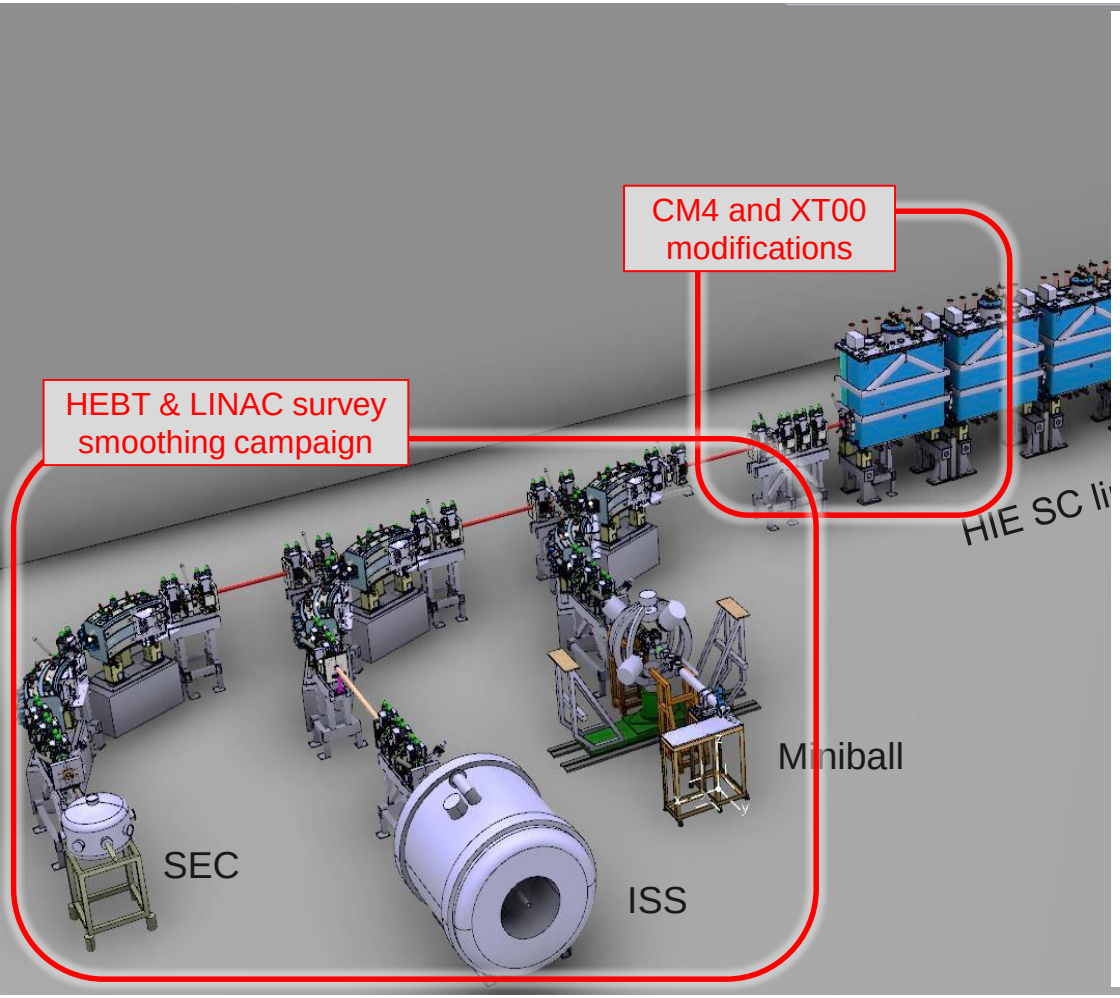
HIE-ISOLDE Status Report

Y. Kadi, W. Venturini Delsolaro, O. Pirotte, J.A. Rodriguez, E. Siesling
for the HIE-ISOLDE project team

Outline:

- Status of Phase 2
  - YETS activities
  - Cryogenic plant
  - Survey & Alignment
  - HW & Beam commissioning
  - Spares production
- Activities foreseen for LS2
- Summary

Phase2 reached completion in May 2018



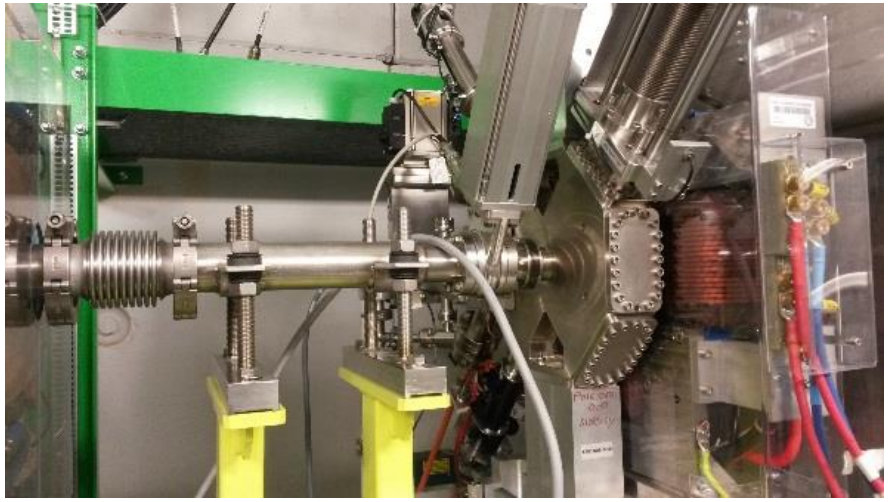
Main installation activities since last INTC, Feb 2018 were:

1) **Installation CM4 services (Cryo, Vac, RF, etc.)**
2) **Completion maintenance of the compressor station and cold box**
3) **Completion repair of the Cryo Distribution System by CRIOTEC**
4) **REX RF maintenance**
5) **XT00 WIC recommissioning**
6) **XLN2 repair & Silicon detector XT02 & XT03 cabling**
7) **Survey smoothing campaign of HIE LINAC & HEBT lines after cooldown**

Others: Installation Solenoid power supply, CM4 RF amplifiers, ISS He filling, tunnel roof fences, REX power supplies consolidation (YETS)

Installation works Feb/March

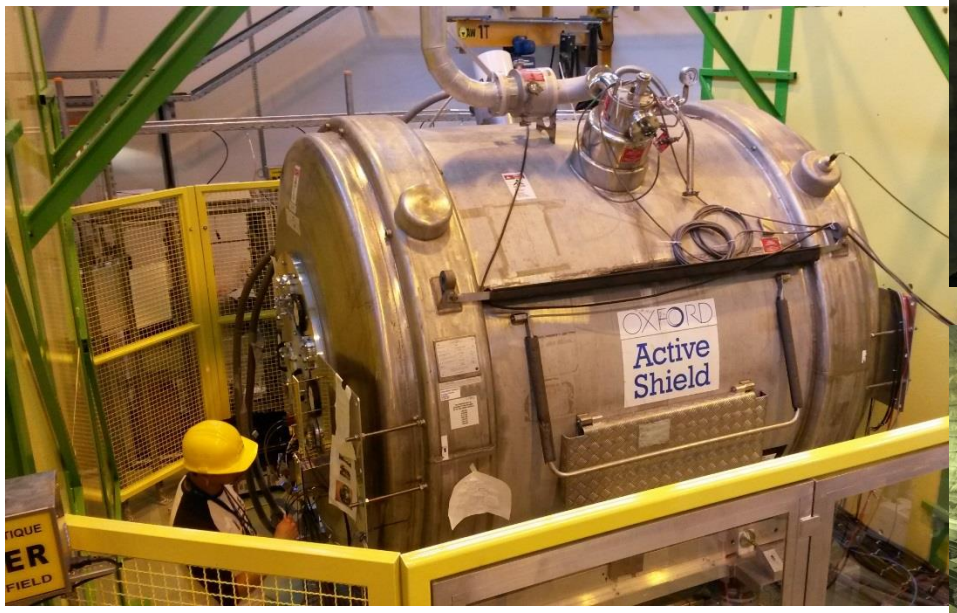
- Vacuum and cryogenics interconnections
  - RF patch panels and cabling, RF motors and controls, LVDT controls, instrumentation and Solenoid connections
- BCAM Survey system (MATHILDE) was (re-) installed
- Despite YETS manpower availability issue CM4 hardware and beam commissioning dates were not affected

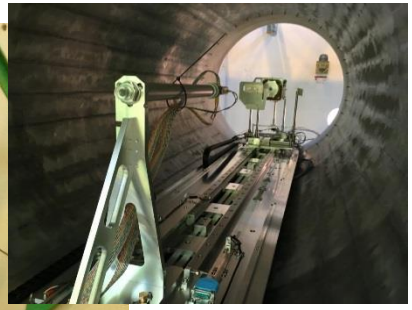


ISS at XT02 installation status

During different installation campaigns the ISS installation has grown steadily

- DAQ and electronics racks installed and cabling infrastructure in place and powered
- End flanges modified with feedthroughs and remounted
- Detector table and carriage mounted inside. Small part of the detector array has been mounted for tests
- Beam diagnostic carriage, Faraday Cup (HIE long type) and Recoil detector (silicon dE-E) have been installed
- ISS has been ramped up to 2.5T and stable beam has successfully been sent to the setup as part of the HIE ISOLDE beam commissioning





Cryogenics works

- Maintenance of the cryo-plant

  => Performed in December 2017

- Repair of the Cryogenic Distribution System to restore nominal performance

  $\Rightarrow$ Performed during Jan-Feb 2018 and validated during the commissioning and the filling with liquid helium of the four cryomodules

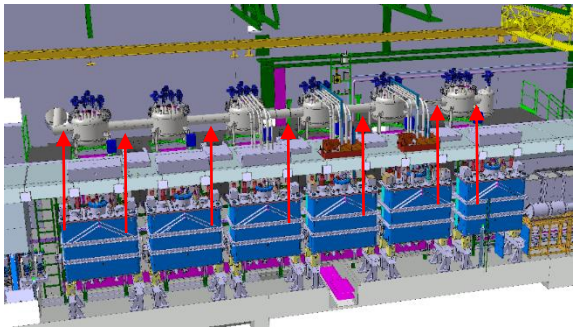
- Integration and connection of CM4

  => Performed during Feb 2018

- Upgrade of the process control for Phase 2 (operation with four cryomodules)

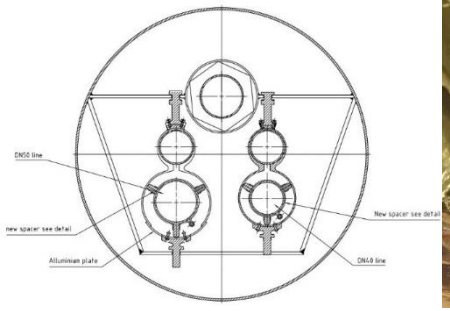
  => Performed during Feb-Mar 2018

Cryogenic Distribution System repair

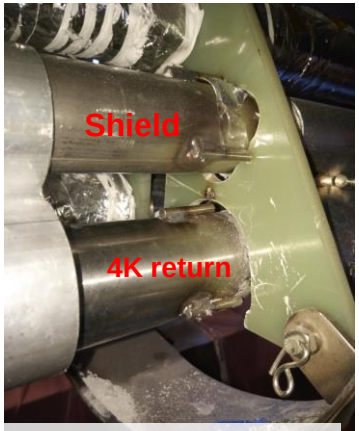


Removing of all vacuum jacket

Opening of Al shield

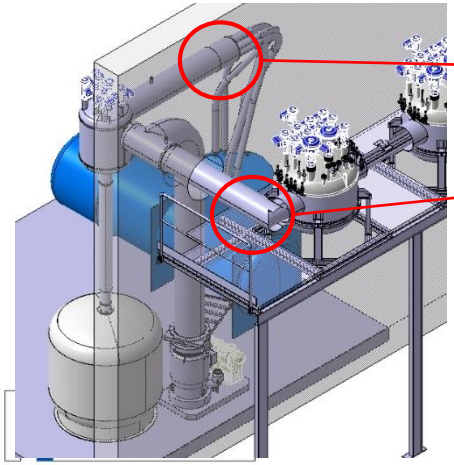


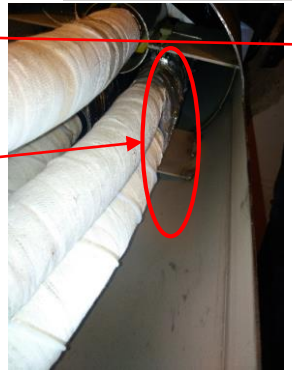
New spacer installation

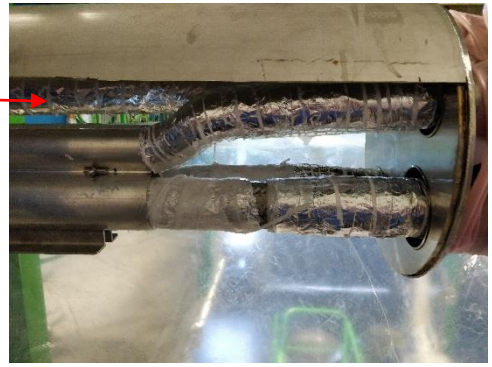


Liberating fixed point

Closing shield & check of spacers position







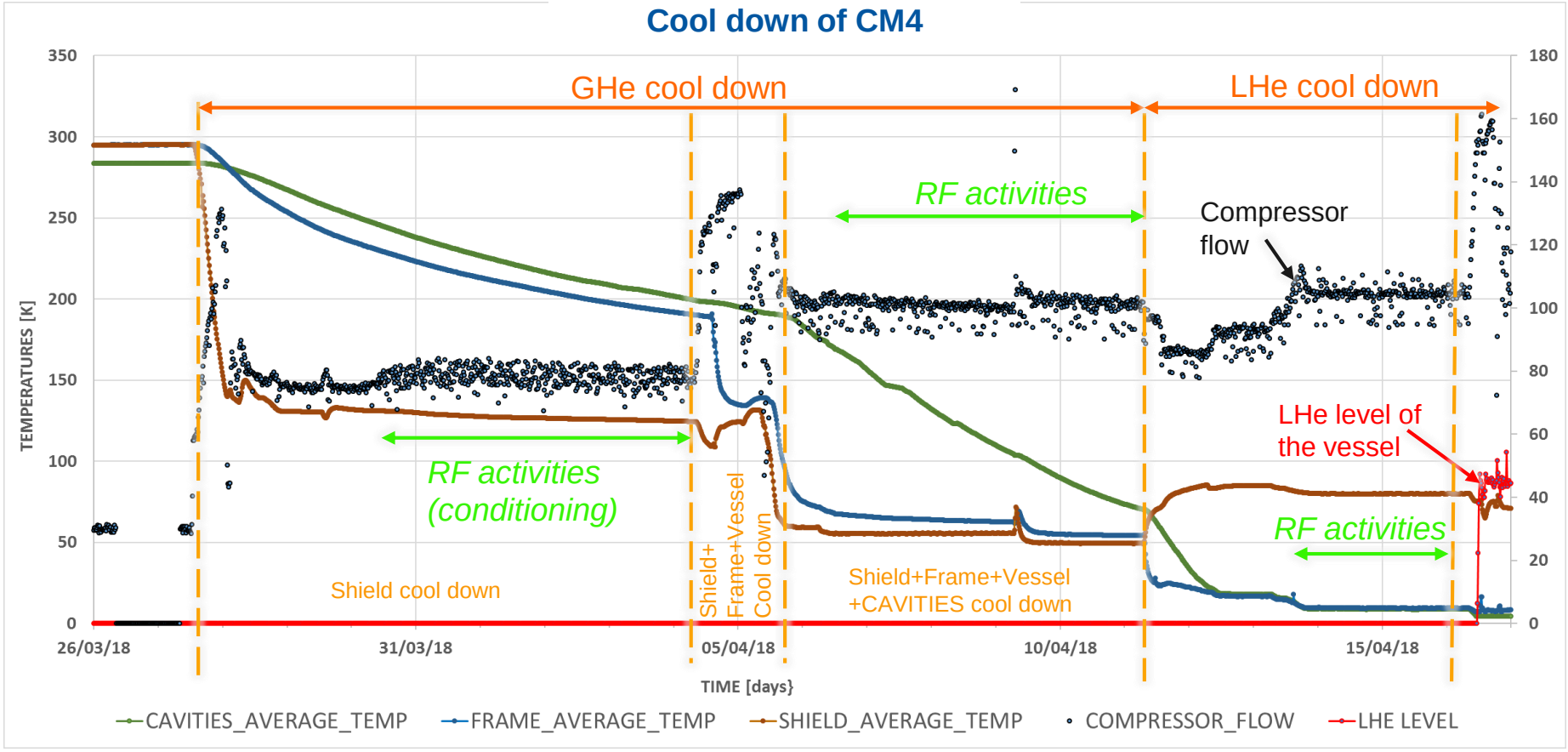
Connection between
CDS and Refrigerator

Installation of a compensator
on the vacuum line

Commissioning of cryogenics system

1. Cool down and filling of the four cryomodules

   => Limit of the cryo-plant has been reached (estimated margin < 10 %)



Commissioning of cryogenics system

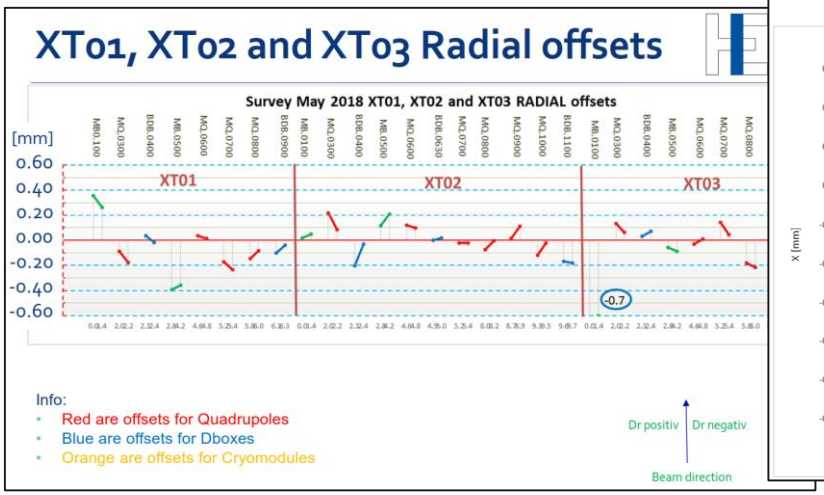
2. Static heat losses test performed on all cryomodules. Three within specifications, one with about three times higher static heat losses

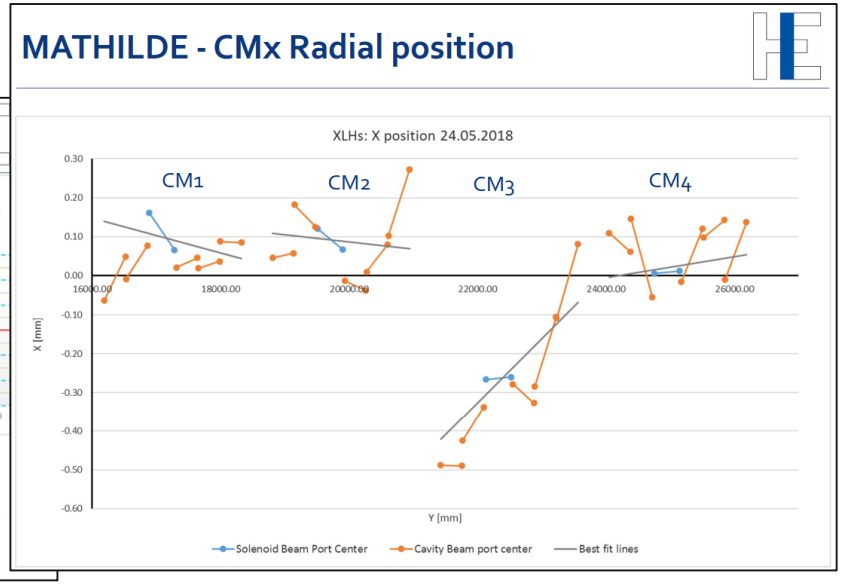
	CM1	CM2	CM3	CM4
Heat losses @ 4.5 K [W]	8.4	21.1	8.5	11.8

3. Tuning of the process control to limit pressure oscillations as much as possible (+/- 10 mbar) : dynamic compensation of the RF power in each cryomodule and fine adjustment of PID parameters

Survey Smoothing campaign

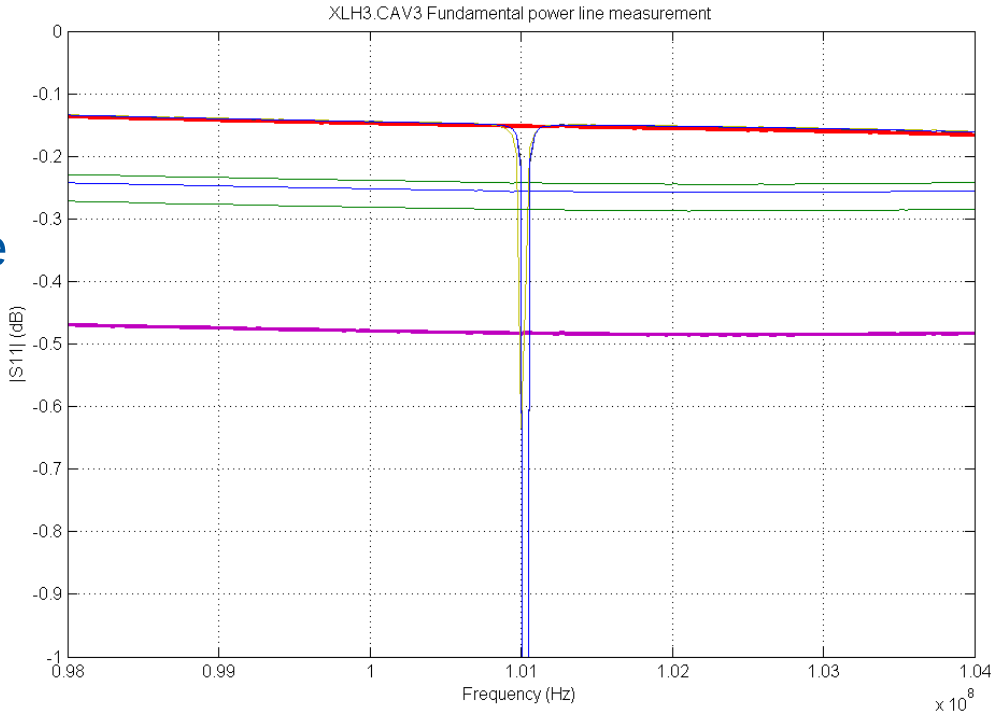
- Hall and HEBT survey measurements outside the tunnel were done during CM4 hardware commissioning, the first half of May
- CM's and XT00 inside the tunnel were measured during a 2 day stop of the RF
- After calculations all appeared to be within tolerances. It was decided to only do a radial correction on CM3 and a tilt correction for the first dipole in XT03 (XT03.MB.0100). Best-fit line for the CM's is biased by the solenoids. For the XT lines the goal is to keep the RMS misalignment of the quads to about 0.2 mm and tilt of the dipoles below 0.2 mrad.
- Survey observed seasonal deformation of the cavern hall/survey network of 0.3mm/10m in horizontal direction (expansion in summer) and a difference in vertical direction (going up in winter)
- The opportunity was used to scan several areas around the REX LINAC for future REX Dbox installation



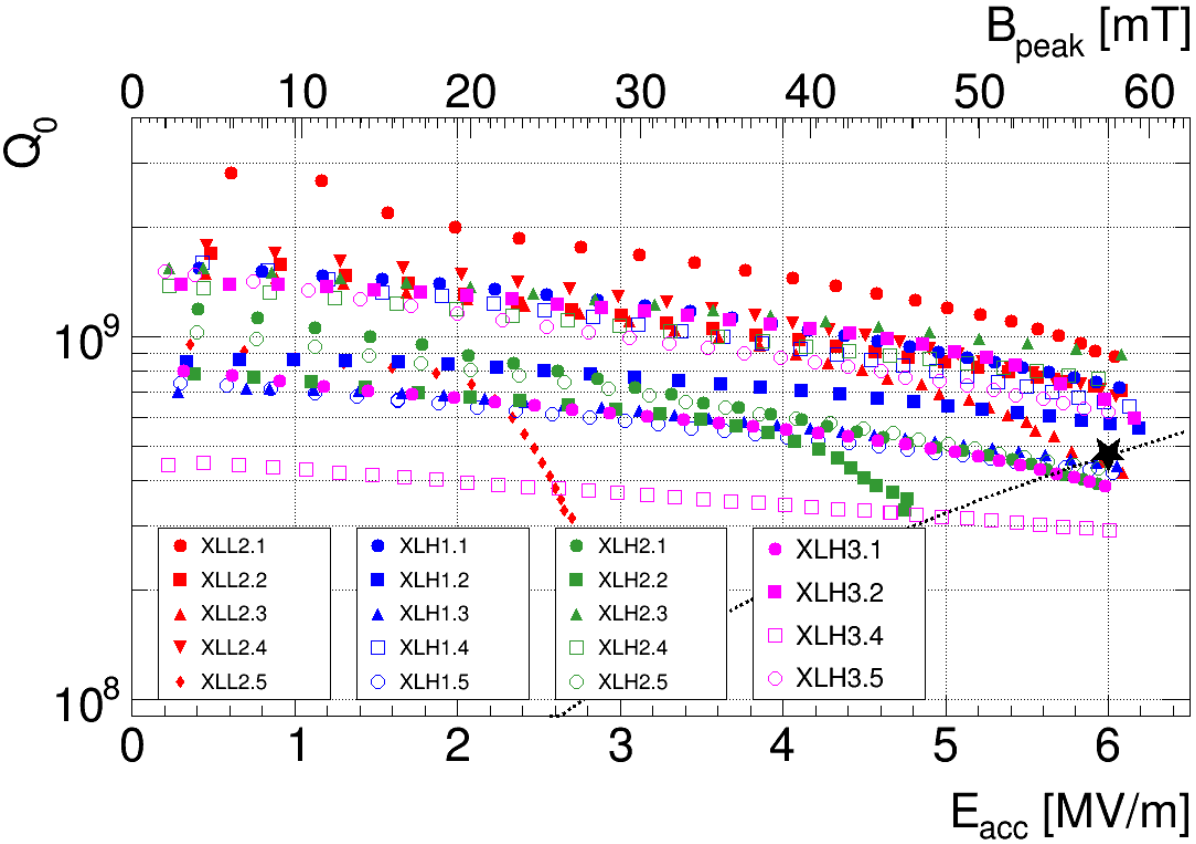


Cavity Conditionning above Tc: XLH3.CAV3 anomaly

- After cool down to 200 K it turned out, it is not possible to inject power into Cavity 3 of CM4
- Warm measurement were normal
- Investigations narrowed down the problem to the connection to the fundamental power coupler
- We decided not to put power in this cavity: the risk is to contaminate the whole cryomodule in case of release of material in the common vacuum



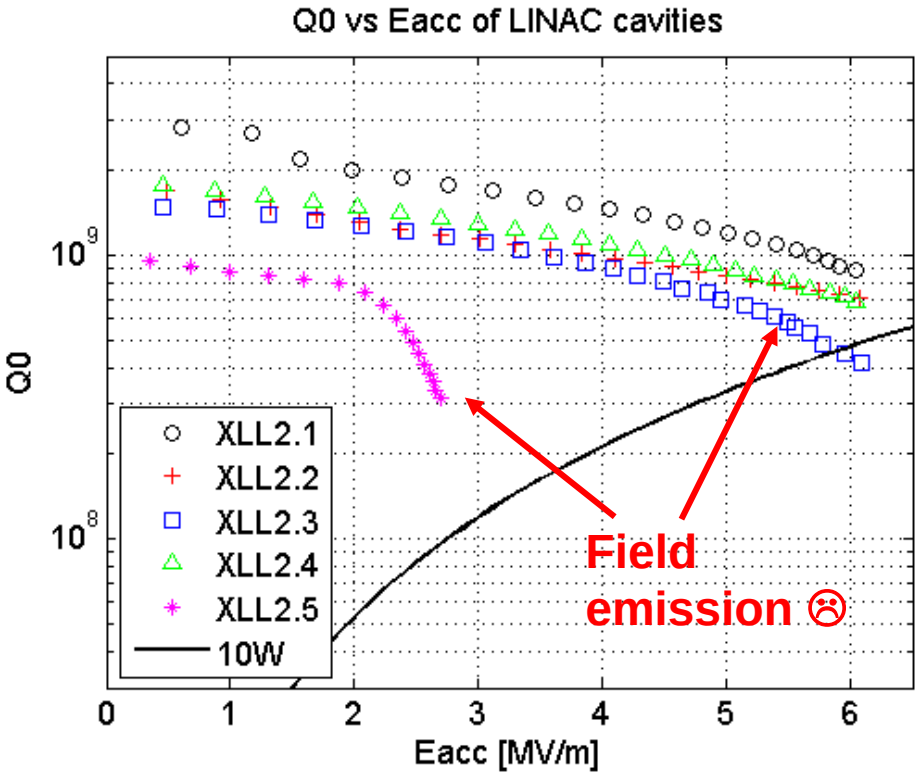
SC Cavitiy Performance



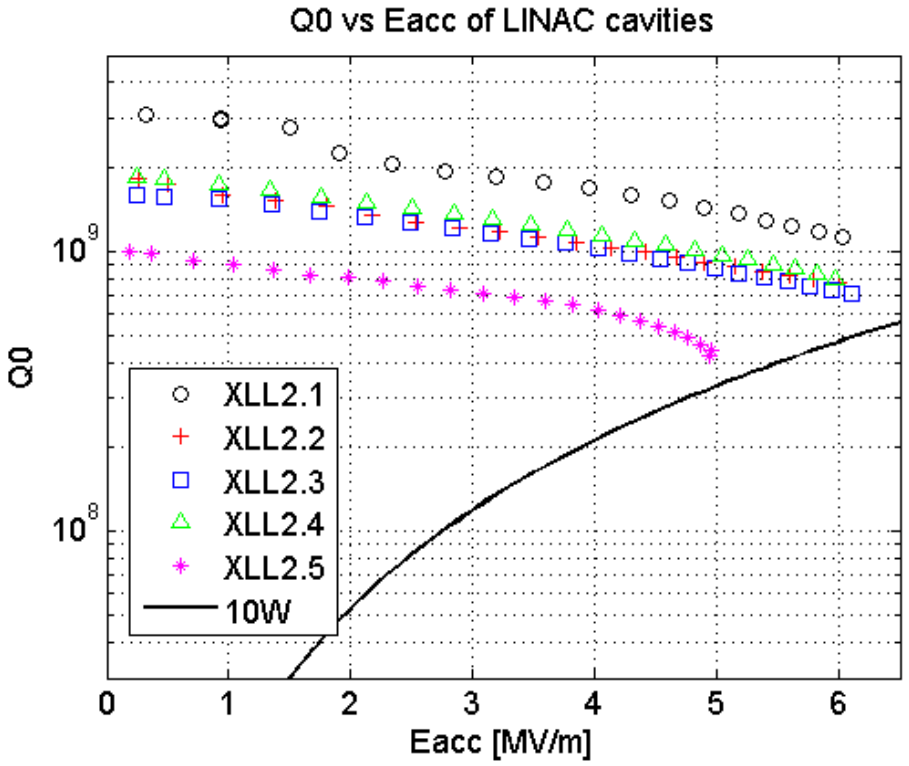
- Cool down gradients over Tc less favourable than in the past
- Most cavities reaching 6 MV/m above specified Q
- 3 cases of field emission (one new). For the moment, no He processing
- CAV3 of CM4 will not be used in 2018

SC Cavitiy Performance: CM1

This Year



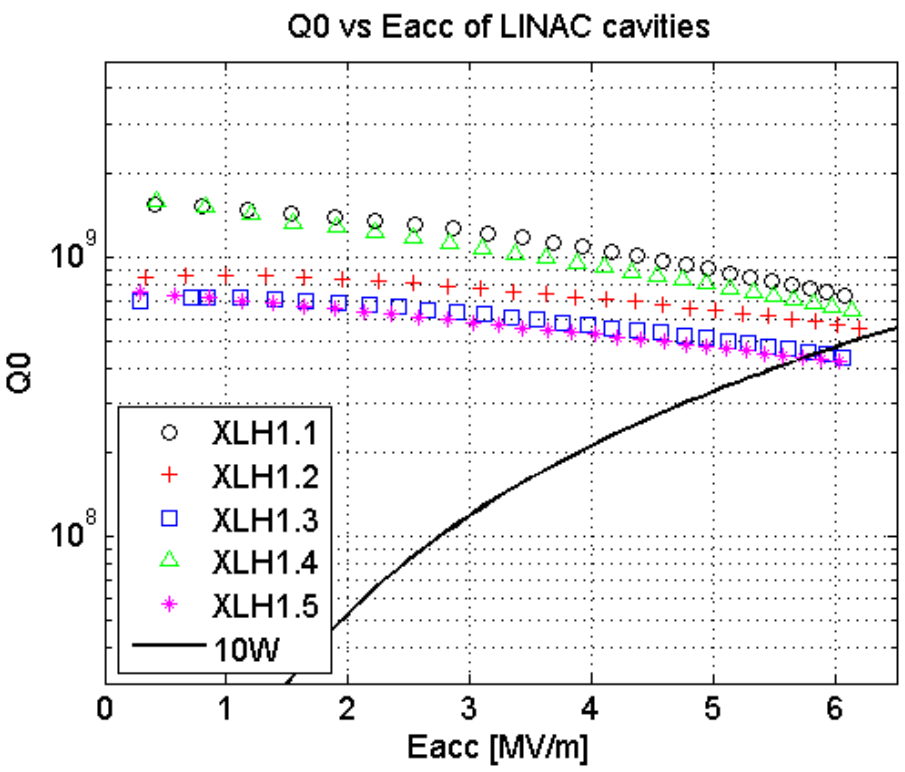
Last Year



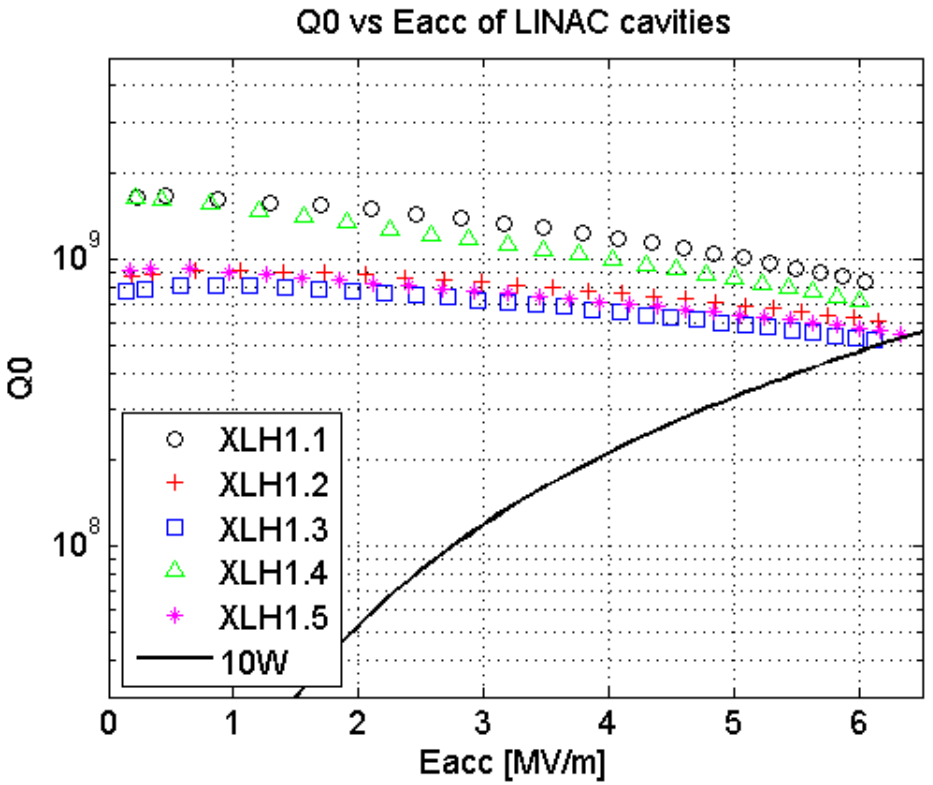
Performance is comparable but contamination produced when coupler was changed at the end of 2015 is still present and a different cavity shows field emission

SC Cavitiy Performance: CM2

This Year



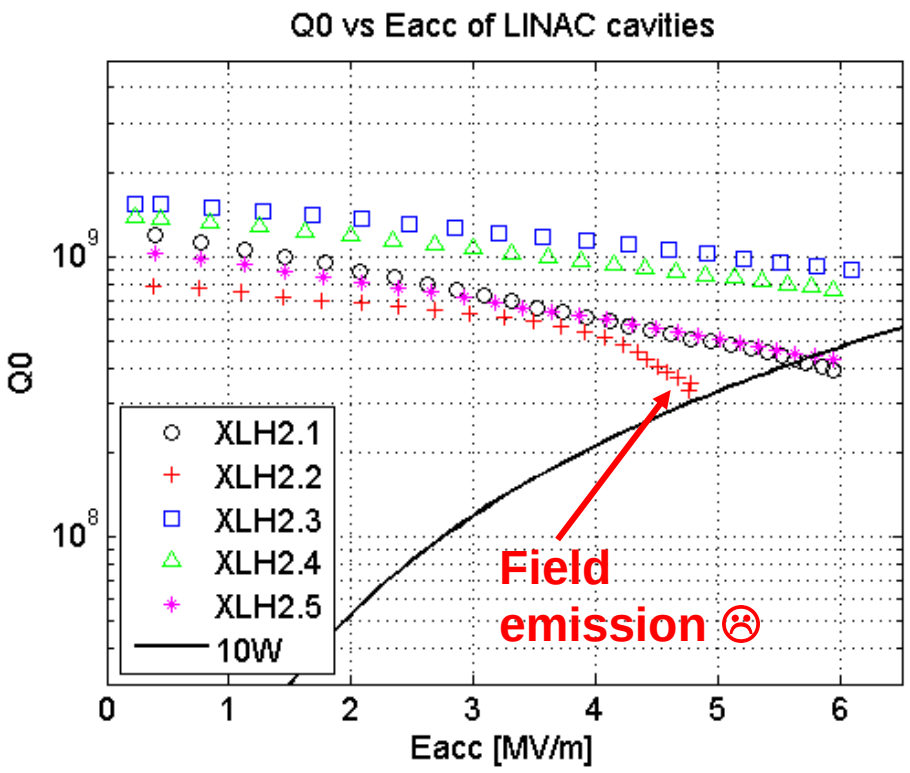
Last Year



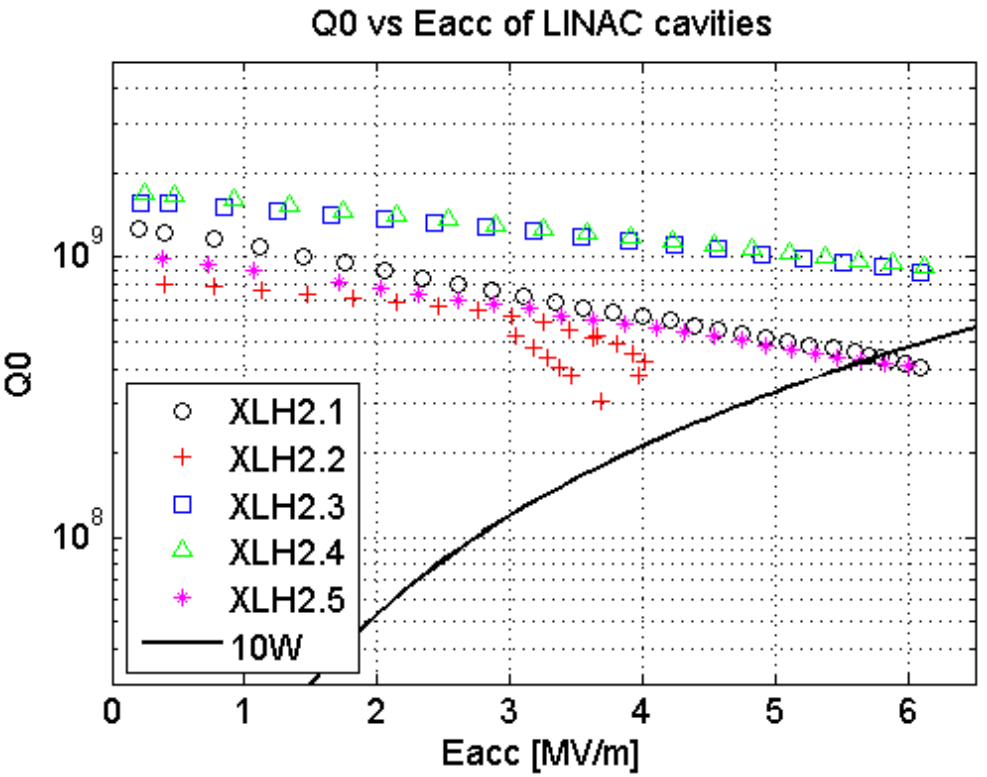
Slightly worse Q caused by slightly worse temperature gradient during cool down

SC Cavitiy Performance: CM3

This Year

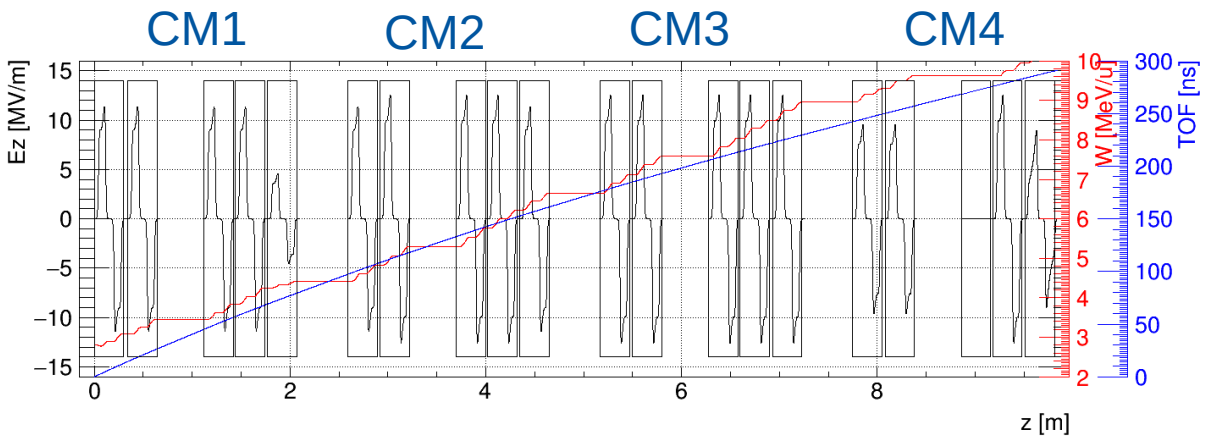


Last Year



Slightly worse Q caused by slightly worse temperature gradient during cool down

SC Cavitiy Performance:



- **10.172 MeV/u for A/q=3.0 expected**
- **7.7 MeV/u for A/q=4.5**
- **Further adjustments of LLRF loops after reliability assessment**

cavity	proposal [MV/m]	Achieved [MV/m]
XLL2.1	5	5
XLL2.2	5	5
XLL2.3	5	5
XLL2.4	5	5
XLL2.5	2	2
XLH1.1	5.5	**5**
XLH1.2	5.5	5
XLH1.3	5.5	5
XLH1.4	5.5	5
XLH1.5	5.5	**5**
XLH2.1	5	**5.5**
XLH2.2	4	**5.5**
XLH2.3	5	**5.5**
XLH2.4	5	**5.5**
XLH2.5	5	**5.5**
XLH3.1	**5**	**4.2**
XLH3.2	**5**	**4.2**
XLH3.3	**0**	**0**
XLH3.4	5	**5.5**
XLH3.5	**5**	**4**

Beam Commissioning:

Commissioning of the REX-TRAP, REX-EBIS and REX Linac:

- All systems recommissioned by week 20 (similar to 2017)
- Proof of concept for a new method to characterize very weak stable contaminants from the REX-EBIS (N. Bidault, IPAC'18 conference proceedings)

Machine Check-out and Beam Commissioning of HIE-ISOLDE (completed):

- Field regulation and automatic degaussing of the HEBT dipoles
- Set-ups for $^{12}C^{4+}$ and $^{22}Ne^{7+}$ using all the SRF cavities to end of XT01 and XT02
- Beam to Miniball (65 hours of $^{22}Ne^{7+}$ at 6.16 MeV/u)
- Beam to ISS (99 hours of $^{22}Ne^{7+}$ at 9.48 MeV/u)
- Initial set-up for A/q=4.0 using all the SRF cavities to XT01.0400

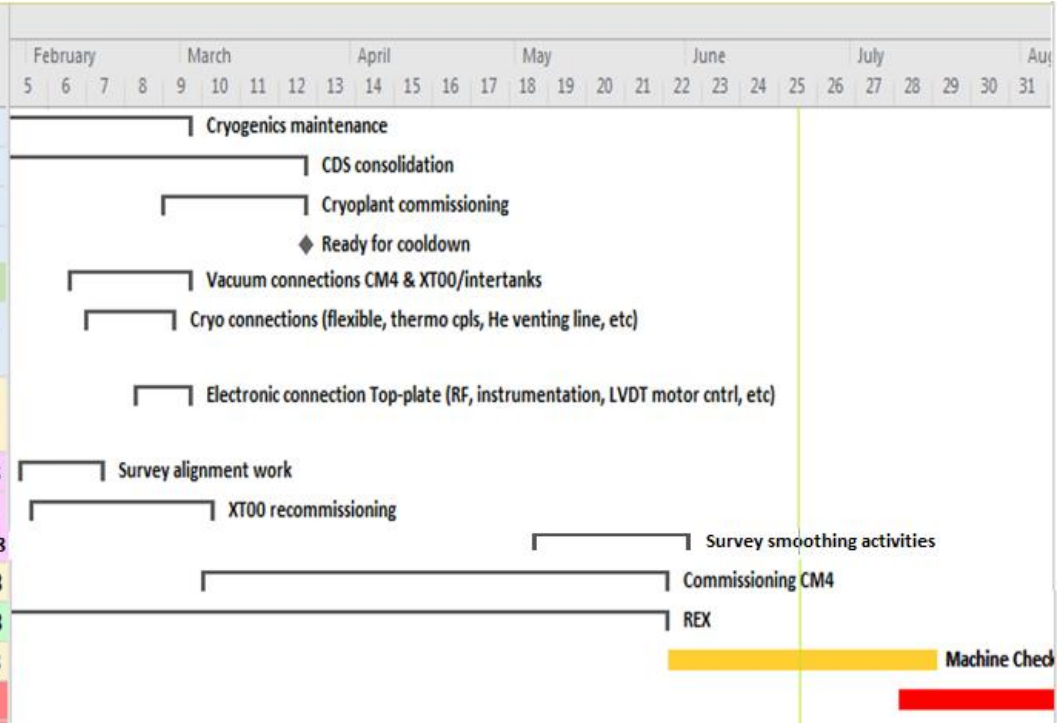
Beam Commissioning of HIE-ISOLDE (pending):

- Set-up for $^{40}Ar^{9+}$ (A/q=4.44) at 7.44 MeV/u to the end of XT01 and XT02
- Transverse and longitudinal phase space characterization
- Beam-based calibration of the SRF cavities

Phase2 Schedule

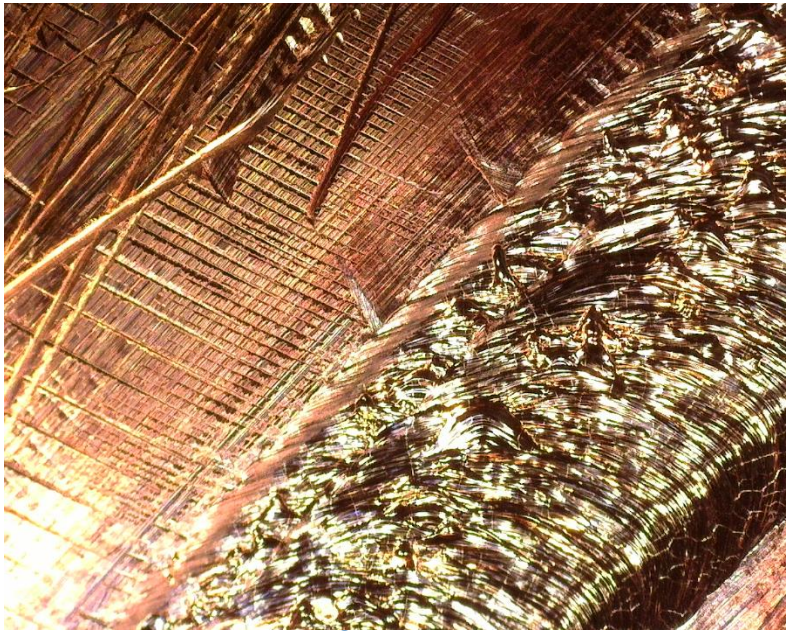
- Due to sufficient contingency and reshuffling of some of the activities the milestones for Commissioning of CM4 (5 March), Cooldown of the cryo modules (26 March), Machine check-out and beam commissioning (28 May) could be kept.
- The CM4 commissioning phase as well as the Survey smoothing campaign finished in time, end of May. Beam Permit was signed and OK given for beam through the LINAC start of June
- HIE ISOLDE Beam Commissioning started as foreseen end of May
- Start of physics foreseen as of 9 July.

Task Name	Start	Finish
Cryogenics maintenance	Mon 15/01/18	Fri 02/03/18
CDS consolidation	Mon 15/01/18	Fri 23/03/18
Cryoplant commissioning	Mon 26/02/18	Fri 23/03/18
Ready for cooldown	Fri 23/03/18	Fri 23/03/18
Vacuum connections CM4 & XT00/intertanks	Fri 09/02/18	Fri 02/03/18
Cryo connections (flexible, thermo cpls, He venting line, etc)	Mon 12/02/18	Tue 27/02/18
Electronic connection Top-plate (RF, instrumentation, LVDT motor cntrl, etc)	Wed 21/02/18	Fri 02/03/18
Survey alignment work	Wed 31/01/18	Wed 14/02/18
XT00 recommissioning	Fri 02/02/18	Tue 06/03/18
Survey smoothing activities	Mon 07/05/18	Thu 31/05/18
Commissioning CM4	Mon 05/03/18	Mon 28/05/18
REX	Mon 04/12/17	Mon 28/05/18
Machine Check out and beam commissioning	Mon 28/05/18	Mon 16/07/18
Beam run Phase 2b	Mon 09/07/18	Fri 16/11/18



Status of Spare Cavities

- **QSS2, QS18, QS20** are fully qualified as spares
- **QS20** has the lowest Q, it could be stripped and re-coated
- **QSS3** substrate delivered at CERN and just accepted→ to be processed
- The fifth spare cavity should come from either **QS6** or **QS18**, both substrates are in bad conditions
- A fourth seamless substrate will be ordered
  (raw material is available, pending acceptance)



Proposed Intervention for XLH3.CAV3

- **Bring back the cryomodule #4 to SM18, open and repair the cable**
  - Dis-installation, transport to SM18 (right after physics run?)
  - Conditioning for ISO5, slow venting
  - Repair works in clean room
- **Profit to replace some of the cavities with the best spares**
  - Spares will be prepared prior to the intervention (minimise “open” time)
  - Anyway advisable to LPW rinse all cavities (→ dismounting)
- **Possibly cold test the cryomodule in M9 bunker**

Endorsed by LS2C on 22 June
(to be schedule starting May 2019)

Summary:

- HIE-ISOLDE phase 2 is deployed
- The 2018 commissioning campaign is over, machine is operational
  - Anomalous static heat load in CM2… not understood
  - Issue with CAV3 of CM4: not a showstopper for 2018,
  - An intervention during LS2 was approved by LS2C
- Spares:
  - 3 cavities already secured
  - 2 solenoids in store
  - 2 cryo compressor engines in store

Acknowledgement

- EN/EA : FABIO FORMENTI
- GS/SE : DANIEL PARCHET
- EN/ACE : STEPHANE MARIDOR, JEAN-CHRISTOPHE GAYDE, ESTRELLA FERNANDEZ, ANTJE BEHRENS, ALEX BEYNEL
- BE/ABP / OP : FREDERIK WENANDER, JOSE ALBERTO RODRIGUEZ, ELEFTHERIS FADAKIS, MIGUEL LOZANO BENITO
- PH/SME : MARIA BORGE, KARL JOHNSTON, GERDA NEYENS
- BE/RF : DANIEL VALUCH, WALTER VENTURINI DELSOLARO, MATHIEU THERRASSE, AKIRA MYAZAKI
- EN/CV : AZIZ AMAMOU, NICOLAS ROGET, HASSANE SABRI
- EN/EL,TE/EPC: RENE NECCA, GEORGI GEORGIEV, MICHELE MARTINO, PAWEL BURDELSKI, NICOLAS DAVID
- TE/CRG : JOS METSELAAR, OLIVIER PIROTTE, NICOLAS GUILLOTIN, REMI GUEYDAN
- EN/STI : RICHARD CATHERALL, ANA-PAULA BERNARDES
- GS/DI : CYRILLE BEDEL, YANNICK BERAUD
- TE/MSC : YANN LECLERCQ, LLOYD WILLIAMS, VITTORIO PARMA, JEREMIE BAUCHE, DAVID SMEKENS, GRAEME BARLOW, JEAN BAPTISTE DESCHAMPS
- DSG/RP : JOACHIM VOLLAIRE, ALEXANDRE DORSIVAL, ELODIE AUBERT
- TE/ABT/ MPE : MATTHEW FRASE, RICHARD MOMPO
- TE/VSC : JOSE FERREIRA SOMOZA, GUILLERMO FERNANDEZ, ABEL GUTIERREZ, PAUL DEMAREST
- BE/BI : WILLIAM ANDREAZZA, SERGEY SADOVICH
- EN/MME : ANTTI KOLEHMAINEN, MARC TIMMINS
- EN/HE : JEAN-LOUIS GRENARD, FRANCK SCHNEITER and the entire Transport Team

Required resources, schedule constraints, risks if not done

Required resources (estimates based on experience with CM1 refurbishment):

BE-OP: coordination of de-installation and re-installation
BE-RF: coordination, clean room assembly work, rinsing, RF testing in SM18 (~ 160 days*FTE)
EN-HE: roof shielding removal, handling, special transport (~ 10 days*FTE)
EN-SMM: survey/alignment in clean room and in the linac (~ 10 days*FTE)
HSE-RP: radiation verification (very low dose rate) (~ 4 days*FTE)
TE-CRG: disconnection in linac, cool down in SM18 (~ 25 days*FTE)
TE-VSC: disconnection, controlled venting, slow pump down, leak detection, etc. (~ 20 days*FTE)
TE-MSC: advise, assistance, and support at critical points in dis-assembly/assembly (~ 25 days*FTE)

Scheduling aspects/constraints:

Time for preparation: (finalization of spare cavity set by May 2019)
Time for dis-installation and transport: ~2 weeks (special transports take 1 day)
Time for intervention in clean room: 5+2 weeks
Time for re-qualification: (cold test in M9): 6 weeks (with SM18 cryogenics availability)
Time for re-installation: ~3 weeks
→ About 4 months: may start anytime between May and October 2019

Risks if not done: Physics program at 10 MeV/u with A/q=4.5 would be compromised