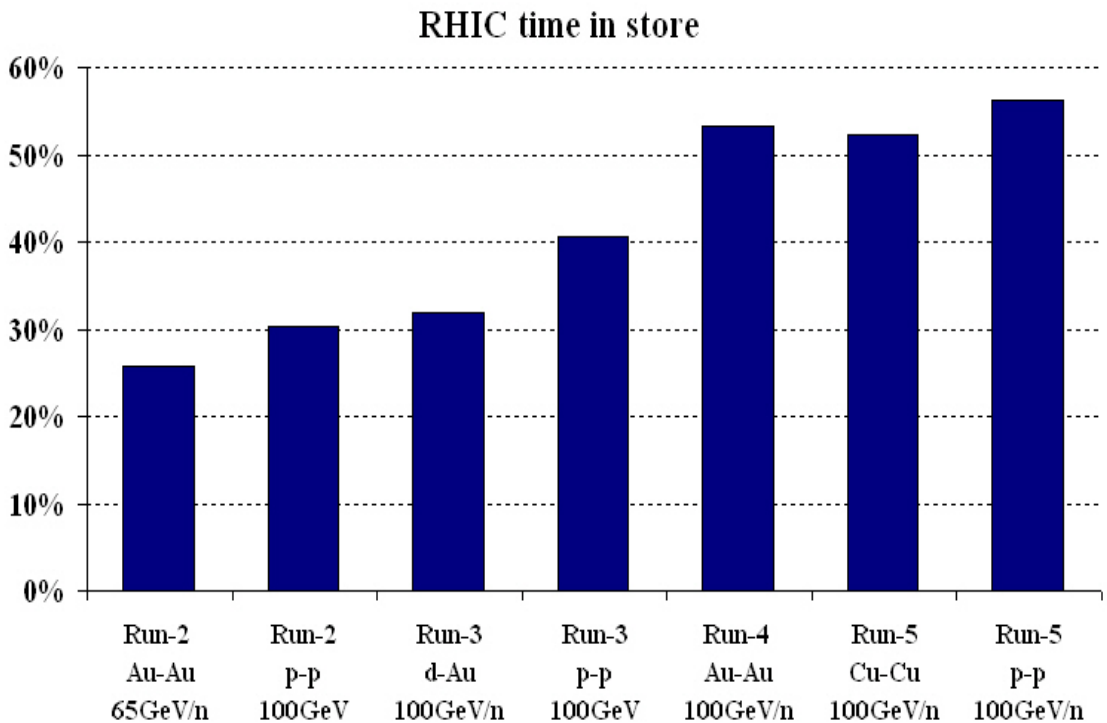
Run-7: Au-Au

- Luminosity Limitations and Projections
- RHIC Improvement Projects 2005->2008
- Run 7 Start-Up

RHIC HI – achieved parameters

Mode [best store or week]	No of bunches	Ions/bunch [10^9]	β* [m]	Emittance [μm]	$\mathcal{L}_{peak}$ [$cm^{-2}s^{-1}$]	$\mathcal{L}_{store\ ave}$ [$cm^{-2}s^{-1}$]	L_{week}
Au-Au [Run-4]	45	1.1	1	15-40	15×10^{26}	5×10^{26}	160 μb^{-1}
Cu-Cu [Run-5]	37	4.5	0.9	15-30	2×10^{28}	0.8×10^{28}	2.4 nb^{-1}
d-Au [Run-3]	55	110/0.7	2	15	7×10^{28}	2×10^{28}	4.5 nb^{-1}
Au-Au design	56	1	2	15-40	9×10^{26}	2×10^{26}	50 μb^{-1}
p↑-p↑ design	112	200	1	20	80×10^{30}	65×10^{30}	20 pb^{-1}



target

by 2008:

For Au-Au, average per store, 3 IRs

$L = 8\cdot10^{26}cm^{-2}s^{-1}$ at 100GeV/u

[incl. beam experiments and maintenance]

HI Luminosity Limitations

To reach enhanced luminosity goals in heavy ion operation

beam/bunch *intensity*

→ Limited by injectors, needs Booster bunch merge
→ Need to double bunch number
currently limited by dynamic pressure rises
→ Up to an additional 50% possible with stochastic cooling
prevents debunching due to IBS, which dominates the bunched beam lifetime

beam *sizes*

→ limited by injector performance and acceleration issues (transition crossing, instabilities, chromaticity, coupling …)

→ IBS

Improvement Projects 2005-2008

For FY2006	For FY2007	For FY2008
	RHIC injectors	
LINAC cooling tower	AGS MMPS transformer	AGS low level rf upgrade
	AGS ion pump controllers	
	RHIC luminosity, polarization and background	
Shielding STAR	Sector 3 triplet 24h movement	Low level rf upgrade
Stochastic cooling test	Stochastic cooling	Transverse damper
NEG pipes (150 m)	NEG pipes (100 m)	
CNI polarimeter vacuum and targets	CNI polarimeter upgrade	
10 Hz IR orbit feedback	Rf storage windows	
Vacuum pumps in arcs	Nonlinear chromaticity correction	
Complete vertical alignment		
	RHIC time in store	
QLI reduction	QLI reduction	
BPM system upgrade	BPM system upgrade	
Orbit correction	Orbit correction	
Injection set-up	Injection set-up	
IR PS reliability	Service building environment	Service building environment
Gradient error correction	Gradient error correction	
Decoupling on ramp		
Beginning-of-store automation		

Projected Au-Au Luminosities -> 2008

Table 4: Projected RHIC Au-Au luminosities.

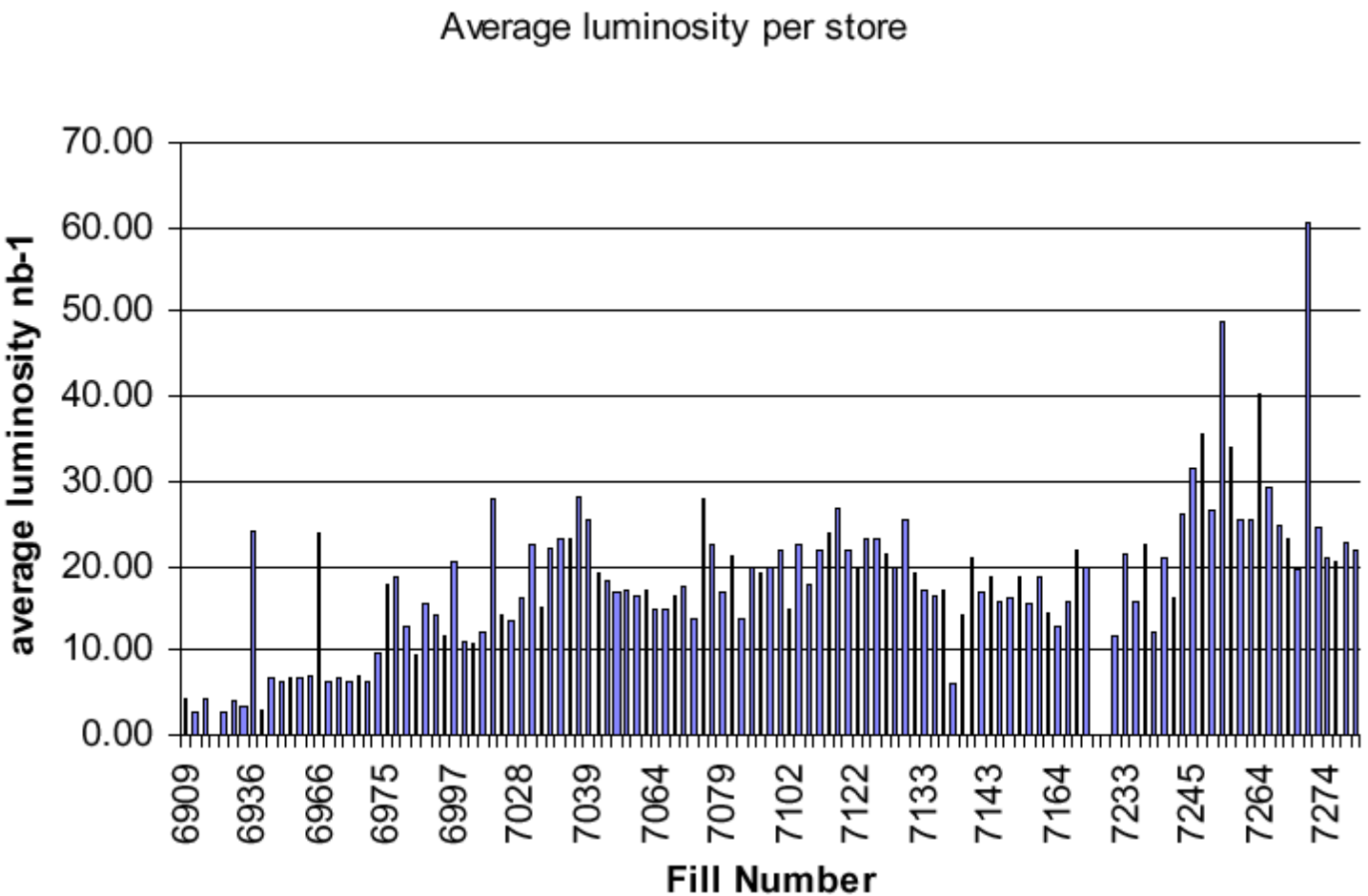
Fiscal year		2002A	2004A	2006E	2007E	2008E
No of bunches	…	55	45	78	90	111
Ions/bunch, initial	10^9	0.6	1.1	1.1	1.1	1.1
Average beam current/ring	mA	33	49	85	98	121
β*	m	1	1	0.9	0.9	0.9
Peak luminosity	10^{26} cm^{-2}s^{-1}	5	15	28	32	40
Average store luminosity	10^{26} cm^{-2}s^{-1}	1.5	4.0	7.0	8.1	9.9
Time in store	%	25	53	56	58	60
Maximum luminosity/week	μb^{-1}	25	160	236	282	360
Minimum luminosity/week	μb^{-1}			160	160	160
Maximum integrated luminosity	μb^{-1}	89	1370	2480	2970	3780
Minimum integrated luminosity	μb^{-1}			1680	1680	1680

Assume:
- **12 weeks production in every year**
- **8 weeks of linear luminosity increase**
- **3 experiments**
- **completion of improvements**

2× increase

factor 2 could also come from bunch intensity and/or emittance preservation.

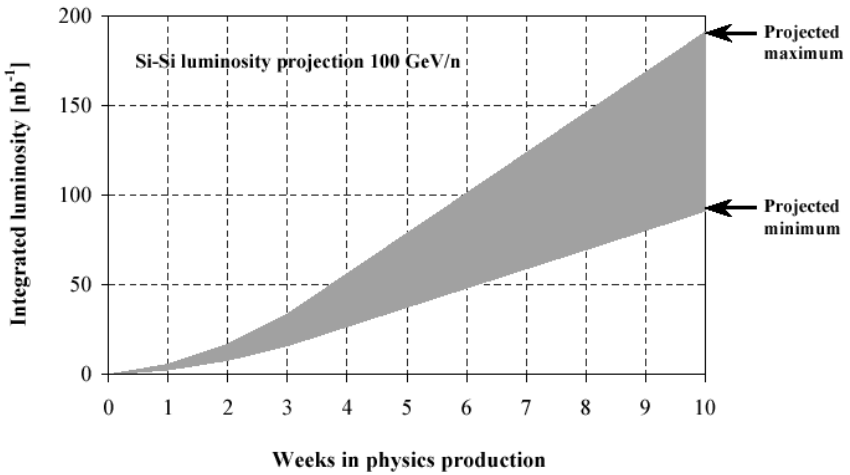
Luminosity Evolution during Run5



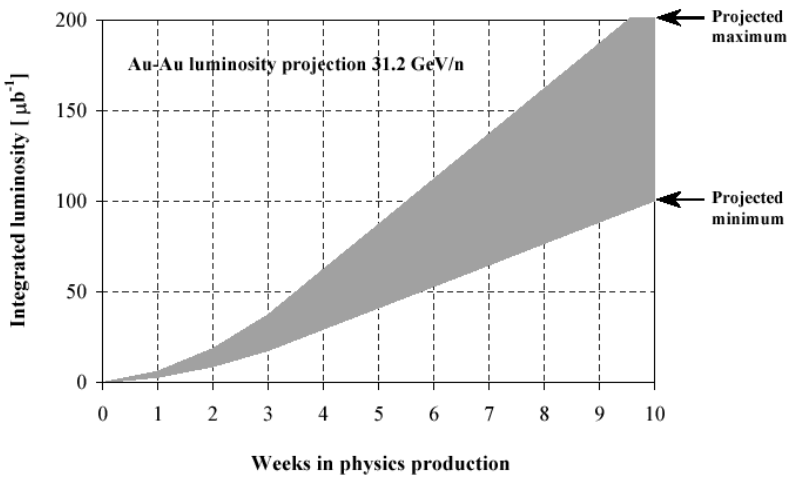
- luminosity evolution has a slope (weeks)
- not constant from fill to fill (some highlights)
- saturates at the end of run
- extensive development could prolong the slope

Projected Luminosities for some other possible HI runs

- Si-Si operation at 100 GeV
  - 68 bunches
  - 10 10^9 ions/bunch
  - 0.9 m β*
  - 15-30 π mmmrad
  - peak/avg. L: 20 10^{28}, 7 10^{28} cm $^{-2}$ s^{-1}
  - int. L/week: 22 nb^{-1}



- low energy Au-Au at 31.2 GeV
  - luminosity scales with energy: ~ 10%
  - 3-5 m β*
  - int. L/week: 35 μb^{-1}



Run 7 Start-Up

- Run7_AuAu_StartUp.html
- pre-run activities (~3 ½ weeks) will provide higher bunch intensities and smaller longitudinal emittance, stochastic cooling
  - long. emittance helps rebucketing and usable luminosity
  - high bunch intensity + higher number of bunches increase delivered luminosity
  - stochastic cooling increases luminosity lifetime

Summary

- so far we've had 100 GeV/n HI in three modes:
  - Gold – gold collisions, peak luminosity = 15×10^{26} cm^{-2} s^{-1}
  - d–Au collisions, peak luminosity = 7×10^{28} cm^{-2} s^{-1}
  - Cu-Cu collisions, peak luminosity = 2×10^{28} cm^{-2} s^{-1}
- we expect x2 between 2006-2008 by increasing number of bunches and more beta-squeezing
- together with increased bunch intensity from injectors and stochastic cooling we could be able to exceed predictions
- running close to a limit might spoil integrated luminosity and reproducibility