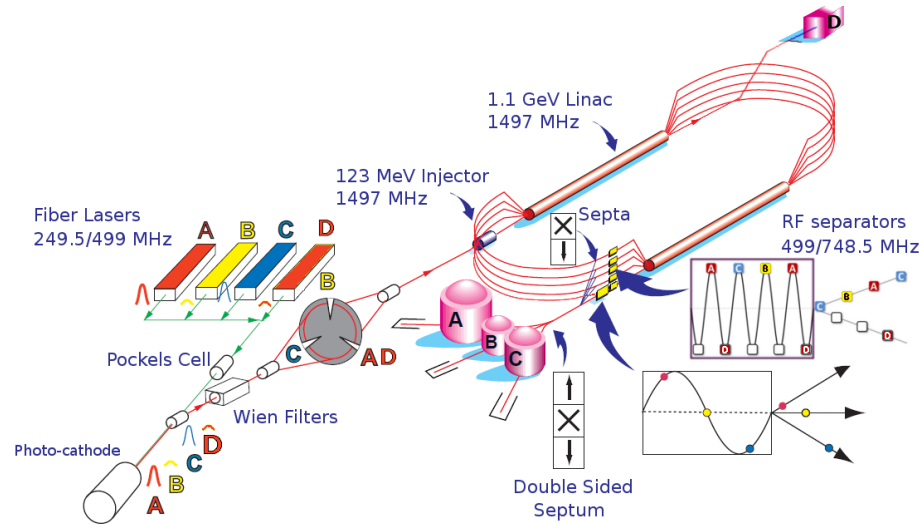


Energy Locks in CEBAF

Michael Tiefenback, Dec 13, 2023

Accelerator Layout



- Energy Regulation -- three regulation points:
 - Injector (nominal 123 MeV at North Linac injection)
 - North Linac (nominal energy gain 1090 MeV)
 - South Linac (nominal energy gain 1090 MeV)

Consequences of Energy Drift

- Momentum dependent spin precession in all arcs
- Apart from synchrotron radiation loss,
 - 1A energy is $Inj+1 * NL$
 - 2A energy is $Inj+1 * NL+1 * SL$
 - 3A energy is $Inj+2 * NL+1 * SL$
 - And so forth
- Beam position in dispersive areas reveals local momentum
- Regulation “locks” Inj, 1A, and 2A total momentum
- Spin control requires locking each of Inj, NL, and SL.
 - e.g., Inj drift shifts NL to correct 1A
 - With unchanged SL, NL shift alters all arcs 3A and up
 - Monitoring all arcs provides a check on spin, energy

What error experience do we have?

- Dominated by BPM system errors:
 - Beam current dependence (as for halls on/off)
 - Hardware failures (soft or hard)
 - Disabled or failing high-weight BPMS
- Other errors include operator errors
 - Alteration of beam steering magnets
 - Misunderstanding of procedure
- Path Length misconfiguration (off-crest in higher arcs)
- All such errors shift (indicated) high-arc momenta
- Global momentum monitoring not presently systematic
 - **We must correct this for best future performance**

Archived example data

- Linac acceleration field not completely stable:
 - Energy locked to trajectory in arc
 - Energy lock changes GSET in selected cavities
 - Sum of $GSET * CavityLength$ drifts (slowly)
- Higher arc momenta can show step changes
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Archived Example March 2023

- Linac energy drift compensated by elock
- ARC[34]:dpp steps ~1 a.m. NOT seen in ARC[12]:dpp
- Suspect BPM induced artifacts (halls on/off, other current changes)

