

REX re-commissioning

Content:



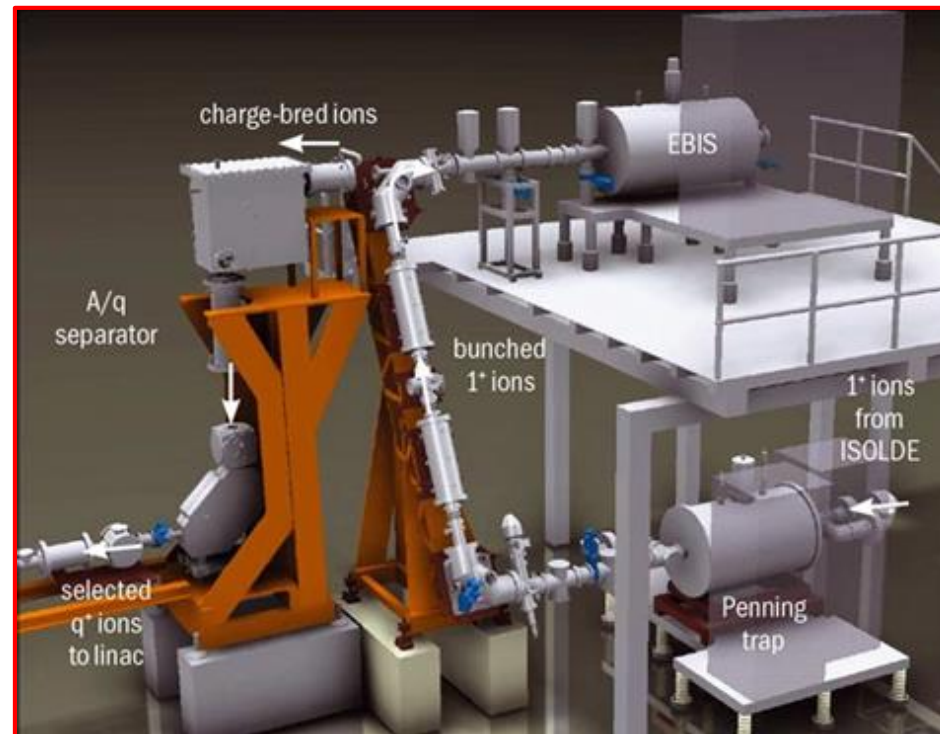
- Status of the REX low energy
- Initial Commissioning Plan for the REX Linac
- Delay and Mitigation Plan
- First Results of the Beam Commissioning
- Summary

Status of the REX low energy:



All REX low energy activities managed by Fredrik Wenander (BE/ABP)

- ✓ All activities during TS completed (Vacuum, Controls...)
- ✓ Ion source, REX-TRAP and REX-EBIS up and running as scheduled (F. Wenander, M. Lozano)
- ✓ New timing system commissioned (Controls, F. Wenander, M. Lozano, E. Fadakis)
- ✓ Emittance measurements with Pepperpot meter completed (J. Pitters, F. Wenander)
- ✓ Slow extraction development completed (N. Bidault, F. Wenander, J.A. Rodriguez)
- ✓ **REX low energy ready for beam commissioning of REX linac since before week 22**



Content:

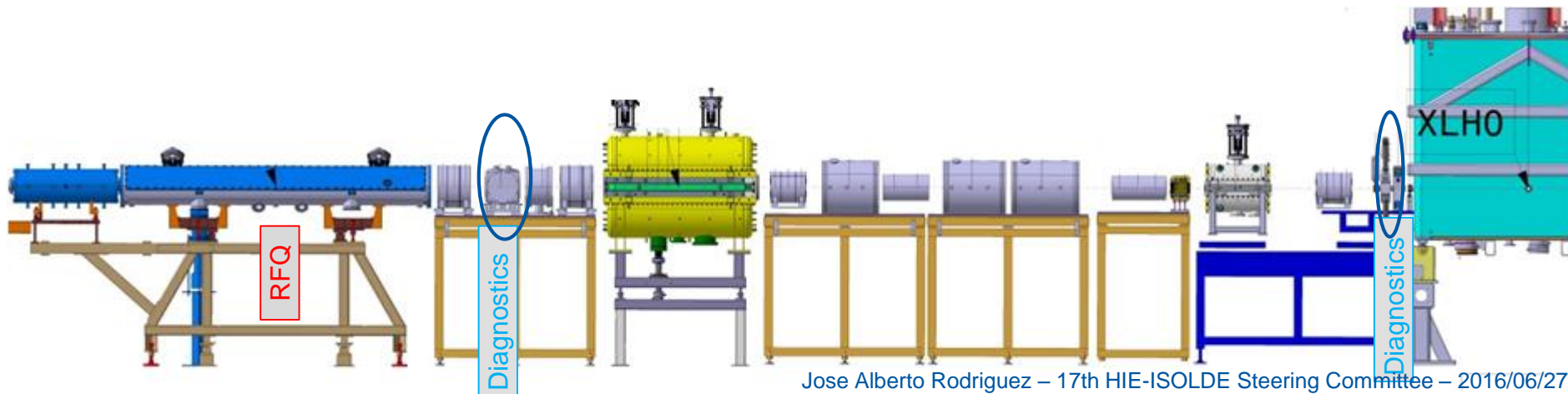


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Initial Commissioning Plan for the REX Linac



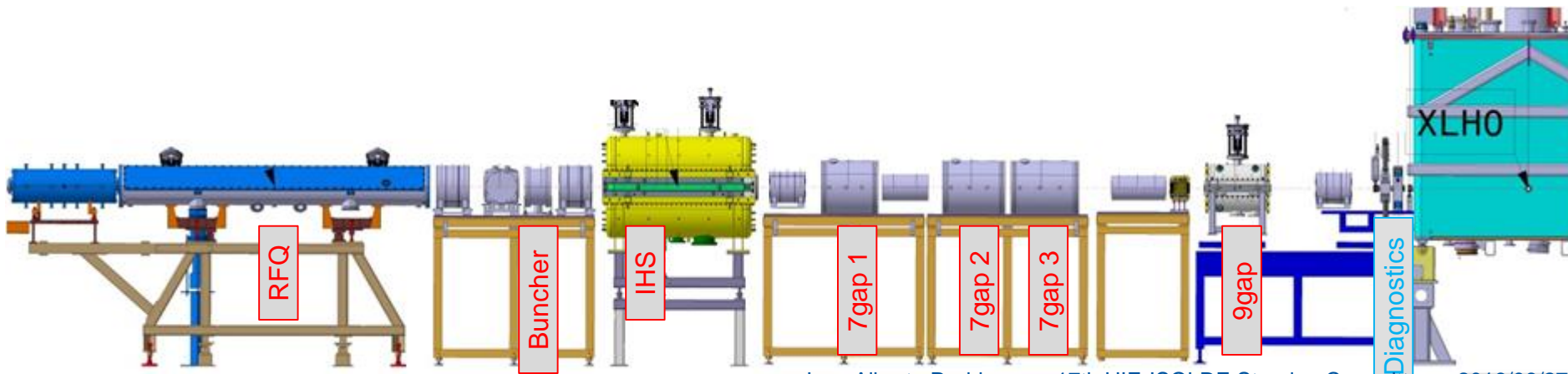
Week	Main activities
23	** REX LINAC HARDWARE COMMISSIONING COMPLETED ($A/q = 3.5, 0.5 \text{ ms}, 50 \text{ Hz}$)** RFQ beam transmission measurements and calibration Beam commissioning of the first HIE-ISOLDE diagnostics box Beam commissioning of the suite of applications for the beam diagnostics of HIE-ISOLDE



Initial Commissioning Plan for the REX Linac



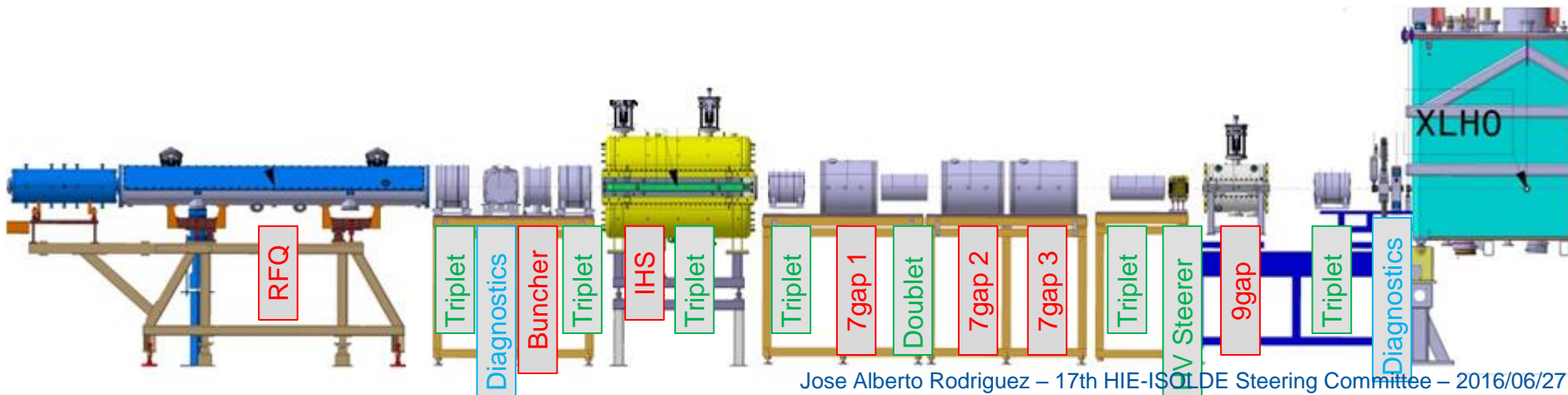
Week	Main activities
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24	Phasing of the buncher, the IH, the three 7gap and the 9gap accelerating structures RF systems up to $A/q = 4.0$, 0.5 ms, 30 Hz. Cavities conditioning over the weekend
25	Phasing of the buncher, the IH, the three 7gap and the 9gap accelerating structures Beam transmission optimization RF systems up to $A/q = 4.5$, 0.5 ms, 10 Hz. Cavities conditioning over the weekend



Initial Commissioning Plan for the REX Linac



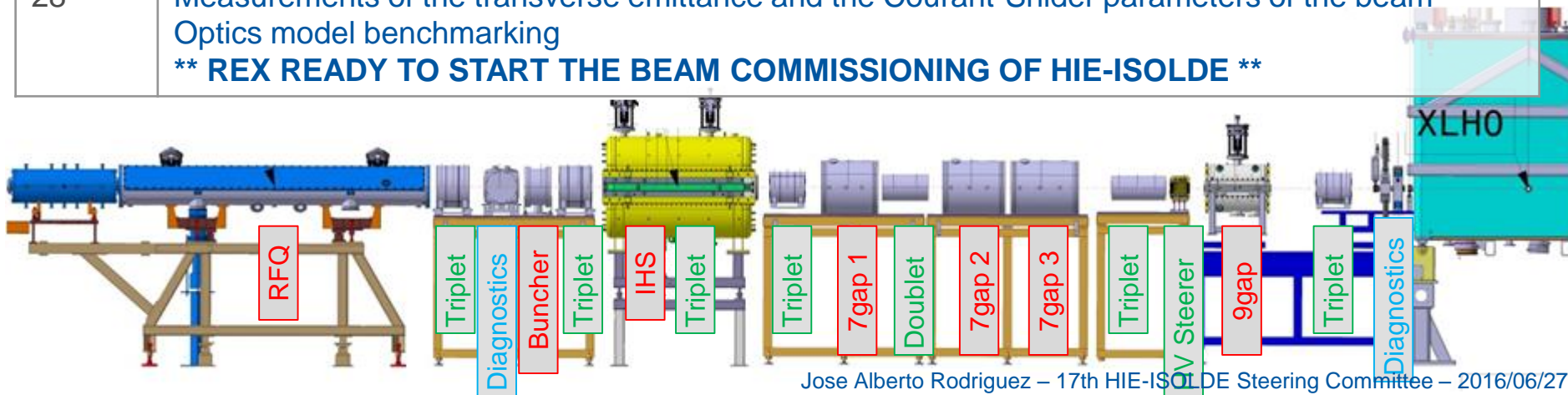
Week	Main activities
23	<p>** REX LINAC HARDWARE COMMISSIONING COMPLETED ($A/q = 3.5$, 0.5 ms, 50 Hz)**</p> <p>RFQ beam transmission measurements and calibration</p> <p>Beam commissioning of the first HIE-ISOLDE diagnostics box</p> <p>Beam commissioning of the suite of applications for the beam diagnostics of HIE-ISOLDE</p>
24	<p>Phasing of the buncher, the IH, the three 7gap and the 9gap accelerating structures</p> <p>RF systems up to $A/q = 4.0$, 0.5 ms, 30 Hz. Cavities conditioning over the weekend</p>
25	<p>Phasing of the buncher, the IH, the three 7gap and the 9gap accelerating structures</p> <p>Beam transmission optimization</p> <p>RF systems up to $A/q = 4.5$, 0.5 ms, 10 Hz. Cavities conditioning over the weekend</p>
26	Machine A/q scaling tests and measurements
27	<p>Machine A/q scaling tests and measurements</p> <p>Preparation of machine tunes for beams with $A/q = 4.0$ and 4.5</p> <p>RF systems up to $A/q = 4.5$, 1-2 ms, 3 Hz. Cavities conditioning over the weekend</p>



Initial Commissioning Plan for the REX Linac



Week	Main activities
23	<p>** REX LINAC HARDWARE COMMISSIONING COMPLETED ($A/q = 3.5$, 0.5 ms, 50 Hz)**</p> <p>RFQ beam transmission measurements and calibration</p> <p>Beam commissioning of the first HIE-ISOLDE diagnostics box</p> <p>Beam commissioning of the suite of applications for the beam diagnostics of HIE-ISOLDE</p>
24	<p>Phasing of the buncher, the IH, the three 7gap and the 9gap accelerating structures</p> <p>RF systems up to $A/q = 4.0$, 0.5 ms, 30 Hz. Cavities conditioning over the weekend</p>
25	<p>Phasing of the buncher, the IH, the three 7gap and the 9gap accelerating structures</p> <p>Beam transmission optimization</p> <p>RF systems up to $A/q = 4.5$, 0.5 ms, 10 Hz. Cavities conditioning over the weekend</p>
26	Machine A/q scaling tests and measurements
27	<p>Machine A/q scaling tests and measurements</p> <p>Preparation of machine tunes for beams with $A/q = 4.0$ and 4.5</p> <p>RF systems up to $A/q = 4.5$, 1-2 ms, 3 Hz. Cavities conditioning over the weekend</p>
28	<p>Measurements of the transverse emittance and the Courant-Snyder parameters of the beam</p> <p>Optics model benchmarking</p> <p>** REX READY TO START THE BEAM COMMISSIONING OF HIE-ISOLDE **</p>



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Delay and Mitigation Plan:



REX linac hardware commissioning was not completed on time:

- ✓ All systems other than the 9gap amplifier ready as scheduled (101 MHz RF systems, vacuum, power converters, magnets, diagnostics, controls...)
- ✗ **Start-up of 9gap RF delayed (originally planned for Monday wk. 23, ready on Tuesday wk. 25)**
 - Causes: availability of equipment experts & interventions in other machines
 - Impact: probably none (on the shadow of the cryomodule cooling delay)

Delay and Mitigation Plan:



REX Initial Beam commissioning Plan:

Week	Main activities
23	** REX LINAC HARDWARE COMMISSIONING COMPLETED ($A/q = 3.5$, 0.5 ms, 50 Hz)** RFQ beam transmission measurements and calibration Beam commissioning of the first HIE-ISOLDE diagnostics box Beam commissioning of the suite of applications for the beam diagnostics of HIE-ISOLDE
24	Phasing of the buncher, the IH, the three 7gap and the 9gap accelerating structures RF systems up to $A/q = 4.0$, 0.5 ms, 30 Hz. Cavities conditioning over the weekend
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26	Machine A/q scaling tests and measurements
27	Machine A/q scaling tests and measurements Preparation of machine tunes for beams with $A/q = 4.0$ and 4.5 RF systems up to $A/q = 4.5$, 1-2 ms, 3 Hz. Cavities conditioning over the weekend
28	Measurements of the transverse emittance and the Courant-Snyder parameters of the beam Optics model benchmarking ** REX READY TO START THE BEAM COMMISSIONING OF HIE-ISOLDE **

Delay and Mitigation Plan:



REX Initial Beam commissioning Plan:

(if beam commissioning of REX needs to be completed by week 28) :

Week	Main activities
23	RFQ beam transmission measurements and calibration
24	Beam commissioning of the first HIE-ISOLDE diagnostics box Beam commissioning of the suite of applications for the beam diagnostics of HIE-ISOLDE RF systems up to $A/q = 4.0$, 0.5 ms, 30 Hz. Cavities conditioning over the weekend
25	** REX LINAC HARDWARE COMMISSIONING COMPLETED ($A/q = 3.5$, 0.5 ms, 50 Hz)** Beam commissioning of the suite of applications for the beam diagnostics of HIE-ISOLDE Phasing of the buncher
26	Phasing of the IH, the three 7gap and the 9gap accelerating structures Beam transmission optimization RF systems up to $A/q = 4.5$, 0.5 ms, 10 Hz. Cavities conditioning over the weekend
27	Beam transmission optimization Machine A/q scaling tests and measurements RF systems up to $A/q = 4.5$, 1-2 ms, 3 Hz. Cavities conditioning over the weekend
28	Machine A/q scaling tests and measurements Preparation of machine tunes for beams with $A/q = 4.0$ and 4.5 ** REX READY TO START THE BEAM COMMISSIONING OF HIE-ISOLDE ** Measurements of the transverse emittance and the Courant-Snyder parameters of the beam Optics model benchmarking

Activities may need to be dropped



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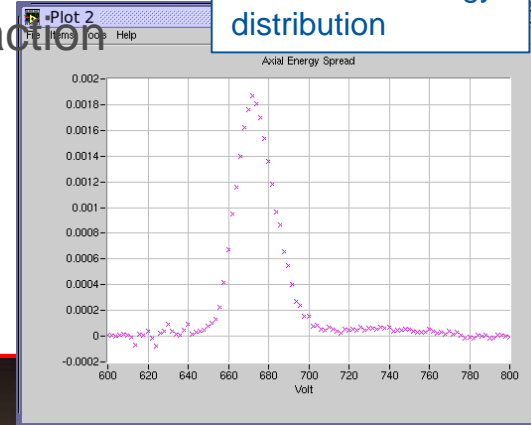
First Results of the Beam Commissioning



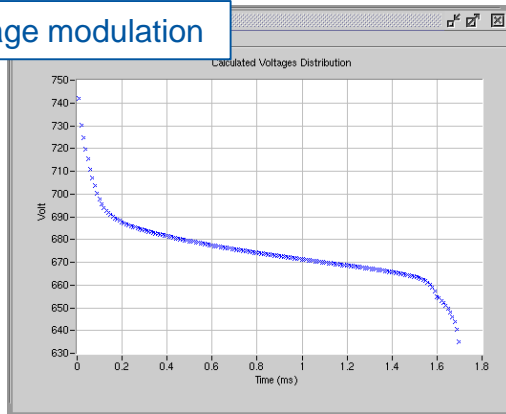
Slow extraction development (worked completed by N. Bidault):

- ✓ Signal of the beam in an MCP used to characterize the extraction
- ✓ Slow extraction set-up procedure developed
 - ✓ Measurement of the beam axial distribution
 - ✓ Initial voltage modulation calculated and applied
 - ✓ Final adjustment possible

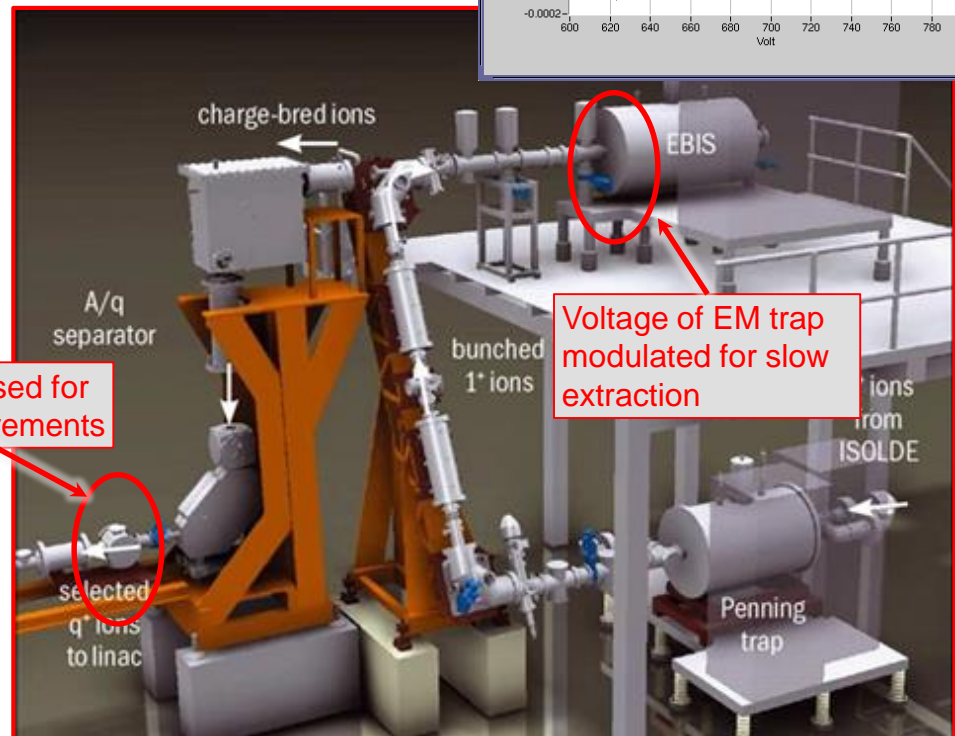
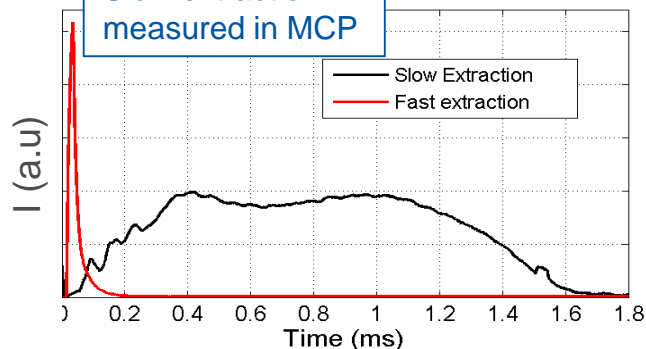
Axial beam energy distribution



Voltage modulation



Slow extraction measured in MCP



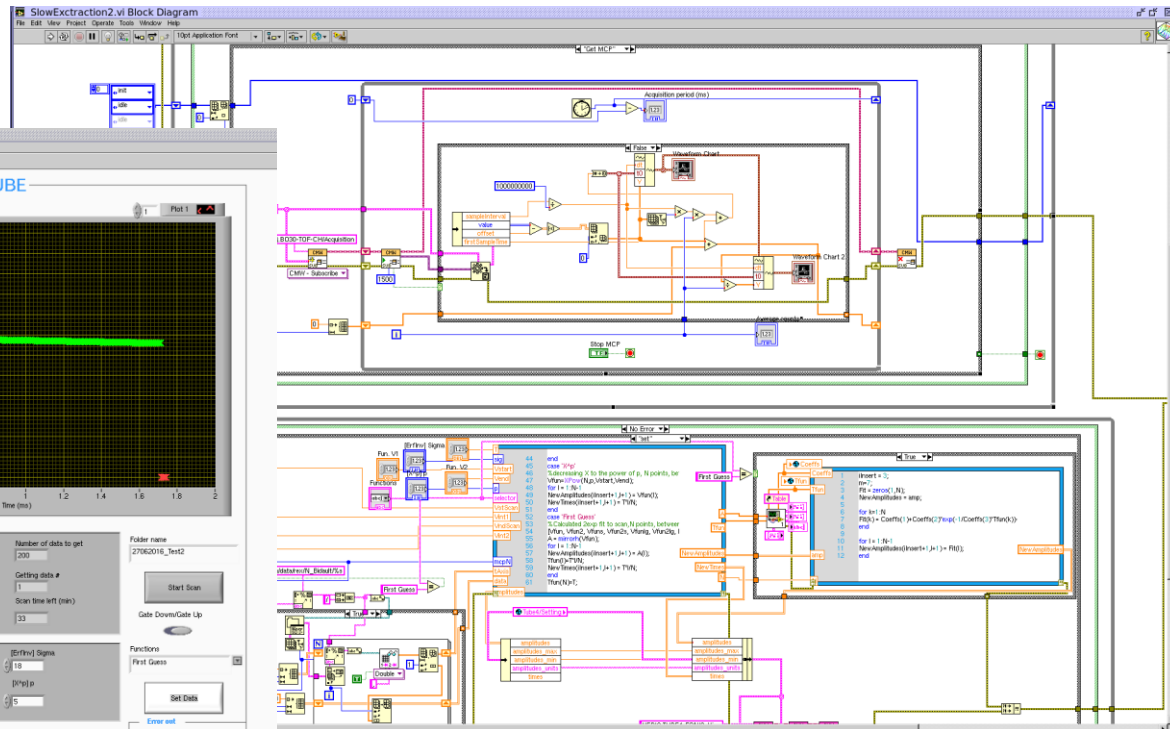
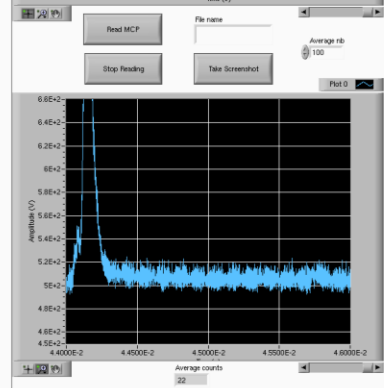
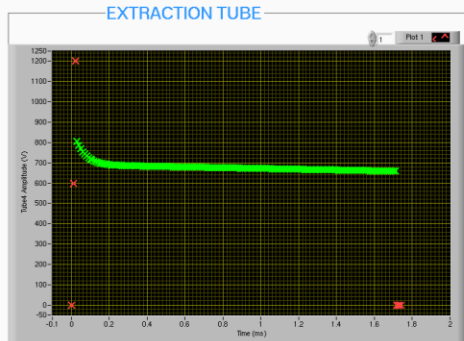
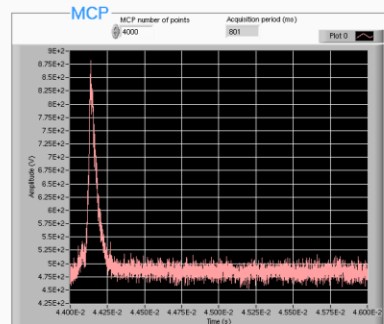
First Results of the Beam Commissioning



Slow extraction development (worked completed by N. Bidault):

- Development of a prototype LabVIEW application for operations this year is almost completed
- Systematic measurements will be done afterwards (different A, A/q, breeding times...)

Prototype LabVIEW application being developed



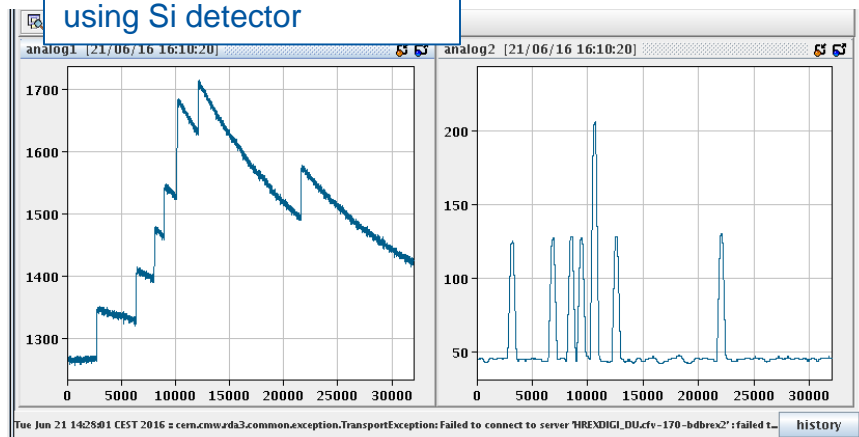
First Results of the Beam Commissioning



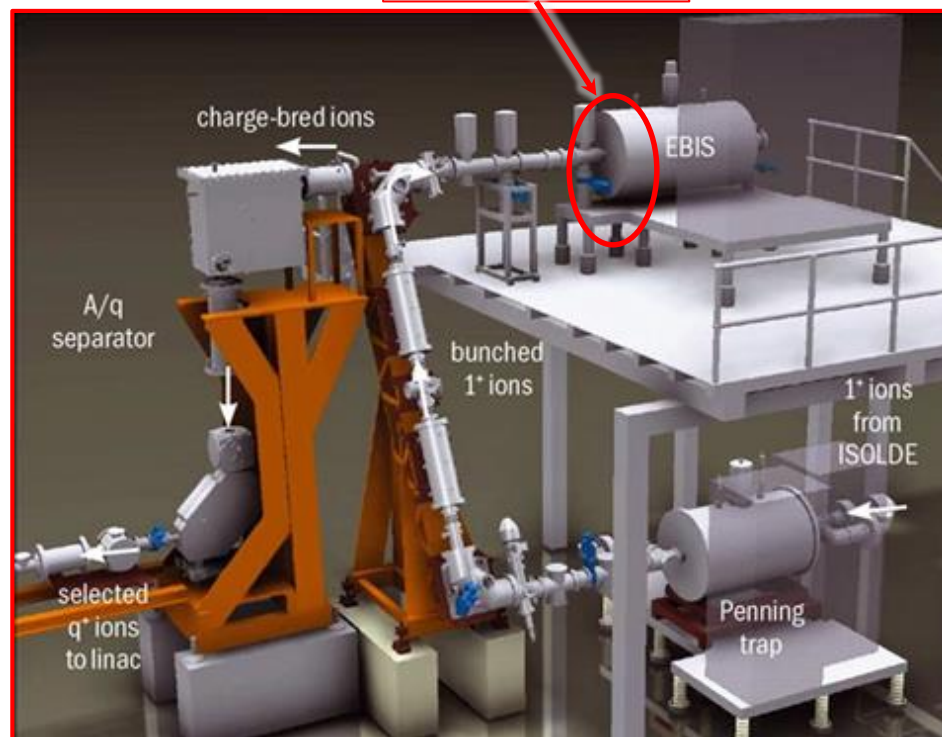
Slow extraction development (worked completed by N. Bidault):

- Independent validation of slow extraction using Si detector in HIE-ISOLDE diagnostics box (digital vs. analog)
 - Proof of concept completed (pulse stretched to ~400 us)
- Software still needs to be developed

Slow extraction validation using Si detector



Voltage of EM trap modulated for slow extraction



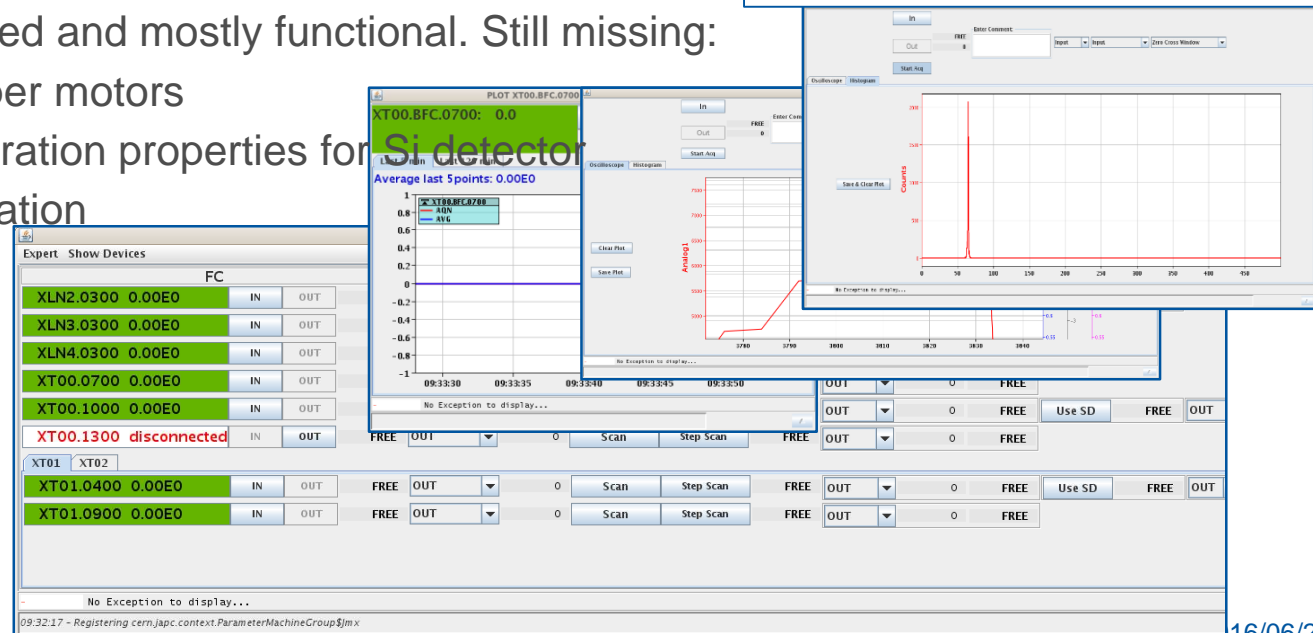
First Results of the Beam Commissioning



Suite of applications for the HIE-ISOLDE beam diagnostics (E. Fadakis):

- ✓ FC and new Si detector hardware re-commissioned (BI, S. Sadovich, OP)
 - Occasional issue touching the limit switch when retracted
- ✓ FESA classes tested. A few modifications/issues being implemented/solved:
 - Calibration of the FC (pC / pulse)
 - Enabling partial setting of properties
 - Voltage of the e- suppressor
- ✓ High-level application tested and mostly functional. Still missing:
 - Enable/disable stepper motors
 - Adding more configuration properties for Si detector
 - Scanning slits application

Suite of HIE-ISOLDE beam diagnostics applications (E. Fadakis)

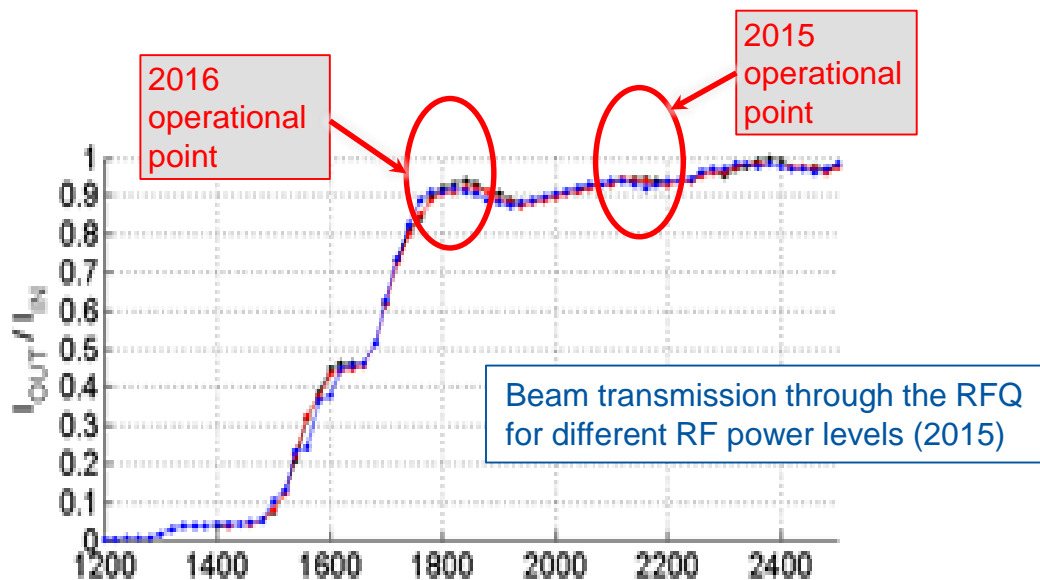


First Results of the Beam Commissioning



RFQ new operational point found for $A/q = 3.5$:

- A/q limited to 3.6 during the 2015 Physics Campaign because of the temporary 9gap amplifier
- Less constraints to define the RFQ operational point
- A/q up to 4.5 during the 2016 Physics Campaign
- We need to find a new operational point compatible with scaling to $A/q = 4.5$
- Some additional work left: need to check beam transmission for beam with $A/q = 4.5$

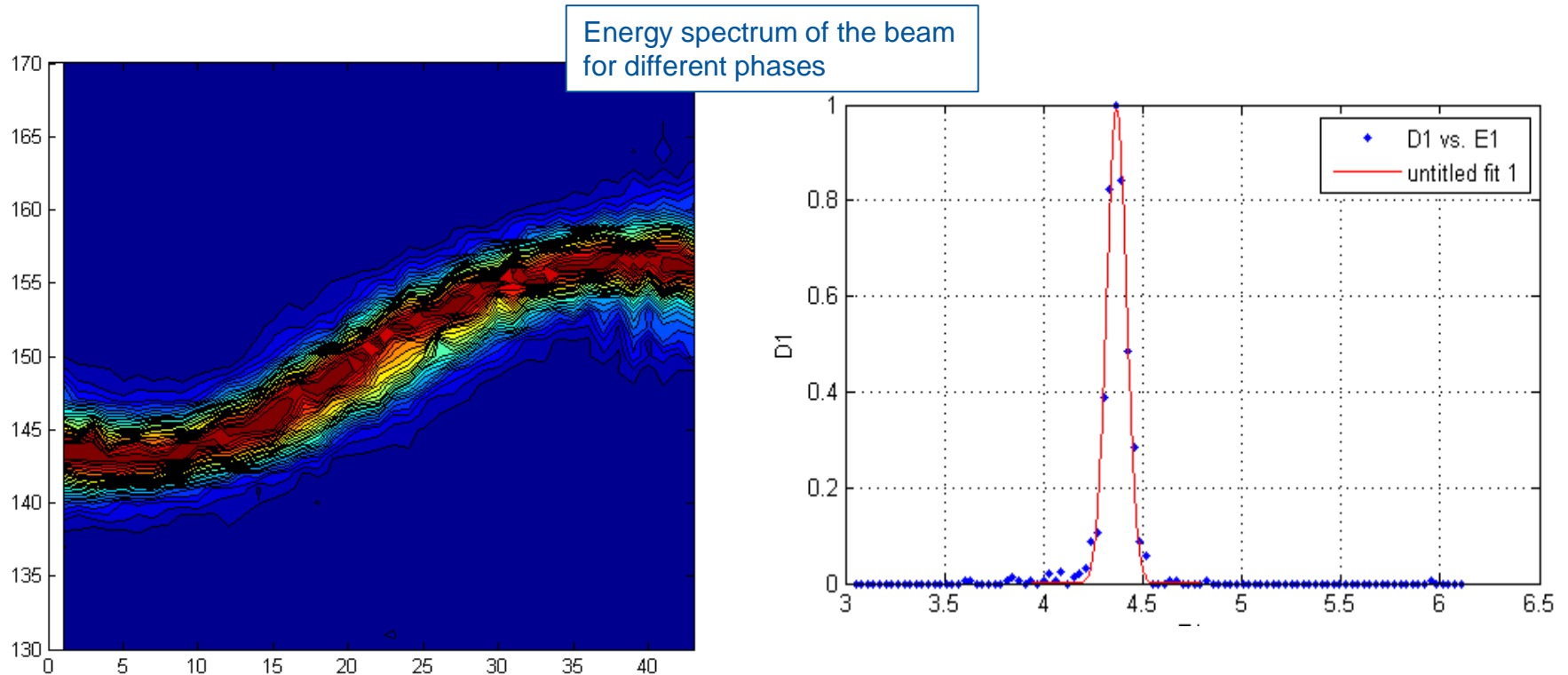


First Results of the Beam Commissioning



Phasing of the buncher:

- ✓ Operational phase has been determined
- It has changed respect to 2015. Needs to be investigated to find the source of this change



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Summary:



Status of the REX low energy (managed by F. Wenander):

- ✓ All systems ready for beam commissioning of the REX linac since before week 22

REX linac (hardware commissioning):

- ✓ All systems other than the 9gap amplifier ready as scheduled (101 MHz RF systems, vacuum, power converters, magnets, diagnostics, controls...)
- ✗ Start-up of 9gap RF delayed by 2.4 weeks
 - Causes: availability of equipment experts & interventions in other machines
 - Impact: probably none (on the shadow of the cryomodule cooling delay)

REX linac (beam commissioning):

- ✓ Slow extraction development completed
 - Software application close to be completed
- ✓ Hardware in first HIE-ISOLDE diagnostics box is working well
- ✓ Most of the FESA classes and high-level control applications completed (a bit more work needed (particularly on the scanning slits))
- ✓ New operational point for the RFQ found
- ✓ Buncher has been phased
 - Phasing of the rest of the RF systems will continue this week

Back-up slides:

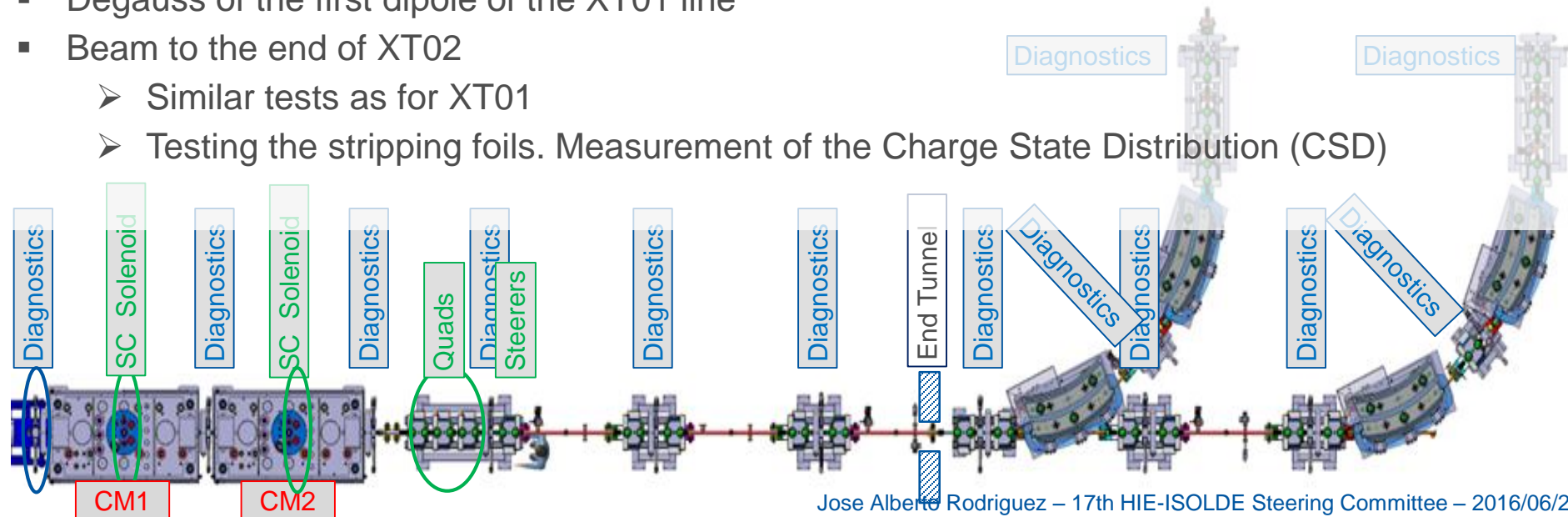


Beam Commissioning Plan for HIE-ISOLDE



Week	Main activities
29	Beam commissioning of optical elements and diagnostic boxes of the linac and HEBTs

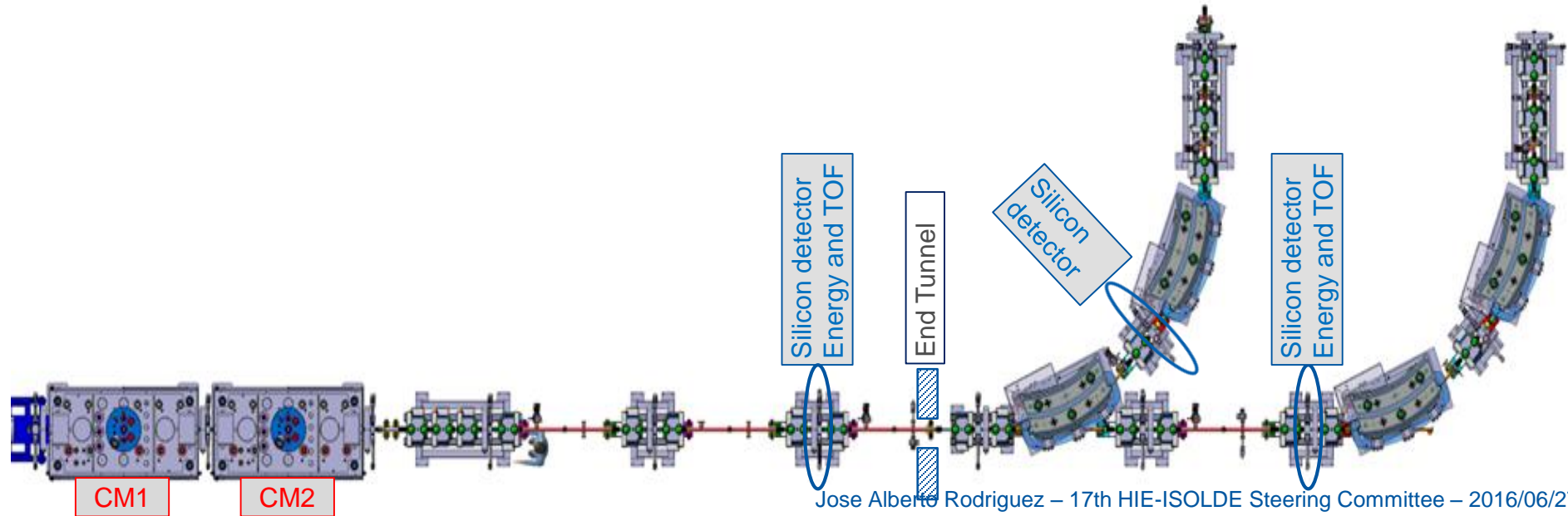
- Beam with REX energy (~ 20 epA of $^{14}\text{N}^{4+}$ at 2.85 MeV/u) to the end of XT01
 - Confirm that there are no major problems with the SC solenoids, quads and dipoles
 - Test the FCs in the linac and XT01
 - Test the collimator apertures and the scanning slits
 - Check the polarities of the steerers using the scanning slits
 - Check the polarities and focusing strengths of the quads using the scanning slits
 - Check the field regulation of the dipoles
- Degauss of the first dipole of the XT01 line
- Beam to the end of XT02
 - Similar tests as for XT01
 - Testing the stripping foils. Measurement of the Charge State Distribution (CSD)



Beam Commissioning Plan for HIE-ISOLDE



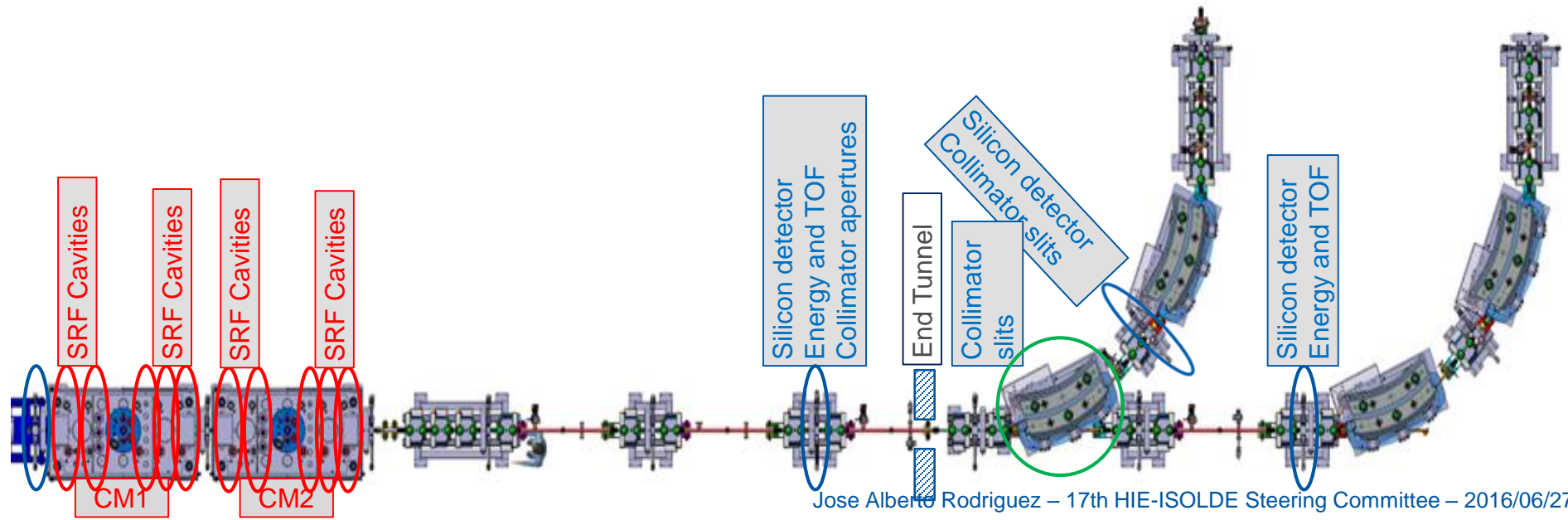
Week	Main activities
29	Beam commissioning of optical elements and diagnostic boxes of the linac and HEBTs
30	Beam commissioning of the silicon detectors Beam commissioning of TOF energy measurement system
31	Beam commissioning of TOF energy measurement system



Beam Commissioning Plan for HIE-ISOLDE



Week	Main activities
29	Beam commissioning of optical elements and diagnostic boxes of the linac and HEBTs
30	Beam commissioning of the silicon detectors Beam commissioning of TOF energy measurement system
31	Beam commissioning of TOF energy measurement system Phasing and energy gain measurements for each SRF cavities
32	Phasing and energy gain measurements for each SRF cavities

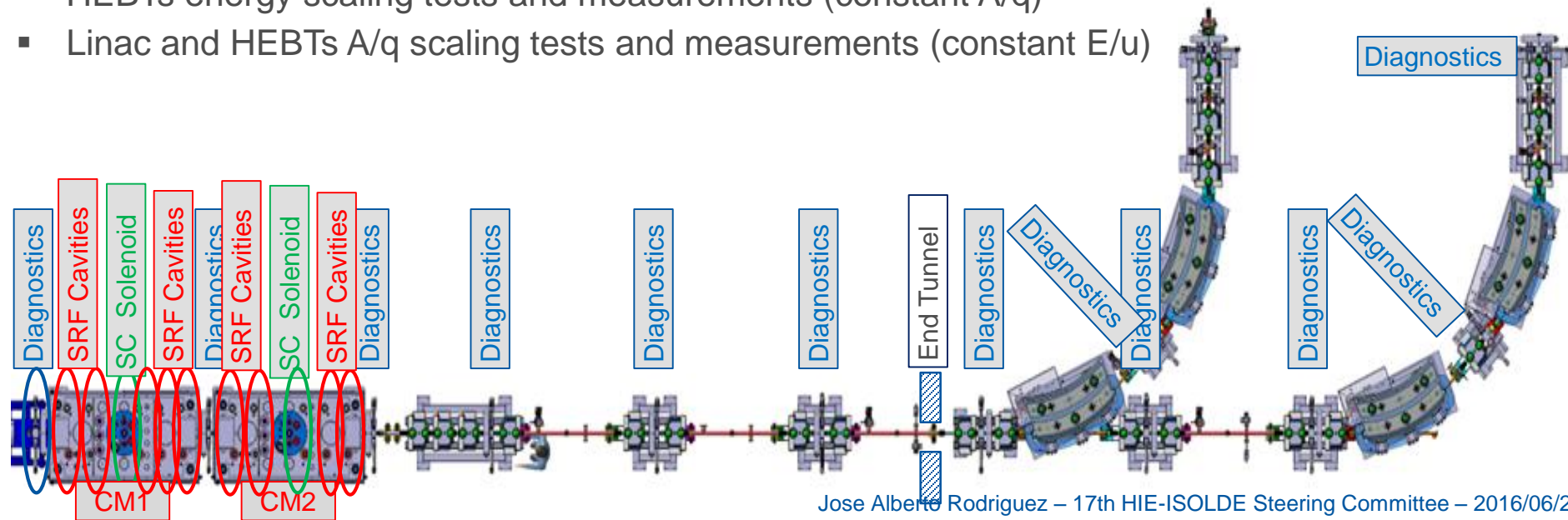


Beam Commissioning Plan for HIE-ISOLDE



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29	Beam commissioning of optical elements and diagnostic boxes of the linac and HEBTs
30	Beam commissioning of the silicon detectors Beam commissioning of TOF energy measurement system
31	Beam commissioning of TOF energy measurement system Phasing and energy gain measurements for each SRF cavities
32	Phasing and energy gain measurements for each SRF cavities
33	Machine scaling tests and measurements

- Beam transmission optimization
- HEBTs energy scaling tests and measurements (constant A/q)
- Linac and HEBTs A/q scaling tests and measurements (constant E/u)



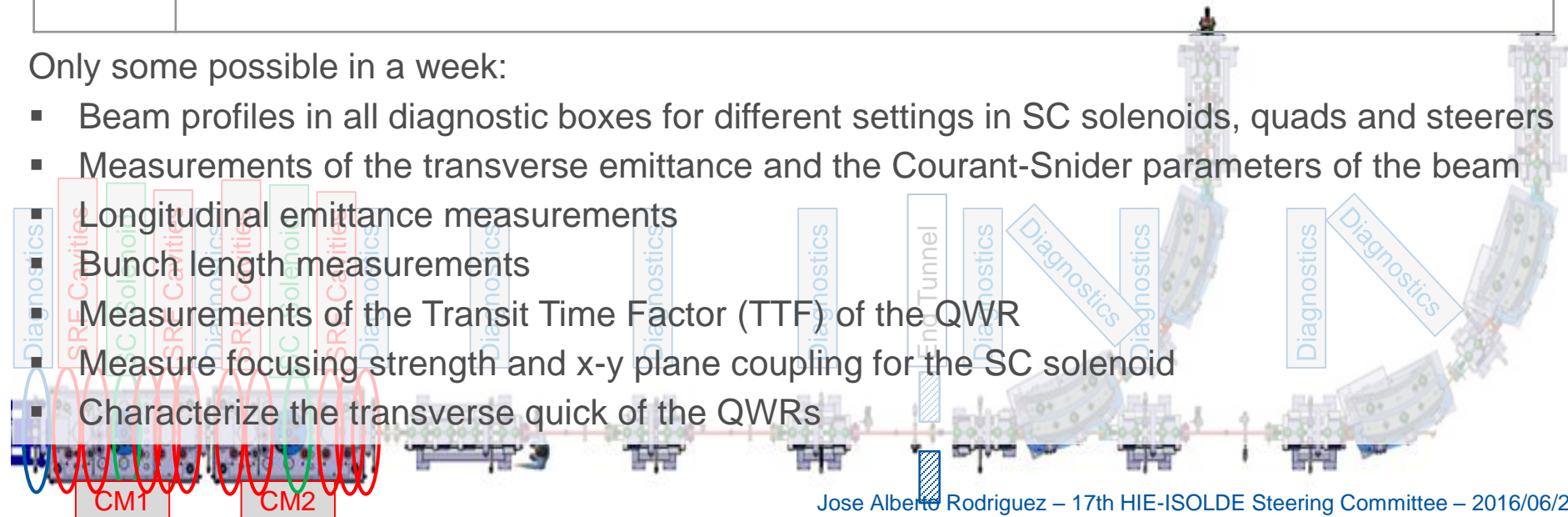
Beam Commissioning Plan for HIE-ISOLDE



Week	Main activities
29	Beam commissioning of optical elements and diagnostic boxes of the linac and HEBTs
30	Beam commissioning of the silicon detectors Beam commissioning of TOF energy measurement system
31	Beam commissioning of TOF energy measurement system Phasing and energy gain measurements for each SRF cavities
32	Phasing and energy gain measurements for each SRF cavities
33	Machine scaling tests and measurements
34	Optics model benchmarking ** REX/HIE-ISOLDE READY TO START THE PHYSICS CAMPAIGN **

Only some possible in a week:

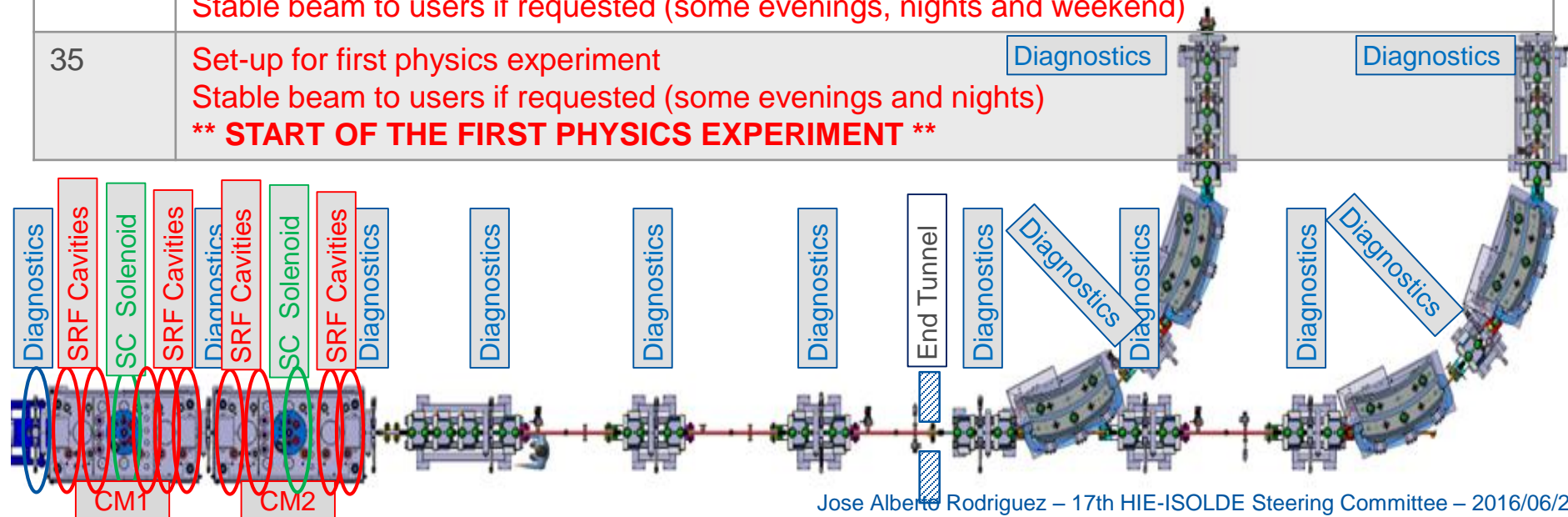
- Beam profiles in all diagnostic boxes for different settings in SC solenoids, quads and steerers
- Measurements of the transverse emittance and the Courant-Snyder parameters of the beam
- Longitudinal emittance measurements
- Bunch length measurements
- Measurements of the Transit Time Factor (TTF) of the QWR
- Measure focusing strength and x-y plane coupling for the SC solenoid
- Characterize the transverse quick of the QWRs



Beam Commissioning Plan for HIE-ISOLDE



Week	Main activities
29	Beam commissioning of optical elements and diagnostic boxes of the linac and HEBTs
30	Beam commissioning of the silicon detectors Beam commissioning of TOF energy measurement system
31	Beam commissioning of TOF energy measurement system Phasing and energy gain measurements for each SRF cavities
32	Phasing and energy gain measurements for each SRF cavities
33	Machine scaling tests and measurements Probably stable beam to users if requested (some evenings, nights and weekend)
34	Optics model benchmarking ** REX/HIE-ISOLDE READY TO START THE PHYSICS CAMPAIGN ** Stable beam to users if requested (some evenings, nights and weekend)
35	Set-up for first physics experiment Stable beam to users if requested (some evenings and nights) ** START OF THE FIRST PHYSICS EXPERIMENT **



Delays and Mitigation Plan:



HIE-ISOLDE Beam Commissioning Initial Plan:

Week	Main activities
29	Beam commissioning of optical elements and diagnostic boxes of the linac and HEBTs
30	Beam commissioning of the silicon detectors Beam commissioning of TOF energy measurement system
31	Beam commissioning of TOF energy measurement system Phasing and energy gain measurements for each SRF cavities
32	Phasing and energy gain measurements for each SRF cavities
33	Machine scaling tests and measurements Probably stable beam to users if requested (some evenings, nights and weekend)
34	Optics model benchmarking ** REX/HIE-ISOLDE READY TO START THE PHYSICS CAMPAIGN ** Stable beam to users if requested (some evenings, nights and weekend)
35	Set-up for first physics experiment Stable beam to users if requested (some evenings and nights) ** START OF THE FIRST PHYSICS EXPERIMENT **

Delays in the start of the beam commissioning of HIE-ISOLDE:

X Cooling down of cryomodules slower than originally planned

Delays and Mitigation Plan:



HIE-ISOLDE Beam Commissioning Initial Plan:

Week	Main activities
29	Hardware commissioning
30	0.5 weeks for Hardware commissioning Beam commissioning of optical elements and diagnostic boxes of the linac and HEBTs (0.5 weeks if number of tasks are limited to essential for start of Physics campaign)
31	Beam commissioning of the silicon detectors Beam commissioning of TOF energy measurement system
32	Beam commissioning of TOF energy measurement system Phasing and energy gain measurements for each SRF cavities
33	Probably stable beam to users if requested (some evenings, nights and weekend) Phasing and energy gain measurements for each SRF cavities (limited to the cavities needed for first Physics experiment)
34	Optics model benchmarking Machine scaling tests and measurements ** REX/HIE-ISOLDE READY TO START THE PHYSICS CAMPAIGN ** Stable beam to users if requested (some evenings, nights and weekend)
35	Set-up for first physics experiment Stable beam to users if requested (some evenings and nights) ** START OF THE FIRST PHYSICS EXPERIMENT **