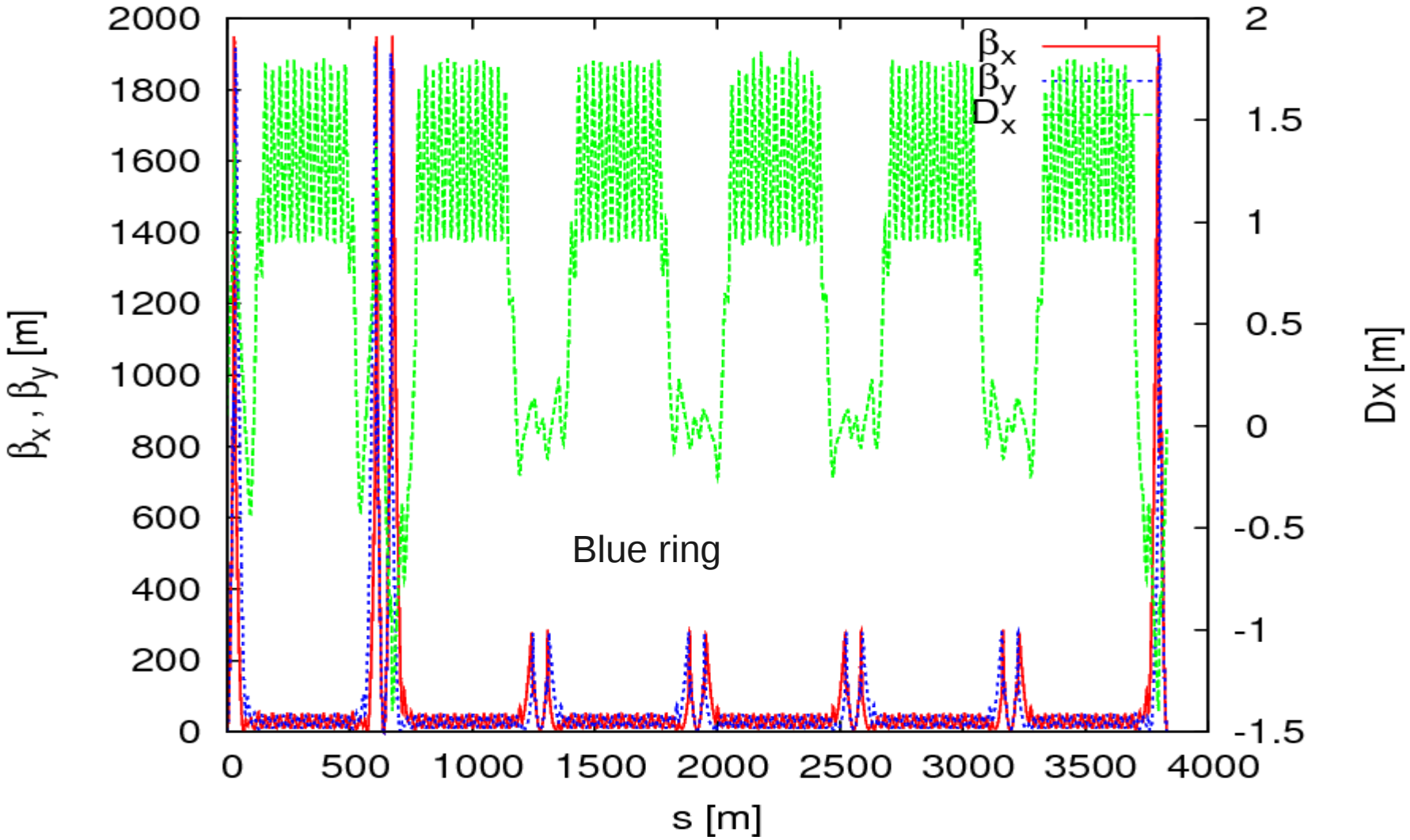
Figure 6: Yellow beam decay of Fill 8825 in Run 2007 and Fill 15853 in Run 2011, both with longitudinal cooling. The burn-off caused beam decay is shown as the black line.

Typical beam loss in 2011 run with transverse cooling :



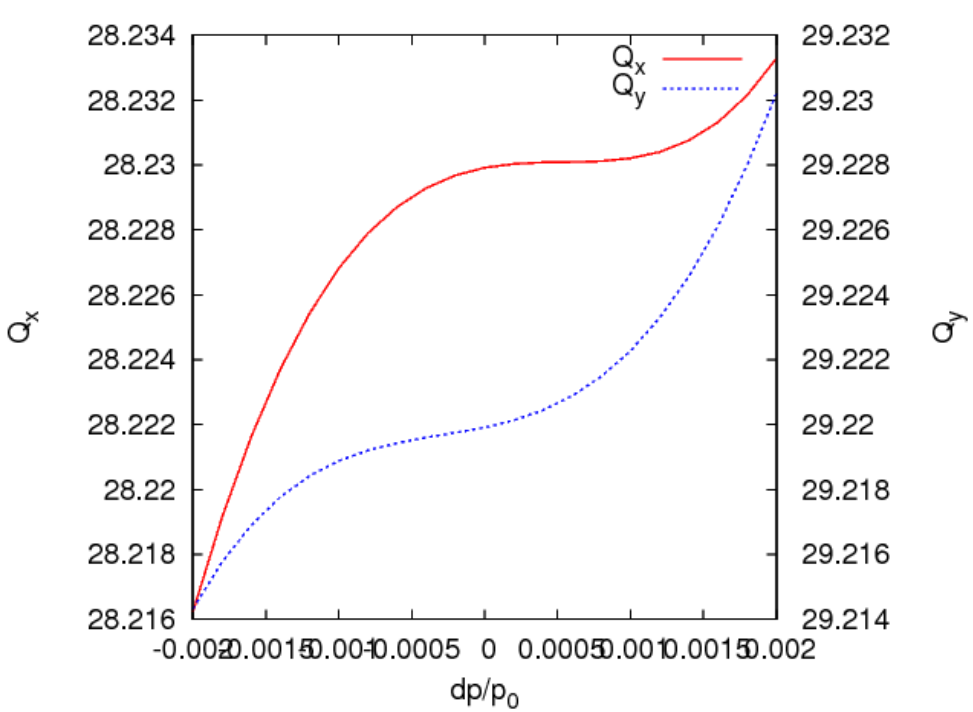
2011 Au-Au run
IBS-suppresion lattice: WP=(31.23, 32.22), beta*=0.7m
Cooling: longitudinal in both rings, vertical transverse in both rings

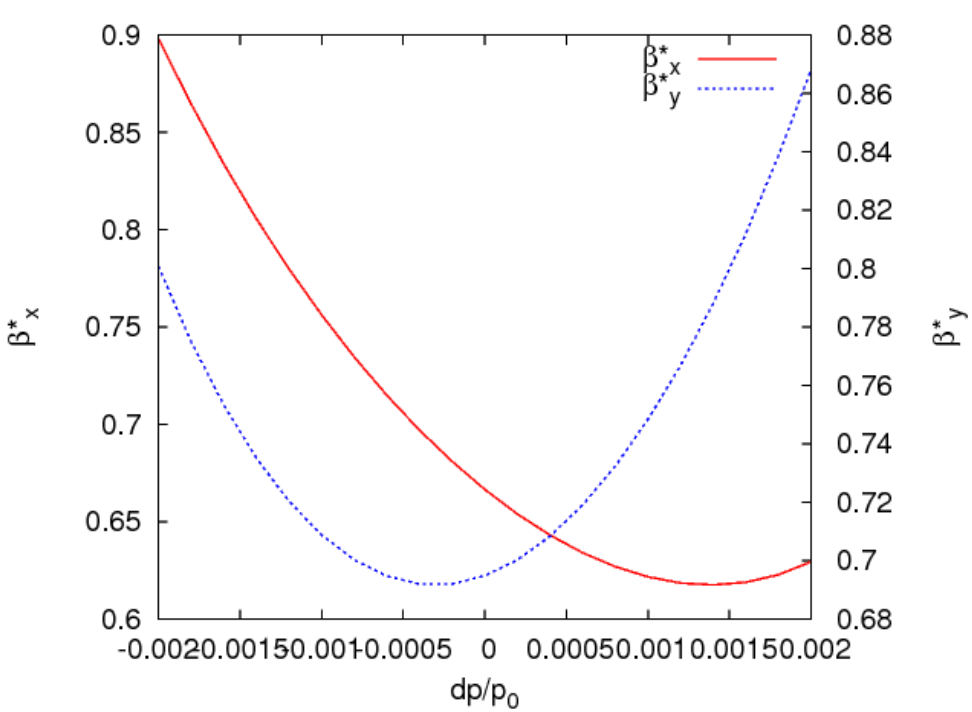
Non-IBS Lattice with beta*=0.7m



Beta*=(0.7, 0.7, 5, 5, 5, 5), lattices derived directly from 250GeV pp run lattice.

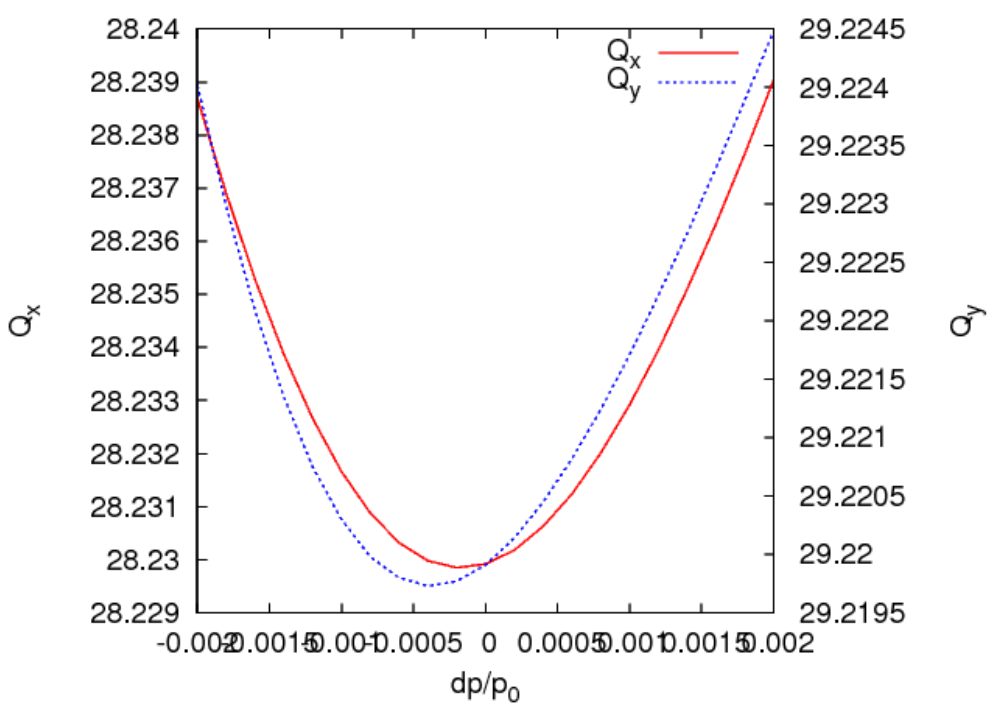
Yellow ring:

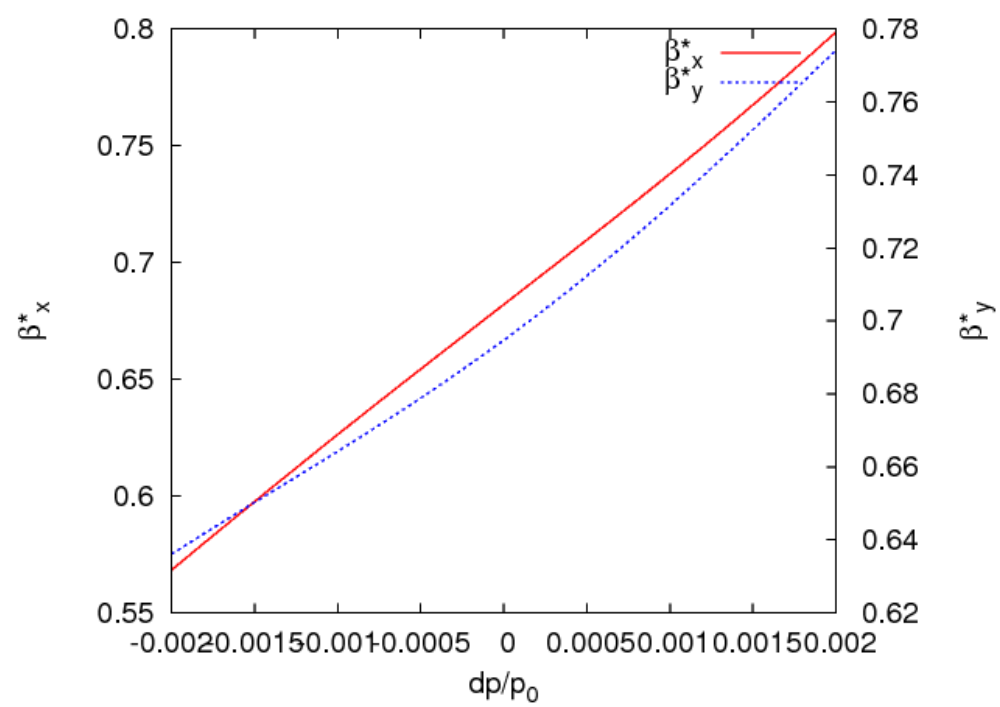





```
-----------------------------------------------------------
 Optics Summary:
     Length:    3833.84518145943
     Tunes :    28.2299169353154    29.2199127142937
     Chrom1:   0.845071379647792   0.936004777208198
     Chrom2:   -1446.21856599687    686.779165901825
     Chrom3:    849519.052896639     760216.23939864
     Beta* :   0.666664642501987   0.694853834611016
     Alfa* : -0.0451522061642743-0.00624435793288908
   Beta_max:    1994.09815958453    1916.01813369719
```

Blue ring:



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-----------------------------------------------------------------
 Optics Summary:
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     Chrom1:    0.847985189283551    0.935742819958623
     Chrom2:     2419.95991325137     1093.04266154269
     Chrom3:    -226167.308003837    -238035.599380058
     Beta* :    0.682015177091394    0.694723264437897
     Alfa* :   -0.056869433020986-0.00548338094188337
   Beta_max:     1950.36687151835     1916.83406983792
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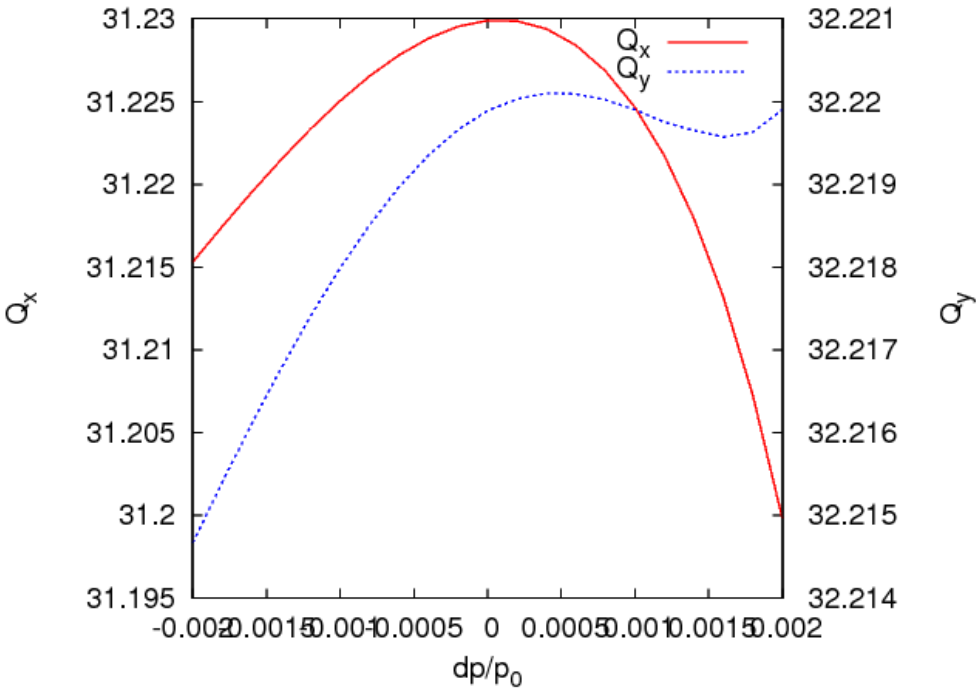
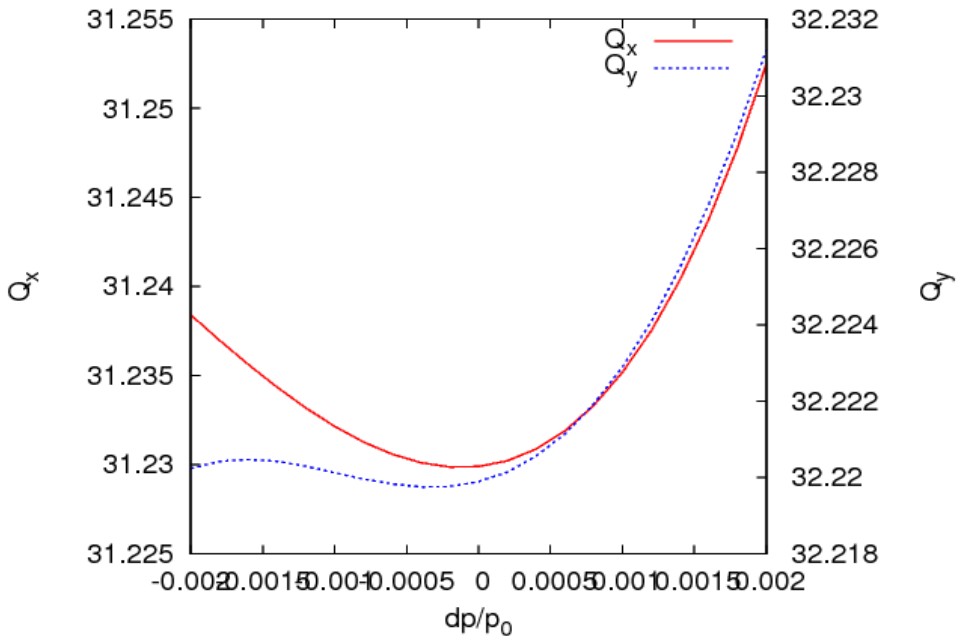
2011 IBS Lattice with beta*=0.7m



BLUE RING



YELLOW RING

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Optics Summary:
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    Tunes :    31.2298928959474    32.2198860032801
    Chrom1:   0.822214676399119   0.912634179977225
    Chrom2:   -4996.33085871504   -1003.64938389556
    Chrom3:   -965939.578212933    16033.414556983
    Beta* :   0.679889063103959   0.696249459731584
    Alfa* :  0.0903222591210017-0.000713021473746723
  Beta_max:    1979.42760304316    1911.0120470737
```

```
-----------------------------------------------------------
Optics Summary:
    Length:    3833.84518145941
    Tunes :    31.2298955872026    32.2198854846351
    Chrom1:   0.865874262635338   0.935593173415996
    Chrom2:    3733.26760237602    1680.91093048964
    Chrom3:    645461.461128368    447037.044800885
    Beta* :   0.767226940652477   0.682680150451032
    Alfa* :  0.0156120166775039 0.00607504654266076
  Beta_max:    1736.23638602676    1948.59400678525
```

Beam Parameters

Charge states:

	U	Cu	Au
A:	238	63	197
Q:	92+	29+	79+
Booster:	39+ (Last night)	11+	32+
AGS:	90+	29+	77+
RHIC:	92+	29+	79+

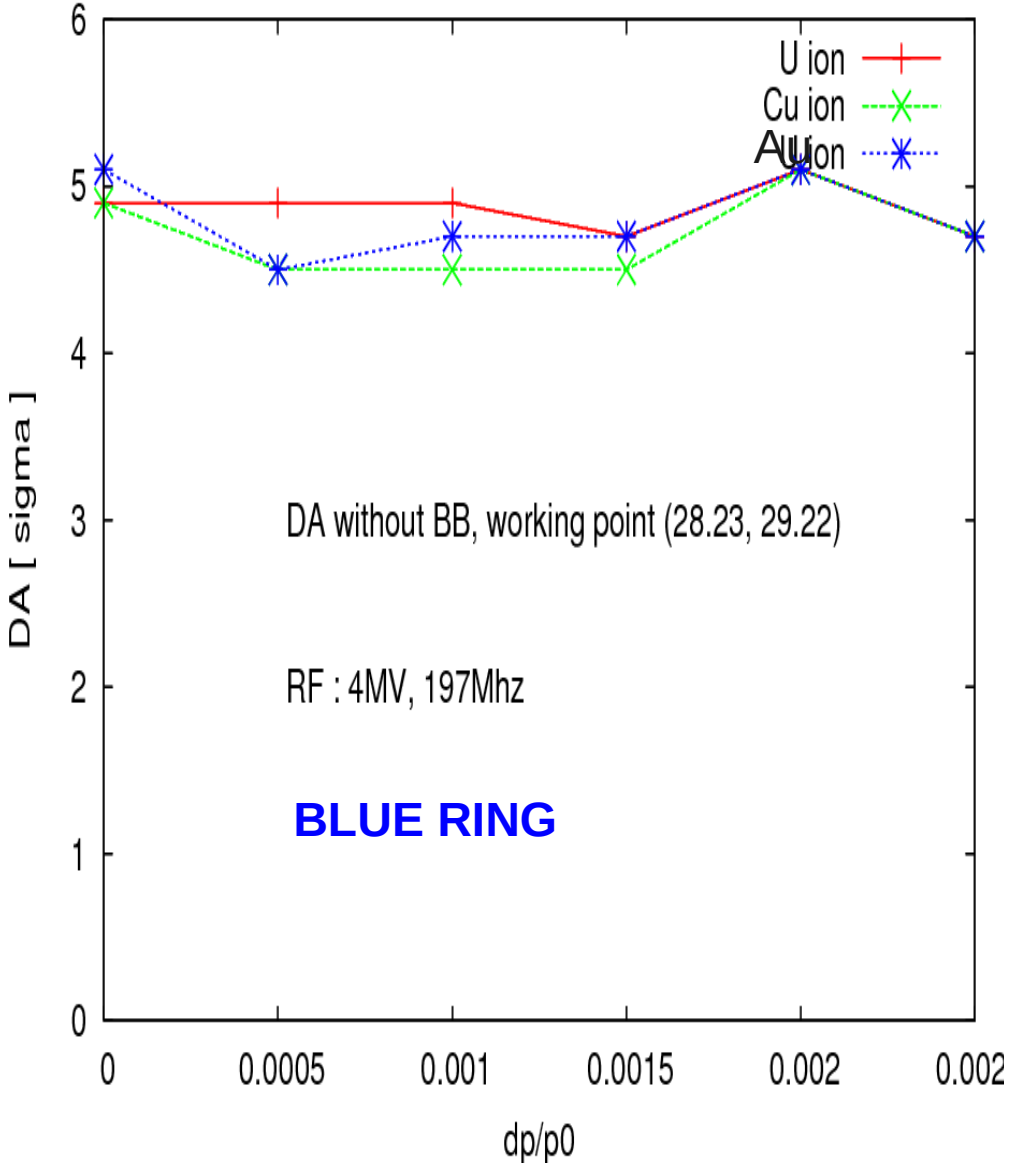
Energy In RHIC (GeV/A)	96.3943	100.6422	100.

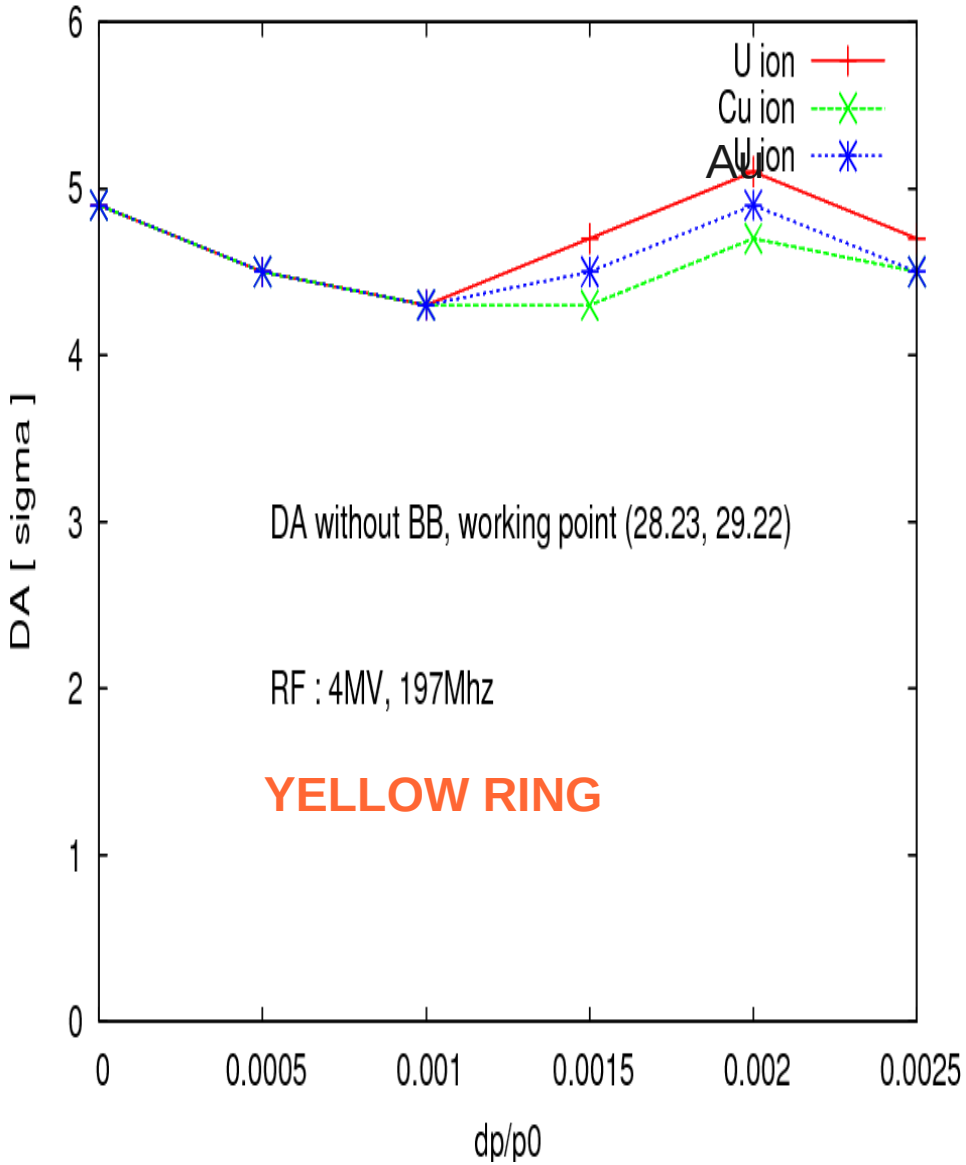
RF frequency should be same for two rings, therefore Brho, Energy slightly different different ions in Blue and Yellow rings.

For more Information: See Kip's notes on beam parameters

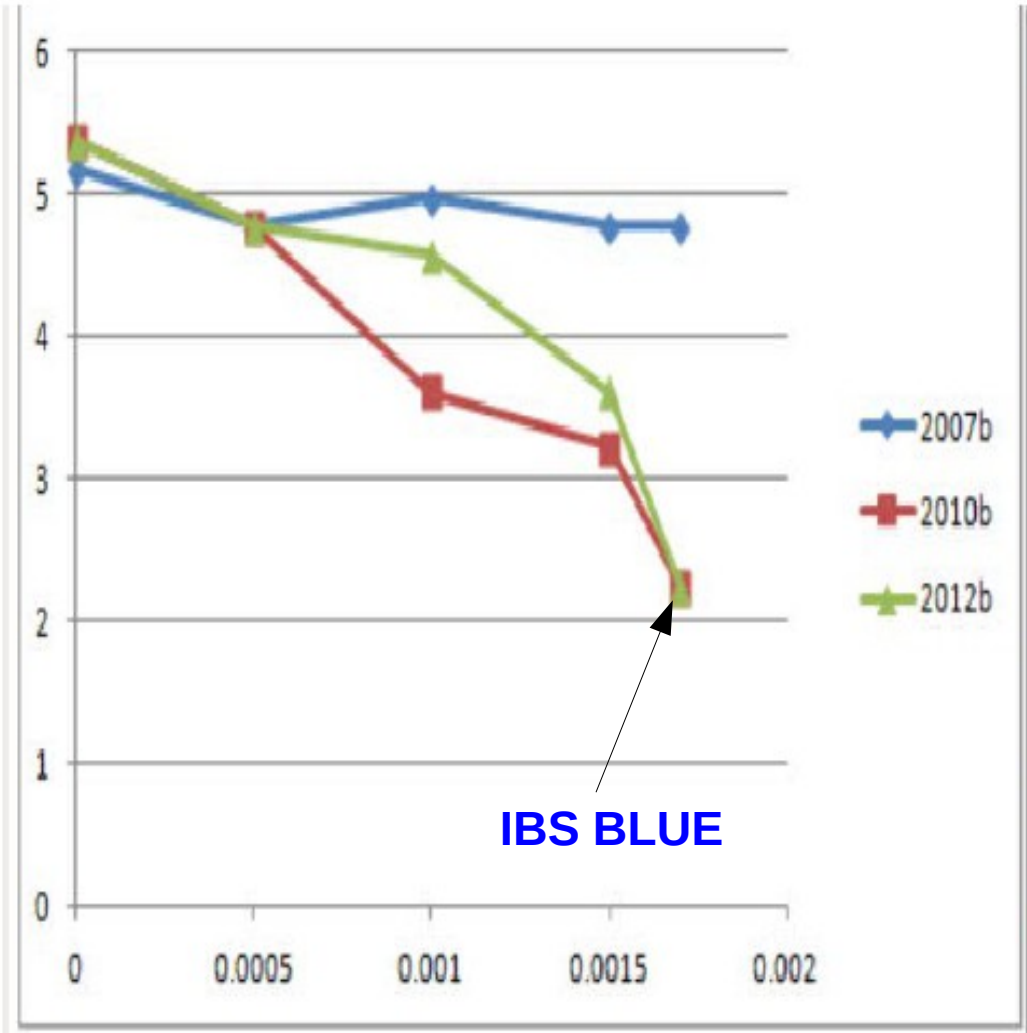
(http://www.cadops.bnl.gov/AP/RHIC2012/)

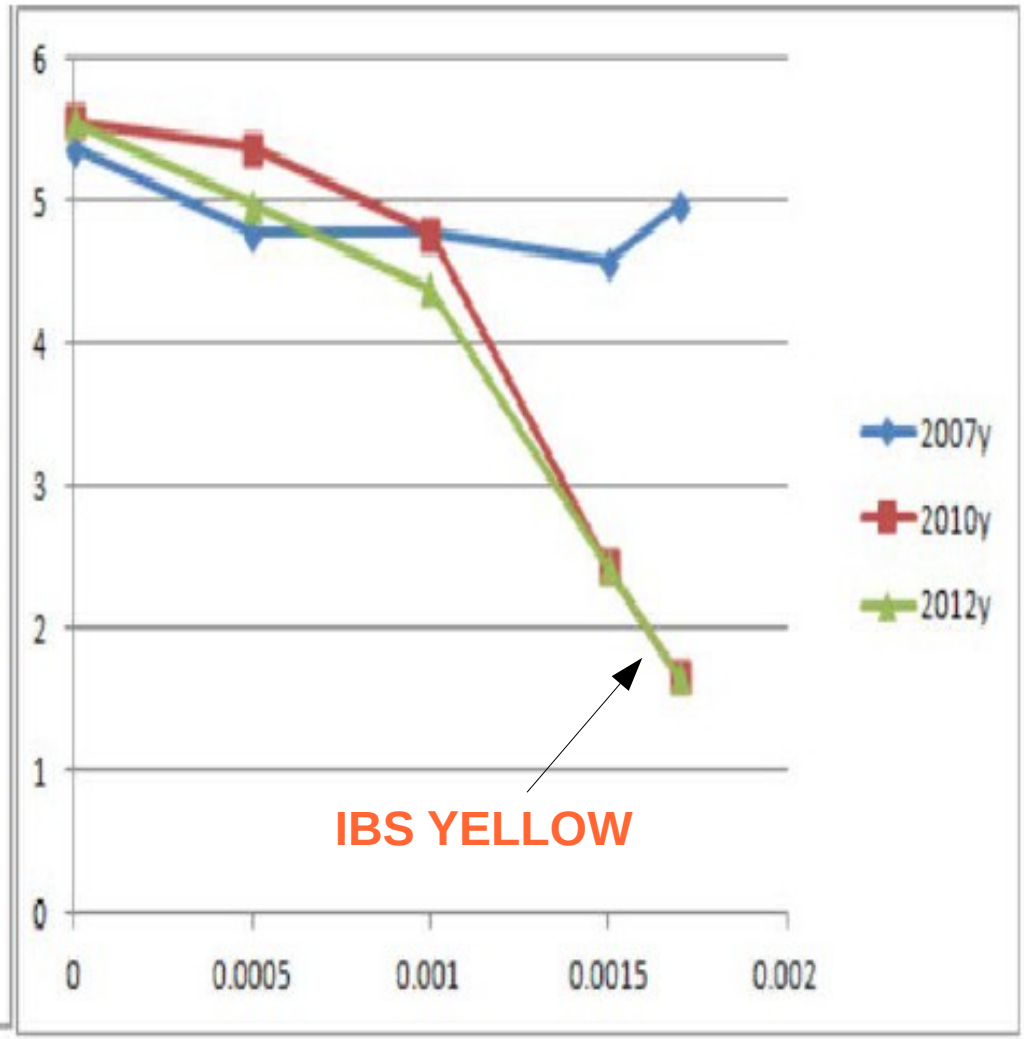
DA tracking(2012 non-IBS lattices)





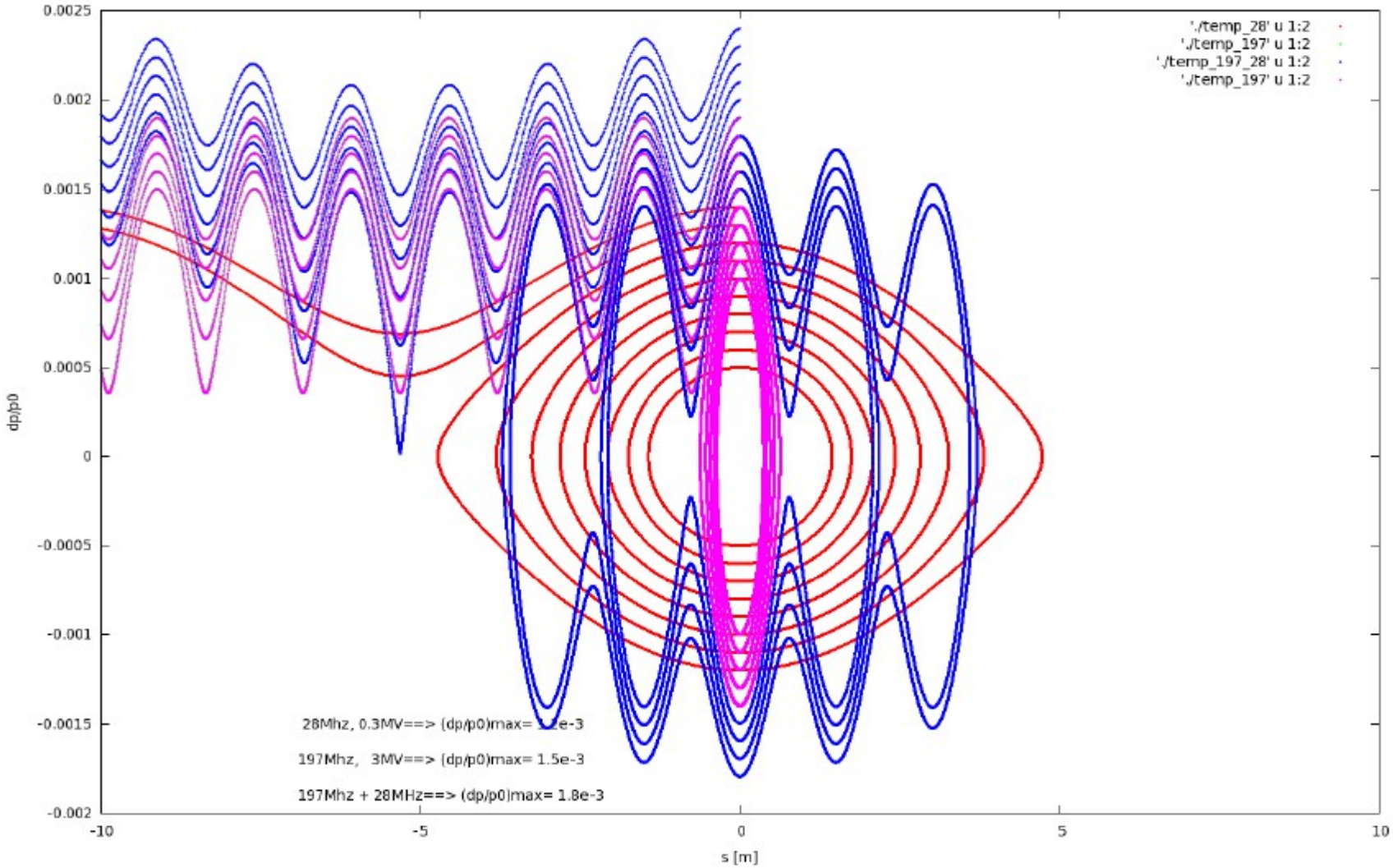
DA tracking(2011 IBS lattices)





(*thanks to Xiaofeng*)

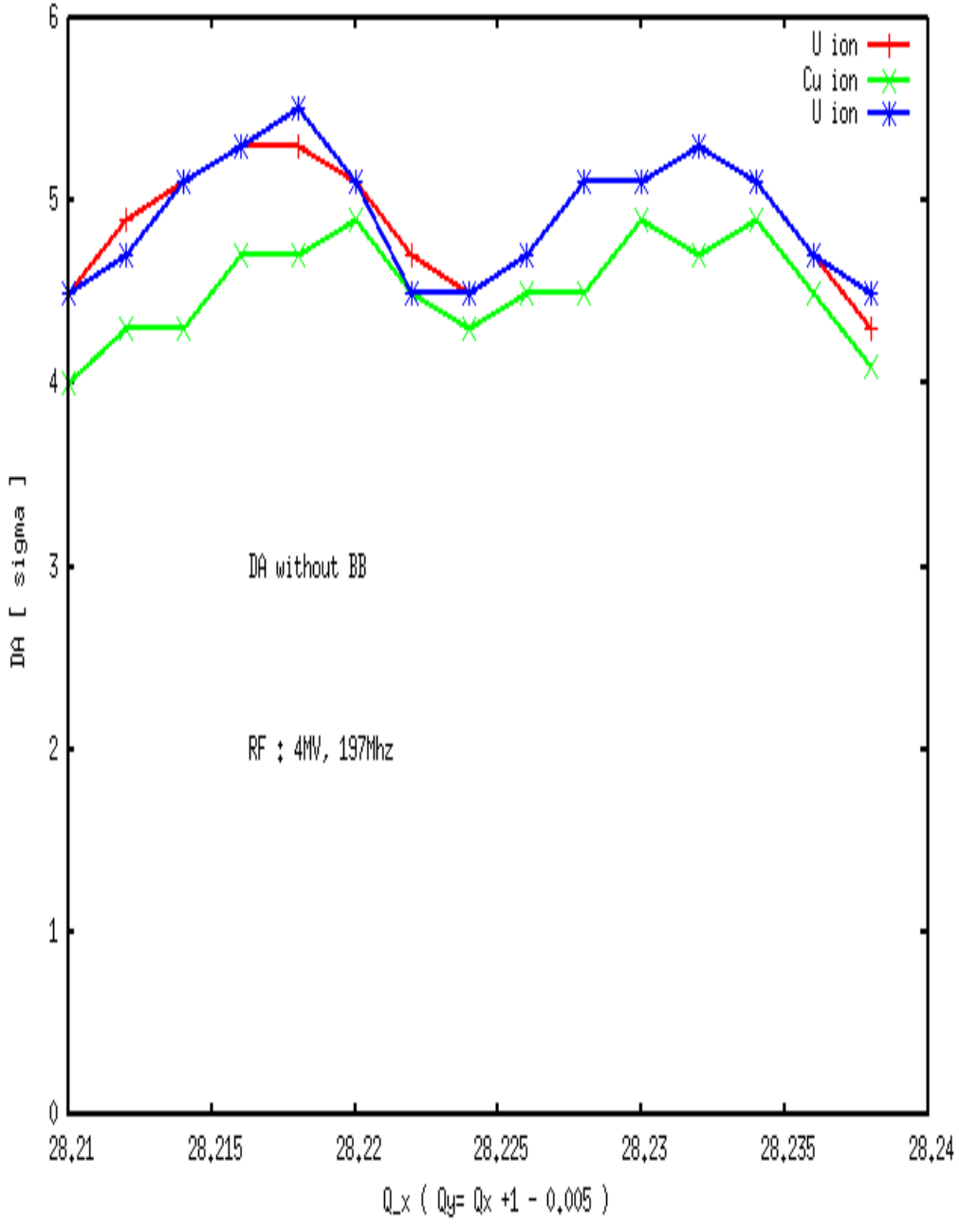
Momentum Aperture Acceptance

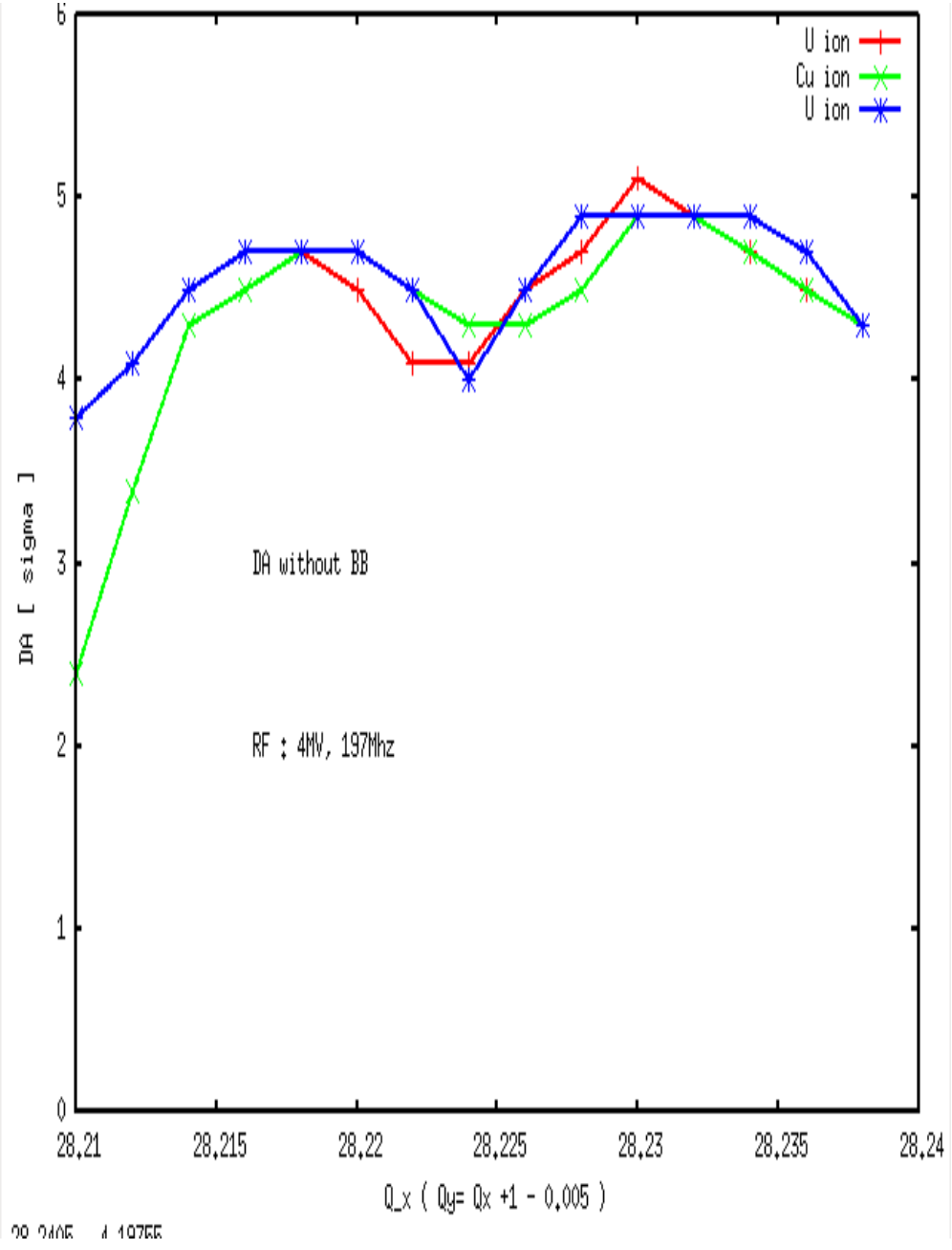


RF system: 197MHz + 28MHz

Off-momentum DA shoud be big enough for dp/p0=1.8e-3 to catch particles leaking out of the center bucket.

Tune Scan with Non-IBS Lattices





Summary

- Based on the momentum aperture calculation and beam loss in the previous Au runs, we decided to adopt Non-IBS (standard) lattices for the 2012 ion heavy ion runs.

- The ion species had not been decided. It depends the proton runs and the budget. We may start the ion run on April 24 and deliver physics stores from May 1.