HIE-ISOLDE Project Status Report

Y. Kadi for the HIE-ISOLDE Project Team

HIE-ISOLDE Workshop: The Technical Aspects
CERN, 28-29 November 2013

OUTLINE

- **Scope of HIE-ISOLDE**
- Upgrade of ISOLDE Facility: HIE-ISOLDE
- Status
- Summary

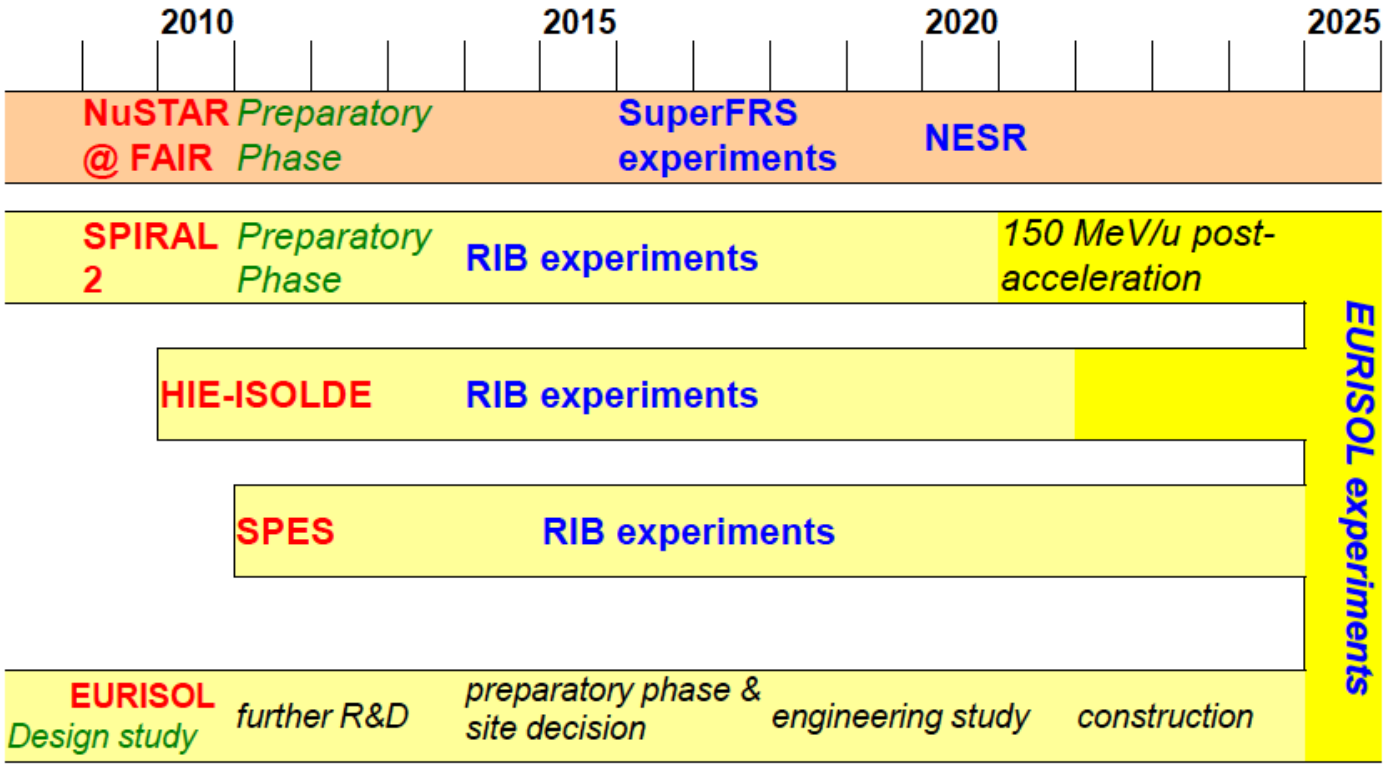
Motivation

The High Intensity and Energy (HIE) ISOLDE project builds on the success of the REX-ISOLDE post-accelerator and will focus on the upgrade of the REX facility but also aims to improve the target and front-end part of ISOLDE to fully profit from upgrades of the existing CERN proton injectors (LINAC4 and PSB Upgrade):

- ✓ Higher energy for the post-accelerated radioactive beam
- ✓ More beams (Intensity wise and different species)
- ✓ Better beams (High purity beams, low emittances, more flexibility in the beam parameters)

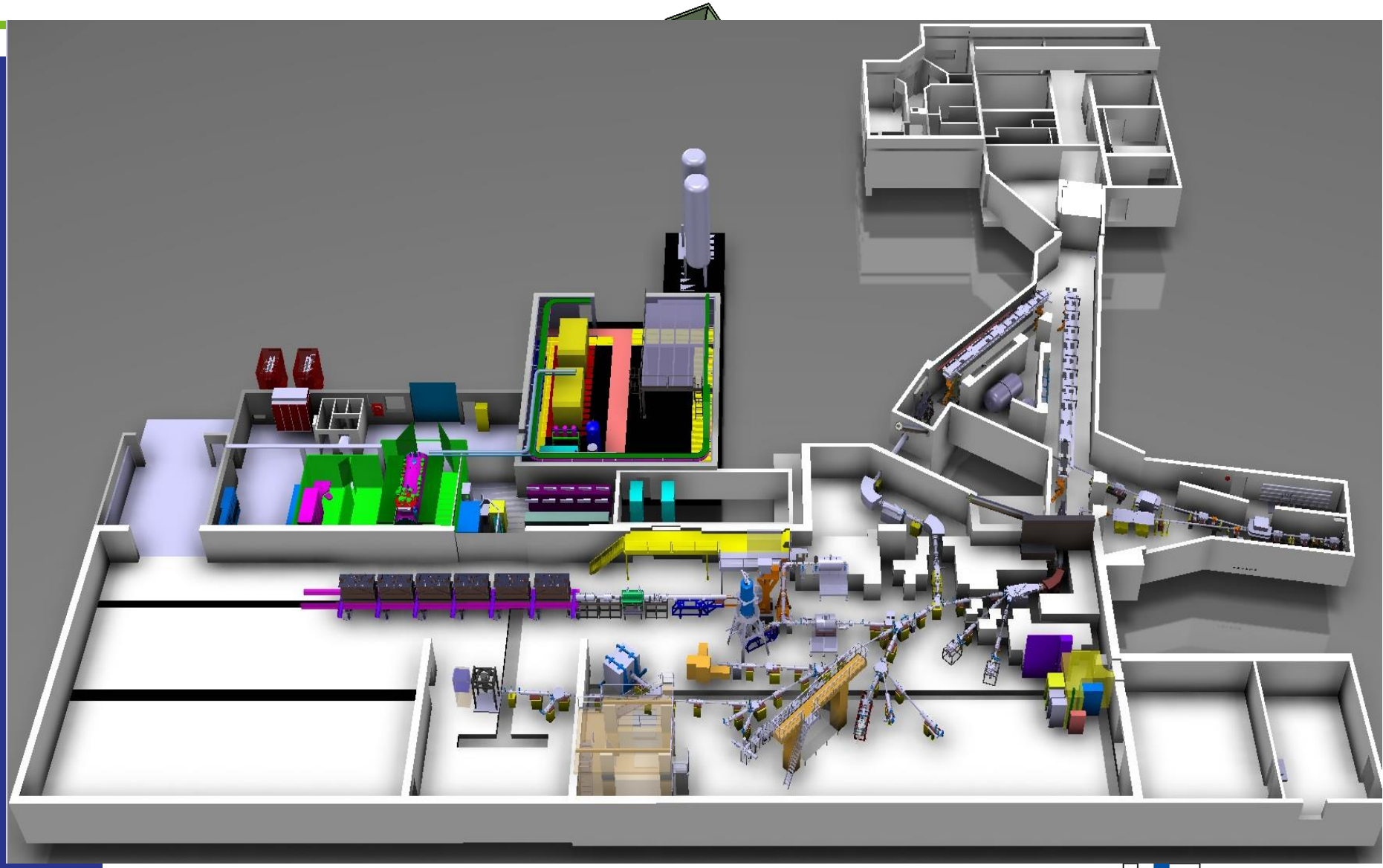
NuPECC Long Range Plan 2010 Timeline for RIB Facilities

HIE-ISOLDE will play an important role in the network of ISOL facilities preparing EURISOL (with SPIRAL2 and SPES)

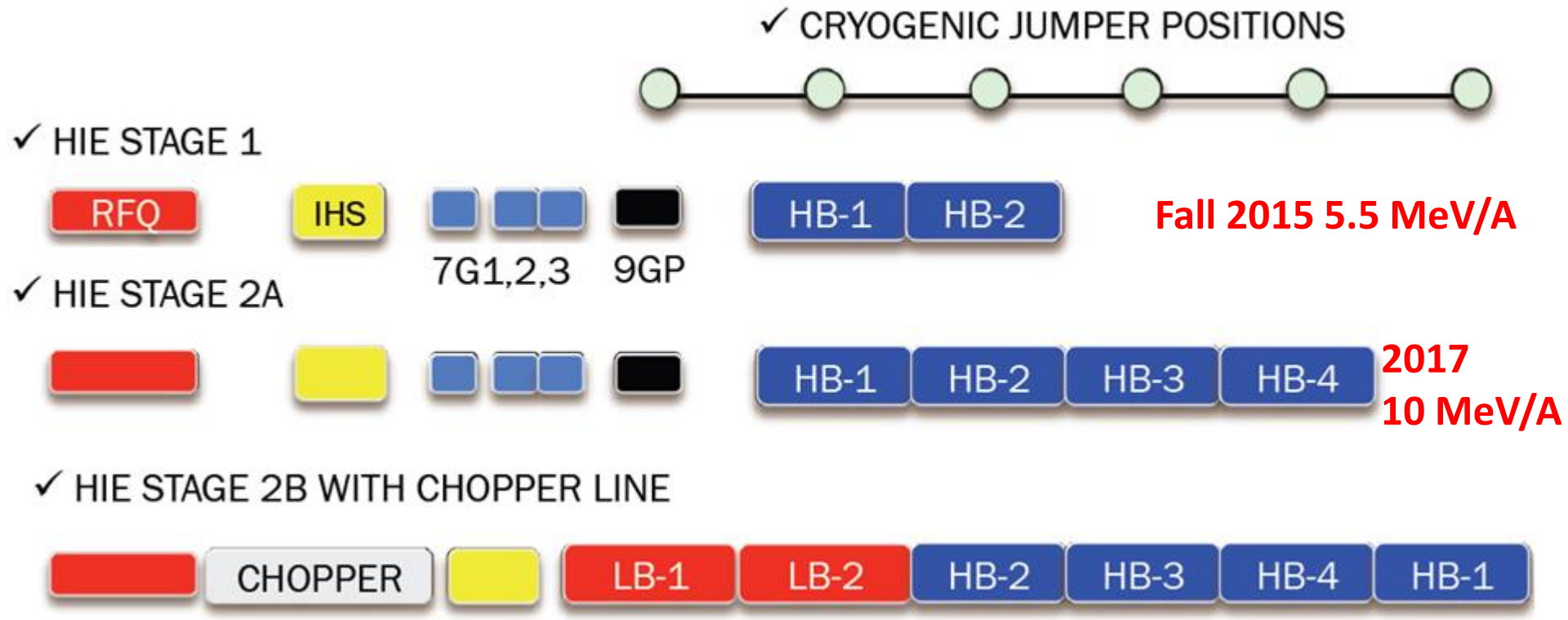


Worldwide: Oak Ridge; TRIUMF; KoRIA...

HIE-ISOLDE aims at increasing the energy of these RIB up to 10A MeV and their intensity by a factor 10

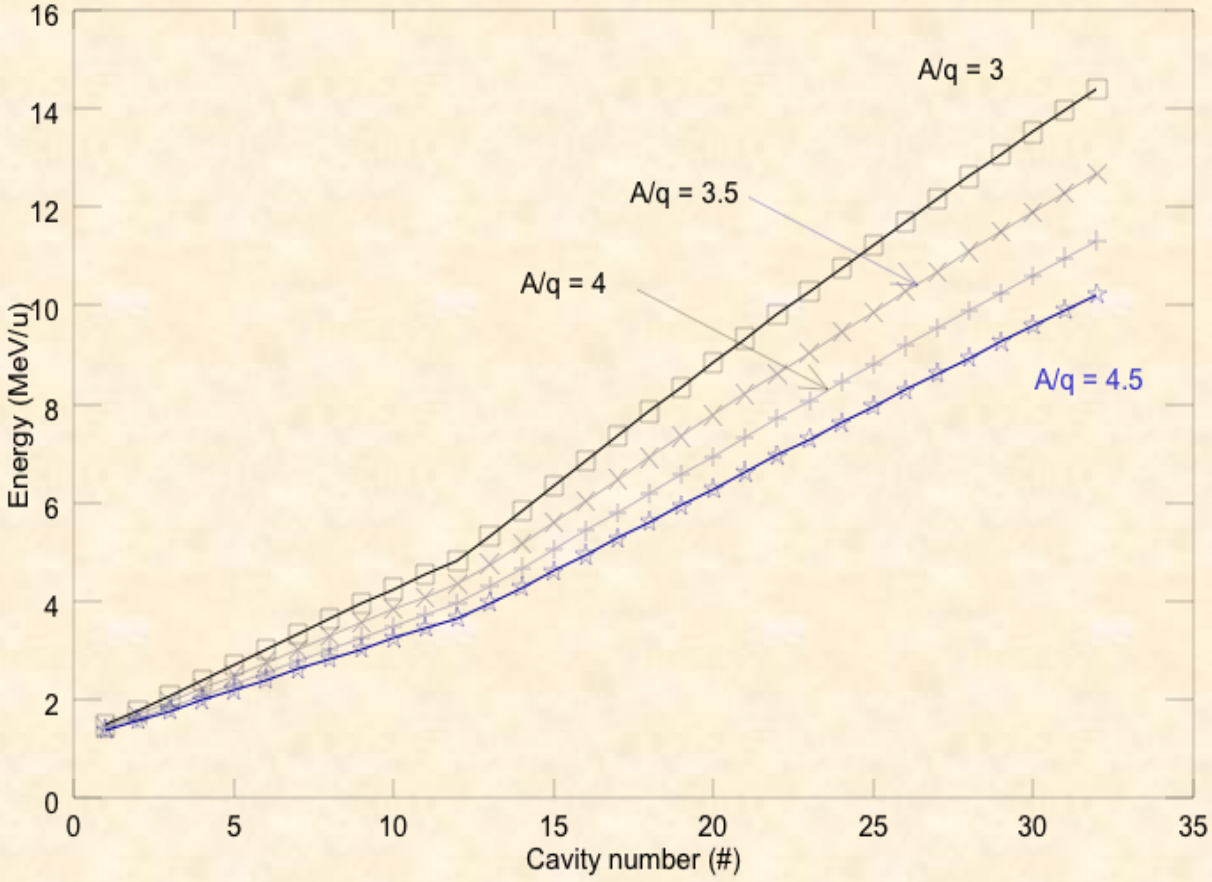


Superconducting LINAC installed in Three Phases



Period 100ns
Resolution 1-2 ns
Background < 1%

Final Beam Energies



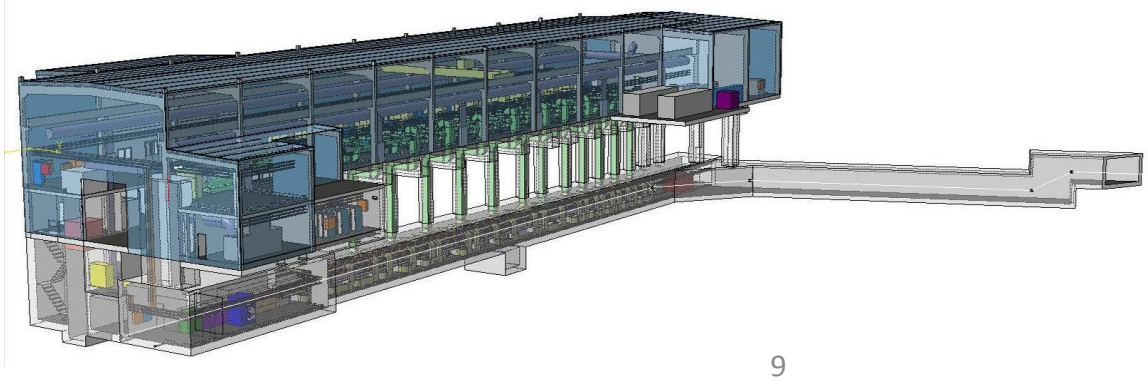
Different reactions and Physics reach with the upgraded facility

Reaction	Physics	Optimum energy	Other requirements
Virtual dipole excitation	Exotic collective modes	10 MeV/ u and higher	Neutron-rich beams
(d,p), (^{3}He,α)… transfer	Single-particle configurations, r-process for nucleosynthesis	10 MeV/u	Small emittance & beam-spot
(^{3}He,p), (d,α), (p,t), (t,p)	pairing	5-10 MeV/u	Small emittance & beam-spot
Deep-inelastic reactions	Structure of neutron-rich nuclei	8 MeV/u	Neutron-rich beams, good timing
Unsafe Coulomb excitation	High-lying collective states	6-8 MeV/u	Small emittance & beam-spot
Compound nucleus reactions	Exotic structure at drip line	5 MeV/u	Neutron-deficient beams
Coulomb excitation, g-factor measurements	Nuclear collectivity and single-particle aspects	3-5 MeV/u	Good energy definition, small beam-spot, small emittance, good timing
(p,p'γ) (p,α),…	nucleosynthesis	2-5 MeV/u	Energy variability and precision

High Intensity Upgrade

Protons/pulse	Intensity (μA)	Energy (GeV)	Cycle (s)	Power (kW)
$3.3x10^{13}$	2.2	1.4	1.2	3.1
$1x10^{14}$	6.7	1.4	1.2	9.3
$1x10^{14}$	6.7	2.0	1.2	13.3

Projected beam parameters considered within the HIE- ISOLDE Design study.
Based on ISOLDE receiving 50% of available proton pulses from the PS-Booster.



Accelerated ^{132}Sn yields (per second) *(fission factories only)*

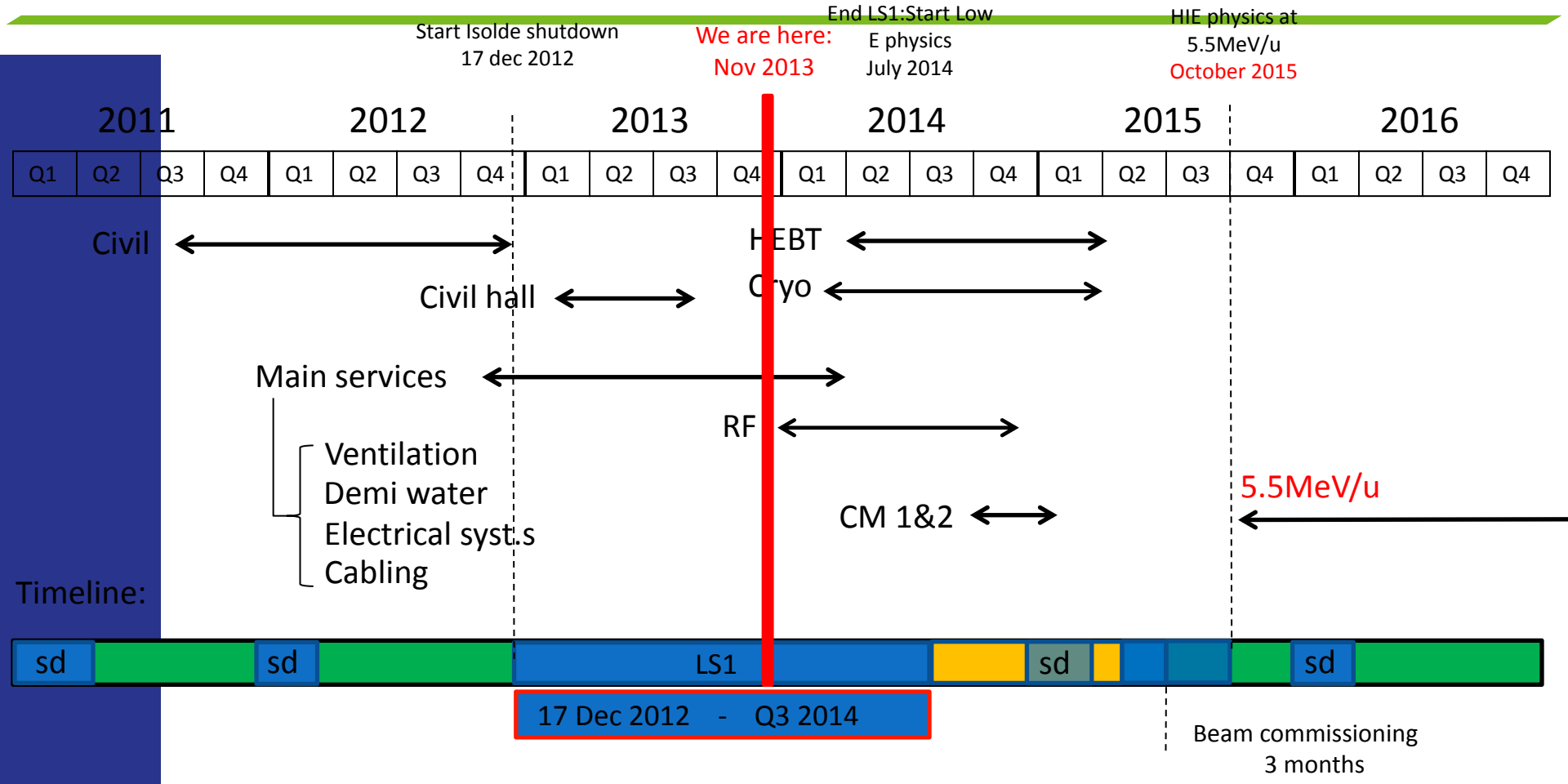
HRIBF	10^5	4.5 MeV/u	(now)
REX-ISOLDE	10^6	3 MeV /u	(now)
CARIBU	$5 \cdot 10^4$	10 MeV/u	(2010)
TRIUMF p-driver	10^7	5 MeV/u	(2010)
CARIBU phase 2	10^6	14 MeV/u	(2013)
HRIBF HDU	10^8	4.5 MeV/u	(2013)
HIE-ISOLDE	$5 \cdot 10^7$	10 MeV/u	(2017)
TRIUMF e-driver	$5 \cdot 10^8$	5 MeV/u	(2015)
SPES	$5 \cdot 10^8$	9 MeV/u	(2015)
SPIRAL-2	10^9	8 MeV/u	(2015)
EURISOL	10^{12}	150 MeV/u	(2025)

HIE ISOLDE installation progress

Technical Advances

- SC Linac
  - Cavity series production started
  - RF coupler and **tuner** systems are being validated
  - LLRF prototype successfully tested => series production underway
  - SC solenoid design approved=> fabrication starting
  - Cryomodule design finalized => procurement underway for long-lead items
- High-Energy Beam Transfer lines
  - Layout frozen => tracing on the floor
  - Dipole and quadrupole Magnets + supports ordered
  - H/V corrector magnets by end of November
  - vacuum chambers design to be finalized soon
  - Diagnostic boxes under procurement
- Installation works @ ISOLDE
- Design Study for the Intensity Upgrade well underway
  - Target + Front-end (FE8 and 9)
  - **Offline separator test bench**
  - HVAC + Cooling => nuclearization
  - **Charge Breeder => assembly of electron gun, test at BNL (US)**

HIE Simplified Planning



shutdown

Isolde Ops

HIE installations and tests (Isolde normal operations)

Machine Check-Out (Isolde normal operations)

Beam Commissioning (Isolde normal operations)

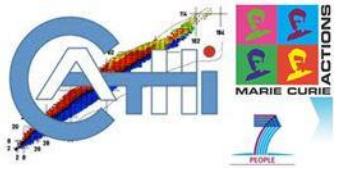
Conclusions (1/2)

- Technical Activities: progress is tangible on most of the machine parts => however one has to carefully monitor the following items:
  - ✓ Series cavity production
  - ✓ Tuning system procurement
  - ✓ Procurement of CM parts and instrumentation
  - ✓ Tooling for clean room assembly
  - ✓ Cryogenics for SM18 test
  - ✓ Transport solutions
  - ✓ Reliability issues
  - ✓ Safety
- Installation Works: High activity in the hall and service buildings; Despite delays we are still in line with the overall schedule which aims for low energy physics during 2014 and HIE physics as of Oct 2015. Critical paths for some activities are being addressed (cryogenics & cryomodule assembly)

Conclusions (2/2)

- Safety:
  - ✓ Shielding study finished – Report under preparation
  - ✓ Beam losses and dump study to be finished
  - ✓ CFD simulations of He leaks done by EN/CV have helped to discuss the access to the tunnel during steady state
  - ✓ Safety folder => Demonstrative part to be finished
  - ✓ Safety review carried out on November 6th 2013
- Budget & Planning: consolidation ongoing

Acknowledgements



- The presence of the CATHI fellows is paramount for the HIE-ISOLDE project:
  - Replace missing staff deployed on other high-priority projects (LS1, LHC Upgrade, L4, LIU, etc…)
  - Represent 1/4 of the total manpower of the project and almost 2/3rd in the case of the Design Study !
  - Help establish or re-inforce existing collaborations
- Keep up with the pace – maintain this good spirit and teamwork

Associated Partners

	Private Sector Participant	Country	Legal Entity Name	Department /Division/ Laboratory	Scientist-in-charge
Full Network Partner					
1		Switzerland	European Organization for Nuclear Research	Engineering Dept.	Yacine Kadi
Associated Partners					
1	√	Italy	CINEL		Sergio Bongiovanni
2		France	CNRS/IN2P3	IPN-Orsay	Sebastien Bousson
3		France	CNRS/IN2P3	LPC- Caen	Nigel Orr
4		UK	Cockroft Institute	Accelerator Science and Technology Center	Peter McIntosh
5		France	GANIL	Technique de la Physique	Pierre Delahaye
6		Italy	Istituto Nazionale di Fisica Nucleare	Laboratori Nazionali di Legnaro - LNL	Gianfranco Prete
7		Germany	Max Planck Institute	MPI- Heidelberg	Klaus Blaum
8		USA	Michigan State University	National Superconducting Cyclotron Laboratory	C. Konrad Gelbke
9	√	UK	Scientific Magnetics		Peter Penfold
10	√	France	SDMS		Pierre Maccioni
11	√	Italy	SIDEA		Marco Mauri
12		Finland	University of Jyvaskyla	Physics Dept.	Ari Jokinen
13	√	Italy	ZANON		Ettore Zanon

New Partners

14	University of Liverpool	LIV	UK	Research and Scientific Training	Carsten P. Welsch c.p.welsch@liverpool.ac.uk
15	University of Manchester	MANU	UK	Research and Scientific Training	Roger M. Jones Roger.Jones@hep.manchester.ac.uk
16	CEA – IRFU	IRFU	FR	Research and Scientific Training	Valentin Blideanu valentin.blideanu@cea.fr
17	Brookhaven National Laboratory	BNL	USA	Research and secondment	Edward Beebe
18	Brandeis University	BRD	USA	Research and Scientific Training	Jim Bensinger bensinger@brandeis.edu
19	TRIUMF	TRIUMF	CA	Research and Secondment	Bob Laxdal lax@triumf.ca

- The research leading to these results has received funding from the European Commission under the FP7-PEOPLE-2010-ITN project CATHI (Marie Curie Actions - ITN). Grant agreement no PITN-GA-2010-264330.

Thank you