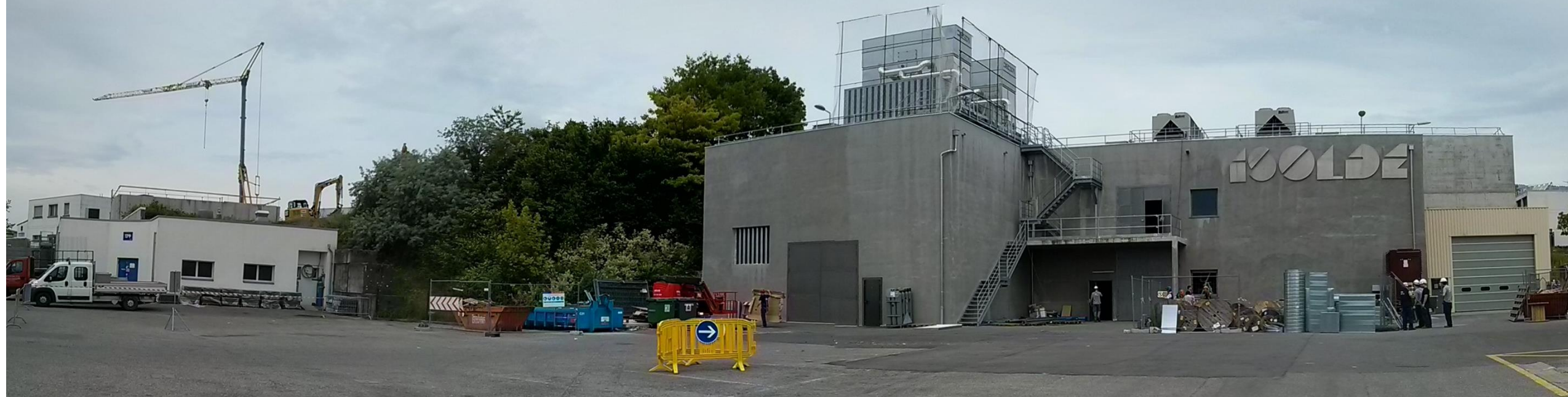


# ISOLDE physics coordinator report: ISCC 26<sup>th</sup> June 2018

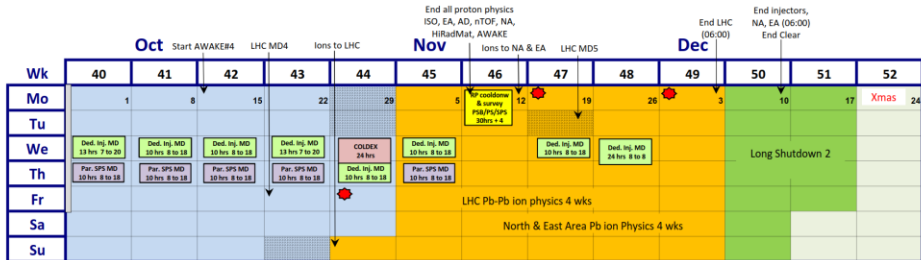
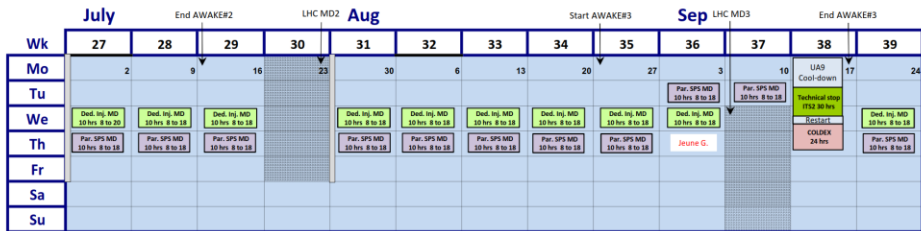
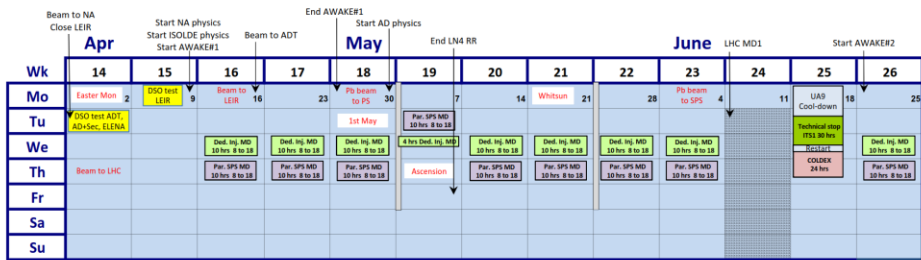
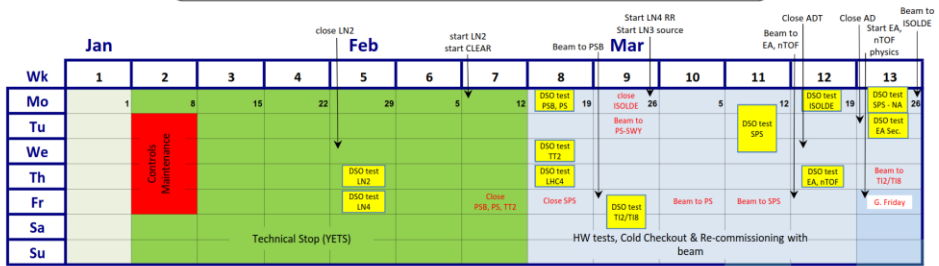
Karl Johnston



- Planning for 2018
- Schedule so far: preparation for HIE-ISOLDE and end of year
- Safety
- Technicians

## Injector Accelerator Schedule 2018

Approved by Research board on 06.12.2017



- Injector Complex MD Block
- Technical stop for the Injector Chain
- Indication of LHC MD blocks proton period
- Special (physics) runs
- HIRadMat: possible beam request
- Ions to NA and/or LHC
- Indication of LHC MD blocks ion period
- Parallel SPS MD, reduced duty cycle for NA
- LINAC 3 Pb oven re-fill

Protons available for physics to ISOLDE from 9<sup>th</sup> April – 12<sup>th</sup> November 2018.

217 days for physics (compared to 224 in 2017)

HIE ISOLDE on track for physics the week of July 9.

This leads to ~ 126 days available for HIE ISOLDE, compared to 150 in 2017. (at least with protons)

Dedicated low energy block from 9<sup>th</sup> April: ~ 90 days for LE.

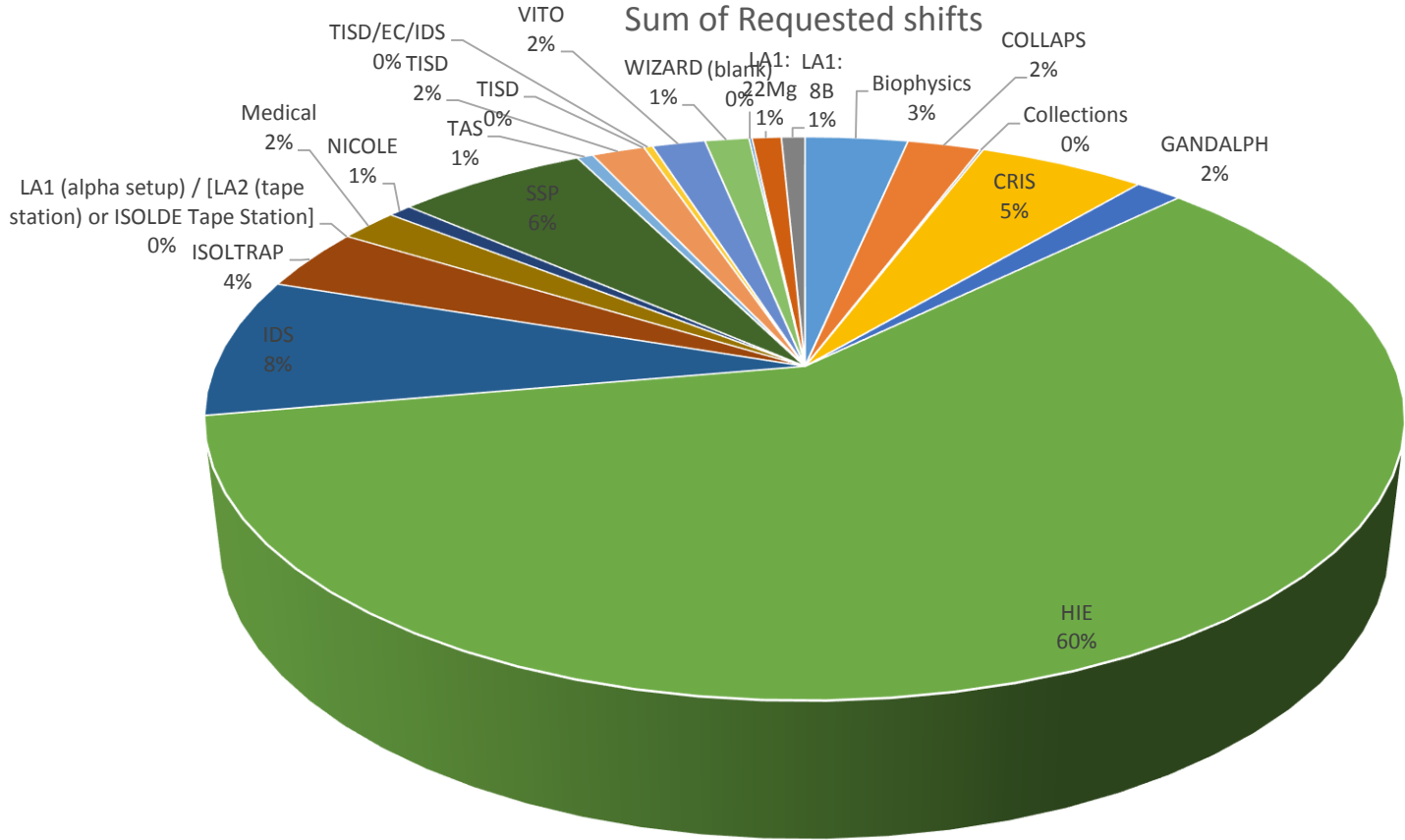
Interleave HIE and LE runs as in 2017.

Strategy for HIE: 4CMS so optimized for reactions.

10MeV/u only available for lighter masses ~ 7.4MeV/u for mid/heavy: consequences for reaction runs.

Starting with CE then switch to T-Rex; XT03 and ISS to be accommodated.

# Summary of beam requests 2018



Row Labels	Sum of Requested shifts
Biophysics	35
COLLAPS	25
Collections	1
CRIS	57
GANDALPH	16
HIE	629.5
IDS	84.501
ISOLTRAP	38
Medical	20
NICOLE	8
SSP	65
TAS	5.5
TISD	18
TISD	0
TISD/EC/IDS	3
VITO	18
WIZARD	15
(blank)	1
LA1: 22Mg	10
LA1: 8B	8
<b>Grand Total</b>	<b>1057.501</b>

# ISOLDE Schedule 2018: weeks 15 – 34

## GPS schedule 2018

	April				May				June				July				August					
WK	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	
MO	2	9	16	#534/567 Sn VDS 23	30	7	MD: FTS 14	21	28	4	11	18	25	2	9	16	23	30	6	13	20	
TU			TISD		May-01	ISOLDE	MD: FTS			IS610		Tech Stop	Medical isotopes						#650 MWCNT			
WE			TISD	ISOLDE Solid State Physics	#599 Ti foils	IS634					ISBM	#655 Ta - W		UC VD7								
TH		#513/ #650			Ascension																	
FR			ISOLDE Decay Station	IS611 IS640			#653 UC - Ta n			#634 LIST	<sup>22</sup> Mg to LA1		IS528 IS638								XT03 (tbc)	
SA				IS647 IS652											IS644 (LOI205)	4.8MeV/ u (IS506)					IS616: 4.5MeV/ u	
SU			IS633	IS653				IS622			IS614	IS528					IS552: 4.1MeV/ u					
			8B: IDS	111Cd		RILIS: Mg		RILIS: Cu		RILIS: In	RILIS: Mg	RILIS: Dy	RILIS: Dy		96Kr / 212Rn		22x Rn					8B

## HRS schedule 2018

	April				May				June				July				August				
WK	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
MO	2	9	16	23	#651 ZrO HP 30	#652 ZrO HP 7	#618 UC - Ta/W 14	21	28	4	11	18	25	2	9	16	23	30	6	13	20
TU					May-01					#626 Ta - W	TBC	Tech Stop		#652 UC Ta (+CF4) 2							
WE	#640 LaC - n				TISD								Machine development		UC W (+CF4)						
TH		CRIS		ISOL TRAP	COLLAPS	ISOL TRAP			CRIS	COLLAPS			Machine development								
FR			#627 Ta - W					#654 UC - W													
SA																					
SU			IS639		IS532	IS623	IS642	IS645	IS620	IS649				IS650 IS637 IS608			IS552 IS553: 4.1MeV/ u				IS613
	HT tests	In RILIS		Sc RILIS In RILIS	RILIS test Ge 345	70Br	26Na		K beams	Sc RILIS				RILIS: Bi		22xRa/142Ba			Sn RILIS		Sn RILIS



Target change
CERN holiday
Setting up/proton scan/yield
Physics GPS
Physics HRS
RILIS run

Week 24 2018		RILIS	GPS	HRS	CAO	p's	MEDICIS	Visits	other
Monday	6/11/2018	AM	LIST/separator setup	IS649	HRS	NORMHRS	#626M (Ta): move to Irradiation point (PM)		
		PM	LIST/separator setup	IS649	HRS	NORMHRS			
		night		IS649	HRS	NORMHRS			
Tuesday	6/12/2018	AM	LIST/separator setup	IS649	HRS	NORMHRS	#626M to exchange point	14:00 Swedish students	
		PM	LIST/separator setup	#661 (if ready)	GPS				
		night	Stable beam to LA1		GPS				
Wednesday	6/13/2018	AM	Proton scan TISD	setup of HRS through cooler (Tim/Stuart/Annie)	GPS	NORMGPS			
		PM	TISD		GPS	NORMGPS			
		night	Stable beam to LA1		GPS	NORMGPS			
Thursday	6/14/2018	AM	TISD		GPS	NORMGPS			
		PM	IS614		GPS	NORMGPS			
		night	IS614		GPS	NORMGPS			
Friday	6/15/2018	AM	IS614		GPS	NORMGPS			
		PM	IS614		GPS	NORMGPS			
		night	IS614		GPS	NORMGPS			
Saturday	6/16/2018	AM	IS614		GPS	NORMGPS			
		PM	IS614		GPS	NORMGPS			
		night	IS614		GPS	NORMGPS			
Sunday	6/17/2018	AM	IS614		GPS	NORMGPS			
		PM	IS614		GPS	NORMGPS			
		night	IS614		GPS	NORMGPS			
Monday	6/18/2018	AM	IS614		GPS	NORMGPS			
		PM	(tbc) protons off at 1600 for TS		GPS	NORMGPS			
		night			GPS	NORMGPS			

Summary of week: COLLAPS finish with Sc on HRS on Tuesday morning. Setup for Mg run using LIST then begins. TISD will make extensive tests. Stable beam to LA1 either Tuesday night or Wednesday. Proton scan Wednesday if ready. Yield checks on Mg once lasers ready. Beam to experiment on Thursday afternoon/evening. On Monday 11th June, the MEDICIS target will be put on the irradiation point for irradiation overnight. Technical stop on 19th June. Protons will be turned off on 1600 Monday 18 June (tbc at next week's FOM).

(GPS): #660 SiC LIST for Mg beams to LA1. Setup at 50-60kV. Isotope for the experiment: 22Mg. **Responsible for target:** Reinhard and TISD group.

(HRS): #626 Ta - W for Sc beams to COLLAPS. HT = 50kV. RFQ in bunching mode. #661 VD5 target for RFQ tests.

**Responsible for the target #626:** David and Sebastian. **Responsible for target: #661** Tim/Stuart/Annie

Protons: NORMHRS till Tuesday morning. NORMGPS from Wednesday

Operations responsible: Emanuele (167813) until 12th June Alberto (167538) afterwards.

For more details about visits: <https://espace.cern.ch/isolde-visits-info/Lists/Calendar/calendar.aspx>

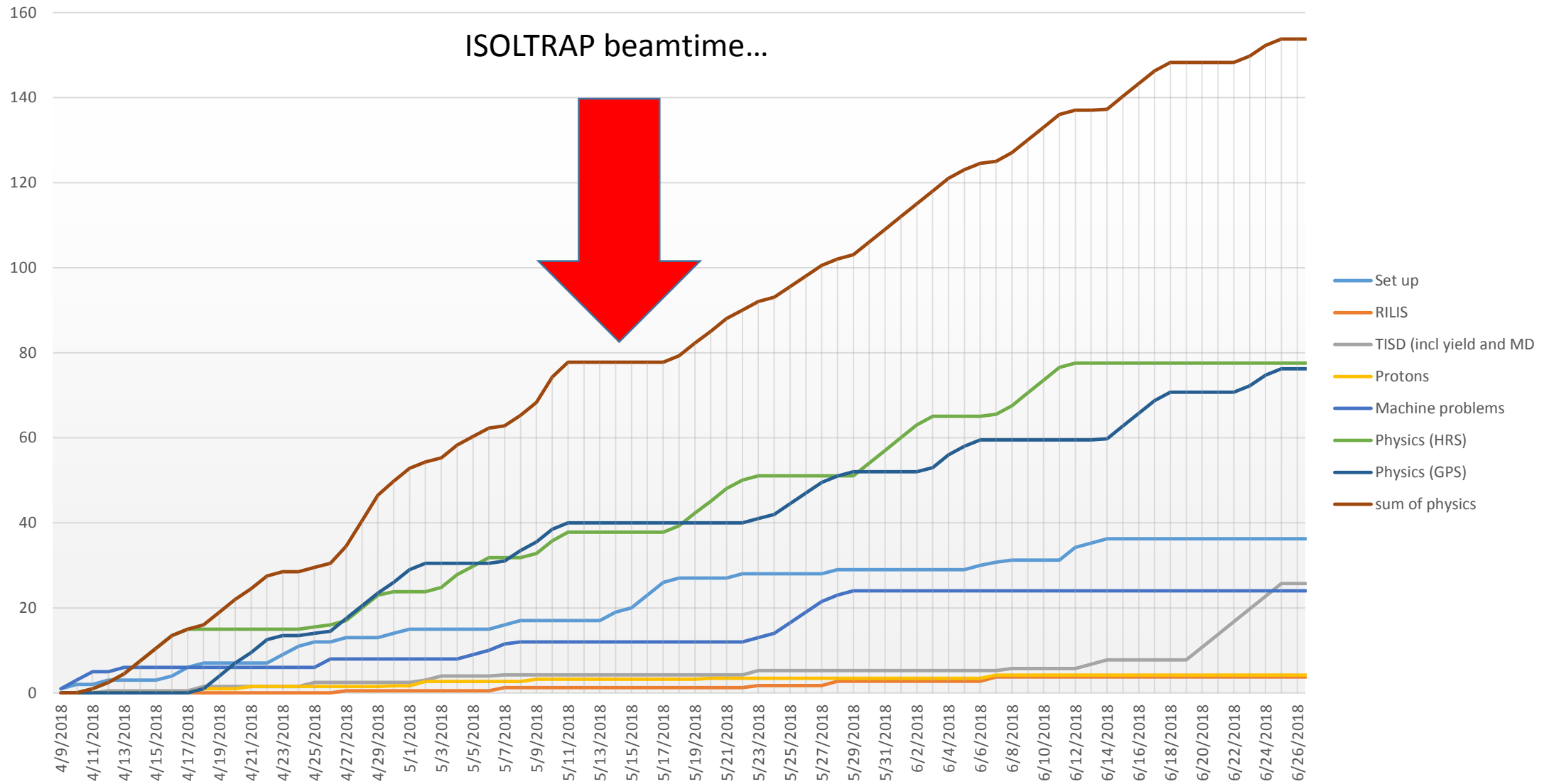
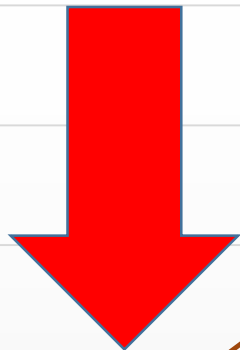
New column to the weekly planning: MEDICIS.

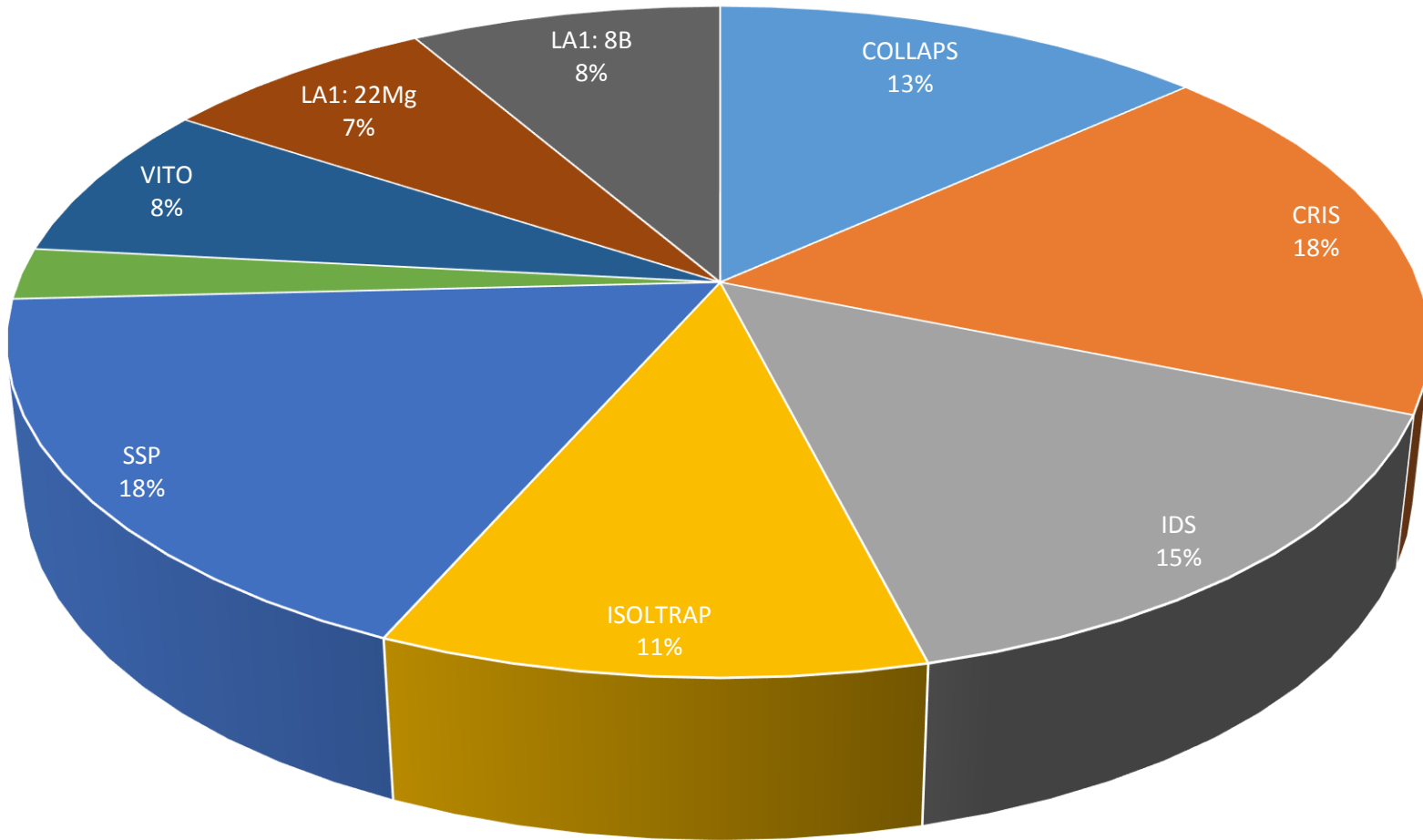
So far no consequence on ISOLDE programme.

MEDICIS station possibly available for offline irradiation of ISOLDE targets in Autumn

New ISOLDE Schedule “TAC” (Technical advisory committee). Similar to what takes place before INTC but for the schedule to avoid surprises, discuss yields, targets impurities, feasibilities etc. (start-up meetings often too close to the beamtime to make changes).

ISOLTRAP beamtime...





Currently on day 79

163 number of shifts so far  
(excluding current medical run...)

18 experiments

ISSUES: Autotune: currently working on a new CERN supported programme and investigating Tim's programme.

Observations: Machine performing even in spite of late start-up (late arrival of water) compressed cold check out...protons were available before ISOLDE was able to take them....

Draft planning (from October onwards very much a draft).

August				September				October				November			
32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
6	13	20	27	3	10	17	24	1	8	15	22	29	2	5	12
#650 MWCNT						tech stop	Pb or Sn					CaO?			
		(tbc)	11Be for XT03 + EC + colls	UC Ta				ISS Hg run(enough energy?)							
	IS616: 4.5MeV/u	uc			Mossbauer (57Mn) + EC		Stagiso run		negative run	Ta				LIEBE?	
	8B										9Li?	WISARD?			

Mixture of T-REX/ISS and XT03 for HIE ISOLDE. Interleaving low energy and negative runs. Also quite a few setups coming together at end of year...

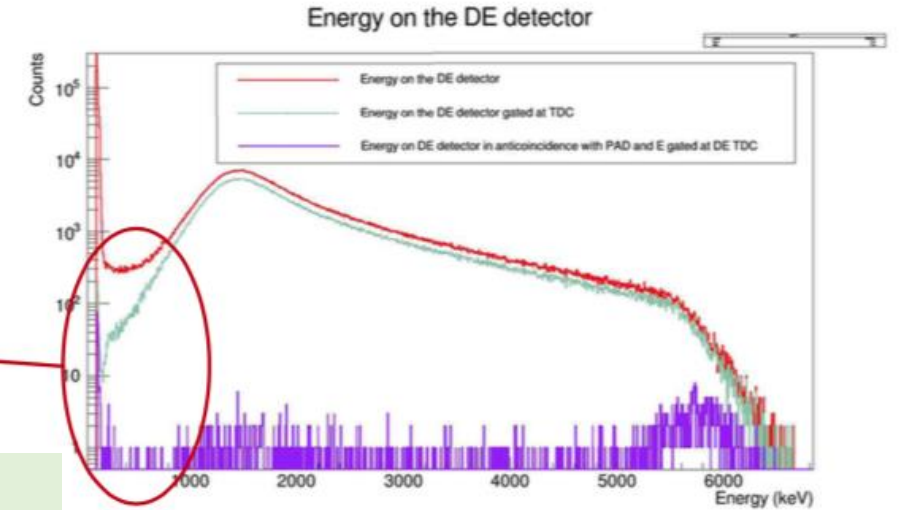
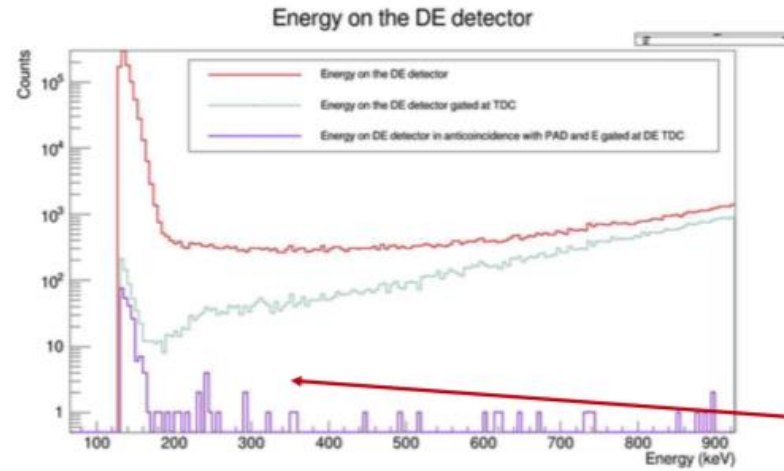
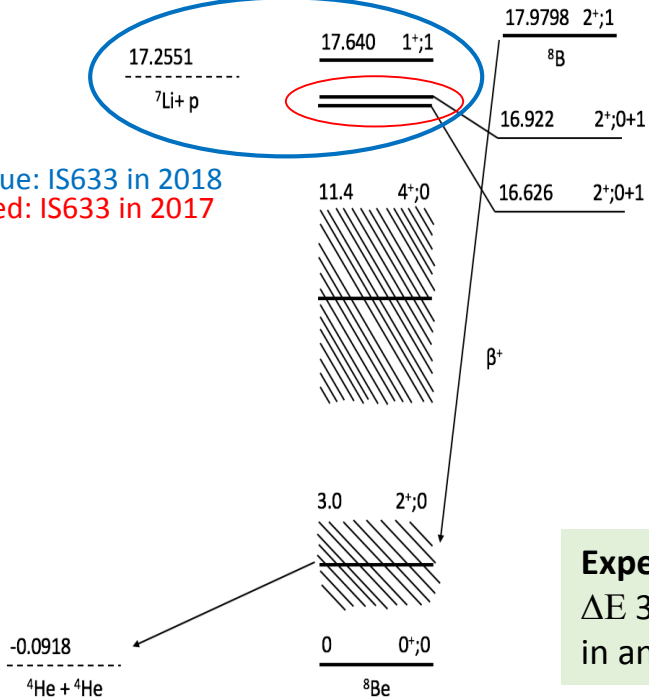
After protons finish on Nov 12<sup>th</sup>: 7Be to XT03 (if target available); 44Ti to XT03 (Edinburgh); RaF to CRIS.

August				September				October				November			
32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
6	13	20	27	3	10	17	24	1	8	15	22	29	2	5	12
	LaC				SiC							COLLAPS Sn (II)			
IS562: 4.4MeV/u				134Sn for TREX: IS654		28Mg for TREX + ISS	28Mg for TREX + ISS	UC n	COLLAPS: Sn (I)	IS595 132Sn + 34S	UC n				
Sn RILIS		Sn RILIS												94Rb for Miniball and XT03? Else MB C-REX.	

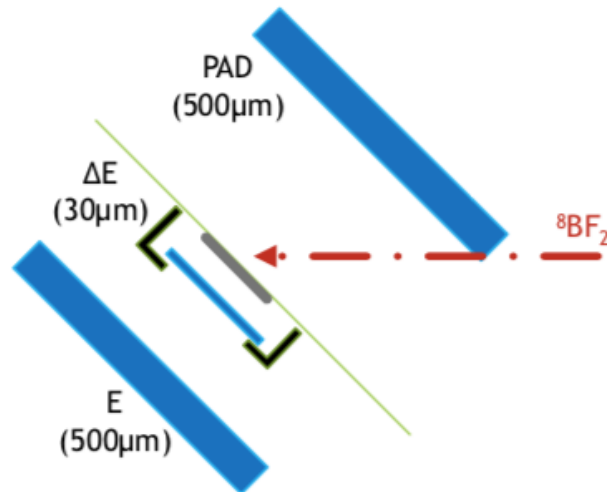
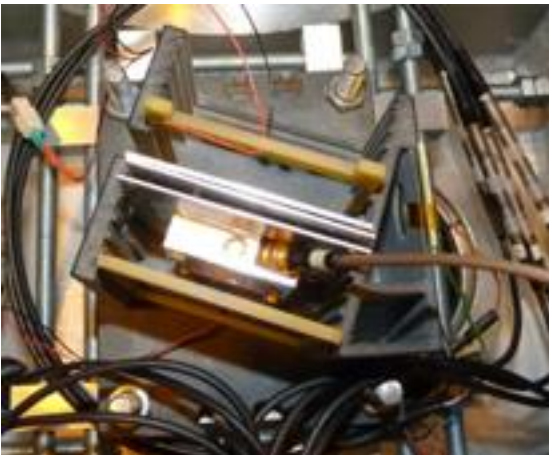


**IS633: Electron capture of  $^8\text{B}$  into the highly excited states of  $^8\text{Be}$  2018; determining the branching ratio to the state at 17.64 MeV  $\rightarrow$   $^7\text{Li}+p$**

Blue: IS633 in 2018  
Red: IS633 in 2017



**Experimental set-up at La1:**  
 $\Delta E$  30  $\mu\text{m}$  thick, 20mm $^2$  Si detector to detect the 330 KeV proton in anti-coincidence with two 5x5cm $^2$  Si-PAD



The main decay of  $^8\text{B}$  is  $\beta \rightarrow \alpha+\alpha$ , determining the branching ratio depends on the overall statics obtained. We had very good yield  $1\text{E}5$   $^8\text{B}/\mu\text{C}$ ; with 70% of the data analysed we have  $3.64\text{E}8$  events in  $\Delta E+\text{PAD}$  coincidence

The task is to have the region of 300KeV clean enough in order to give an experimental limit on the branching ratio to the 17.25 MeV level.

The theoretical upper limit is  $2.3 \cdot 10^{-8}$  [3] was calculated factorizing the wave function as a proton halo.

# Spring 2018 at

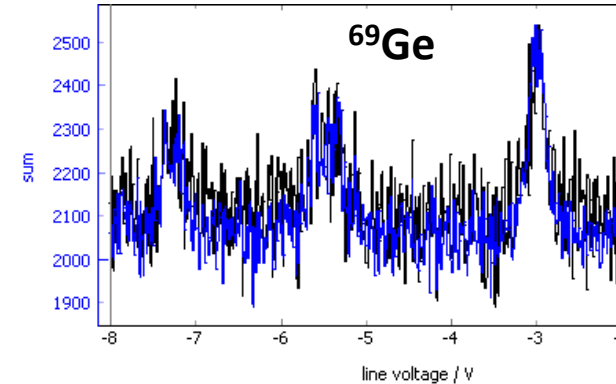


## Ge (Z = 32) isotopes across the N=40 subshell closure

- $^{68-74}\text{Ge}$  (N = 36 – 42)
  - ✓ Part of physics goal was reached
  - ☹  $^{65-67,75-76}\text{Ge}$  and isomers in  $^{71,73}\text{Ge}$  out of reach
- First use of new laser frequency mixing unit

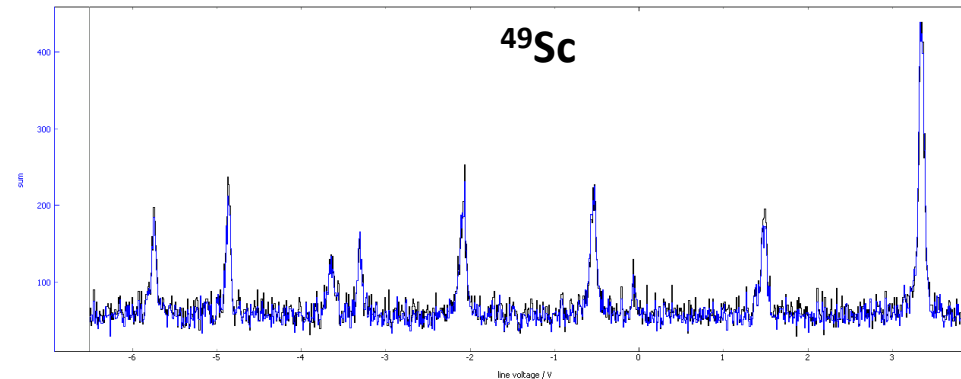
**BUT ...**

- Overwhelming amount of contamination
  - nA of beam at some masses (luckily decreased over time)
- No Ge mass marker (in combination with large contamination) slowed down setting up COLLAPS



## Sc (Z = 21) isotopes across N=28

- $^{44-50}\text{Sc}$  (N = 23 – 29)
  - ✓ Main physics goal reached
  - Only partial spectrum of  $^{50}\text{Sc}$
- Smooth ISOLDE operation



## Generally

- Continuous AC problems in laser lab
- Frequent tripping of power supplies at ISOLDE make long scans even more difficult!

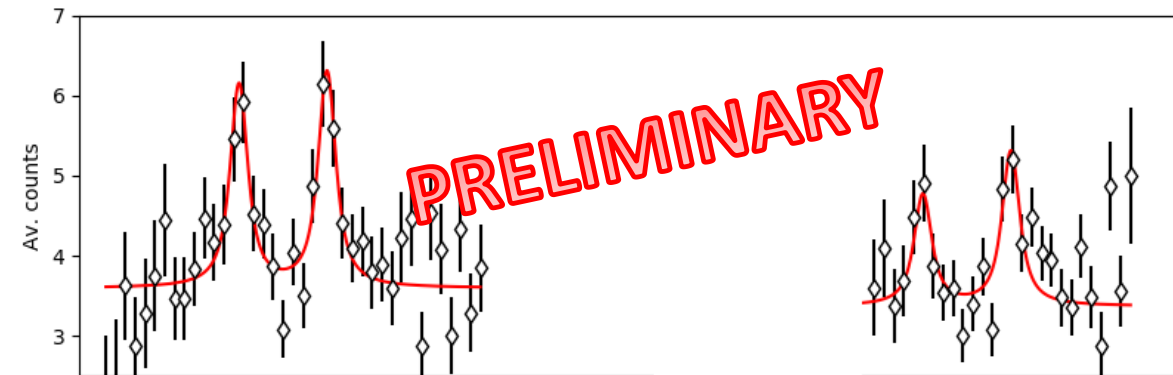
# Study of neutron-rich K isotopes at CRIS IS620

## Goal of the experiment

- ❖ Measuring the hyperfine structure of  $^{52,53}\text{K}$
- ❖ Investigating the N=32,34 shell closures

## Results

- ❖ Hyperfine structure of  $^{38,41,42,47-51}\text{K}$  using ion detection
- ❖ Due to high (stable) contamination at mass 52, 53 ion detection was not possible at these masses
- ❖ Beta detection of resonantly laser ionized isotopes enabled the measurement of  $^{52}\text{K}$
- ✓ First use of beta detection at CRIS
- ❖  $^{52}\text{K}$  (N=33) is an excellent laboratory to investigate the N=32 shell closure
- ❖ Hyperfine structure of  $^{53}\text{K}$  was not obtained



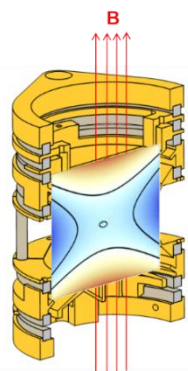
Hyperfine structure of  $^{52}\text{K}$  obtained by detecting the beta decay of resonantly ionized  $^{52}\text{K}$  isotopes

Contamination @ mass 52	$\sim 10^7$ ions/s
$^{52}\text{K}$ yields	$\sim 300$ ions/s

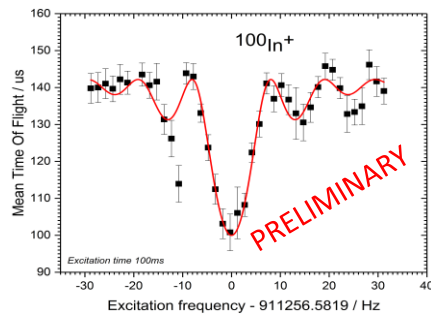


# ISOLTRAP : experimental campaigns in 2018

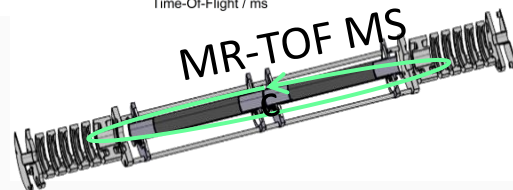
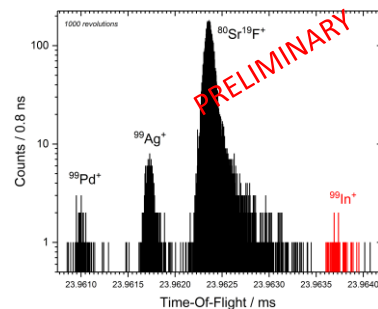
April 2018 – LaC<sub>x</sub> + RILIS: high-quality Indium beams.



Precision Penning trap

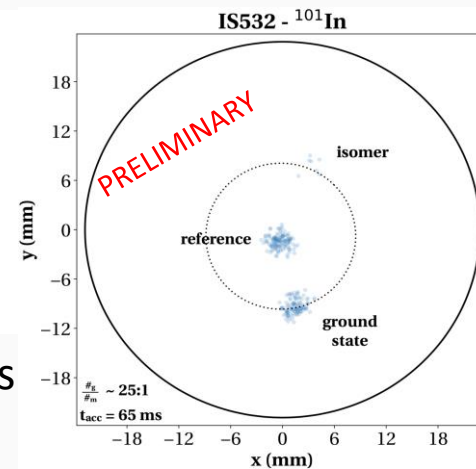


Penning trap measurements improve the mass uncertainty of  $^{100}\text{In}$  by a factor 100.



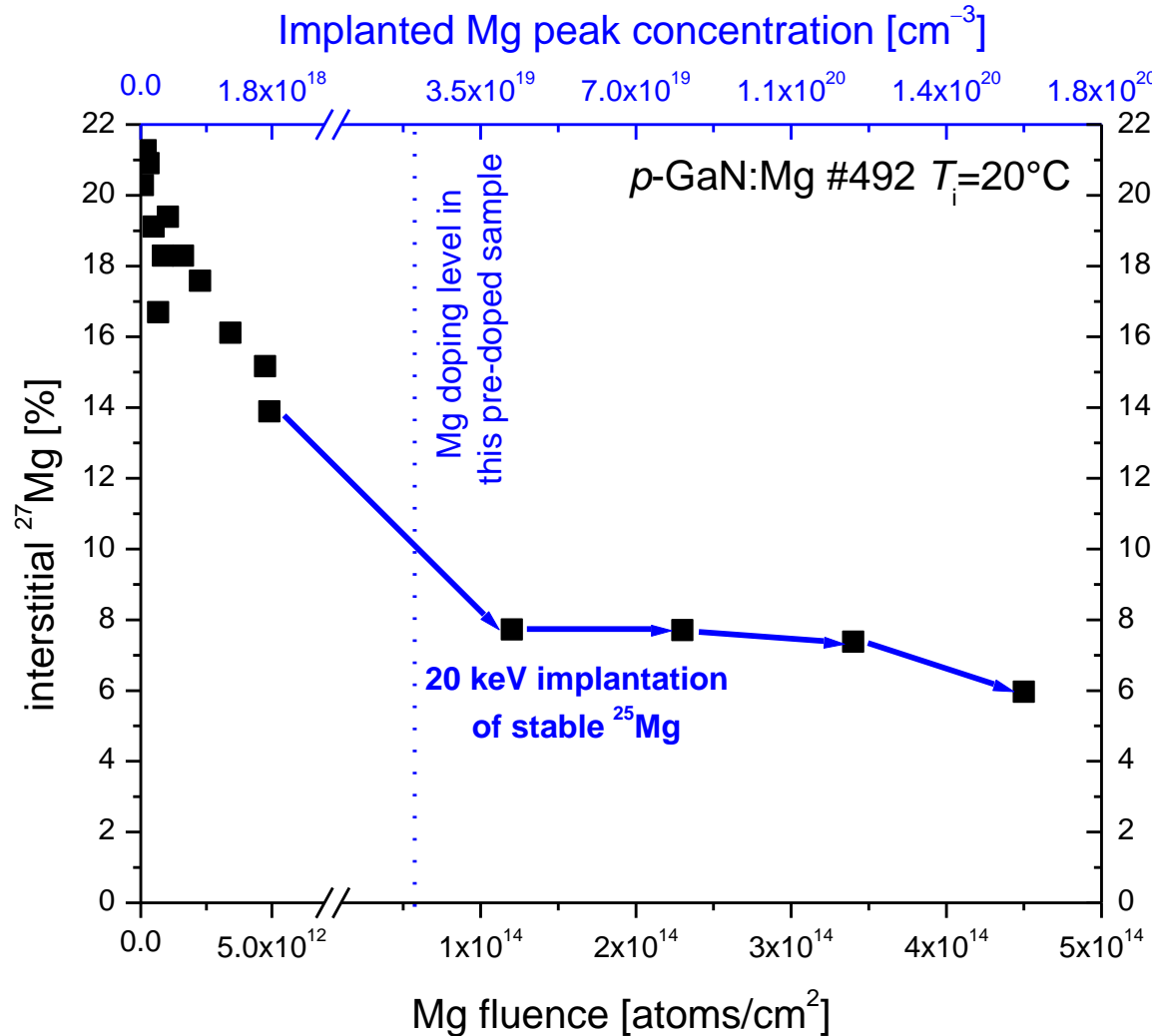
MR-TOF MS allows first mass measurement of  $^{99}\text{In}$

PI-ICR technique allows first mass measurement of  $^{101}\text{In}_{g,m}$ .



- $^{52-55}\text{Sc}$  run (RILIS+Ta-foil target)
  - Confirms that neutron rich Sc up to  $A=52$  are produced 😊
  - Stable Ti-V-Cr isobaric contamination too strong ☹️
  - Impossible to measure the Sc isotopes of interest
  - Run redirected to In 😊😊😊
- $^{70}\text{Br}$   $Q_{ec}$  value : Mai 2018
  - lower production rate and higher than expected contamination ☹️

# IS634: Exploring the limits of $p$ -type doping in GaN



- **Aim of 2018 beam time:** explore lattice location (substitutional vs interstitial) of ion implanted Mg in GaN **at technologically relevant doping levels**
- 20 keV operation of GPS
- Interstitial Mg undergoes a fast drop within fluence range up to  $1 \times 10^{13} \text{ cm}^{-2}$
- Even for Mg fluences as high as  $5 \times 10^{14} \text{ cm}^{-2}$ , i.e.  $[\text{Mg}] \sim 1.6 \times 10^{20} \text{ cm}^{-3} = 0.3\%$ , interstitial Mg does not reappear,  $\sim 93\%$  of Mg continues to be implanted into Ga sites



# First $^{111}\text{Cd}$ PAC measurements of free molecules (IS640), here $\text{CdI}_2$

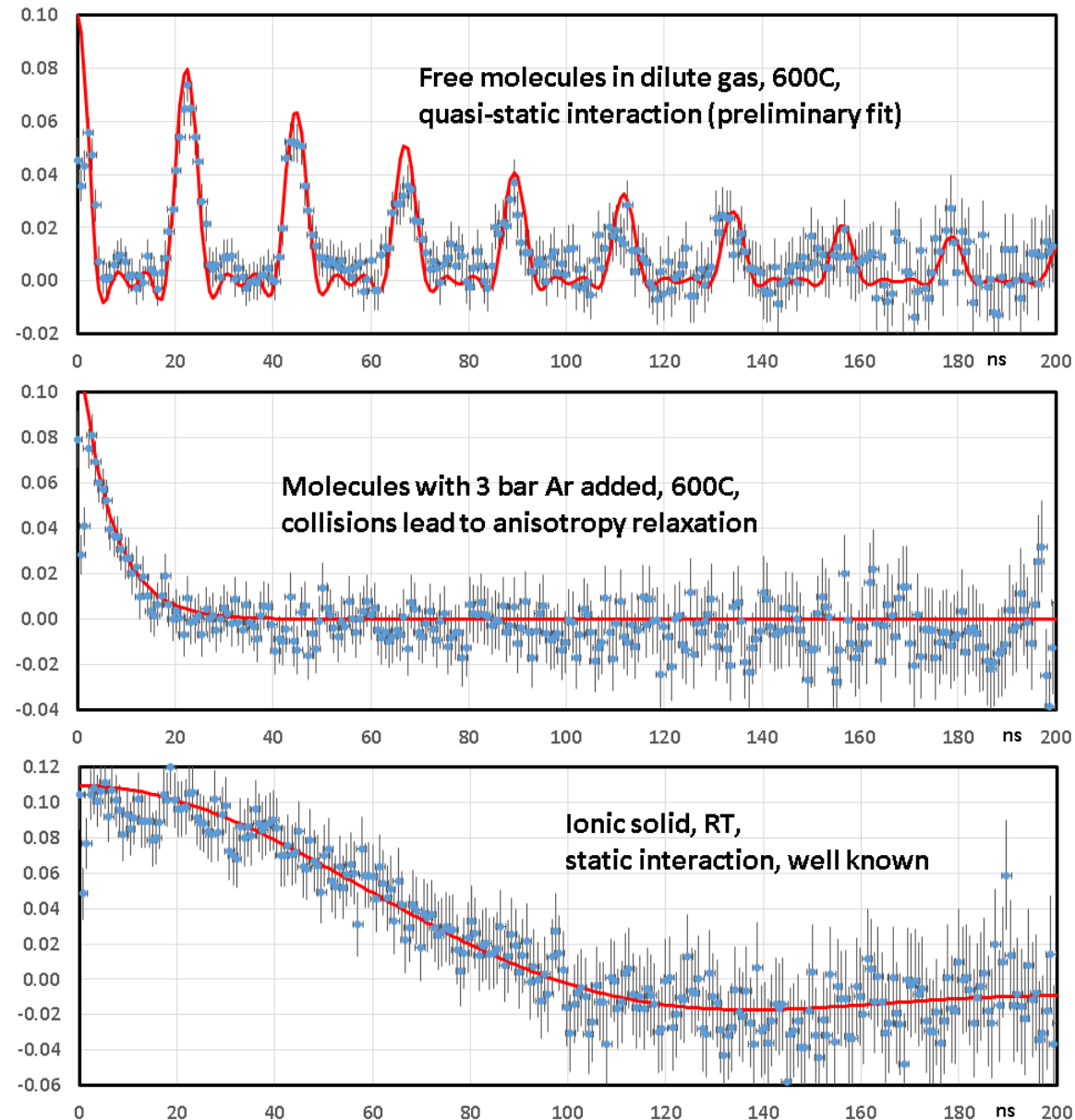
**The problem:** Measure quadrupole interaction in free molecules to determine  $Q$  for  $^{111}\text{Cd}$  (and  $^{199}\text{Hg}$ )

**The concept:** Freely rotating linear molecules have the rotation axis  $J$  perpendicular to the molecule, thus the EFG along  $J$  is (minus) half the molecular one

**The task:** Produce highly dilute samples so that collisions do not change the orientation of  $J$  during the measuring time, typically 100ns

**The status:** Concept has been confirmed for Hg halides last year. Now high precision data for  $\text{CdI}_2$  (less precise for  $\text{CdCl}_2$  and  $\text{CdBr}_2$ )

**The next step:** Quantum chemistry calculations (in progress)

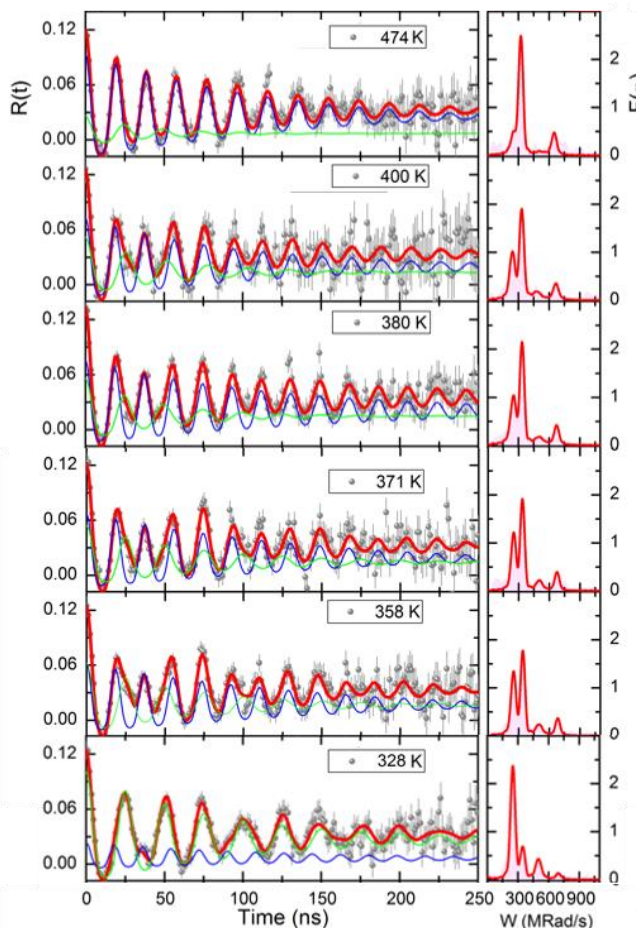


# IS647 - PAC studies in $\text{Ca}_3\text{Mn}_2\text{O}_7$ naturally layered perovskite

## Hybrid Improper Ferroelectric

$^{111}\text{mCd}/\text{Cd}$  PAC at CERN-ISOLDE (May 2018)

**Orthorhombic  
 $A_{caa}$  – non polar**



**Orthorhombic  
 $A_{2,am}$  – polar**

**NON LOCAL METHODS say:**

Is there a negative thermal expansion (NTE) and/or soft mode?

YES

Where? In the High T  $A_{caa}$  non polar or Low T  $A_{2,am}$  polar phase?

$A_{caa}$  non polar phase

Is phase coexistence indeed needed to see NTE and/or soft mode?

YES

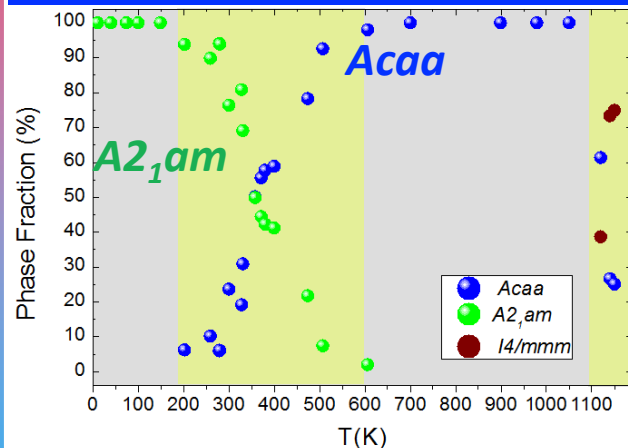
**We say: PAC / DFT results**

**IT IS POSSIBLE**

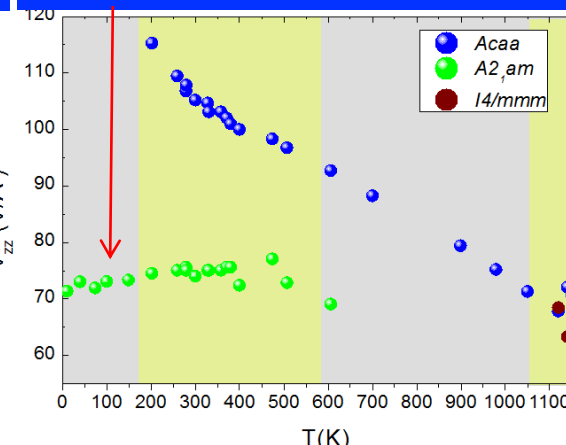
**Low T  $A_{2,am}$**

**SEEMS NOT !!**

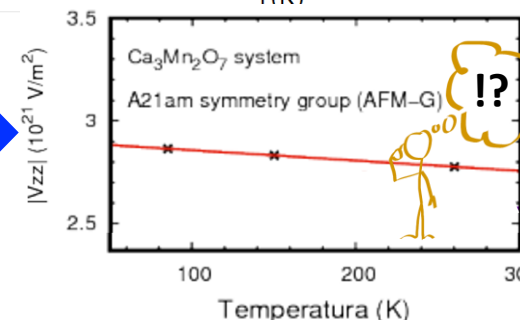
**Phase Coexistence & Transitions**



**$A_{2,am}$  atypical  $V_{zz}$  negative thermal dependency**



**DFT  $A_{2,am}$   $V_{zz}$  thermal dependency calculations using the high-resolution synchrotron X-ray diffraction data from PRL 114, 035701, 2015**



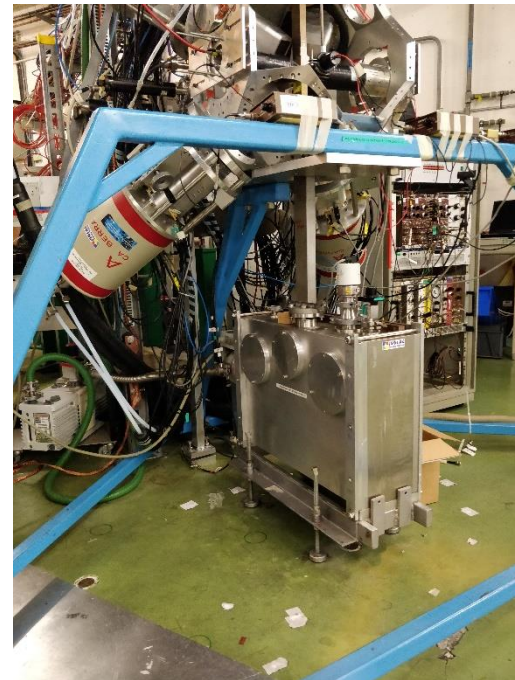
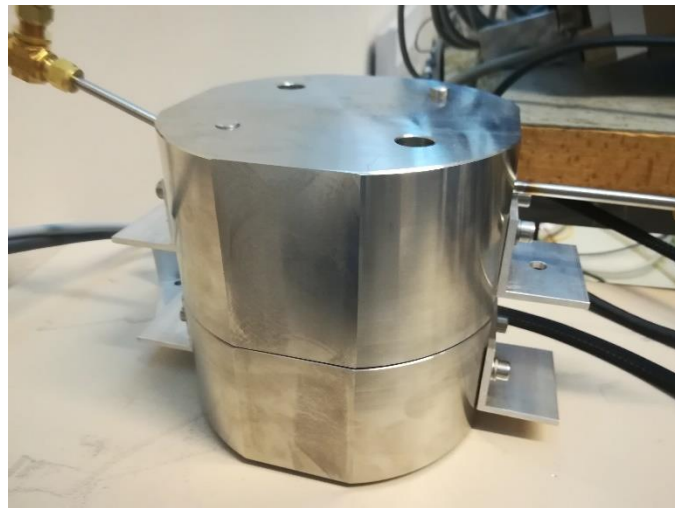
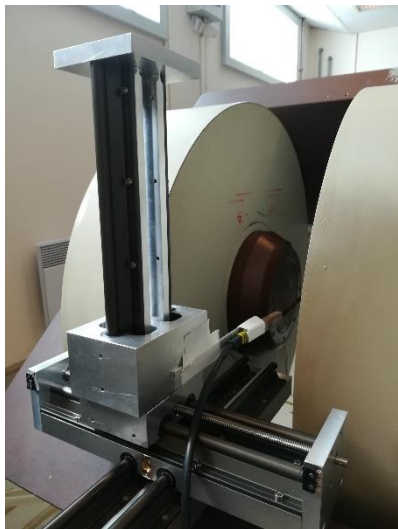
# EP technicians

Antonio Goncalves and Francois Garnier: supported by the collaboration.

Available for jobs for users to assist experiment: especially mechanical work.

Work carried out for MIRACLS, IDS, HIE-ISOLDE, VITO, biophysics and others.

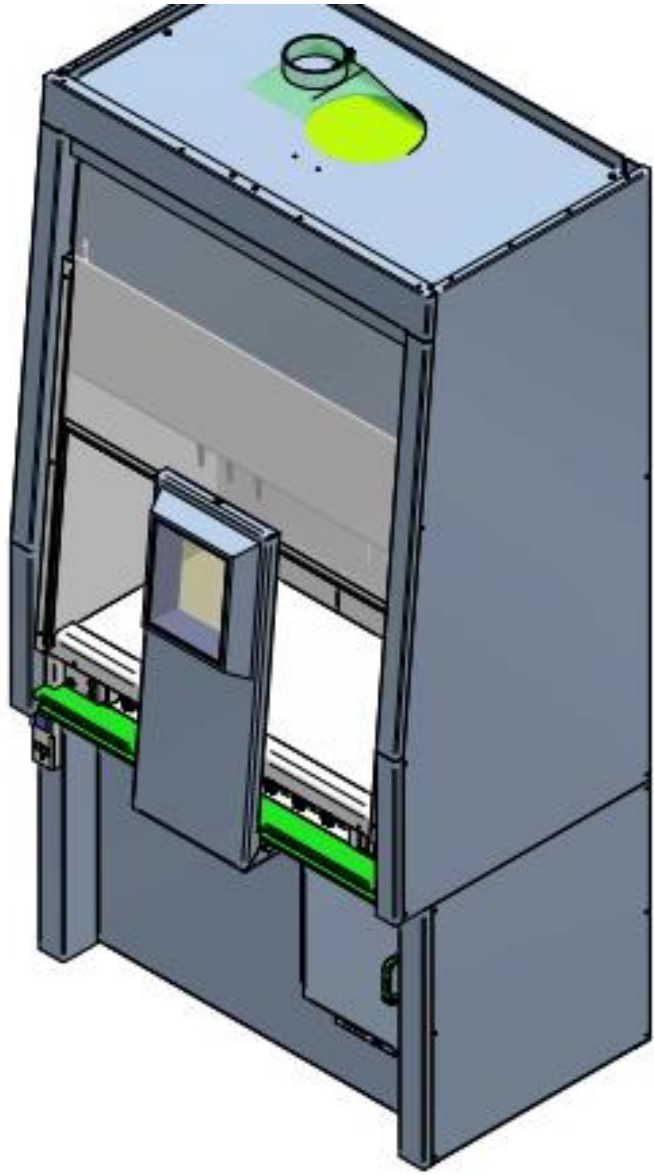
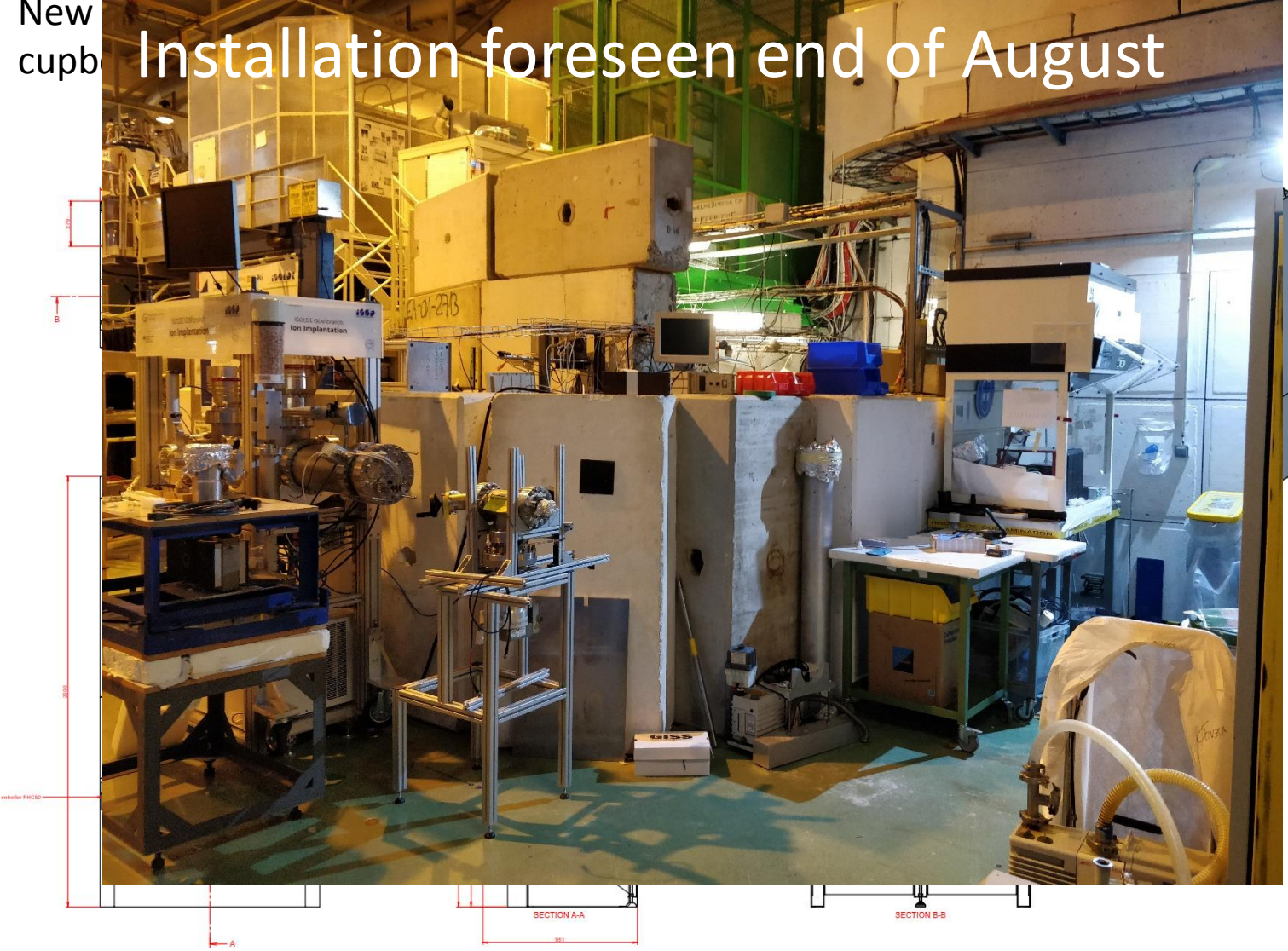
Day to day involvement in the hall could be improved, otherwise very positive feedback.





# Ergonomics around GLM/GHM area

New cupb Installation foreseen end of August



# Training etc

Hands on courses: electrical awareness and RP

Online courses: safety at CERN, RP supervised area

Expiration date for hands on courses: should be a mistake

Refreshing courses: new approach during LS2, currently being finalized. More frequent.

# INTC matters

Presentation of LOIS at tomorrow's INTC

First status report for TAS

Preparation for discussion of incomplete experiments.

Meeting in February could be skipped.