

A multiple-pass energy-recovery experiment at CEBAF
Thu. 11 June 2015
ERL 2015 Workshop satellite meeting

Minutes

Introduction

A 1hr45 satellite meeting was held during ERL 2015 workshop in Stony Brook University (on Thursday 11 June, 0900-1045am), a joint BNL-JLab initiative, as a follow on of earlier e-mail exchanges, and of a dedicated joint meeting that took place during IPAC 15. The goal of this ERL'15 meeting was to carry on the discussion regarding a multiple-pass ER experiment using CEBAF, in particular regarding the objectives of such an experiment, and the way to make it happen.

It was at the origin planned to hold a closed meeting, however, it was eventually decided to open it, in order to benefit from the participation of experts present at ERL'15. The meeting so gathered about 25 participants, from BNL (V. Ptitsyn, N. Tsoupas, Berg, FM, etc.), JLab (F. Pilat – on video, M. Spata, A. Bogacz), CERN (at least 2), Cornell (at least 4) and other labs.

An introduction, by V. Ptitsyn followed by F. Pilat, started the meeting, this introduction emphasized the interest of both parties, BNL for eRHIC project purposes, JLab in view of contributing and of advanced accelerator studies. Then followed the three planned presentations by FM, A. Bogacz and N. Tsoupas, slides available [here](#). The talks essentially addressed the general motivations for such experiment (FM), and preliminary approaches of ways to technically achieve it (AB, NT). The question of an FFAG arc was also addressed in a similar manner, yet shortly, by both parties, BNL and JLab.

Excerpts from the presentations and discussion :

- ER with 1GeV per linac and 5 pass (10.1 GeV beam) is doable. A 100:1 ratio at 100 MeV injection energy. ER goal is 99%.
- Main aspects of the modifications to be done to the optics have already been investigated, they can be done.
- Main constraint is to maintain $E_{\text{max}}/E_{\text{inj}}$
- A conservative 3-chicane string (θ -2 θ - θ chicanes, 2m long 2 θ dipole) can be installed in the new arc 10, to achieve $\delta l = \lambda/2$. It is not possible to achieve that if based on sole orbit deformation (aperture would only allow ~30%).
- A cryomodule has to be removed to place the beam dump, upstream of arc 10, at the downstream end of the South linac. The CM will be put back in place after the experiment.
- Costing of an ER experiment (cf. also slide #8 in FM's presentation) : Mike Spata will engage JLab engineering on the beam-line and magnets aspects. Besides, various components may be available, TBC, that might reduce costs compared to slide #8 data.
- BBU has been subject to substantial discussion, many ideas/points have been discussed/addressed, amongst which (see also slide #7, FM pres.) :
 - possibilities of increased current, limit of beam dump is 20kW, so allowing 200 μ A ER-ed beam
 - BBU studies at low I/high E at CEBAF compared to high I/low E R&D projects

- Intensity upgrade on the injector front
 - at constant beam power the lower rep.-rate limit is 31MHz (limit is space charge in the injector). No such constraint if power is not maintained.
 - possibilities of exciting BBU, including removal of HOM dampers in the upgrade CMs (in the number of 5 per linac) for which HOM ports are out of the CM
 - question of the equivalence low Int./strong HOMs ↔ high Int./weak HOMs
 - parameter scan, as turn dependence, etc.
 - SR loss can be a limitation in power increase. SR loss is 105 MeV for the nominal 12 GeV lattice.
 - Chroma effects (typical of eRHIC FFAG lattice) could be studied using CEBAF sextupoles
 - Possibilities to study SR effects, compensation (based on RF phase, off-crest tuning).
 - Plans for *ad hoc* diagnostics for such multiple-pass ER experiment
 - It was argued that iron trapping might be more a problem than BBU
 - Feasibility of parasitic operation of the experiment during physics run
 - Extending CEBAF run, a matter of ~2 weeks, for an ER experiment. Requires dedicated funds
 - RF and klystrons : seems doable to increase Int. in ER mode since no additional power draw from RF.
- How far ?

The FFAG arc discussion has addressed the following points :

- It is possible to insert a two-beam arc, 7GeV+9GeV, between CEBAF arcs 7 and 9. Clearance is 50cm, fits with eRHIC permanent magnet cross section. Beam steering into the arc is doable.
- Lower energy arc/lower cost/lower synchrotron radiation versus high E/higher cost/eRHIC level SR for SR studies
- Using RF kickers (frequency in range up to e.g. ~400MHz) in place of regular spreader-combiner, for simplicity and flexibility

Other FFAG R&D plans were brought up, besides CEBAF ones : CEBAF ERL is available, the interest is there for possible multiple-pass ER and FFAG arc R&D. It was suggested to add an appendix with such a proposal in a bid to JLab PAC.

Plans for future

The next CEBAF Physics Advisory Committee will be around April-May 2016. Calls for proposals happen late summer / early fall, proposals to be finalized by the end of the year. We BNL/JLab group plan to submit a proposal through the regular approval process, just like the 1-loop experiment.

We plan to meet in very close future to, amongst others,

- establish a list of objectives to be achieved in an ER experiment aimed at exploring eRHIC performance parameters
- establish a list of tasks to be undertaken, and names to go with
- make necessary decision as to the proposal and its writing

In a very first step, we plan to meet at JLab by early July to visit CEBAF tunnel, and establish the necessary collaborations with machine designers in preparation to that proposal.