VERS. 2.0 PK 7/17/91

POSITRON YIELD TUNING PROCEDURES

I. OVERVIEW

this section summarizes the main things available to look at and tune in the e+ system. A step by step tuning procedure follows in the next section

1. CONFIGURATIONS

these are the relevant configs for the e+ system and should always have gold configs loaded.

magnet configurations

EXTraction line

EPOSLINE

CID-01

SRING

energy configurations

KEPOS

KSRING

timing configurations

TIMEPOS

TIMSRING

2. DIAGNOSTICS AVAILABLE

the following is a summary list of major toools available to look at or "tune on" to bring up the e+ yield

PYIELD display

tabulates the yield and subyield through out the e+ system

• use this to immediately diagnose where we are losing the most yield

reference values for subyields are listed as a guide

PYIELD correlation plot variables

•allows you to put the PYIELD display values in a correlation plot to optimize a tuning parameter

From the correlation plot acquisition panel use the button macro "positron yields" to load all the pyield variables

ETA foils and bunch length monitor scope

indicate the energy, energy spread and amount of charge□bunch length

BPM Orbits

indicate whether launch and steering in each subsystem are correct

PROFile monitor screen EP01 185 (upstream of target)

jitter, tails and energy spread in the scavenger beam are apparent.

Sector 1 wire scanners

measure the emittance and beta mismatch of positrons at the end of Sector 1

- scans only possible when S1 PLIC is very low

  S1 PLIC is optimized by longitudinal phase space tuning and by the optimizing the launch into S1

SLTR Profile monitor

PROF DR01 175

- at a high dispersion point so energy spread and tails are visible

PLIC signal scope

WTA-SDR ndicates beam losses in S1 as well as SLTR and launch into ring

- see reference PLIC signal map to identify points along the beam line

Positron Return Line PLIC

4 x 6 PLIC

SDR envelope monitor scope

- shows the actual intensity at a BPM in the ring as a function of turn number in real time.

  tells you immediately if the knob you are turning has a strong effect on the SDR intensity, but it is misleading to tune on this only. The shape of the envelope indicates the rate of loss at injection

SDR synchrotron feedback scope

indicates longitudinal oscillations as beam launched into ring

- large oscillations if energy or phase badly matched
- oscillations grow if loop at fault or beam instability (pi mode)

  pi mode instability at present controlled by manual setting cavity tuners

SDR synchrotron light spot

indicates if ring is coupled

- round spot when emittances equal in each plane indicating tunes are coupled

Tune measuring spectrum analyzer

measures fractional tune in each plane

- frequency of each peak divided by 8.5 MHz gives fractional tune which should be 0.17 ± 0.01

Turns monitor

SDR BPM X, Y and TMIT as a function of turn number on a single bunch

- operated via a MATLAB program on a VAX terminal

  still an experimental tool

3. SCAVENGER BEAM TUNING

scavenger beam steering

Prof EP01 171 shows production and scavenger bunch at Horiz. Lambertson

- check for tails and correct kicker operation
- check extr. line kicker waveform monitor scope
- check kicker time and amplitude jitter

scavenger beam energy

set by feedback and feedforward loops

must match extr line magnets

- assigning knob EXT4_GEV.mkb displays required scavenger energy in GeV

scavenger beam energy spread

influenced by phase ramp setting

- phase ramp usually set to give correct energy spread at the BSY

target steering

controlled by the set points of the target steering feedback loop

- optimize PT01 529 yield by scanning setpoints on either side of current settings if yield is more than 2% below 4.0

4. LONGITUDINAL PHASE SPACE TUNING TOOLS

Sector 20 klystrons

note that these settings are strongly dependant on the beam intensity

20-3 drive amplitude

this is usually set at the maximum value after it was processed and should not be channged during routine tuning

20-4 drive amplitude

- tune to set the *energy* correctly on the ETA foils.
- In principle,it should also maximize Li01 831 yield and minimize S1 PLIC

determines the energy of the e+ and hence how well they are captured in sector 1 rf bucket

combined phase shifter

- POS PHASE 34 knob tuned to optimize the *energy spread* on the ETA foils.
- This knob is *frequently* tuned and should also maximize Li01 831 yield and minimize S1 PLIC and minimize energy spread in the SLTR

changes phase of 20-3 and 20-4 in unison and hence also controls the energy and phase of the e+ reaching S1

20-3 and 20-4 phases

• in routine operation it is not normal to change the relative phases between the two klystrons

Phase 20-3 is nominally set to maximize acceleration
Phase 20-4 controls energy spread in EP02

Trombone

• tune to maximize Li01 831 yield and minimize S1 PLIC and minimize energy spread in the SLTR

changing the e+ path length determines their arrival time at S1 and hence their phase w.r.t. S1. The phase in S1 in turn determines energy spread in the SLTR

Sector 1 klystrons

Klys 1-6 amplitude

- tune to correct energy in SLTR. This is difficult if e- are being co-accelerated in S1 because a simultaneous change must be made to e- energy in Li00

orbit in the SLTR reveals energy offsets at high dispersion points

SLTR compressor

klystron amplitude set at maximum

klystron phase set to leave the energy of the beam unchanged

- look at a difference orbit in the ring with the compressor on and off

SDR station phase

set to maximize capture in the ring, rarely needs changing

the phase of the ring rf bucket is changed w.r.t. to the incoming beam phase

5. TRANSVERSE PHASE SPACE TUNING

Launch optimization

scavenger e- onto target

- use feedback setpoints

from PRL into WTA

- feedback correctors at end of PRL should maximize subyield in EP05 and also provide headroom for:

from WTA into S1

- 4 launch knobs (e.g. EP_X_MM.MKB etc.) should be used to maximize yield as far as Li01 835 only and should minimize S1 PLIC.

from S1 into SLTR

- 4 launch knobs to maximize yield to end of SLTR only

from SLTR into SDR

- 4 launch knobs to maximize SDR throughput and minimize first turn orbit difference with stored orbit.

Steering

Center beam in beam pipe. Beam should match gold ref orbit and PLIC minimized

- only attempted after upstream orbit and launch correct

All regions can be auto-steered using the mikado method with minimum corrector action. Consult an e+ physicist if you believe the SDR stored orbit steering is wrong.

Orbit bumps are used in specialized regions to move a short length of the orbit around.

- SDR septum bumps move the stored orbit around the septum blade. The launch and/or extraction orbit needs reoptimization afterwards. Bifurcated bumps (B_SEPT_*.mkb) combine both these actions.

Beta matching

On the S1 wires the BMAG parameter should be close to 1 when the e+ emittances are measured

- 4 quadrupoles in the WTA are used to control this parameter using the online beta matching package (consult an e+ physicist)

BMAG is a parameter quantifying the mismatch of the transverse beam ellipse compared to the design beam.

II. A TUNING RECIPE

Determine where upstream yield is starting to drop

use special PYIELD display and compare subyields to gold subyields at each toroid

Start with the upstream problems first

Use a serialized approach to increase yield

only tune the yield up to the point of the next downstream toroid.

DO NOT tune an upstream parameter looking only at the SDR intensity

Be sure gold configs are loaded and green

DISPLAY RED on the gold config will also tell you if hardware is out of tolerance

1. TARGET YIELD PT01 529

Check profile monitor 185 (near target) for a small round stable spot

otherwise fix scavenger beam parameters first

Center the scavenger beam on the target

scan the feedback setpoints to either side of current value in steps of 0.2mm

2. ETA YIELD EP02 812

Check the ETA foils scope

CENTER the peak on the middle foil by controlling the energy with klystron drive 20-4

MAXIMIZE the peak making it narrower by optimizing the energy spread with PHASE 30-4

- tune for yield AND stability

Iterate tuning on phase and drive knobs

failure to restore yield may indicate that phases 90-3 and 90-4 are wrong, but be careful.

3. PRL YIELD LI19 TO LI04

Check orbits EP02 through Li01 in the return line

if autosteering is used ensure no bad BPMs are included

4. WTA YIELD EP05 3152

Check launch from PRL into WTA

slow feedback setpoints control launch

- check that correctors used at end of PRL are not at maximum

5. YIELD INTO S1 LI01 141

4 launch knobs use correctors at exit of the WTA

knobs can only be coarsely set at this toroid, fine tuning at next step

• S1 toroids don't read out when e- co-accelerated at 60, 120Hz

6. S1 YIELD LI01 835

Tune to maximize yield and minimize PLIC

DO NOT change correctors in S1 away from configuration values

the orbit in S1 is a compromise for e+ and e- and will not benefit from further tuning!

Optimize launch from WTA

fine tune launch knobs from previous step

Optimize longitudinal tuning

optimize energy and phase of beam launched into S1

• fine tune energy with drive 20-4 and phase 30-4

• S1 toroids don't read out when e- co-accelerated at 60, 120 Hz

Emittance and beta match check

this is not something to tune on, but a diagnostic if you suspect something is not right with the system

use S1 wires if PLIC low enough

• emittance should be around 2E-3 in each plane

• beta mismatch parameter BMAG should be less than 1.10

an online beta matching package exists, but please consult with a e+ physicist first

• if S1 PLIC too high for clean scans then energy collimate the beam using ETA collimators EP02 740, 741

move one jaw in until intensity drops ~25% then the other for a further 25% ensuring a symmetric reduction in energy spread

7. BEGINNING OF SLTR DR01 241

Optimize launch from S1

use 4 launch knobs

• make sure correctors at end of S1 not near maximum and

• if launch knobs generate S1 PLIC something else is wrong with S1 orbit so back up a step

Optimize energy spread

fine tune trombone

• putting in PROF DR01 175 is the only reliable way of verifying energy spread

8. SLTR YIELD DR01 1481

Optimize energy

use drive 1-6 to set energy to center orbit in SLTR

• unfortunately this also changes e- energy at and above 60 Hz
• so change e- energy simultaneously in Li00

Steer SLTR orbit flat

can be autosteered using mikado method, minimizing corrector strengths

- pay attention to correctors near maximum and fighting each other

loss along SLTR should not be more than 10%

Check phase of energy compressor

look at a difference orbit in the ring

- no change in orbit when compressor on/off

9. SDR THROUGHPUT DR03 71

Optimize launch

4 launch knobs use correctors at end of SLTR

- maximize ring throughput
- 1st turn difference should then match stored orbit

Check energy

if correct from previous step should not need changing

- orbit should be symmetric about zero

Check stored orbit

compare with gold orbit, especially near septa

- scan septa bumps if orbit is suspect using bifurcated closed orbit bumps

closed orbit bumps make only a local bump leaving the rest of the ring undisturbed (check that this is true). To maintain correct launch conditions from the SLTR or a correct orbit into the SRTL we use bifurcated bumps that also use correctors outside of the ring

Check synchrotron oscillation feedback scope

should show small, damped oscillation

- otherwise check SDR cavity tuning angle
- SDR rf station phase may conceivably be wrong particularly if CID was recently retuned!

Check synchrotron light spot

spot should be round indicating coupling

- otherwise measure and correct tunes as necessary

a tune knob for each plane controls quadrupoles in the SDR to change each tune by a predetermined amount

Check tunes

good idea if sync light spot not round or orbit bumps not closing

Check extraction

beam at PROF DR03 should be stable and not shadowed by septum

SRTL orbit should match gold

the SRTL orbit is crucial to good matching into the linac