

APEX: Injection studies for the EIC

A. Fedotov, D. Kayran, S. Seletskiy, V. Schoefer,
K. Mernick, M. Blaskiewicz, V. Ptitsyn, A. Blednykh,
others

January 26, 2024

BROOKHAVEN
NATIONAL LABORATORY



Goals of experiment

In the EIC, high-intensity protons will be injected **in modified 28MHz RF** system, while presently in RHIC they are injected in 9MHz RF.

The goal of this experiment is to:

1. Explore and establish proper beam parameters of high intensity protons at injection **with 28MHz RF system**
and
2. Study beam stability and mitigations of instabilities observed.

Benefits:

Knowing proper proton beam parameters and understanding stability limitations at injection energy is required to accurately design injection and Precooling schemes for the EIC.

Experiment description

1. **Pre-APEX work:** AGS setup and measure beam parameters at AGS extraction for three proton intensities: $1e11$, $2e11$, $3e11$ per bunch.
2. **Pre-APEX work:** establish **quad pumping RF setup** which allows to inject into 28MHz RHIC RF.
3. **Establish baseline with 9MHz:**
Inject high intensity proton bunches in 9MHz RHIC RF, both in Yellow and Blue rings. Measure longitudinal and transverse emittances: repeat for intensities $1e11$, $2e11$, $3e11$.
4. **Using 28MHz RF:** inject high-intensity bunches in both Yellow and Blue rings.
Measure longitudinal and transverse emittances: repeat for intensities $1e11$, $2e11$, $3e11$.
5. **Find instability thresholds in both Yellow and Blue Ring**, as measured longitudinal impedance are very different in two rings, 5.4 and 1.5 Ohm, respectively.
When beam becomes unstable longitudinally or transversely, find regimes and settings to make beam stable.
6. **Perform stability studies** both in Yellow and Blue:
 - 6.1) Stabilization of longitudinal instabilities with Landau cavities
 - 6.2) Stabilization of transverse instability with octupoles.
 - 6.3) Stabilization with chromaticity
 - 6.4) Explore effects of space charge (shifts and nonlinear spread) on instabilities.
 - 6.5) Inject and explore effect of larger longitudinal emittance

Time estimates

- 1) Baseline: Protons with 9MHz RF for 3 different intensities (1h)
- 2) **Protons with 28MHz RF** (4 hrs)
 - a. Find proper RF setup for various intensities 1 hr
 - b. Measurements of beam parameters for different intensities 1 hr
 - c. Longitudinal stability studies in both Yellow and Blue rings: 1-2hr
 - d. Transverse stability studies in both Yellow and Blue rings: 1-2hr

Total time: 5-6 hours

There will be additional related APEXs:

- 1) D. Kayran et al.: Studies with dual RF at injection, as proposed to alleviate space charge effects by reducing peak current.
- 2) A. Blednykh et al.: Systematic study of instabilities at injection.