

Commissioning of REX

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Introduction

Beam produced or charge-bred in the EBIS is injected into the REX linac and accelerated to 2.85 MeV/u before it is sent to the superconducting linac

RF Systems:

RF Structure	Final Energy [MeV/u]
4-rod RFQ	0.3
Buncher	0.3
IHS	1.2
7gap 1	1.55
7gap 2	1.88
7gap 3	2.2
9gap	2.85

Magnets:

Triplets	6
Doublets	1
Steerers	1H, 1V

Power converters:

200 A, 50 V	20 (1 spare)
bipolar 3.5 A	2

Diagnostics:

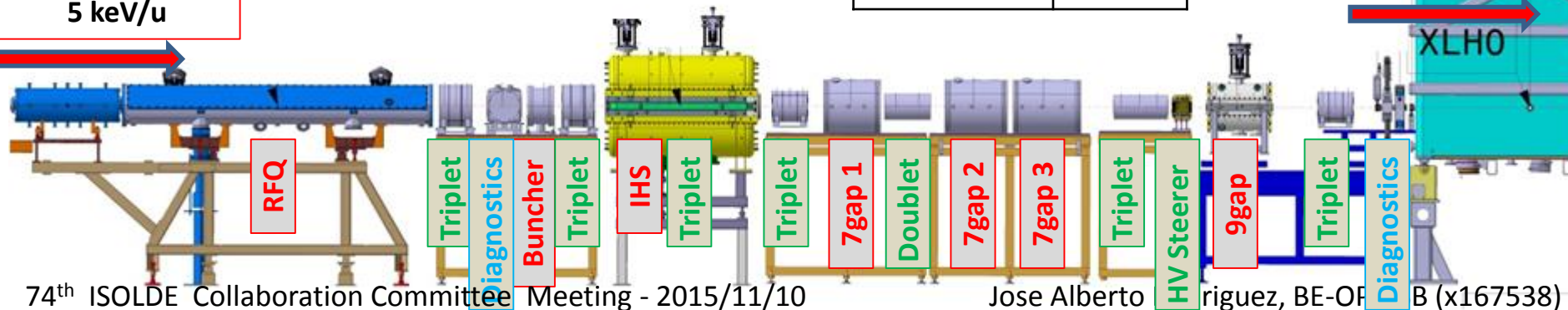
REX	HIE-ISOLDE
FC	FC
MCP	Si detector
Collimator apertures	Scanning Slits
Beam attenuators	Collimator apertures

Vacuum (incl. low energy):

Sectors	10
Turbopumps	~20
Cryopumps	3
Gauges	~25

Beam from EBIS
5 keV/u

Beam to HIE-ISOLDE
2.85 MeV/u



Hardware commissioning

Power converters and magnets (ready before wk. 25):

- ✓ New power converters for quads (19 units)
- ✓ New cooling water circuits for all the quads operational
- ✓ Electrical short in last triplet repaired and triplet refurbished
- ✓ Additional tests and measurements in other quadrupoles completed (thermal switches, temperature rise...)

Vacuum (ready before wk. 25):

- ✓ Scheduled maintenance completed. Faulty turbo pumps, controllers and gauges replaced
- ✓ Fast Penning gauges for fast acting valve to protect cryomodule installed

Controls (ready before wk. 25):

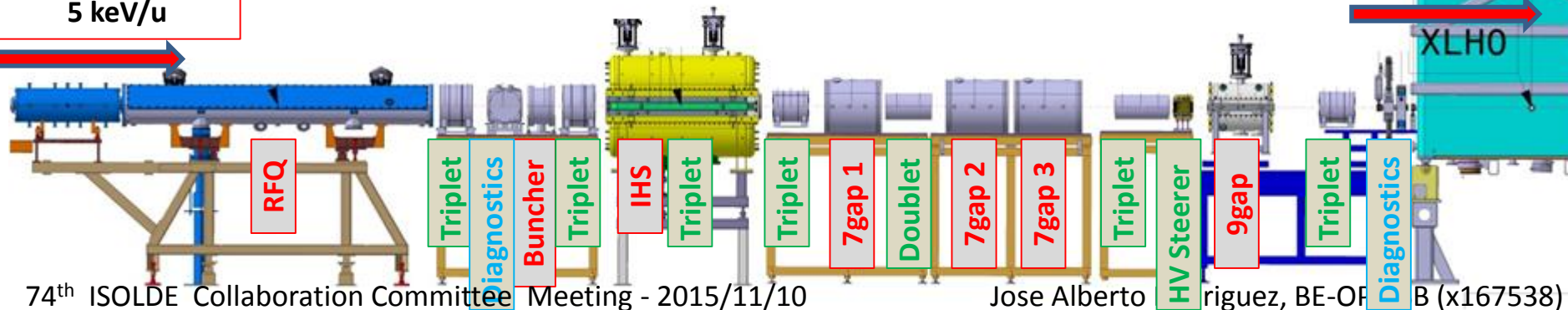
- ✓ New low level controls functional (new power converters, RF amplifiers...)
- ✓ High level applications updated (working sets and equipment arrays ready)

RF systems

- ✓ Maintenance and refurbishment of amplifiers for the six first structures. DC converters (incl. the spares) refurbished, HV diode repaired, new cooling...
- ✓ Temporary 9gap amplifier has been refurbished, installed and ready since wk. 25. New low loss RF line.
- ✓ PLC software for amplifiers upgraded
- ✓ Connection to the new HIE-ISOLDE RF reference line

Beam from EBIS
5 keV/u

Beam to HIE-ISOLDE
2.85 MeV/u

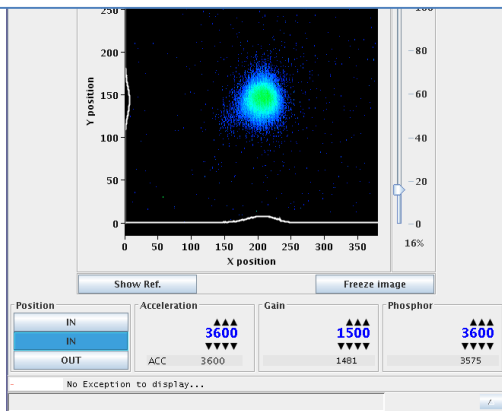


Commissioning with beam

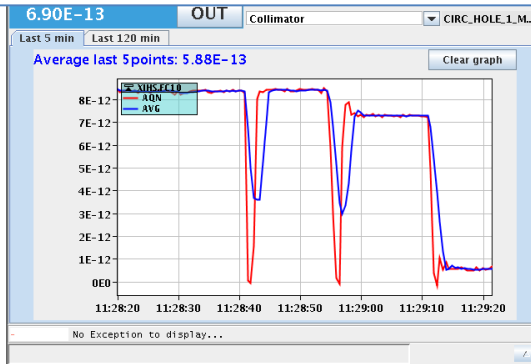
Stage 1: REX diagnostics box:

- ✓ Commissioning with beam started on wk. 25 (June 16th)
- ✓ Beam with an A/Q=4.0 was accelerated to 0.3 MeV/u (RFQ output energy)
- ✓ We reached the first diagnostic box and re-commissioned the FC, MCP and collimator wheel on wk. 25
- ✓ Beam transmission through RFQ for different power levels on wk. 26

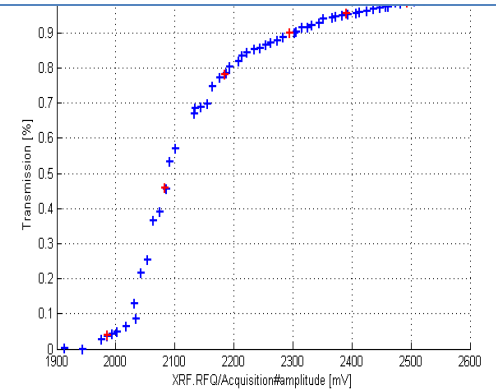
MCP image of the beam after the RFQ



Beam in FC after RFQ for different collimator aperture sizes (15, 5, 3 and 1 mm)

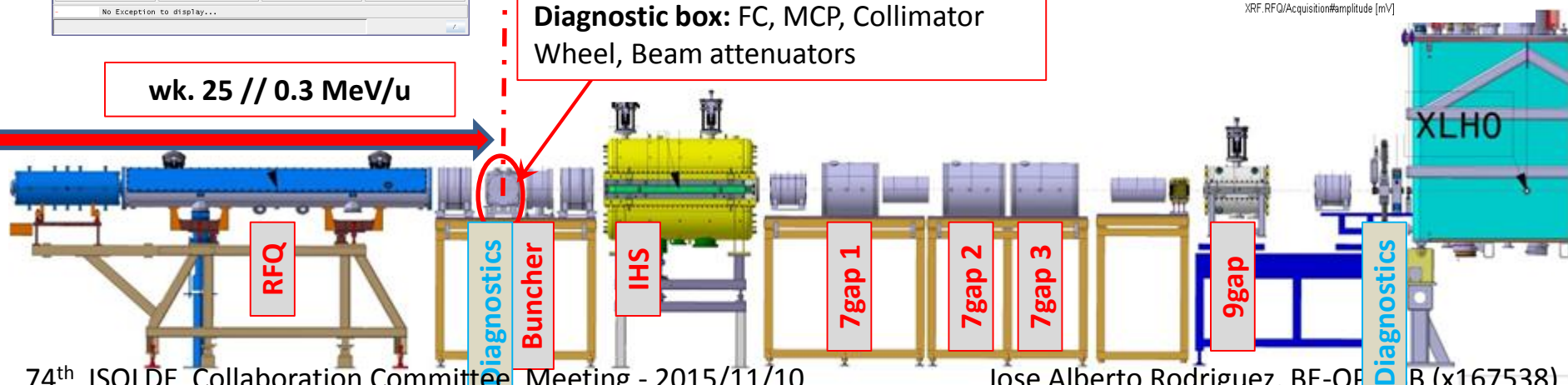


Beam transmission thru the RFQ vs RF power for A/Q=4.0



Diagnostic box: FC, MCP, Collimator Wheel, Beam attenuators

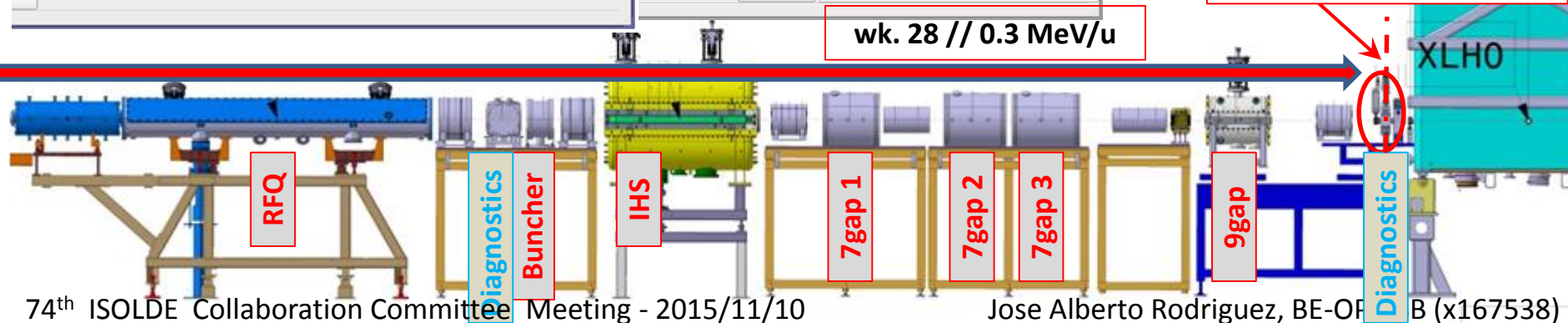
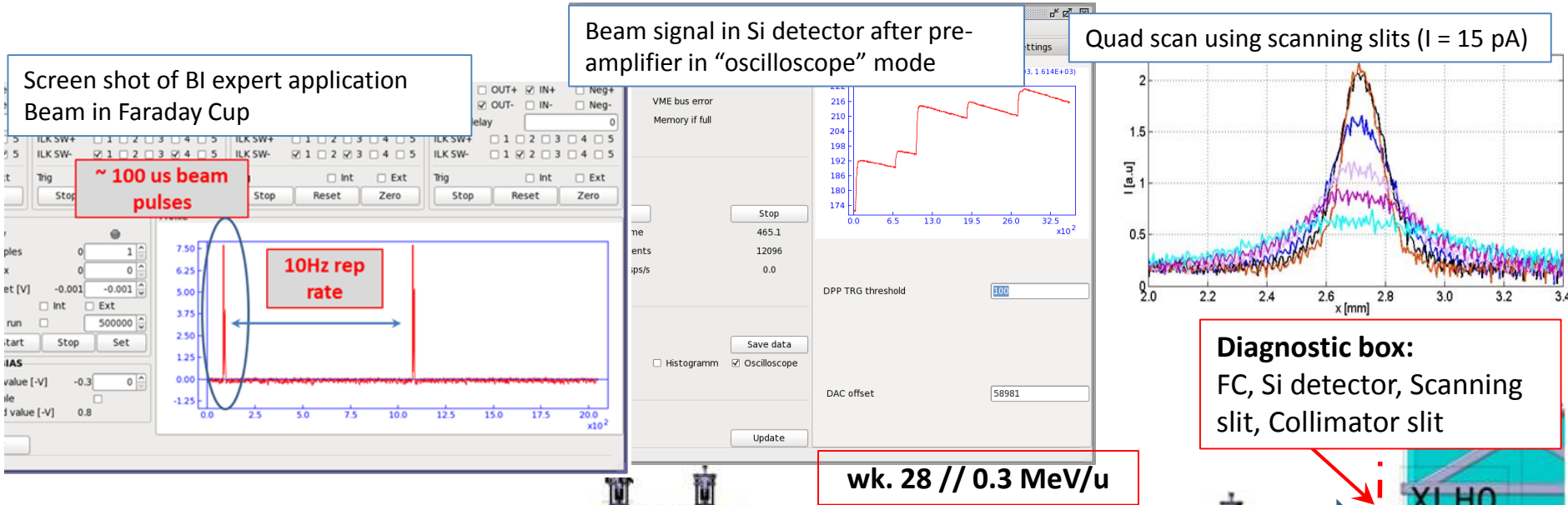
wk. 25 // 0.3 MeV/u



Commissioning with beam

Stage 2: First HIE-ISOLDE diagnostics box:

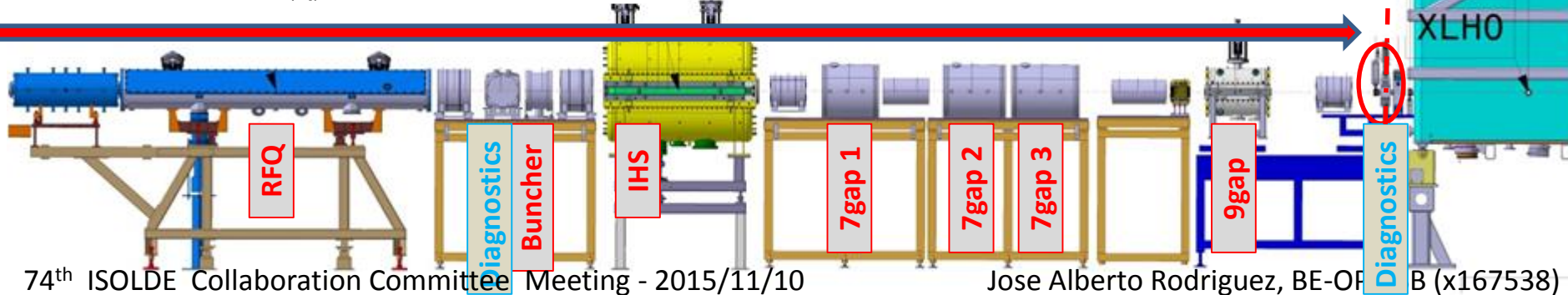
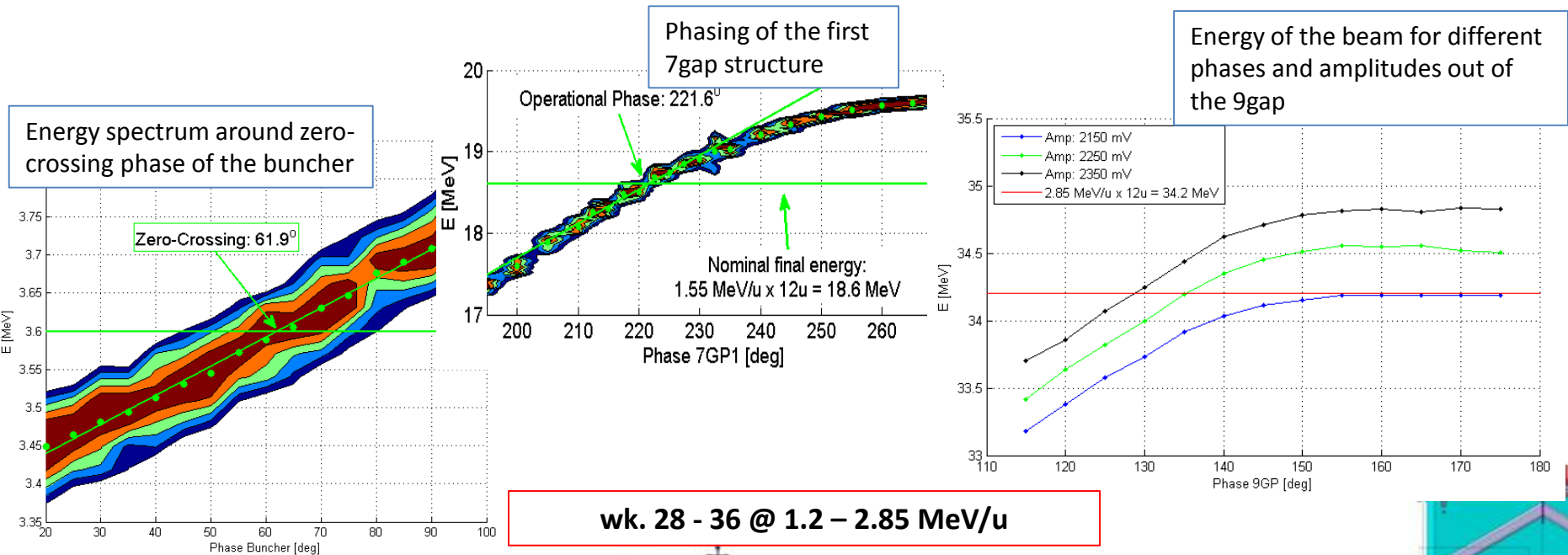
- ✓ First diagnostics box of HIE-ISOLDE installed at the end of wk. 27
- ✓ First beam in FC and to the Si detector with 0.3 MeV/u energy on wk. 28
- ✓ Systematic characterization by E. D. Cantero and S. Sadovich on wk. 33 and after



Commissioning with beam

Stage 3: Commissioning and phasing of RF Structures in REX:

- ✓ Cavities and their amplifiers were commissioned after they were turned on by the RF team
- ✓ Several problems in the different RF systems were discovered and solved at this time
- ✓ Finally, operational settings (phases and amplitudes) for all RF cavities were determined

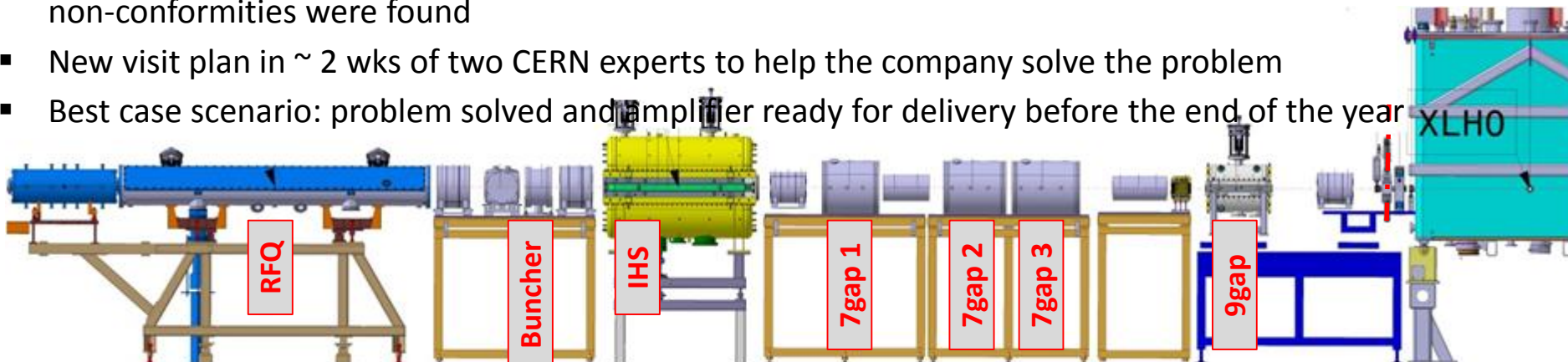


Status of the RF amplifiers

- ✓ RF amplifiers have been very stable and reliable since week 36
- ✓ Only one short intervention for the 7gap1 was necessary during the commissioning with beam and operations of HIE-ISOLDE (negligible downtime)
- ✓ The average and peak powers were not very demanding (repetition rate was 10 Hz or lower)
 - We will need to confirm reliable operation under the more demanding conditions needed for next year
 - Several cooling fans have failed and will need to be replaced during the winter shutdown

Status of the final 9gap amplifier:

- The final amplifier was supposed to be ready for the start of the physics program this year
- The delivery was delayed and the RF group provided a temporary amplifier that has been used during the physics run this year after some modifications
- **This amplifier is limited in peak power and duty cycle and will introduce many constrains in the physics program next year if it is not replaced**
- The final amplifier failed an acceptance test conducted on wk. 36 in the company headquarters
- The situation had improved by wk. 41 when the next visit to the company took place. However, several non-conformities were found
- New visit plan in ~ 2 wks of two CERN experts to help the company solve the problem
- Best case scenario: problem solved and amplifier ready for delivery before the end of the year



Summary

Hardware refurbishment and commissioning :

- Hardware refurbishment and commissioning all systems other than some of the RF completed finished before the start of the commissioning with beam on wk. 25
- RFQ, buncher and 9gap (temporary amplifier) ready on wk. 25
- The hardware recommissioning of the rest of the amplifiers took a few additional weeks
- Due to delay in delivery of the final 9gap amplifier, we had to use the temporary amplifier (constrains in maximum A/Q and time structure deliver to users)

Commissioning with Beam:

- Commissioning started in wk. 25 and progressed as hardware was ready
- $^{12}\text{C}^{4+}$ beam produced in the charge breeder has been accelerated to 2.85 MeV/u (REX nominal final energy) on wk. 36

Status of the final 9gap amplifier:

- Acceptance tests in wk. 36 and wk. 41 showed that the amplifier was not ready
- Two CERN experts will visit the company in ~ 2 weeks to try to solve the problem