Phased Schedule

Installation, commissioning and exploitation of Cβ will be performed in phases over several years. Installation and commisioning of the first ERL-FFAG (a single-turn machine) will be possible within two years, with multi-turn experiments using both 1.3GHz and 433MHz hardware occurring in the following years as the hardware becomes available. Note that as 433MHz=1.3GHz/3, a 180 degree phase shift line can be designed for both, producing 1.5 RF periods at 1.3GHz and 0.5 periods at 433MHz. The major schedule phases, broken into stages and goals are:

A. **Linac cryomodule only** (year 1) *IN PROGRESS*

Clean out test area, move injector and linac module. Test injector for high current and cryomodule with RF and low current beam.

1. Clear out the experimental hall (3 months) *DONE*
2. Install the injector and linac cryomodule (3 months) *IN PROGRESS*
3. Install cryogenics and RF power (2 months)
4. Commission the injector and cryomodule (3–6 months)

B. **Single-turn ERL-FFAG** (26–86MeV, year 2)

Install FFAG loop with magnets for the lower energy range (up to 86MeV) and run the Cornell linac module in single-turn ERL mode with energy gain tunable between 20 and 80MeV. An electromagnetic optics matching line will be installed at both ends of the linac to match to the FFAG, adjustable for any linac energy in the range.

1. Install FFAG magnets and rest of return loop for low energy operation, including matching lines for a single energy (4 months)
2. Commission single-turn ERL-FFAG (3 months)
3. FFAG energy scan optics and correction studies (5 months)

World-first capabilities demonstrated:

- ERL using FFAG recirculating arc;
- NS-FFAG line with momentum acceptance factor of 4;
- Permanent magnets used as primary steering magnets for either FFAG or ERL return arcs (as in eRHIC);
- Adiabatic transitions from curved to straight FFAG lattices.

C. **4-turn ERL-FFAG with BNL 433MHz module** (86MeV, year 3)

Install the BNL 433MHz cavity instead of the 1.3GHz Cornell one, in order to test current thresholds at the higher levels appropriate for eRHIC. The BNL cavity will operate with $\sim$20MeV energy gain per turn but with four ERL passes, so the other three optics matching splitter arms will be installed at both ends of the linac module. This can be operated as a 1, 2, 3 or 4-turn ERL with top energy of 26, 46, 66 or 86MeV. This step has some flexibility as in theory the extra splitter arms could initially be commissioned without the 433MHz module, or vice versa.

1. Install additional splitter lines for 4-turn operation (4 months)
2. Move 1.3GHz module to the side, install BNL 433MHz cavity (2 months, in parallel)
3. Commission BNL cavity running to dump (1 month)
4. Commission splitter lines settings and FFAG return loop with up to 4 turns (3 months)
5. Perform high-current experiments: BBU threshold etc. (4 months)

World-first capabilities demonstrated:

- Multi-pass superconducting ERL;
- Simultaneous transmission of factor 4 energy range through a NS-FFAG (and adiabatic transitions);
- Highest-ever energy NS-FFAG (beating EMMA at 20MeV).

D. **Full-energy 4-turn with Cornell 1.3GHz module** (286–326MeV, year 4 onwards)

The Cornell module can accelerate by up to 70–80MeV per pass, so by reinstalling it and upgrading the strength of the FFAG magnets by adding more PM material, it can be operated as a 4-turn ERL with a top energy of 286–326MeV for both FFAG and physics experiments.

1. Upgrade FFAG magnets in arcs for high energy operation (4 months)
2. Re-commission FFAG return loops at high energy and 1.3GHz module in multi-turn ERL mode (4 months)
3. FFAG experiments driven by BNL (open ended)
4. Physics experiments using high-energy beam driven by Cornell (open ended)

World-first capabilities demonstrated:

- Highest-ever energy NS-FFAG (again!)

The injector has already been tested, but needs to be relocated to a new area, re-commissioned, and The main linac cryomodule will not have undergone any testing before its installation. The first commissioning step is to cool down the entire system to 2 K, taking from one week to one month. Once cold, each cavity will be tested individually using a 5 kW solid state amplifier. Multi-cavity tests will be performed when more amplifiers are available. Cavity Q's will be measured, and the operation of the tuners, couplers and HOM's will be checked. Testing will take 3 to 6 months.