



HIE-ISOLDE Project Status Report

52nd ISOLDE & nTOF Technical Committee meeting
February 3rd 2016

Y. Kadi
On behalf of the HIE-ISOLDE Project Team

OUTLINE

Status of the Machine

- ✓ RF coupler issues
- ✓ CM2 assembly
- ✓ Shut-down works

Schedule 2016

- ✓ Physics @ 5.5 MeV/u

Conclusions

Main Achievements 2015

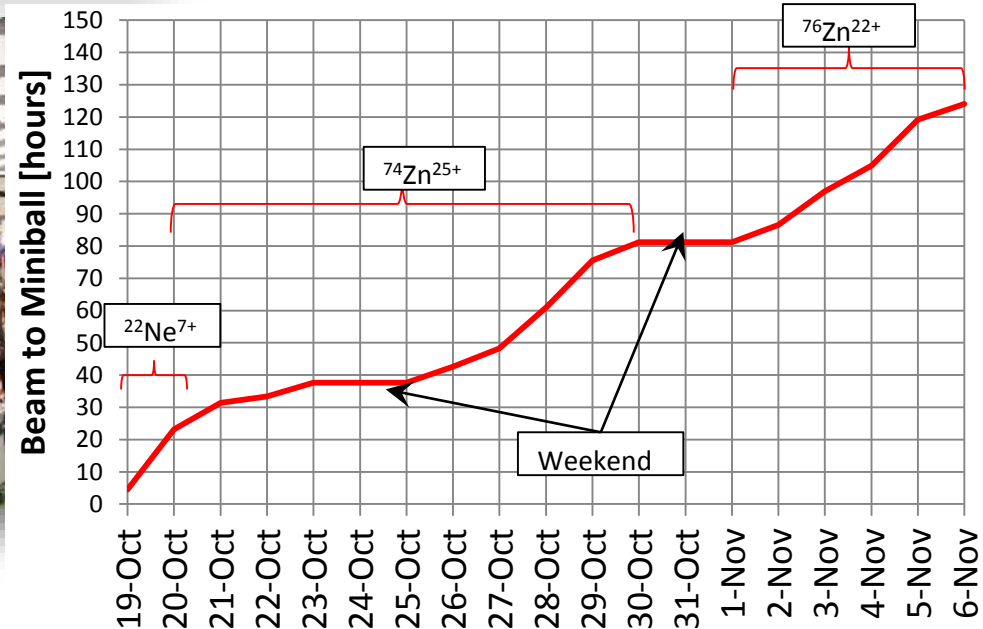
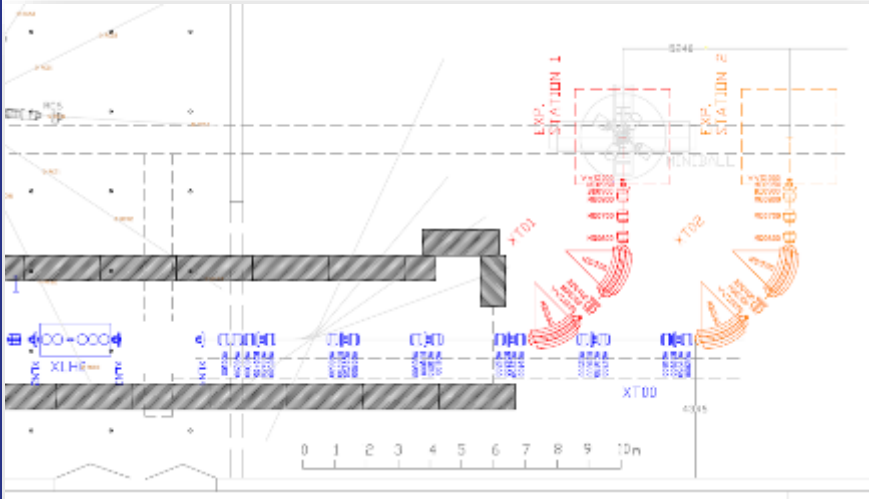
The 2015 Commissioning campaign achieved its goals

CM design choices validated

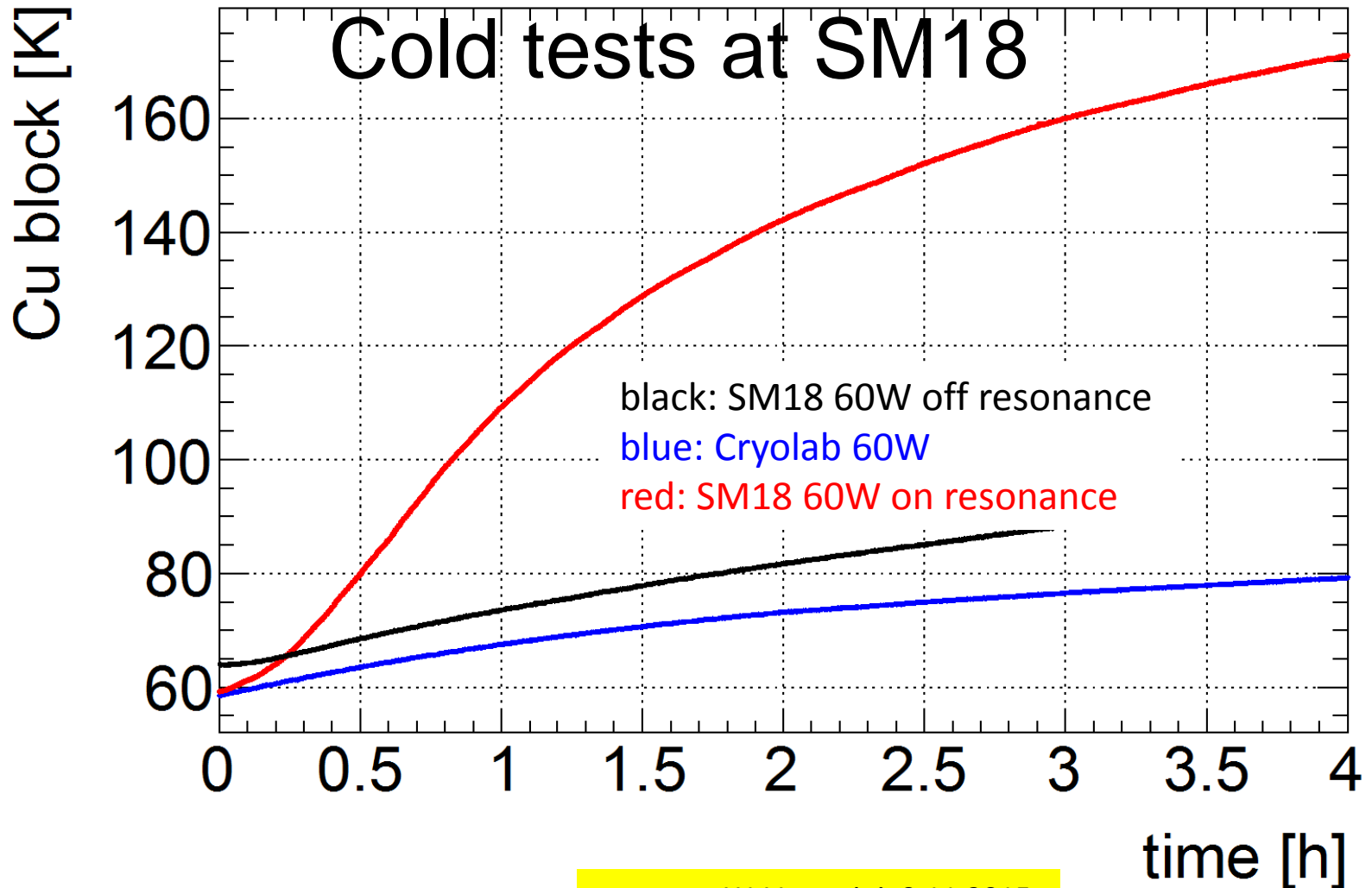
SC cavities performance were confirmed with beam

RF coupler problem identified, being addressed

Physics run started on 19th October, on schedule

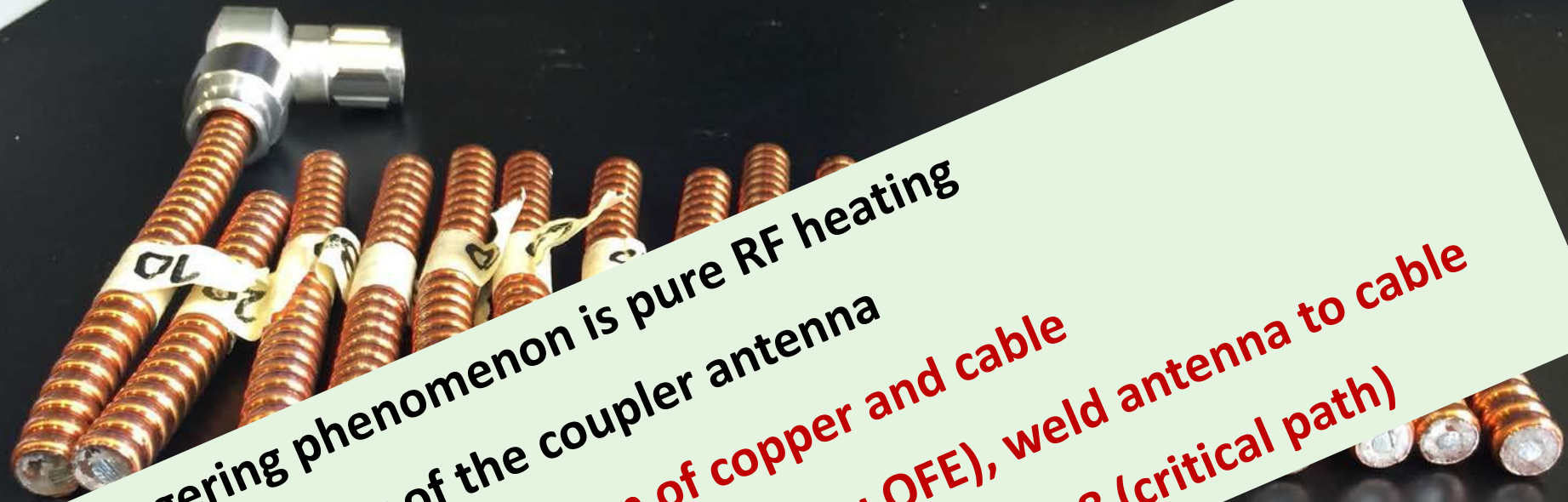


RF Line/Coupler Issue



courtesy W. Venturini, 9.11.2015

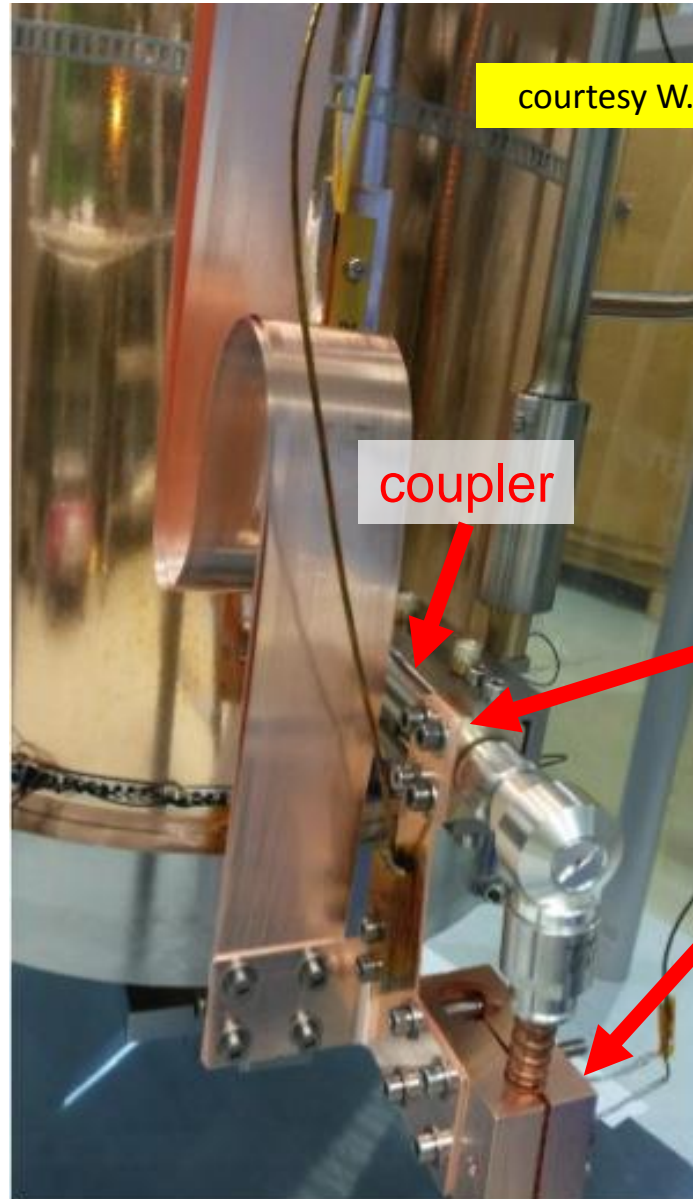
RF Line/Coupler Issue



- Triggering phenomenon is pure RF heating
- Key is cooling of the coupler antenna
 - ⇒ New thermalization of copper and cable
 - ⇒ Change antenna material (Cu OFE), weld antenna to cable
 - ⇒ Crash program: Full validation in SM18 (critical path)



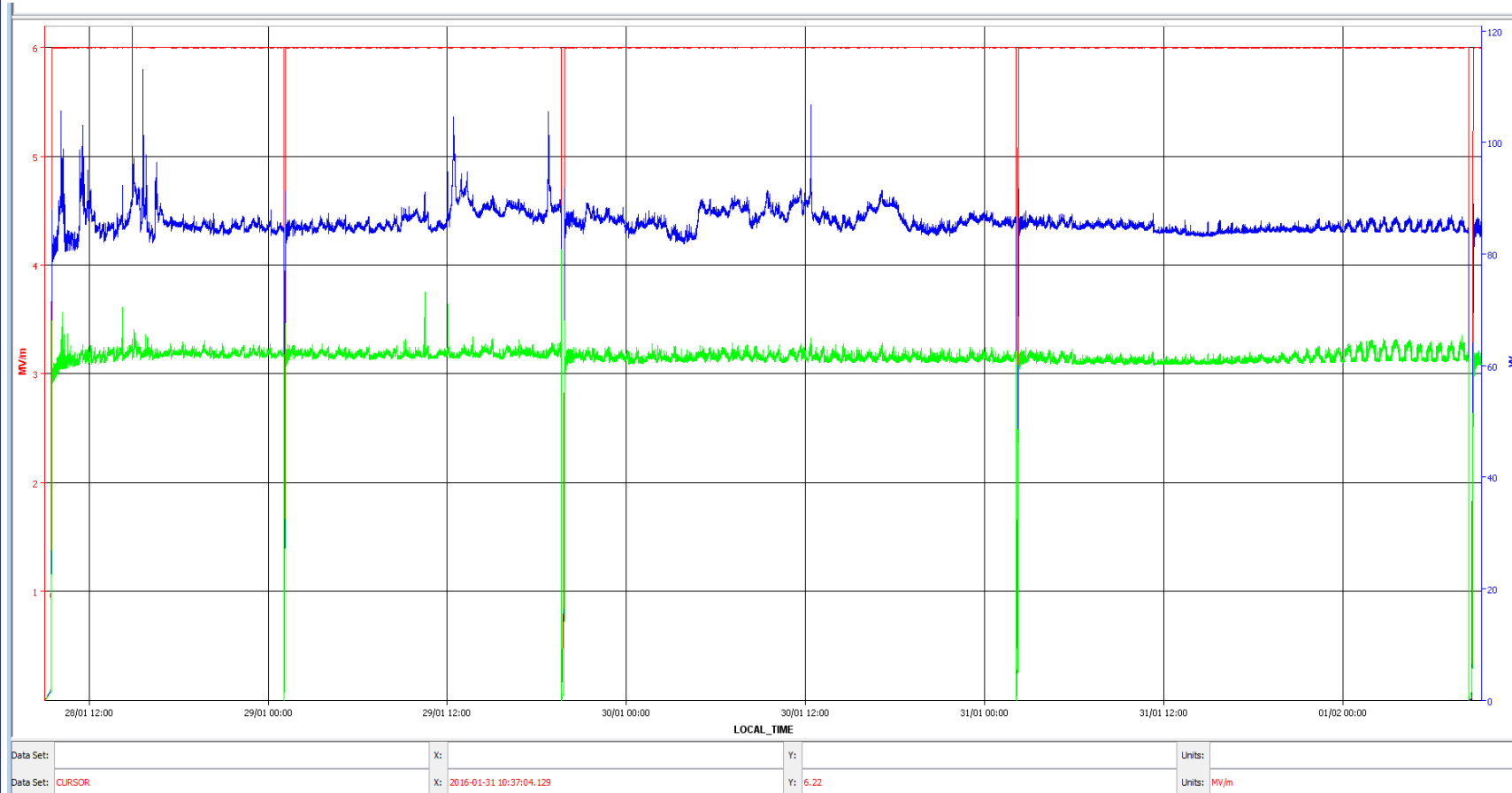
Validation tests in SM18 (December 2015)



Heat run with LLRF loops closed (Jan 2016)

4 days at 6 MV/m with amplitude and phase controlled,
and ~ 90 W forward power

courtesy W. Venturini, 2.2.2016



Assembly of CM2

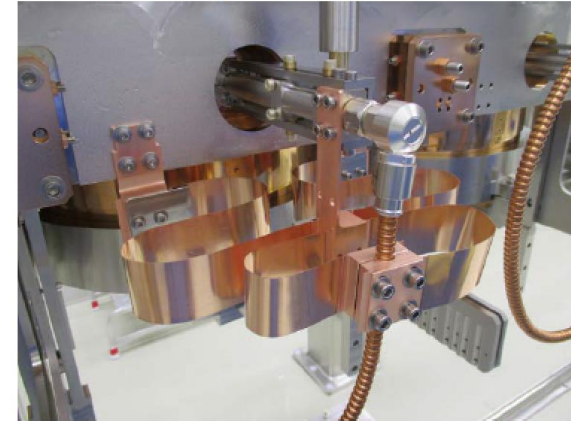
Courtesy Y. Leclercq, 29.01.2016

Achieved W04 – CM2

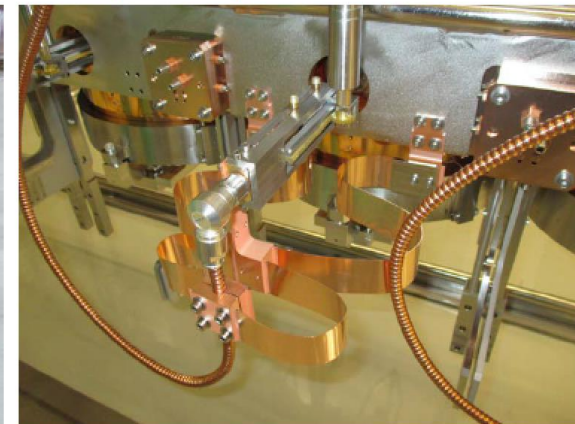
- Routing instrumentation
- Installation thermalization
 - Coupler thermalization OK
 - 3rd cable thermalization: rework needed : OK
- Tightening bellows
- Preparation for installation of additional temperature sensors
- Preparation for outside clean room tests
 - Pressure test equipment (CRG + AL4030)
 - HSE
 - VSC availabilities
 - Survey procedures



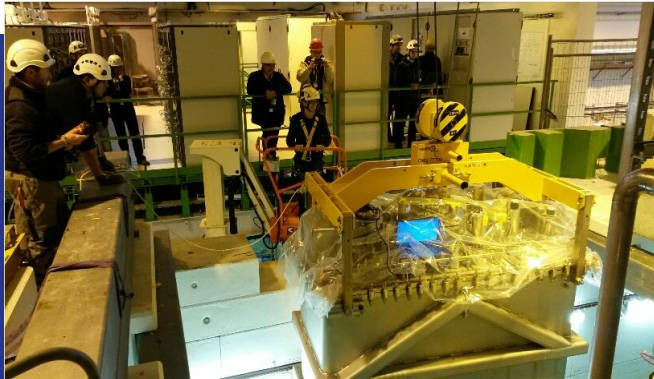
Coupler fully IN



Coupler fully OUT



Dismounting & Transport of CM1



Cryo Module 1 transport to SM18:
for retrofitting of the couplers.
Friday 8 January.
To be received back end of March.



Preparation for running w/ CM1 + CM2

Main HIE ISOLDE installation and start-up tasks:

- Removal CM1: End-of-year 2015 / Wk1 2016
- Modifications and repair BI Dboxes: Jan 2015 – April 2016
- Installation CM2: end Feb – end March 2016
- Installation REX 9-Gap RF amplifier: end Feb – end March 2016
- Re-installation CM1: end March – end April 2016
- Cryo modifs & maintenance: Dec 2015 – end April 2016
- HW & Beam commissioning CM1 & CM2: May – mid Aug 2016

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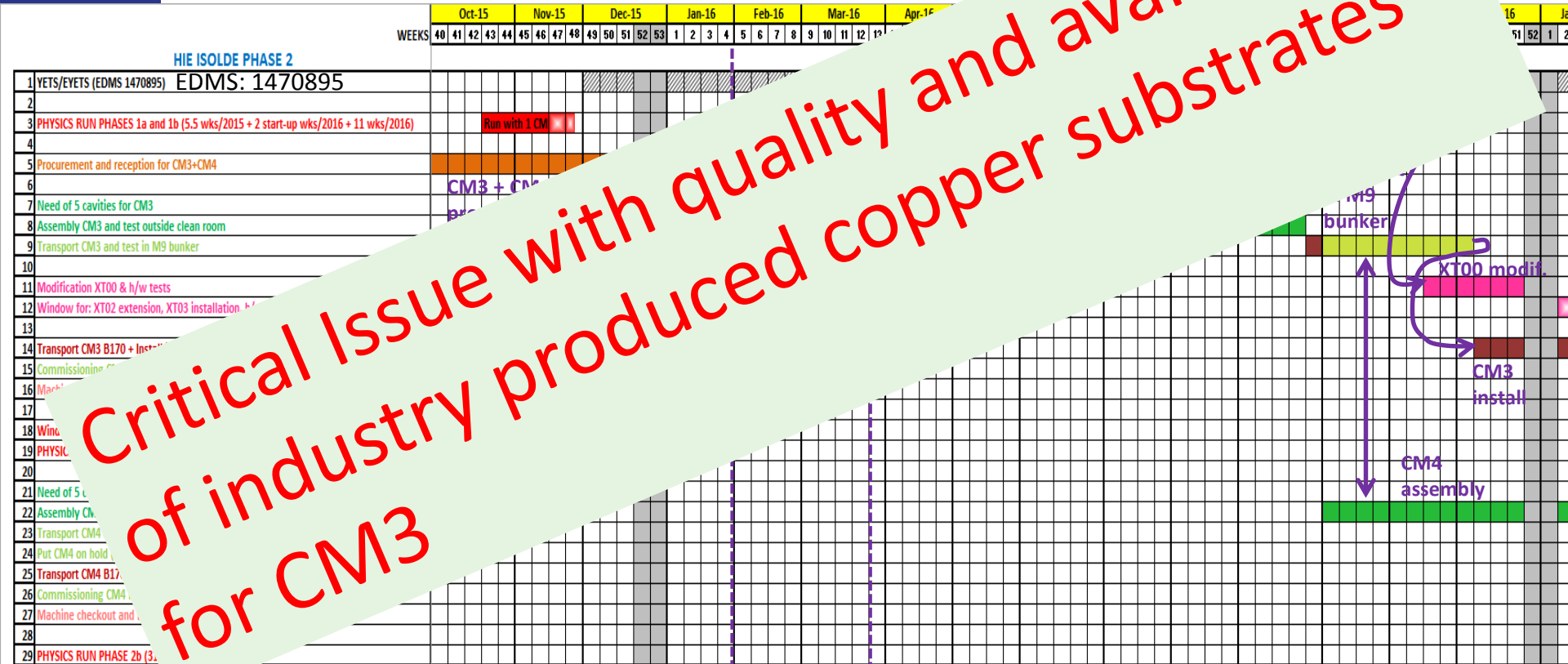
Schedule 2016

- ✓ Physics @ 5.5 MeV/u

Conclusions

Forecast for HIE-ISOLDE Phase 2 (years 2015- 2016)

Critical Issue with quality and availability of industry produced copper substrates for CM3



courtesy F. Formenti, 2.12.2015

General remarks:

- ❖ Test in M9 bunker are foreseen for CM3 and CM4 while the HIE-ISOLDE facility is in operation
- ❖ XT00 modification for PHASE 2



CM2/CM3 cavities status (2015)

Production process	QS2	QS5	QS7	QS8	QS9	QS10	QS11	QS12	QS13	QS14
	2.3	5.2	7.2	8.1	9.1	10.1	11.1	12.1	13.1	14.1
Substrate reception	x	x	x	x	x	x	x	x	WE34	WE34
Frequency pre-tuning	NP	x	x	x	x	x	NP	WE36		
Annealing	NP	NP	NP	x	x	NP	NP	WE40		
Surface treatment	x	x	x	x	x	WE35	NP	WE41		
Nb coating	x	x	x	x	Cut & inspection at CERN	WE36	Process stopped due to substrate non-conformity	WE42		
RF vertical test at 4.5K	WE36	x	x	x		WE40		WE45		
Storage /on hold	CM2	CM2	CM2	CM2		CM2		CM3		
Nb stripping										

Performance of series cavities for CM2 (vertical test)

name	Eacc (10W) [MV/m]
QS2.3	5.6
QS5.2	5.6
QS7	5.6
	15.3
	15.7

How to get better substrates for CM4

- Change raw material specs?
- Weld parameters? thermal treatments?
- 3 pre-machined cavities not annealed at RI (QS21-23)
- High(er) beta cavity machined out of bulk w/o beam ports
=> New design & production process

Status: CM3 & CM4

Achieved W04 – CM1 – CM3 – CM4

- CM1
 - Cleaning well advanced
 - Coordination on-going
- CM3-CM4
 - Thermal shield:
 - One reception + leak test complete: some limited fixing, oxidation.
 - 2nd one starting next week
 - Reservoir:
 - On hold
 - VV: OK
 - Frames: both leak tight and complete
 - Additional parts: reception on-going



Overall Summary

- Radioactive beam delivered to Miniball experiment on Oct. 22nd 2015 as initially planned.
- The results of the hardware tests highlighted that CM1 is not fully qualified for sustained operation (problem on RF couplers):
 - CM1 has been de-installed and will be re-worked during this shutdown;
 - New RF couplers with improved thermalisation of the RF power line tested on QS12 and installed on CM2.
- New coherent planning is proposed for Phase 2
 - Agree with Collaboration on a common scope for Physics run 2 & 3 (2016-2017)
 - Preparation of CM3/CM4 components on-going
 - Issue with cavity substrates being addressed
- Procurement for the 3rd beam line and extension of XT02 for HELIOS has been launched



Thank you for your attention



HIE ISOLDE Cu QWR series production

courtesy W. Venturini, 2.2.2016

- Order for 15 (+5) pieces placed 25.05.2013
- Production planning: first cavity due by November 2013
- QS1 delivered in... June 2014
- QS1 non conformities: weld projections, geometry
- QS2 delivered in July 2014
- QS2 non conformities: traces of foreign material, geometry
- QS3 delivered in August 2014
- QS3: **defects close to the weld HAZ seen for the first time**
- Constant delays during production, and recurrent defect issues
- Several interventions at the company: weld parameters retuned, magnetic steering in EB machine fixed, weld preparation reviewed: each time problem seemed solved...
- But it was not: by QS11, 40% of the production was badly affected
- In July 2015 shrink fitting and welding at RI were put on hold
- We decided to start systematic investigations at CERN
- In December green light was given to RI to finalize QS14 and QS15
- Severe delays and uncertainties on the planning persisting in 2016

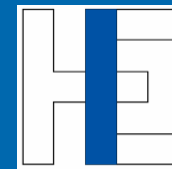
How to get usable substrates (degraded mode option for CM3)

courtesy W. Venturini, 2.2.2016

- QS14 → at RI for final machining
- QS15 → at RI for shrink fit and weld
- QS13 is under reparation at CERN with EBW. Can it be finalized at CERN?
- QS6 was laser “repaired” by RI: we could try to use it but would require tumbling + heavy SUBU, or EP
- QS11 is on hold at CERN, it has cracks but the geometry is finalized: repairing it here is the quickest way to restart coating!



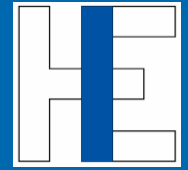
Heat load inventory for 4 CM



Heat load type	Quantity [-]	Individual load [W] or [g/s]	Load @4.5 K [W]	Load @ 50K-75 K [W]	Liquefaction [g/s]
Low-β cavity @ 4.5K (RF)	0	7	0		
High-β cavity @ 4.5K (RF)	20	10 16	200 320 ← latest measures		
RF power supply cable	20	1	20		
Cryostat @ 4.5 K	4	13	52		
Cryostat shield @ 50-75 K	4	270		1080	
Transfer line @ 4.5 K	32	0.6	19		
Trans. line shield @ 50-75 K	32	3.1		99	
Dewar 2'000 L @ 4.5 K	1	3	3		
Flexi. line with bayo @ 4.5 K	24	4	96		
Cryogenic valve @ 4.5 K	30	3	90		
Cryogenic valve @ 50-75 K	16	3		48	
Current leads for 4 solenoids	8	0.05 0.00			0.40 0.00
TOTAL			480 600	1227	0.40 0.00



Heat load vs existing cold box cooling power



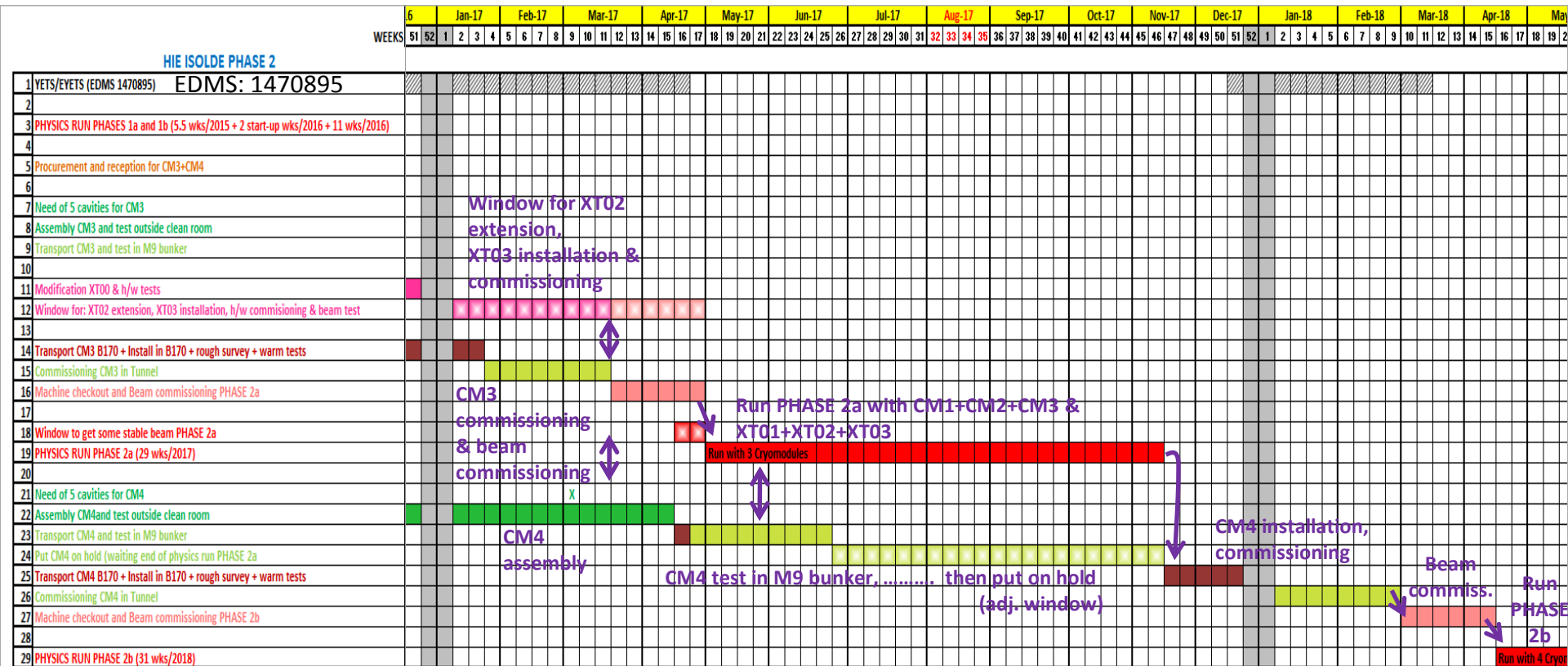
► Summary table:

	4.5 K level [W]	50 K - 75 K level [W]	Liquefaction [g/s]
Client's heat load inventory with 2 cryo-mod	266 326	669	0.2 0.00
Client's heat load inventory with 4 cryo-mod	480 600	1227	0.4 0.00
Client's heat load inventory with 6 cryo-mod	680 800	1785	0.8 0.00
« ALEPH » cold box cooling power (measured)	630 ←	Not measured	1.7
« Hall 180 » cold box cooling power (measured)	1050	Not measured	1.5

► Remark:

«ALEPH» and «Hall 180» cold boxes require the same cycle flow of 155 g/s (provided by the compressors), but « ALEPH » cold box has only 2 turbines whereas « Hall 180 » has 3 turbines.

Forecast for HIE-ISOLDE Phase 2 (years 2017- 2018)



General remarks:

courtesy F. Formenti, 2.12.2015

- ❖ PHASE 2 run could be split into PHASE 2a (2017) and PHASE 2b (2018)
 - HIE-ISOLDE Physics workshop in February 1st 2016
- ❖ **Regain RF performance with high-beta cavities of CM4**

3D view of HELIOS on XT02

