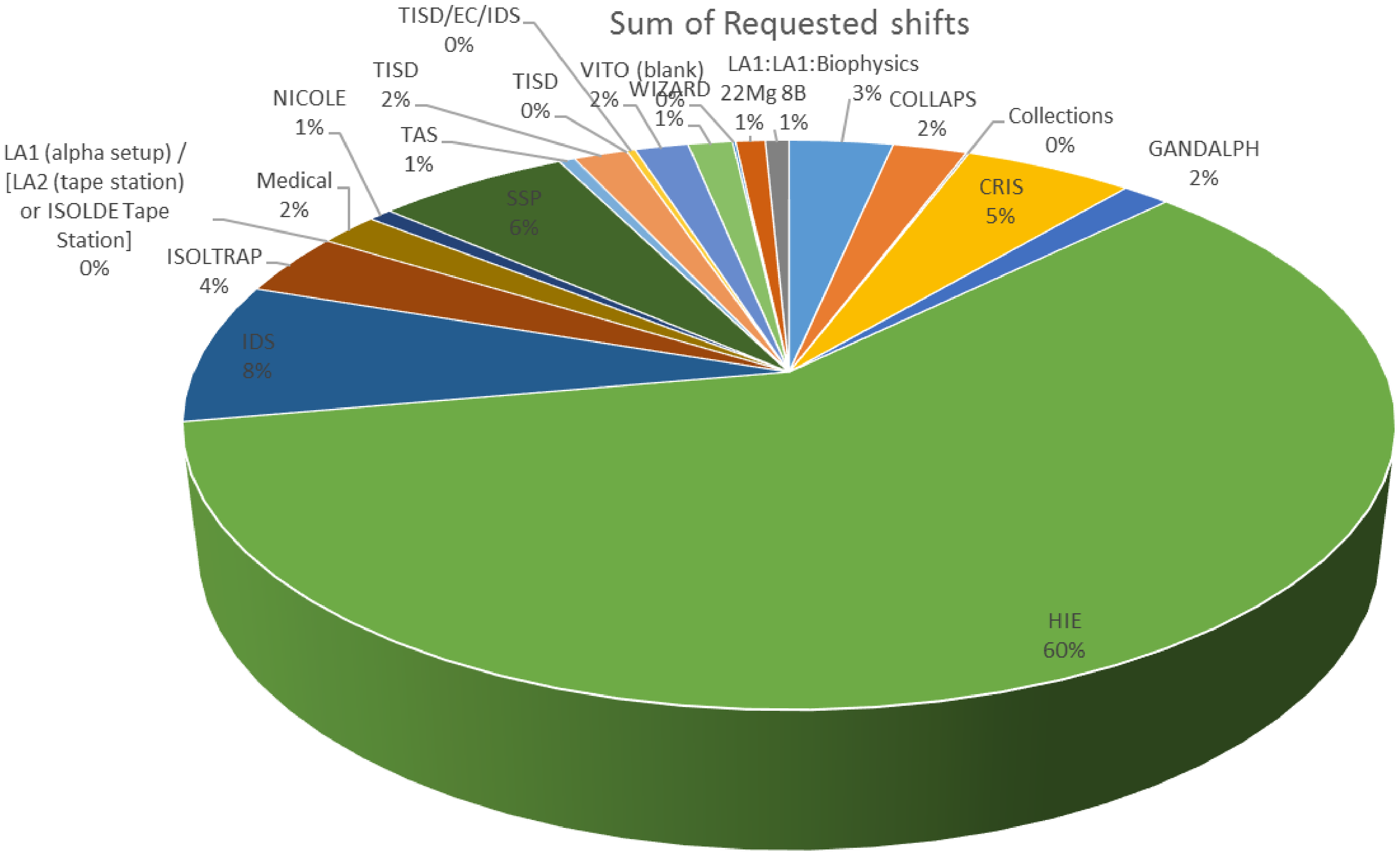
ISOLDE physics coordinator report: INTC 7th November 2018

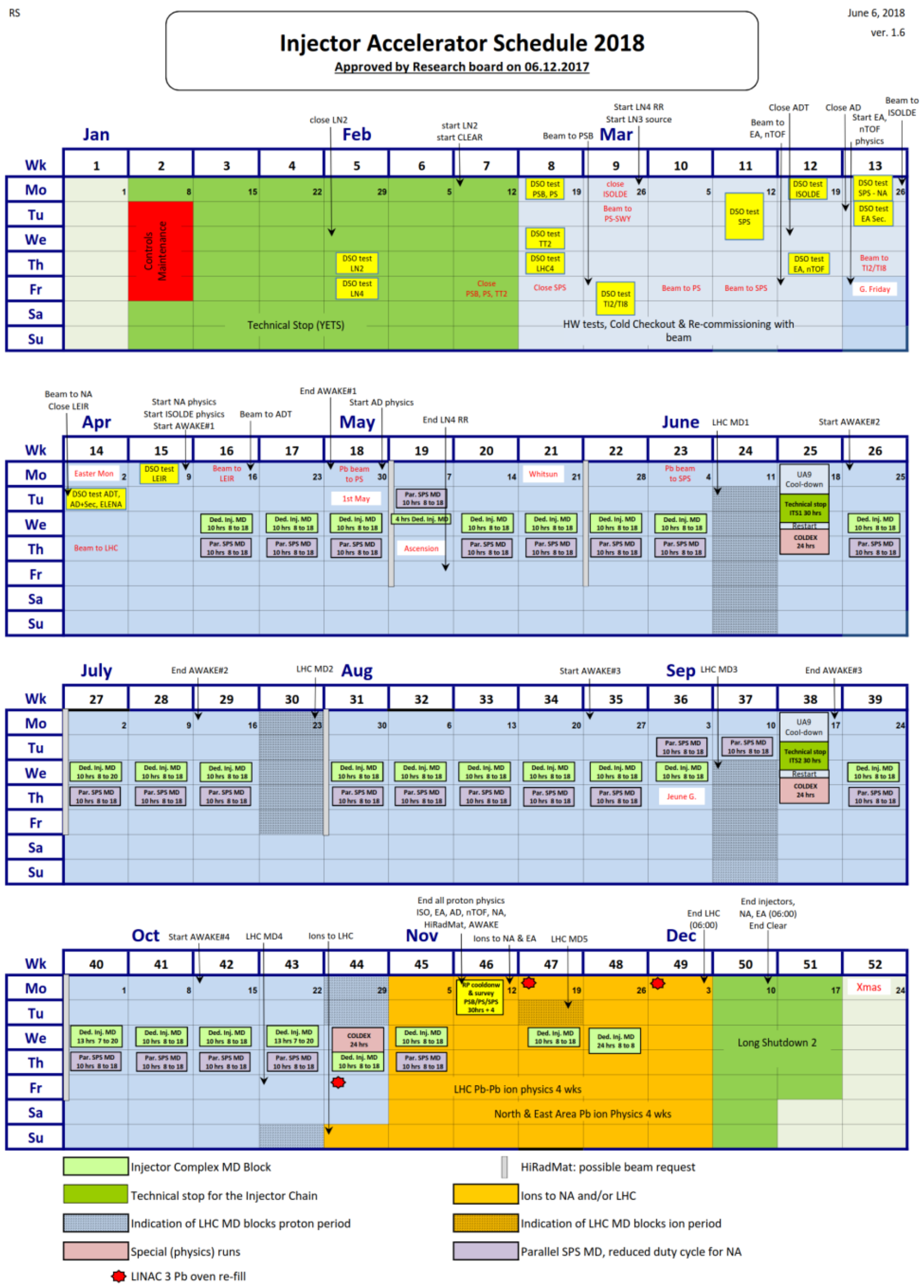
Karl Johnston

- Summary of 2018: proton and winter physics schedules
- Safety/training
- Technicians
- Publications

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
Grand Total	**1057.501**



Protons available for physics to ISOLDE from 9th April – 12th November 2018.
(no extension possible)
1 week less physics with protons than 2017
217 days compared to 224

HIE ISOLDE was ready from 9th July after 90 days of LE physics

HIE: Started with a Coulomb excitation block then focused on the reaction experiments
More setup time often needed for these plus more varied setups.
All three HIE beamlines in use e.g. ISS calibrating/commissioning while Miniball ran CE, installations ongoing at XT03.

Low energy runs allowed for some breathing space (and exchange of EBIS cathode). To allow for best use of machine, some experiments ran in parallel/invisible mode e.g. Solid state physics: one dedicated run in 2018 i.e. blocking CBL and with new target.

Focus on LOIS at end of year: looking forward…. Winter physics programme to start in Week 46 for HIE (x2) and CRIS

Final ISOLDE schedule

2
1
3

GPS schedule 2018

	April				May				June					July		
WK	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
MO	9	16	#534/567 Sn VD5 23	30	7	MD: FTS 14	21	28	4	11	18	25	2	9	16	23
TU		TISD		May-01		MD:FTS			IS610		Tech Stop	Medical isotopes				#665 53Mn
WE		TISD		#599 Ti foils	IS634					ISBM	#655 Ta - W		#659 UC VD7			
TH	#513/ #650				Ascension					^{22}Mg to		IS528 IS638				
FR						#653 UC-Ta n			#634 LIST	LA1					IS644:	#632 ThC VD7
SA														IS644	4.8MeV/	
SU		IS633	IS611 IS640 IS647 IS652 IS653				IS622			IS614	IS528			(LOI205)	u (IS506)	
		8B: IDS	111Cd		RILIS: Mg		RILIS: Cu		RILIS: In	RILIS: Mg	RILIS: Dy	RILIS: Dy		96Kr / 212Rn		
											(night-time)					

	July		August				September				October				November	
WK	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
MO	30	6	13	20	27	IS629 3	#641 UC Ta 10	17	24	1	8	#633Th 15	22	#638 UCW 29	5	p+ off 0600 12
TU						IS634		Tech stop	#619 Pb VD5							Prep for
WE					IS629:			(IS655)					#534 Sn VD5			winter
TH		#650/513 MWCNT	XT03	#635 UC Ta	11Be @	Jeune	IS576	(IS604)	IS585						(IS655)	Physics
FR	IS552:		IS616:		7MeV/u		IS578		IS602			Gandalph		XT03		(separate file)
SA	4.1MeV/		4.5MeV/		(IS655)		IS630 IS648		IS638		IS631 206Hg @ ~	Negative			LOI198	
SU	u		u		XT03		IS653		IS640		7.5MeV/u	run: IS615	IS611 IS640 IS647 IS652 IS653	IS561 9Li @ 7.5MeV/u	IS637	
	22x Rn		8B		RILIS: Be	RILIS: Be	RILIS: Mn		199Hg		RILIS: Hg	RILIS: At	111Cd		RILIS: Ac	
												MD on HIE			(GLM/GHM/LA1)	

HRS schedule 2018

	April				May				June					July		
WK	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
MO	9	16	23	#651 ZrO HP 30	#652 ZrO HP 7	#618 UC-Ta/W 14	21	28	4	11	18	25	#658 UC Ta (+CF4) 2	9	16	23
TU				May-01					#626 Ta - W	TBC	Tech Stop					
WE				TISD								Machine development			#637 UC W (+CF4	
TH					Ascension						Machine development					IS552
FR		#627 Ta -W					#654 UC - W						IS650			IS553:
SA													IS637			4.1MeV/
SU	IS639		IS532	IS623	IS642	IS645		IS620	IS649				IS608			u
	In RILIS		Sc RILIS	RILIS test	70Br	26Na		K beams	Sc RILIS				RILIS: Bi			22xRa/142Ba
	(#640 LaC - n)		In RILIS	Ge 34S												

	July		August				September				October				November	
WK	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
MO	30	6	13	20	27	3	10	17	24	#662 UC n 1	IS638 8	15	22	#642 UC n(ew)-conv	TISD 5	p+ off0600 12
TU								Tech stop				(tbc) UC		TISD	TISD	Prep for
WE							IS654								#672 CaO VD7	winter
TH	#631 LaC Ta		#639 LaC Ta			Jeune						tuning IDS	IS645			Physics
FR		IS562:			#643 UC+34S	134Sn @	#623 SiC	IS651 28Mg	IS621			VITO	IS641			(separate file)
SA		4.4MeV/				7.33MeV		@	28Mg@9.5						WISArD	
SU		u		IS613		/u		9.5MeV/u	MeV/u	IS635			(end Sat night)		LOI172	
		Sn RILIS		Sn RILIS		134Sn+34S		RILIS: Mg		RILIS: Sb			RILIS: Tl		RILIS: for TISD	
												MD on HIE				

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

KJ: 08.10.18

GPS schedule 2018

WK		
15	April	MO 9; TH #513/ #650
16	April	MO 16; TU TISD; WE TISD; IS633; 8B: IDS
17	April	MO #534/567Sn VD5 23; IS611 IS640 IS647 IS652 IS653; 111Cd
18	April	MO 30; TU May-01; WE #599 Ti foils
19	May	MO 7; IS634; Ascension; RILIS: Mg
20	May	MO MD: FTS 14; TU MD:FTS; #653 UC-Ta n
21	May	MO 21; IS622; RILIS: Cu
22	May	MO 28
23	June	MO 4; IS610; #634 LIST; RILIS: In
24	June	MO 11; ISBM; ^{22}Mg to LA1; IS614; RILIS: Mg
25	June	MO 18; Tech Stop; #655 Ta - W; IS528; RILIS: Dy
26	June	MO 25; Medical isotopes; IS528 IS638; RILIS: Dy; (night-time)
27	June	MO 2; #659 UC VD7
28	July	MO 9; IS644 (LOI205); 96Kr / 212Rn
29	July	MO 16; IS644: 4.8MeV/u (IS506)
30	July	MO 23; #665 53Mn; #632 ThC VD7
31	July	MO 30; IS552: 4.1MeV/u; 22x Rn
32	July	MO 6; #650 513MWCNT
33	August	MO 13; XT03; IS616: 4.5MeV/u; 8B
34	August	MO 20; #635 UC Ta
35	August	MO 27; IS629: 11Be @ 7MeV/u (IS655) XT03; RILIS: Be
36	August	MO IS629 3; IS634; Jeune; RILIS: Be
37	September	MO #641 UC Ta 10; IS576 IS578 IS630 IS648 IS653; RILIS: Mn
38	September	MO 17; Tech stop; (IS655) (IS604)
39	September	MO 24; #619 Pb VD5; IS585 IS602 IS638 IS640; 199Hg
40	September	MO 1
41	October	MO 8; IS631 206Hg @ ~7.5MeV/u; RILIS: Hg
42	October	MO #633Th 15; Gandalph; Negative run: IS615; RILIS: At; MD on HIE
43	October	MO 22; #534 Sn VD5; IS611 IS640 IS647 IS652 IS653; 111Cd
44	October	MO #638 UCW 29; XT03; IS561 9Li @ 7.5MeV/u
45	November	MO 5; (IS655); LOI198; IS637; RILIS: Ac; (GLM/GHM/LA1)
46	November	MO p+ off 0600 12; Prep for winter Physics (separate file)

Cu FT
In FT
Bi FT/in-source
Tl/Hg SPEDE

Sc/In
70Br

n-def In
n-rich K
n-def Sn

Ge + S
Sc
n-rich Sb

Medical Biophysics

119Sb for biopac
149Tb/152Tb
199Hg
Ac beam development

β-NMR on liquids

Parallel Hg/Cd

Mg,Be
Mn, Ac

Good Mn run

Travelling

8B @ LA1
22Mg @ LA1
Ac development
(2 setups)
GANDALPH (-ve)

TISD/MD

-ve beams
LIST
New n-conv
RFQ MD
HIE MD
FTS commissioning
(no LIEBE)

Later….

XT03

HRS schedule 2018

WK		
15	April	MO 9; IS639; In RILIS; (#640 LaC - n)
16	April	MO 16; #627 Ta - W
17	April	MO 23; IS532; Sc RILIS; In RILIS
18	April	MO #651 ZrO HP 30; May-01; TISD; IS623; RILIS test; Ge 34S
19	May	MO #652 ZrO HP 7; Ascension; IS642; 70Br
20	May	MO #618 UC-Ta/W 14; IS645; 26Na
21	May	MO 21; #654 UC - W
22	May	MO 28; IS620; K beams
23	June	MO 4; #626 Ta - W; IS649; Sc RILIS
24	June	MO 11; TBC
25	June	MO 18; Tech Stop; Machine development
26	June	MO 25; Machine development
27	June	MO #658 UC Ta (+CF4) 2; IS650 IS637 IS608; RILIS: Bi
28	July	MO 9
29	July	MO 16; #637 UC W (+CF4
30	July	MO 23; IS552 IS553: 4.1MeV/u; 22xRa/142Ba
31	July	MO 30; #631 LaC Ta
32	July	MO 6; IS562: 4.4MeV/u; Sn RILIS
33	August	MO 13; #639 LaC Ta
34	August	MO 20; IS613; Sn RILIS
35	August	MO 27; #643 UC+34S
36	August	MO 3; Jeune; 134Sn @ 7.33MeV/u; 134Sn+34S
37	September	MO 10; IS654; #623 SiC
38	September	MO 17; Tech Stop; IS651 28Mg @ 9.5MeV/u; RILIS: Mg
39	September	MO 24; IS621 28Mg@9.5 MeV/u
40	September	MO #662 UC n 1; IS635; RILIS: Sb
41	October	MO IS638 8
42	October	MO 15; (tbc) UC; tuning IDS; VITO; MD on HIE
43	October	MO 22; IS645; IS641; (end Sat night); RILIS: Ti
44	October	MO #642 UC n(ew)-conv; TISD
45	November	TISD; TISD; #672 CaO VD7; WISArD; LOI172; RILIS for TISD
46	November	MO p+ off 0600 12; Prep for winter Physics (separate file)

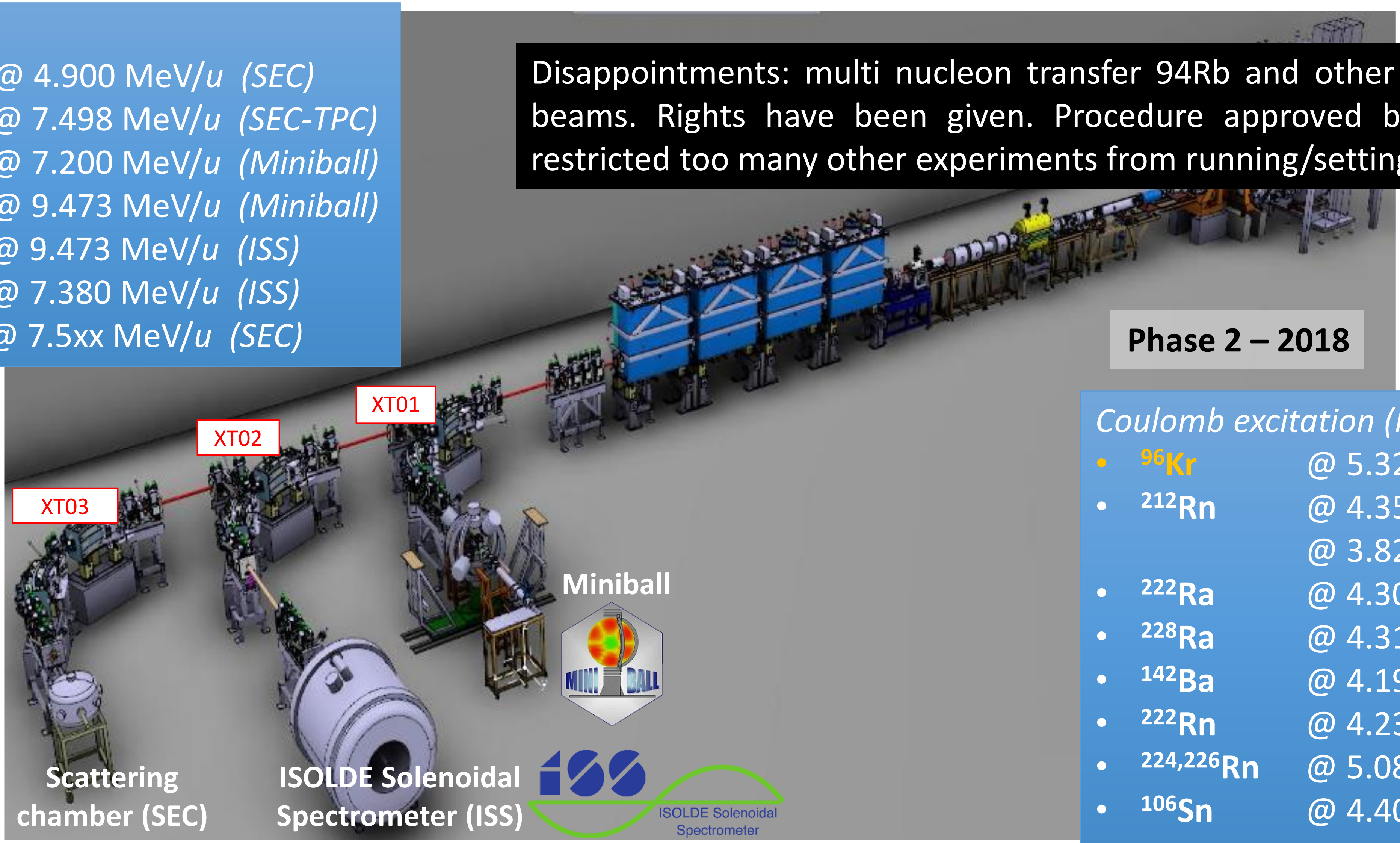
HIE-ISOLDE EXPERIMENTS 2018

reaching 9.5 MeV/u with HIE-ISOLDE

Reactions:

- ^{8}**B**(^{64}Zn) @ 4.900 MeV/*u* (*SEC*)
- ^{11}**Be**(decay) @ 7.498 MeV/*u* (*SEC-TPC*)
- ^{132,134}**Sn**(*d,p*) @ 7.200 MeV/*u* (*Miniball*)
- ^{28}**Mg**(*t,p*) @ 9.473 MeV/*u* (*Miniball*)
- ^{28}**Mg**(*d,p*) @ 9.473 MeV/*u* (*ISS*)
- ^{206}**Hg**(*d,p*) @ 7.380 MeV/*u* (*ISS*)
- ^{9}**Li**(*t,p*) @ 7.5xx MeV/*u* (*SEC*)

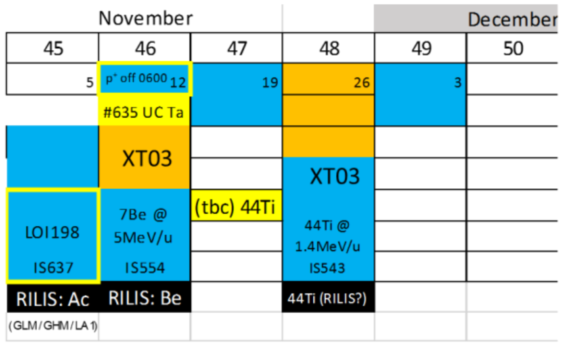
Disappointments: multi nucleon transfer 94Rb and other strong primary beams. Rights have been given. Procedure approved but would have restricted too many other experiments from running/setting up in 2018.



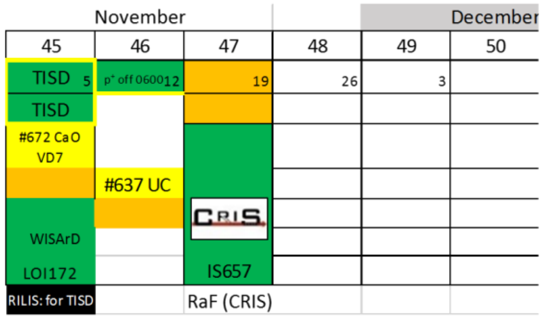
Coulomb excitation (Miniball):

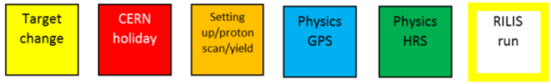
- ^{96}**Kr** @ 5.325 MeV/*u*
- ^{212}**Rn** @ 4.355 MeV/*u*
  @ 3.824 MeV/*u*
- ^{222}**Ra** @ 4.305 MeV/*u*
- ^{228}**Ra** @ 4.310 MeV/*u*
- ^{142}**Ba** @ 4.190 MeV/*u*
- ^{222}**Rn** @ 4.230 MeV/*u*
- ^{224,226}**Rn** @ 5.080 MeV/*u*
- ^{106}**Sn** @ 4.404 MeV/*u*

GPS



HRS





KJ: 26.10.18

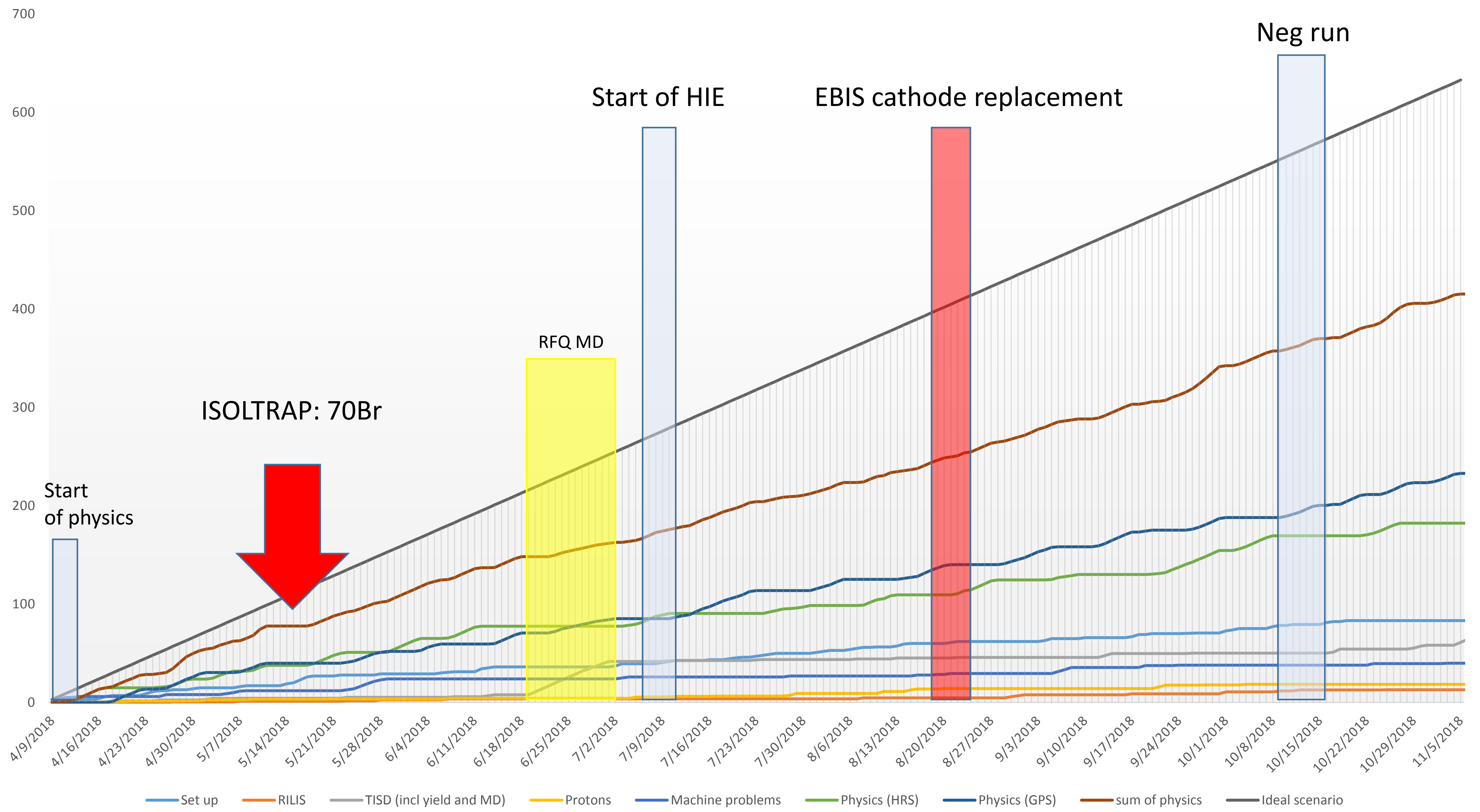
Winter physics programme:

7Be @ 5MeV/u to XT03 (similar setup to recently used 9Li run)
Target irradiated in past weeks (cold). Be mass marker.

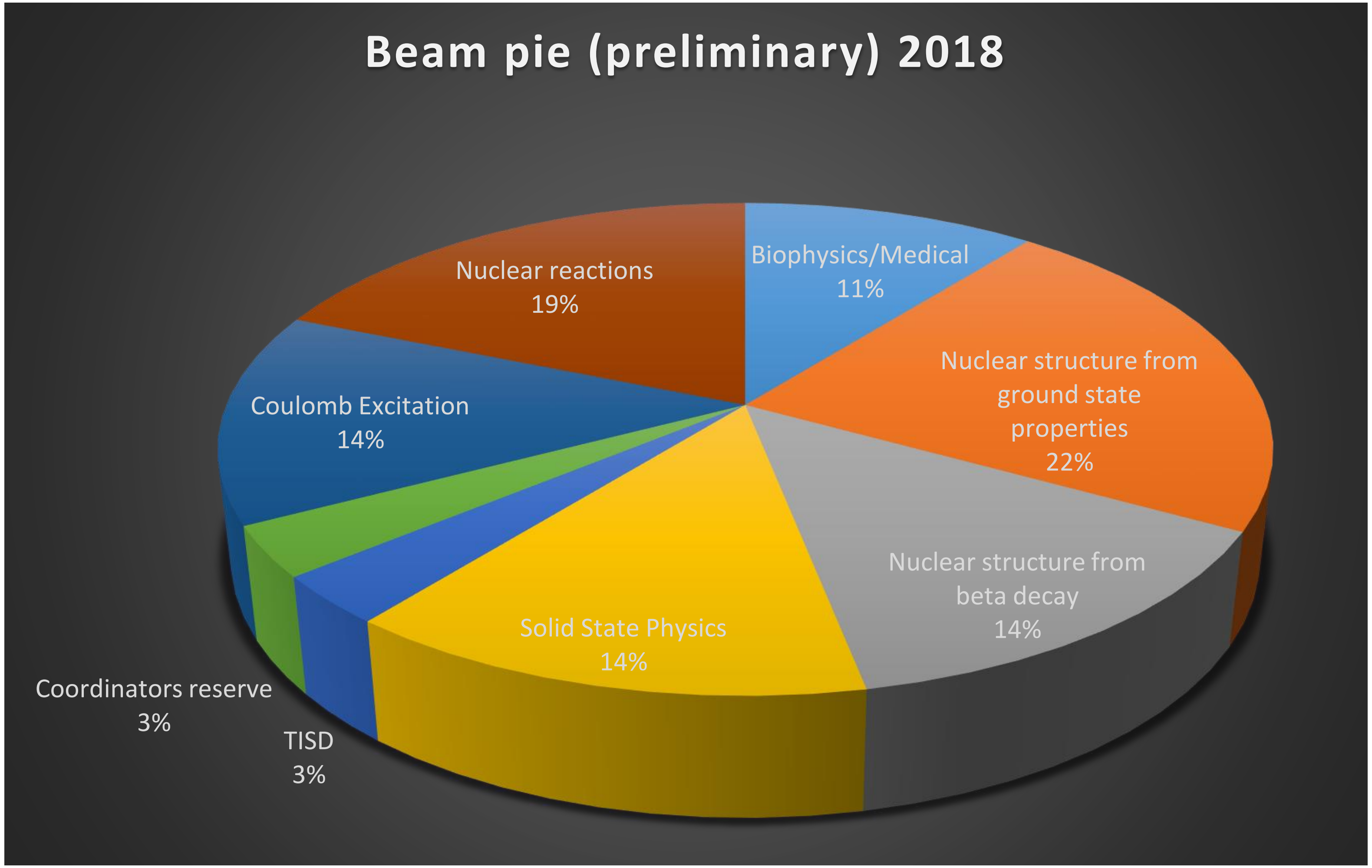
RaF for CRIS: target with CF4 leak irradiated at MEDICIS.

44TI for Edinburgh chamber (similar to 59Cu in 2017). Planning ongoing with PSI for importation of material.

In addition some emittance test requestd by MIRACLS on both HRS and GPS.

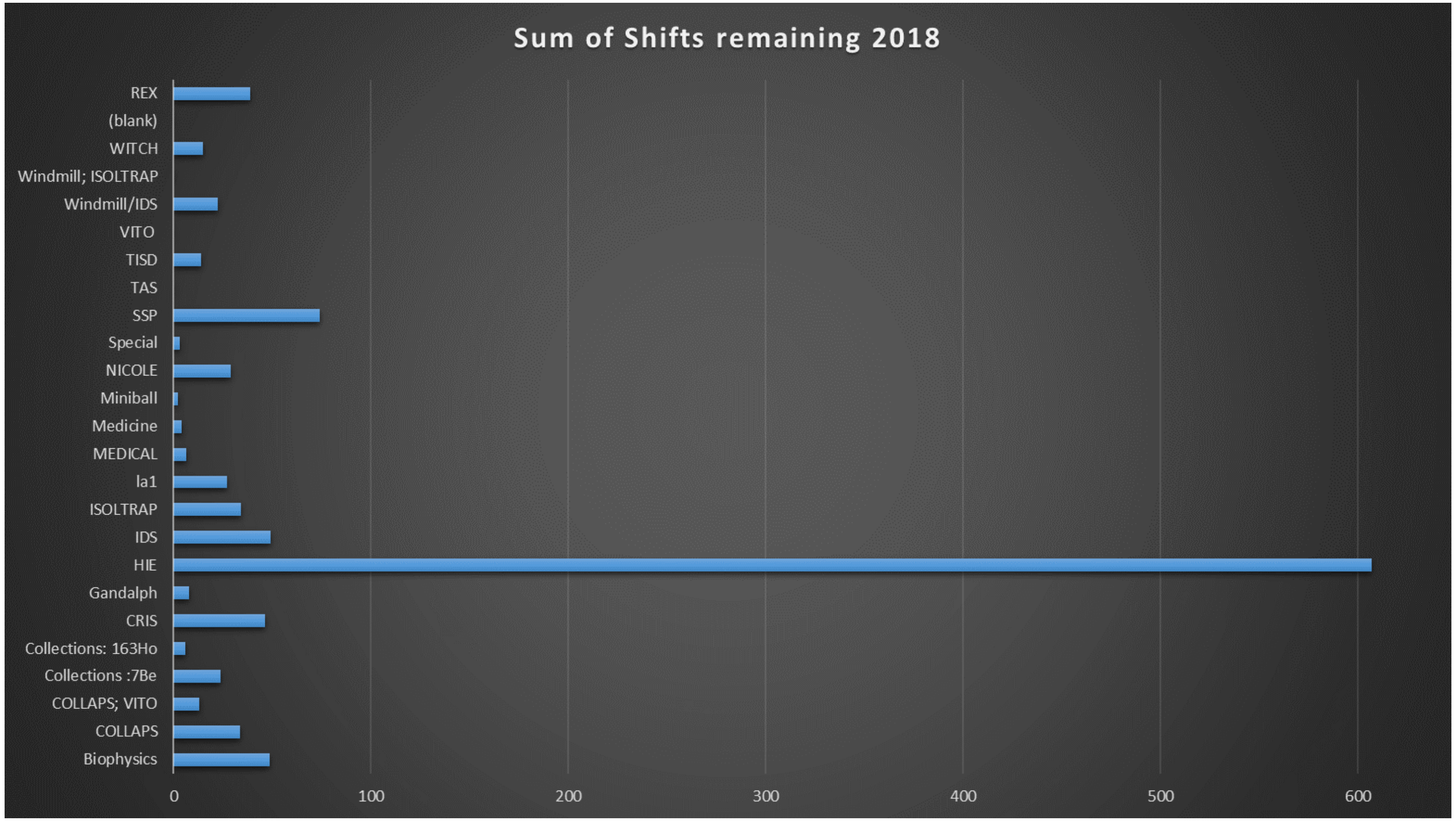


700
600
500
400
300
200
100
0
Neg run
Start of HIE
EBIS cathode replacement
RFQ MD
ISOLTRAP: 70Br
Start
of physics
4/9/2018
4/16/2018
4/23/2018
4/30/2018
5/7/2018
5/14/2018
5/21/2018
5/28/2018
6/4/2018
6/11/2018
6/18/2018
6/25/2018
7/2/2018
7/9/2018
7/16/2018
7/23/2018
7/30/2018
8/6/2018
8/13/2018
8/20/2018
8/27/2018
9/3/2018
9/10/2018
9/17/2018
9/24/2018
10/1/2018
10/8/2018
10/15/2018
10/22/2018
10/29/2018
11/5/2018
Set up
RILIS
TISD (incl yield and MD)
Protons
Machine problems
Physics (HRS)
Physics (GPS)
sum of physics
Ideal scenario



Setup	Count of Delivered 2018	Sum of Delivered 2018
Biophysics	4	31
COLLAPS	3	35.5
COLLAPS; VITO		
Collections :7Be		
Collections: 163Ho		
CRIS	3	39
Gandalph	1	9
HIE	11	139.5
IDS	5	43
ISOLTRAP	2	17
la1	1	10
MEDICAL	2	18.5
Medicine		
Miniball		
NICOLE		
REX	1	8
Special		
SSP	13	64.5
TAS		
TISD		
VITO		
Windmill/IDS		
Windmill; ISOLTRAP	1	3
WITCH		
(blank)		
Grand Total	47	418

Row Labels	Sum of Shifts remaining (Feb 2018)	Sum of Delivered 2018	Count of Delivered 2018	Sum of Shifts remaining 2018
Biophysics	79.5	31	4	48.5
COLLAPS	69	35.5	3	33.5
COLLAPS; VITO	13			13
Collections :7Be	24			24
Collections: 163Ho	6			6
CRIS	85.5	39	3	46.5
Gandalph	17	9	1	8
HIE	746.5	139.5	11	607
IDS	92	43	5	49
ISOLTRAP	51	17	2	34
la1	37	10	1	27
MEDICAL	25	18.5	2	6.5
Medicine	4			4
Miniball	2			2
NICOLE	29			29
Special	3			3
SSP	138.5	64.5	13	74
TAS	11.5			0
TISD	14			14
VITO	0			0
Windmill/IDS	22.5			22.5
Windmill; ISOLTRAP	3	3	1	0
WITCH	15			15
(blank)	0			0
REX	47	8	1	39
Grand Total	1535	418	47	1105.5



NOTE: preliminary counting; includes RB recommendation that TAS experiments be closed from INTC-59

Fall 2018 at COLLAPS

Sb (Z = 51) isotopes across N = 82

✓ $^{112-134}$Sb (N = 61 – 83): **23 isotopes incl. several isomers**

☺ Many new moments and radii: large part of physics goal reached

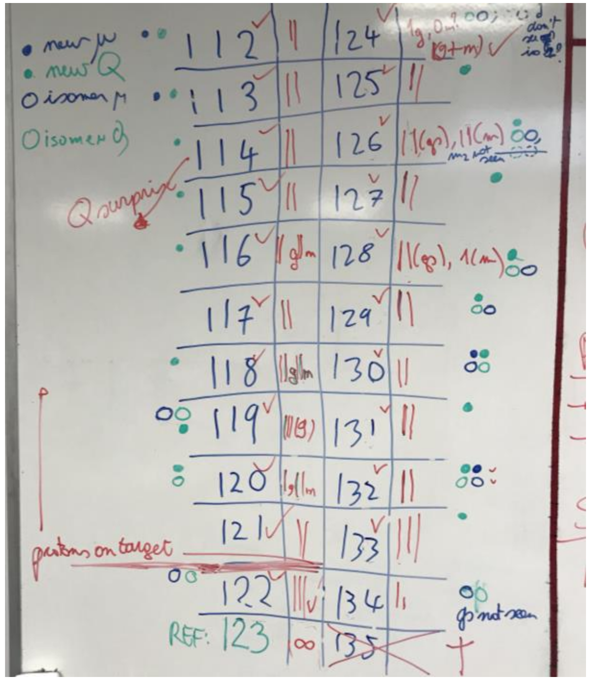
☺ Smooth ISOLDE/RILIS operation

☹ The interesting ^{135}Sb (probably) out of reach considering the contamination level/available shifts*

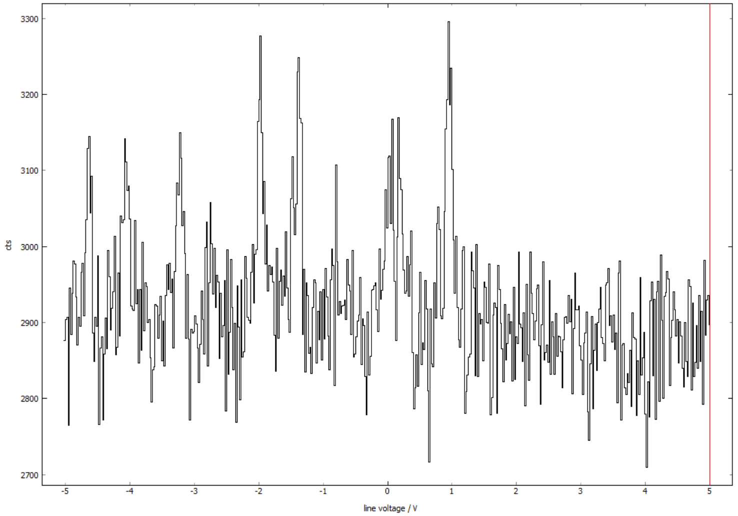
✓ Second element using frequency quadrupling (217 nm)

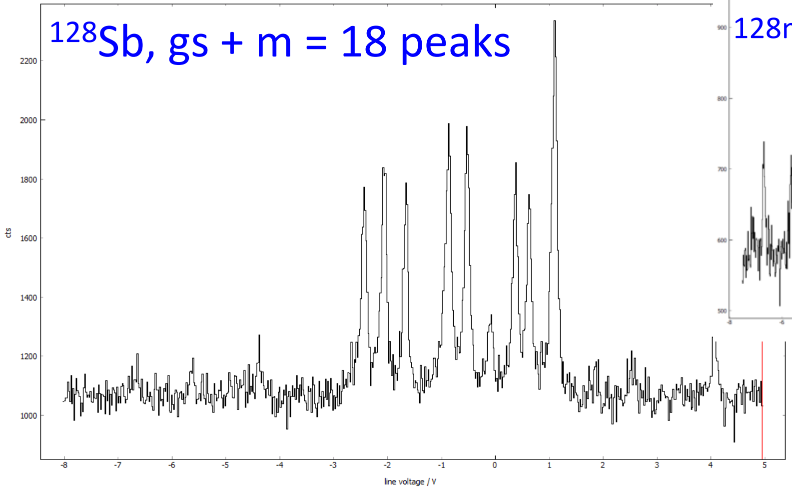
- 2^{nd} Sb run canceled in favour of the VITO run, compensation with ~2 additional shifts in 1^{st} run

Candidate for LIST after LS2? (impossible with present front end)

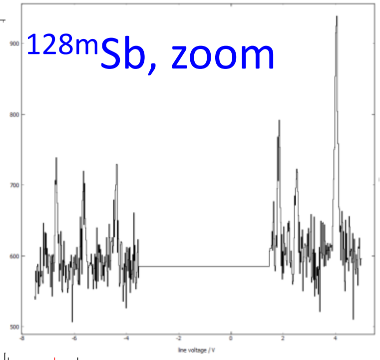


^{134}Sb, ~1 shift of statistics





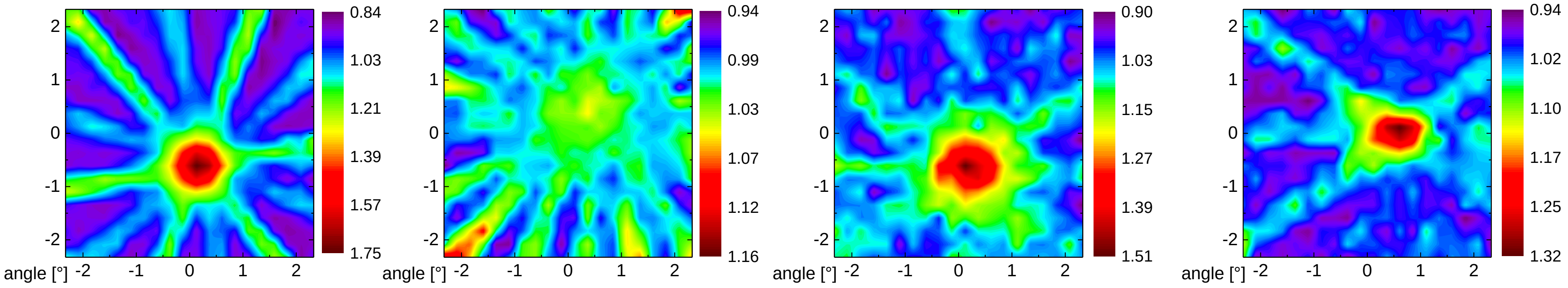
^{128}Sb, gs + m = 18 peaks



^{128m}Sb, zoom

Emission channeling (EC-SLI)

Lattice location of dopant atoms in functional electronic materials



^{27}Mg (Mg RILIS)
in *n*-type GaN
[0001] axis
T = 300 K

^{11}Be (Be RILIS)
in *p*-type GaN
[0001] axis
T = 300 K

^{56}Mn (Mn RILIS)
in $Ge_{0.87}Mn_{0.13}Te$
<110> axis
T = 100 K

^{61}Co (Mn RILIS)
in diamond
<110> axis
T = 300 K

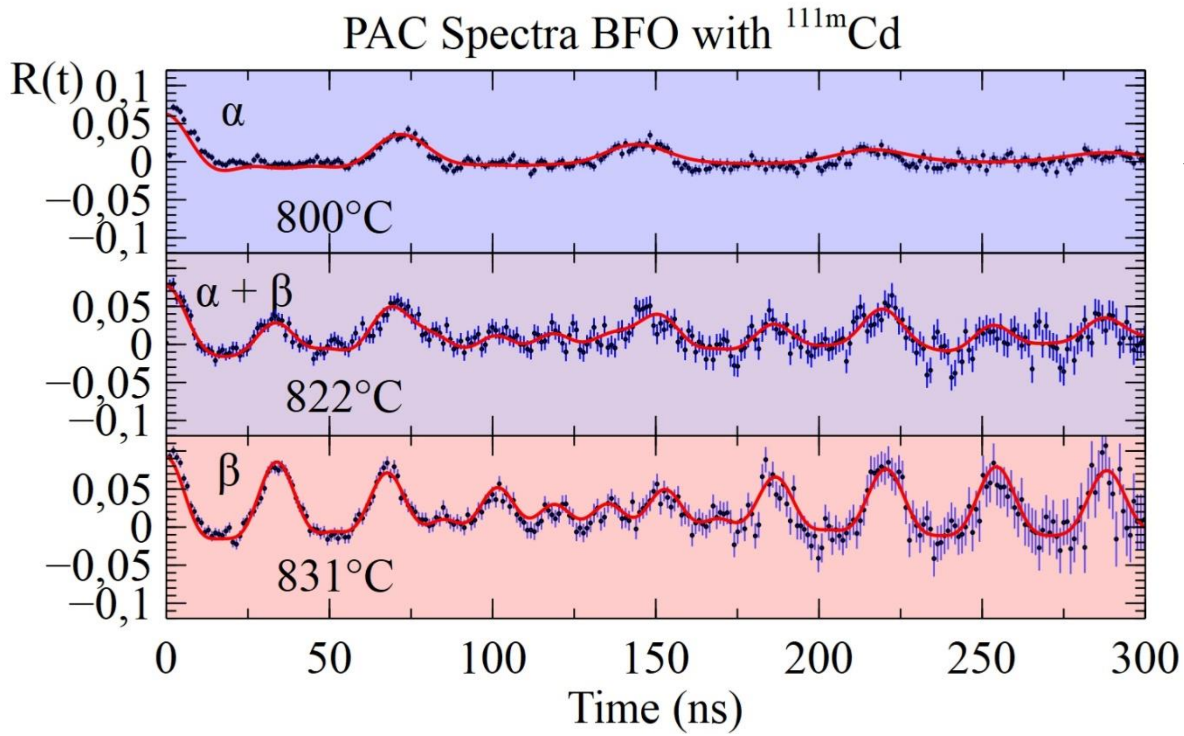
Mg and Be are p-type dopants in GaN, a *wide-gap semiconductor.*
Continuation of our previous work [1]
Application context: **Optoelectronics**

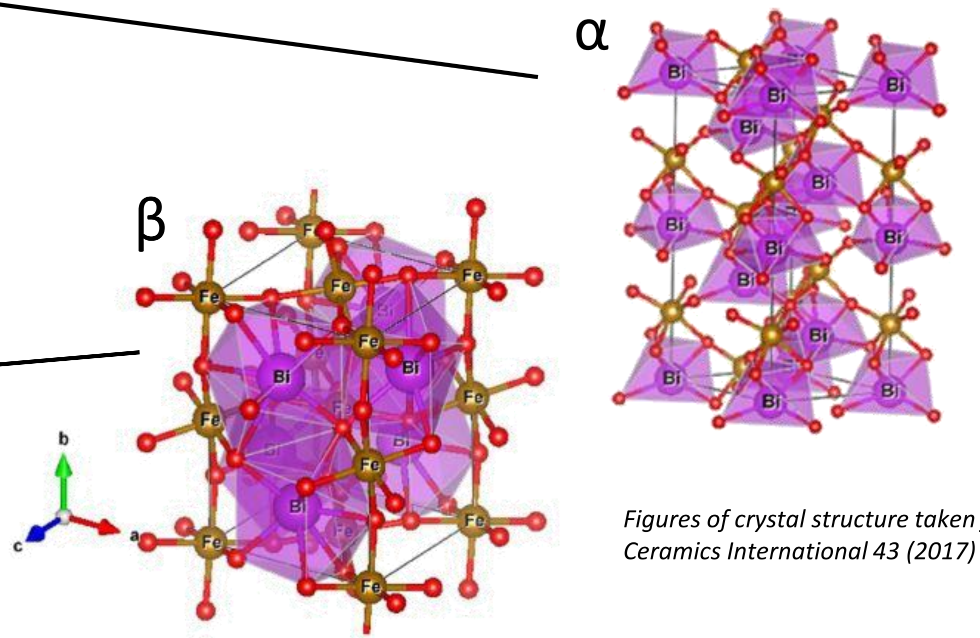
Mn is a magnetic dopant in $Ge_{1-x}Mn_xTe$, a model *multiferroic Rashba semiconductor.*
Application context: **Spintronics**

Co in diamond is a potential *single-photon emitter.*
Application context: **Quantum information**

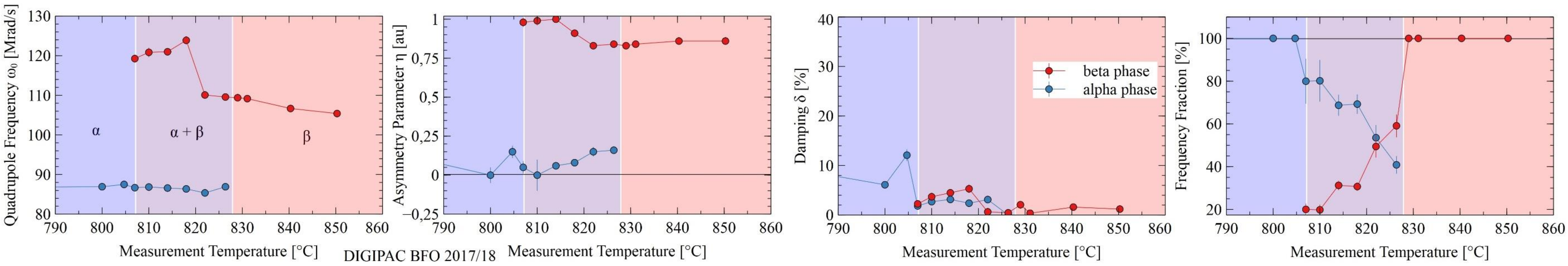
[1] U. Wahl *et al.*, *Phys. Rev. Lett.* **118**, 095501 (2017)

IS647 - Local probing of multiferroic compounds





Figures of crystal structure taken from Ceramics International 43 (2017) 1256–1264

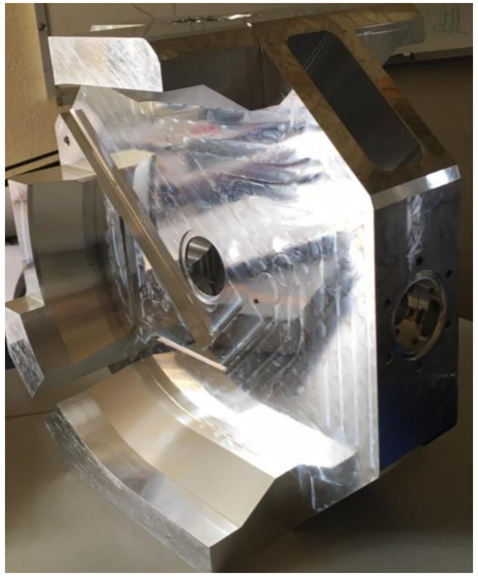


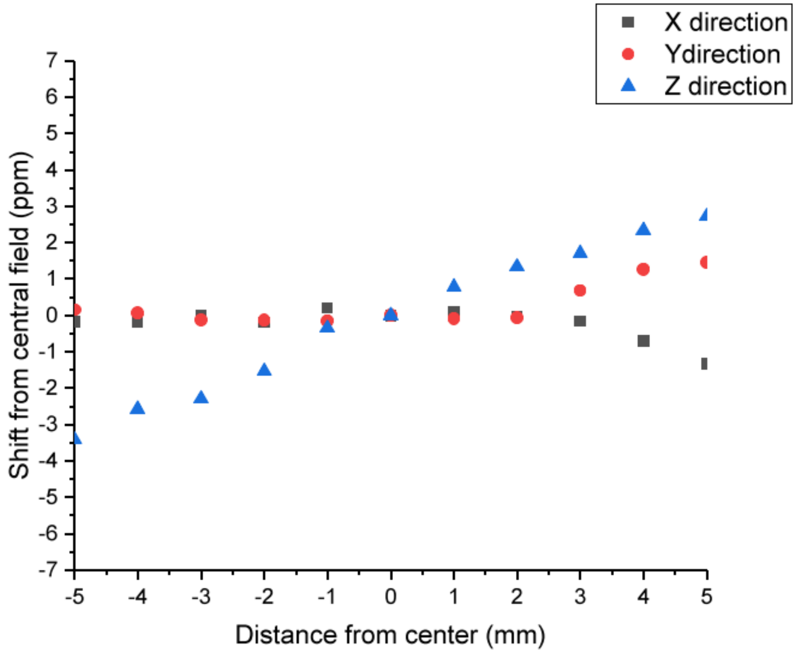
Georg Marschick, Juliana Schell – IS647 collaboration

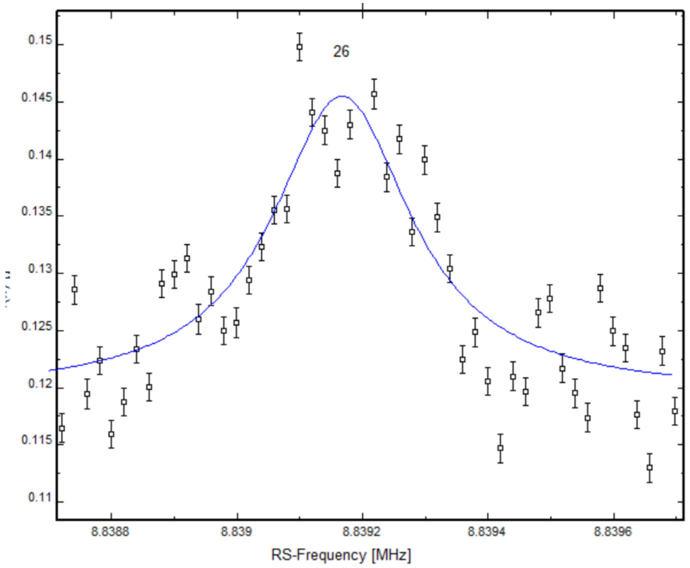
ISOLDE Solid State Physics
Bundesministerium für Bildung und Forschung
UNIVERSITÄT DUISBURG ESSEN
TECHNISCHE UNIVERSITÄT WIEN

VITO since last INTC

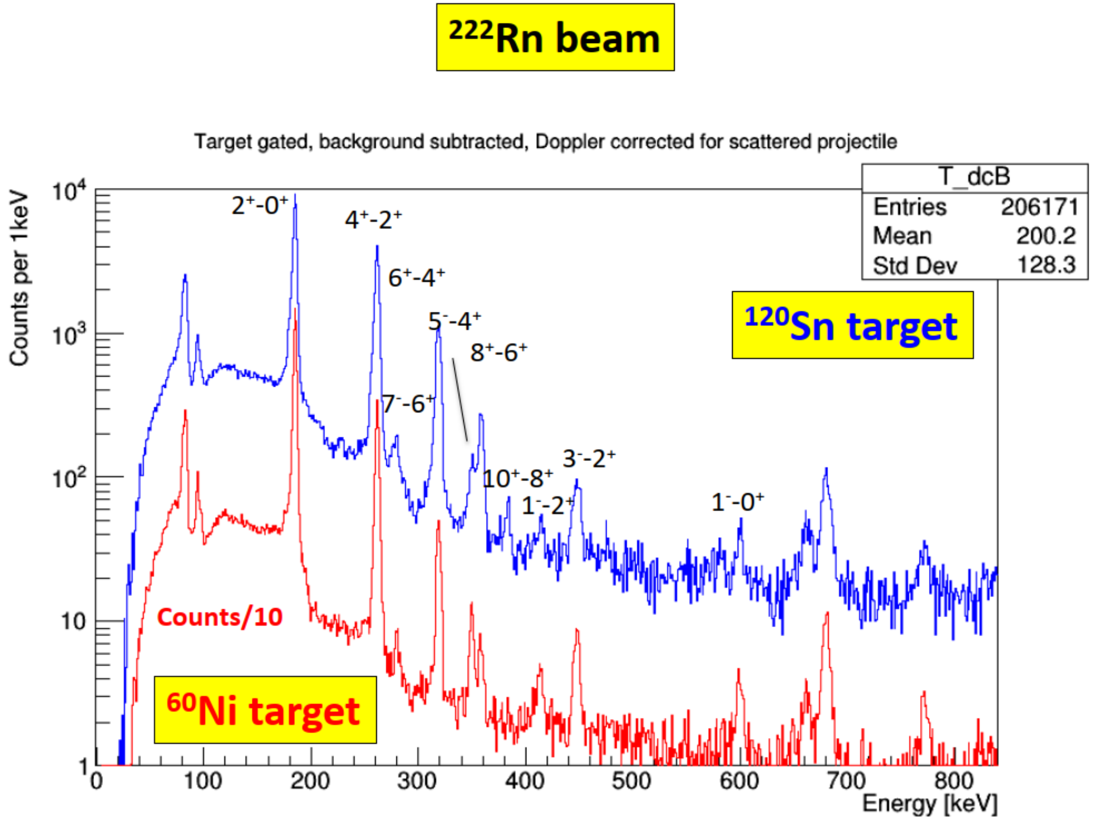
- Work on technical improvements since May beamtime
  - More homogenous, stable, and stronger magnet
  - Fitting NMR chamber
  - Fitting transitional field section
  - New NMR system for field readout and stabilization
- Vacuum tests and NMR studies on new solutions and DNA samples
  - 17ppm shift for DNA G-quadruplex confirmed in a vacuum-compatible solution
- Beamtime 2 weeks ago
  - Very stable and reliable setup
  - many NMR resonances and relaxation-time data of DNA G-quadruplexes and crown-ether solutions in different solvents

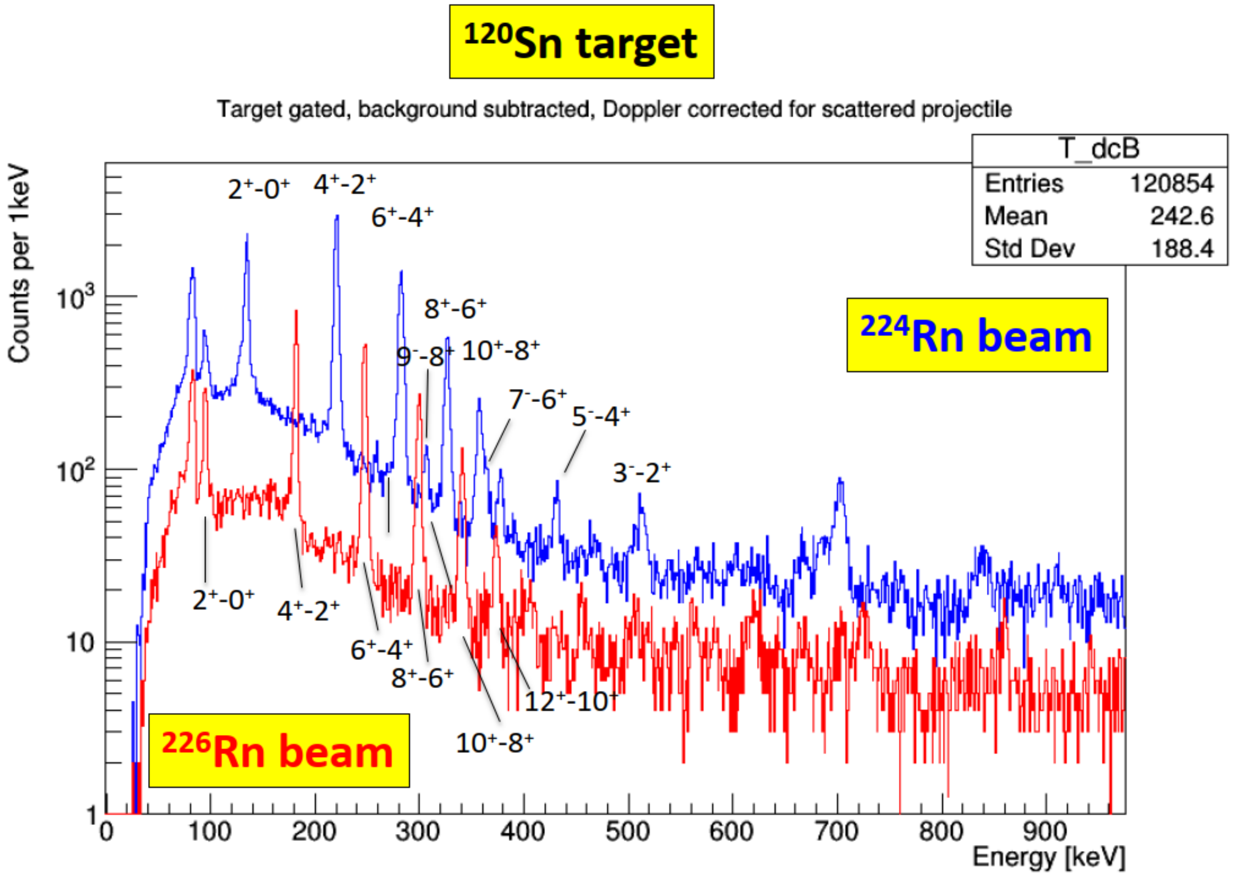






Coulomb excitation of Ra/Rn isotopes: IS552





Heaviest isotopes post-accelerated at ISOLDE (and beyond?) Difficult/busy run with many energy changes and isotopes but demonstration of how much progress has been made in understanding the machine in the past 2 years.

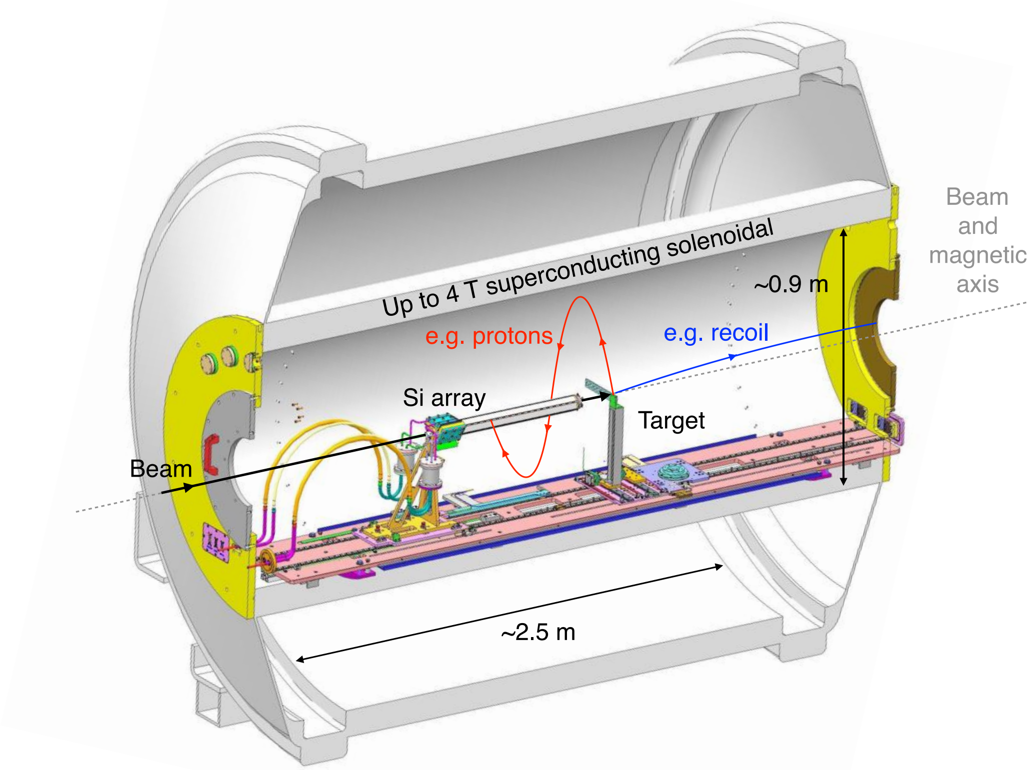
Analysis ongoing (and making impressive progress…)

Warsaw TPC chamber: no spectra to show yet: but mid-run celebratory tirimisu

Preliminary data from ISS

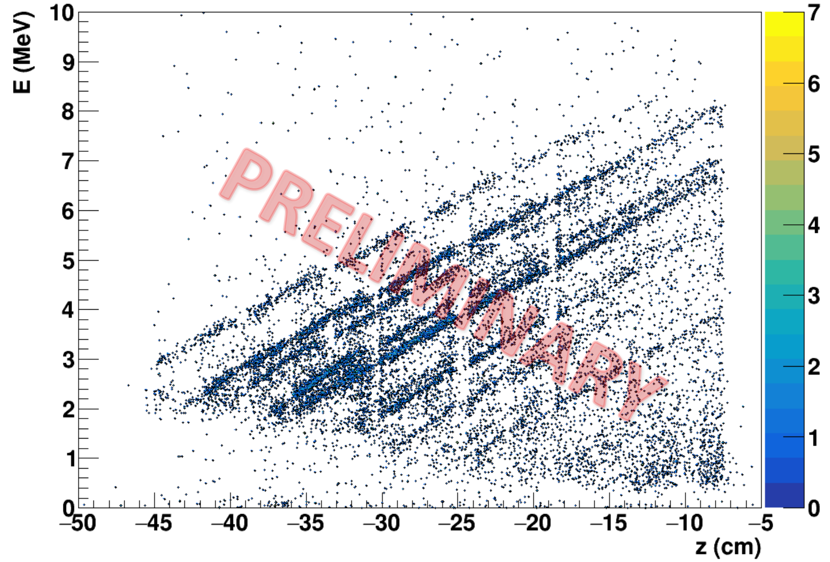
Courtesy Dave Sharp

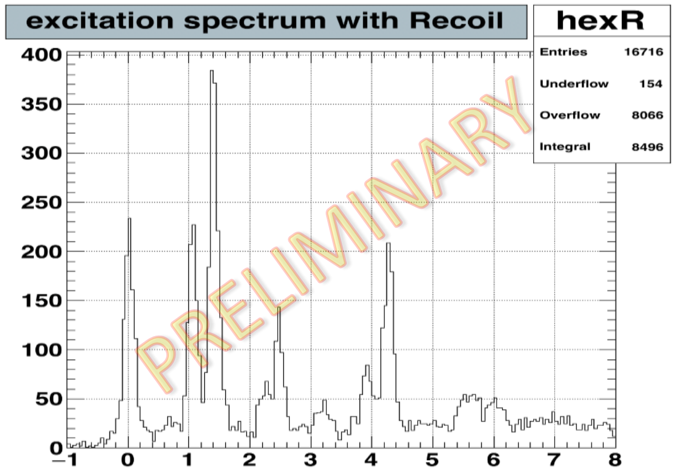
^{28}Mg(d,*p*)^{29}Mg reaction in ISS
with accelerated ^{28}Mg beam at **9.473 MeV/u**
highest HIE-ISOLDE beam energy ever !



Study bound and unbound quantum states in ^{29}Mg **up to 6 MeV**.
Resolution ~**100keV** – able to resolve most states of interest

Recoil proton energy versus position on detector





Exploring terra incognita with ISS (IS631)

A study of the hitherto unknown single-neutron structure of ^{207}Hg was carried out using a ***7.4 MeV/u ^{206}Hg beam*** and the ***ISOLDE Solenoidal Spectrometer*** to momentum analyze the protons following the neutron-adding (*d,p*) reaction

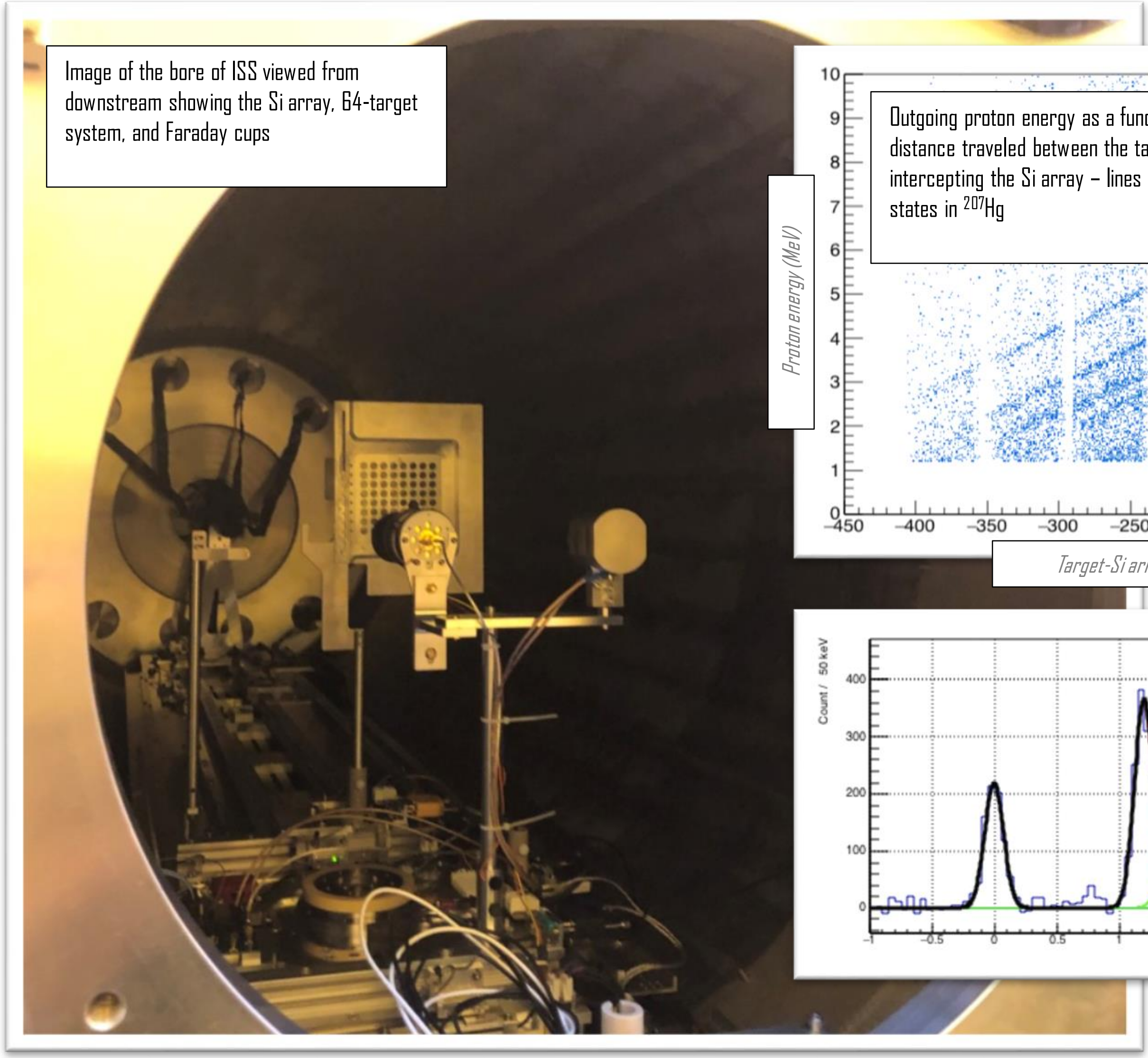
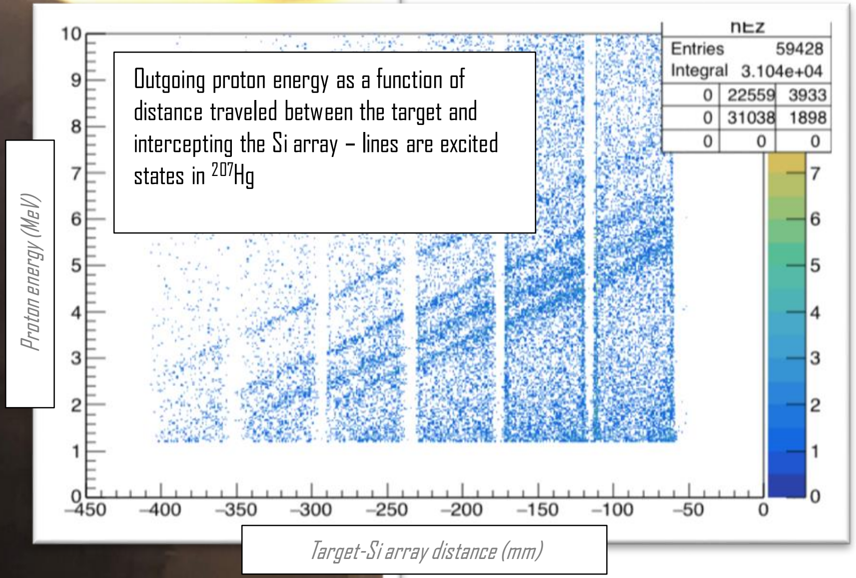
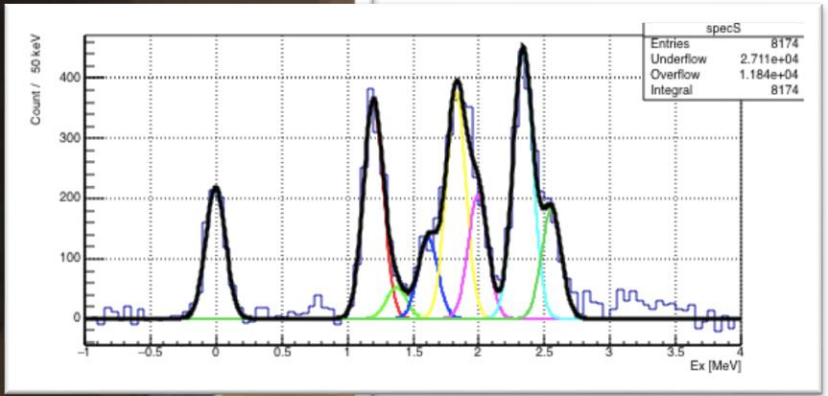


Image of the bore of ISS viewed from downstream showing the Si array, 64-target system, and Faraday cups



Outgoing proton energy as a function of distance traveled between the target and intercepting the Si array – lines are excited states in ^{207}Hg



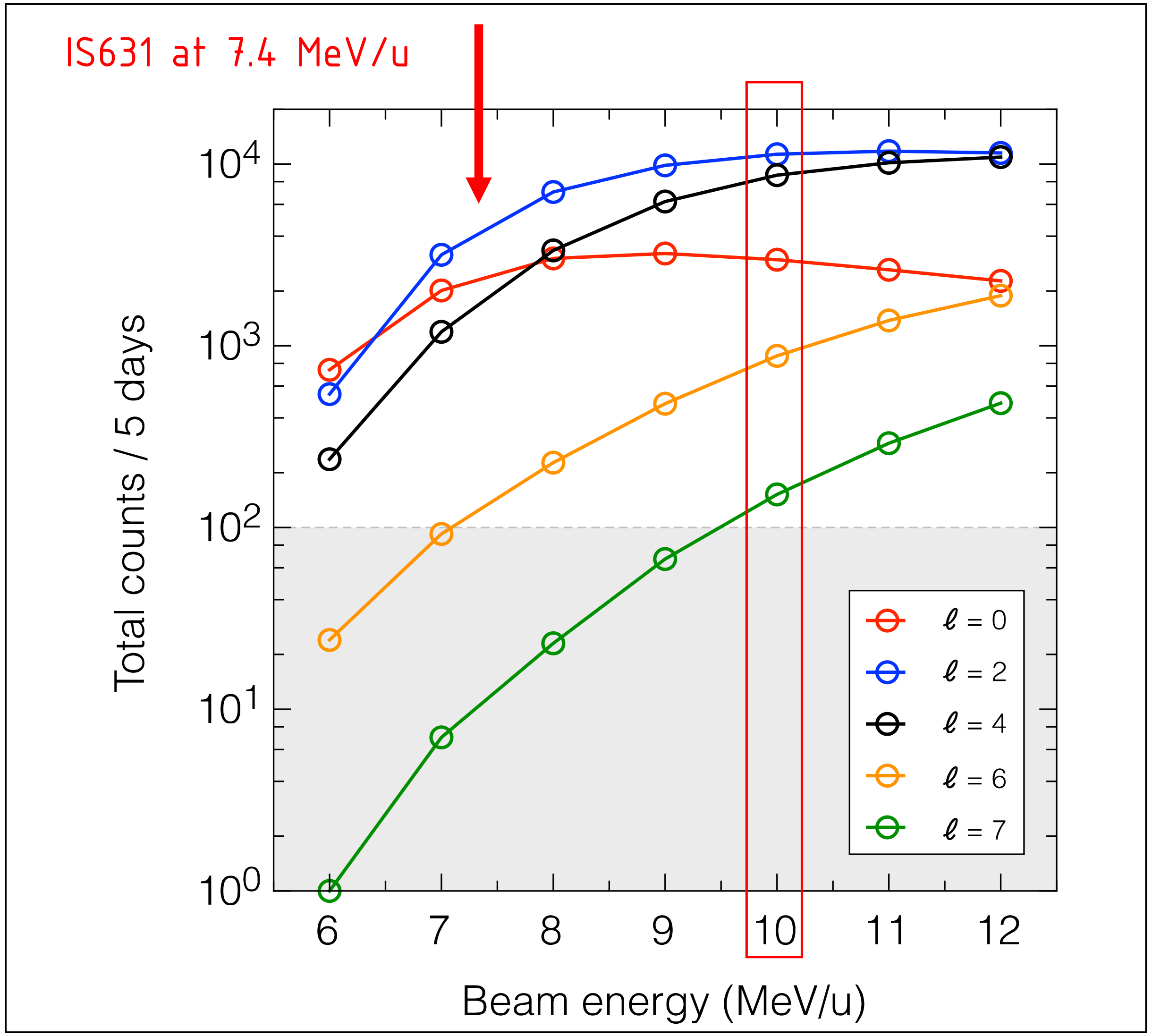
First exploration of single-particle states outside N = 126, south of Pb, made possible by ISS.

Experimental info:

- ~***5×10^5 ions per second*** of ^{206}Hg for ~***82 hours***
- Beam ***purity of >98%***
- Measured in singles mode
- Using ***>30*** deuterated polyethylene ***targets*** of thickness around 165 μg/cm^2 (to deal with target degradation)
- ISS set to a B-field of 2.5 T

HIE-ISOLDE beam energy

Importance of 10 MeV/u for exploitation of the direct-reaction studies at HIE-ISOLDE with ISS and Miniball – 10 MeV/u is ideal (for example the ^{28}Mg(d,p) study IS 621), leading to larger (optimal) cross sections and more distinct angular distributions for all reactions and masses, thus maximizing the efficiency of the experimental program



<u>Using the example of IS631</u>

Yields based on a 5-day experiment (typical for many ISOLDE runs)

10 MeV/u would allow the full complement of single-particle states to be probed in heavy nuclei, for which ISOLDE excels.

At a reduced beam energy, the higher *j* single-particle states (populated more weakly) are out of reach, but present at 10 MeV/u

Some observations through the year

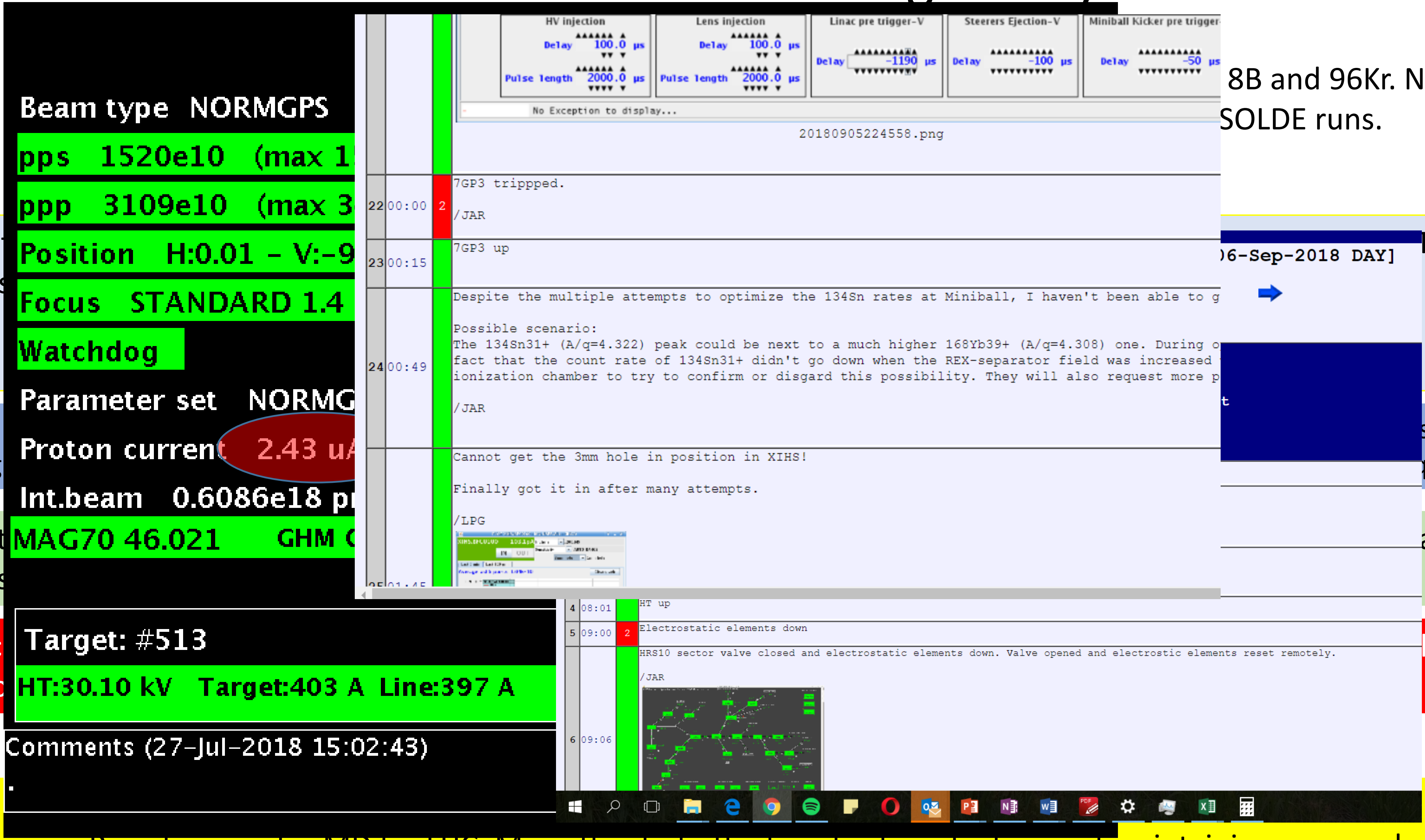
8B and 96Kr. Not realized
SOLDE runs.

Operat... Their
unders...

Machine ... s (wells in
bunching ... quently broken.

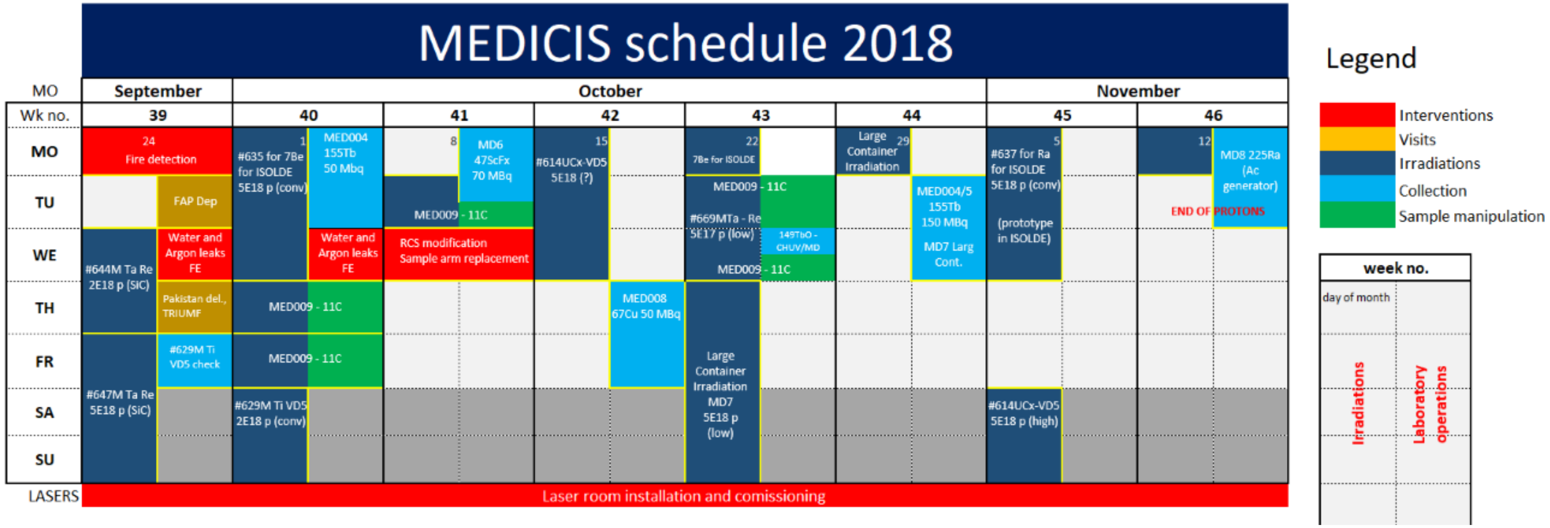
Stabilit... ars ago not
being s...

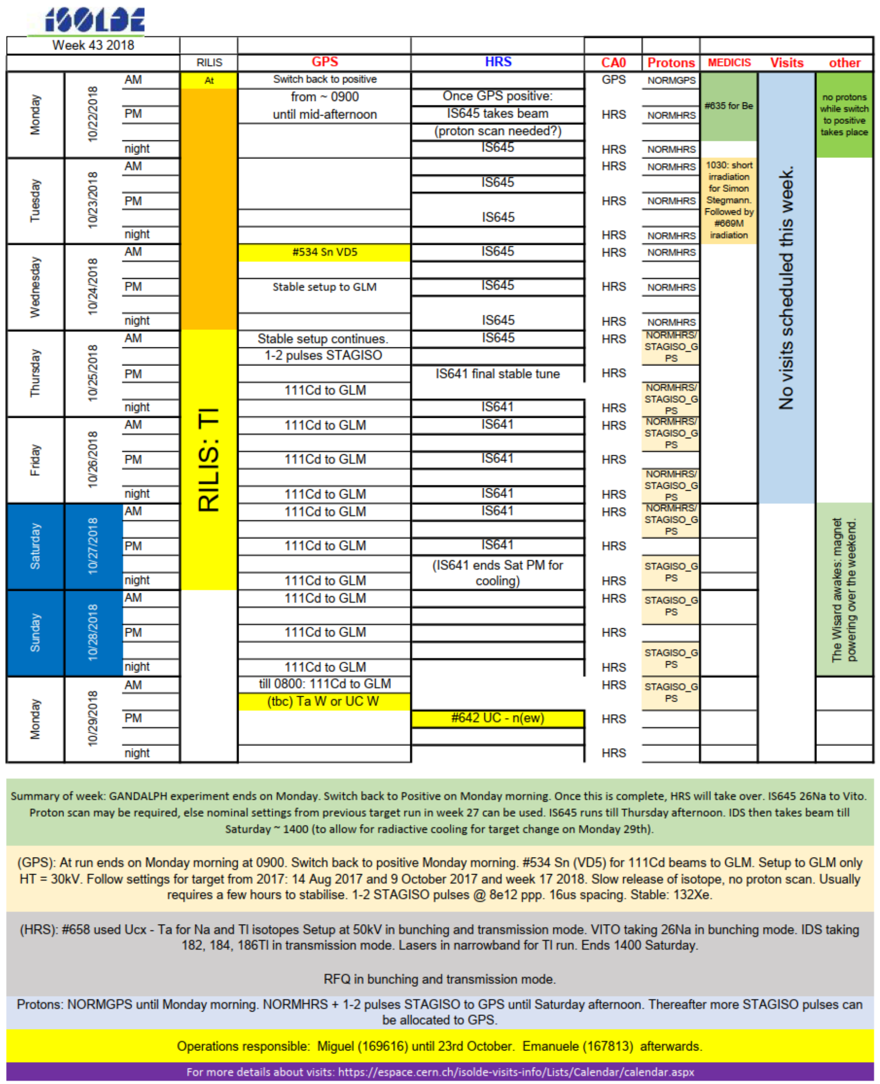
Molec... his year were
for mc...



Priority given for MD for LHC. Many thanks to the booster for adapting and maintaining our needs.

Interaction with MEDICIS





Interaction with MEDICIS has been constructive; still learning. Close interaction with Joao Pedro Ramos (MEDICIS run coordinator). Can be mutually beneficial: e.g. irradiation for winter physics. Improvements to the montrac security chain for target changes would also help. But physics programme has not been hit by MEDICIS.

Possibility now of collecting non-medical isotopes: e.g. would have greatly helped for 53Mn sample for nTOF.

NOTE: MEDICIS has not yet really been running in “MEDICIS mode”….direct irradiation through targets until the wider units for MEDICIS become available

Researchers night 2018: official opening of the esplanade.

ISOLDE participation highly regarded. Perhaps new ideas next year…

Interminable queue pour rentrer dans la sphère…

Nuit des chercheurs : la rançon du succès

Vendredi 28 Septembre de 17 h à 23 h, le CERN ouvrait ses portes et proposait des animations exceptionnelles.

SAINT-GENIS-POUILLY

Scientifiques en herbe, passionnés et novices de tout âge se sont retrouvés pour la Nuit des Chercheurs, un événement gratuit et ludique. Le plus grand laboratoire de physique des particules du monde accueille le grand public en septembre depuis 9 ans déjà.

On pouvait fabriquer son propre détecteur de particules et programmer des robots. Le Synchrocyclotron (SC) se visitait, (premier accélérateur de particules du CERN), des casques de réalité virtuelle emmenaient le public au cœur du détecteur CMS et du Centre de Calcul. Et surtout, c'était la soirée pour rencontrer les chercheurs du CERN, qui présentaient leurs expériences à travers des démonstrations interactives ! Le hic, (pas le boson), c'est que près de 5000 personnes se sont amassées autour de ces animations prévues pour 3 fois moins de monde (la fréquentation de l'année dernière). La question de l'origine de l'univers et de ses premiers instants semble intéresser tout le monde.

JÉRÔME LIGAT

Des documentaires, des animations, des ateliers et des expositions nocturnes.

Tout était bondé, les particules n'étaient pas seules en collision.

Anna de Manincor la réalisatrice d'un long métrage sur le CERN.

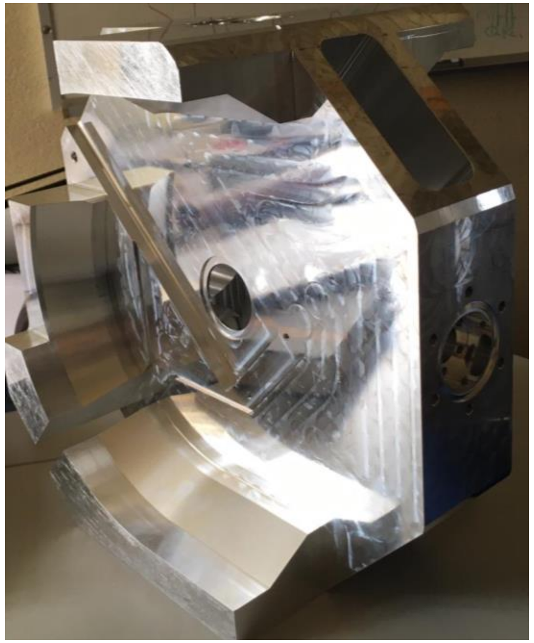
Une myriade d'animations étaient proposées.

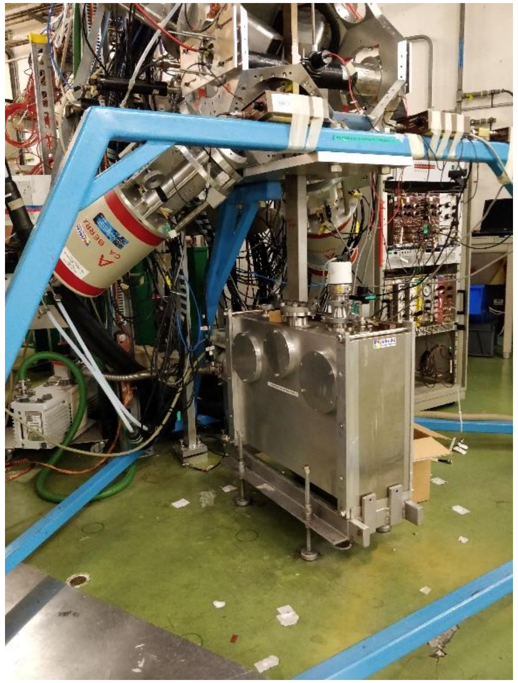
EP technicians

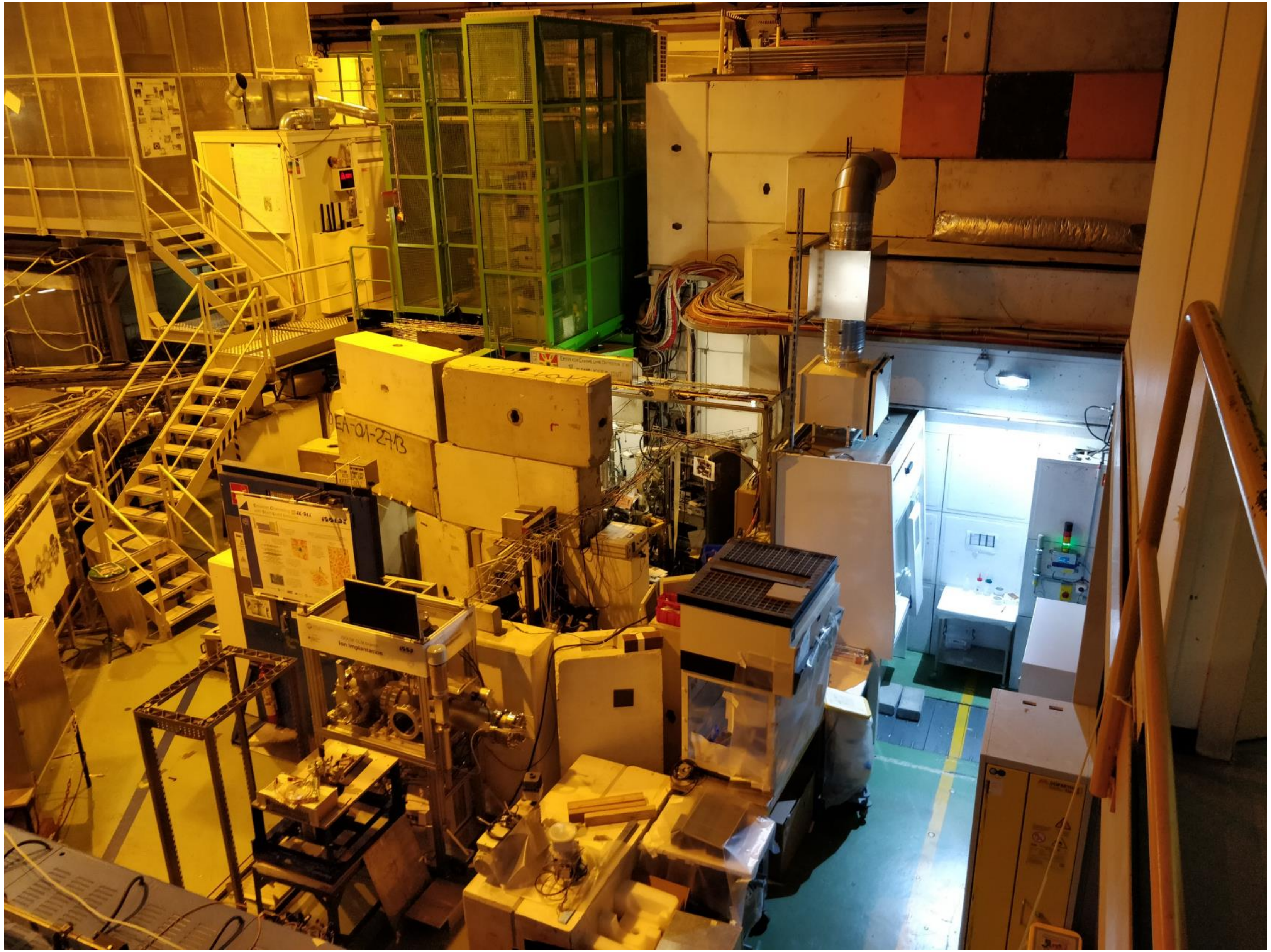
Antonio Goncalves and Francois Garnier: supported by the collaboration.

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

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







GLM/GHM:

Installation of new shielded fume cupboard.

New collection chamber to go online

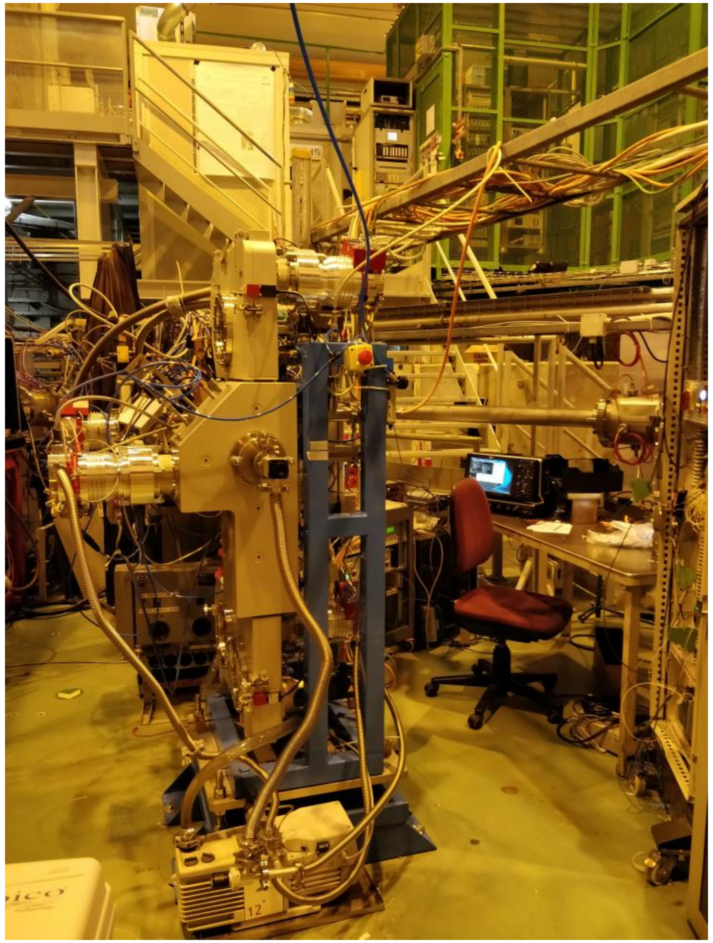
Redistribution of space and semi-closing for class C workspace.

HOWEVER: important to maintain access for visiting/temporary/new setups.


ESCO
Frontier Acela

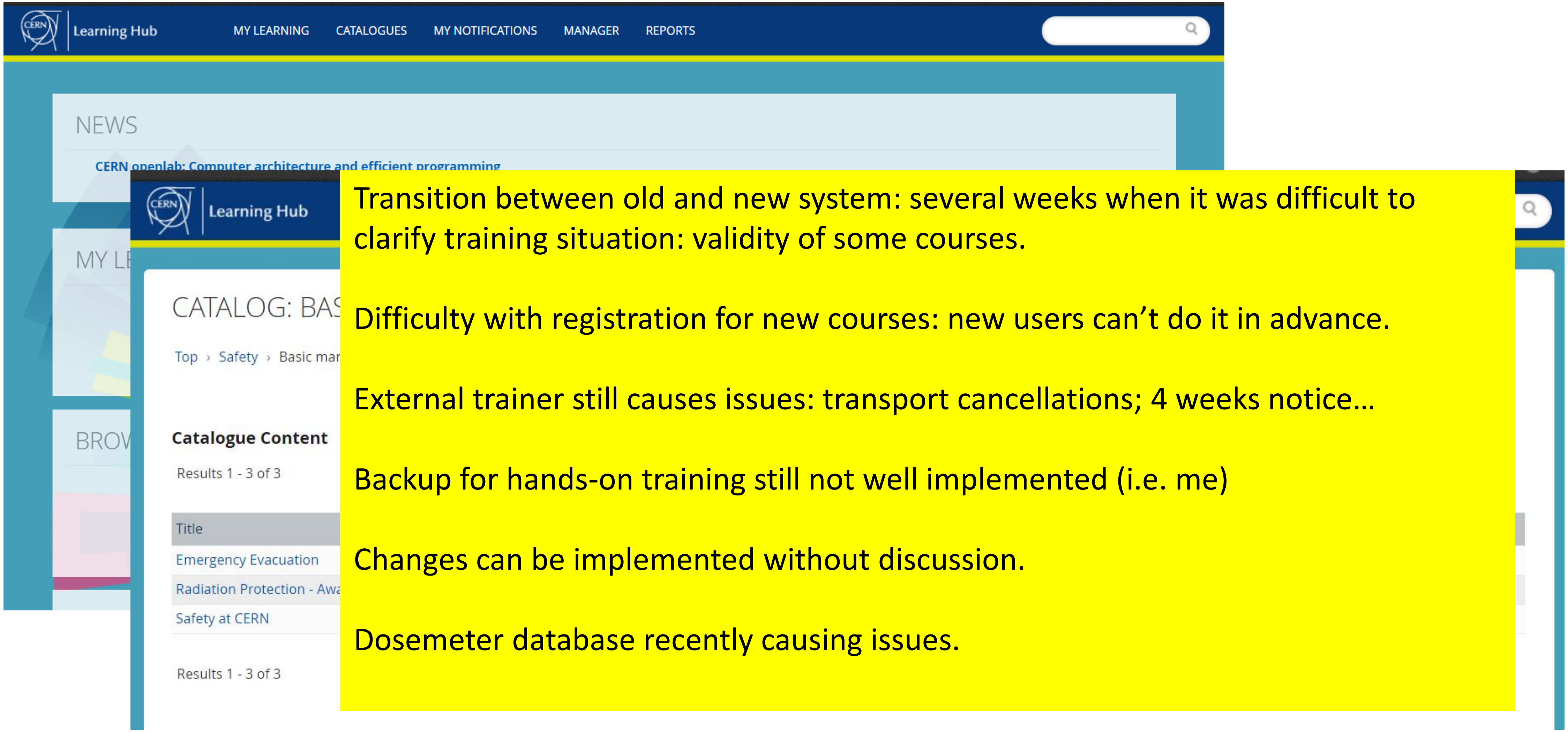
LA1/LA2

LA1 to be kept for travelling experiments.



LA2 currently occupied by FTS;
future site for MIRACLS?

Initial feedback from new learning “hub” (safety training for most users)



Transition between old and new system: several weeks when it was difficult to clarify training situation: validity of some courses.

Difficulty with registration for new courses: new users can’t do it in advance.

External trainer still causes issues: transport cancellations; 4 weeks notice…

Backup for hands-on training still not well implemented (i.e. me)

Changes can be implemented without discussion.

Dosemeter database recently causing issues.

Publications

nature physics LETTERS
https://doi.org/10.1038/s41567-018-0292-8

Characterization of the shape-staggering effect in mercury nuclei

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In rare cases, the removal of a single proton (Z) or neutron (N) from an atomic nucleus leads to a dramatic shape change. These instances are crucial for understanding the components of the nuclear interactions that drive deformation. The mercury isotopes (Z = 80) are a striking example[1,2]: their close neighbours, the lead isotopes (Z = 82), are spherical and steadily shrink with decreasing N. The even-mass (A = N + Z) mercury isotopes follow this trend. The odd-mass mercury isotopes ^{181,183,185}Hg, however, exhibit noticeably larger charge radii. Due to the experimental difficulties of probing extremely neutron-deficient systems, and the computational complexity of modelling such heavy nuclides, the microscopic origin of this unique shape staggering has remained unclear. Here, by applying resonance ionization spectroscopy, mass spectrometry and nuclear spectroscopy as far as ^{177}Hg, we determine ^{181}Hg as the shape-staggering endpoint. By combining our experimental measurements with Monte Carlo shell model calculations, we conclude that this phenomenon results from the interplay between monopole and quadrupole interactions driving a quantum phase transition, for which we identify the participating orbitals. Although shape staggering in the mercury isotopes is a unique and localized feature in the nuclear chart, it nicely illustrates the concurrence of single-particle and collective degrees of freedom at play in atomic nuclei.

Atomic nuclei, comprising protons and neutrons, exhibit a rich array of quantum phenomena. These complex many-body systems obey the Pauli exclusion principle which dictates a nucleonic shell-like structure, akin to Bohr's model of electrons in an atom. In the vicinity of closed shells, at the magic numbers of Z, N = 8, 20, 28, 50, 82 and N = 126, the nuclear wavefunction is dominated by the last few particles (or holes) and excitations thereof. In contrast to this single-particle nature, collective behaviour appears away from the closed shells, as increased nucleon–nucleon correlations drive the minimum-energy configuration of the nucleus to deformation. Consequently, the ground states of most isotopes in the nuclear chart are non-spherical. Most commonly they are prolate (rugby-ball) shaped, although different shapes, corresponding to alternative nucleon configurations, can coexist within the same nucleus[3,4]. It remains a challenge to pin down the full picture of the underlying microscopic origin of this phenomenon.

Optical spectroscopy is able to measure subtle shifts in the energy of the atomic electron levels, arising from changes in the charge distribution of the nucleus[5]. Along the isotopic chain of a given element, this effect is known as the isotope shift. From this, the change in mean-square charge radius, $\delta\langle r^2\rangle$, can be extracted in a nuclear-model-independent way. Similarly, the hyperfine splitting of the electronic levels gives direct access to the nuclear properties: spin (I), magnetic dipole (μ) and electric quadrupole (Q) moments. Such measurements are therefore a sensitive and direct probe of the valence particle configuration and changes in nuclear size or deformation as a result of the addition or removal, and consequential redistribution, of nucleons.

The radioactive isotopes in the lead region have been the subject of a variety of optical spectroscopy studies for several decades. An intensified interest in this region was sparked by the study of the mercury isotopic chain, in which a sudden and unprecedented increase in charge radius was observed for ^{185}Hg, ^{183}Hg and ^{181}Hg (refs [1,2]). For the heavier mercury isotopes the changes in charge radii mirror those of lead[6]: steadily shrinking with decreasing N. This seminal discovery of shape staggering between odd and even neutron-deficient mercury isotopes is unparalleled elsewhere in the nuclear chart and was key to establishing the idea of shape coexistence at low excitation energy[4,7]. A plethora of studies on the excited states of these nuclei[8,9] provided a further substantial insight into shape coexistence, complementing the laser spectroscopy studies of ground and isomeric states. However, to acquire a full understanding

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CERN willing to support certain publications for open access which feature CERN author.

For ENSAR2 open access for all publications.

CERN EP creating a designated area for ISOLDE pre-prints which can be used for future publications. (but not retrospectively).

First Accurate Normalization of the β-delayed α Decay of ^{16}N and Implications for the $^{12}C(\alpha,\gamma)^{16}O$ Astrophysical Reaction Rate

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The $^{12}C(\alpha,\gamma)^{16}O$ reaction plays a central role in astrophysics, but its cross section at energies relevant for astrophysical applications is only poorly constrained by laboratory data. The reduced α width, γ_{11}, of the bound 1^- level in ^{16}O is particularly important to determine the cross section. The magnitude of γ_{11} is determined via sub-Coulomb α-transfer reactions or the β-delayed α decay of ^{16}N, but the latter approach is presently hampered by the lack of sufficiently precise data on the β-decay branching ratios. Here we report improved branching ratios for the bound 1^- level [$b_{\beta,11} = (5.02 \pm 0.10) \times 10^{-2}$] and for β-delayed α emission [$b_{\beta\alpha} = (1.59 \pm 0.06) \times 10^{-5}$]. Our value for $b_{\beta\alpha}$ is 33% larger than previously held, leading to a substantial increase in γ_{11}. Our revised value for γ_{11} is in good agreement with the value obtained in α-transfer studies and the weighted average of the two gives a robust and precise determination of γ_{11}, which provides significantly improved constraints on the $^{12}C(\alpha,\gamma)$ cross section in the energy range relevant to hydrostatic He burning.

DOI: 10.1103/PhysRevLett.121.142701

In the hot and dense interior of stars, helium is burned into carbon and oxygen by means of the triple-α reaction and the $^{12}C(\alpha,\gamma)$ reaction. The rates of the two reactions regulate the relative production of carbon and oxygen—a quantity of paramount importance in astrophysics affecting everything from grain formation in stellar winds to the late evolution of massive stars and the composition of type-Ia supernova progenitors [1]. At the temperatures characteristic of hydrostatic He burning, the triple-α reaction is dominated by a single, narrow resonance—the so-called Hoyle resonance—and hence it has been possible to constrain the reaction rate through measurements of the properties of the Hoyle resonance. In contrast, the $^{12}C(\alpha,\gamma)$