# Commissioning of REX

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on behalf of the ISOLDE operations team

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- Summary

# 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<br>MCP<br>Collimator apertures<br>Beam attenuators | FC<br>Si detector<br>Scanning Slits<br>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**

XLH0

RFQ — Triplet — Diagnostics — Buncher — Triplet — IHS — Triplet — Triplet — 7gap 1 — Doublet — 7gap 2 — 7gap 3 — Triplet — HV Steerer — 9gap — Triplet — Diagnostics

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**Power converters:**

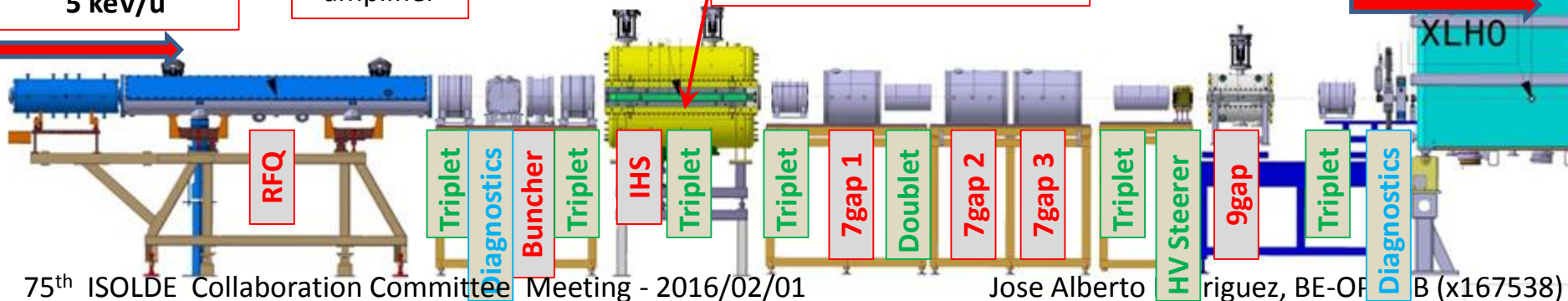| 200 A, 50 V | 20 (1 spare) |
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"New" in 2016:
- New/rebuilt 9gap RF amplifier
- Longer RF pulses
- Higher repetition rate (x3 higher RF average power)
- Higher A/Q (x1.5 higher RF peak power)
- Higher A/Q (more heat dissipation in quads)
    *Concern: triplet inside IH structure

Beam from EBIS 5 keV/u

New RF amplifier

Higher A/Q than in 2015

Beam to HIE-ISOLDE 2.85 MeV/u

XLH0

RFQ · Triplet · Diagnostics · Buncher · Triplet · IHS · Triplet · Triplet · 7gap 1 · Doublet · 7gap 2 · 7gap 3 · Triplet · HV Steerer · 9gap · Triplet · Diagnostics

# Hardware commissioning:

**Vacuum systems: ready in week 11**

- A couple of weeks earlier for the low energy side (TRAP, EBIS and separator vacuum sectors)
- Cryopumps maintenance scheduled for week 10 (RFQ and 7gap vacuum sectors)
- Testing the upgraded controls and user interface

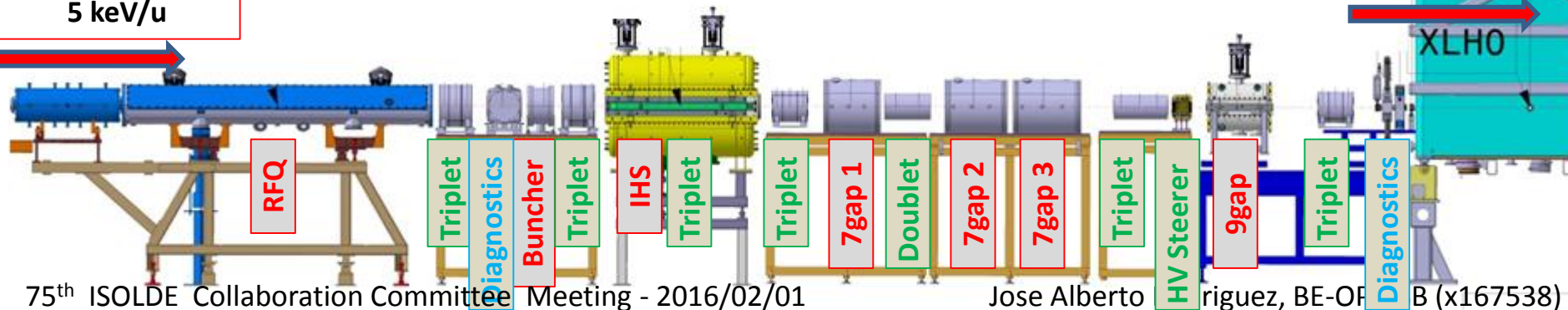**Power converters and magnets: ready in week 15**

- Cooling water back on Feb. 29th (week 9)
- Revisit the grounding of magnets and supports
- Temperature and cooling water flow interlock tests
- Deconsignation of power converters

**Diagnostics: ready in week 16**

- Installation of diagnostics box before CM1 in week 14
- FESA classes for FCs, scanning slits and Si detectors being tested and debugged
- HIE-ISOLDE high level control application commissioning without beam in week 14-15

**Beam from EBIS
5 keV/u**

**Beam to HIE-ISOLDE
2.85 MeV/u**



RFQ · Triplet · Diagnostics · Buncher · Triplet · IHS · Triplet · Triplet · 7gap 1 · Doublet · 7gap 2 · 7gap 3 · Triplet · HV Steerer · 9gap · Triplet · Diagnostics · XLH0

# Hardware commissioning:

**9gap amplifier:**
- Will arrive to CERN in week 8
- Installation in weeks 9-10
- RF in load and acceptance tests in week 11
- Integration in CERN's control system in week 12
- First tests with RF in accelerating structure during weeks 13-17
- Conditioning and long reliability test in weeks 17-18

**Other RF systems:**
- Maintenance work started last year and is on-going
- Cooling water flow interlock tests
- First tests with RF in accelerating structure during weeks 13-17
- Conditioning and long reliability test in weeks 17-18

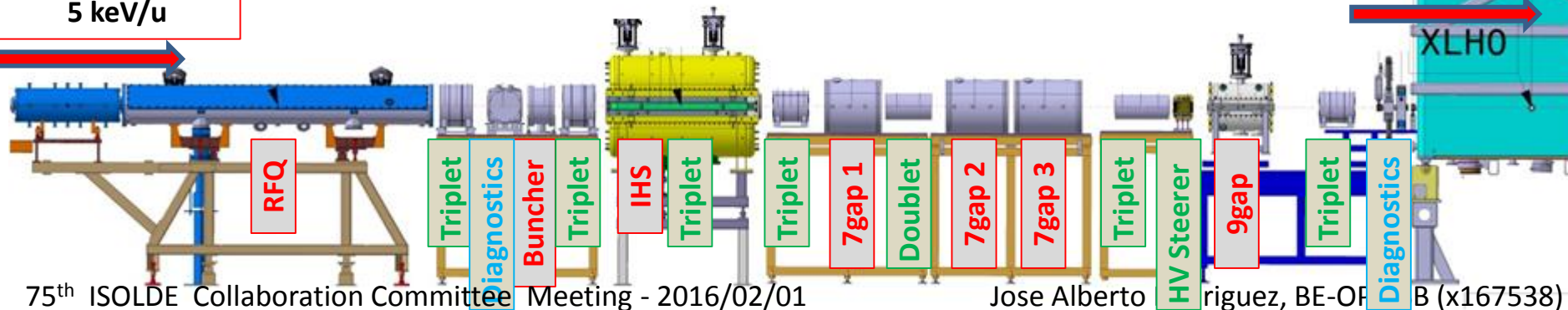Needs to be coordinated with the cryomodule installation work

Tentative dates. Needs to be confirmed by RF team

**REX machine check-out: week 19**
- REX linac ready for commissioning with beam

**Beam to HIE-ISOLDE 2.85 MeV/u**

**Beam from EBIS 5 keV/u**

XLHO

RFQ | Triplet | Diagnostics | Buncher | Triplet | IHS | Triplet | Triplet | 7gap 1 | Doublet | 7gap 2 | 7gap 3 | Triplet | HV Steerer | 9gap | Triplet | Diagnostics
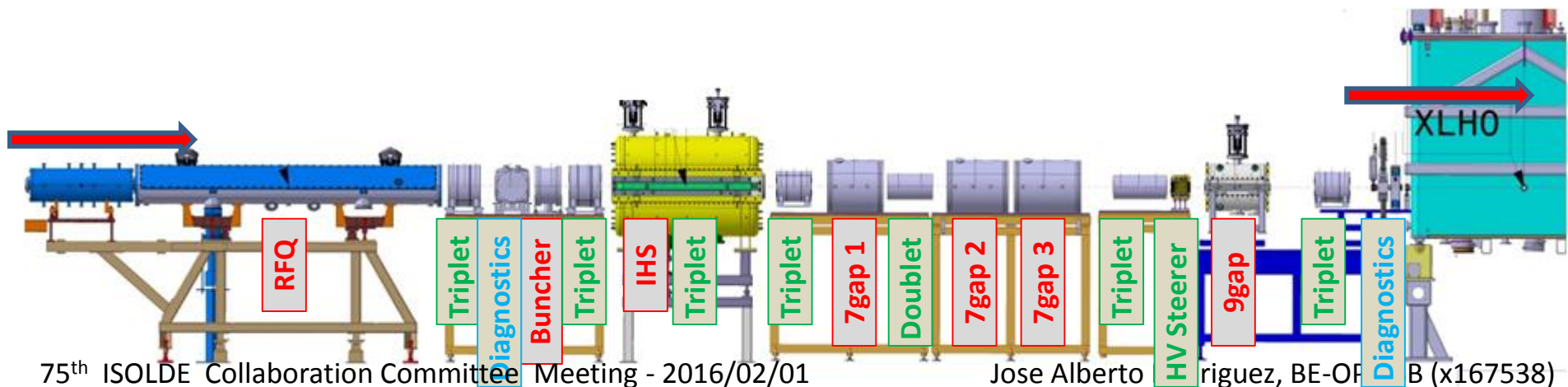
# Commissioning with beam:

Note that the tunnel needs to be closed during the linac beam commissioning (ie. scheduled during hardware commissioning of CM1 and CM2 after the installation phase in completed)

**Main tasks:**

- Ion source / REX-TRAP / REX-EBIS / Separator start-up and beam commissioning (week 16-17)
- Timing system commissioning
- Slow extraction development
- Beam commissioning of high level beam diagnostics application (week 20)
- Phasing and calibration of RF accelerating structures (week 21-22)
- Beam transmission optimization
- Transverse emittance measurement
- Longitudinal emittance measurement methodology tests
- Optics model benchmarking
- Machine scaling studies
- Beam ready for HIE-ISOLDE beam commissioning (end of week 28)

Strong boundary conditions



RFQ · Triplet · Diagnostics · Buncher · Triplet · IHS · Triplet · Triplet · 7gap 1 · Doublet · 7gap 2 · 7gap 3 · Triplet · HV Steerer · 9gap · Triplet · Diagnostics · XLH0

# Summary:

**Hardware commissioning :**

- Focus on the installation and hardware commissioning of the new/rebuilt 9gap amplifier

    - Will arrive at the end of February

    - Will be installed and tested in an RF load in March

    - First RF in 9gap accelerating structure at the end of March

- Much higher operational requirements for RF systems than last year

    - ~ 50 % higher peak power for A/Q = 4.2

    - Much higher repetition rate (25-50 Hz possible)

    - Much higher average power (x5 higher possible)


**Commissioning with Beam:**

- The tunnel needs to be closed. Scheduled during the HIE-ISOLDE hardware commissioning after the installation work is completed

- Beam needs to be ready for beam commissioning of HIE-ISOLDE at the end of week 28

- Other important objectives:

    - Commissioning of new timing system

    - Slow extraction development

    - Testing machine scalability

    - Commissioning the diagnostics high level control application