



ISOLDE consolidation and performance upgrade strategy

Joint Accelerator Performance Workshop –
05/12/2022 – 08/12/2022

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Outline

- **Previous presentations and events on ISOLDE consolidation and improvement**
- **Availability REX HIE Linac (physics with post-accelerated radioactive ion beams)**
- **2.0 GeV Study Group (BTY line consolidation/upgrade)**
- **FIRIA recommendations follow-up (fire safety and radiation protection improvement)**
- **Status of ISOLDE Beam Dump Replacement Study (IBDRS)**
- **Other systems needing attention – Proposed strategy**
- **Summary of actions and decisions needed**

Previous presentations / events

- **Injectors and Experimental Facilities Workshop - S. Gilardoni [presentation](#). Focus:**
 - Secure the future of ISOLDE leadership as flagship facility for nuclear physics
 - Several proposals to improve the CAPACITY and CAPABILITY. Safety aspects (FIRIA).
 - Status of ongoing (IBDRS) and past studies (2 GeV upgrade studies from 2013 and beyond)

- **309th IEFC meeting (01/07/2022) - S. Gilardoni [presentation](#): Focus**
 - Roadmap for decision process (approval routes and timeline)
 - Performance Improvement Consolidation (PIC). Dependencies and synergies
 - Emphasis on reduced HIE ISOLDE physics availability (technical problems encountered in 2022)

- **Mini-Workshop on ISOLDE Consolidation and Improvement –([Indico](#) – [Minutes](#))**
 - Technical discussions with perspectives from the users and operation section as well as contribution from several technical teams:
 - input on required/planned consolidations. Proposal for possible Performance Improvements
 - [Summary](#) of the workshop presented during the 318th IEFC meeting (18/11/2022)

Availability REX HIE Linac – Mini CONS WS outcome (1)

Concerns reported on REX-HIE ISOLDE Linac:

- Duration of High Energy Physics run (starting ~3rd week of July). Backlog of experiment.
- Technical issues encountered during the restart phase in 2022 reduced the beam commissioning period (impact on the entire HIE ISOLDE physics campaign)
- Operability of the REX NC Linac with large A/Q values not stable :
 - Nominal 4.5 but operation possible at 4.2 / 4.3 only (stable at A/Q=4.2)
 - The consequence is degraded beam performances and operation (lower intensity, longer breeding time and not optimal beam time structure). Setting time unpredictable above 4.2....
- Long term performances (loss of available accelerating gradient in the SC section over time) and mechanical stress due to thermal cycles (instrumentation, lifetime of mechanical tuners, imperfect soldering of RF cables ...)
- Problem with REX-EBIS solenoid encountered during 2022 run: two unexplained rapid LHe boil-offs. Operating at 1.5 T instead of 2.0 T since July.

Availability REX HIE Linac – Mini CONS WS outcome (2)

Identified actions to improve/ensure availability and mitigate failure risks (**REX – NC section**):

- Repair strategy for REXEBIS solenoid (YETS 22/23): dedicated IEFC presentation by F. Wenander
- REXEBIS & REXTRAP solenoid, long term spare strategy:
 - CONS request put forward (BE-ABP existing request, increased priority and revised scope): Asked to green-light project, and clarify exact scope in February 2023 based on repair outcomes. Technical Support from TE-MS. Timescale 2023-2026. Guess cost estimate **~1 MCHF + manpower** depending on scope.
- Replacement of REX-ISOLDE HLRF: 6 water-cooled 101 MHz 90 kW solid-state amplifiers and spares (current amplifiers installed in 2001 and soon reach their end of life).

CONS SY-RF: **Request from D2 to P1 (1.58 MCHF)** – Timescale 2024-2026.

- For NC cavities: SY-RF assessment concluded that problem encountered linked to different external vibration sources. Permanent vibration monitoring to be implemented during YETS22/23.

SY-RF : Only solution is to fight vibrations directly.

Availability REX HIE Linac – Mini CONS WS outcome (3)

Identified actions to improve/ensure availability and mitigate failure risks (SC/cryo systems):

- Continuous upgrade of annual preventive maintenance to reduce risks of failure.
- Process hardening to become more resilient to instrumentation defaults.
- Hardware improvement to make the HIE ISOLDE cryogenics station more resilient to external systems failure (ex. new compressed air backup implemented during the YETS. To be tested/validated during restart phase)
- Study : TE-CRG proposes to rework of the cryogenics process to allow for faster reconnection after a stop. Improvement can also reduce the impact of the CM instrumentation failures
- Other possible improvement: evaluate the feasibility of maintaining the HIE ISOLDE RF-cavities close to 100K during several weeks in YETS period (cold helium gas circulation into cryomodule shields and/or frames and/or vessel's circuits with an independent LN2/Helium heat exchanger). Specification will involve SY-RF/TE-VSC.

If implemented: new comprehensive hardware, cryogenic process and operation procedure development with adapted resources, material, cryogenic fluid availability and extended period of tests for validation.

- Two above studies will require resources (TE-CRG will define needs and studies scope early 2023)
- Spare HIE ISOLDE cryomodule: some of the issues in the CM can't be adressed by in-situ intervention (transport to SM18 – several months). **~1 MCHF + 600 kCHF 2026-2029 CONS request in D1.** After LS3.

2.0 GeV Study Group (BTY line consolidation/upgrade) (1)

- Mandate for 2.GeV study group ([318th IEFC presentation](#)):
 - Studies started in 2013 defined an overall plan. Revisited several times over the year, no show-stopper identified.
 - Emphasis on beam losses management (also looking at higher intensity) and energy consumption
 - Looking at staging possibility and implementation scenario.
 - Deliverable:
 - Preliminary cost breakdown
 - Resource loaded planning
 - Deadlines: IEFC presentation in January 2023 and report in Q3/2023
- 1.7 GeV Machine Development with beam to GPS target station in 2022:
 - Measurements of yield increase between 1.4 GeV and **1.7 GeV**. 107 yield ratios already analysed (many left !)
 - Dedicated runs: UCx-Mk1Ta+RILIS (4 schemes) / LaCx-Mk1Ta + RILIS (Sn)
 - Promising results (up to factor 2 increase for many isotopes). Validation of MC calculations (confidence in extrapolation for yield increase with **2.0 GeV**).
 - Keep 1.4 GeV (optimization according to physics needs and minimization of PSB main magnets additional stress)

2.0 GeV Study Group (BTY line consolidation/upgrade) (2)

- Talks during Mini-WS (SY-ABT, SY-EPC and TE-MS) distinguished baseline consolidations needed and hardware requirements for 2 GeV upgrade
 - Basic CONS + 2 GeV - SY-EPC: (aging power convertors deprecation G64 electronics). Proposal for a 2 GeV and ppm compatible solution proposed (with cost sharing for 2 GeV driven hardware). **(1.15 MCHF – 2023-2026)**
 - Basic CONS +2 GeV: TE-MS **4 Quadrupoles (CONS)**, **2 correctors (CONS)**. Possibly four bending magnets for 2 GeV. Technical choices for different magnets (refurbishment of existing spares or production new magnets with energy efficiency aspects to be recommended by 2.0 GeV study group)
 - Basic CONS (SY-BI): Two fixed SEMGRID must be exchanged (30 yo - broken wires). Pre-study performed. Specification for 1.4/2.0 GeV compatible system needed. Installation possible during a YETS (~50 kCHF)
 - Clear benefit (overall cost/resources) of global strategy and synergy with other activities highlighted.
- SY/ABT studies and measurements during 1.7 GeV beam MD campaign will be a key input for the study group (specification of magnet aperture....). BTY line (GPS and HRS) optics model now in LSA and YASP
- Decision on BTY line upgrade will need to be consistent with dump replacement and design (beam termination point designed for 1.0 GeV operation)

Status of the ISOLDE Beam Dump Replacement Study

- Justification (reminder): dumps operated since 1992. Uncertainty on the mechanical integrity of the iron blocks absorbing the beam (no accessibility for inspection). Shielding not sufficient already.
- **IBDRS project** (PMP plan):
 - Extremely well structured and active project team (**thanks to all contributors**)
 - Dedicated dismantling study (soil, shielding blocks, blocks absorbing the beam)
 - Two configurations studied:
 - Basic option: proper sizing of dump core, monitoring, improved shielding, accessibility to dumps for exchange. The rest of the ISOLDE infrastructure remain unchanged.
 - FLEXI option Same as above and overcoming of several limitations of the ISOLDE target area (accessibility, maintenance, handling....). Staging possible for shielding.
 - Study report prepared for Q1 2023
 - Decision process should be consistent with BTY line plans (previous slides).
 - Decision driven by implementation schedule (**18 months long intervention – Long LS**)
 - Decision needed by **mid-2023** latest for execution during LS3 (procurement and preparation phase)
 - Frontend exchanges during LS3 postponed (FE8 at offline2 upgraded as spare of FE10/11)

FIRIA recommendations follow-up – Resources

- **Proposal for an extension of Building 197 to host new EN-CV equipment:**
 - IRP Due Diligence for Building 197 approved (November). Infrastructure cost: 1 MCH + 360 kCHF
 - SCE to start with IRP design study in 2023
 - Project Management Plan to be written (Q1 2023): WP, coordination, integration of equipment....
 - Functional Specification of the upgraded ventilation system (operational and safety requirements)
 - FIRIA.2 analysis input (HSE unit: results presented for the separator zones and report in preparation)
- **Preparatory work:**
 - Starting 03/2023: 0.4 FTE (draftsman) working on making as-built model of EN-CV equipment (45 kCHF)
 - YETS 2023/2024: Relocation of services: 360 kCHF (decision needed)
 - Civil Engineering work to start in 2024. New ventilation system finalization and commissioning during LS3
- **Synergies:**
 - Space (small surface) for the two beam dump cooling systems
 - Relocation of water cooling station for GPS and HRS (currently in 197/R401)
 - Specification based on current (HRS separator zone Temp. problem) and future Requirements (example: air cooled power convertor for BTY line....)



Fig. 4. SCE layout proposal: schematic view of the new Building at the top of the existing B. 197 and water-cooled chiller removed on the roof of B. 170

Other systems needing attention – Proposed strategy

- Several problems, limitations or risks associated to different ISOLDE systems reported during the Mini-Cons Workshop and/or during Technical Coordination Meetings. Non exhaustive list:
 - Beam Gates: Short term solution in place (fully manual). Need a new system integrated in controls (timing, logic, logging). Link to RILIS fast beam gate and requirement for CAO switching project. Specification required. Formalize responsibility and assign corresponding resources.
 - ISCOOL (RFQcb): improvements proposed by BE-OP and STI-SY. Input from users in preparation. Develop plan and secure resources as needed.
 - Switchyard YGHM/GLM.ZDP.0100: System at risk. Organize technical review S1-2023 and recommend strategy (exchange, spare, redesign, simplified spare....). Formalize ownership.
 - Beam instrumentation: spares and exchange of Separator FC and SEMGRID. CONS request to be initiated (SY-BI pre-study done and needs indentified).
 - Planned consolidations as replacement of the PS for electrostatic elements (bipolar PS selected) will solve known issues and allows improvements: No manual swapping when changing beam destination. Necessary hardware for CAO (central beam line) switching project....
 - Solution for the low energy beam lines documentation found since Mini-Cons workshop (ABT will work on the sequences and optics with a FELL supported by the ISOLDE collaboration)

Conclusions

- Possibility for consolidations and improvements of the ISOLDE facility to maximize its physics output (capacity, capability) have been put forward in the last months (outcome of 2021/2 runs, MINI CONS workshop).
- Exact scope of work for run3, LS3 and beyond will depend on approval and arbitration process
- Some decisions will be required already in 2023 for implementation during LS3 (unique time window)
- Global coordination would facilitate the co-existence and synergies of such large spectrum of activities.
- Some ongoing or approved consolidation activities were not mentioned today (in the spirit of the WS), they are still very welcome and important for the facility !
- And last but not the least, thanks to all colleagues helping solving problems when they occurred during the last run. Often got support from experts outside working hours or even from their vacation place !

Summary Table (order not related to priority) – (1)

Activity / Study / Action	Type	Timescale	Comment
REXEBIS & REXTRAP solenoid, spare strategy	CONS	2023-2026	Scope to be validated Q1 2023. 1 MCHF Guess. Cost and manpower needs defined with scope.
101 MHz 90 kW solid-state amplifiers	CONS		Request from D2 to P1 (1.58 MCHF).
Implementation of permanent vibration monitoring for NC cavity	Action	YETS 22/23	Temporary system in place until July. More permanent monitoring needed to validate correlation
Rework of the cryogenics process (HIE). LN2/Helium heat exchanger solution	Study+ Action	Study 2023 - ? Implement -	TE-CRG will define needs and studies scope early 2023 Hardware / operation implications of LN2/Helium solution
Spare HIE ISOLDE cryomodule	CONS	After LS3	Flexibility to intervene in CM when required (transport to SM18). 1.6 MCHF.
2 GeV study and BTY line CONS strategy Power Convertors CONS request Magnets CONS request (4 Quad.)	Study		SY-EPC CONS request compatible with 2.0 GeV (1.15 MCHF with proposal for cost sharing). Study will recommend needs for magnets, BI....
Beam Dump Replacement Study (IBDRS)	Study CONS	Approval S1/23 LS3 - implement	18 months time window required to exchange dumps Decision needed in 2023 for LS3.

Summary Table (order not related to priority) – (2)

Activity / Study / Action	Type	Timescale	Comment
FIRIA follow-up. Ventilation upgrade for fire safety and radiation protection. Building 197 extension.	CONS	2023-2026	Relocation of services during YETS 23/34 (decision needed). Construction in 2024. Commissioning during LS3, resource leveling possibility.
ISOLDE Beam Gates			Specification required and new system to be build/deployed. Formalize responsibility.
ISCOOL (RFQcb) consolidation / improvements			Specification and needs to be documented (BE-OP, EN-STI, EP-SME)
Switchyard YGHM/GLM.ZDP.0100	CONS		Organize technical review to decide on spare strategy. Formalize responsibility for system.
Beam instrumentation: spares and exchange of Separator FC and SEMGRIDs. Other in the hall.	CONS	2023 - 2026	Cons request to be initiated by Technical Coordination (with support from SY-BI – pre-study done)
Beam Switching of Central Beam line			Ongoing (support from ISOLDE collaboration). Compatibility with SY-EPC PS upgrade for electrostatic elements
Low energy beam lines documentation and optics	Study	Start in 2023	SY-ABT to start in 2023 with support from fellow (ISOLDE collaboration)