



Readiness for start-up HIE ISOLDE and 2021-2022 YETS

91st ISCC meeting 16 June 2021, CERN

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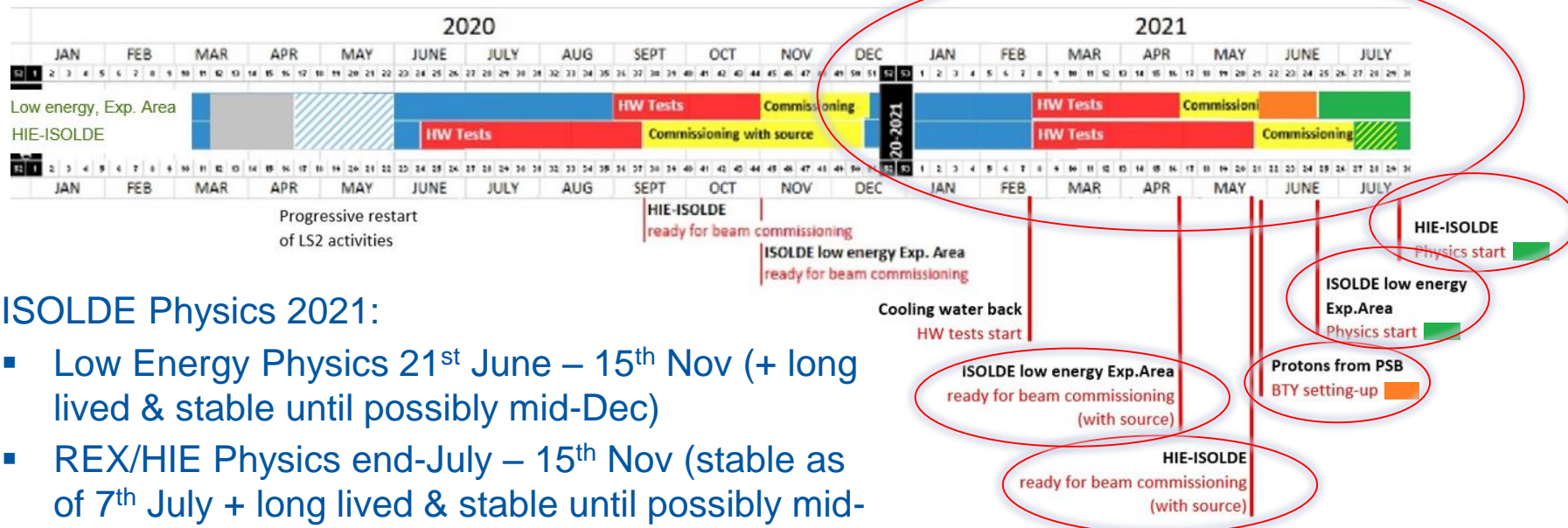
Outline

- Overall planning
- REX/HIE ISOLDE hardware commissioning and activities
- HIE Cryo plant interruptions
- REX/HIE ISOLDE beam commissioning
- Conclusions and final remarks

Overall planning for REX/HIE ISOLDE:

Restart 2021:

- On the Low Energy side, the 2021 planning was mainly driven by the readiness of FE11 and the availability of the protons from PSB
- On the HIE ISOLDE side, the planning was mainly driven by the maintenance of CV (cooling towers) and Cryogenics (restart of the cryo plant, the cooldown of the SC Linac and associated recommissioning of the Cryo Modules)
- All planning milestones were kept, there has been no delay on the start-up of the facility so far



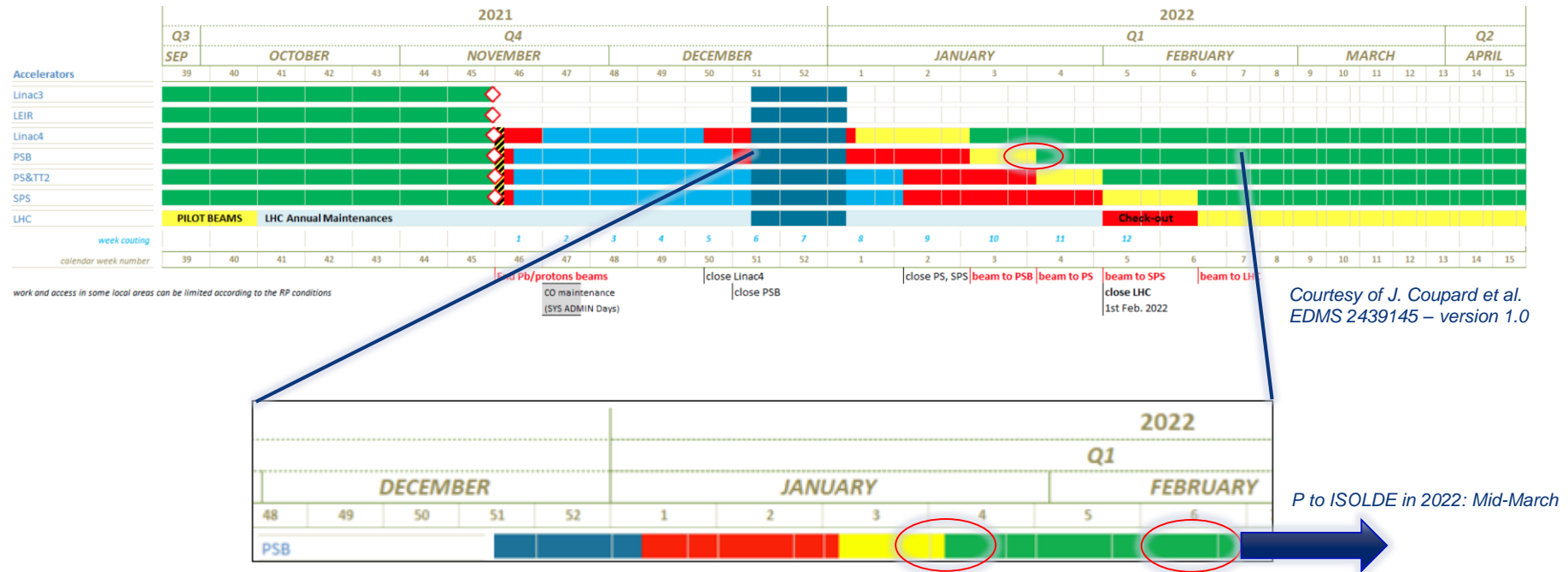
ISOLDE Physics 2021:

- Low Energy Physics 21st June – 15th Nov (+ long lived & stable until possibly mid-Dec)
- REX/HIE Physics end-July – 15th Nov (stable as of 7th July + long lived & stable until possibly mid-Dec)
- End of the 2021 run with protons might be subject of chance dictated by the LHC ion run

Overall planning for REX/HIE ISOLDE:

Protons in 2022: Short YETS '21-'22 as presented at the ISCC 1 Feb '21

(R. Steerenberg BE-OP, IEFC – 29 Jan 2021)



Courtesy of J. Coupard et al.
EDMS 2439145 – version 1.0

- Protons from PSB available towards the end of Jan 2022 -> possible early start of 2022 ISOLDE Physics with protons as wk 6: However, outcome of the 7th June meeting with the LHC experiments is that the LHC program will be delayed by ~3wks pushing the protons to ISOLDE to mid-March 2022. An update of the YETS and injectors schedules is in the making and will be presented at the IEFC this Friday
- Requirements for an early start of 2022 REX/HIE ISOLDE physics: No stop of the cooling water plant and continuation of the Cryo plant for the SC HIE Linac over the '21-'22 annual closure:

Request to run HIE ISOLDE Cryo over the 21/22 shutdown:



With no installation work on the HIE Linac foreseen there would be no significant reason to warm-up the machine other than for Cryo and CV maintenance.

Request ISCC, recommendation INTC, endorsed SY-RF (W. Venturini):

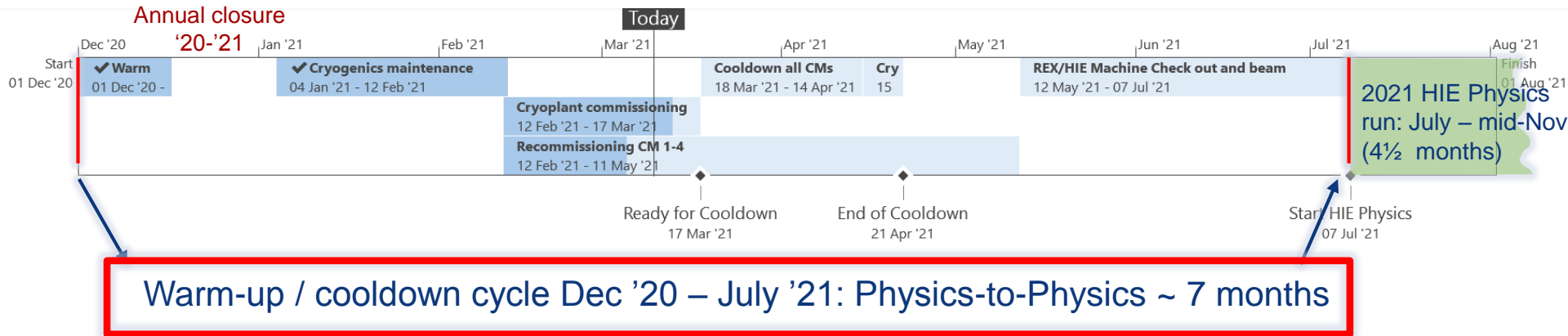
- No warm-up of the HIE ISOLDE SC Linac during the '21-'22 YETS / annual closure

3 main reasons/advantages:

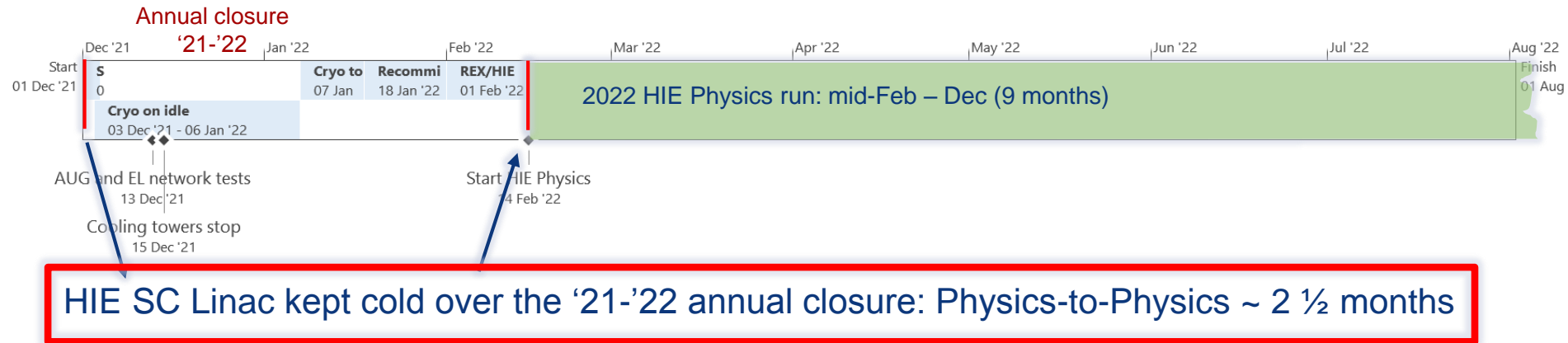
- 1) Gain Physics: 2022 protons available as of wk6 (PSB: B. Mikulec) allowing HIE physics to start in Feb instead of July (gain 4½ months)
 - 2) Protect equipment: No thermo-mechanical stress on the machine
 - 3) Save Manpower: Avoid lengthy process of restart: cryo recommissioning, RF reconditioning, CMs recommissioning and beam recommissioning (all together 6 months)
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- A study was carried out by Cryo, SRF, CV and EL and results presented at the IEFC meeting (26th March)

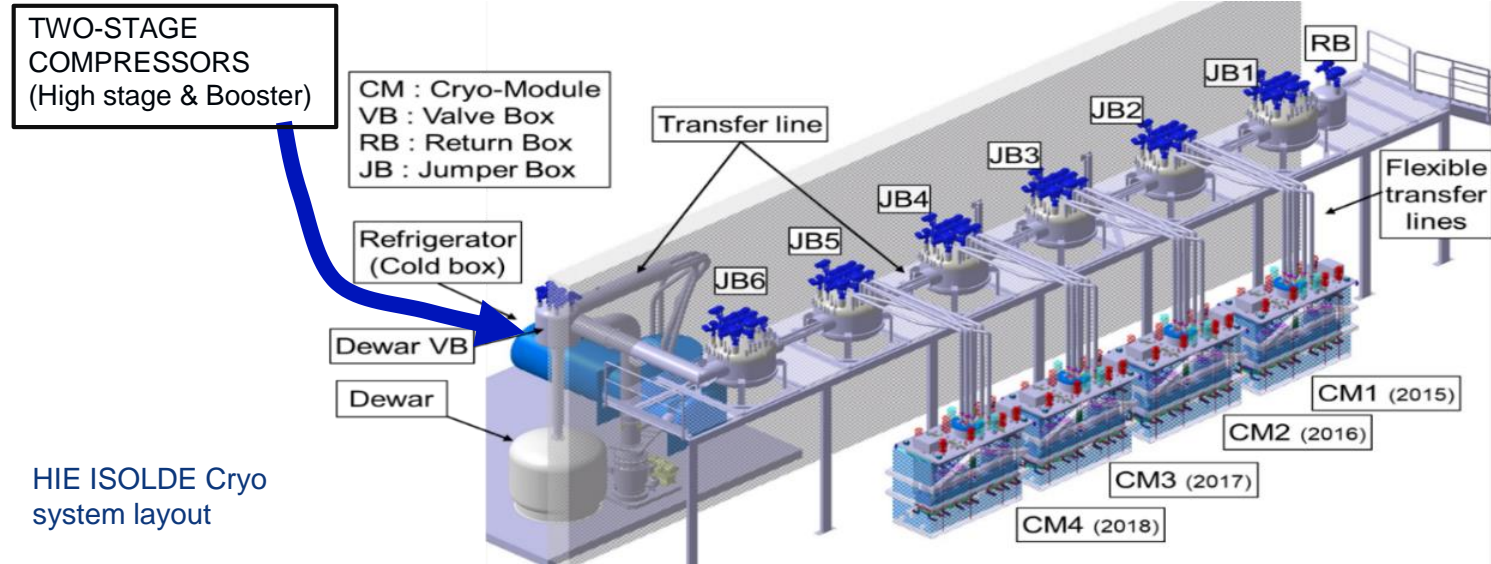
Timelines:

2020 – 2021: Typical warm-up / cooldown cycle



2021 – 2022: (hypothetical if HIE SC Linac is kept cold)





Technical and manpower challenges for the HIE ISOLDE Cryo plant:

Running the Cryo plant over the annual closure (manpower and interventions)

- Main impact on the Cryo plant in case of a temporary or full stop
- Main actions after a full cryo stop

Maintenance of the Cryo plant to be performed in 2022

- Maintenance and periodicities

Maintenance of the Cryo plant to be performed in 2022: TE-CRG (N. Guillotin, J. Bremer)

HIE ISOLDE, CRYOGENICS APPROACH FOR MAINTENANCE & OPERATION, March 12ve, Nicolas Guillotin

EQUIPMENT	PERIODICITY (H)	DURATION BEFORE NEXT MAINTENANCE (H) -STARTING FROM FEB. 21-	REMARKS
LP compressor	40,000	13,000	A nominal yearly run is ~7'000h ⇒ Durations < 7'000h will have to be considered beginning 2022 for Maintenance
HP compressor	40,000	13,000	
M120 motor	40,000	12,000	
Oil pump P600	24,000	20,000	
M121 motor	30,000	2,500	Important but not that critical. Motor 0.55kW / 1 on stock
M600 motor	30,000	2,500	Submitted to regular vibration controls during the operation. Can not be anticipated. No possible forecast
Reducer ("gear box")	8,000	7,500	<p>HIGHLY CRITICAL AND MANDATORY (Minimum Maintenance in > 3 to 4 days for reducer itself) If reducer is replaced, then alignment must be made again Cycle of ~100h in standalone of the compressor is advised</p>
Balancing Motor//Reducer	Complete Maintenance is about 1 wk up to 2 wks in case of troubles for re-alignment		
Cartridge B140 replacement	32,000	5,300	
Cartridge Coalescers F160,F161	16,000	5,300	
Charcoal replacement	24,000	8,500	CRITICAL
Roots pump P360 Cryo Distribution	40,000	10,000	
Couplings lubrication	7,000	7,000	CRITICAL
Oil separator	7,000	7,000	CRITICAL

MUST BE DONE BEGINNING 2022



Maintenance foreseen 21-22
 Maintenance foreseen 22-23

The minimum maintenance for 2022 will require a cryo stop of 1-2 wks

Conclusions of the study:



Keeping the HIE ISOLDE SC Linac cold during the '21-'22 annual closure and running it till Dec '22 is **not** possible

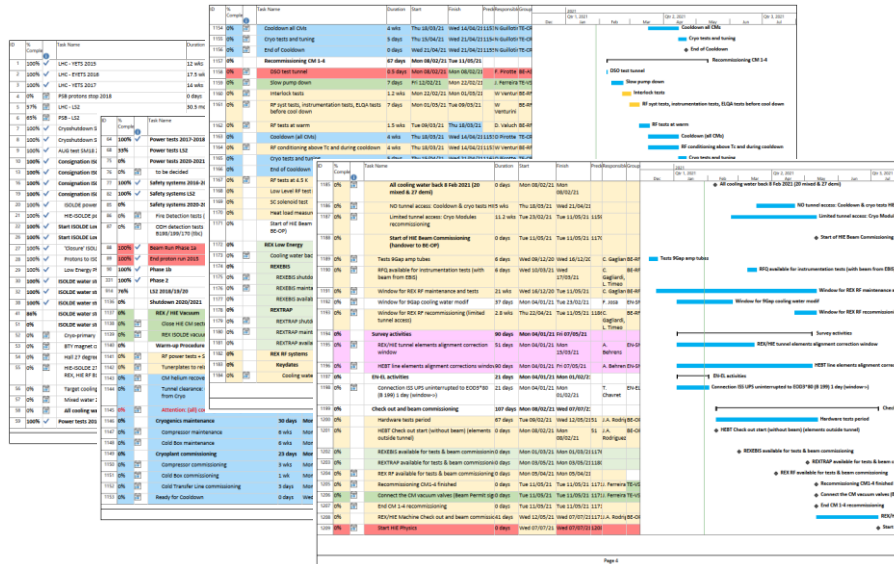
Other outcome:

- To study: Systems to improve the Cryo plant reliability and reduce recovery time in case of an accidental or programmed stop:
 - LN2 system to keep the LHe and screens cold (example INFN – Legnaro, Italy)
 - UPS system to coop with (short) power interruptions
- Optimize the warm-up – cooldown cycle (possible gain of several weeks):
 - Optimize Cryo maintenance window on year to year basis: Depends significantly on the different periodical actions (parts to be send abroad or not, etc.)
 - Optimize the SRF and Beam recommissioning programs (no additional CMs)

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REX/HIE ISOLDE hardware commissioning and activities:



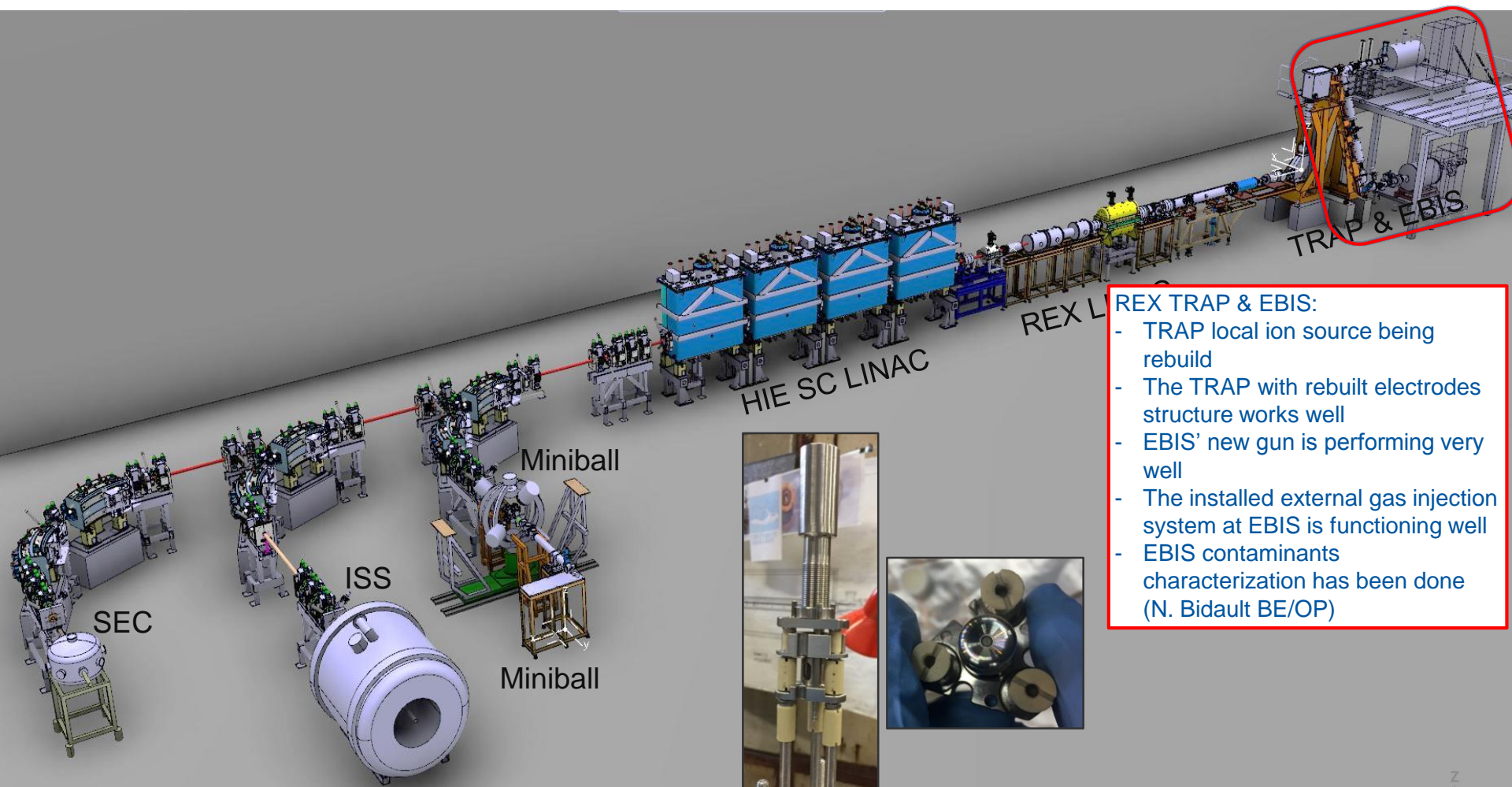
HIE ISOLDE Cryo plant



Key-dates and planning drivers:

- Warm-up of the SC linac started on the 3rd Dec and over the annual closure
- Stop of all cooling water and lock-out as of the 16th Dec
- Cryo primary water back 25th Jan, all other as of 8th Feb -> Unlocking power supplies and start of Hardware Test period
- Cryo maintenance until 12th Feb followed by recommissioning of the plant. Cooldown of the Cryo Modules 18th March – 21st April -> Recommissioning of CM1-4 with RF at cold (4.5K)
- Start of machine check-out and (stable) beam commissioning as of 12th May
- So far all milestones have been kept, despite several critical Cryo interruptions
- Stable beam available to the HIE experimental stations as of 7th July
- HIE ISOLDE (RIB) Physics start as of end-July

We are here

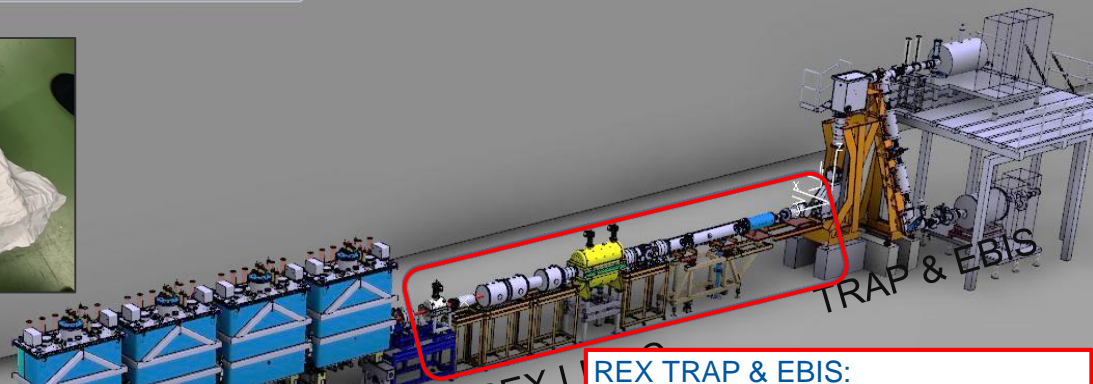


- REX TRAP & EBIS:**
- TRAP local ion source being rebuild
 - The TRAP with rebuilt electrodes structure works well
 - EBIS' new gun is performing very well
 - The installed external gas injection system at EBIS is functioning well
 - EBIS contaminants characterization has been done (N. Bidault BE/OP)

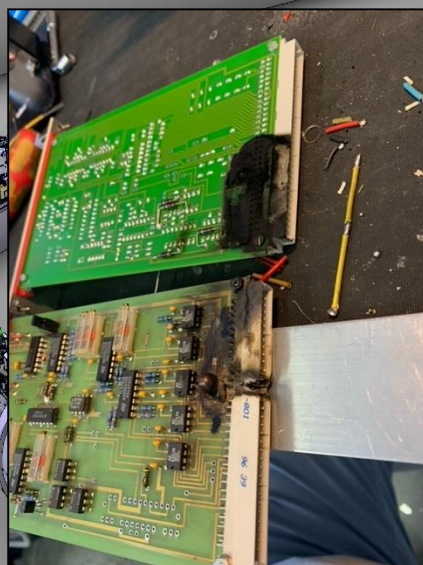
Installation new E-gun at REX EBIS
(courtesy G. Kathri, F. Wenander, S. Mataguez)



REX Linac 9Gap anodic capacitor repair
(courtesy C. Gagliardi)



TRAP & EBIS



Burned 7GAP3 controller card at amplifier start-up. Capacitors replaced on all amplifiers (C. Gagliardi SY/RF)

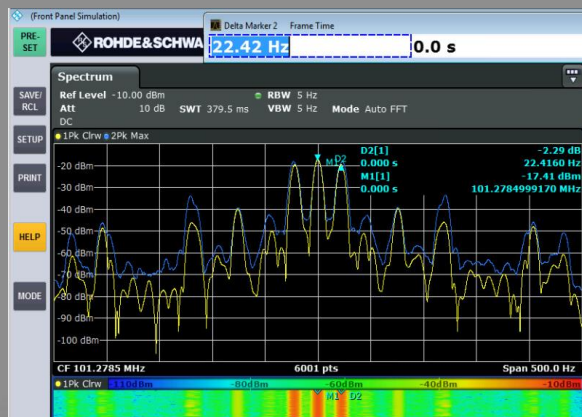
REX NC LINAC:

- All REX RF systems were successfully recommissioned in time including the repaired 9GAP amplifier (anodic capacitor)
- A water leak on the IH structure occurred and was repaired
- The 7Gap3 amplifier controller board caught fire due to aging and wrong type of capacitors. Replaced on all amplifiers
- 7Gap3 preamplifier failed. Broken components replaced (C. Gagliardi SY/RF). No spare.
- Excellent support from RF (C. Gagliardi SY/RF)
- All beam instrumentation in REX & HIE recommissioned

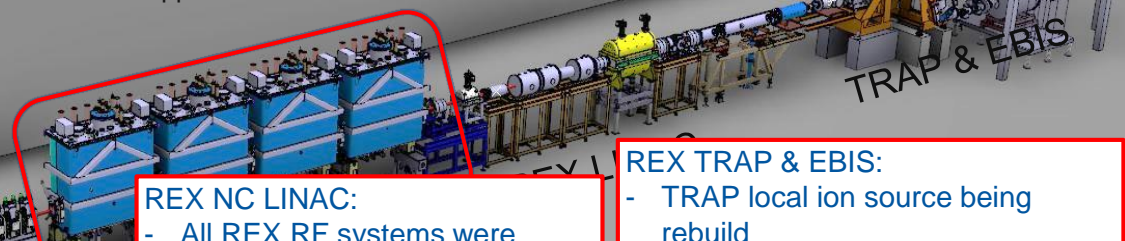
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SEC



Microphonic vibrations around 20Hz that were seen in previous years have significantly gone down or disappeared



HIE SC LINAC:

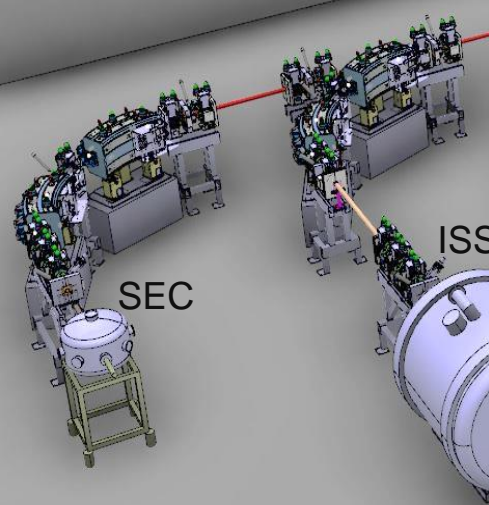
- All 4 CMs cooldown according to schedule
- Alignment of all SRF cavities and Solenoids verified at cold – no realignment necessary
- All SRF RF systems recommissioned successfully and with higher performance and stability due to less vibrations in the cryo system
- Total operational gradient of $\sim 104\text{MV/m} = 87\%$ with all SRF close to nominal 6MV/m
- Excellent work by RF and Cryo (D. Valuch SY/RF, N. Guillotin TE/CRG)

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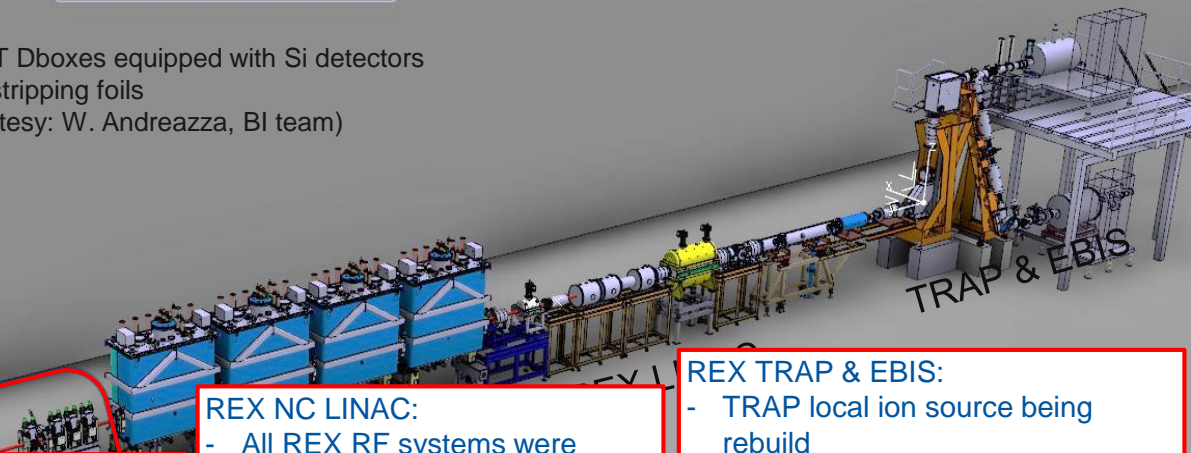
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HEBT Dboxes equipped with Si detectors and stripping foils
(courtesy: W. Andreatza, BI team)



TRAP & EBIS

HEBT:

- Dboxes in all three lines equipped with Si detectors
- Stripping foils ready for installation when required (Aug) for all three lines as well as at two positions in the straight section (redundancy)
- Optimization of the overall alignment of the HEBT elements has been carried out by Survey (A. Behrens, A. Beynel BE/GM)
- Instrumentation tested except for some in the XT02/03 lines

Experiments:

- ISS uninterrupted power connected (chiller and compressor)
- No MINIBALL this 2021 run..

HIE SC LINAC:

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Severe HIE ISOLDE Cryo Plant interruptions:

Friday 14 May: Unexpected / uncontrolled

- An unexpected stop of the Meyrin site compressed air and cooling water systems stopped the HIE ISOLDE Cryo plant. No significant increase in the sensitive frames' temperature and no critical LHe level decrease. The SRF cavities stayed under 5K, cryo recovered over the weekend and no changes were observed in the SRF cavities' gradients

Sunday 30 May: Unexpected / uncontrolled -> **Very critical one**

- A failing temperature sensor in CM3 (XLH2) provoked an interlock and stopped the cold box bringing down the entire Cryo plant. This time the LHe levels decreased critically and several SRF cavities went above critical temperature (>9.3K). It took several days to recover. Fortunately, the SRF cavities recovered to their gradients and no reconditioning was necessary. A cryo study is on-going in order to determine the possible process optimizations to eliminate or reduce such events.

Thursday 10 June: Controlled stop

- An intervention on the HIE ISOLDE Cryo plant dominated by a preventive action on replacing a partial clogged up water flow meter at the compressor station. The intervention of ~1hr demanded 6 hrs to recover the LHe levels in the cryo modules and before the system was stable again, however, an uncontrolled stop would have been much more severe than that.

Monday 14 June: Controlled stop

- Clogging was observed in the cooling water circuit of the compressor gear box. Operations agreed in cooperation with Cryo on an intervention as soon as possible with again in mind the benefits of a controlled stop. Estimation was a ~1h30 intervention with a recovery of ~10 hrs. The actual intervention took only 30 min with consequently shorter recovery time.

Recovery:

- Excellent support from the Cryo group (N. Guillotin & team TE/CRG)



HIE ISOLDE Cold Box



HIE ISOLDE Compressor station

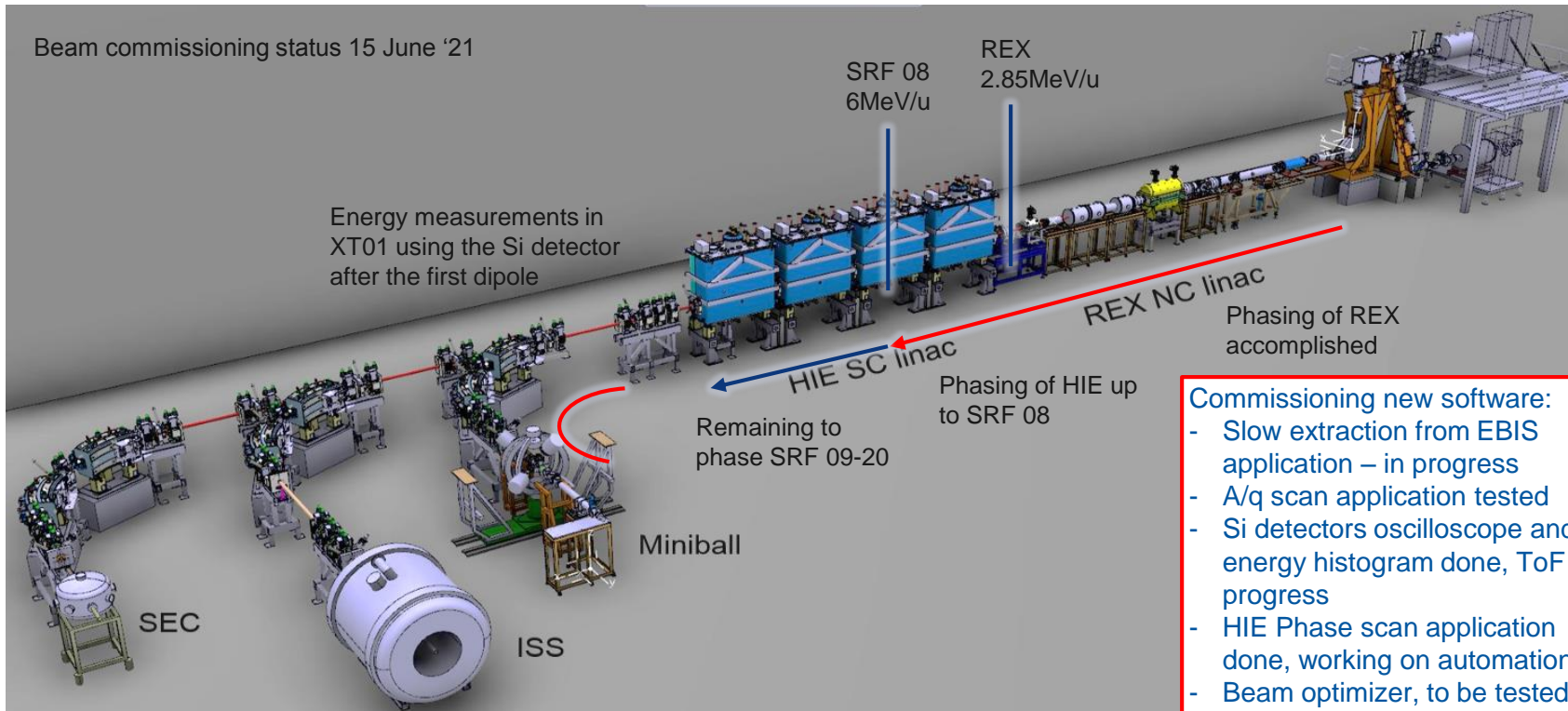
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REX/HIE ISOLDE Beam Commissioning: (status 15 June 2021)



- All REX Linac cavities have been phased and a total energy of 2.85MeV/u has been reached before injection into the HIE Linac
- Set-ups for:
 - $^{20}\text{Ne}^{7+}$ - $A/q = 2.857$
 - $^{20}\text{Ne}^{6+}$, $^{40}\text{Ar}^{12+}$ - $A/q = 3.33$
 - $^{40}\text{Ar}^{9+}$ - $A/q = 4.44$ (to do)
- These pilots will be covering the 2021 scheduled experiments so far (Oct '21) – Talk by K. Johnston
- Despite the Cryo interruptions the HIE ISOLDE Linac SRF cavities have been phased up to SRF 08 bringing the total energy to 6MeV/u. We hope to phase the remaining 12 SRF cavities this week
- Total HIE operational gradient of $\sim 104\text{MV/m} = 87\%$ with the SRF cavities close to nominal 6MV/m and very stable cryogenics
- REX/HIE Physics end-July – 15th Nov with stable as of 7th July



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Conclusions and final remarks:



Planning: 2021 and YETS 21/22

- 2021 REX/HIE stable beam will be available as of the 7th July and physics with radioactive beam are to start end-July until 15th Nov, with this end date being subject to chance depending on the LHC ion run. Possibly long lived & stable beam until mid-Dec depending on dates for YETS EN/EL tests
- Protons to be expected back mid-March in 2022.
- Keeping the HIE ISOLDE linac cold over the 21/22 annual closure has been proven not to be possible. However, systems to improve the cryo plant reliability as well as optimisation of warm-up and cooldown procedures will be studied. For 2022 the commissioning of the HIE Linac can be considered to be similar to this years' – HIE physics to start end-July 2022

REX/HIE hardware commissioning

- The 2021 recommissioning and restart of the REX/HIE ISOLDE part of the facility has been going to schedule
- All existing and new systems have been recommissioned successfully despite some incidents.
- The total gradient of the HIE SRF cavities has never been as high (cavities close to 6MV/m, total ~104MV/m, 87% of nominal) due to a very stable cryo system → worry: the cause of such a stable cryo this year is unknown..
- Excellent support from the REX RF, HIE SRF and HIE Cryo experts

Cryo interruptions

- Despite the cryo being very stable there have been some unforeseen interruptions. Two where unexpected of which one could have set back the commissioning by several weeks had the SRF cavities gone up higher in temperatures -> debriefing of the interruptions will follow to decide on actions to be taken for higher reliability.

REX/HIE Beam commissioning: Readiness for the 2021 run

- Despite several interruption we are on track and believe to be in time and in very good shape for the 2021 run (to start on 7th July with stable beam followed end-July with radioactive beam)

Many thanks to all involved in the hardware and beam
commissioning of (REX/HIE) ISOLDE



Thank you for your attention