



# **Cryogenics update for HL-LHC**

**(crab cavities activity in SM18 M7 and SPS BA6)**

Krzysztof Brodzinski

With contribution from: S. Claudet, L. Delprat,  
J.H. Derking, C. Fluder, A. Lees, J. Metselaar and O. Pirotte



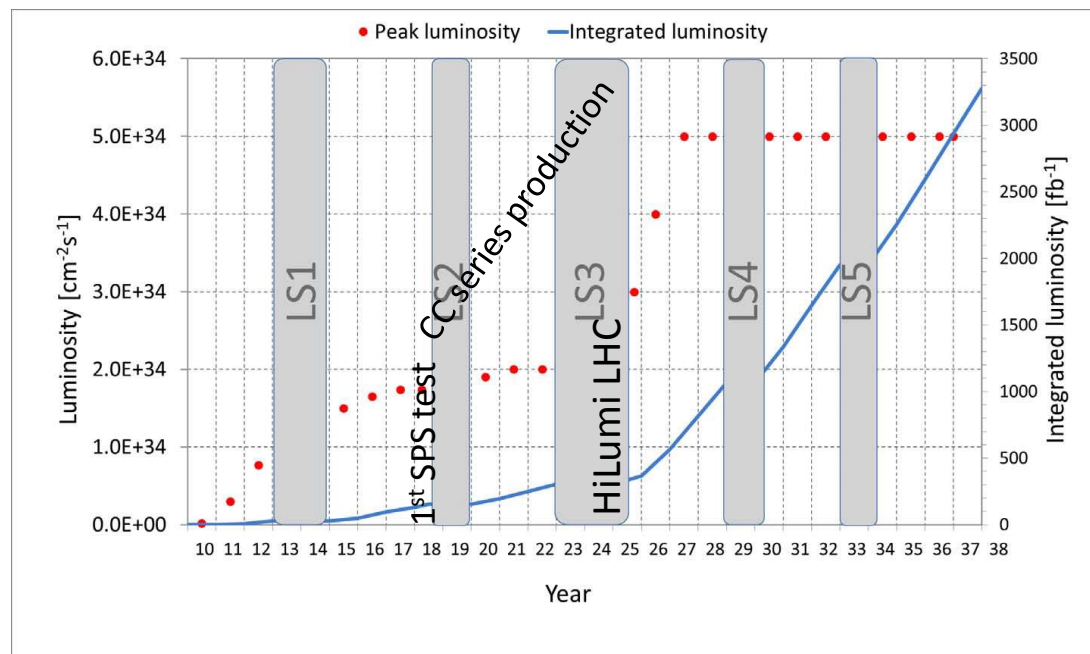
HiLumi Annual Meeting, Madrid, Spain – 16 November 2017

# Outline

- Introduction
- SM18 M7 activities
  - Planning, test program, status
- SPS BA6 activities
  - Main equipment fabrication and delivery status, commissioning and operation perspectives
- Conclusion and final remarks

# Introduction and timeline

- Prior to installation in LHC, the crab cavity prototype modules will be tested in SM18 (without beam) where cryogenics will provide necessary connections in M7 bunker,
- SPS is not equipped with any cryogenic infrastructure except BA4 where ColdEx experiment is running, therefore BA6 cryogenic installation has to be built from scratch,
- The SM18 cryogenic infrastructure commissioning is underway,
- The baseline to commission SPS cryogenic infrastructure is YETS (beginning of 2018)



# SM18 M7 cryogenic activities – status

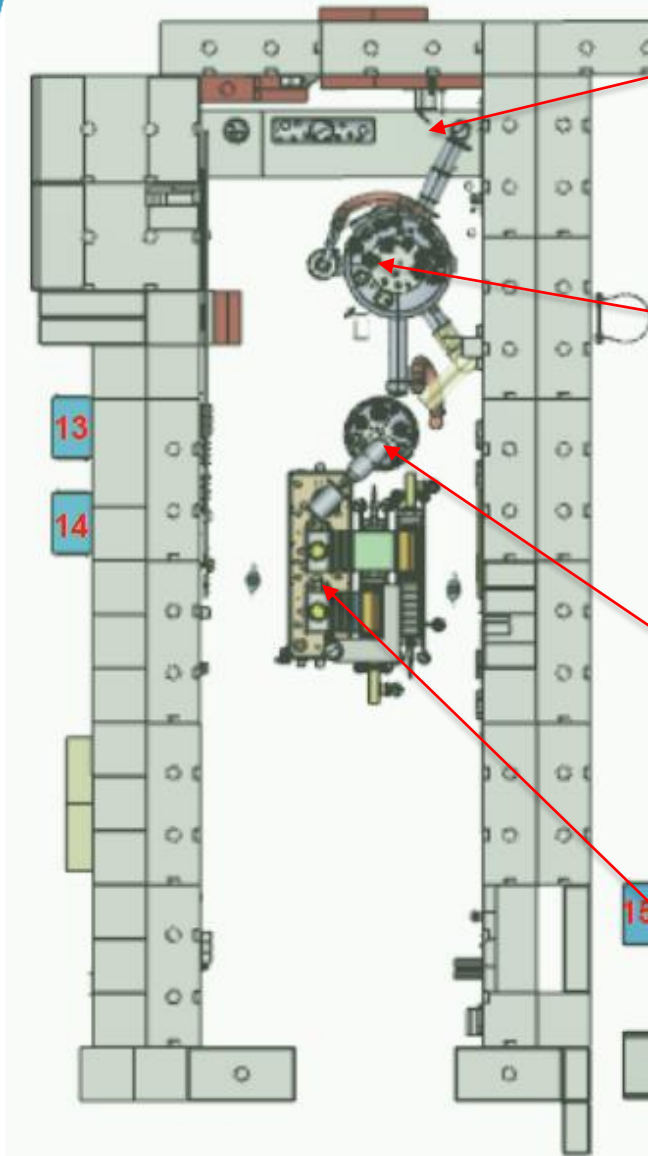
Annual CERN closure

The planning for M7 activities:

	November											December																										
KB, GV_02.09.2016, small updates on 13.11.2017	20	21	22	23	24	25	26	27	28	29	30	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24			
welding of internal lines with CM and VB	█	█																																				
leak test			█																																			
insulation and welding of interconnections ext. env.				█	█	█																																
vacuum pumping					█	█																																
leak test under vacuum								█	█																													
cabling CM (precised in Nov.2017)									█	█																												
comissioning CE/CI										█																												
RF connections - wave guides										█																												
operational comissioning and cool down												█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	
warmup																																						
cutting lines																																						
transport preparation in January 2018																																						
transport to BA6 in January 2018																																						

Remark: if the cryo commissioning and cool down goes smoothly and faster than foreseen some days for RF test between 12<sup>th</sup> and 18<sup>th</sup> Dec. may be allocated.

# SM18 M7 cryogenic activities – status



SM18 cryo infrastructure, installed

M7 Valve Box, not delivered on time, replaced by “Plan B” solution delivered and installed by CERN. This solution allows for testing but with reduced diagnostics of the crab cryo module (precise heat load measurement will be possible in SPS)

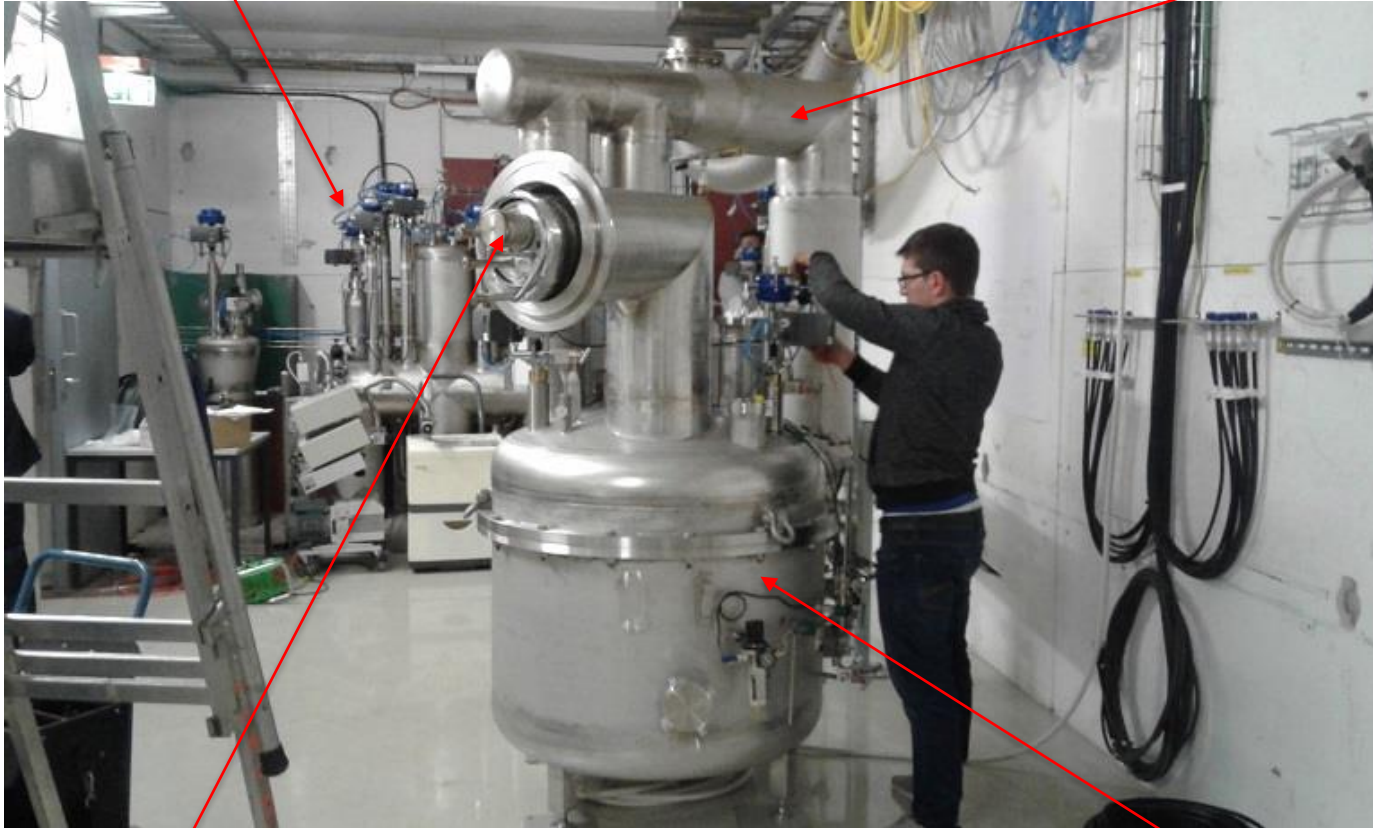
Cryogenic Service Box (pressure tested, cold cycled at 80 K, tightness tested at factory AS Scientific in UK), installed in M7.

Crab Cavity Cryo module, pressure and tightness tested in SM18 – ready for installation

# SM18 M7 cryogenic activities – status

SM18 cryo infrastructure

M7 “Plan B” solution



Interface to the Crab cryo module,  
connection from Monday 20<sup>th</sup> Nov.

Cryogenic Service Box

# SPS cryogenic infrastructure

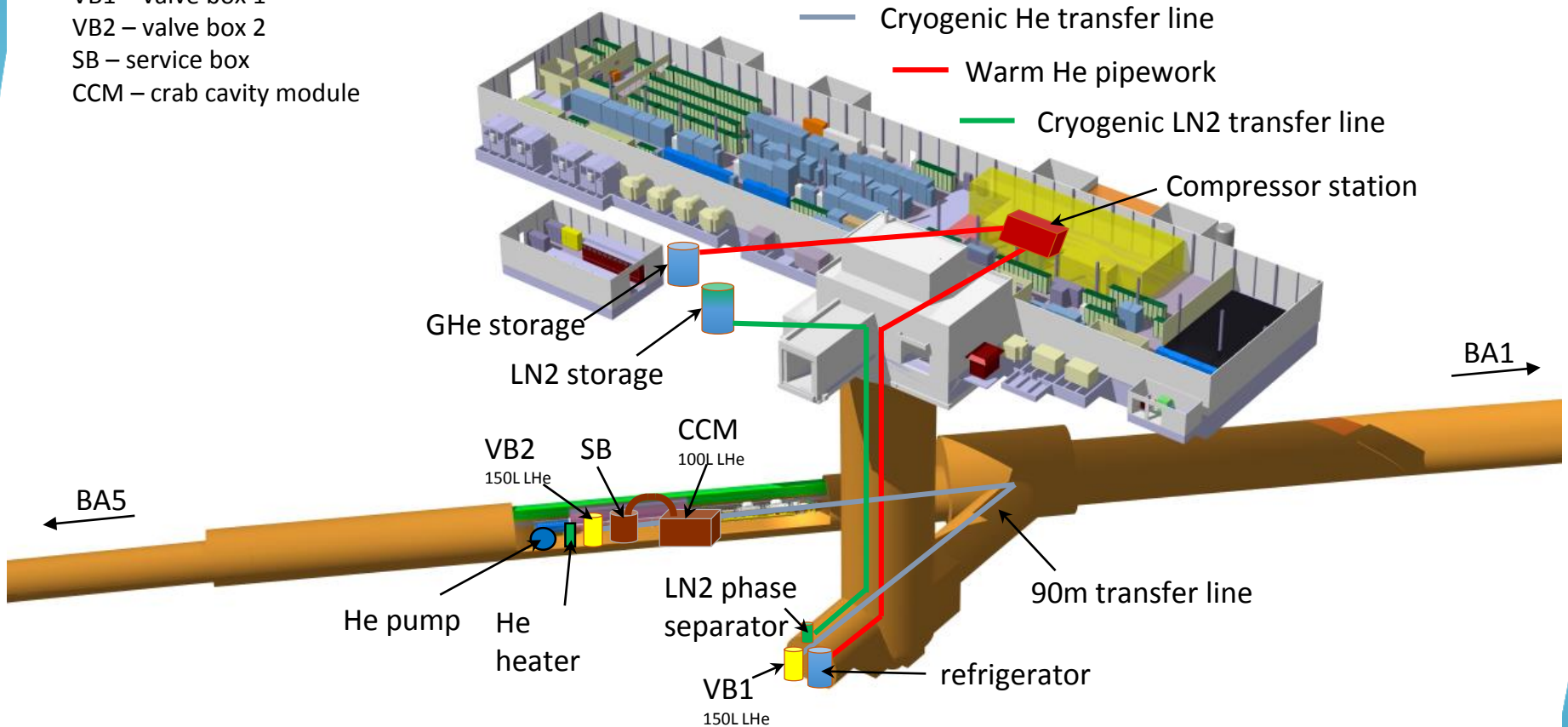
Legend:

VB1 – valve box 1

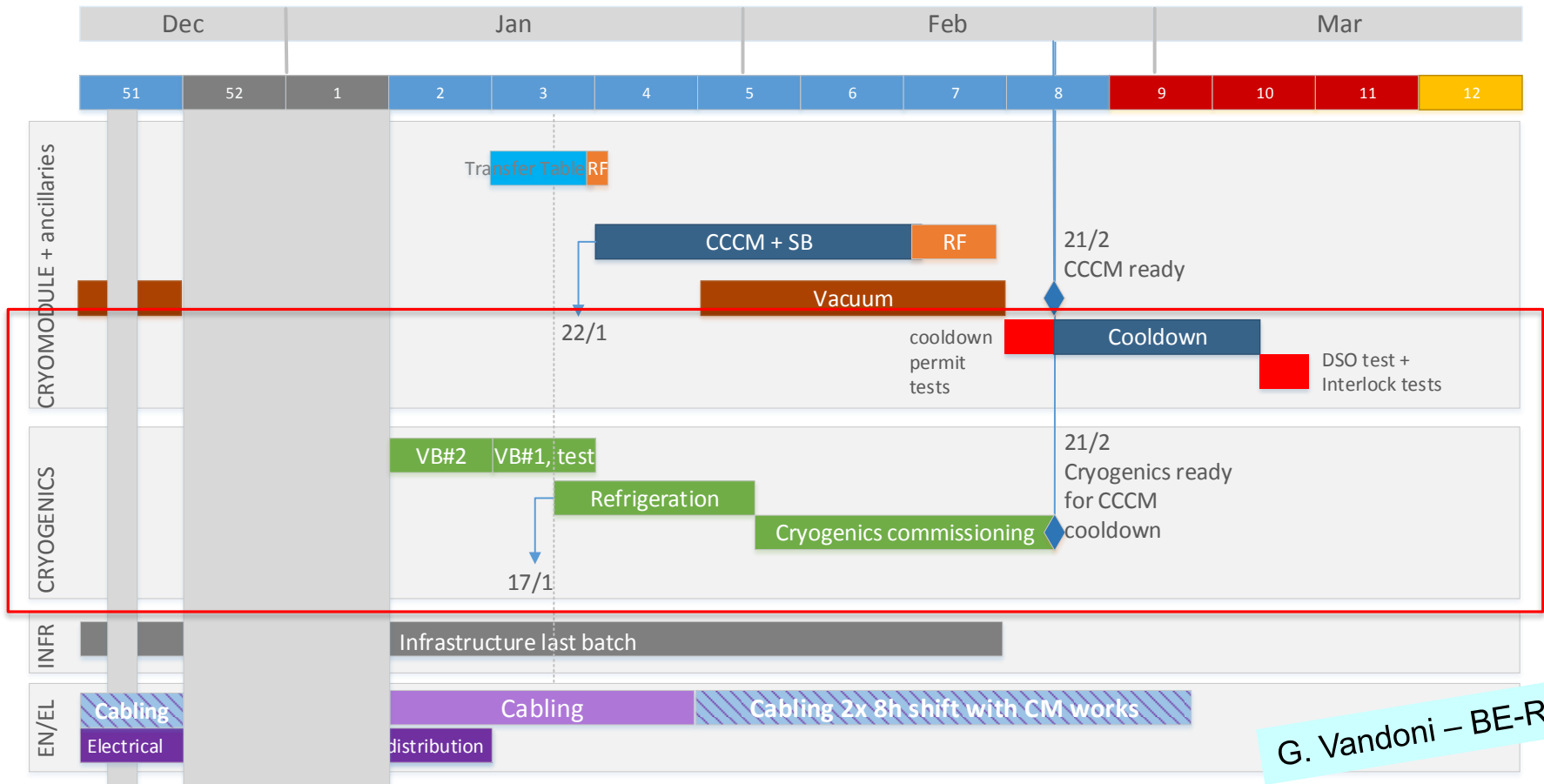
VB2 – valve box 2

SB – service box

CCM – crab cavity module



# SPS cryogenics – planning



G. Vandoni – BE-RF

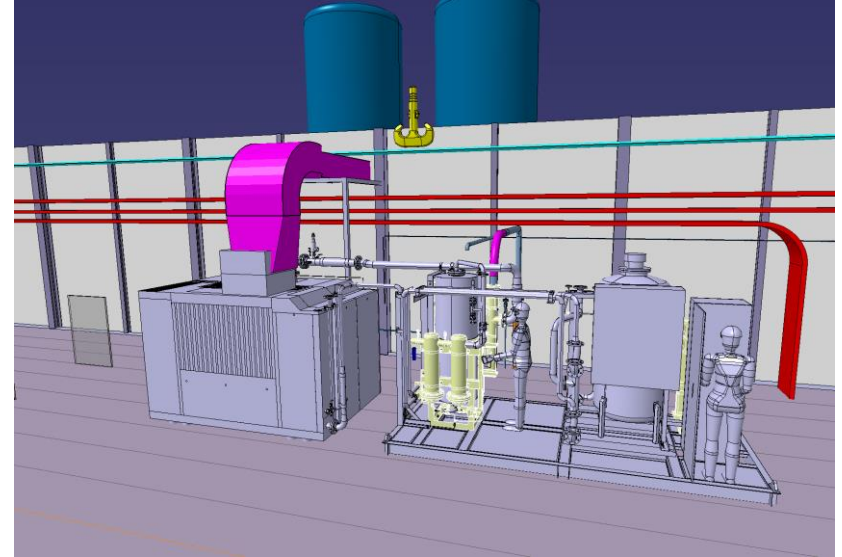
The planning is very ambitious regarding parallelism of activities. One week of access more could bring more reliability and efficiency for visual inspections and tuning of the cold system.

# SPS BA6 cryogenics – status

BA6 – cryo surface equipment



Compr. station and oil removal system



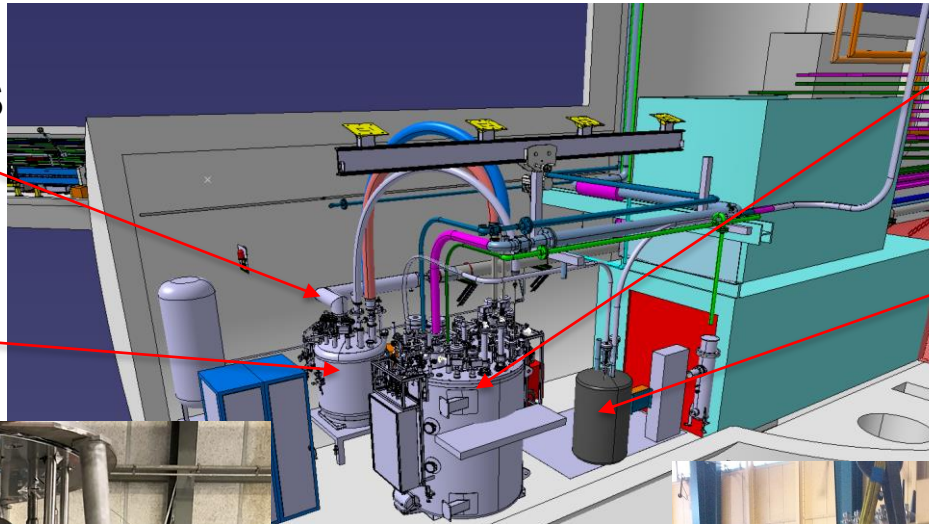
← Oil removal system – status 10<sup>th</sup> Nov.

Entire compressor station and oil removal system will be delivered and installed at BA6 from mid-Jan 2018.

# SPS cryogenics – status

Transfer line –  
installed in EYETS

VB1



Main refrigerator

LN2 phase  
separator  
(fabrication  
underway in UK,  
delivery mid Jan.

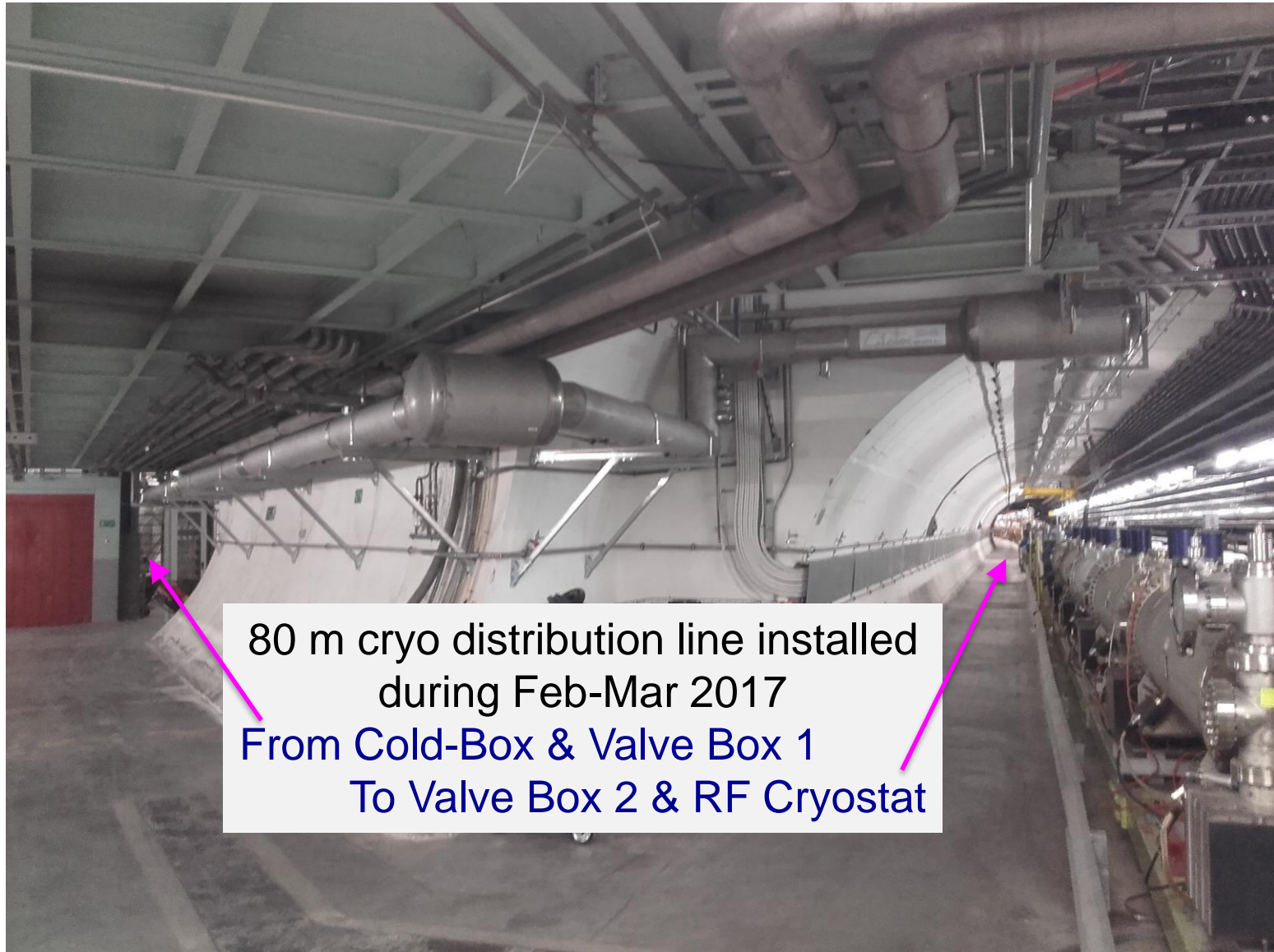


Main refrigerator on 10<sup>th</sup> Nov. –  
on time for delivery 17<sup>th</sup> Jan OK.



VB1 and VB2 were delivered to CERN

# SPS cryogenics – status



80 m cryo distribution line installed  
during Feb-Mar 2017  
From Cold-Box & Valve Box 1  
To Valve Box 2 & RF Cryostat

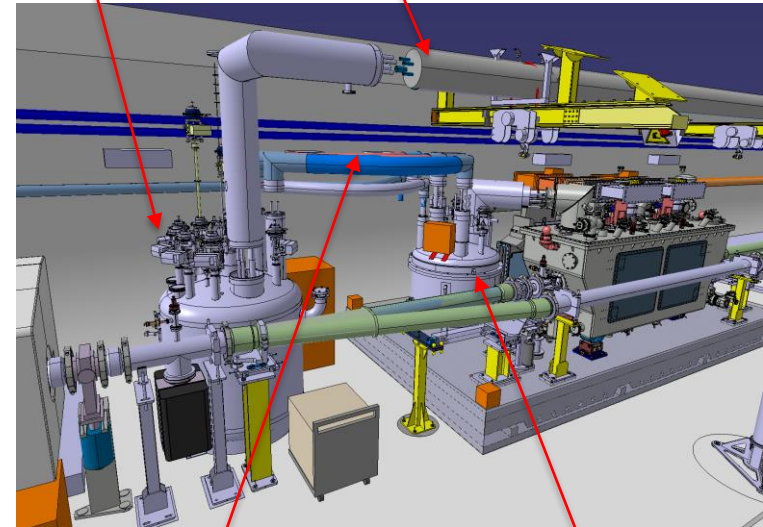
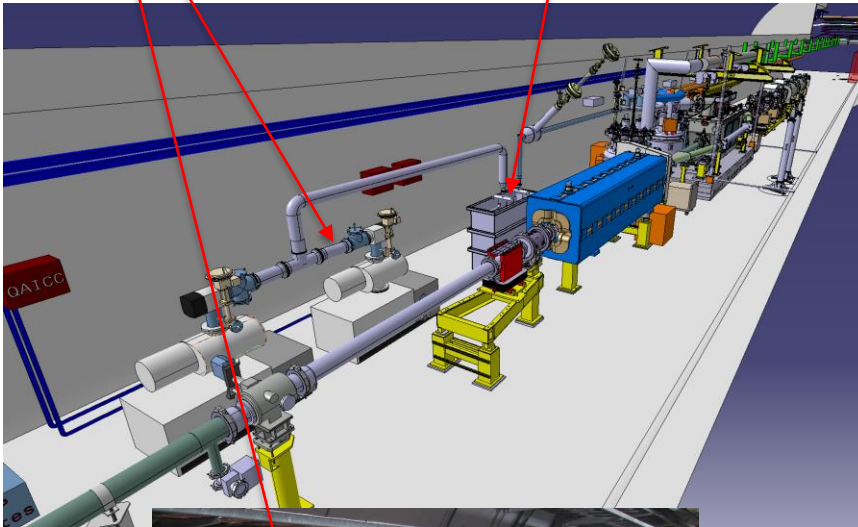
# Transfer line and valve boxes – status

He pumps  
(installed)

He H2O heater  
(available at CERN)

VB2

Transfer line



Flex lines fabrication  
underway in UK – on time

Service Box

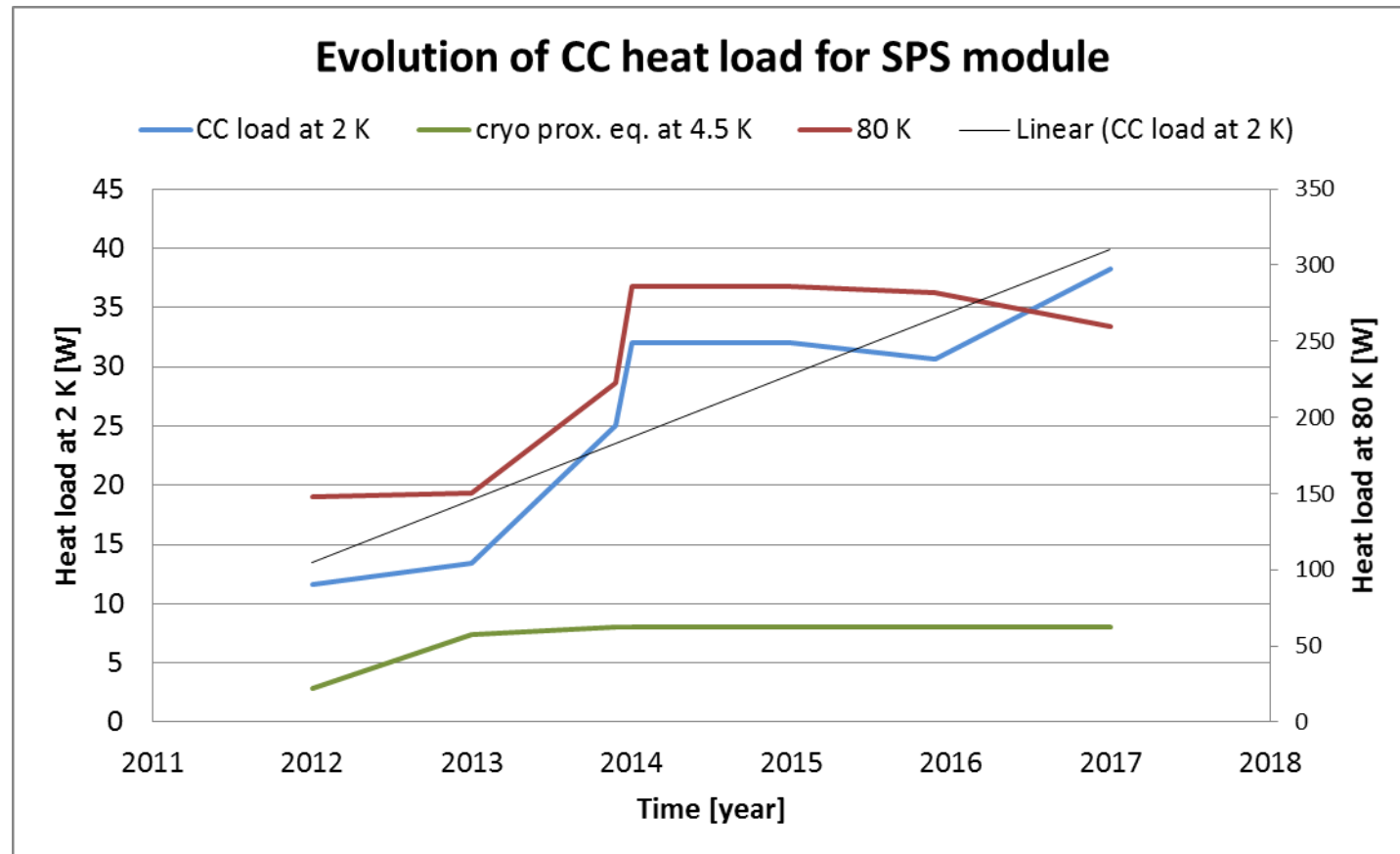
The He pumps are installed in LSS6, will be connected with utilities and hydraulically with He process pipes during next YETS Jan, Feb 2018.

# SPS cryogenics – heat load evolution

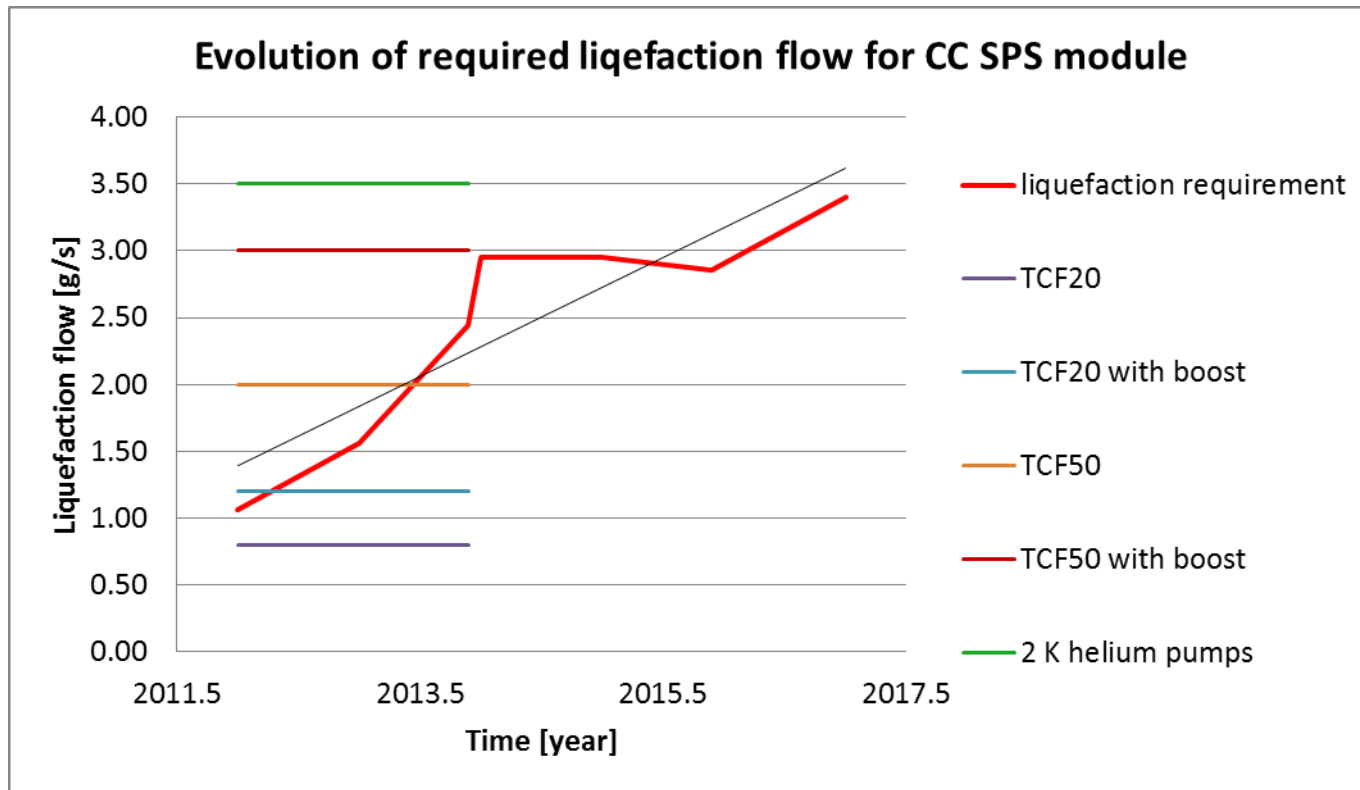
DQW static HL: 16.8 W @ 2 K

DQW dynamic HL: 20.4 W @ 2 K

Cryo prox. equipment: 8 W @ 4.5 K



# SPS cryogenics – limitations evolution



New 4.5 K cold box will have liquefaction capacity of  $\sim 7$  g/s and will allow for using of full capacity of 2 K pumping units ( $\sim 3.5$  g/s @30 mbar) as well as to cover client and distribution heat load with safety factor of  $\sim 1.5$ .

**Warning!** No additional helium pumps can be added to the infrastructure respecting present planning and integration constraints.

# Conclusions and final remarks

- The cryogenic equipment for M7 test was installed, however “Plan B” was applied to replace originally foreseen M7 valve box (less diagnostics available).
- Most of the cryogenic equipment for SPS was fabricated and partially installed (transfer lines, VBs, SM, He pumps), the main refrigerator, LN2 separator and some local lines are in final fabrication stage and will be delivered on time for installation during YETS.
- The control system and control logic for M7 and BA6 are under construction. Will be commissioned in M7 just before the cool down and in BA6 in February.
- Safety reviews were performed in 2015 and 2017 with no major issue noticed.
- YETS time dedicated for installation and commissioning is very dense and success oriented. It will require good coordination between different working teams to succeed.



***THANK YOU !***

***QUESTIONS?***

