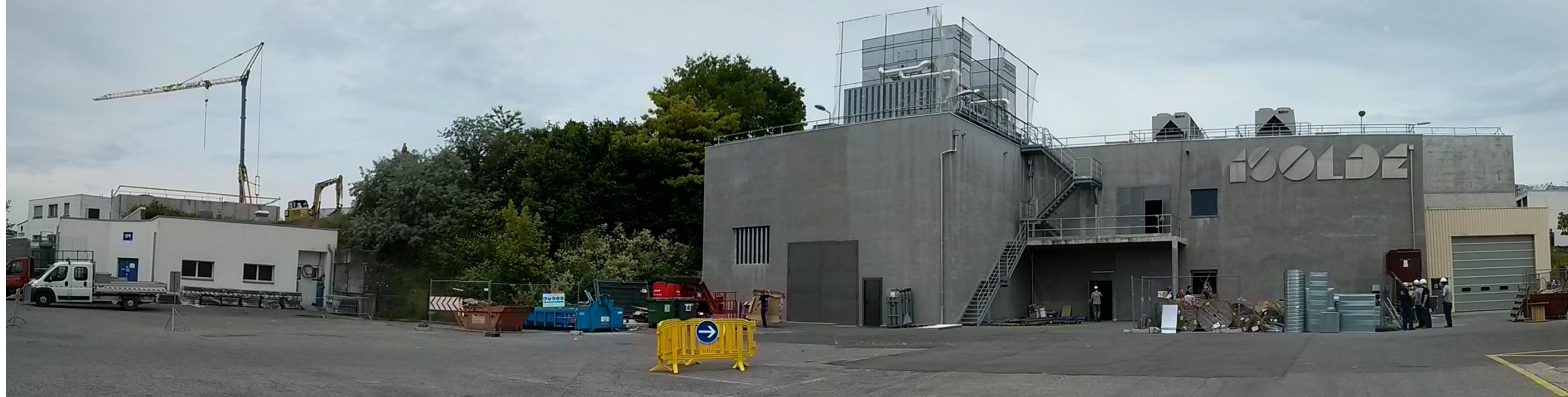


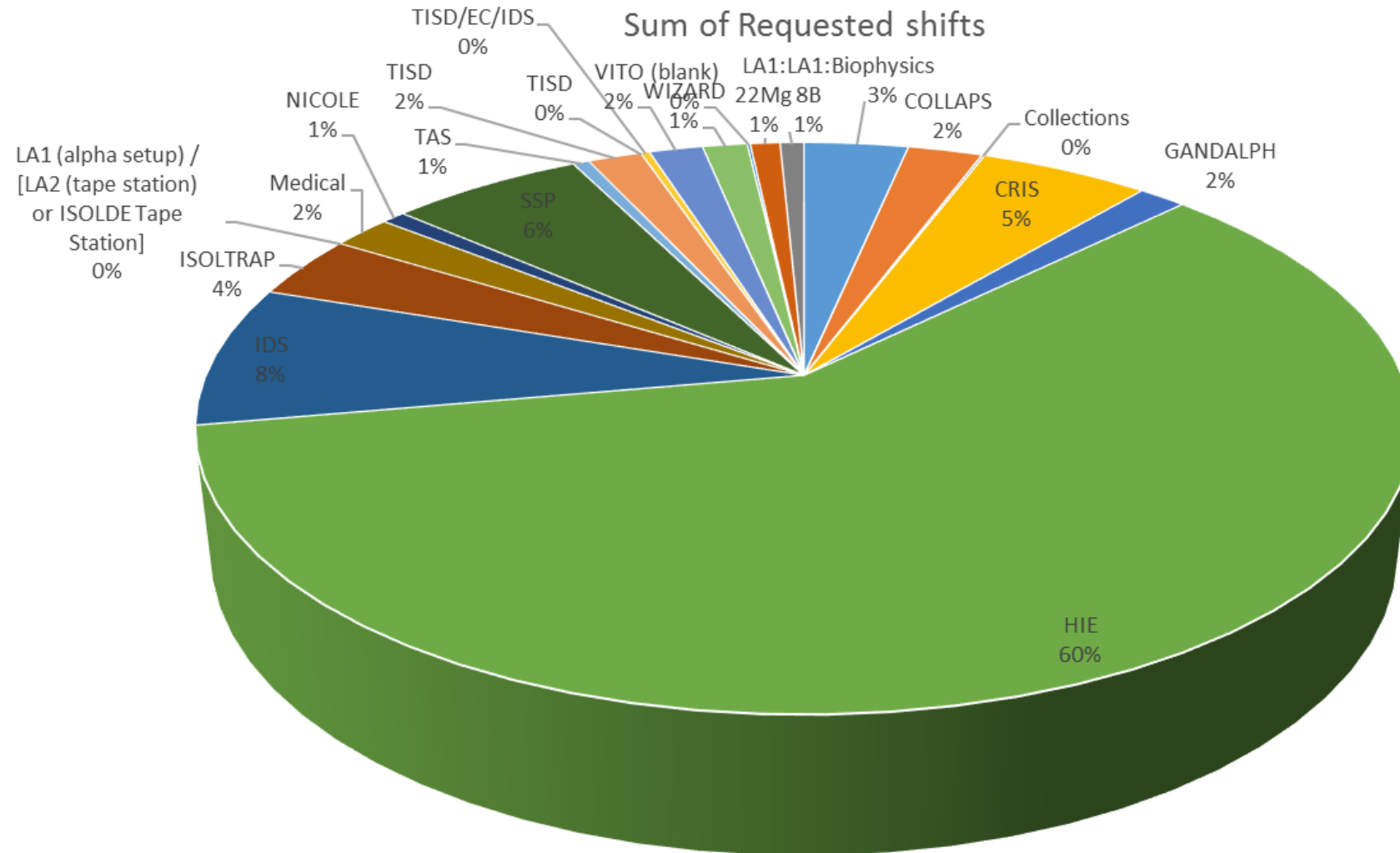
ISOLDE physics coordinator report: ISCC 6th November 2018

Karl Johnston



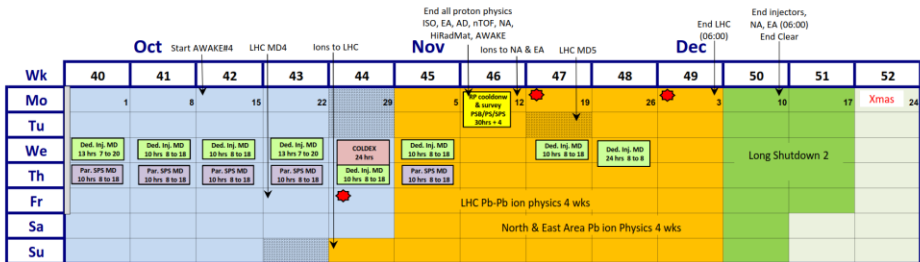
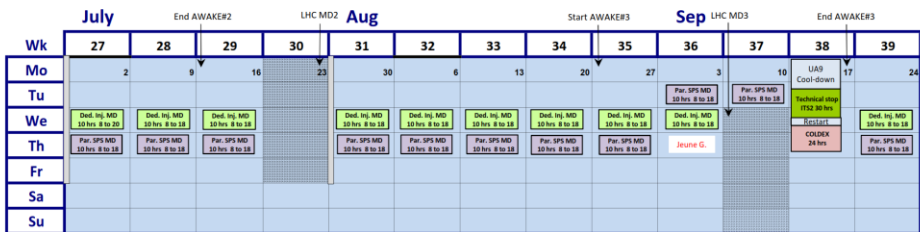
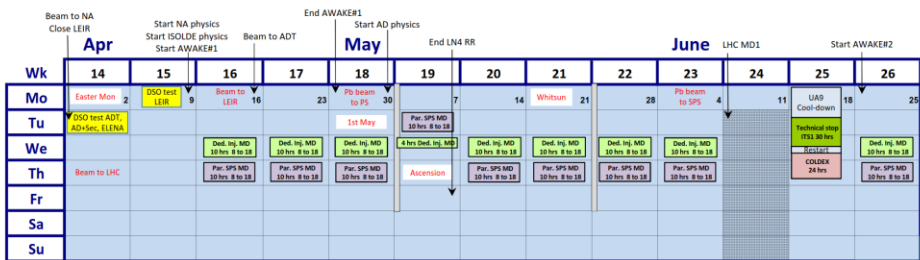
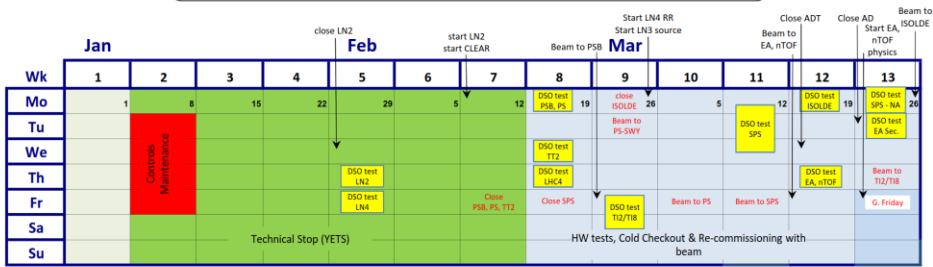
- Summary of 2018: proton and winter physics schedules
- Safety/training
- Technicians
- Publications

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

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
- LINAC 3 Pb oven re-fill
- 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

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

ISOLDE Schedule 2018: weeks 15 – 46

GPS schedule 2018

	April				May				June				July				August				September				October				November						
WK	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46		
MO	2	9	16	23	30	MD: FTS	14	21	28	IS610	4	11	18	25	2	9	16	23	30	7	14	21	28	5	12	19	26	1	8	15	22	29	36	43	50
TU			TISD		May-01	MD: FTS						Tech Stop	Medical isotopes																						
WE			TISD																																
TH		#513/ #650																																	
FR																																			
SA																																			
SU																																			
			8B: IDS	111Cd		RILIS: Mg		RILIS: Cu		RILIS: In	RILIS: Mg	RILIS: Dy	RILIS: Dy		96Kr / 212Rn		22x Rn		8B				RILIS: Be	RILIS: Be	RILIS: Mn		199Hg		RILIS: Hg	RILIS: At	111Cd				

Final weeks were provisional: in the end too tight; molecular Sn for HIE had to be cancelled.

W45/46
Provisional period: tbc

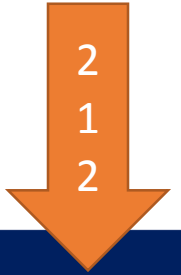
HRS schedule 2018

	April				May				June				July				August				September				October				November						
WK	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46		
MO	2	9	16	23	30	MD: FTS	14	21	28	IS626 Ta - W	4	11	18	25	2	9	16	23	30	7	14	21	28	5	12	19	26	1	8	15	22	29	36	43	50
TU					May-01																														
WE	#540 La C - n																																		
TH																																			
FR																																			
SA																																			
SU																																			
			In RILIS		Sc RILIS	RILIS test	70Br	26Na	K beams	Sc RILIS																									



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

Final ISOLDE schedule



GPS schedule 2018

Wk	April			May			June			July			August			September			October			November												
	15	16	17	19	20	21	23	24	25	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46						
MO	9	16	23	#513/ #650	MD: FTS	21	IS610	Tech Stop	Medical isotopes	96Kr / 212Rn	22x Rn																							
TU		TISD			MD: FTS																													
WE		TISD	May-01	#599 Ti foils				ISBM	#655 Ta - W																							Prep for winter		
TH					Ascension			ISBM																								Physics		
FR																																		
SA																																		
SU																																		
		8B: IDS	111Cd		RILIS: Mg		RILIS: Cu		RILIS: In	RILIS: Mg	RILIS: Dy	RILIS: Dy																						

HRS schedule 2018

Wk	April			May			June			July			August			September			October			November												
	15	16	17	19	20	21	23	24	25	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46						
MO	9	16	23	#612 Zr HF	#618 UC-TaW	21																												
TU																																		
WE																																		Prep for winter
TH					Ascension																													Physics
FR																																		
SA																																		
SU																																		
		In RILIS	Sc RILIS	RILIS test	70Br	26Na																												



Target
change

CERN
holiday

Setting
up/proton
scan/yield

Physics
GPS

Physics
HRS

RILIS
run

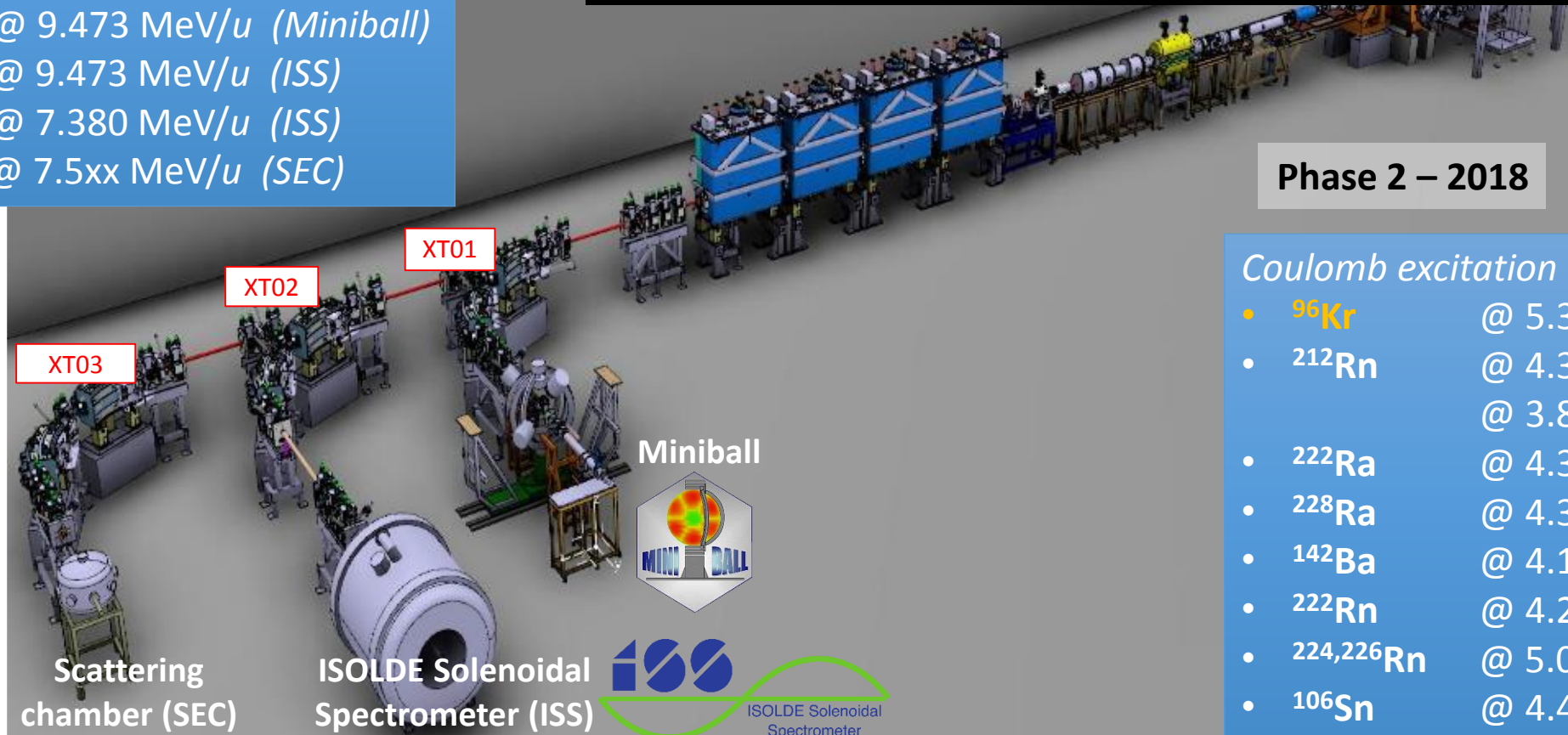
HIE-ISOLDE EXPERIMENTS 2018

reaching 9.5 MeV/u with HIE-ISOLDE

Reactions:

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

Disappointments: multi nucleon transfer ^{94}Rb 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.



Phase 2 – 2018

Coulomb excitation (Miniball):

- ^{96}Kr @ 5.325 MeV/u
- ^{212}Rn @ 4.355 MeV/u
- ^{212}Rn @ 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
- $^{224,226}\text{Rn}$ @ 5.080 MeV/u
- ^{106}Sn @ 4.404 MeV/u

GPS

November			December		
45	46	47	48	49	50
	5 p ⁺ off 0600 12	19	26	3	
	#635 UC Ta				
	XT03				
LOI198	7Be @ 5MeV/u	(tbc) 44Ti	44Ti @ 1.4MeV/u		
IS637	IS554		IS543		
RILIS: Ac	RILIS: Be		44Ti (RILIS?)		
(GLM/GHM/LA 9)					

HRS

November			December		
45	46	47	48	49	50
TISD	5 p ⁺ off 0600 12	19	26	3	
TISD					
#672 CaO VD7					
	#637 UC				
WISArD		CRIS			
LOI172		IS657			
RILIS: for TISD		RaF (CRIS)			

Target change	CERN holiday	Setting up/proton scan/yield	Physics GPS	Physics HRS	RILIS run
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Winter physics programme:

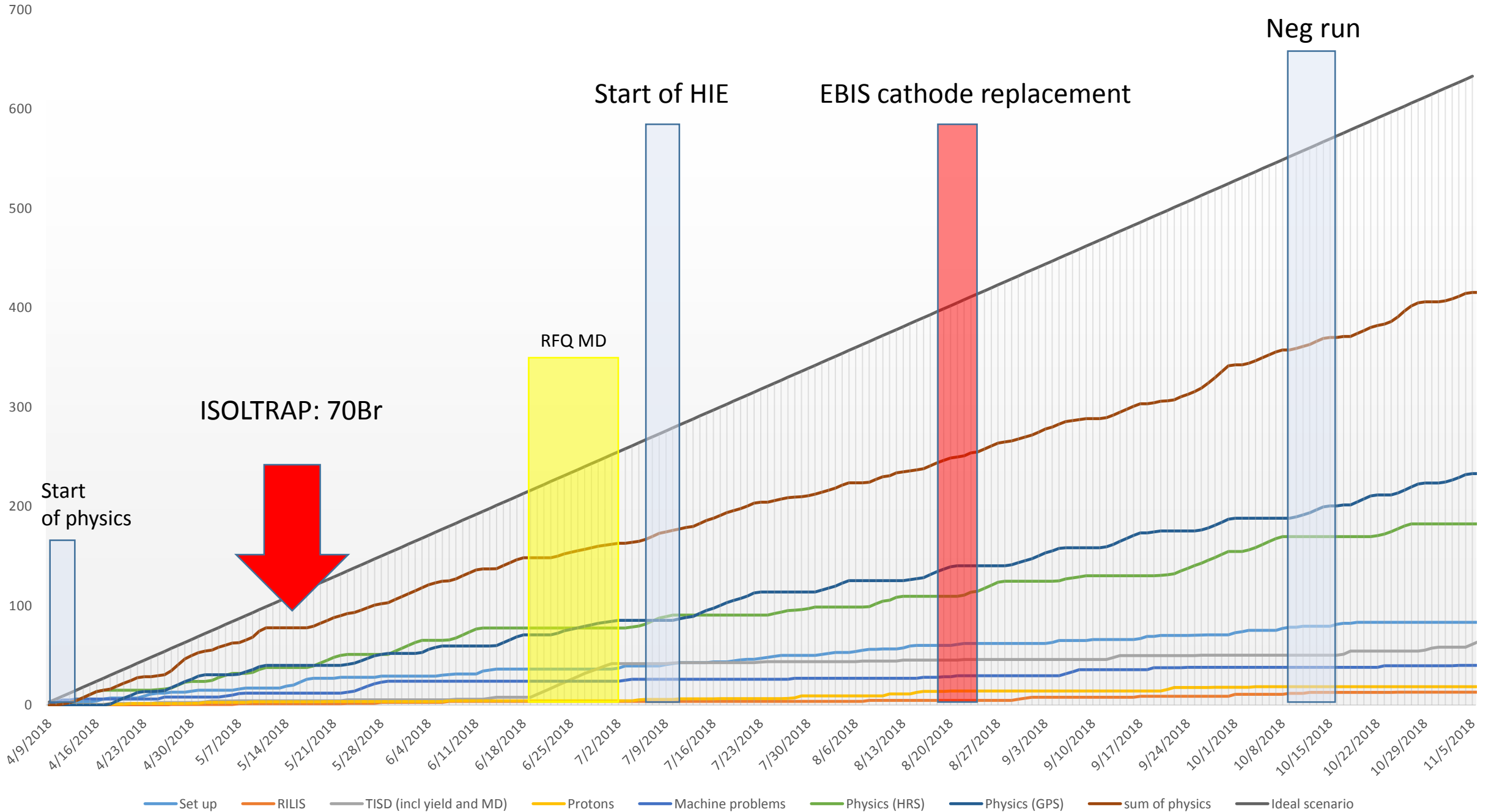
7Be @ 5MeV/u to XT03 (similar setup to recently used 9Li run)

Target irradiated in past weeks (cold). Be mass marker.

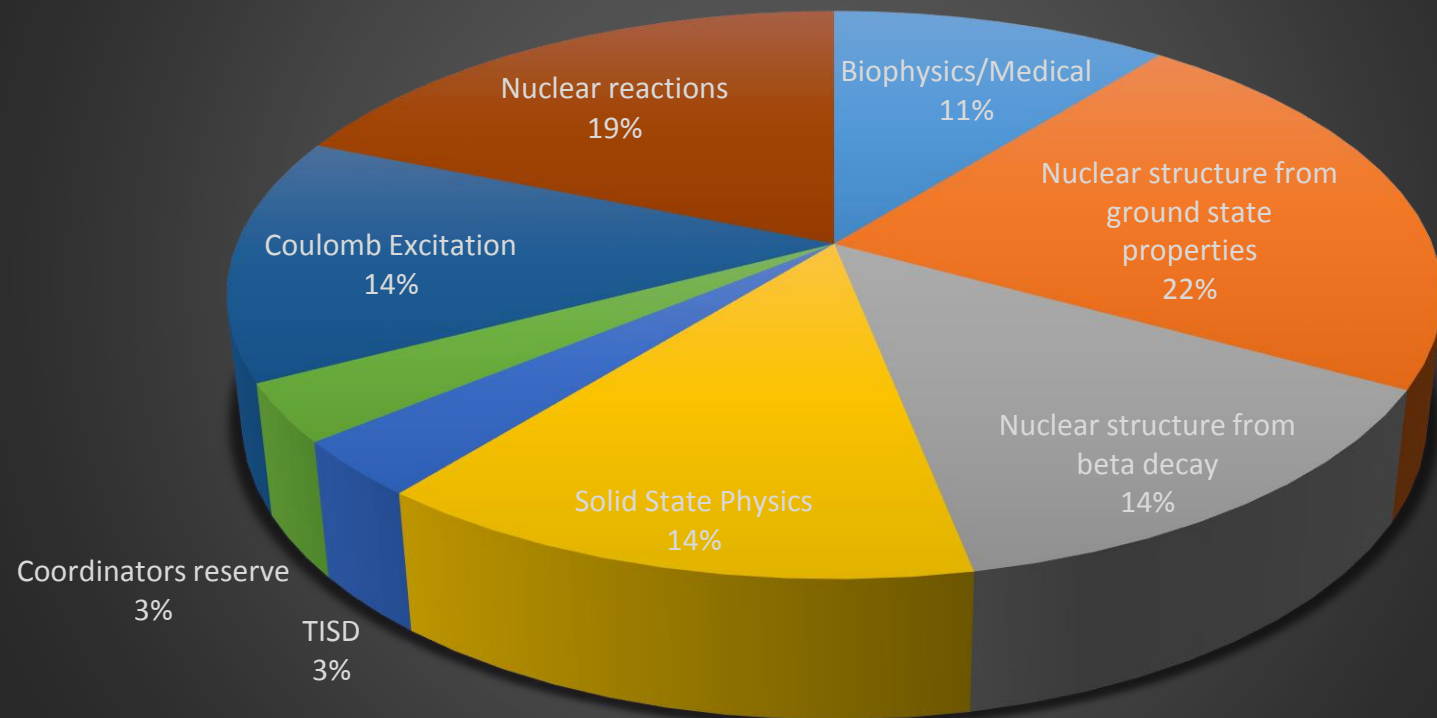
RaF for CRIS: target with CF4 leak irradiated at MEDICIS.

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.

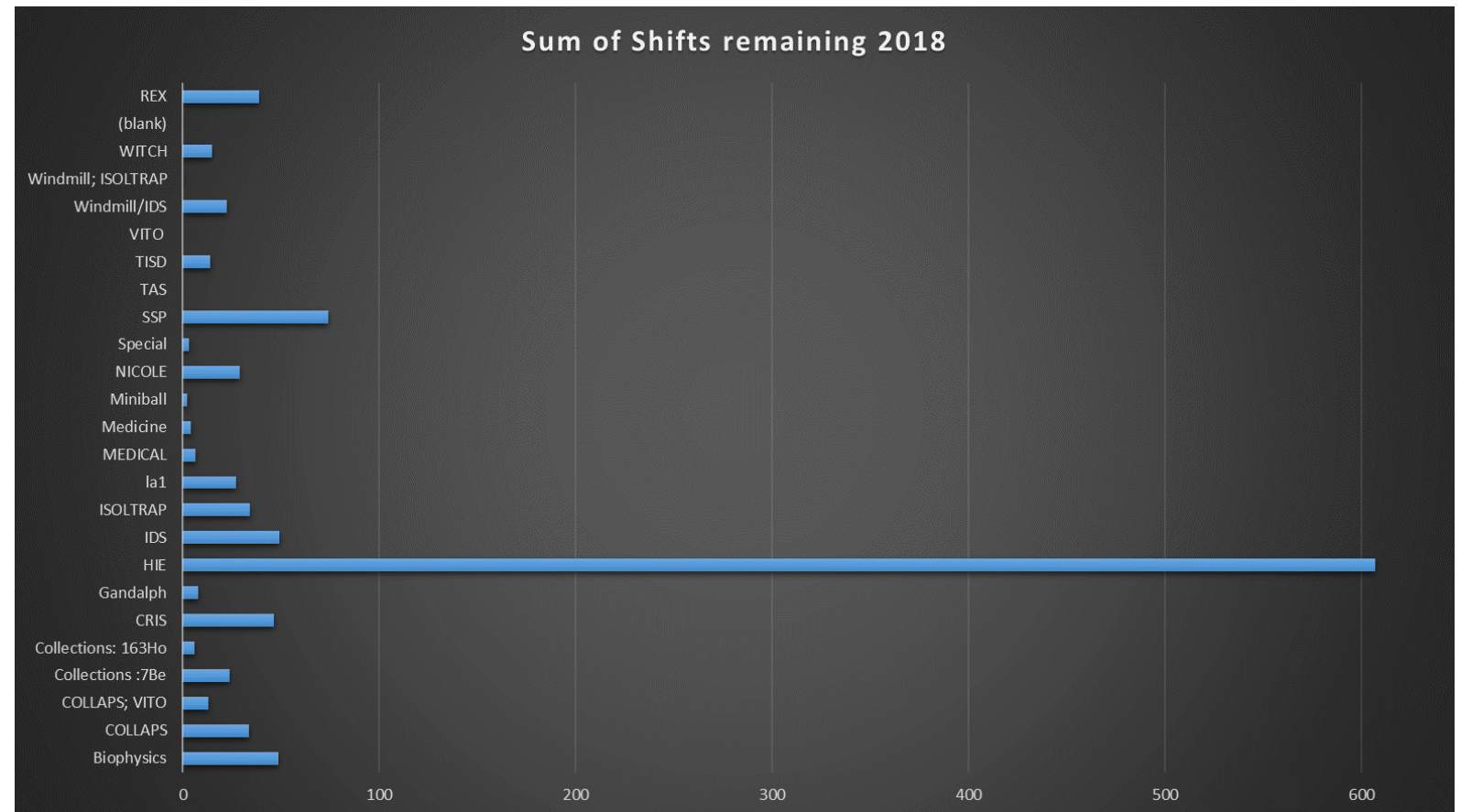


Beam pie (preliminary) 2018



	Count of Delivered 2018	Sum of Delivered 2018
Setup		
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
Ia1	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



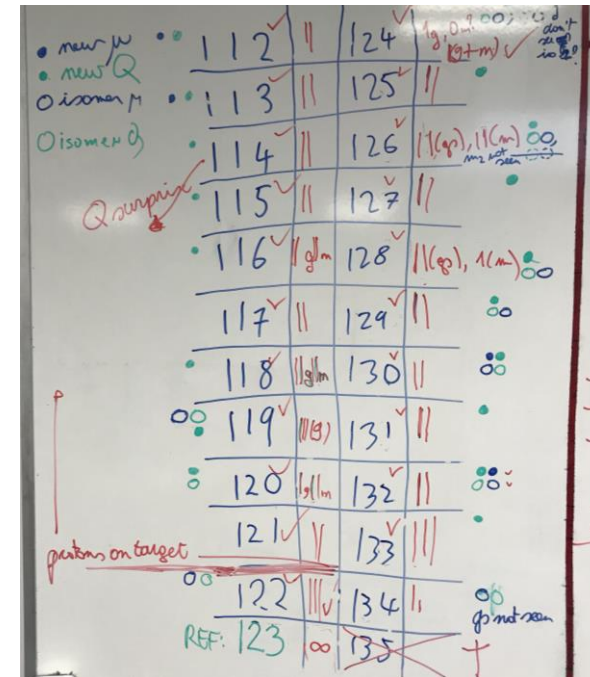
NOTE: preliminary counting; includes RB recommendation that TAS experiments be closed from INTC-59

Fall 2018 at

Sb (Z = 51) isotopes across N = 82

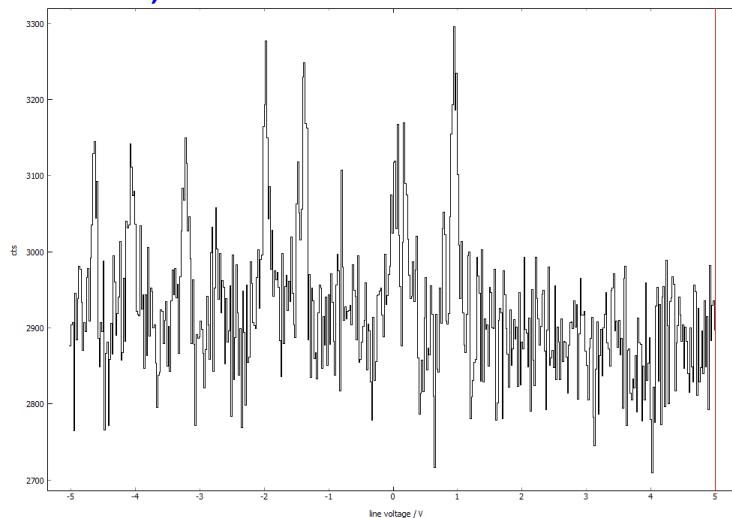
- ✓ $^{112-134}\text{Sb}$ (N = 61 – 83): **23 isotopes incl. several isomers**
 - ☺ Many new moments and radii: large part of physics goal reached
 - ☺ Smooth ISOLDE/RILIS operation
 - ☹ **The interesting ^{135}Sb (probably) out of reach considering the contamination level/available shifts***
- ✓ Second element using frequency quadrupling (217 nm)
 - 2nd Sb run canceled in favour of the VITO run, compensation with ~2 additional shifts in 1st run

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

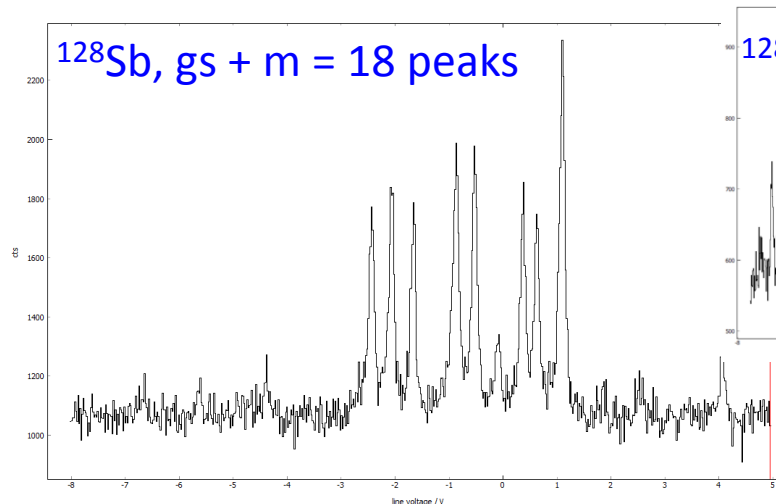


new μ	112 ✓	124 ✓	125 ✓
new Q	113 ✓	125 ✓	126 ✓
isomer μ	114 ✓	126 ✓	127 ✓
isomer Q	115 ✓	127 ✓	128 ✓
	116 ✓	128 ✓	129 ✓
	117 ✓	129 ✓	130 ✓
	118 ✓	130 ✓	131 ✓
	119 ✓	131 ✓	132 ✓
	120 ✓	132 ✓	133 ✓
	121 ✓	133 ✓	134 ✓
	122 ✓	134 ✓	135 ✓
REF:	123	135	

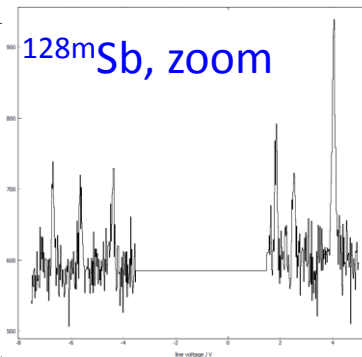
^{134}Sb , ~1 shift of statistics



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

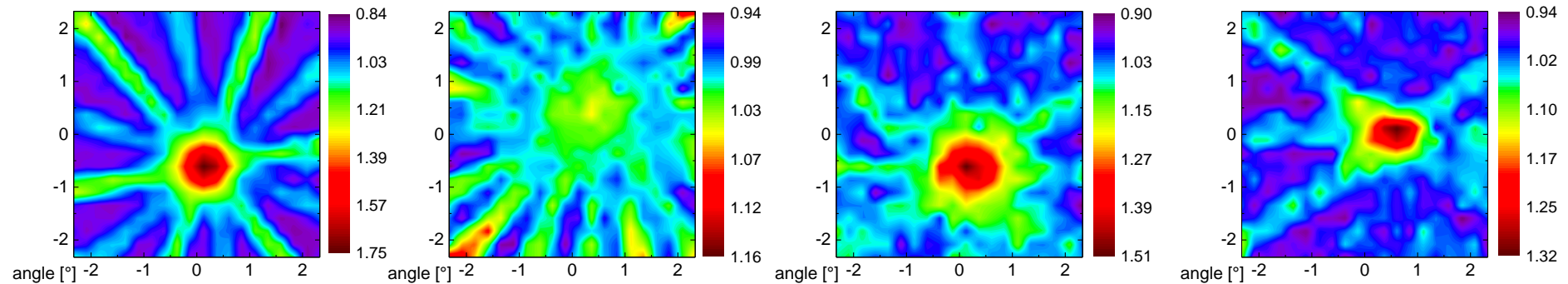


^{128m}Sb , zoom



Emission channeling (EC-SLI)

Lattice location of dopant atoms in functional electronic materials



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

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

^{56}Mn (Mn RILIS)
in $\text{Ge}_{0.87}\text{Mn}_{0.13}\text{Te}$
<110> axis
 $T = 100\text{ K}$

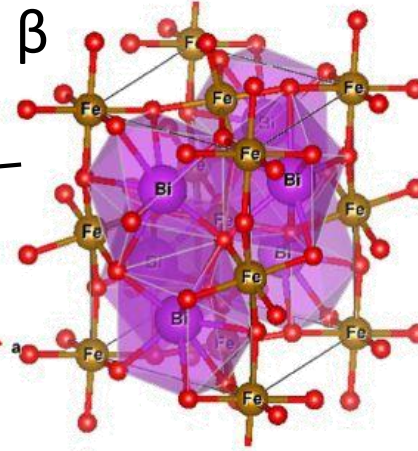
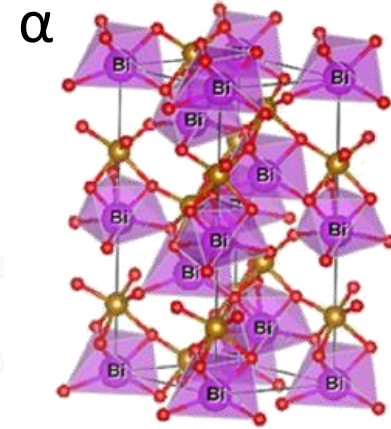
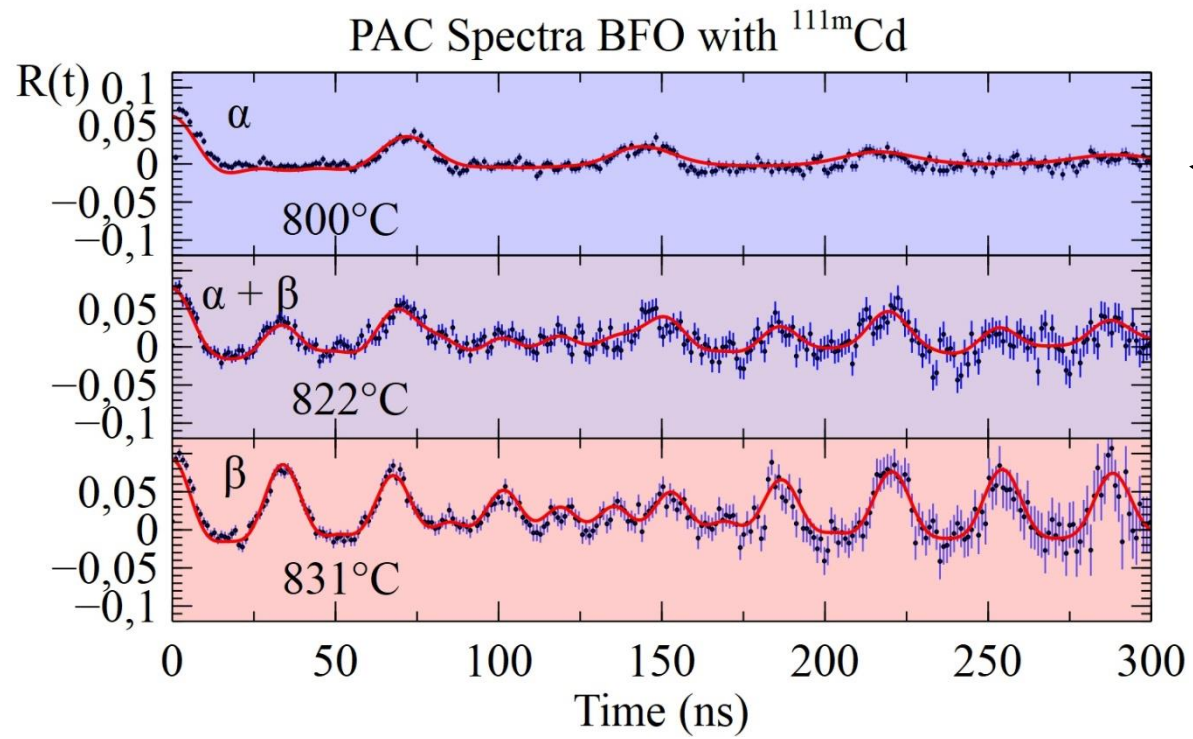
^{61}Co (Mn RILIS)
in diamond
<110> axis
 $T = 300\text{ K}$

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

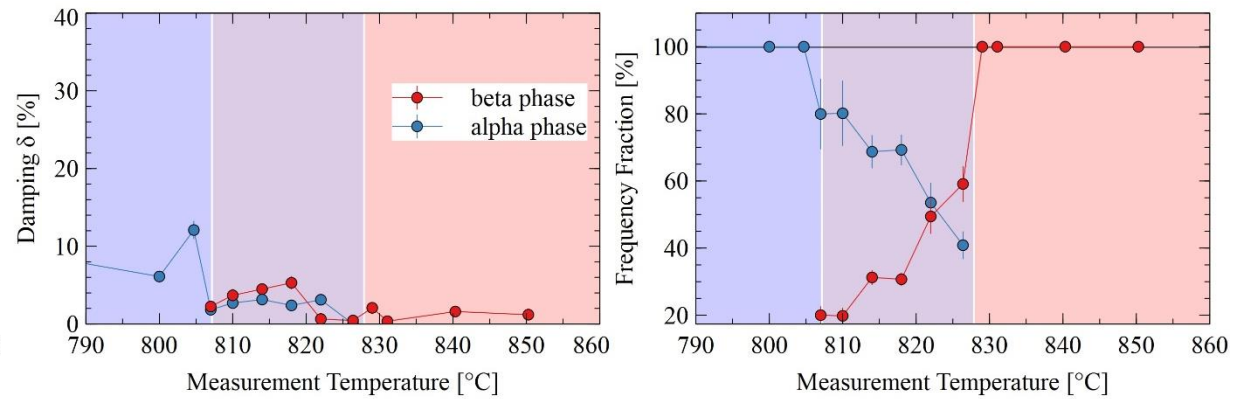
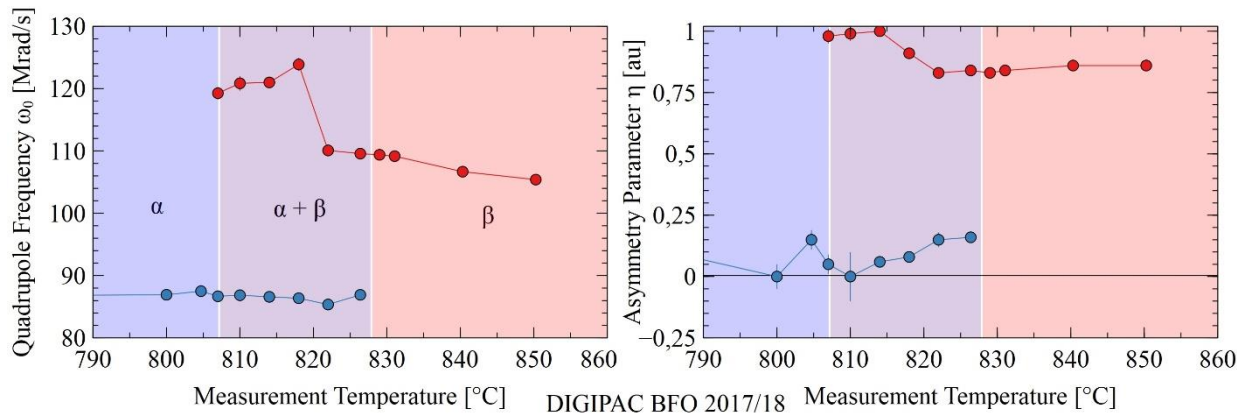
Mn is a magnetic dopant in
 $\text{Ge}_{1-x}\text{Mn}_x\text{Te}$, a model
multiferroic Rashba semiconductor.
Application context: **Spintronics**

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

IS647 - Local probing of multiferroic compounds

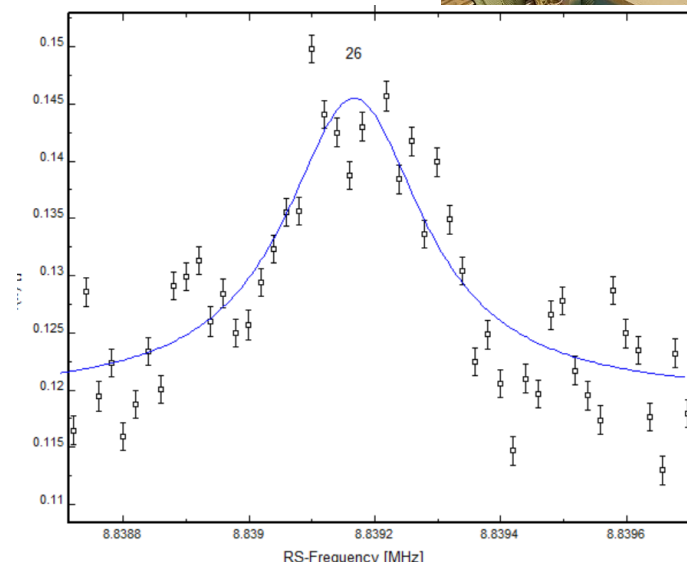
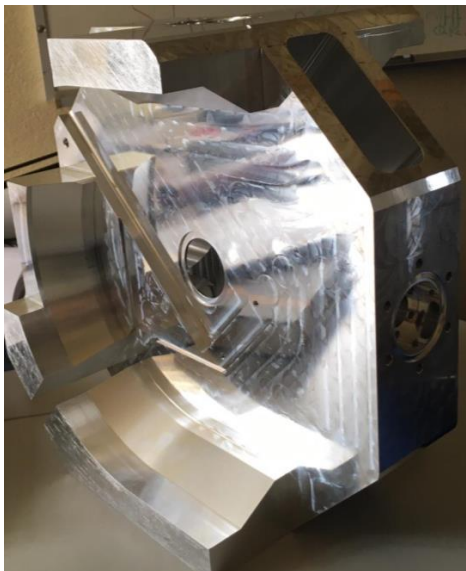


Figures of crystal structure taken from *Ceramics International* 43 (2017) 1256–1264



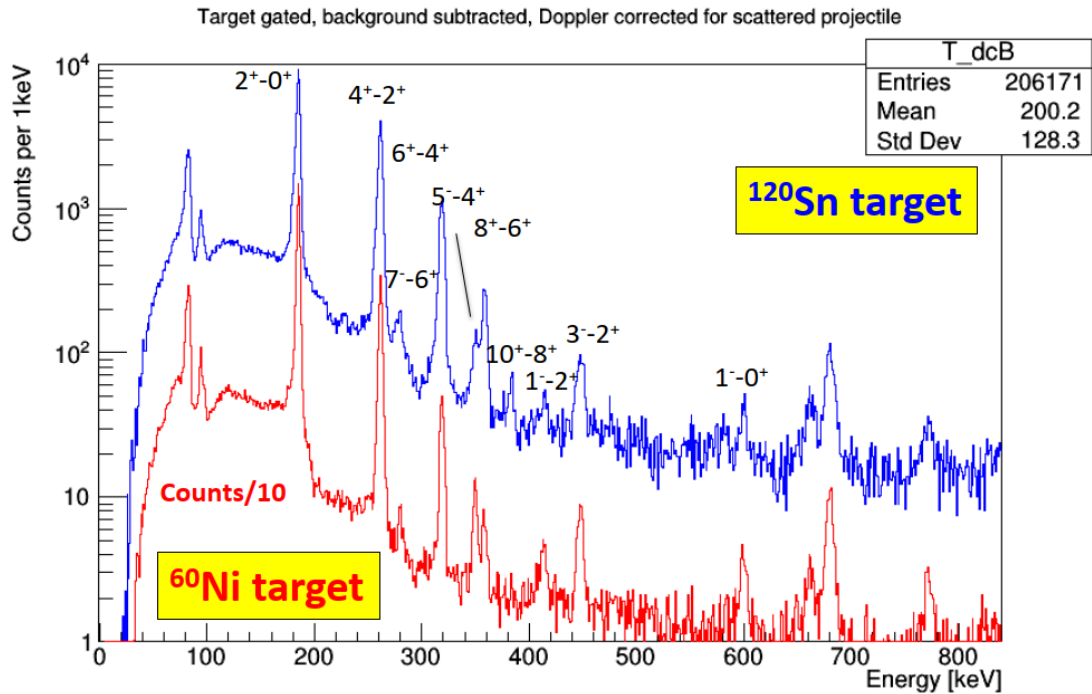
VITO since last ISCC

- 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

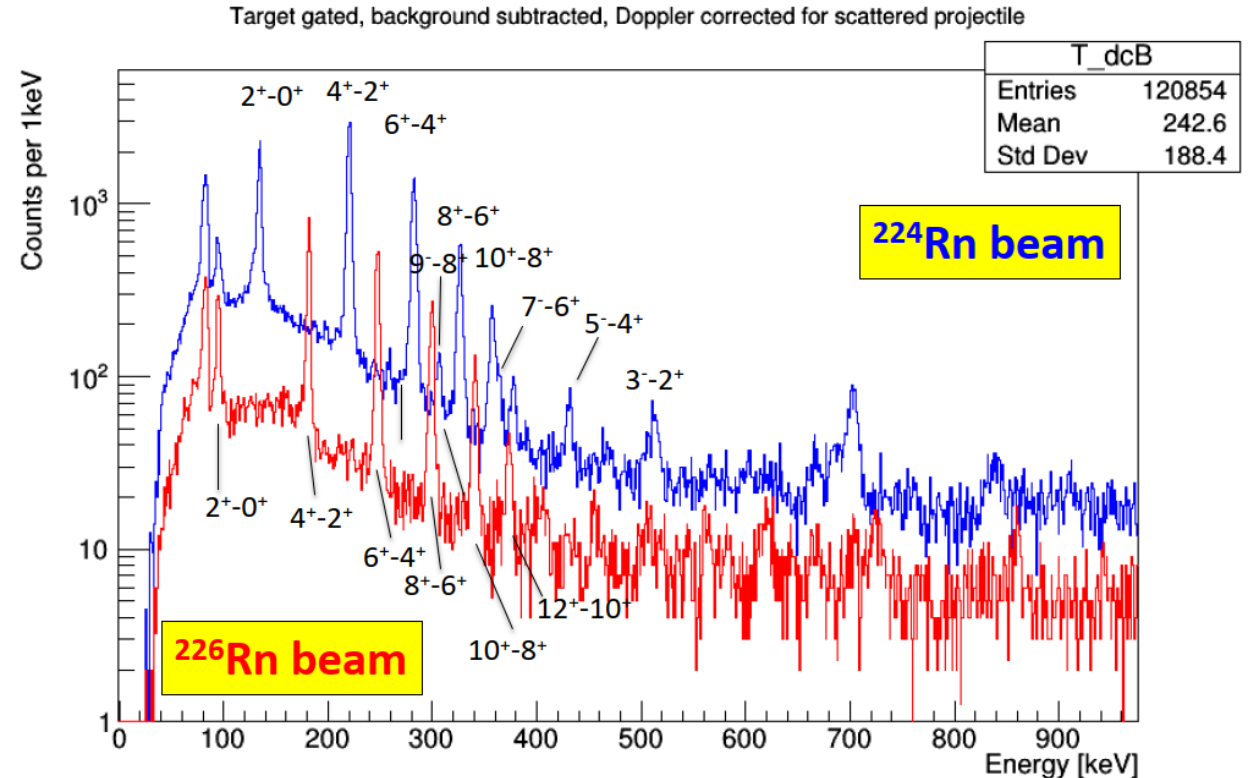


Coulomb excitation of Ra/Rn isotopes: IS552

^{222}Rn beam



^{120}Sn target



Heaviest isotopes post-accelerated at ISOLDE (and beyond?) Difficult/busy run with many energy changes and isotopes.
Analysis ongoing (and making impressive progress...)

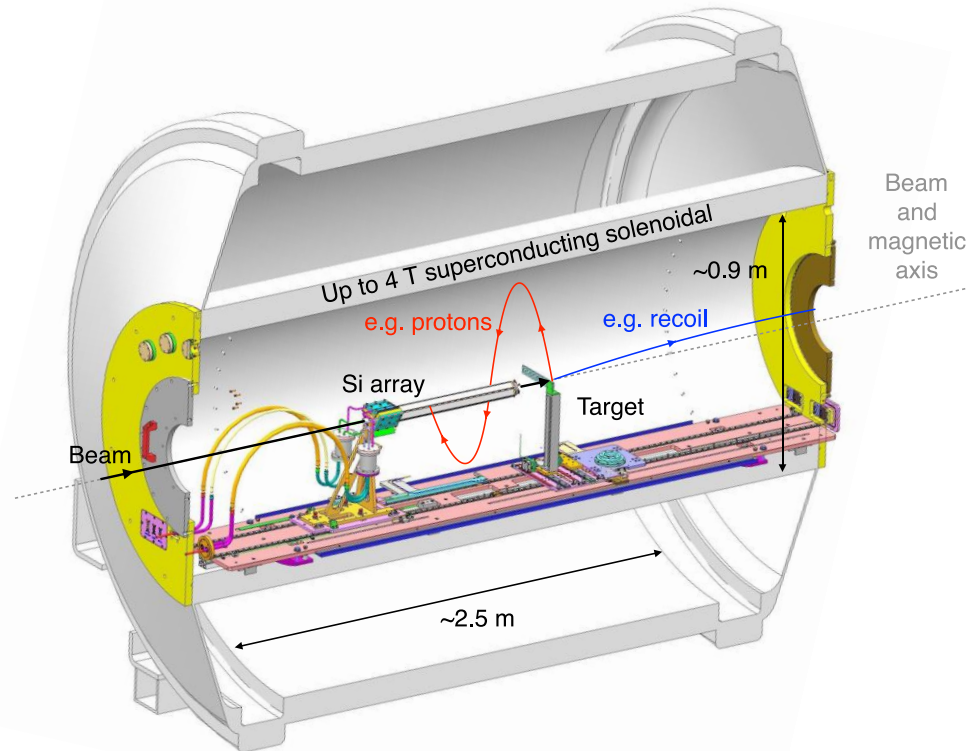


Warsaw TPC
chamber: no
spectra to show
yet: but mid-run
celebratory
tirimisu

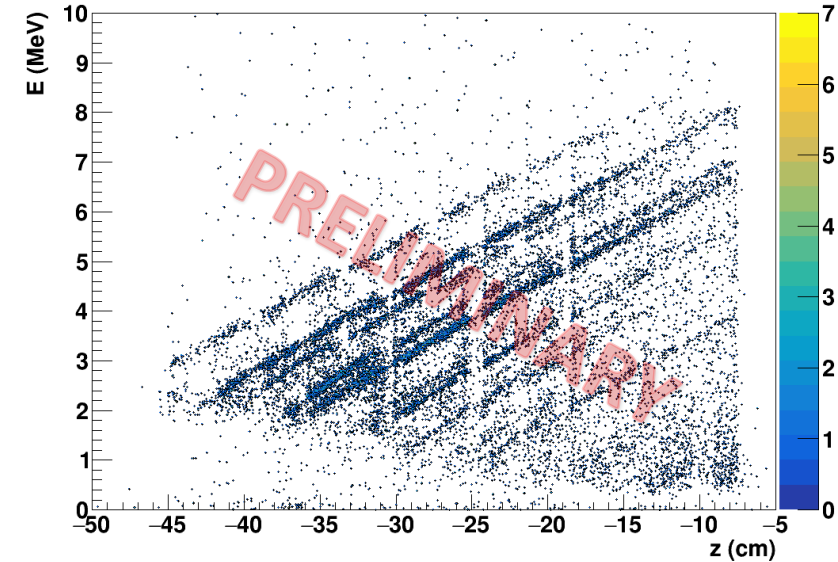
Preliminary data from ISS

Courtesy Dave Sharp

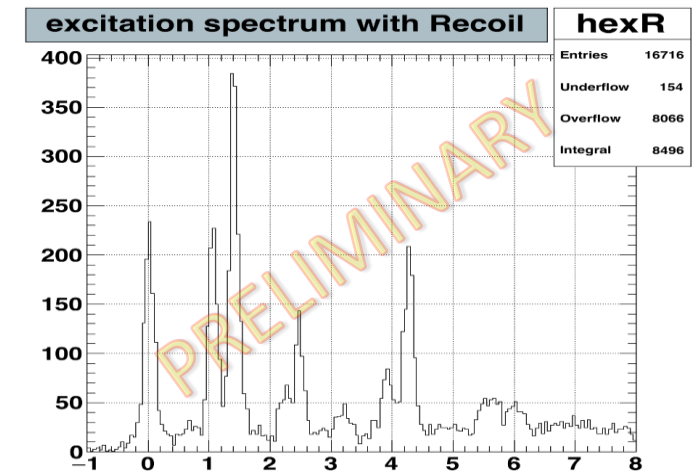
$^{28}\text{Mg}(d,p)^{29}\text{Mg}$ reaction in ISS
with accelerated ^{28}Mg beam at **9.473 MeV/u**
highest HIE-ISOLDE beam energy ever !



Recoil proton energy versus position on detector



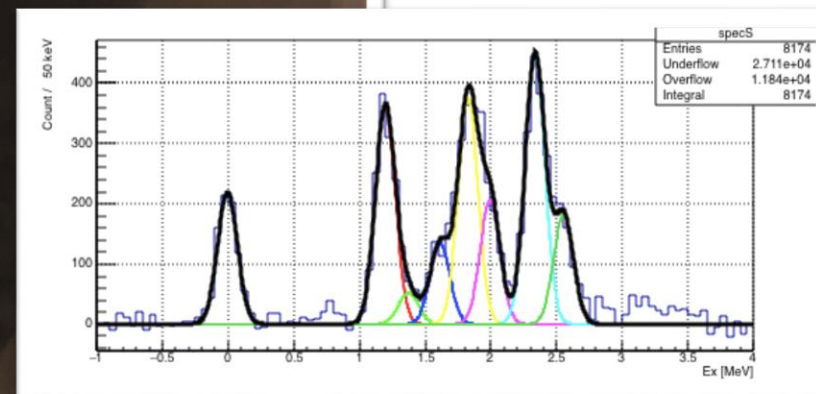
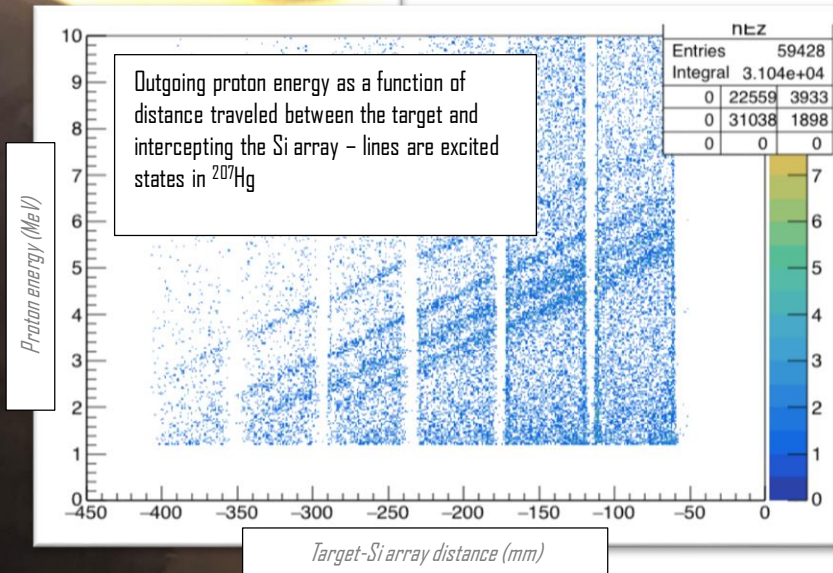
Study bound and unbound quantum states in ^{29}Mg
up to 6 MeV.
Resolution ~100keV – able to resolve most states of interest



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



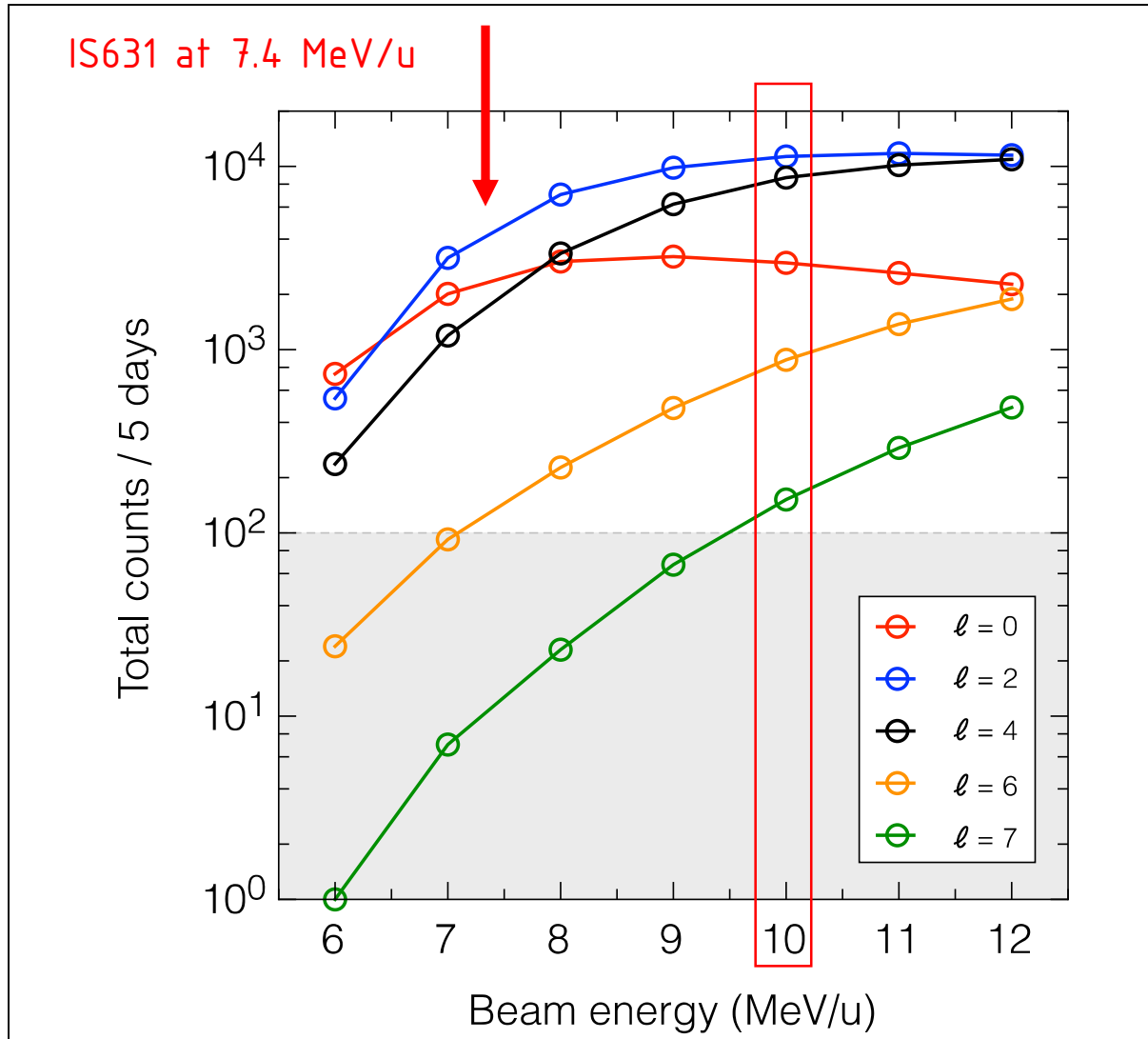
First exploration of single-particle states outside $N = 126$, south of Pb, made possible by ISS.

Experimental info:

- $\sim 5 \times 10^5$ 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 $165 \mu\text{g}/\text{cm}^2$ (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 $^{28}\text{Mg}(d,p)$ 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



Using the example of IS631

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

Beam type NORMGPS

pps 1520e10 (max 1520e10)

ppp 3109e10 (max 3109e10)

Position H:0.01 - V:-9

Focus STANDARD 1.4

Watchdog

Parameter set NORMGPS

Proton current 2.43 uA

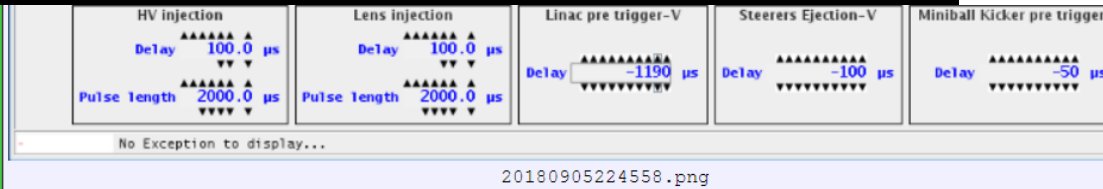
Int.beam 0.6086e18 p

MAG70 46.021 GHM C

Target: #513

HT:30.10 kV Target:403 A Line:397 A

Comments (27-Jul-2018 15:02:43)



8B and 96Kr. Not realized SOLDE runs.

Operational
unders

16-Sep-2018 DAY] Their

Machine
bunching

s (wells in
quently broken.

Stability
being

ears ago not

Molec
for mo

this year were

MD for life is not easy to plan for (not much communication in advance). SOLDE has suffered less than fixed target programmes downstream. Many thanks to the booster for adapting and maintaining our needs.

Interaction with MEDICIS

MEDICIS schedule 2018							
MO	September		October			November	
Wk no.	39	40	41	42	43	44	45
MO	24 Fire detection	#635 for 7Be for ISOLDE 5E18 p (conv)	MED004 155Tb 50 MBq	8 MD6 42ScF _x 70 MBq	#614UCx-VDS 5E18 (?)	22 7Be for ISOLDE	29 Large Container Irradiation
TU	FAP Dep		MED009 - 11C		MED009 - 11C		#637 for Ra for ISOLDE 5E18 p (conv)
WE	Water and Argon leaks FE	Water and Argon leaks FE	RCS modification Sample arm replacement		#669MTa - Re 3E17 p (low)	14PTNO - GHUV/MD	MED004/5 155Tb 150 MBq (prototype in ISOLDE)
TH	#644M Ta Re 2E18 p (SIC)	Pakistan del. TRIUMF	MED009 - 11C		MED008 67Cu 50 MBq		
FR	#629M Ti VDS check		MED009 - 11C				
SA	#647M Ta Re 5E18 p (SIC)	#629M Ti VDS 2E18 p (conv)					#614UCx-VDS 5E18 p (high)
SU							
LASERS	Laser room installation and commissioning						

Legend

- Interventions
- Visits
- Irradiations
- Collection
- Sample manipulation

week no.
day of month
Irradiations
Laboratory operations

Week 43 2018		RILIS	GPS	HRS	CAO	Protons	MEDICIS	Visits	other
Monday	10/22/2018	AM	Switch back to positive from ~ 0900 until mid-afternoon	Once GPS positive: IS645 takes beam (proton scan needed?)				#35 for Be	no protons while switch to positive takes place
		PM		IS645	HRS	NORMHRS			
		night							
Tuesday	10/23/2018	AM		IS645	HRS	NORMHRS			
		PM		IS645	HRS	NORMHRS			
		night							
Wednesday	10/24/2018	AM	#534 Sn VDS	IS645	HRS	NORMHRS			
		PM	Stable setup to GLM	IS645	HRS	NORMHRS			
		night							
Thursday	10/25/2018	AM	Stable setup continues. 1-2 pulses STAGISO	IS645	HRS	NORMHRS			
		PM		IS641 final stable tune	HRS	NORMHRS			
		night		111Cd to GLM	HRS	NORMHRS			
Friday	10/26/2018	AM		IS641	HRS	NORMHRS			
		PM		IS641	HRS	NORMHRS			
		night		111Cd to GLM	HRS	NORMHRS			
Saturday	10/27/2018	AM		IS641	HRS	NORMHRS			
		PM		IS641	HRS	NORMHRS			
		night		111Cd to GLM	HRS	NORMHRS			
Sunday	10/28/2018	AM		IS641	HRS	NORMHRS			
		PM		IS641	HRS	NORMHRS			
		night		111Cd to GLM	HRS	NORMHRS			
Monday	10/29/2018	AM	111Cd to GLM till 0800: 111Cd to GLM (tbc) Ta W or UC W		HRS	NORMHRS			
		PM		#642 UC - n(ew)	HRS	NORMHRS			
		night			HRS	NORMHRS			

Summary of week: GANDALPH experiment ends on Monday. Switch back to Positive on Monday morning. Once this is complete, HRS will take over. IS645 26Na to Vito. Proton scan may be required, else nominal settings from previous target run in week 27 can be used. IS645 runs till Thursday afternoon. IDS then takes beam till Saturday ~ 1400 (to allow for radioactive cooling for target change on Monday 29th).

(GPS): At run ends on Monday morning at 0900. Switch back to positive Monday morning. #534 Sn (VDS) for 111Cd beams to GLM. Setup to GLM only HT = 30kV. Follow settings for target from 2017: 14 Aug 2017 and 9 October 2017 and week 17 2018. Slow release of isotope, no proton scan. Usually requires a few hours to stabilise. 1-2 STAGISO pulses @ 8e12 ppp. 16us spacing. Stable: 132Xe.

(HRS): #658 used Ucx - Ta for Na and TI isotopes Setup at 50kV in bunching and transmission mode. VITO taking 26Na in bunching mode. IDS taking 182, 184, 186TI in transmission mode. Lasers in narrowband for TI run. Ends 1400 Saturday.

RFQ in bunching and transmission mode.

Protons: NORMGPS until Monday morning. NORMHRS + 1-2 pulses STAGISO to GPS until Saturday afternoon. Thereafter more STAGISO pulses can be allocated to GPS.

Operations responsible: Miguel (169616) until 23rd October. Emanuele (167813) afterwards.

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

Interaction with MEDICIS has been mostly constructive; still learning. Close interaction with Joao Pedro Ramos (MEDICIS run coordinator). Can be mutually beneficial: irradiation for winter physics. If protons could be maintained during target movement could be essentially transparent to ISOLDE. Improvements to the montrac security chain for target changes would also help. But physics programme has not been hit hard by MEDICIS.

Possibility of collecting non-medical isotopes: would have greatly helped for 53Mn

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

No visits scheduled this week.

The Wisard awakes: magnet powering over the weekend.

Researchers night 2018: official opening of the esplanade.

ISOLDE participation highly regarded. Perhaps new ideas next year...



12 LE PAYS GÉNIEN Jeudi 4 octobre 2018 Pays de Gex



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 On pouvait fabriquer son propre détecteur de particules et programmer des robots. Le Synchro-cyclotron (SC) se visitait, (premier accélérateur de particules du monde) et les visiteurs de tous âges se sont retrouvés pour la Nuit des Chercheurs. CERN, des coqs de réalité virtuelle ont accompagné 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 prenaient leurs expériences à travers des démonstrations interactives ! Le hic, (pas le bon), 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.

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



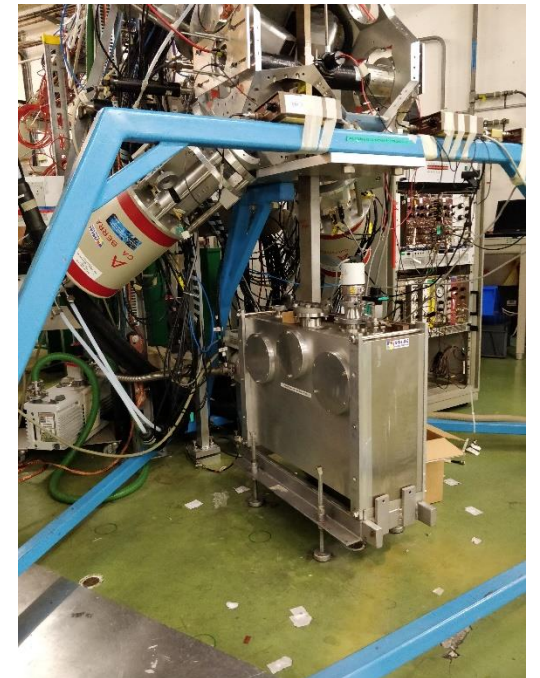
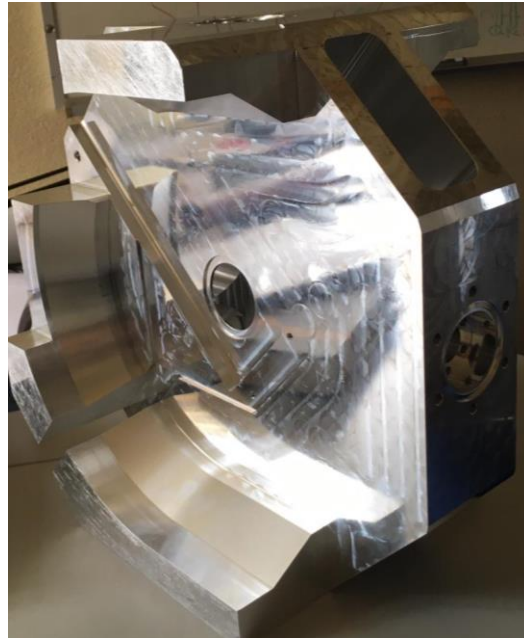
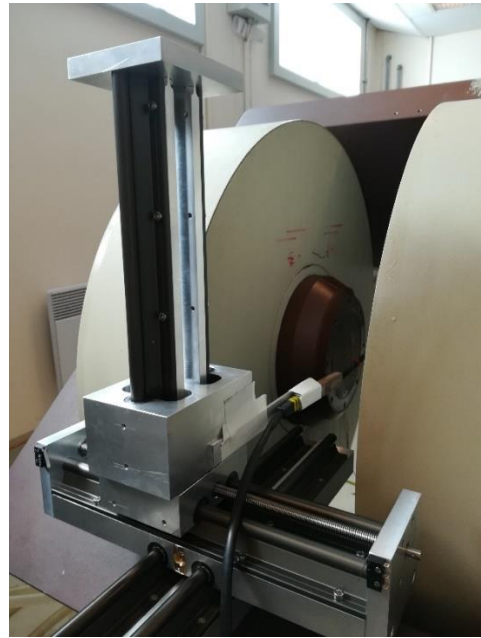
Tout était bondé, les particules n'étaient pas seules en collision. Arna de Manincor la réalisatrice d'un long métrage sur le CERN. Une myriade d'animations étaient proposées.

EP technicians

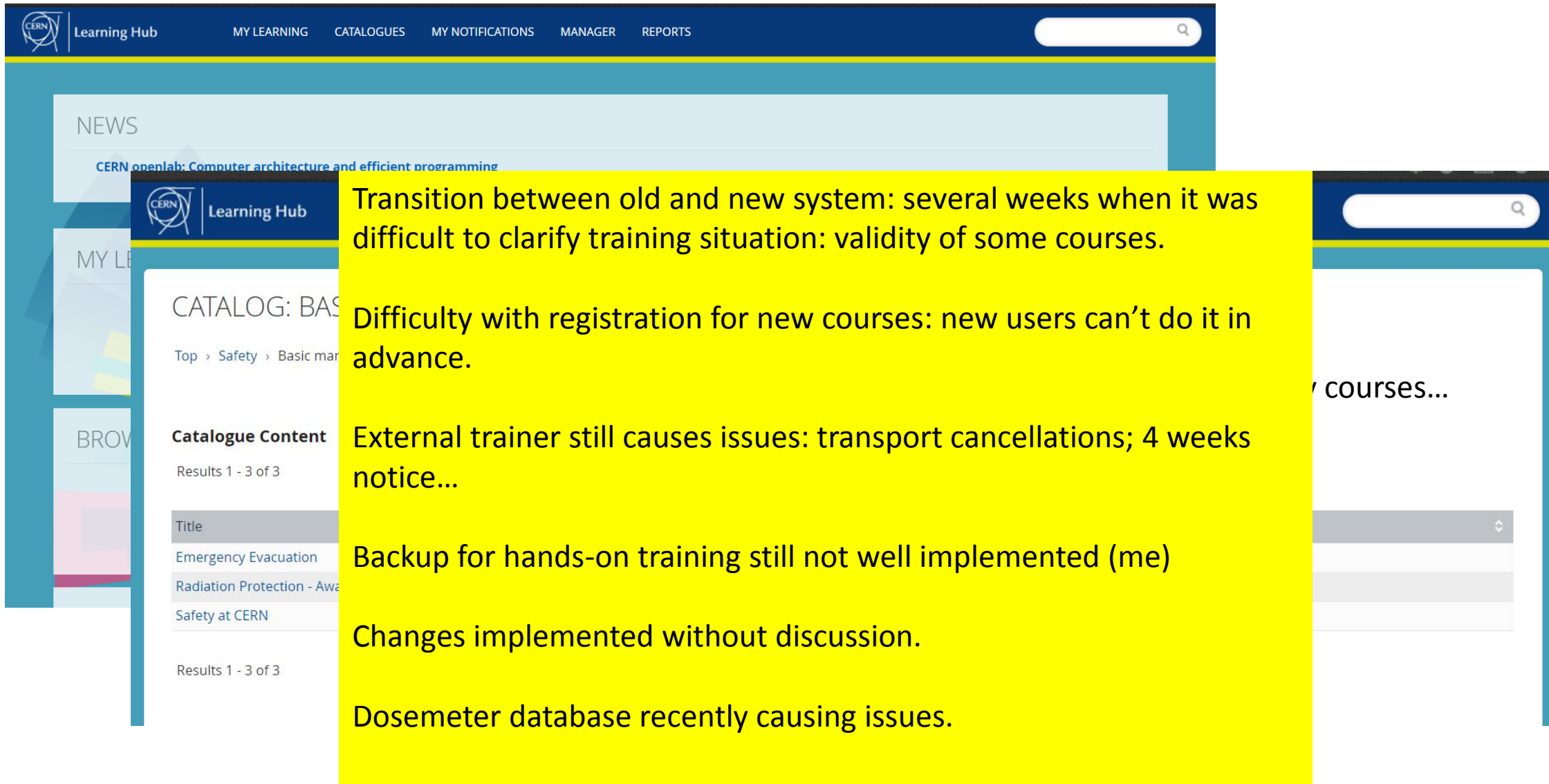
Antonio Goncalves and Francois Garnier: supported by the collaboration.

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

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



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



The image shows a screenshot of the CERN Learning Hub website. The top navigation bar includes the CERN logo, the text "Learning Hub", and menu items: "MY LEARNING", "CATALOGUES", "MY NOTIFICATIONS", "MANAGER", and "REPORTS". A search bar is located on the right. Below the navigation, there is a "NEWS" section with a link to "CERN openlab: Computer architecture and efficient programming". The main content area is titled "CATALOG: BAS" and shows a breadcrumb trail: "Top > Safety > Basic mar". Under "Catalogue Content", it displays "Results 1 - 3 of 3" and a table with the following entries:

Title
Emergency Evacuation
Radiation Protection - Aw
Safety at CERN

Below the table, it shows "Results 1 - 3 of 3". A yellow text overlay is positioned in the center of the screenshot, containing the following feedback points:

- 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 (me)
- Changes implemented without discussion.
- Dosemeter database recently causing issues.

Publications

nature
physics

LETTERS

<https://doi.org/10.1038/n41567-018-0292-8>

Characterization of the shape-staggering effect in mercury nuclei

B. A. Marsh^{1*}, T. Day Goodacre^{1,2,18}, S. Sels^{3,19}, Y. Tsunoda⁴, B. Andel⁵, A. N. Andreyev^{6,7}, N. A. Althubiti⁷, D. Atanasov⁸, A. E. Barzakh⁹, J. Billowes², K. Blaum⁸, T. E. Cocolios^{2,3}, J. G. Cubiss¹⁰, J. Dobaczewski¹, G. J. Farooq-Smith^{2,3}, D. V. Fedorov¹⁰, V. N. Fedosseev¹¹, K. T. Flanagan¹, L. P. Gaffney^{12,30}, L. Ghys³, M. Huyse³, S. Kreim³, D. Lunney¹¹, K. M. Lynch¹, V. Manea⁹, Y. Martinez Palenzuela³, P. L. Molkanov⁹, T. Otsuka^{3,4,12,13,14}, A. Pastore⁶, M. Rosenbusch^{13,15}, R. E. Rossel¹, S. Rothe¹², L. Schwelkhart¹⁵, M. D. Selverstov⁹, P. Spagnoletti¹⁰, C. Van Beveren¹, P. Van Duppen³, M. Veinhard¹, E. Verstraelen¹, A. Welker¹⁶, K. Wendt¹⁷, F. Wienholtz¹⁸, R. N. Wolf⁸, A. Zadornaya³ and K. Zuber¹⁶

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^{1–3}; 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^{4,5} 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 ¹⁹²Hg, we determine ¹⁹²Hg 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 = 2, 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 nucleus⁴. 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 nucleus⁵. 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 ¹⁹²Hg, ¹⁹⁴Hg and ¹⁹⁶Hg (refs 1–3). For the heavier mercury isotopes the changes in charge radii mirror those of lead³: 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^{6,7}. A plethora of studies on the excited states of these nuclei⁸ provided a further substantial insight into shape coexistence, complementing the laser spectroscopy studies of ground and isomeric states. However, to acquire a full understanding

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

For ENSAR2 open access for all publications. Can be a repository e.g. ARXIV.

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

PHYSICAL REVIEW LETTERS 121, 142701 (2018)

First Accurate Normalization of the β -delayed α Decay of ¹⁶N and Implications for the ¹²C(α,γ)¹⁶O Astrophysical Reaction Rate

O. S. Kirsebom^{1,*}, O. Tengblad², R. Lica^{3,4}, M. Munch¹, K. Riisager¹, H. O. U. Fynbo¹, M. J. G. Borge^{2,3}, M. Madurga⁵, I. Marroquin⁶, A. N. Andreyev^{5,18}, T. A. Berry⁷, E. R. Christensen¹, P. Diaz Fernández¹, D. T. Doherty⁵, P. Van Duppen⁸, L. M. Fraile⁹, M. C. Gallardo⁹, P. T. Greenlees^{10,11}, L. J. Harkness-Brennan¹², N. Hubbard^{1,5}, M. Huyse³, J. H. Jensen¹, H. Johansson¹, B. Jonson¹, D. S. Judson¹², J. Konkki^{3,10,11}, I. Lazarus¹³, M. V. Lund¹, N. Marginean⁴, R. Marginean⁴, A. Perea², C. Mihai², A. Negret⁴, R. D. Page¹², V. Pucknell¹³, P. Rahkila^{10,11}, O. Sorlin^{3,14}, C. Sotty⁴, J. A. Swartz¹, H. B. Sørensen¹, H. Törnqvist^{15,16}, V. Vedia⁹, N. Warr¹⁷, and H. De Witte⁸

¹Department of Physics and Astronomy, Aarhus University, DK-8000 Aarhus C, Denmark

²Instituto de Estructura de la Materia, CSIC, E-28006 Madrid, Spain

³CERN, CH-1211 Geneva 23, Switzerland

⁴Horia Hulubei National Institute for Physics and Nuclear Engineering (IFIN-HH), RO-077125 Bucharest-Magurele, Romania

⁵Department of Physics, University of York, York YO10 5DD, United Kingdom

⁶Department of Physics, University of Surrey, Guildford, GU2 7XH, United Kingdom

⁷Department of Physics, Chalmers University of Technology, S-41296 Göteborg, Sweden

⁸KU Leuven, Instituut voor Kern- en Stralingsfysica, 3001 Leuven, Belgium

⁹Grupo de Física Nuclear, Universidad Complutense de Madrid, E-28040 Madrid, Spain

¹⁰University of Jyväskylä, Department of Physics, P.O. Box 35, FI-40014 University of Jyväskylä, Finland

¹¹Helsinki Institute of Physics, University of Helsinki, P.O. Box 64, FI-00014 Helsinki, Finland

¹²Oliver Lodge Laboratory, University of Liverpool, Liverpool L69 7ZE, United Kingdom

¹³STFC Daresbury, Daresbury, Warrington WA4 4AD, United Kingdom

¹⁴GANIL, CEADSM-CNRS/IN2P3, Bvd Henri Becquerel, 14076 Caen, France

¹⁵Institut für Kernphysik, Technische Universität Darmstadt, Darmstadt, Germany

¹⁶GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany

¹⁷Institut für Kernphysik, Universität zu Köln, D-50937 Köln, Germany

¹⁸Advanced Science Research Centre (ASRC), Japan Atomic Energy Agency (JAEA), Tokai-mura, Ibaraki 319-1195, Japan

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The ¹²C(α,γ)¹⁶O 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 ¹⁶O 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 ¹⁶N, 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 [$b_{\alpha,11} = (1.59 \pm 0.06) \times 10^{-3}$]. Our value for $b_{\alpha,11}$ 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 ¹²C(α,γ) 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 ¹²C(α,γ) 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 ¹²C(α,γ)

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¹CERN, Geneva, Switzerland. ²School of Physics & Astronomy, The University of Manchester, Manchester, UK. ³KU Leuven, Instituut voor Kern- en Stralingsfysica, Leuven, Belgium. ⁴Center for Nuclear Study, University of Tokyo, Tokyo, Japan. ⁵Department of Nuclear Physics and Biophysics, Comenius University in Bratislava, Bratislava, Slovakia. ⁶Department of Physics, University of York, York, UK. ⁷Advanced Science Research Centre, Japan Atomic Energy Agency (JAEA), Tokai-mura, Japan. ⁸Max-Planck-Institut für Kernphysik, Heidelberg, Germany. ⁹Petersburg Nuclear Physics Institute (PNPI), NRC Kurchatov Institute, Gatchina, Russian Federation. ¹⁰School of Engineering & Computing, University of the West of Scotland, Paisley, UK. ¹¹CSNSM-IN2P3-CNRS, Université Paris-Sud, Orsay, France. ¹²Department of Physics, University of Tokyo, Tokyo, Japan. ¹³RIKEN Nishina Center, Wako, Japan. ¹⁴National Superconducting Cyclotron Laboratory, Michigan State University, East Lansing, MI, USA. ¹⁵Institut für Physik, Universität Greifswald, Greifswald, Germany. ¹⁶Technische Universität Dresden, Dresden, Germany. ¹⁷Johannes Gutenberg Universität, Mainz, Germany. ¹⁸These authors contributed equally. ¹⁹T. Day Goodacre, S. Sels. *e-mail: bruce.marsh@cern.ch