ReA Experiments Service Level Description

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Table of Contents

Revision History

Revision	Issued	Changes
R001	31 July 2023	Original issue

Authorizing Document

None

Authorized Documents

None

Authorized Committees and Boards

None.

Named Program Roles

None

Awareness Training

None

Enabling Training

None.

1 Objective

This document describes the level of support available to ReA users. It presents the standard configuration of ReA, the services and the utilities presently available for experiments in the ReA3 and ReA6 experimental areas. It also clarifies user responsibilities for experiments are ReA.

2 Acronyms

BMIS: Batch Mode Ion Source

BCB: Beam Cooler-Buncher

EBIT: Electron Beam Ion Trap

GPL: General Purpose beam Line

ReA: ReAccelerator

3 Standard configuration

The ReAccelerator (ReA) at FRIB accelerates stable and rare isotope beams from 300 keV/u to the present maximum of 12 MeV/u depending on the charge-to-mass ratio of the ions. Colutron sources, the Electron Beam Ion Trap (EBIT) charge breeder, the Batch Mode Ion Source (BMIS) or the N4 gas cells are all possible sources for beams to be reaccelerated:

- Colutron sources – Stable isotopes of certain elements
- EBIT – Stable isotopes from residual gas
- BMIS – Long-lived or stable isotopes from source material ($T_{1/2}$ > 2 weeks)
- Gas cells (FRIB) – Short-lived isotopes from secondary beams from ARIS ($T_{1/2}$ > 50 ms)

From the sources other than the EBIT, the beams are extracted as 1+ or 2+ atomic or molecular ions and transported into the BCB. Here, some molecular ions can be dissociated by collisions with the buffer gas in the BCB. For injection and capture into the EBIT the beam is released from the BCB as a short ion bunch. In the EBIT, low-charged ions are bred to higher charge states Q and extracted as a pulsed beam with an energy of 12 keV/u. A magnetic charge-over-mass selector allows a desired charge state Q to be selected and transported to the room-temperature Radio Frequency Quadrupole (RFQ) linac which allows beams to be accelerated to 550 keV/u. Following the RFQ the beam is accelerated with two sections of a Superconducting RF linac, ReA3 and ReA6. Achievable beam energies are determined by the ratio of the charge state Q of the ion and its atomic mass number A:

- ReA3 linac with 15 superconducting cavities accelerates beams to E (MeV/u) = 12 (Q/A), for 1/5 < Q/A < 1/2
- ReA6 linac with 8 superconducting cavities, accelerates beams to E (MeV/u) = 24 (Q/A), for 1/5 < Q/A < 1/2

The minimum energy available is 300 keV/u, achieved when using selected resonators as decelerators. Both the SRF linac and the RFQ operate at a frequency of 80.5 MHz.

3.1 ReA3 experimental area (Room 1421)

The ReA3 experimental area layout is depicted in Figure 1. This vault has three experimental lines: SECAR beamline, and two general purpose beam lines, GPL1/BTS31 and GPL2/BTS33 beamlines.

The main entrances to the vault are from the northeast and southeast side. Large equipment can be brought into the area through the northeast entrance, there is a 37 inches clearance, but attention must be paid to the 90 degree turn necessary in the ReA6 rack corridor. The ReA3 shield wall can be opened to allow larger equipment to be moved inside.

Presently, personnel are not allowed inside the ReA3 experimental vault while beam is delivered into the vault. Operators are responsible for securing and un-securing the vault, therefore users must contact the control room to access the vault during beam time.

General utilities available in the ReA3 area:

- Cranes available: portable gantry crane and foldable hydraulic shop crane
- Tool box
- Flammable material storage cabinet
- Radioactive source cabinet
- Radiation survey: NaI detector (beta-decay counter available at the safety office)
- Cleaning supplies

Table 1 summarizes utilities present in the ReA3 vault at the end of the GPL beam lines and upstream of the SECAR separator.

Table 1: Utilities available in the ReA3 experimental vault

Utility	Specification	GPL1/BTS31	GPL2/BTS33	SECAR
LN2 supply		Yes	Yes	No
Building dry-N2 supply	10 PSI, connector needed: Parker B2C	Yes	Yes	Yes
Compressed air	80 PSI, connector needed: Parker BH1-61	Yes	Yes	Yes
Telescope mount		Upon request	Yes	Yes
Flammable gas exhaust	KF25	Yes	Yes	-
Permanent monitors	ODH	Yes	Yes	-
	Hydrogen	No	No	Yes
Network ports	DAQ	4	4	
	Office	2	0	
	Controls	4	2	
	Private network	2	4	

Utility	Specification	GPL1/BTS31	GPL2/BTS33	SECAR
Power outlets "dirty"	120V, 20 A, 1-phase (NEMA 5-20R)	12	16	-
	208 V, 20 A, 1-phase (NEMA L6-20R)	1	0	-
	208 V, 30 A, 3-phase (NEMA L15-30R)	1	2	-
	208 V, 40 A, 3-phase (NEMA L15-50R)	0	1	-
Power outlets "clean"	120V, 20 A, 1-phase (NEMA 5-20R)	12	20	-
	120 V, 15 A, 1-phase (NEMA L5-15R)	6	0	-
	120 V, 20 A, 1-phase (NEMA L5-20R)	1	2	-
Signals	to DataU (BNC)	5	5	5
	Video	1	1	1
	SHV	1	1	1
	User provided - TTL signal for count rate	2	2	2
Mobile box (accommodates only 2 diagnostic devices)	Faraday cup	1	1	-
	Aperture	1	1	-
	Viewer	1	1	-
	Pumping system	1	1	-

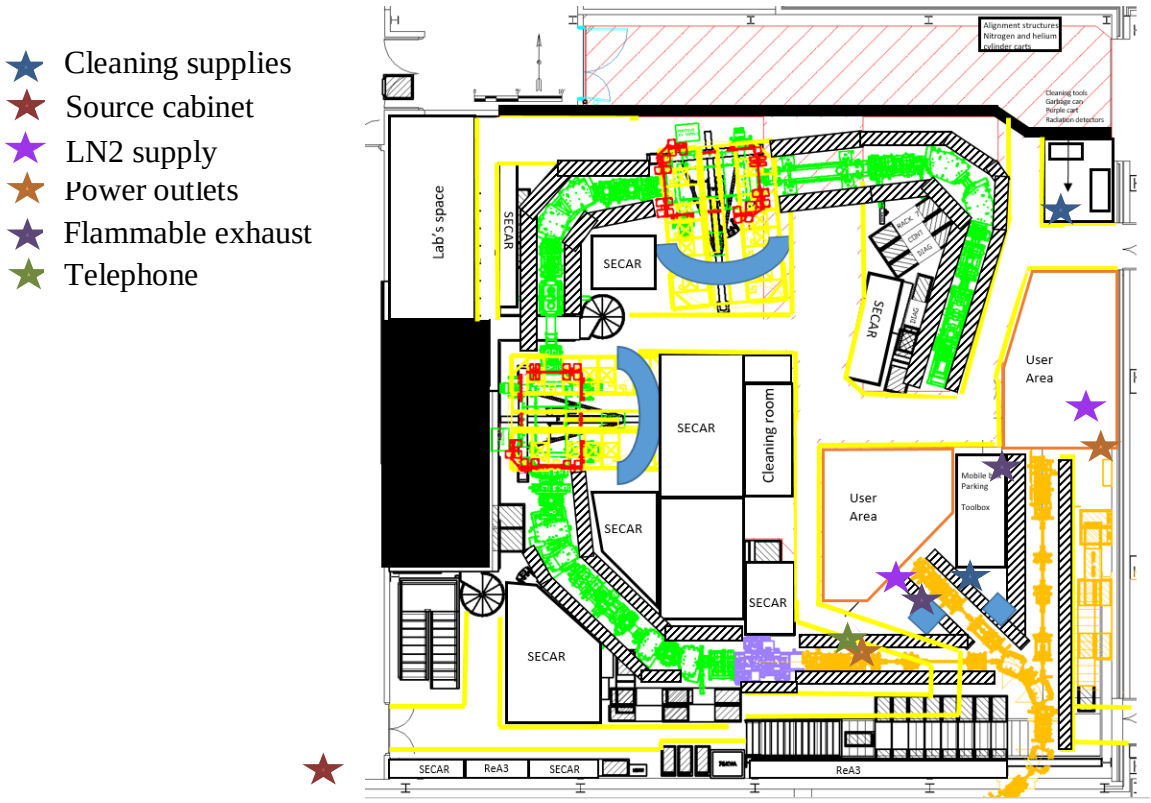

Figure 1 - ReA3 experimental area layout.

3.2 ReA6 experimental vault (Room 1480A)

The ReA6 experimental vault layout is shown in Figure 2. This vault has two experimental lines, the SOLARIS beamline and a GPL beamline. The entrance for users is from the Northwest side of the vault.

Personnel is not allowed in ReA6 experimental area while beam is delivered into the vault. Operators are responsible for securing and unsecuring the vault, therefore users must contact the control room to access the area during beam time.

General utilities in the vault:

- Cranes available: overhead crane, portable gantry crane and foldable hydraulic shop crane
- Tool box
- Flammable material storage cabinet
- Radioactive source cabinet
- Radiation survey: NaI detector. (A beta-decay counter if needed is available at the safety office)
- Cleaning supplies

Table 2 summarizes the utilities available in the ReA6 experimental area, excluding utilities dedicated to SOLARIS experiments.

Table 2: Utilities available in the ReA6 vault

Utility	Specification	SOLARIS beamline	GPL beamline
LN2 supply		-	Yes
Building dry-N2 supply	10 PSI, connector needed: Parker B2C	Yes	Yes
Compressed air	80 PSI, connector needed: Parker BH1-61	Yes	Yes
Telescope mount		Upon request	Yes
Flammable gas exhaust		Yes	No
Permanent monitors	ODH	Yes	Yes
Network ports	DAQ	4	3
	Office	2	4
	Controls	4	2
	Private	2	3
Power outlets	120 V, 20 A, 1-phase “clean”	12	40
	120 V, 20 A, 1-phase “dirty”	12	16
Signal	BNC to Data-U	5	5
	Video	1	1
	SHV	1	1
	BNC to ReA rack	5	5
	TTL for count rate	2	2
Mobile box (accommodates only 2 diagnostic devices)	Faraday cup	1	1
	Aperture	1	1
	Viewer	1	1
	Pumping system	1	1

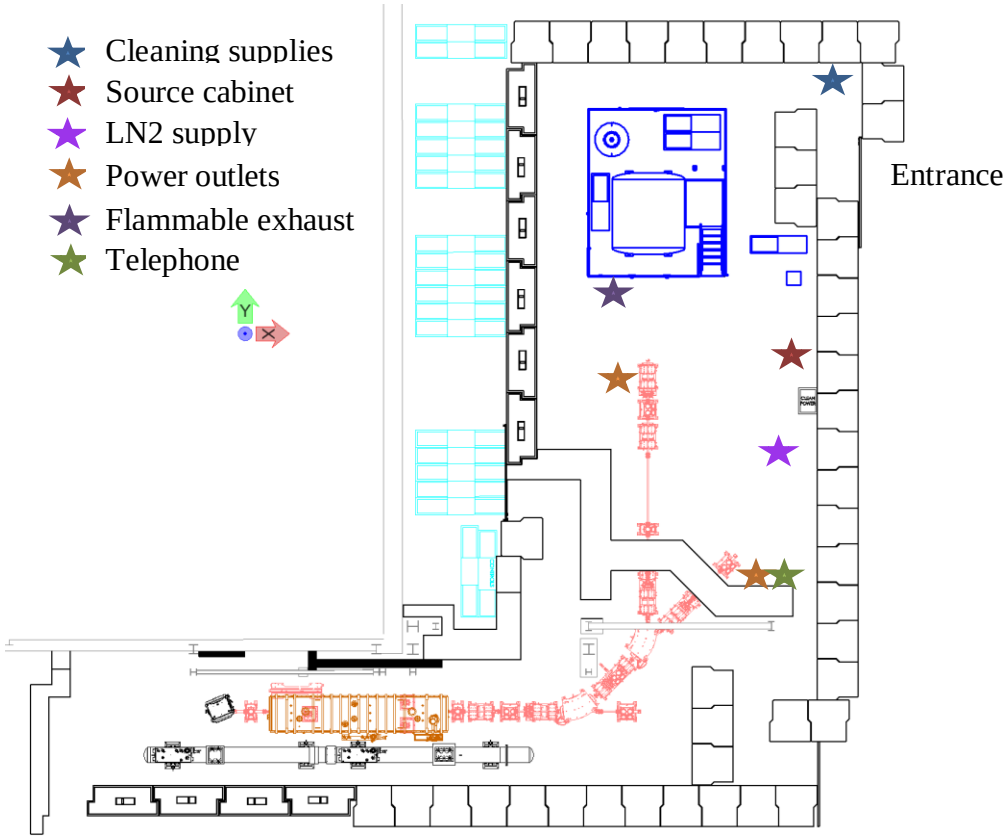

Figure 2- ReA6 experimental vault layout.

3.3 ReA signals available to experiments

- Beam macrostructure: EBIT beam extraction pulse (TTL signal)
- Beam microstructure:
  - RF 80.5 MHz Clock (sinusoidal signal)
  - RF Clock Frequency Divider (TTL signal) with ratios: 1-6, 8-10, 12, 15, 16, 18, 24, 30, 32

4 User support

ReA staff will provide support and information through the different stages of an experiment. All support requests should be made to the User Relations Manager and/or ReA User Liaison Scientist.

4.1 Proposal submission support

Upon request, information can be provided for proposal submission as well for any discretionary time request. This includes feasibility, beam intensities, beam emittance, estimates of contaminants and timing structure.

Beams not listed require development and are not included in the base level of support. The request to develop new beams and beam requirements should be done via a Letter of Intent (LOI) to the FRIB Director or by submission of a full proposal.

After submission, FRIB personnel will provide feedback to the PAC on the technical feasibility of submitted proposals or LOIs.

4.2 Experiment preparation support

Every experiment will go through FRIB's multi-step Experiment Readiness Review (ERR) process [1].

FRIB personnel will meet with the users prior to the first ERR to prepare for it. Required resources other than those already stated in the approved proposal need to be identified by the user at this time.

Resources available for the preparation and the setup of an experiment include:

- Mechanical design support
- Installation and alignment support
- Vacuum support including leak checking
- Electric and plumbing work
- Data Acquisition Support [2]
- Control system support for archiving of process variables (e.g. Faraday cup readings)

4.3 Experiment support

Before the start of the experiment, the ReA User Liaison Scientist will send a preliminary operations plan which will include the vault access, the expected tuning time to experiment and any beam changes planned.

After the beam is tuned to the experiment, the ReA User Liaison Scientist will report to the user the beam properties. The experiment beam on target time will start when the user accepts the beam.

5 User responsibilities

The ReA users follow the FRIB Roles and Responsibilities of Scientific Users document [3]. In more detail, the FRIB expectations for ReA users are:

- Taking the leading role during the preparation and running phase of the experiment.
- Being responsible for the integrity and safety of their experimental system.
- Informing the ReA User Liaison Scientist about required beam properties and experimental setup prior to the first ERR.
- Responsible for timely identification of utilities and services needed for their experiment
- Communicating pre- and post-experiment ReA space occupation duration.
- Communicating to the ReA User Liaison an execution plan for the experiment.
- Communicating any incident to the Operator-in-Charge (OIC) and the ReA User Liaison
- Discussing changes of the experiment in a timely manner. Some requests may need to engage different system experts who may only be available during weekdays and normal business hours.
- Keeping the vault space allocated to the experiments tidy and leave the vault space as found or better.
- Providing a signal (NIM or TTL) to ReA for monitoring the count rate and to support final tuning of the beam to the experiment target.

- Maintaining a pressure of <1E-6 Torr or better in their setup as needed for ReA linac operation.
- Providing the vacuum gauge controller make and model in case users bring their own vacuum equipment. The cold cathode or hot filament ionization gauge controller set point and analog reading are used to interlock the last beamline gate valve.

6 References

[1] FRIB Experiment Readiness Review Program, FRIB-S30206-PG-000033
[2] Scientific Data Acquisition Service Level Description, FRIB-S30206-RC-008646
[3] Roles and Responsibilities of the Scientific Users, FRIB-S30206-PG-000028