APEX 2009
–
Dynamic Beta* Squeeze

G. Robert-Demolaize, F. Pilat, T. Satogata, N. Malitsky, S. Tepikian, A. Marusic

OUTLINE

I – Motivation

II – Previous experiments

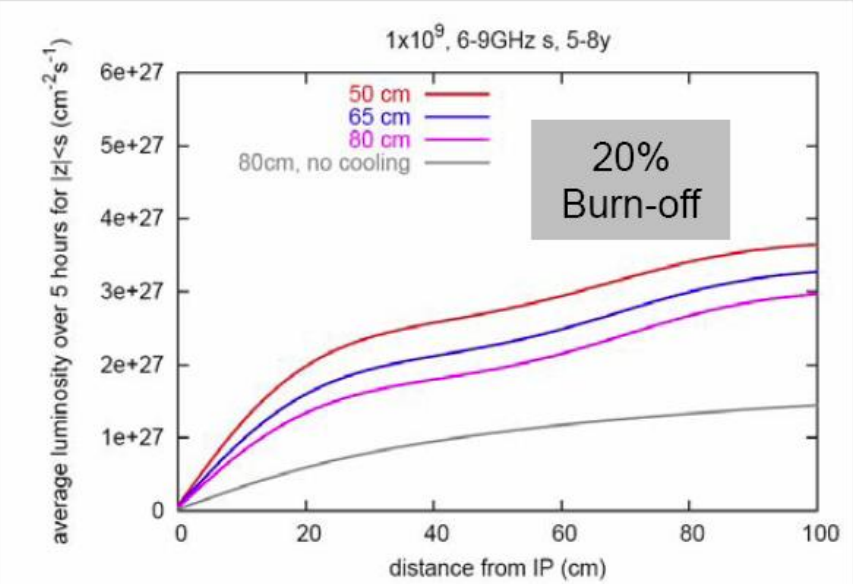
III – Plans for Run10

I – Motivation

- Run10: longitudinal and vertical Stochasting Cooling (SC) should be operational => improve luminosity by a factor 2 for β* = 0.8m !!

- To help reaching higher peak luminosity, an application is being developed using the RHIC online model to further push the squeeze of β* in the experimental insertions IR6 and IR8.

This year with 4 planes of cooling

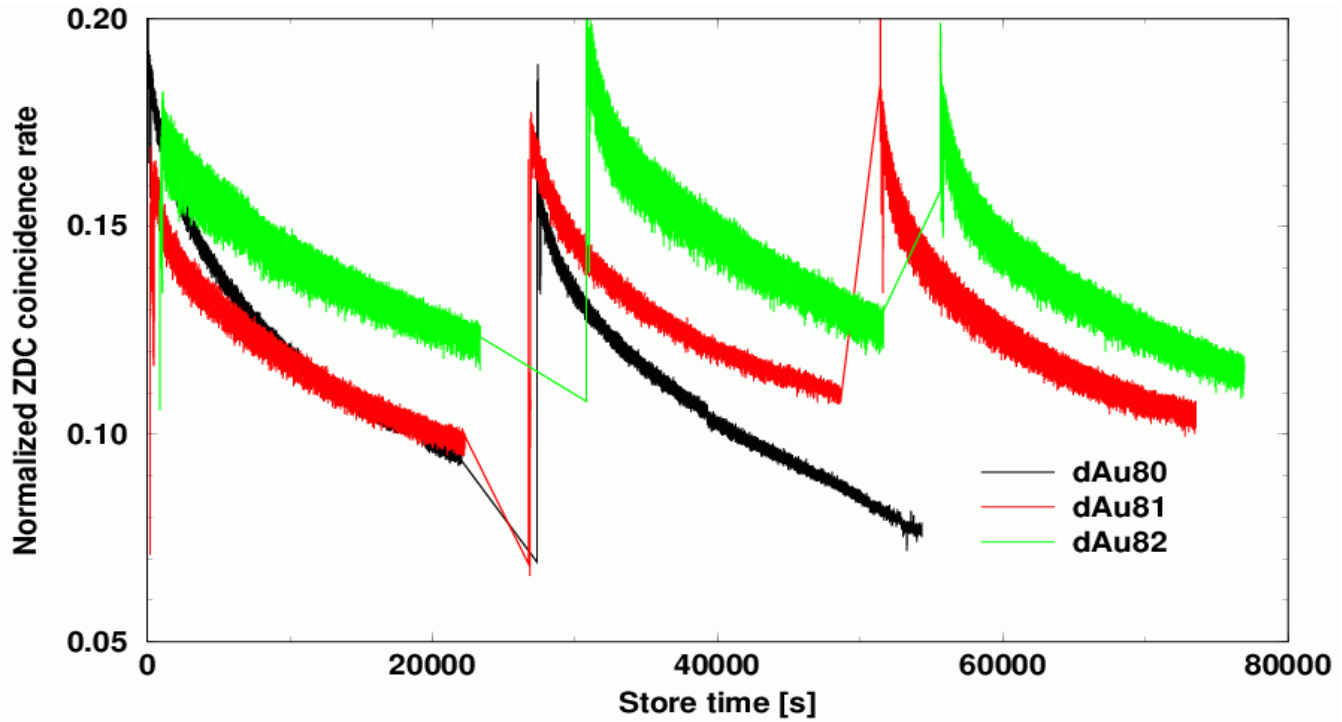


M. Brennan & M. Blaskiewicz, RHIC S&T Review 2009

- The goal is to have an application similar to the one used for orbit correction at store: β* as a function of time should follow the change in emittance as "controlled" by SC.

II – Previous Experiments

- Run8:
  - d-Au @ 100 GeV: β* squeeze: 1.0 m → 0.7 m
    => predicted 30% integrated luminosity increase was measured !!



F. Pilat et al., PAC proceedings 2009

dAu80: β * = 1.0 m Blue/Yellow
dAu81: β * = 1.0 m Blue, 0.7 m Yellow
dAu82: β * = 0.7 m Blue/Yellow

II – Previous Experiments

- Run8:
  - d-Au @ 100 GeV: β^* squeeze: 1.0 m → 0.7 m
    => predicted 30% integrated luminosity increase was measured !!
  - polarized p-p @ 100 GeV: APEX, β^* squeeze: 1.0 m → 0.65 m; used only in study time, reached ~95% ramp efficiency
    => allowed development of operational β^* = 0.7m lattice for Run9 for both 100 GeV and 250 GeV !!

II – Previous Experiments

- Run8:
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  - polarized p-p @ 100 GeV: APEX, β^* squeeze: 1.0 m → 0.65 m; used only in study time, reached ~95% ramp efficiency
    => test for operational Run9 lattice with β^* = 0.7m for 100 GeV and 250 GeV !!
- Run9: attempt to improve lifetime by unsqueezing β^* (0.7 m → 0.8 m)
  => allowed testing of Online Model script, highlighted some important limitations (CPU time, changes in other lattice parameters…).

II – Previous Experiments

```
Terminal
cdevRequestObject Error: Server failed to respond after 10.0 seconds
% cdev model "set default" "value OptiCalcTest"
% set ramp pp100-91rot
pp100-91rot
% set stone pp100-91rot::store
pp100-91rot::store
% cdev $stone "set StartMatch"
% cdev $stone "set BetaStar" "beamline Blue" "ir 6" "bstar 0.75"
cdevRequestObject Error: Server failed to respond after 10.0 seconds
% cdev $stone "set BetaStar" "beamline Blue" "ir 6" "bstar 0.8"
cdevRequestObject Error: Server failed to respond after 10.0 seconds
% cdev $stone "set BetaStar" "beamline Blue" "ir 8" "bstar 0.75"
cdevRequestObject Error: Server failed to respond after 10.0 seconds
% cdev $stone "set BetaStar" "beamline Blue" "ir 8" "bstar 0.8"
cdevRequestObject Error: Server failed to respond after 10.0 seconds
% cdev $stone "set BetaStar" "beamline Yellow" "ir 6" "bstar 0.75"
cdevRequestObject Error: Server failed to respond after 10.0 seconds
% cdev $stone "set BetaStar" "beamline Yellow" "ir 6" "bstar 0.8"
cdevRequestObject Error: Server failed to respond after 10.0 seconds
% cdev $stone "set BetaStar" "beamline Yellow" "ir 8" "bstar 0.75"
cdevRequestObject Error: Server failed to respond after 10.0 seconds
% cdev $stone "set BetaStar" "beamline Yellow" "ir 8" "bstar 0.8"
cdevRequestObject Error: Server failed to respond after 10.0 seconds
%
```

- Apply the unsqueezing for each IR separately.
- Need to do it in steps of 0.05 m to avoid a crash from the process, as the matching loop then takes too long in the model…

II – Previous Experiments

RampEditor

Ramp Edit Buffer Optics Stepstone Compare Diagnostics Help

Editing: pp100-91rot Live Stone: pp100-91rot::injection Ramp State: FirstStone Save Activate / Make Live

Optics Table | Stepstone Editor | Compare/Revert

Blue | Yellow

	Time	Stepstone	TuneY	ChromX	ChromY	Transition	BetaX6	BetaY6	BetaX8	BetaY8	Bet	TuneX	TuneY	ChromX	ChromY
1	0.0	injection	29.6612	7.5	0.5	22.772	8.27	6.36	8.28	6.50		28.7939	29.6612	7.5	0.5
2	8.0	t8	29.6521	8.0	1.1	22.922	8.19	6.62	8.23	6.74		28.7928	29.6521	8.0	1.1
3	16.0	snapback	29.6638	8.2	0.6	23.087	7.95	6.84	7.98	6.93		28.7932	29.6638	8.2	0.6
4	31.0	t31	29.6774	7.3	-0.5	23.419	7.61	7.24	7.55	7.29		28.7861	29.6774	7.3	-0.5
5	34.0	t34	29.6806	7.8	-0.5	23.488	7.60	7.31	7.52	7.35		28.7818	29.6806	7.8	-0.5
6	37.0	t37	29.6875	7.9	-0.5	23.495	7.54	7.27	7.45	7.31		28.7865	29.6875	7.9	-0.5
7	43.9	gg63	29.6902	8.2	1.6	23.507	7.00	6.79	6.92	6.84		28.7788	29.6902	8.2	1.6
8	70.4	gg98	29.7096	8.1	2.0	23.632	4.51	4.47	4.45	4.52		28.7665	29.7096	8.1	2.0
9	73.9	gg104	29.7122	8.1	2.1	23.634	4.46	4.43	4.40	4.48		28.7652	29.7122	8.1	2.1
10	100.0	t100	29.7208	7.5	2.4	23.685	2.80	2.83	2.77	2.89		28.7550	29.7208	7.5	2.4
11	112.2	gg179	29.7162	7.8	2.3	23.650	2.14	2.15	2.12	2.21		28.7454	29.7162	7.8	2.3
12	131.6	flattop	29.6885	6.5	3.6	23.583	1.90	1.90	1.89	1.96		28.7130	29.6885	6.5	3.6
13	140.0	t140	29.6848	6.1	2.8	23.567	1.75	1.74	1.75	1.80		28.7064	29.6848	6.1	2.8
14	150.0	t150	29.6849	6.3	3.0	23.564	1.50	1.47	1.50	1.52		28.7043	29.6849	6.3	3.0
15	160.0	t160	29.6808	6.1	4.4	23.562	1.24	1.21	1.25	1.25		28.6988	29.6808	6.1	4.4
16	170.0	t170	29.6786	5.7	4.3	23.563	1.02	0.99	1.03	1.02		28.6941	29.6786	5.7	4.3
17	180.0	t180	29.6804	5.4	5.1	23.561	0.85	0.83	0.86	0.85		28.6902	29.6804	5.4	5.1
18	190.0	t190	29.6801	3.0	6.0	23.556	0.74	0.73	0.75	0.74		28.6870	29.6801	3.0	6.0
19	200.0	beta	29.6821	2.3	5.8	23.557	0.70	0.69	0.71	0.71		28.6885	29.6821	2.3	5.8
20	384.0	t384	29.6853	1.8	5.9	23.549	0.70	0.69	0.71	0.71		28.6832	29.6853	1.8	5.9
21	568.0	t568	29.6851	1.4	6.0	23.538	0.70	0.69	0.71	0.71		28.6747	29.6851	1.4	6.0
22	660.0	t660	29.6856	-0.5	6.1	23.531	0.70	0.69	0.71	0.71		28.6695	29.6856	-0.5	6.1
24	762.0	collide	29.6943	-0.8	7.3	23.531	0.74	0.73	0.75	0.75		28.6638	29.6805	-3.4	5.1
25	772.0	store	29.7261	2.7	11.9	23.552	0.79	0.78	0.80	0.80		28.6753	29.6946	-2.5	7.6

Tune Nudge = 0.0005

Menu Selection: Optics -> Show Expanded Table (May 29 11:24:34)
Menu Selection: Optics -> Show Expanded Table (May 29 11:26:19)
Menu Selection: Optics -> Show Expanded Table (May 29 11:26:21)

II – Previous Experiments

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Editing: pp100-91rot Live Stone: pp100-91rot::injection Ramp State: FirstStone Save Activate / Make Live

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	Time	Stepstone	TuneY	ChromX	ChromY	Transition	BetaX6	BetaY6	BetaX8	BetaY8	Bet	TuneX	TuneY	ChromX	ChromY
1	0.0	injection	29.6821	9.2	-1.0	22.813	8.27	6.50	8.32	6.55		28.8247	29.6821	9.2	-1.0
2	8.0	t8	29.6751	10.0	-0.4	22.939	8.27	6.78	8.25	6.83		28.8060	29.6751	10.0	-0.4
3	16.0	snapback	29.6814	11.7	-0.4	23.100	8.06	7.02	8.03	7.07		28.8026	29.6814	11.7	-0.4
4	31.0	t31	29.6928	11.4	-1.5	23.430	7.63	7.43	7.69	7.47		28.7935	29.6928	11.4	-1.5
5	34.0	t34	29.6952	11.6	-2.9	23.498	7.58	7.51	7.68	7.55		28.7887	29.6952	11.6	-2.9
6	37.0	t37	29.7000	11.2	-2.9	23.504	7.52	7.47	7.62	7.50		28.7918	29.7000	11.2	-2.9
7	43.9	gg63	29.7007	11.3	-2.1	23.515	7.03	7.02	7.11	7.05		28.7837	29.7007	11.3	-2.1
8	70.4	gg98	29.7172	10.9	-0.4	23.639	4.59	4.65	4.60	4.65		28.7696	29.7172	10.9	-0.4
9	73.9	gg104	29.7179	9.9	-1.3	23.639	4.53	4.60	4.54	4.60		28.7672	29.7179	9.9	-1.3
10	100.0	t100	29.7273	9.1	0.0	23.685	2.86	2.94	2.86	2.95		28.7534	29.7273	9.1	0.0
11	112.2	gg179	29.7260	9.2	1.8	23.650	2.19	2.27	2.20	2.28		28.7437	29.7260	9.2	1.8
12	131.6	flattop	29.7324	6.3	3.0	23.619	1.92	2.03	1.94	2.05		28.7412	29.7324	6.3	3.0
13	140.0	t140	29.7223	6.0	3.2	23.597	1.75	1.86	1.77	1.88		28.7296	29.7223	6.0	3.2
14	150.0	t150	29.7069	5.6	3.6	23.570	1.43	1.56	1.45	1.58		28.7082	29.7069	5.6	3.6
15	160.0	t160	29.7048	5.2	5.4	23.558	1.14	1.25	1.15	1.27		28.6937	29.7048	5.2	5.4
16	170.0	t170	29.7132	3.5	5.3	23.557	0.92	1.00	0.93	1.01		28.6882	29.7132	3.5	5.3
17	180.0	t180	29.7205	1.6	5.2	23.554	0.79	0.83	0.79	0.84		28.6840	29.7205	1.6	5.2
18	190.0	t190	29.7280	-0.0	5.9	23.547	0.72	0.74	0.73	0.75		28.6805	29.7280	-0.0	5.9
19	200.0	beta	29.7304	0.1	8.0	23.543	0.70	0.71	0.71	0.72		28.6785	29.7304	0.1	8.0
20	384.0	t384	29.7343	1.0	8.1	23.536	0.70	0.71	0.71	0.72		28.6739	29.7343	1.0	8.1
21	568.0	t568	29.7337	-1.1	8.2	23.527	0.70	0.71	0.71	0.72		28.6662	29.7337	-1.1	8.2
22	660.0	t660	29.7344	-2.6	8.3	23.522	0.70	0.71	0.71	0.72		28.6628	29.7344	-2.6	8.3
23	752.0	non_coll	29.7335	-3.4	9.3	23.515	0.70	0.71	0.71	0.72		28.6577	29.7335	-3.4	9.3
24	762.0	collide	29.7470	0.6	11.8	23.518	0.75	0.75	0.75	0.76		28.6576	29.7334	-2.2	9.3
25	772.0	store	29.7643	4.7	12.9	23.533	0.80	0.81	0.80	0.81		28.6661	29.7347	-0.6	7.9

Tune Nudge = 0.0005

Menu Selection: Optics -> Show Expanded Table (May 29 11:38:39)
Menu Selection: Optics -> Show Expanded Table (May 29 11:38:44)
Menu Selection: Optics -> Show Expanded Table (May 29 11:38:45)

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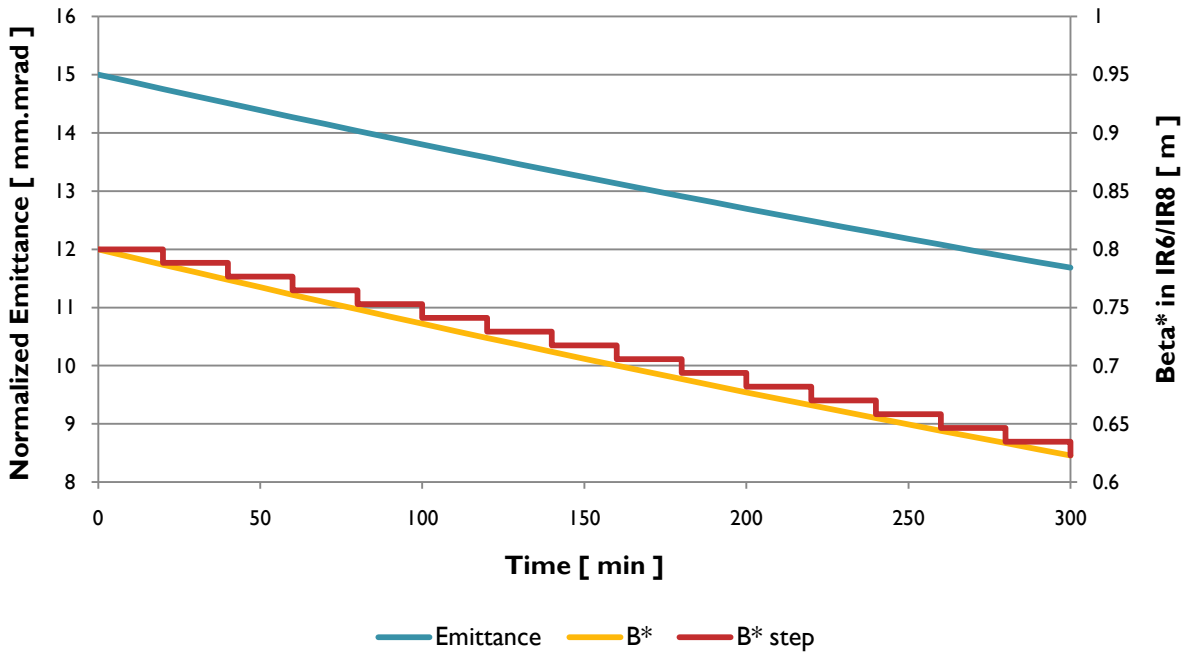
  - d-Au @ 100 GeV: β* squeeze: 1.0 m → 0.7 m
    => predicted 30% integrated luminosity increase was measured !!
  - polarized p-p @ 100 GeV: APEX, β* squeeze: 1.0 m → 0.65 m; used only in study time, reached ~95% ramp efficiency
    => test for operational Run9 lattice with β* = 0.7m for 100 GeV and 250 GeV !!
- Run9: attempt to improve lifetime by unsqueezing β* (0.7 m → 0.8 m)
  => allowed testing of Online Model script, highlighted some important limitations (CPU time, changes in other lattice parameters…)
- Before Run8, β* squeeze also showed that some PS upgrade is required in order to reach values as low as 0.5 m. Adjusting collimation and non-linear corrections remains a must (need to develop automatic processes for these in the fullness of time).

III – Plans for Run10

- Test the online model for limitations on squeeze steps.

- Main goal: use the effect of SC on emittance changes along a store to increase luminosity by dynamically reducing β* (i.e. keep the ratio ε/β* constant).



- This can be done in stages: first a step function, then a fitted polynomial (matching SC effect on beam emittance once the system is fully commissioned).