

MI \rightarrow RR Injection

Phase and Energy Mismatch: Measurements using W24

Chandra Bhat, Bob West & Ming-Jen

MI Group Meeting

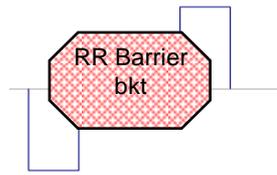
February 10, 2010

Abstract: An application program is developed (based on Ming-Jen's R86) measure the injection phase, rf mismatch and bunch intensities during MI to RR pbar injection. We plan to make this measurement as a part of the standard operation and correct injection oscillations due to phase, energy and rf mismatch to improve the injection efficiency.

Chandra, Bob and Ming-Jen

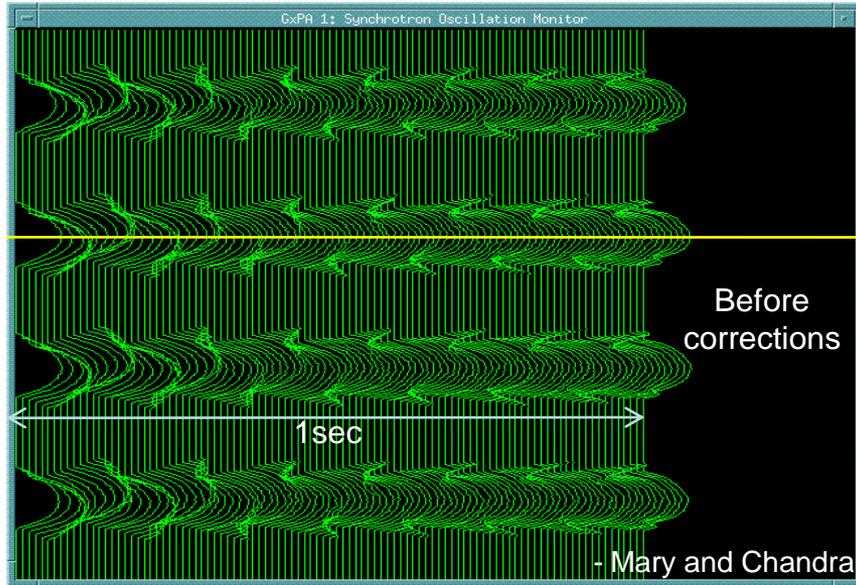


Examples of MI to RR Injection Water Fall with R94



10/06/2009

Energy & Phase Mismatch



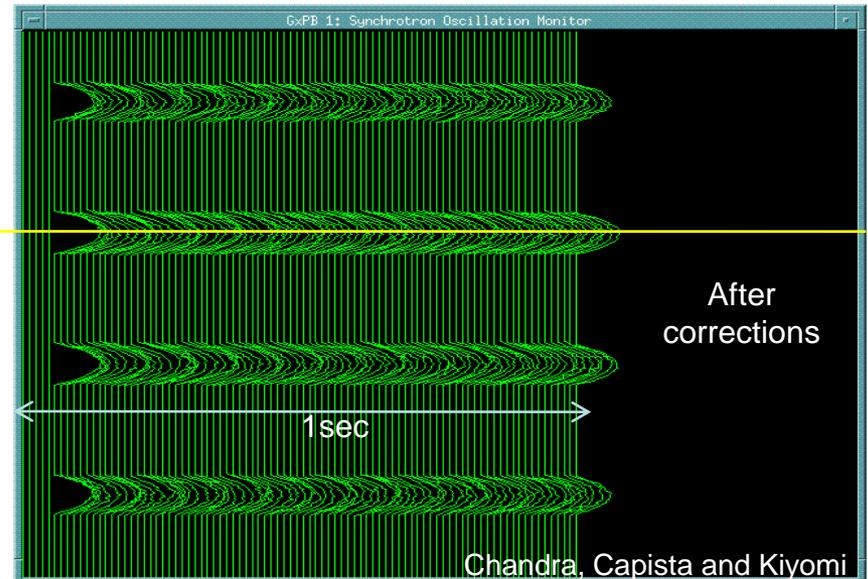
- >25% larger longitudinal emit. for the injected beam
- Overall broad shoulder in the Schottky tail on the stash?

(Strong dependance was observed between incoming LE and the breadth of the Schottky spectrum -now we know why)

So far, the **energy, phase and rf voltage** mismatch are estimated from these data manually. About couple of months ago Sasha asked me if I can automate it.

10/08/2009

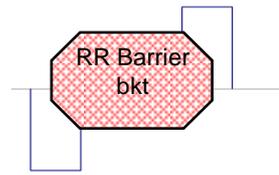
2D Minidip energy lowered by 4 MeV and & Phase reduced by 11 deg ($\cong 0.6$ bkt).



- No longitudinal emit. growth for the injected beam
- Overall less broad shoulder in the Schottky tail on the stash?

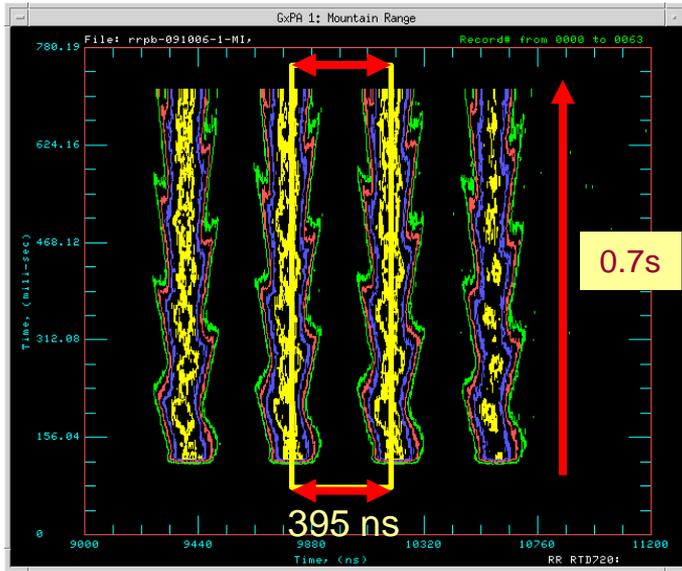


Examples of MI to RR Injection Contour plots with R86 (Ming-Jen's program)



10/06/2009

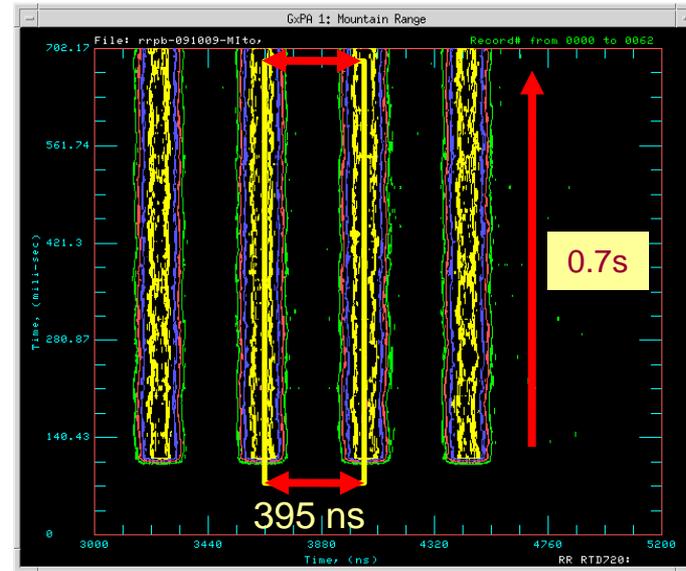
Energy & Phase Mismatch



Before
corrections

10/08/2009

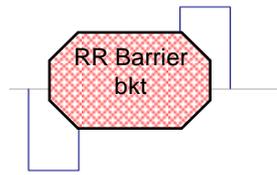
**2D Minidip energy lowered by 4 MeV and
& Phase reduced by 11 deg.**



After
corrections



R86 (by Ming-Jen) → W24



```
PB W24<NoSets>
W24  ♦Menu♦  ♦Get/Plot♦  09-FEB-10 17:58:13  ♦Pgm_Tools♦

Digitizer data
*Timer:  -<I:RTDARM>+.  Status: <*ON/ off>

*Clear digitizer          *Verify setup
*Arm digitizer on < 0>    *Send setup
*Get data for [Channel one] *Trigger setup

File area: [Default ] /usr/local/cbs_files/c
*Save data to file
*File directroy: [* .dat ]
*Recall data from file

Digitizer config
Ch 1   Ch 2   Ch 3   Ch 4
Range [ .1 ] [ .5 ] [ 1 ] [ 1 ] Volts
Offset [ 0 ] [ 0 ] [ 0 ] [ 0 ] Volts
State [ ON ] [ off] [ off] [ off]

Acquire Length: [ 4096]
Records: [ 128]
Intervals: [ 2 ] nsec

Trigger Mode: [ NORMAL]
Source: [ EXTERNAL]
Position: [ 1920 ] ns
Level: < 1 > volts
LevelType: [ VOLT ]
TurnDelay: [ 1000]

Digitizer status
Acquire state: HLDM
ID: TEK/RTD720A,V81.1,DIG/2.  UID: B050342
Option: OPT 06: 4 CHANNELS,OPT 10: 512k NVRAM
Digitizer events.....

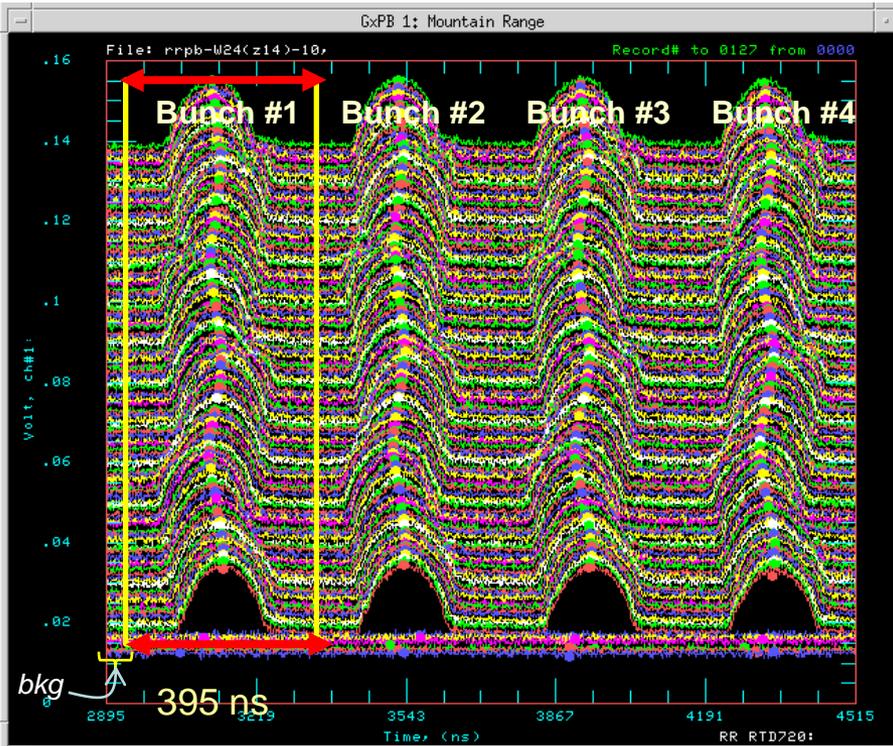
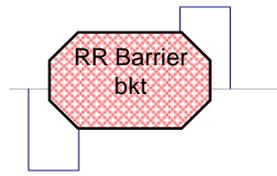
Range] on [GxPB 1]
+ to ( 0 ) ns
to ( 0 ) MHz
scale

<Exit>
```

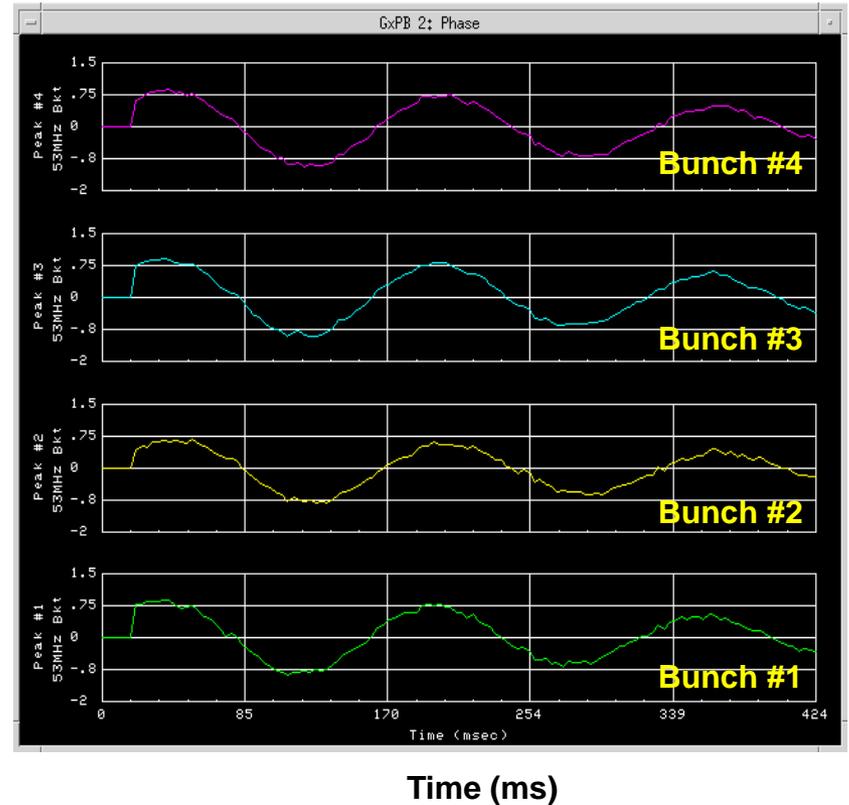


Default Plots from W24

(data taken on 01/21/2010)



Phase Measured in Units of R:FARBP5

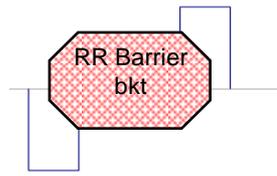


$$\text{Bunch Center} = \frac{\sum_{i=1}^N (I_i - bkg_i) t_i}{\sum_{i=1}^N (I_i - bkg_i)}$$

- Mainly phase mismatch
- ~+0.75 bkt phase offset from R:FARBP5



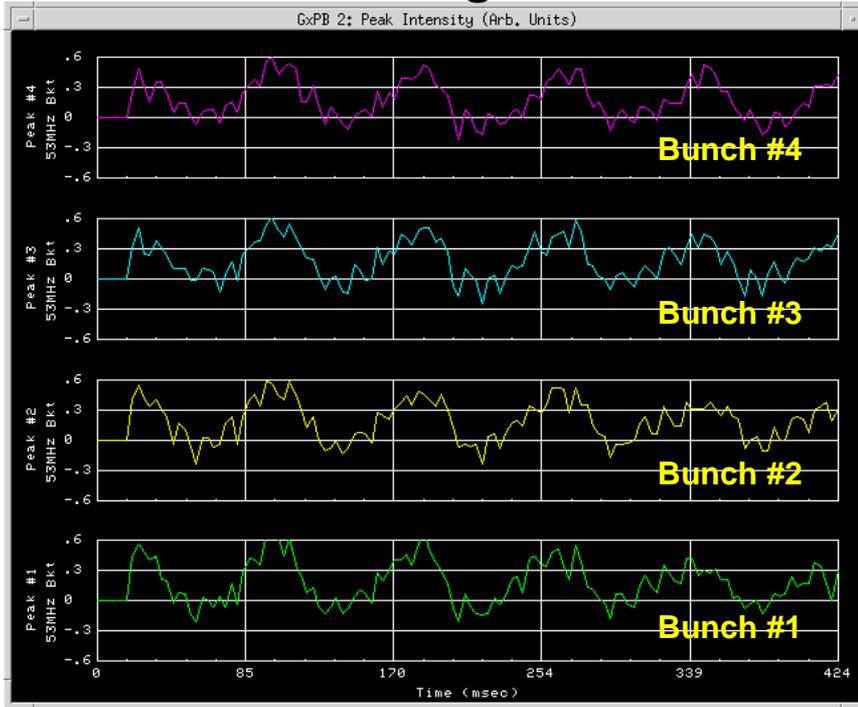
“Other Peak Plots” from W24 (in cyclic)



The variation of peak intensity of a bunch as function of time represents rf voltage mismatch (quadrupole oscillations)

RF Voltage mismatch

Bunch peak intensity (arb. Units)

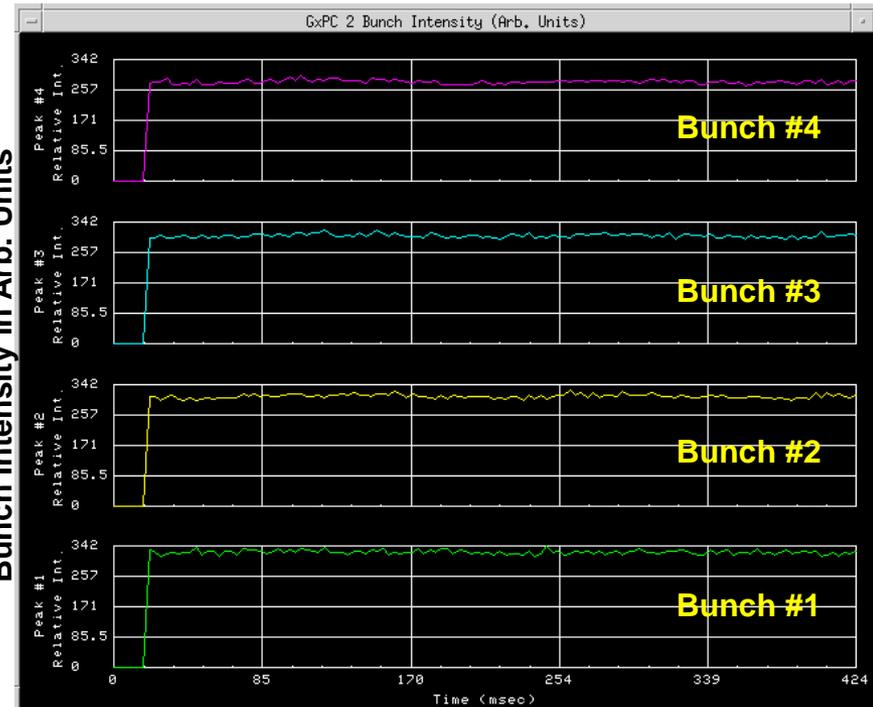


Time (ms)

Bunch Intensity

$$\text{Bunch Intensity} = \sum_{i=1}^N (I_i - bkg_i)$$

Bunch Intensity in Arb. Units



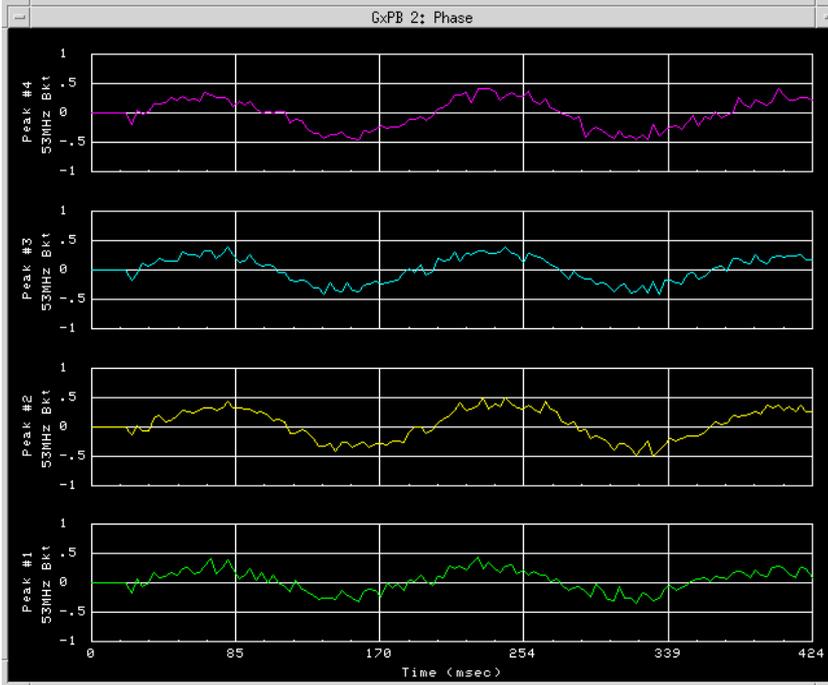
Time (ms)



Data after January 27, shutdown

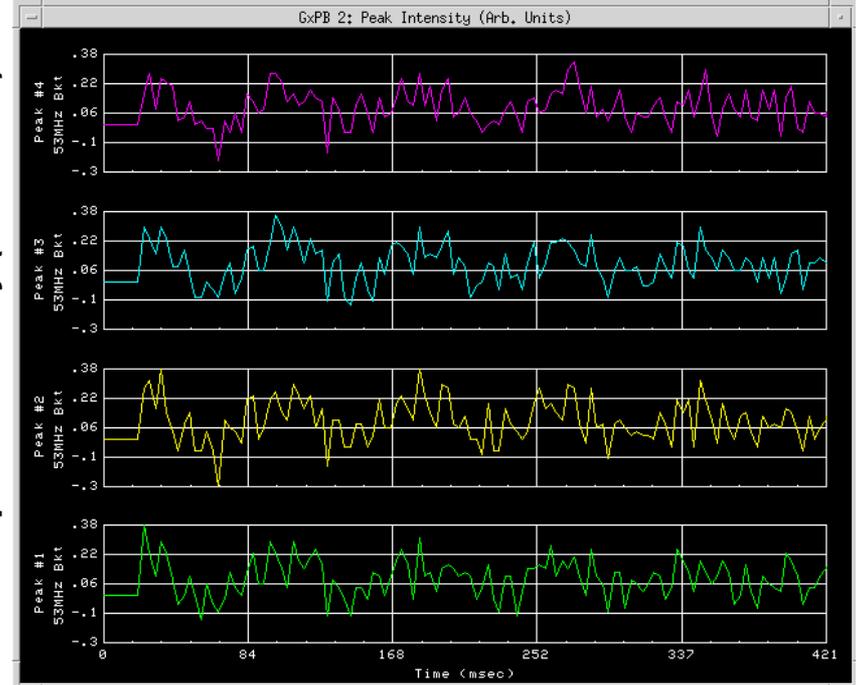
RR Barrier
bkt

Phase Measured in Units of R:FARBP5



Time (ms)

Bunch peak intensity (arb. Units)



Time (ms)

Data of 01/30/2010

- Mainly Energy mismatch

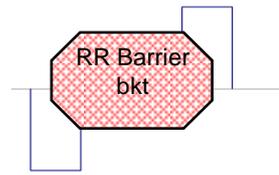
$$\text{Energy Offset (MeV)} = 6.57 \frac{\text{Max offset (bkts)}}{10.5}$$

$$= 0.3 \text{ MeV}$$

- rf mismatch is about the same as before



Future Work



- Make this program
 - ❑ As a part of the standard operation ← to use by MCR and Machine Experts to monitor phase and energy mismatch on all transfers
 - ❑ In case of any mismatches are seen then,
 - Phase Mismatch: Can be set on R6 <22> if it is >0.5 bkts
 - Energy Mismatch: If Max offset <1.6bkts (1MeV) ← **OK**
If Max offset >1.6bkt should be reported.
- Please feel free to use W24 as often as possible. Please give us your inputs and comments to debug and improve it.
- Fit injection phase mismatch data & extract the necessary quantities
 - ❑ Fitting curve:
$$\dot{y} = A \sin(2\pi f_{synch\ freq} t + \phi_{injphase}) e^{-\lambda t}$$
- Want to datalog the measured injection phases to monitor how the injection phase is changing in time. We may need a dedicated scope for this purpose.