Plans for Low Energy Studies in Run-11

Christoph Montag

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Run-10 experience at low energies

- Good performance ($\geq$ 10 min lifetime) at $\sqrt{s} = 7.7$ and 11.5 GeV

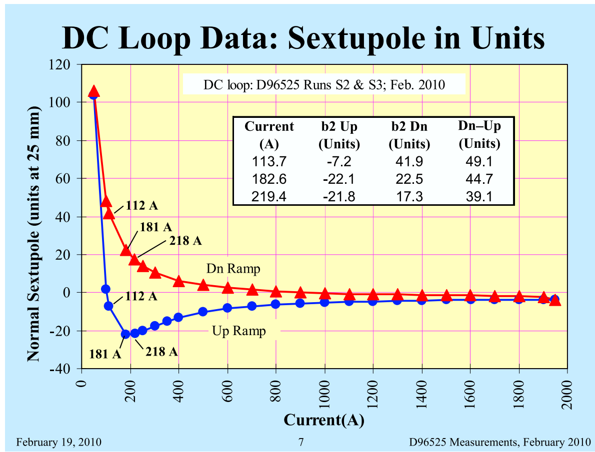
- Only 4 sec lifetime at $\sqrt{s} = 5$ GeV

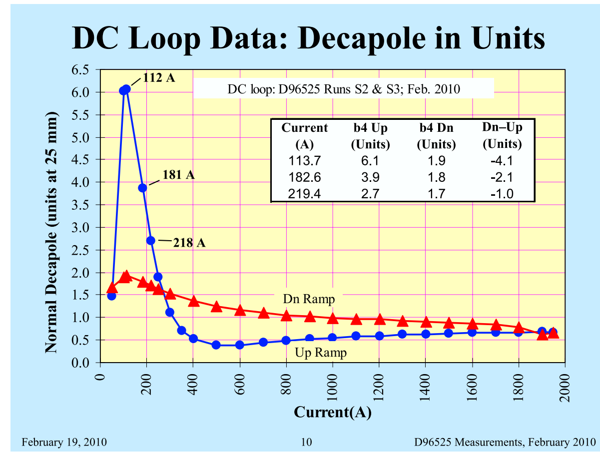
- Tiny bunch intensities ($\approx 10^8$) at lowest energy $\Rightarrow$ space charge should not have been an issue

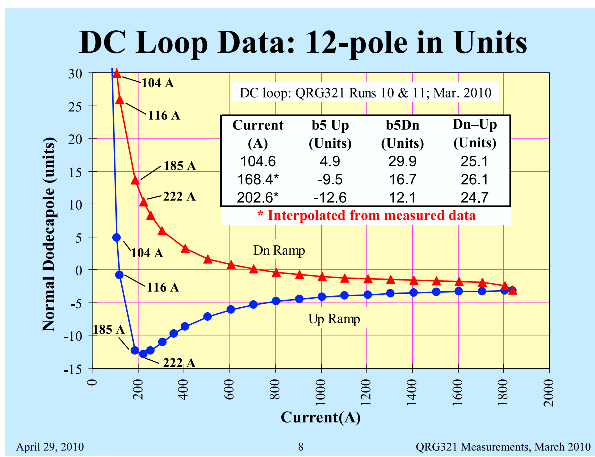
- Observed large tune spread at 5 GeV, but short lifetime did not allow for chromaticity measurements

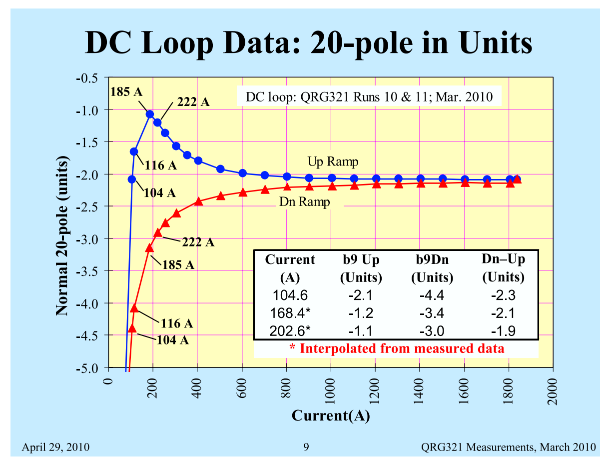
- Scanned chromaticities instead over a range of 40 units; no effect

Multipole measurements









Multipoles at four different energies

	$\sqrt{s} = 5$ GeV	$\sqrt{s} = 7.7$ GeV	regular injection	100 GeV protons
sextupole	-7.2	-22.1	-10	-3
10-pole	6.1	3.9	0.4	0.7
12-pole	4.9	-9.5	-7	-3
20-pole	-2.1	-1.2	-1.9	-2.1

10-pole is 50 percent larger at 5 GeV than at 7.7 GeV

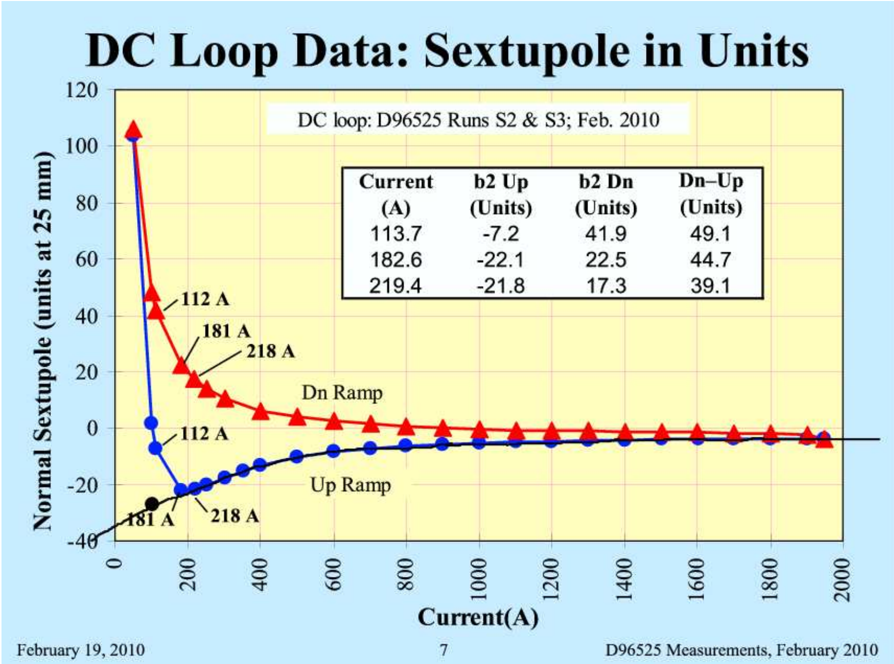
12-pole has opposite sign at 5 GeV, but is not larger than at the other energies

Sextupole and 20-pole are well within "normal range"

No obvious reason for poor performance at 5 GeV

What happened?

In the model, b_2 as function of energy is calculated by a fit function, based on data between injection and store:



At $\sqrt{s} = 5\,\text{GeV}$, this fit (black line) gives ≈ -30 units instead of the correct -7.2 units

One unit of b_2 corresponds to ≈ 5 units in chromaticity

- Large tune spread may indicate that chromaticities were indeed far off. Need better modeling.

- Triplet multipoles are not known at these energies, but can be simulated (Animesh, Ramesh). At $\beta^* = 10\,\mathrm{m}$ they should not dominate the beam dynamics anyway, unless triplet quads perform much worse there than arc magnets

- Need tracking studies to determine whether 50 percent larger 10-pole and opposite sign for 12-pole can make such a big difference. Include "bipolar" sextupole scheme

Simple APEX study with low intensity beam at injection: How far off does the chromaticity have to be to get only a few seconds lifetime?

Parameters for a 6.1 GeV test

- $h = 378 = 42 \cdot 9$ allows collisions at both experiments
- Multipoles:

	$\sqrt{s} = 6.1$ GeV	$\sqrt{s} = 7.7$ GeV	regular injection	100 GeV protons
sextupole	-12	-22.1	-10	-3
10-pole	5	3.9	0.4	0.7
12-pole	-2	-9.5	-7	-3
20-pole	-1.5	-1.2	-1.9	-2.1

Or are we confident enough now to just try 5 GeV again?

Summary

- RHIC performed well at $\sqrt{s} = 7.7\,\text{GeV}$ and above

- At $\sqrt{s} = 5\,\text{GeV}$, lifetime was only seconds, even at tiny intensity

- Measured main magnet multipole errors cannot explain this poor performance

- Most likely explanation is a totally wrong main dipole b_2 component in the model that resulted in failed chromaticity correction

- Energy for Run-11 test still to be decided - $\sqrt{s} = 5$ or 6.1 GeV