ATR Matching

APEX Workshop 2008

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Overview

- Motivation
- Match from AGS
- ATR model and correction schemes
- Match to RHIC
- Lambertson drives
- Possible APEX studies

Motivation: why study ATR?

- There is little empirical evidence of good match to RHIC.
- Operations devotes excessive effort to extraction/ATR/injection tune. 5 min/ramp = 1 day at store
  - Line corrections made for extraction equipment.
  - Large bends have hysteresis issues, but have yet to be included in correction algorithms.
  - Injection steering rails power supplies, operates close to high loss conditions.
  - Steering through lambertson onto RHIC closed orbit involves steering magnets far upstream. Initial tune as well as maintenance of setup is problematic.
- Losses, beam decay sometimes cannot be ameliorated.
- Emittance growth in RHIC is observed but its origin remains unknown.

AtrOrbitDisplay

File Select Orbit Display Correct Diagnostic

Beam ==> Lattice: BTransfer Section: uwx

s [m] (S-atr)

Horizontal orbit position [mm]

s [m] (S-atr)

Vertical orbit position [mm]

s [m] (S-atr)

AtrOrbitDisplay

File Select Orbit Display Correct Diagnostic Help

Beam ==> Lattice: BTransfer Section: uwx

s [m] (S-atr)

Horizontal orbit position [mm]

s [m] (S-atr)

Vertical orbit position [mm]

s [m] (S-atr)

Start Acquisition

Logging Off

Stop Acquisition

Logging Setup...

Comment: blue, yellow orbit from golden fill 9940

Gains: x10

Orbits

R	V	L	D	Orbit - push for details	Bunch
	-	-	-	No comment	0
	V	-	-	No comment	0
	-	-	-	No comment	0
	V	-	-	No comment	0
	-	-	-		
	-	-	-		
	-	-	-		
	-	-	-		
	-	-	-		
	-	-	-		
	-	-	-		
	-	-	-		

	-	-	-	No comment	1
	V	-	-	No comment	1

Match to AGS

- AGS extraction parameters are fairly well understood.
  - Measurements match theoretical prediction. See PAC 2001 paper.
  - Tune, dispersion, chromaticity
- Areas of concern
  - Vertical angle in G10 kicker (μrad) has large affect on (vertical) orbit at beginning of ATR.
  - Measured (by flags) beam parameters at beginning of ATR can vary over the long term. Nonlinear aspect of ATR combined function magnets is suspected (see presentation by N. Tsoupas).

The ATR model

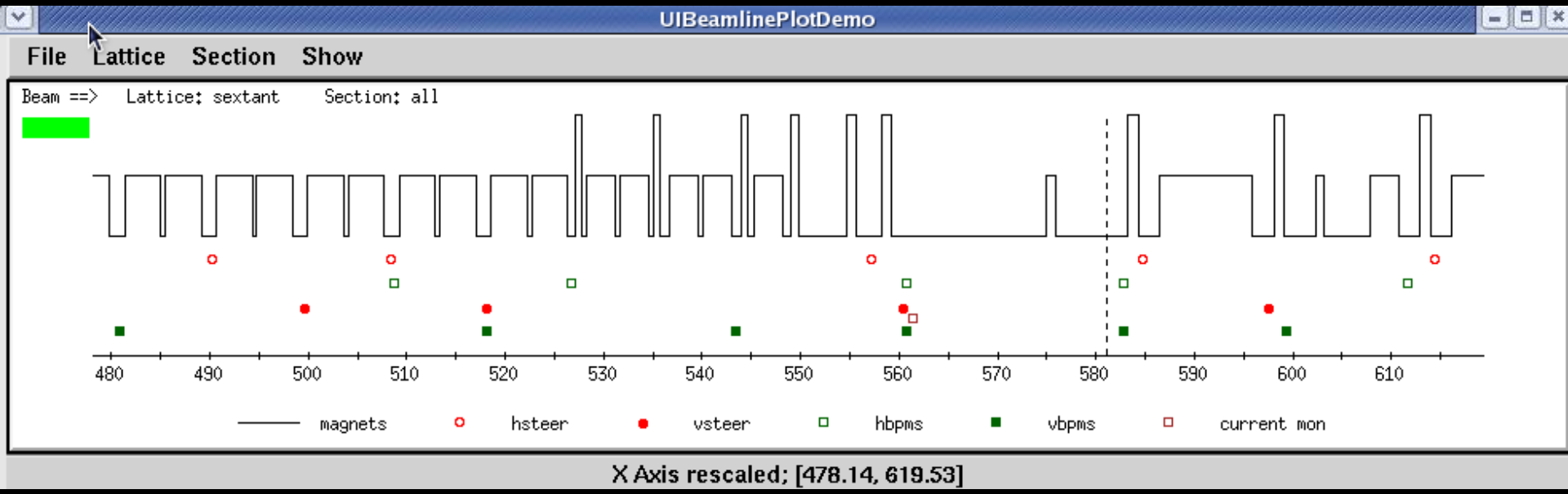
- We only make use of model in an online sense for
  - Magnet current/strength calculations
  - RHIC injection orbit steering
- Why do dipoles run off design?
  - Typical currents 0.16-0.68% per magnet off design strength
  - AGS energy not well known?
    - Some arcs above design, some below
  - PS current not well known?
  - Hysteresis?
- ATR model confirmed by kicking trajectory with trim correctors.
  - Little data exists to confirm quad variations compared to model predictions.
- Some measurements of achromatic sections of line have been taken in the past.
- Little or no data has been taken in recent runs.
- G10 kicker and H10 septum currents have drastic effects down the ATR line, but correction algorithms haven't (yet) taken this into account.

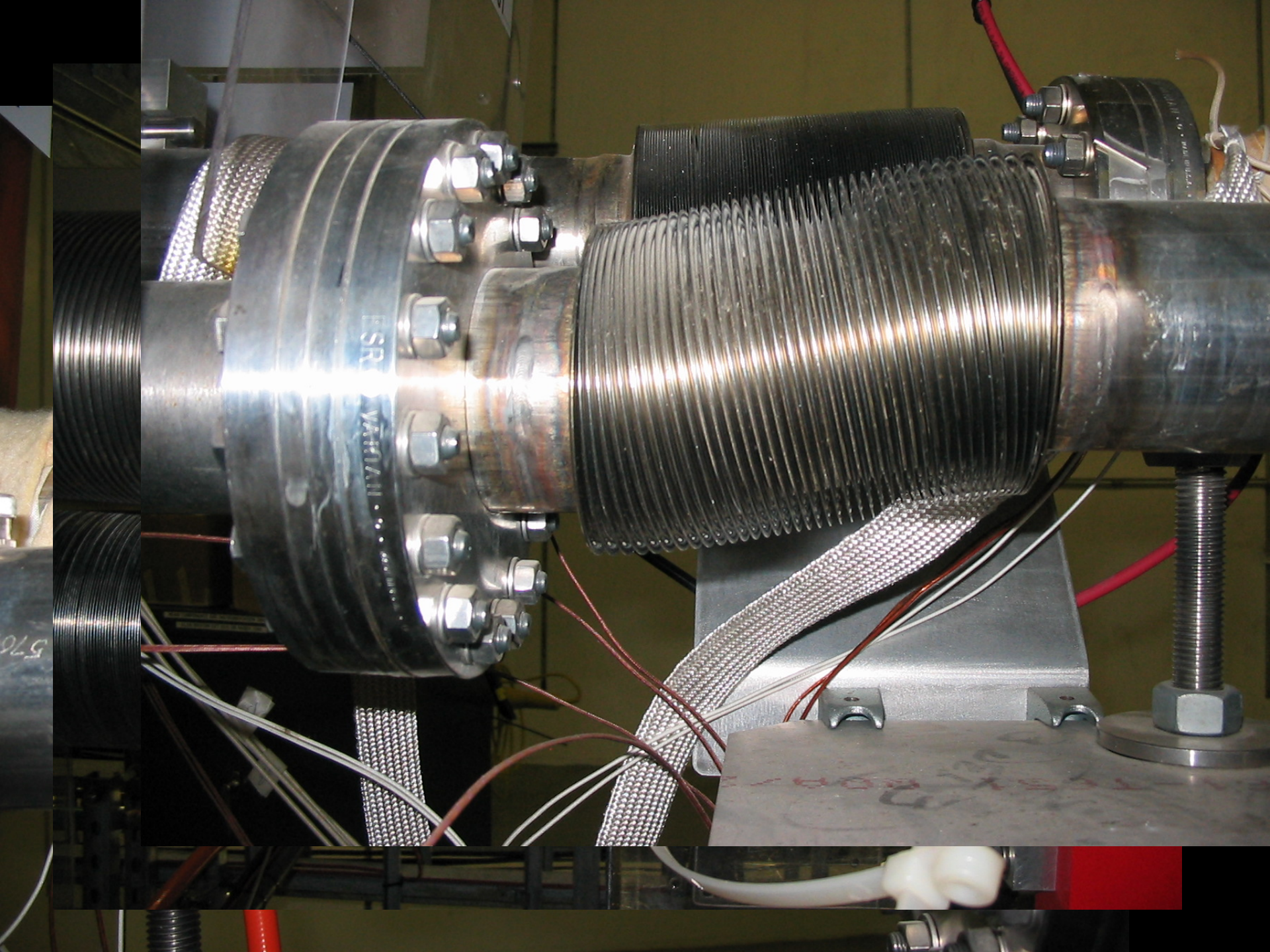
Match to RHIC

- ATR design changes are usually made to match RHIC lattice changes.
- Quality of match has not been verified with beam (we have verified that it could be worse…).
- Original lambertson alignment calculations had an injection bump for circulating beam in mind.
  - Discarded due to kicker strength considerations.

Lambertson drives

- 2 horizontal, 1 vertical trim between arc and pitching/lambertson magnets
- 2 BPMs




ESR
VARDAN

Future APEX topics

- Lambertson position study
  - Probe aperture of circulating beam. Revisit injection bumps.
  - Attempt injection steering at various positions.
  - Determine if additional correctors or BPMs could improve situation.
- RHIC injection matching study
  - TBT IPM measurements (not possible with protons).
  - CNI bunch-by-bunch emittance measurements.
  - Investigate first vs. second turn losses.
- ATR model studies
  - Arc trajectories
    - Investigate non-linearities of combined function magnets.
    - Attempt to design a solution impervious to the non-linearities.
    - Include x- and y-arcs.
  - Vary quad strengths, verify measured β vs. predictions.
  - Investigate hysteresis effects of large bends.

Summary

- There are few opportunities to study the ATR. Severe intensity degradation is typically the only cause for investigation.
- Work continues to provide online model tools that will aid operations and streamline study data acquisition.
- Some topics could impact current operations (emittance, time at injection) if addressed.