

# ISOLDE physics coordinator report: INTC 61

Karl Johnston

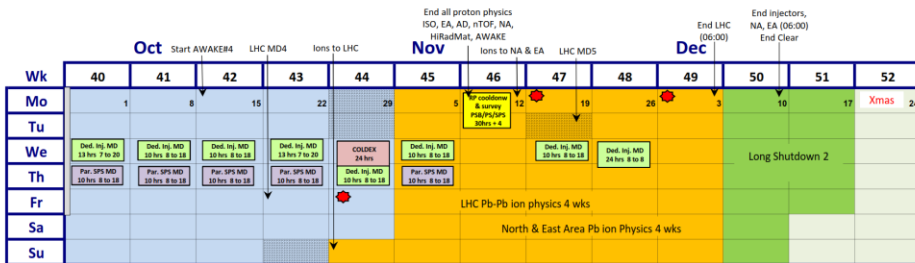
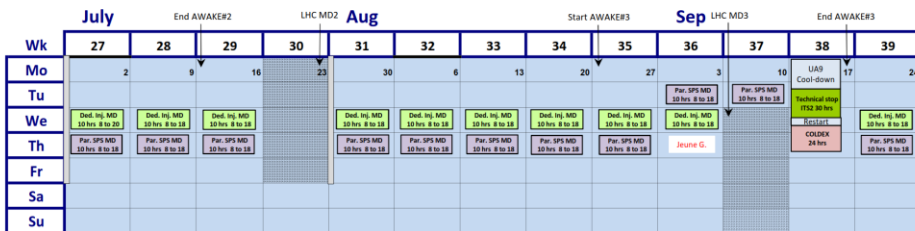
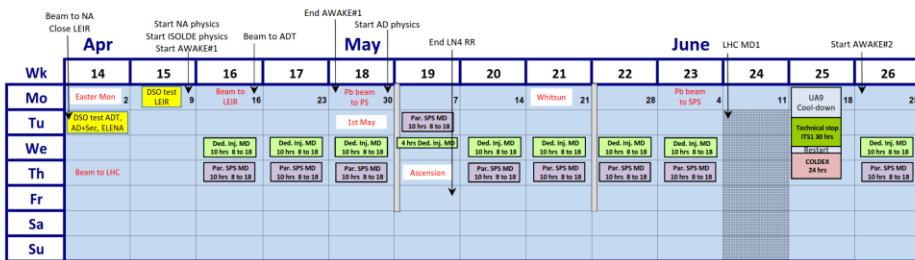
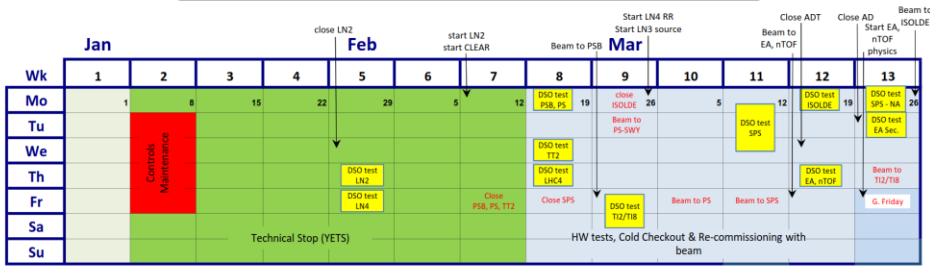


- Summary of end of 2018 physics
- Shift Count
- Physics highlights
- Shift status for INTC



### 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 9<sup>th</sup> April – 12<sup>th</sup> November 2018.  
(no extension possible)  
1 week less physics with protons than 2017  
217 days compared to 224

HIE ISOLDE was ready from 9<sup>th</sup> 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: Winter physics programme began in Week 46 for HIE and CRIS

# GPS schedule 2018

	April				May				June				July				August				September				October				November				
WK	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	9	1.6	#534/267 Sn VDS 2.3	30	MD: FTS 1.4	2.1	2.8	4	11	18	2.5	2	2	9	1.6	2.3	30	32	6	13	20	27	IS629 3	#641 UC Ta 1.0	1.7	2.4	1	8	#633 Th 1.5	2.2	#638 UC W 2.9	5	p* off 0800 1.2
TU		TISD		May-01	MD: FTS				IS610		Tech Stop	Medical isotopes				#665 SB Mn							IS634		Tech stop	#619 Pb VDS						Prep for winter	
WE		TISD		#599 Ti foils	IS634					ISBM	#655 Ta - W	#659 UC VD7											IS629:	IS634								Physics	
TH	#513/ #650			Ascension																			IS629:	IS634									
FR						#63 UC - Ta n																	IS629:	IS634									
SA																							IS629:	IS634									
SU		IS633																					IS629:	IS634									
		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						



Medical Biophysics



TISD/MD

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

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

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

Parallel Hg/Cd

Travelling

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



Mg, Be  
Mn, Ac

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

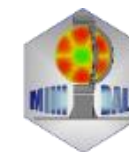
Next...

Sc/In  
70Br

Ge + S  
Sc  
n-rich Sb

β-NMR on liquids

Good Mn run



XT03

# HRS schedule 2018

	April				May				June				July				August				September				October				November			
WK	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	9	1.6	2.3	#631 2D HP 3.0	#632 2D HP 7	#618 UC - Ta W 1.4	2.1	2.8	4	11	18	2.5	2	9	1.6	2.3	30	32	6	13	20	27					IS638 8	1.5	2.2	#642 UC n (new) conv	5	p* off 0800 1.2
TU				May-01					#626 Ta - W	TBC	Tech Stop																					Prep for winter
WE				TISD																												Physics
TH				Ascension																												
FR		#627 Ta - W																														
SA																																
SU		IS639																														
		In RILIS			Sc RILIS	RILIS test	70Br	26Na																								
		#640 LaC - n			In RILIS	Ge 34S																										



# 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)

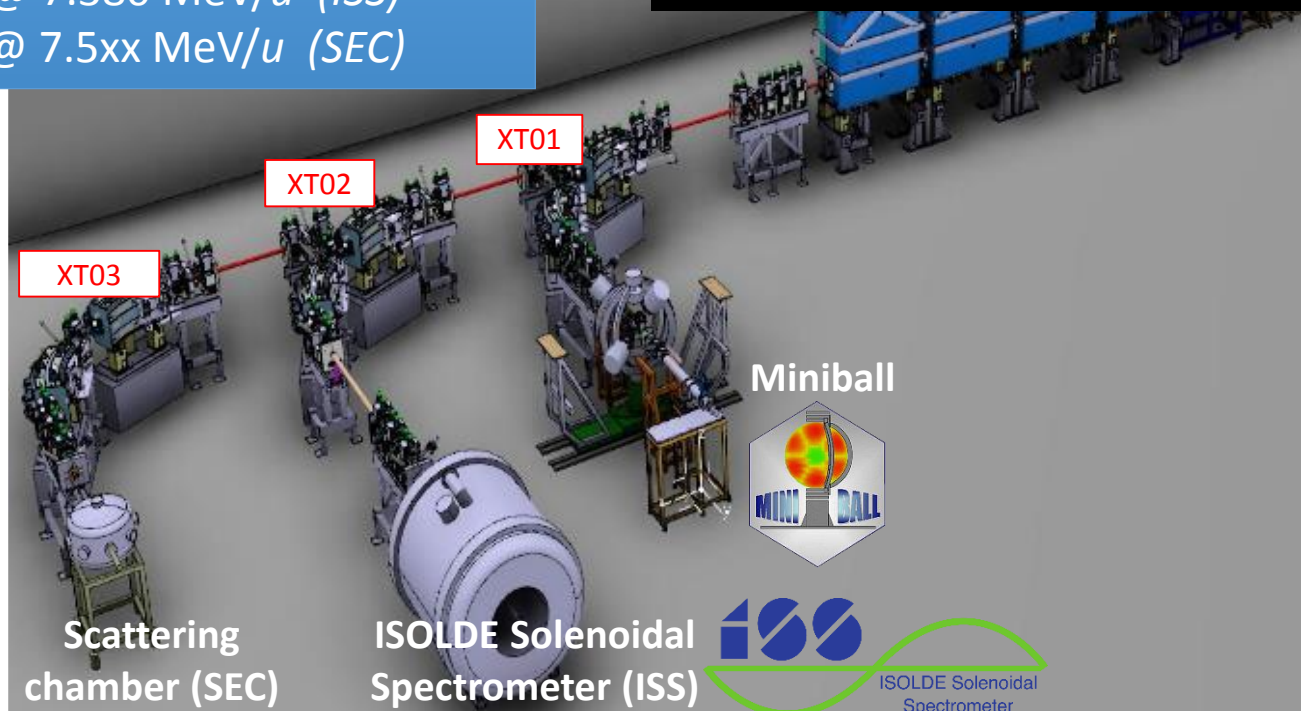
Disappointments: multi nucleon transfer  $^{94}\text{Rb}$  and other strong primary beams. Procedure now in place and approved but would have restricted too many other experiments from running/setting up in 2018.

Cancellation of  $^{132}\text{Sn}$  in October run after difficulties encountered in August.

## Phase 2 – 2018

### Coulomb excitation (Miniball):

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



# GPS

November			December		
45	46	47	48	49	50
	p <sup>+</sup> off 0600 <sub>12</sub>				
	#635 UC Ta				
	XT03				
LO1198	7Be @ 5MeV/u	(tbc) 44Ti	44Ti @ 1.4MeV/u		
IS637	IS554		IS543		
RILIS: Ac <small>(GLM/GHM/LA 1)</small>	RILIS: Be		44Ti (RILIS?)		

# HRS

November			December		
45	46	47	48	49	50
TISD 5	p <sup>+</sup> off 0600 <sub>12</sub>				
TISD					
#672 CaO VD7					
	#637 UC				
WISArD		CRIS			
LO1172		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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KJ: 26.10.18

## Winter physics programme:

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

Target irradiated in October (cold). Be mass marker.

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

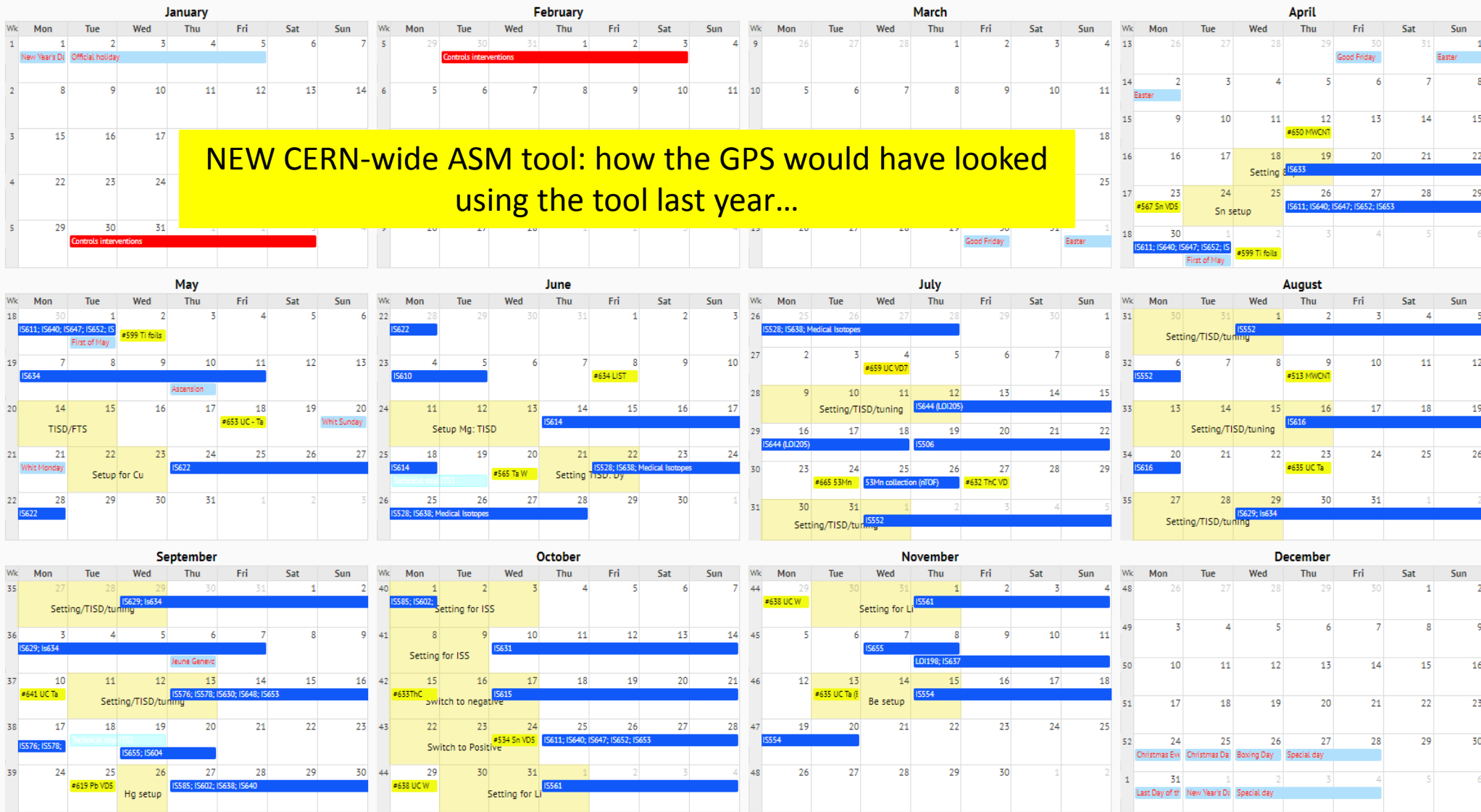
44Ti for Edinburgh chamber (similar to 59Cu in 2017). Doubts over the efficiency of the ion source resulted in this being cancelled (CRIS continued to run until the very end!)

Very successful and smooth campaign with Be and RaF.

- Schedules
- MD Planning
- Controls Changes
- Reports

- johnston
- Keyboard shortcuts
- Documentation
- Support
- Logout








NEW CERN-wide ASM tool: how the GPS would have looked using the tool last year...



	Apr			May				June					
WK	14	15	16	17	18	19	20	21	22	23	24	25	26
Mo	Easter	9	16	#567 Sn VDS	30		TISD/FTS	Whit Monday	28	IS610	11		25
Tu				Sn setup	First of May			Setup for Cu			Setup Mg: TISD	Technical stop IT51	
We			Setting 88/TISD		#599 Ti foils							#565 Ta W	
Th		#550 MWCONT				IS634						Setting TISD: Dy	
Fr										#634 LIST		IS528; IS638; Medical isotopes	
Sa			IS633				#553 UC - Ta n	IS622			IS614		
Su				IS611; IS640; IS647; IS652; IS653			Whit Sunday						

	July			Aug				Sep					
WK	27	28	29	30	31	32	33	34	35	36	37	38	39
Mo	2		16		30	6	13	20	27	3	#641 UC Ta	17	24
Tu		Setting/TISD/tuning		#665 53Mn	Setting/TISD/tuning		Setting/TISD/tuning		Setting/TISD/tuning			Technical stop IT52	#619 Pb VDS
We	#559 UC V07										Setting/TISD/tuning		Hg setup
Th		IS644 (LO2/09)		53Mn collection (nTDF)		#513 MWCONT		#635 UC Ta		IS629; IS634		IS655; IS604	
Fr				#632 Thc V07									
Sa			IS506		IS552						IS576; IS578; IS630; IS648; IS653		IS585; IS602; IS638; IS640
Su							IS616						

	Oct			Nov				Dec					
WK	40	41	42	43	44	45	46	47	48	49	50	51	52
Mo			#633 Thc		#638 UC W								Christmas Eve
Tu	Setting for ISS	Setting for ISS	Switch to negative	Switch to Positive			#635 UC Ta (Be)						Christmas Day
We				#634 Sn VDS	Setting for LI		IS655	Be setup					Boxing Day
Th													Special day
Fr													
Sa		IS631	IS615	IS611; IS640; IS647; IS652; IS653	IS561	LO1198; IS637							
Su							IS554						

	Target Change GPS (3d 0h)		ISOLDE GPS Physics (100d 14h)		ISOLDE Target change (0d 4h)
	Control intervention (5d 0h)		ISOLDE setup/proton scan/yield (38d 6h)		Technical stop (3d 8h)
	Official Holidays (5d 0h)				

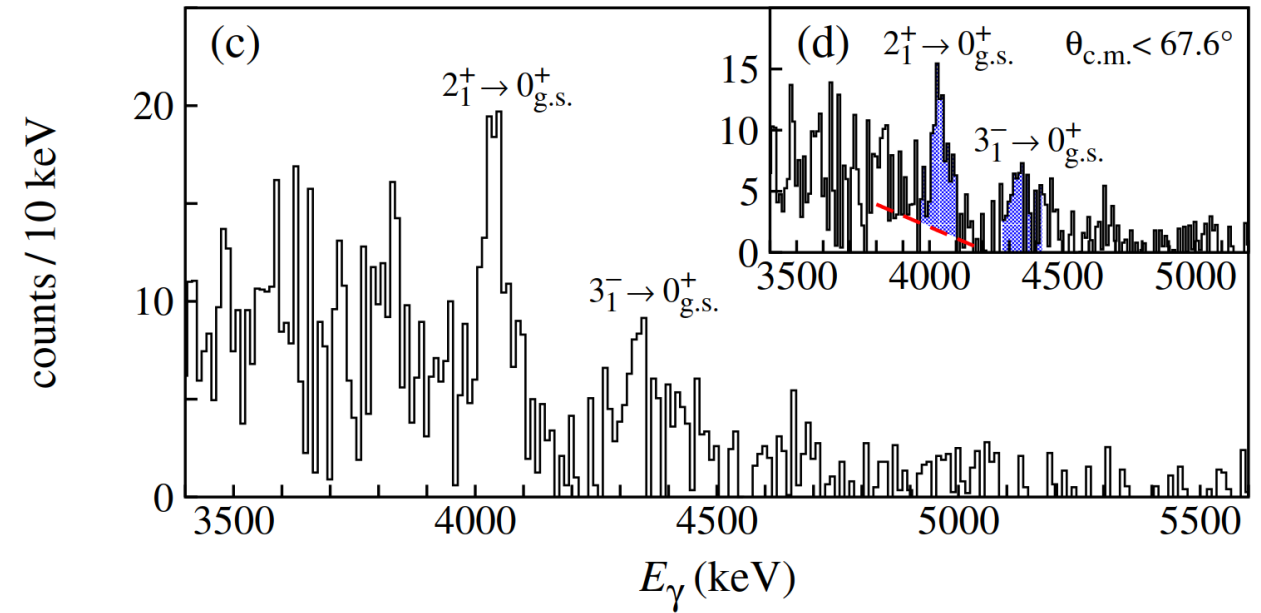
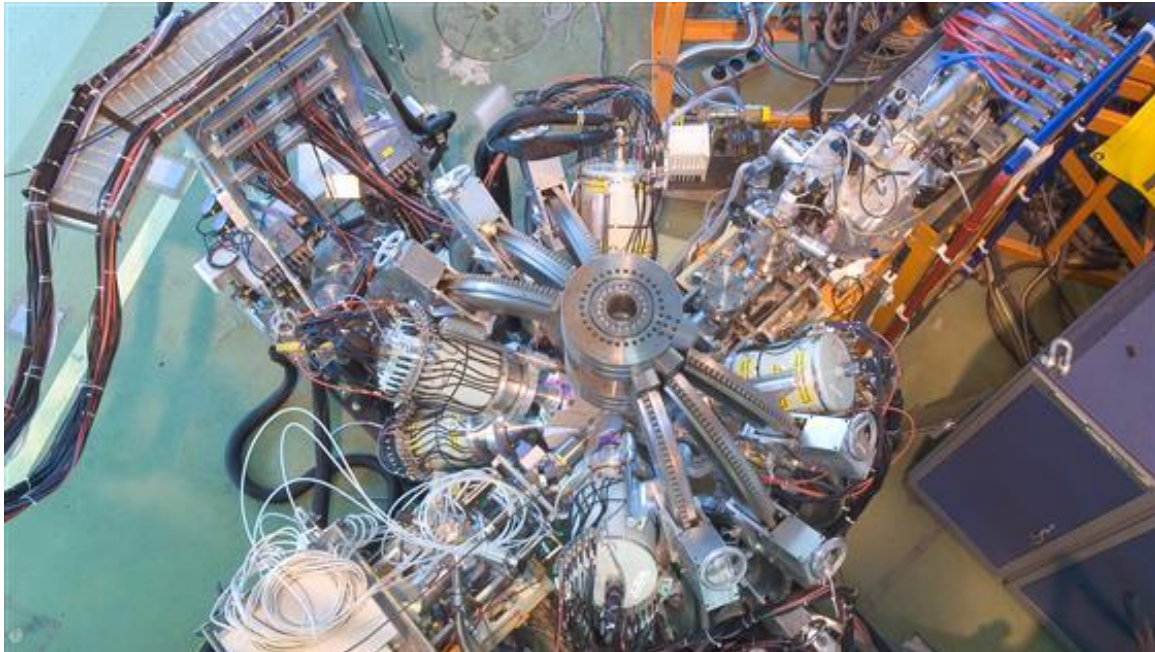
Example of how schedule is represented in excel (colour choice can be worked on...)

Advantages: instant output to excel format etc...will aid for schedule updates and weekly planning.

Ease of use has improved considerably since the early version in 2018. Now fit for purpose and will be used for schedules after LS2 (perhaps also for stable runs in 2020).

Will still produce the existing one page ISOLDE schedule.

# Recent output from HIE ISOLDE: Enhanced Quadrupole and Octupole Strength in Doubly Magic $^{132}\text{Sn}$



Confirmation of doubly magic nature of  $^{132}\text{Sn}$



## Output from HIE ISOLDE: II

### HIE-ISOLDE + MINIBALL+CD July-August 2018

**radon** from ThC target; ionised using VADIS with cooled transfer line; separated in GPS

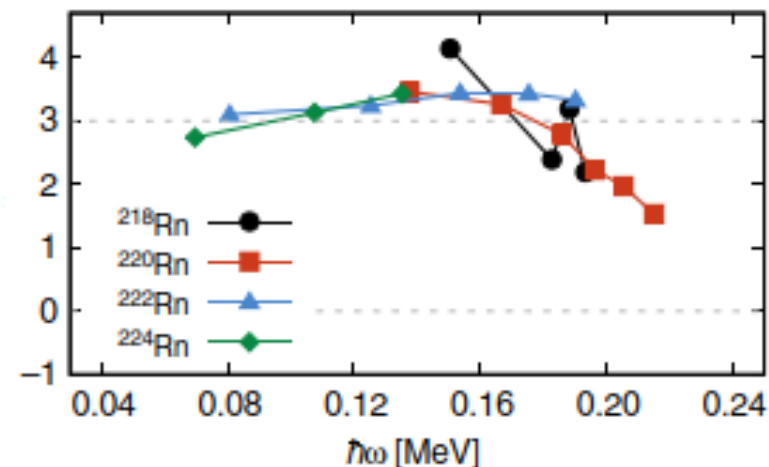
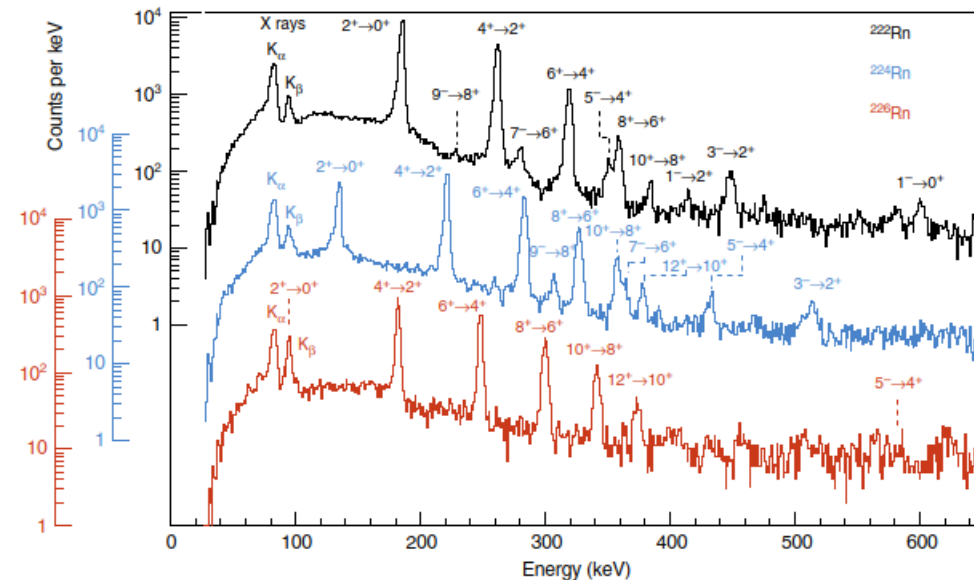
$^{222}\text{Rn } 51^+$	4.23 MeV/u	$6 \cdot 10^5 / \text{s}$
$^{224}\text{Rn } 52^+$	5.08 MeV/u	$1.1 \cdot 10^5 / \text{s}$
$^{226}\text{Rn } 52^+$	5.08 MeV/u	$2 \cdot 10^3 / \text{s}$

**radium** from UC target; ionised using W surface ion source ; separated in HRS

$^{222}\text{Ra } 51^+$	4.305 MeV/u	$6 \cdot 10^5 / \text{s}$
$^{228}\text{Ra } 53^+$	4.31 MeV/u	$6 \cdot 10^5 / \text{s}$

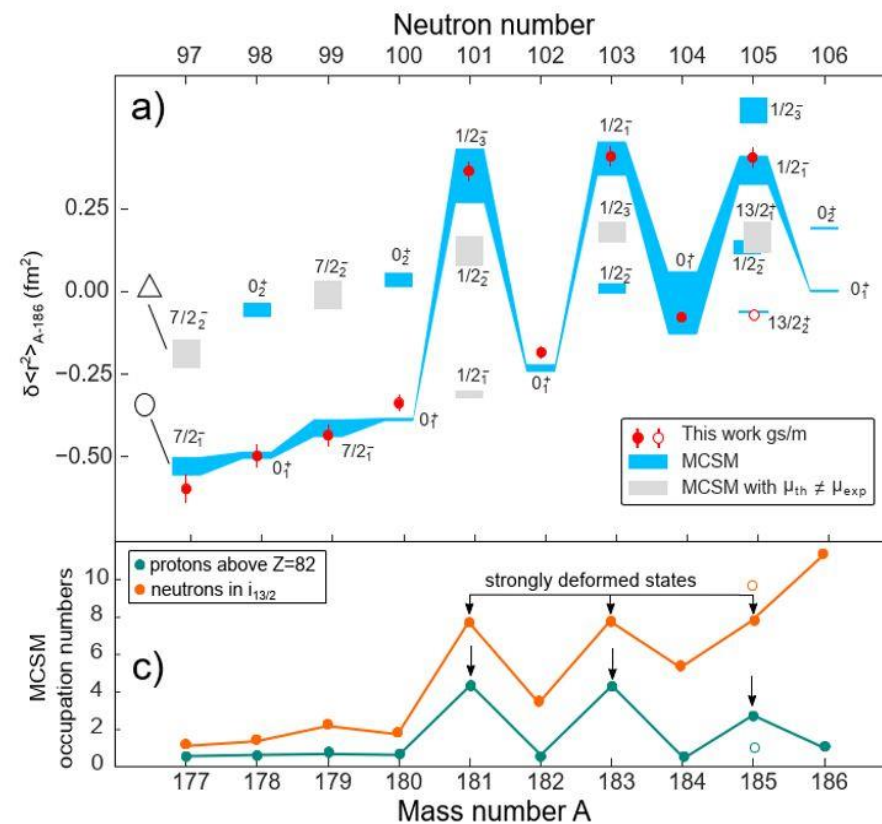
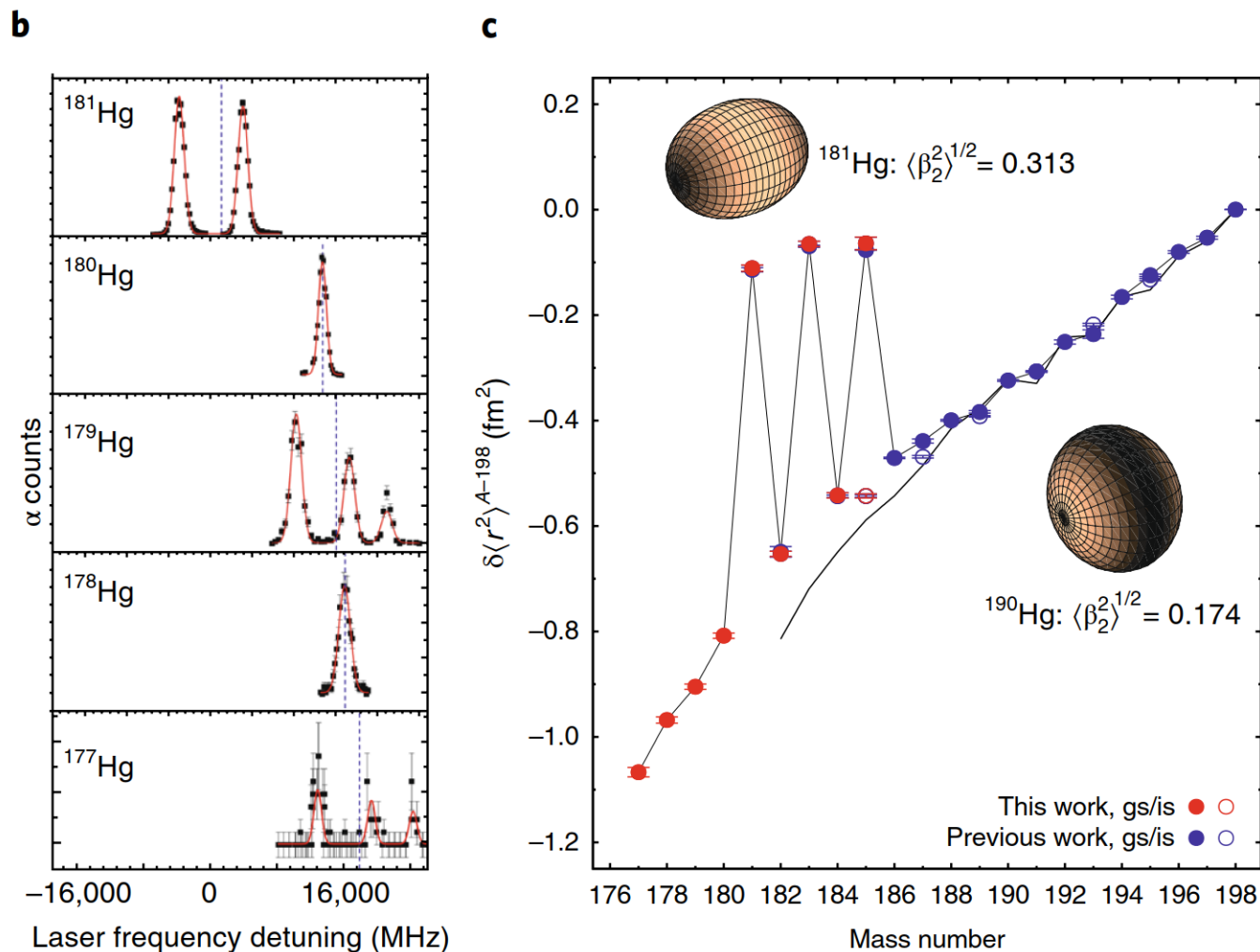
EBIS breeding time 500-700 ms

Challenging beamtime (many changes in isotopes...energies)

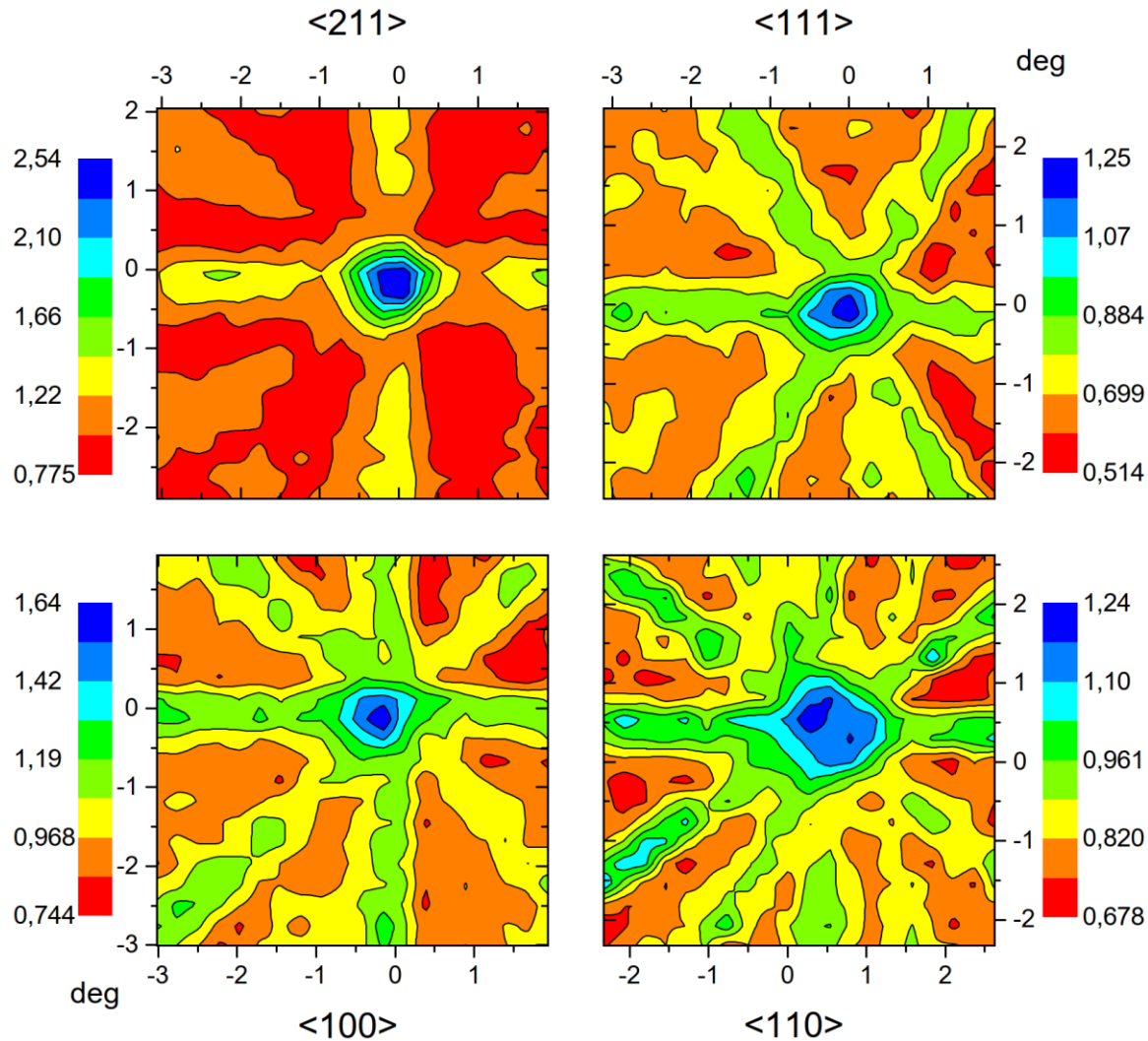


Rn isotopes undergo octupole vibrations but **not** static pear-shapes in their ground states

# Characterization of the shape-staggering effect in mercury nuclei



# Thorium clock: LOI198



Study of isomeric level by removing IC decay path. Check this with implantation into CaF (wide band gap material)

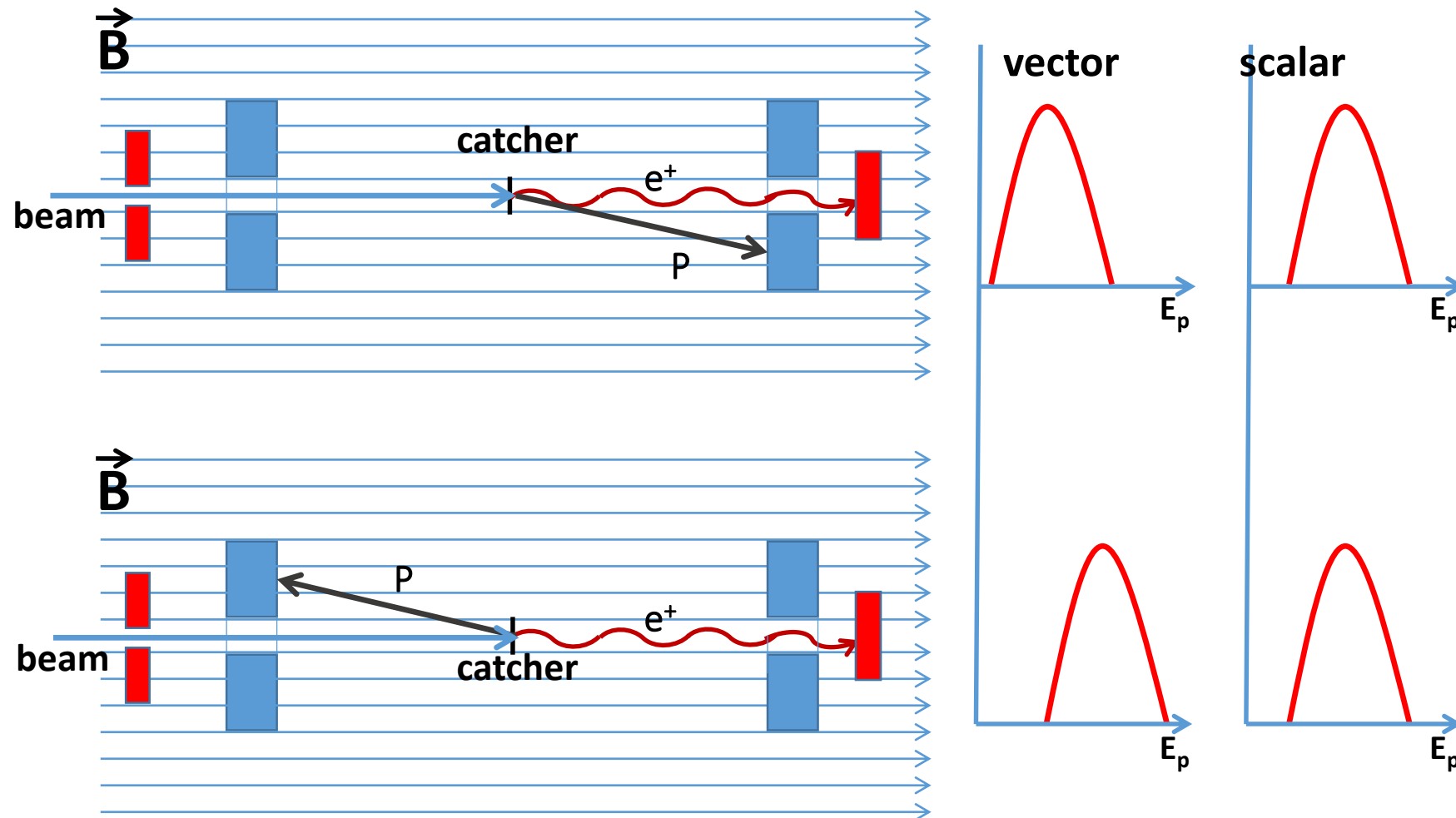
Preliminary data indicate from  $^{229}\text{Ac}$  beam that significant fraction on substitutional sites: study of isomer possible.

Complemented with new setup to measure low energy conversion electrons...

# WISArD = Weak-interaction studies with Ar32 decay

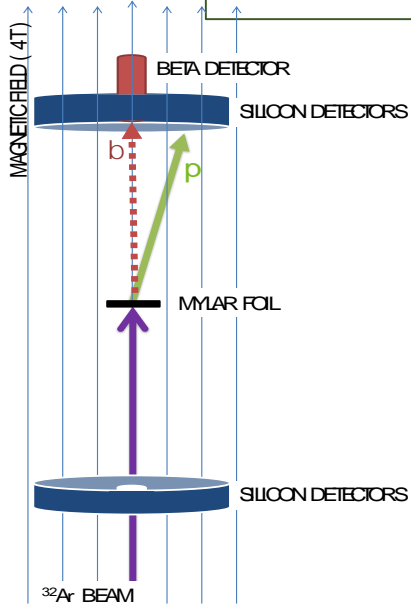
coll. Bordeaux, Leuven, LPC Caen, NPI-Prague

→ Measure kinematic shift using  $\beta$ -p coincidences in  $\beta$ -delayed p decay



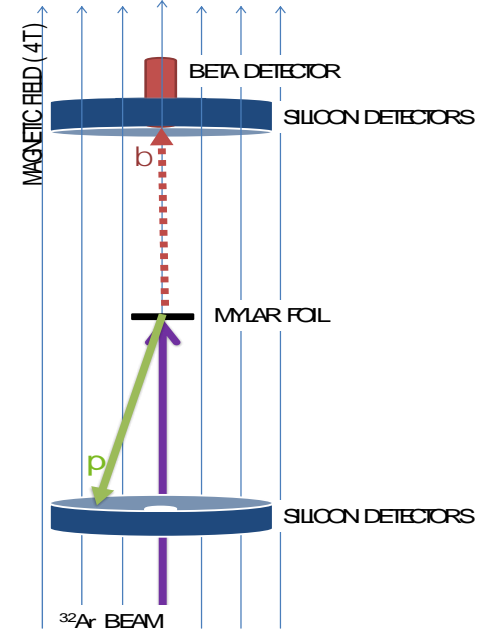


# Online proton spectra from the IAS after the $\beta$ -decay of $^{32}\text{Ar}$

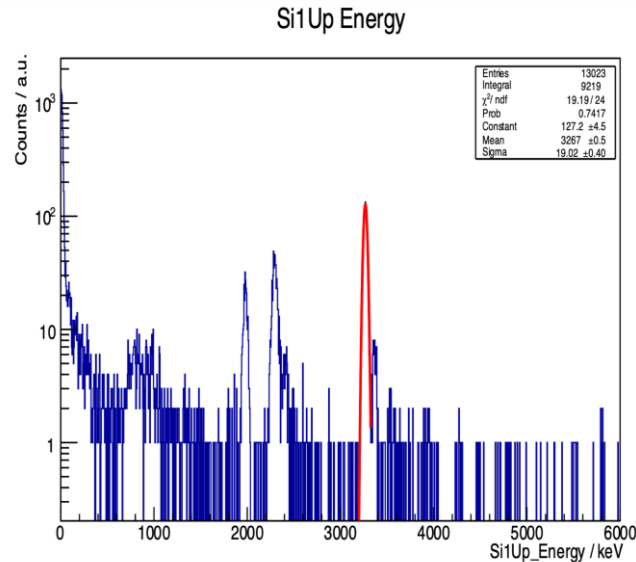


Positron up  $\rightarrow$  recoil nucleus  
down  $\rightarrow$  proton emitted  
upwards from downwards  
moving nucleus  $\rightarrow$  **lower  
energy**

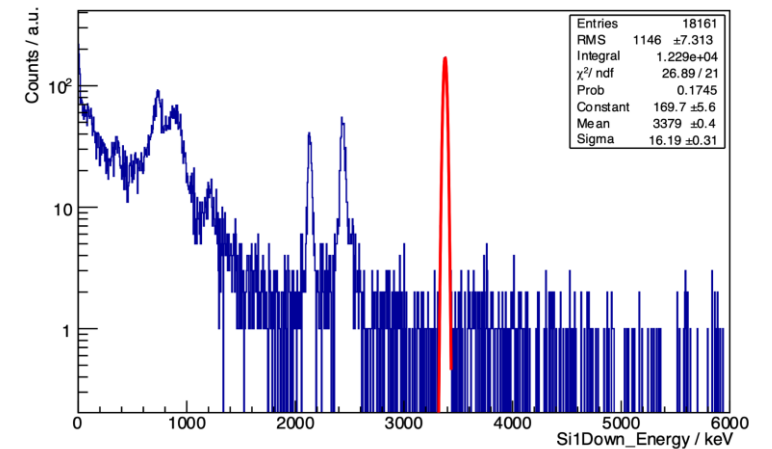
Positron up  $\rightarrow$  recoil nucleus  
down  $\rightarrow$  proton emitted  
downwards from  
downwards moving  
nucleus  $\rightarrow$  **higher energy**



Si1 Down Energy

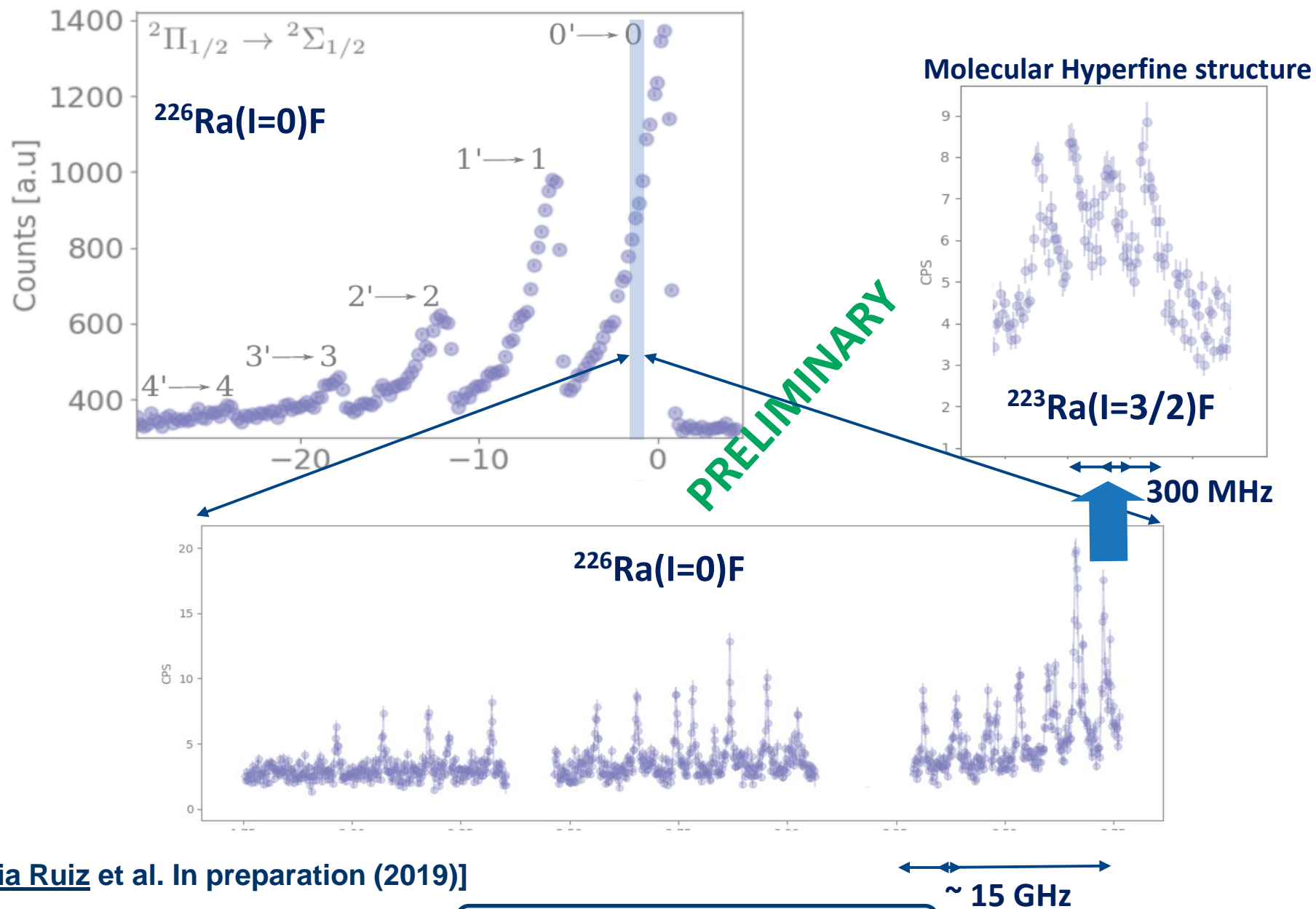


**PRELIMINARY**





# RaF: Results (November 2018)



[Garcia Ruiz et al. In preparation (2019)]

From THz to MHz

→ Low-lying structure of RaF?

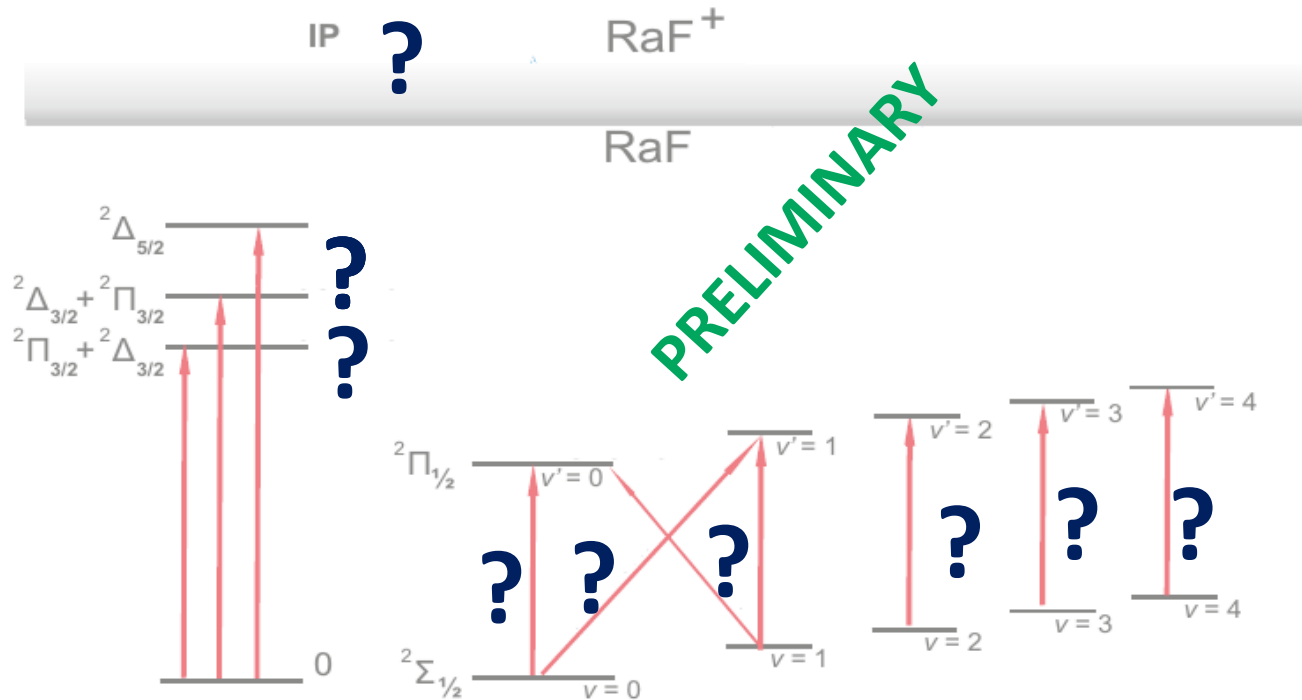
... and many-more properties successfully measured!

→ For the first time: Low-lying structure, Ionization potential, ...

→ A suitable laser cooling scheme has been established!

→ Measurements extend to  $^{223}\text{RaF}$ ,  $^{224}\text{RaF}$ ,  $^{225}\text{RaF}$ ,  $^{226}\text{RaF}$ ,  $^{228}\text{RaF}$

→ Hyperfine structure of  $^{223}\text{Ra}(I=3/2)\text{F}$  successfully measured



[Garcia Ruiz et al. In preparation (2019)]



# Irradiations for ISOLDE at MEDICIS

MEDICIS collaboration board approved use of MEDICIS for non-medical applications, as long as they are approved by INTC.

$^7\text{Be}$  (53.22d) at 5 MeV/u for IS554

#635-UCx -  $7.96\text{E}17$  p (direct)

+4 indirect irradiations

2.2 days – EoB 23/10/2018



6 extra days of beamtime  
(16/11->21/11) for ISOLDE  
IS554

$^{223}\text{RaF}$  (11.4d),  $^{225}\text{RaF}$  (14.8d),  $^{226}\text{RaF}$   
(1600 a) for IS657

#637-UCx -  $6.74\text{E}17$  p (direct)

3.4 days – EoB 19/10/2018



12 extra days of beamtime  
(21/11->03/12) for ISOLDE  
IS657

Total of 18 days (~54 shifts) of  
extra beam time for ISOLDE  
physics thanks to MEDICIS!

# Interaction with MEDICIS

MEDICIS schedule 2018									
MO	September			October				November	
Wk no.	39	40	41	42	43	44	45	46	
MO	24 Fire detection	#635 for 7Be for ISOLDE 5E18 p (conv)	MED004 155Tb 50 MBq	MD6 475CfX 70 MBq	#614UCx-VD5 5E18 (?)	7Be for ISOLDE	Large Container Irradiation	#637 for Ra for ISOLDE 5E18 p (conv)	MD8 225Ra (Ac generator)
TU	FAP Dep		MED009 - 11C						END OF PROTONS
WE	#644M Ta Re 2E18 p (SIC)	Water and Argon leaks FE	Water and Argon leaks FE	RCS modification Sample arm replacement		#669MTa - Re 3E17 p (low)	149PmO <sub>2</sub> /MD	MED004/5 155Tb 150 MBq (prototype in ISOLDE)	
TH		Pakistan del. TRIUMF	MED009 - 11C			MED008 67Cu 50 MBq			
FR		#629M Ti VD5 check	MED009 - 11C						
SA	#647M Ta Re 5E18 p (SIC)		#629M Ti VD5 2E18 p (conv)						
SU						Large Container Irradiation MD7 5E18 p (low)			
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?)					
		PM							
		night							
Tuesday	10/23/2018	AM		IS645					
		PM							
		night							
Wednesday	10/24/2018	AM	#534 Sn VD5	IS645					
		PM	Stable setup to GLM	IS645					
		night							
Thursday	10/25/2018	AM	Stable setup continues. 1-2 pulses STAGISO						
		PM		IS641 final stable tune					
		night							
Friday	10/26/2018	AM		IS641					
		PM		IS641					
		night							
Saturday	10/27/2018	AM		IS641					
		PM		IS641					
		night							
Sunday	10/28/2018	AM		IS641					
		PM		IS641					
		night							
Monday	10/29/2018	AM	111Cd to GLM till 0800: 111Cd to GLM (tbc) Ta W or UC W						
		PM		#642 UC - n(ew)					
		night							

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 radiative cooling for target change on Monday 29th).

(GPS): At run ends on Monday morning at 0900. Switch back to positive Monday morning. #534 Sn (VD5) 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: NORMGMS 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 constructive.

No serious impact on ISOLDE physics programme and the irradiation possibilities for winter physics was a great boost for ISOLDE as a whole.

Possibility of non-medical isotope collections after LS2 can also be beneficial to the facility as a whole.

## Shift and experiment count for 2018

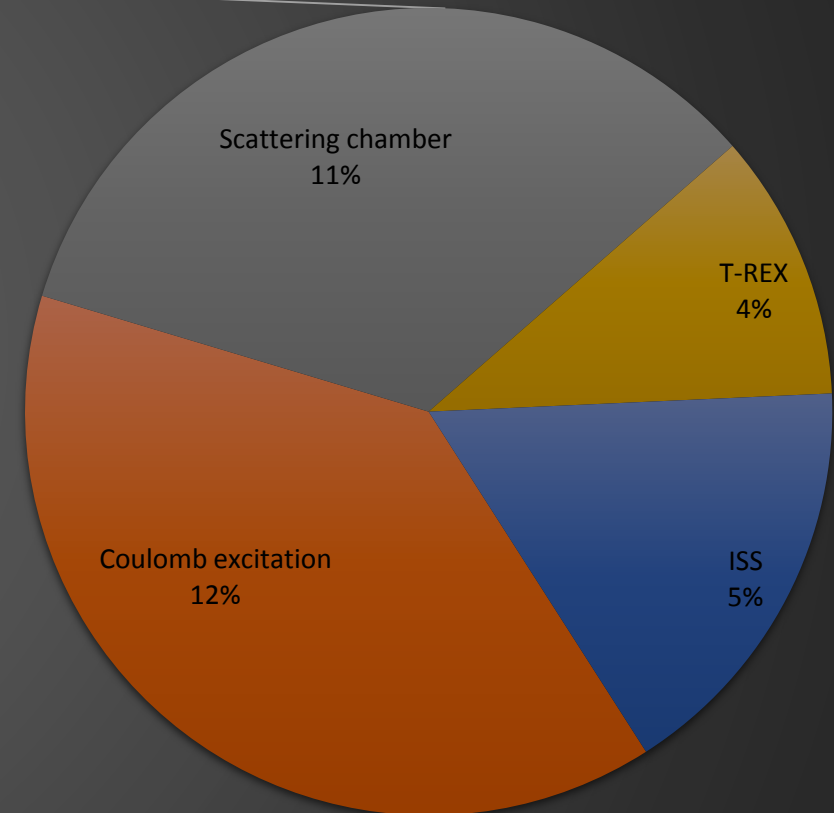
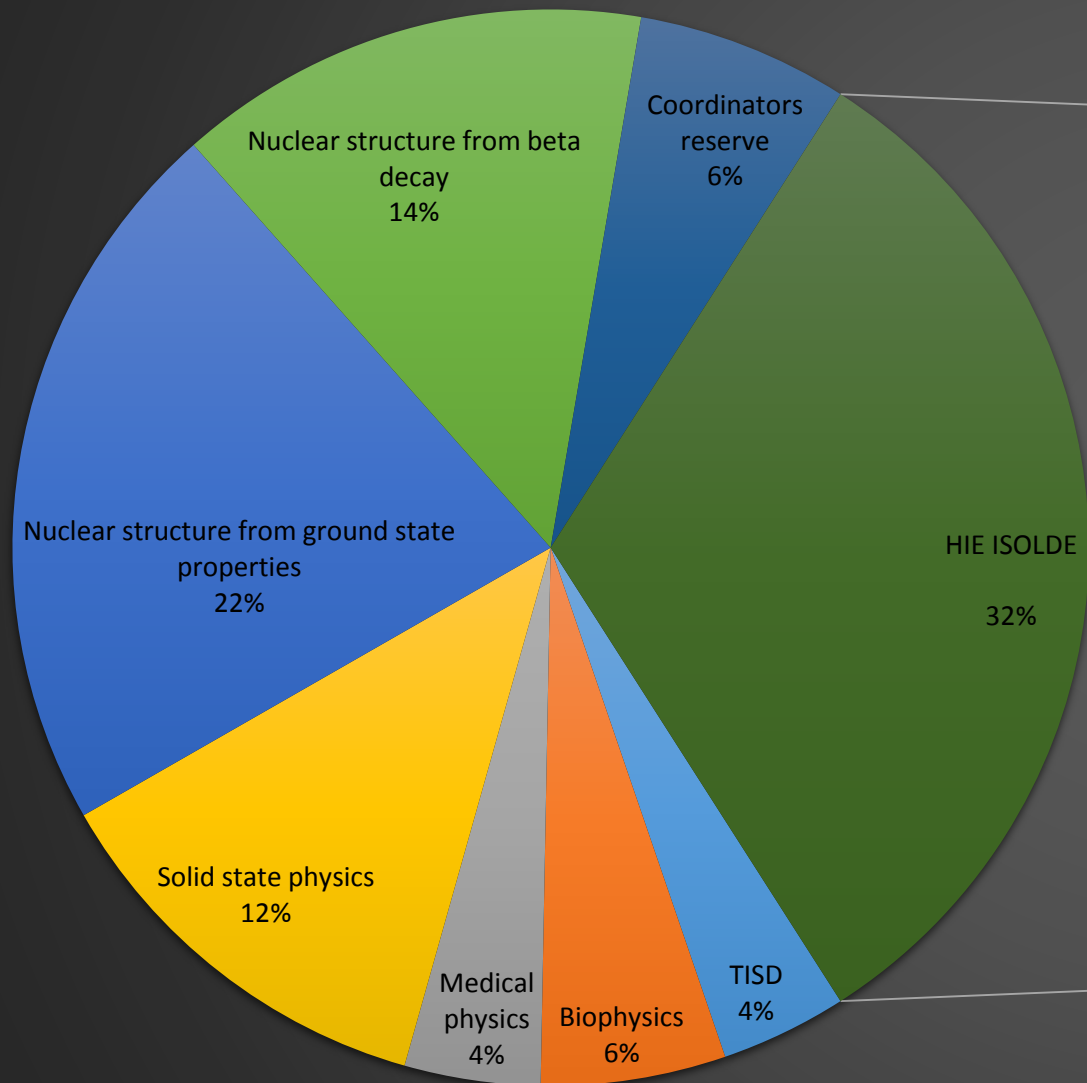
Étiquettes de lignes	Nombre de Delivered 2018
Biophysics	4
COLLAPS	3
COLLAPS; VITO	
Collections :7Be	
Collections: 163Ho	
CRIS	4
Gandalph	1
HIE	12
IDS	5
ISOLTRAP	2
la1	1
MEDICAL	2
Medicine	
Miniball	
NICOLE	
REX	1
Special	1
SSP	13
TAS	
TISD	
VITO	
Windmill/IDS	
Windmill; ISOLTRAP	1
WITCH	1
(vide)	
<b>Total général</b>	<b>51</b>

Delivered	2018	2017	2016	2015	2014	2012	2011
<b>Protons</b>	TBC	8.00E+19	7.80E+19	9.40E+19	5.50E+19	1.15E+20	8.05E+19
<b>Shifts for IS exp</b>	463	394	343	263	208.5	416	313.5
<b>Shifts for LOIs</b>	11	5	10	4	6.5	15.5	16
<b>HIE/REX shifts (IS +LOI)</b>	162.5	182	95	Special	-	221.5	190.5
<b>Average IS shifts/day</b>	1.94	1.76	1.65	1.4	1.55	1.61	1.55

An intense year: a big thanks to all the technical and operations teams for their commitment and also to the users for their understanding and cooperation (especially at the end of the year)

532 shifts (including TISD, reserve etc) in 2018

# ISOLDE PIE 2018





## Status January 2019

Étiquettes de lignes	Sum of Shifts remaining (Feb 2018)	Sum of Delivered 2018	Count of Delivered 2018	Count of Exp. no.	Sum of Shifts remaining 2018	Sum of Shifts remaining Jan 2019
Biophysics	79,5	31	4	6	48,5	48,5
COLLAPS	69	35,5	3	6	33,5	33,5
COLLAPS; VITO	13			1	13	13
Collections :7Be	24			1	24	24
Collections: 163Ho	6			1	6	6
CRIS	85,5	57	4	8	28,5	28,5
Gandolph	17	9	1	2	8	8
HIE	746,5	152,5	12	48	594	585
IDS	92	36	5	12	56	56
ISOLTRAP	51	17	2	8	34	34
Ia1	37	10	1	6	27	27
MEDICAL	25	20,5	2	2	4,5	0
Medicine	4			3	4	4
Miniball	2			1	2	2
NICOLE	29			2	29	29
Special	3	3	1	1	0	0
SSP	138,5	66,5	13	27	72	72
TAS	11,5			3	0	0
TISD	14			3	14	14
VITO	0			1	0	0
Windmill/IDS	22,5			1	22,5	22,5
Windmill; ISOLTRAP	3	3	1	1	0	0
WITCH	15	5	1	1	10	10
(vide)	0			2	0	0
REX	47	8	1	6	39	6
<b>Total général</b>	<b>1535</b>	<b>454</b>	<b>51</b>	<b>153</b>	<b>1069,5</b>	<b>1023</b>

## INTC meetings in 2019

776.5 shifts requested to be retained (some may be released after collaboration meetings in 2019...)

Effective backlog now ~776.5 shifts, some experiments may change after collaboration meetings.

New proposals may be accepted in early 2020 (tbc).

Étiquettes de lignes	Sum of Shifts remaining Jan 2019
Biophysics	48,5
COLLAPS	23
Collections :7Be	24
Collections: 163Ho	6
CRIS	23,5
Gandalph	8
HIE	461
IDS	33
ISOLTRAP	22
Ia1	20
Miniball	2
NICOLE	29
SSP	43
TISD	11
Windmill/IDS	22,5
<b>Total général</b>	<b>776,5</b>