HIE-ISOLDE Users interface and beam properties for 2017

Lefteris Fadakis on behalf of BE-OP-ISO

Content

- REX/HIE-ISOLDE Users Interface
  - Vacuum system
  - Diagnostics
  - SRF
  - Equipment Array
  - Specification concerning final beam delivery checkpoint for OP
  - Establish a fast separator course for newcomers prior to each experiment
- Beam Properties
  - Energy and Energy spectrum
  - Time structure (Repetition rate, Pulse length, Slow extraction)
  - A/q
- Set Up Time
  - Provide examples varying from best to worst case.

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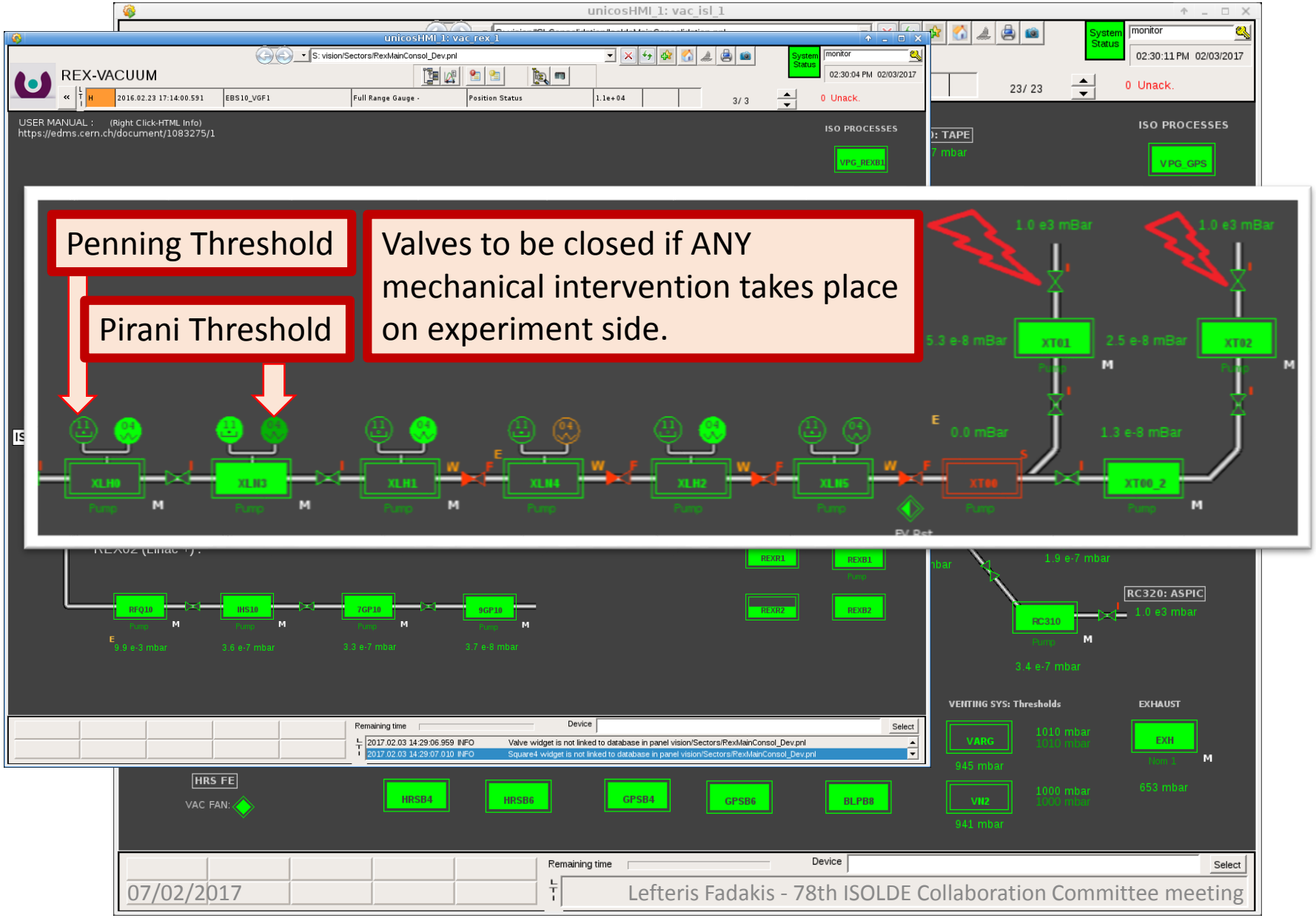
HIE-ISOLDE Users Interface - Vacuum system



Added labels for each experiment in the low energy panel.

Login for:

- Low energy is isoop
- Rex is rexop
- HIE is your nice login which you need to provide at least a week in advance to grand access.

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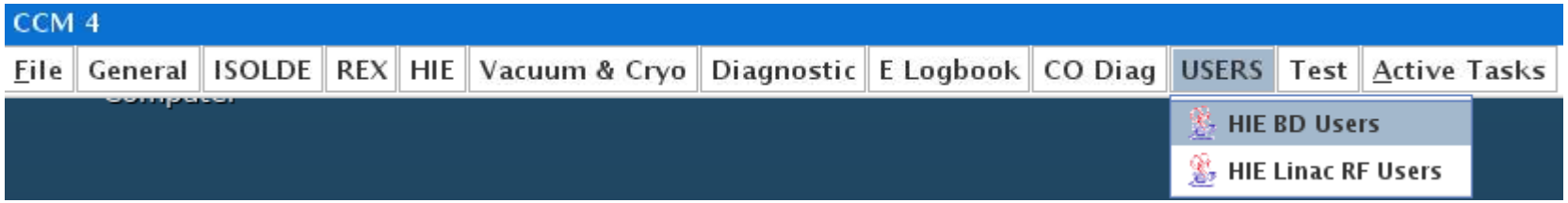
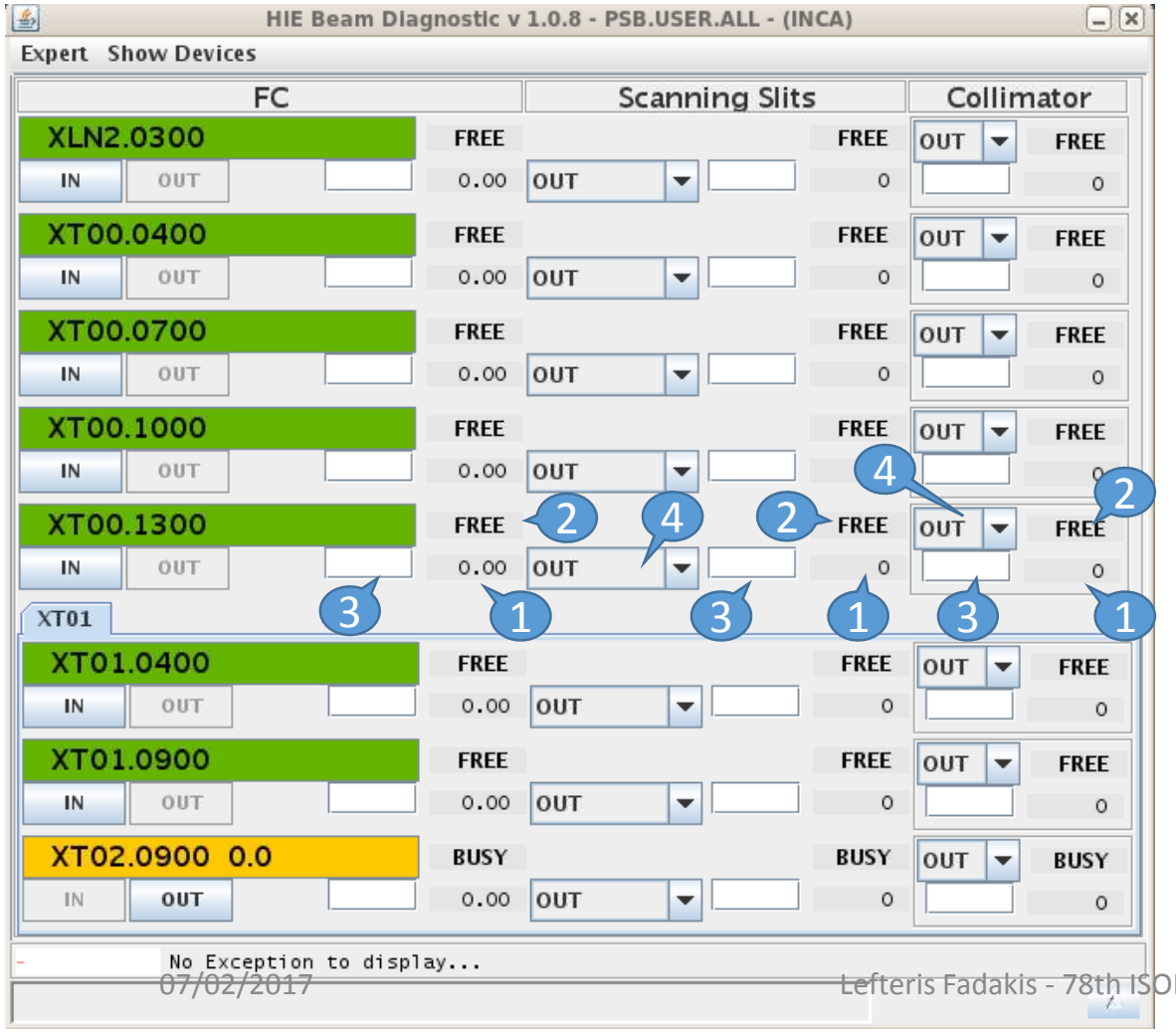
REX/HIE-ISOLDE Users Interface – Beam Diagnostics



<- Where to find it



<- GUI will evolve as the BI evolves (adding more equipment)

We will not add a bricolage/last minute solution for any FC after the last diagnostic box into the existing control system.

<- explanation of each element:

1. Current position acquisition
2. Layer availability
3. Offset movement in respect to current position
4. Go to default possible positions

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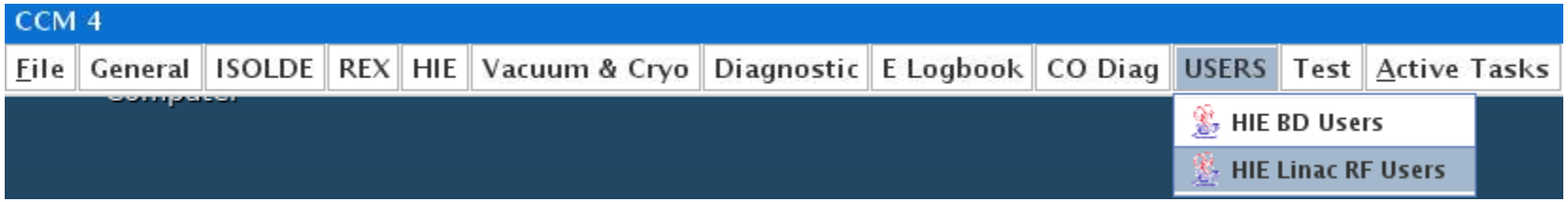
HIE-ISOLDE Users Interface – RF Controls



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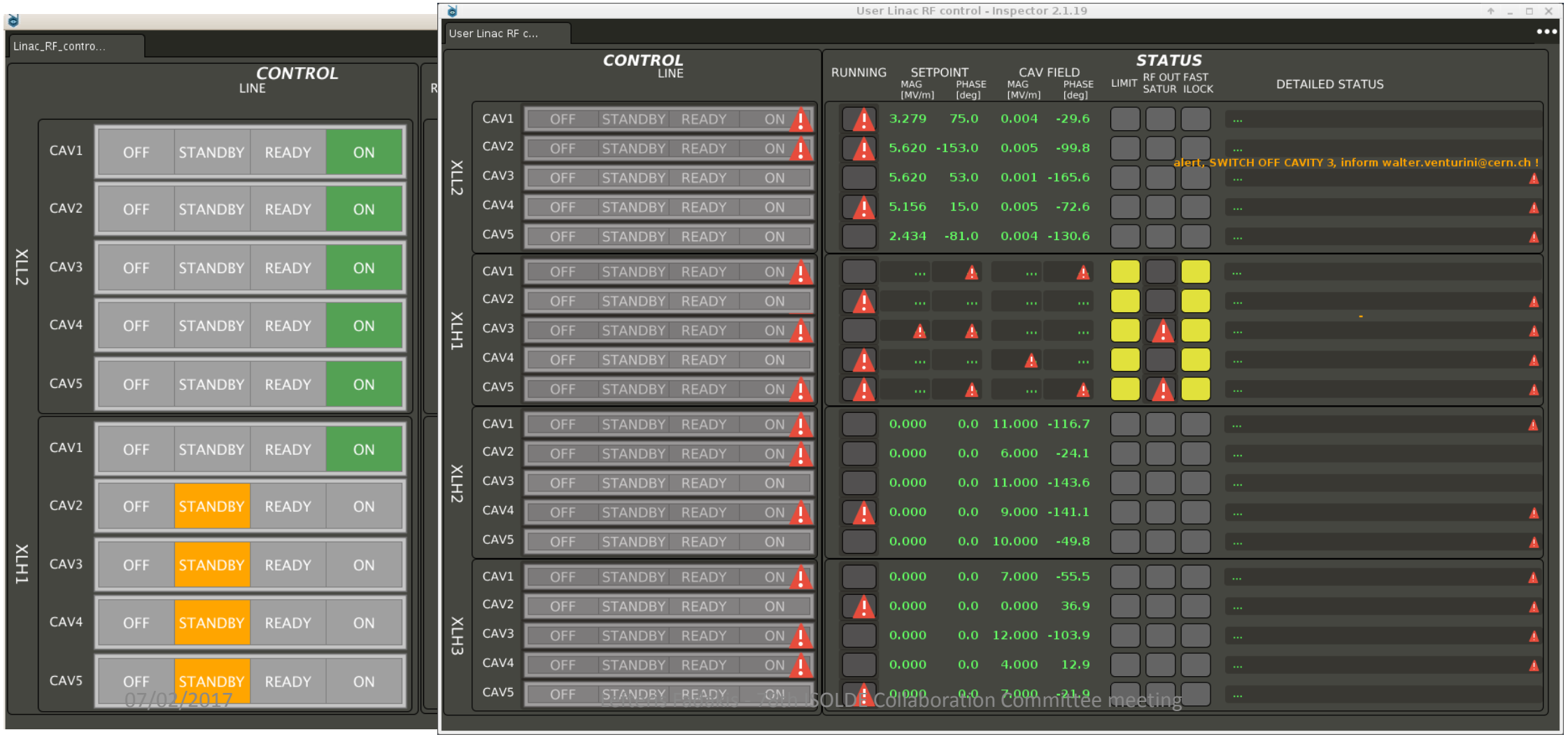

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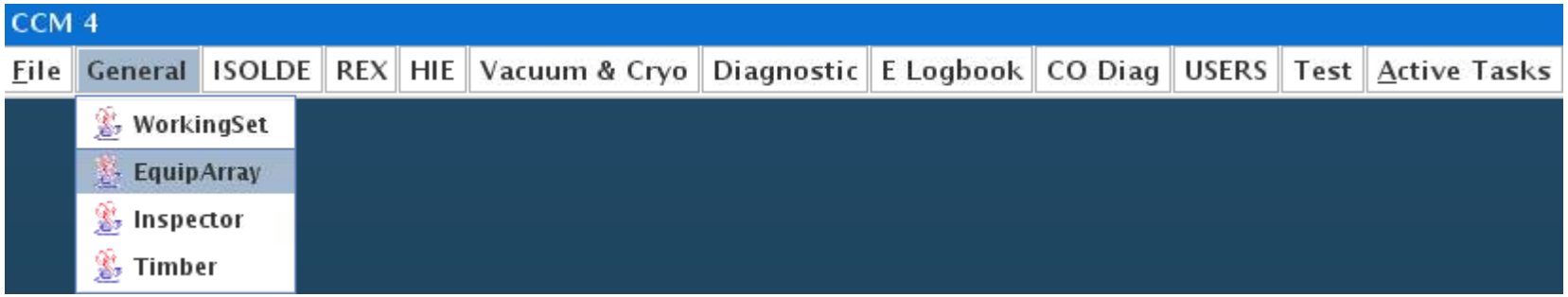
HIE-ISOLDE Users Interface – Equipment Array



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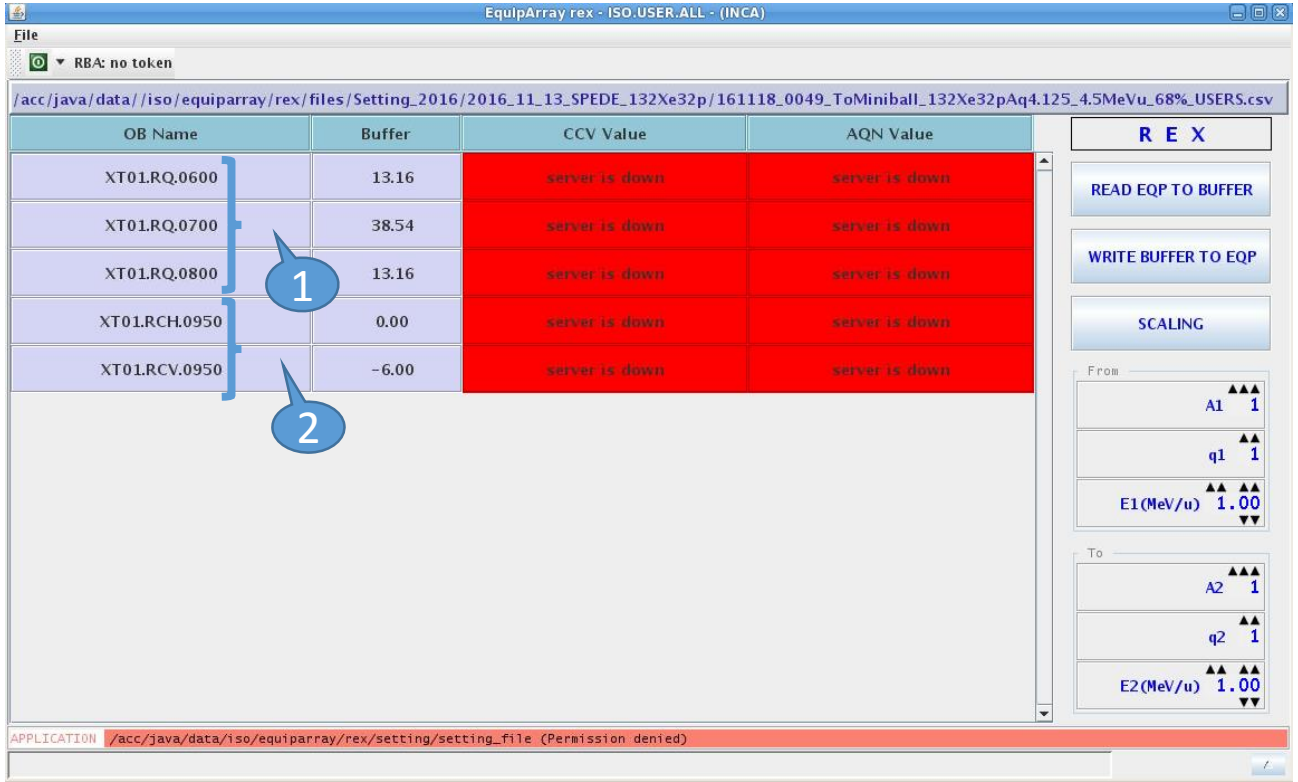

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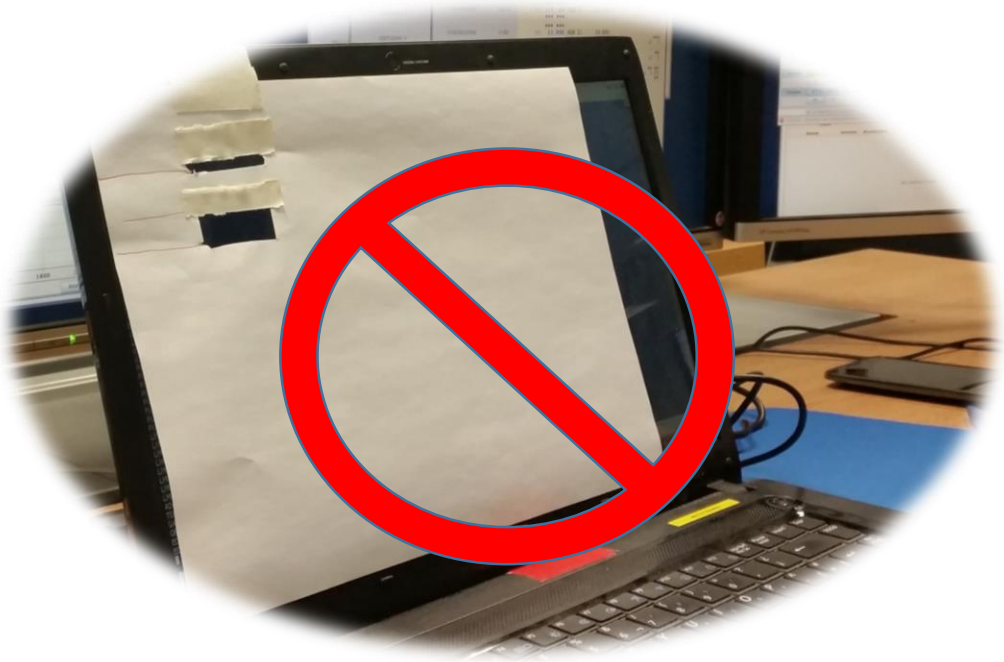
Final beam delivery checkpoint for OP

In 2017 OP will deliver beam as far as the faraday cup in the last diagnostics box before the experiment.
OP will not be responsible to inject beam into the users experiment.



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ISOLDE Separator course

Each year OP teaches the basics of ISOLDE to our new users.

- Beam set up, targets, beam diagnostics, call the PSB operator if there are no protons, etc
- Adding another day being considered, if people are interested in REX/HIE.

ISOLDE crush course before each experiment

In addition to the yearly separator course a crush course will be provided.

- Before each experiment we cover the basics (if needed).
  - Working sets/knobs
  - Fixed displays screens
  - Relevant applications (beam instrumentation etc)

- Verify that each users account has been granted access in the vacuum system.

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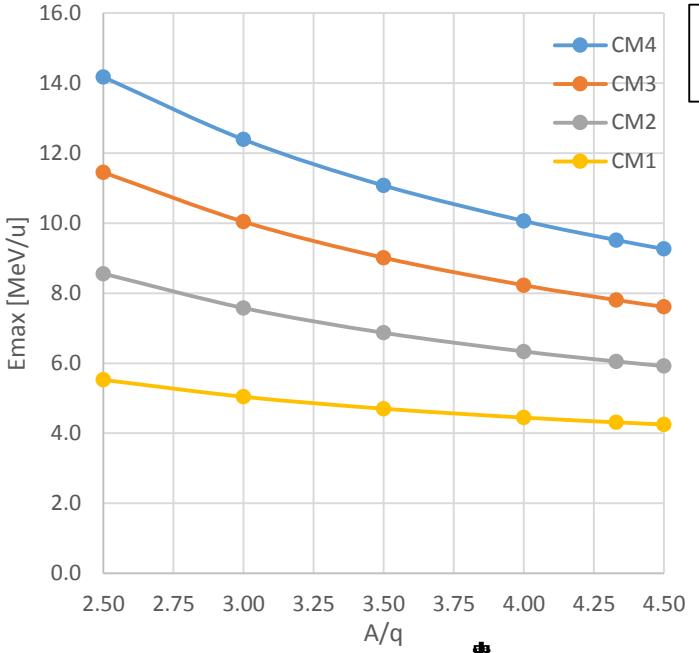
Beam Properties for 2017: Beam Energy and Energy Spread

Expected for 2017:

- A third cryomodule is currently being installed and should be ready for the 2017 Physics campaign
- The third HEBT line (XT03) should also be ready
- Highest reachable energy of a beam with A/q = 4.0:
  - If average SRF gradient is 6.0 MV/m: 8.2 MeV/u
  - If average SRF gradient is 5.5 MV/m: 7.8 MeV/u
  - If average SRF gradient is 5.0 MV/m: 7.3 MeV/u

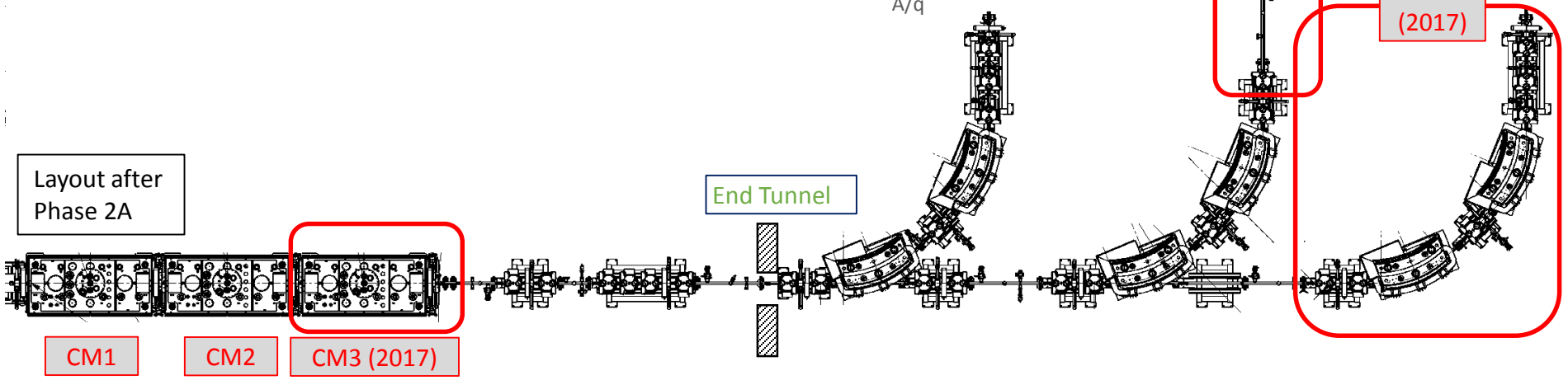


Highest beam energy (assuming all cavities at 6MV/m) for different A/q

A/q	CM1	CM2	CM3	CM4
2.5	5.5	8.6	11.4	14.2
3.0	5.0	7.6	10.0	12.4
3.5	4.7	6.9	9.0	11.1
4.0	4.4	6.3	8.2	10.1
4.3	4.3	6.1	7.8	9.5

Phase 2A of the HIE-ISOLDE project

# Cryomodules	3
# HEBT lines	3
E [MeV/u] (A/q = 2.5)	11.4
E [MeV/u] (A/q = 4.3)	7.8



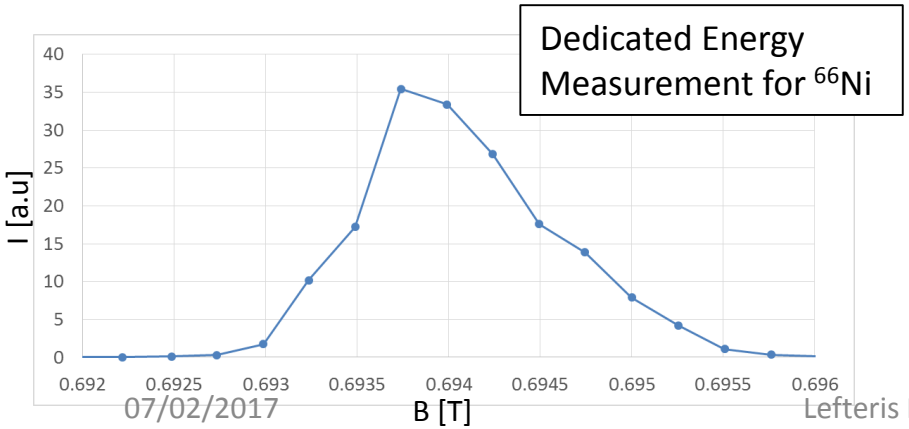
Beam Properties for 2017: Beam Energy and Energy Spread

In 2016:

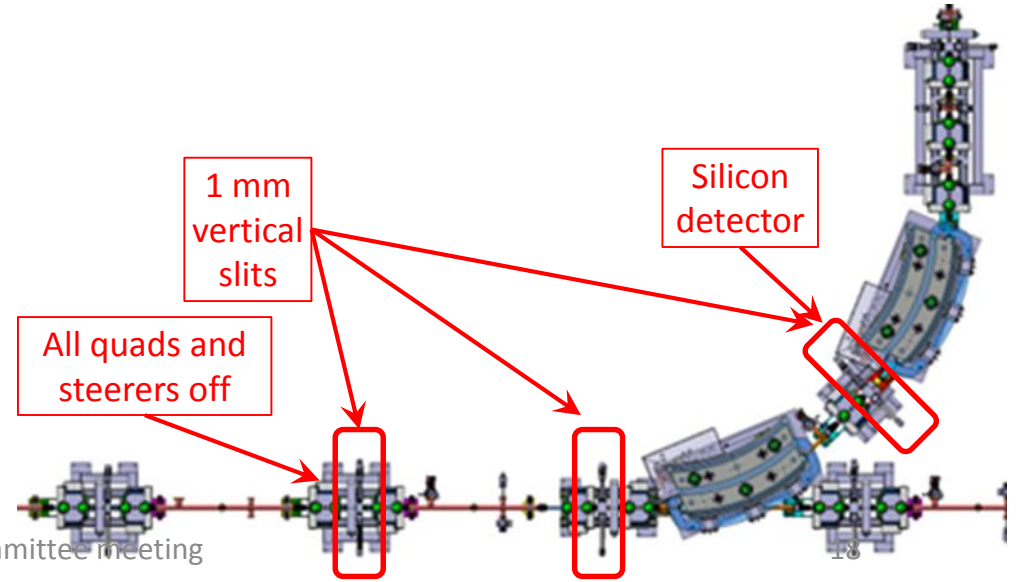
- Dedicated energy measurement (~ 4 hours were needed) using the dipole done for the last four experiments
- Due to problems with the machine (9gap amplifier for ^{110}Sn, target for ^{142}Xe), the dedicated measurements were not done in the first two experiments
- Best guess Energy is based on the settings of the dipole when beam was delivered to the users. But, it is not corrected for steerers and quads kicks

Energy and Energy Spread for experiments in 2016

	Nominal Energy [MeV/u]	Measured Energy [MeV/u]	Energy Spread HWHM [%]	Energy Best guess(1) [MeV/u]	Best guess / Measured
$^{66}Ni^{16+}$	4.5	4.47	0.2	4.46	0.998
$^{9}Li^{3+}$	6.9	6.72	0.5	6.74	1.003
$^{132}Sn^{31+}$	5.5	5.49	0.4	5.40	0.984
$^{78}Zn^{20+}$	4.3	4.27	0.3	4.30	1.007
$^{142}Xe^{33+}$	4.5			4.39	
$^{110}Sn^{26+}$	4.5			4.39	



(1)
- quads and steerers ON
- Slits retracted



Beam Properties for 2017: Beam Energy and Energy Spread

Expected for 2017:

- A new timing class for the Si detectors (including count rates) has been developed and will be commissioned this year
- Energy measurements will be a lot faster (expected ~ 1 hour for the second half of the campaign)
- Energy spread optimization may be possible to approach the theoretical 0.25% HWHM for all experiments
- Spokesperson should decide and inform in advance if a dedicated measurement is needed
- OP will decide when to schedule it

Energy and Energy Spread for experiments in 2016

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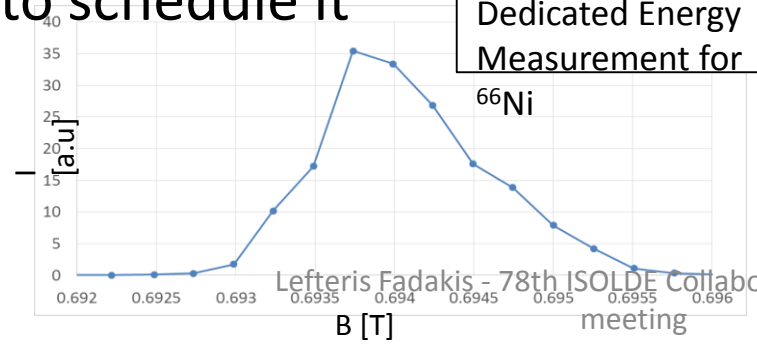
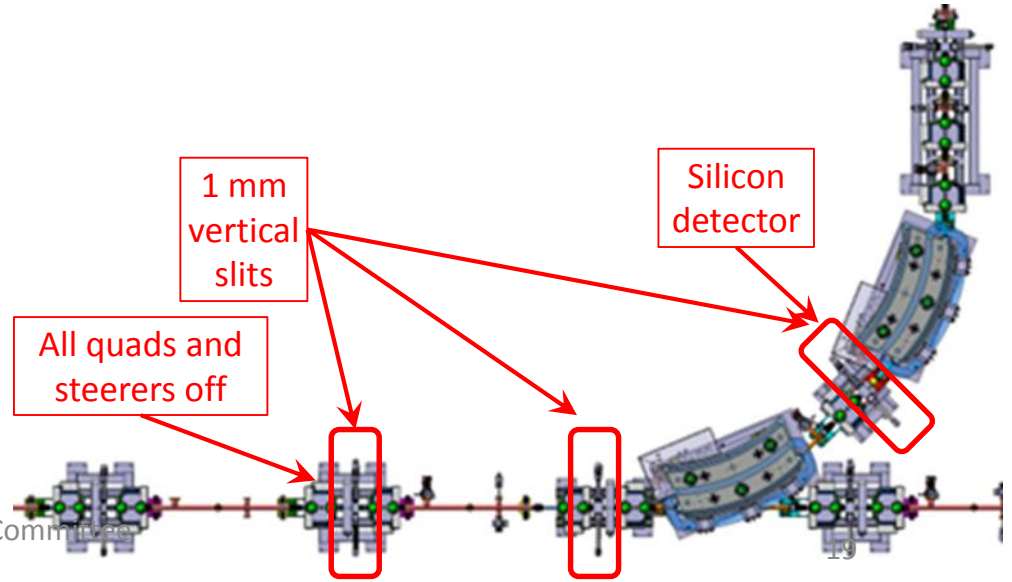
Dedicated Energy Measurement for ^{66}Ni





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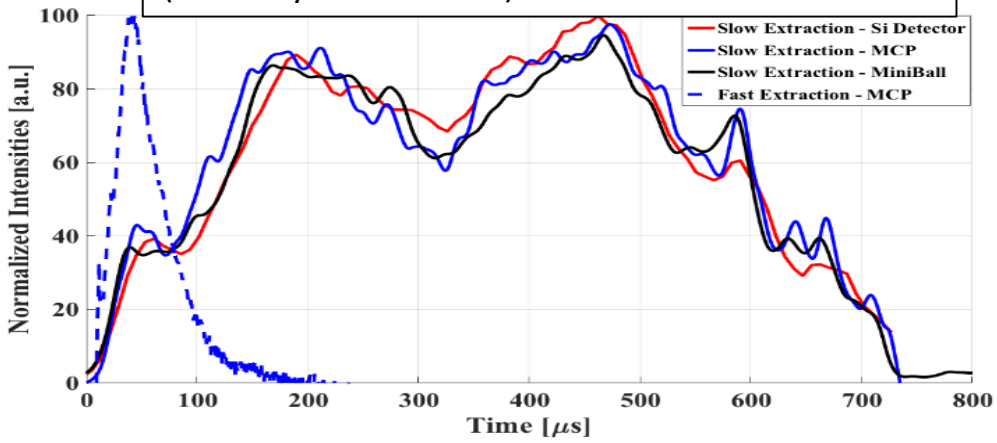
Beam Properties for 2017: Time Structure

In 2016:

- Repetition rate: up to 50 Hz
- RF Pulse length: up to 1 ms → Beam Pulse Length ~ 0.7 ms (with slow extraction)
- Average power in 9gap < 2.5 kW

Natural Extraction vs. Slow Extraction during 2016
(Courtesy of N. Bidault)



Expected for 2017:

- Repetition rate: up to 50 Hz
- RF Pulse length 2 ms → Beam Pulse Length ~ 1.7 ms
  - Heat exchangers installed during the technical stop
  - Bertronix will be at CERN on wk. 7 and make the necessary modifications
- Average power in 9gap < 2.5 kW
- Spokesperson should inform OP if slow extraction is needed in advance (typically, a couple of hours are needed to set it up)

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Beam Properties for 2017: A/q

Before 2016:

- Nominal minimum A/q was 2.5
- Nominal maximum A/q was 4.5

Since 2016:

- Nominal minimum A/q still 2.5
- Nominal maximum A/q changed to 4.33
  - Several REX amplifiers not reliable at the power levels needed for beams with A/q = 4.5
- Impact of the change in specs is limited (needs to be analysed case by case):
  - Some light beams are not possible (ex: $^{9}Li^{2+}$)
  - Charge breeding efficiency for some heavy beams could become lower (by a factor 2-4)

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HIE-ISOLDE Operations (Scenario 1):

- Alternating high and low energy physics. GPS for HIE-ISOLDE physics preferred
- Target installed on Friday, set-up Monday to Thursday, beam to users Thursday evening (earlier if lasers are not needed), Friday contingency
- Monday beam characterization and isotope/energy change if needed
- Target would reach its expected lifetime on Wednesday morning (1.8 µA avg. current assumed)
- Stable beam could be sent to the users during the weekends

	HRS										GPS										HIE
	08:30	09:30	10:30	11:30	12:30	13:30	14:30	15:30	16:30	17:30	08:30	09:30	10:30	11:30	12:30	13:30	14:30	15:30	16:30	17:30	
Fr	------						LE Physics				Target Installation						Pumping/Heating				
Sa	LE Physics										Pumping/Heating										Stable
Su	LE Physics										Pumping/Heating										Stable
Mo	LE Physics										Separator Set-Up				RILIS Set-up						
Tu	------							LE Physics			CA0	p-Scan			Target yields			CA0			
Wd	------							LE Physics			CA0	TRAP/EBIS Set-Up						CA0			
Th	------										CA0	EBIS Set-Up			RIB to linac			HIE Physics			
Fr	Target Installation						Pumping/Heating				------							HIE Physics			RIB
Sa	Pumping/Heating										HIE Physics										RIB
Su	Pumping/Heating										HIE Physics										RIB
Mo	Separator Set-Up							-----			RIB Charact.				HIE Physics						RIB
Tu	-----										HIE Physics (16.25 shifts, 5.3E18)										RIB
Wd	-----										HIE Physics (19.25 shifts, 6.2E18)										RIB
Th	CA0	p-Scan			Target yields				LE Physics		-----										
Fr	------						LE Physics				Target Installation						Pumping/Heating				
Sa	LE Physics										Pumping/Heating										Stable
Su	LE Physics										Pumping/Heating										Stable
Mo	LE Physics										Separator Set-Up				RILIS Set-up						
Tu	------							LE Physics			CA0	p-Scan			Target yields			CA0			
Wd	------							LE Physics			CA0	TRAP/EBIS Set-Up						CA0			
Th	------										CA0	EBIS Set-Up			RIB to linac			HIE Physics			
Fr	Target Installation						Pumping/Heating				------							HIE Physics			RIB
Sa	Pumping/Heating										HIE Physics										RIB
Su	Pumping/Heating										HIE Physics										RIB

	Shifts	%
HIE Physics	19.3	45.8
LE Physics	17.0	40.5
Targets	2.8	6.5
REX/HIE	1.8	4.2
LE to HIE to LE	0.5	1.2
CA0 + p-Scan	0.8	1.8
Total	42.0	100
RILIS	0.6	1.5
Separators	1.6	3.9
REX/HIE	5.0	11.9
HIE Stable Phys.	8.0	19.0

ISOLDE Beam Set Up Time Examples

- Best Case #1

  Same isotope with different energies.

  - If desired energies are known to OP then we can set up the machine the first time in a way that to change energy is a matter of switching off a number of cavities.

- Best Case #2

  Different isotope but close in mass

- Worst Case

  Completely different isotope in mass and energy

Summary

- Users should communicate to us before their experiment if they require beam energy measurement to take place.
- They should also provide a list of people to be granted access to the vacuum controls for the duration of their experiment.
- OP will not invest time in any last minute beam instrumentation solutions.
- Expected average SRF gradient for a beam with A/q = 4.0 to be 5.0 MV/m: 7.3 MeV/u.
- Faster energy measurement in 2017.
- RF Pulse length 2 ms → Beam Pulse Length ~ 1.7 ms (with slow extraction)
- Nominal maximum A/q changed to 4.33.
- 46% of HIE RIB physics
- 20% of REX/HIE stable beam physics
- 40% low energy physics

Thank you

Questions?