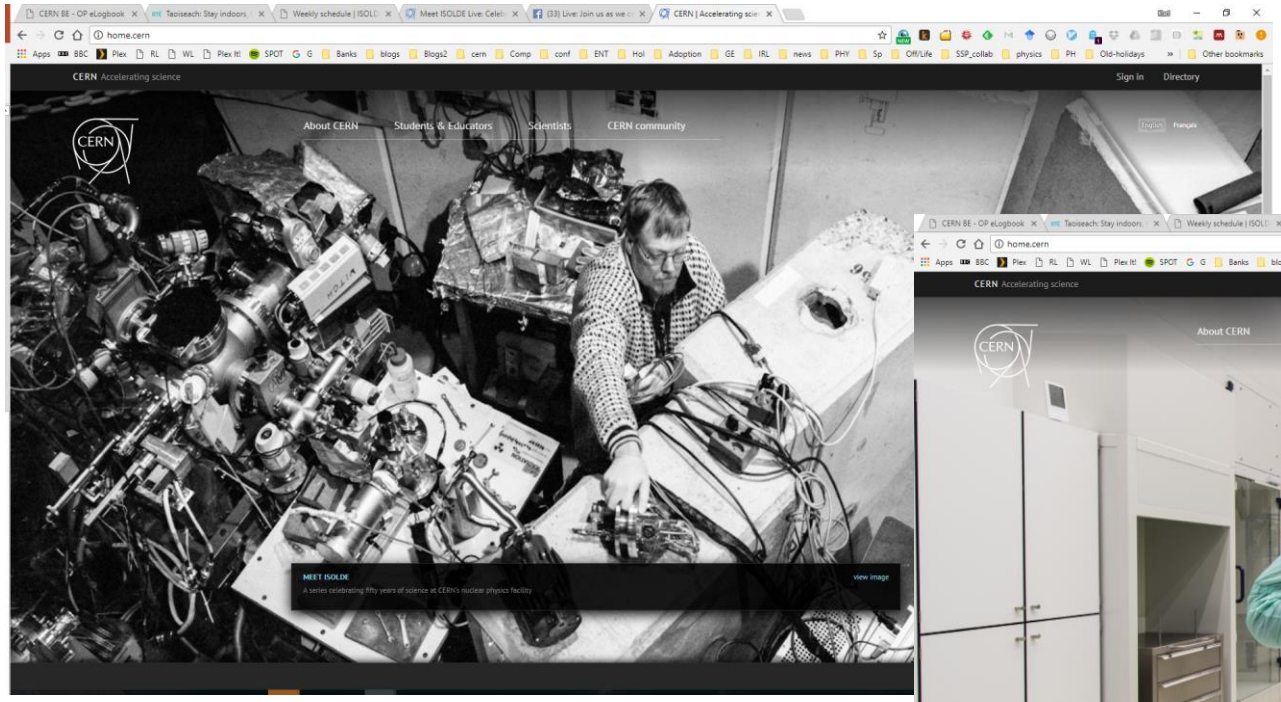
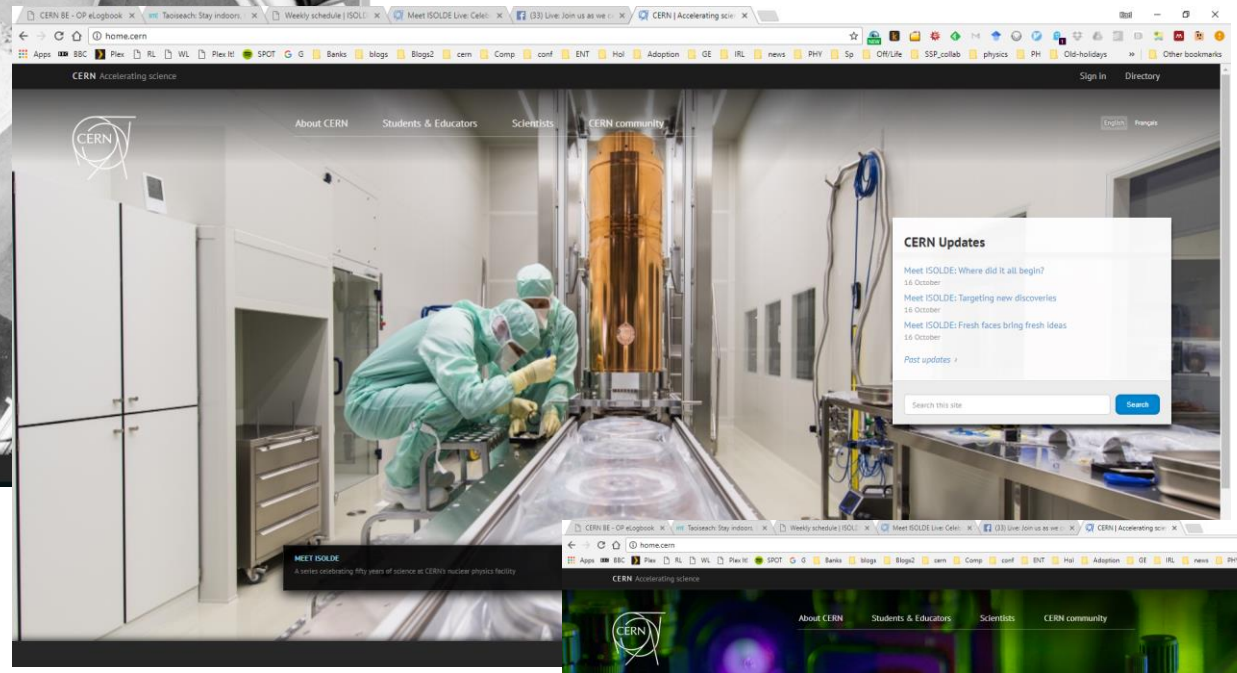
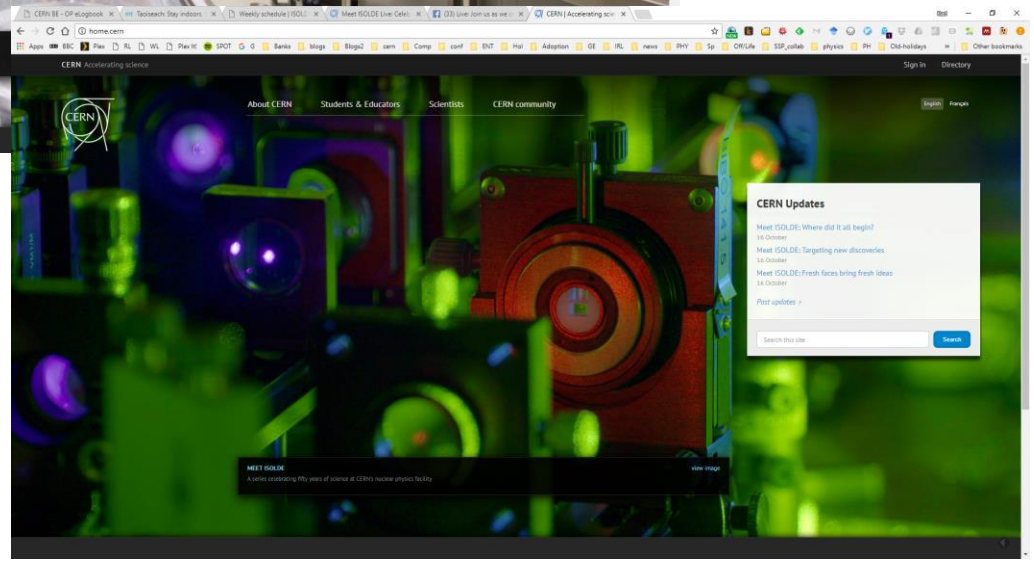
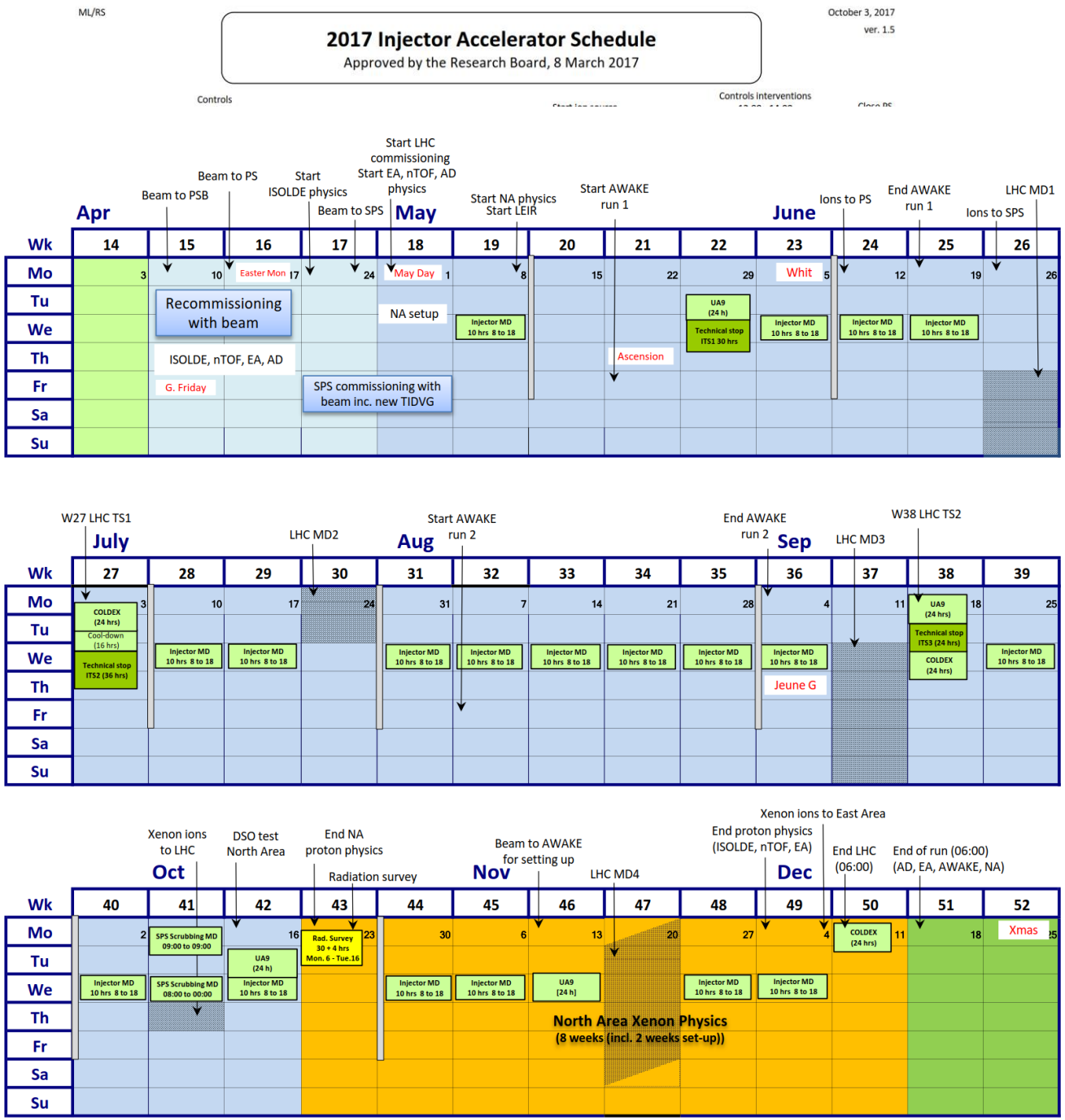




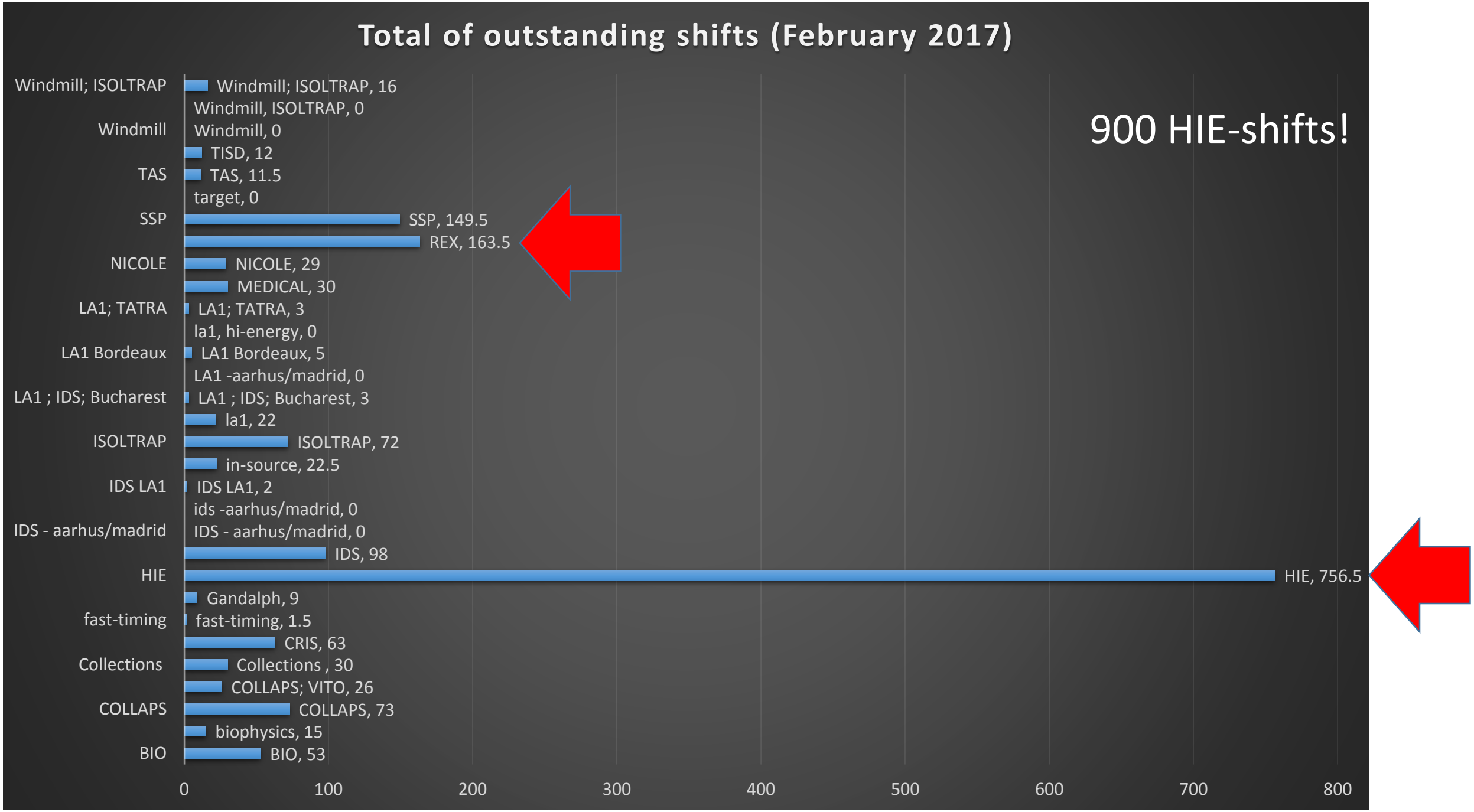


News from the 2017 ISOLDE running period

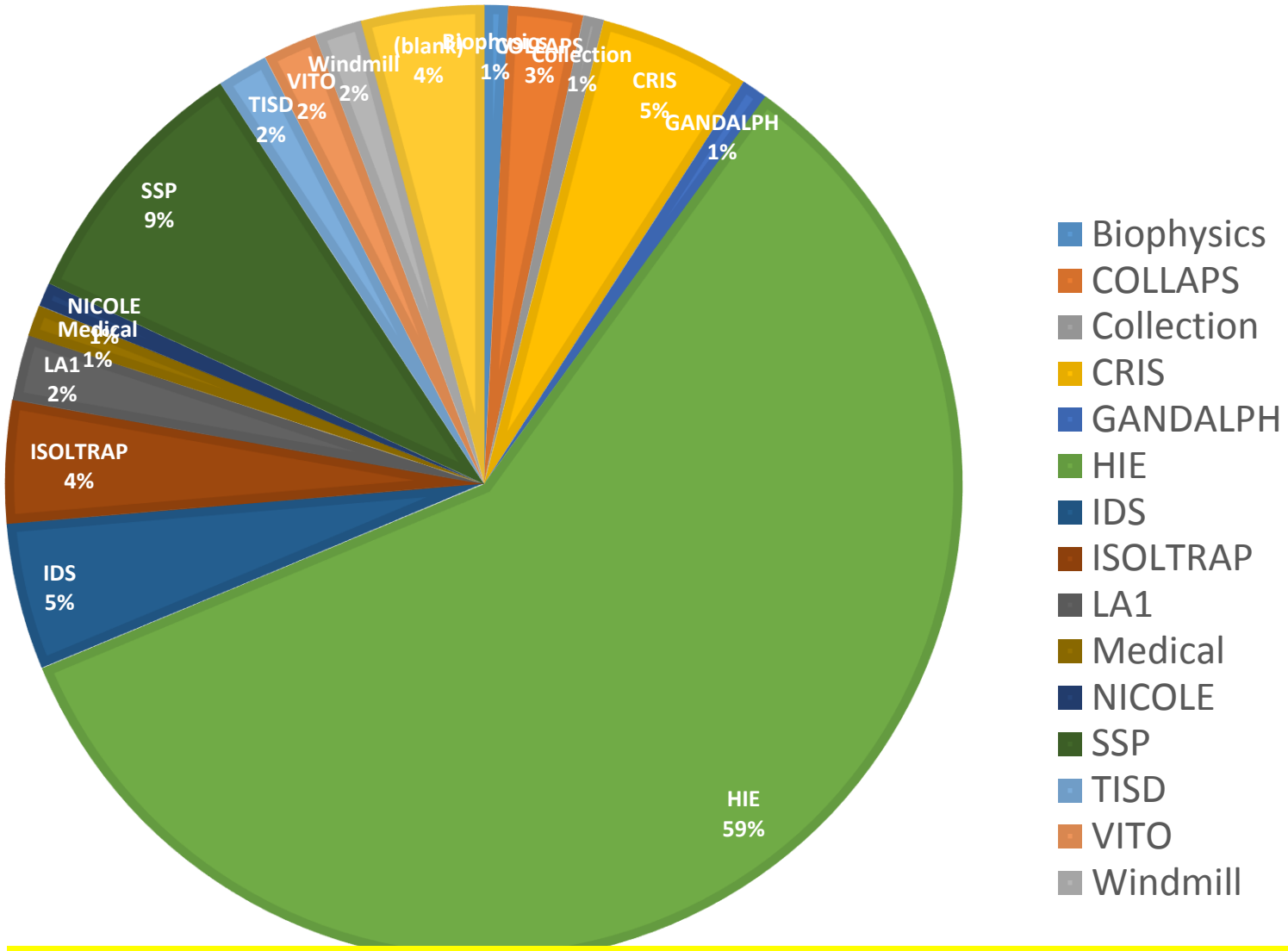
Karl Johnston



- Protons to ISOLDE for physics since week 17
- Original end of protons was week 47 (Nov 20th)
- Negotiated extension of two extra weeks
- 224 days of physics: currently on day 197


Total of outstanding shifts (February 2017)
900 HIE-shifts!
Windmill; ISOLTRAP
Windmill; ISOLTRAP, 16
Windmill, ISOLTRAP, 0
Windmill
Windmill, 0
TISD, 12
TAS
TAS, 11.5
target, 0
SSP
SSP, 149.5
REX, 163.5
NICOLE
NICOLE, 29
MEDICAL, 30
LA1; TATRA
LA1; TATRA, 3
la1, hi-energy, 0
LA1 Bordeaux
LA1 Bordeaux, 5
LA1 -aarhus/madrid, 0
LA1 ; IDS; Bucharest
LA1 ; IDS; Bucharest, 3
la1, 22
ISOLTRAP
ISOLTRAP, 72
in-source, 22.5
IDS LA1
IDS LA1, 2
ids -aarhus/madrid, 0
IDS - aarhus/madrid
IDS - aarhus/madrid, 0
IDS, 98
HIE
HIE, 756.5
Gandalph, 9
fast-timing
fast-timing, 1.5
CRIS, 63
Collections
Collections , 30
COLLAPS; VITO, 26
COLLAPS
COLLAPS, 73
biophysics, 15
BIO
BIO, 53
0
100
200
300
400
500
600
700
800

BEAM REQUESTS 2017



Row Labels	Sum of Requested shifts (summary)
Biophysics	8
COLLAPS	25
Collection	7
CRIS	50.5
GANDALPH	9
HIE	583
IDS	49.001
ISOLTRAP	41
LA1	22
Medical	10.5
NICOLE	8
SSP	88
TISD	17
VITO	18
Windmill	16
(blank)	41
Grand Total	993.001

49 HIE-ISOLDE Experiments; 27 requested beam in 2017

ISOLDE Schedule 2017: weeks 16 - 48

GPS	April		May					June				July					August				September				October					November				Dec
Wk	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	47	48	49
Mo	17	24	1	8	15	# 513 MWNC 22	29	5	12	19	26	3	10	17	24	31	7	#534 Sn VD5 14	#613 CaO 21	28	#565(?) Ta - Ta 4	11	18	25	2	9	#615 Ta - Ta 16	23	30	#622 ZrO2 6	13	20	27	4
TU			(IS611)									setting	#612 ZrO2-HP	#607 UC Ta	142Ba						IS528*							XT03			XT03			End of protons 2017: 4th Dec @ 0600
WE	SEMgrid			#599 Ti foils		Ascension	Tech stop					Tech stop								XT03	IS638/ISOLTRAP/RILIS		Tech stop		(IS528)						#513			
TH																					Jeûne				(IS528)									
FR	#595 UC - n		#575 UC - CP		IS453		# 601 UC - n	IS578	#603 UC - n		#605 ZrO2 -HP	IS597 72Se @ 4.4MeV/u (IS626)	IS569 70Se @ 5.5MeV/u (IS612)	Set for 4.1MeV/u		#608 Ta - GdB6					#611 UC - Re		#609 Ta GdB6		#534 Sn			#619 Pb VD5				LIEBE	TISD: LIEBE tests	
SA					IS634			IS580						Stable tests if not ready for protons												IS585 IS514 IS636 IS640 IS647	IS561 9Li @ 7.3MeV/u			IS547 206Hg @ 4.1MeV/u IS515 IS585 IS602 IS640 (199Hg)						
SU		IS632		IS490		IS633		IS630		IS608					IS553: 144Ba @ 4.1MeV/u		IS558 140Sm @ 4.65MeV/u	IS611 IS638 IS640	IS619 15C @ 4.3 MeV/u	IS619 15C @ 4.3 MeV/u		IS572 94Rb @ 6.3MeV/u		IS546 @ 3.6 (or) 4.5MeV/u						IS607 59Cu @ various; 64Cu for IS626	Stable C for REX trap			
		In RILIS	In RILIS	98Kr/48Ar	Mg RILIS	8B		Mn RILIS	In RILIS	Bi RILIS		Se (mol) beam		BaF beams	BaF beams		Sm RILIS	Cd beams	15C	15C	Dy RILIS	Rb beams		Nd RILIS		Cd beams	Li beams			Cu RILIS			(Hg RILIS?)	

Re-used target: leaking

Had to re-use#513…

Se beams…

Ge beams…

TISD/Dy week

Incorrect ic
source pro
stop difficu
setup:
machine+e
ment

Row Labels	Count of Experiment
Biophysics	3
COLLAPS	3
CRIS	3
HIE	10
IDS	2
ISOLTRAP	3
Medical	1
SSP	13
TISD	1
VITO	2
Windmill	1
Grand Total	**42**

Low/no yields; HRS problems

HRS	April		May					June					September				October					November				Dec
Wk	16	17	18	19	20	21	22	23	24				36	37	38	39	40	41	42	43	44	45	46	47	48	49
Mo	17	24	1	8	15	22	29		12				28	4	11	18	25	2	#620 LaC 9	16	23	30	6	13	20	27	4
TU	#596 CaO	IS601			TISD	TISD										Tech stop											
WE		(IS632)		CRIS		Ascension	Tech stop																		UC (used)		
TH													Jeûne	Reuse #599		#595 UC n			#628 UC - n			Installation of plunger begins	IS628 22Ne @ 5.5MeV/u			End of protons 2017: 4th Dec @ 0600
FR		#597 UC - n		#597 remains		#600 UC - Ta		#602 UC - W				Ta											#623 SiC (tbc)			
SA	Stable tests for IS601																									
SU			IS639				IS617		IS620				IS568		IS645 LOI168		IS571	IS562 108Sn @ 4.4MeV/u		IS573 121-136Sn			IS628 22Ne @ 5.5MeV/u	IS628 28Mg @ 5.5MeV/u	(tbc) IS645 VITO	
		35Ar	In RILIS	In RILIS			Al RILIS		51-53K				Ni RILIS		Na beams		Ga RILIS	Sn RILIS		Sn RILIS				Mg RILIS		

Target change

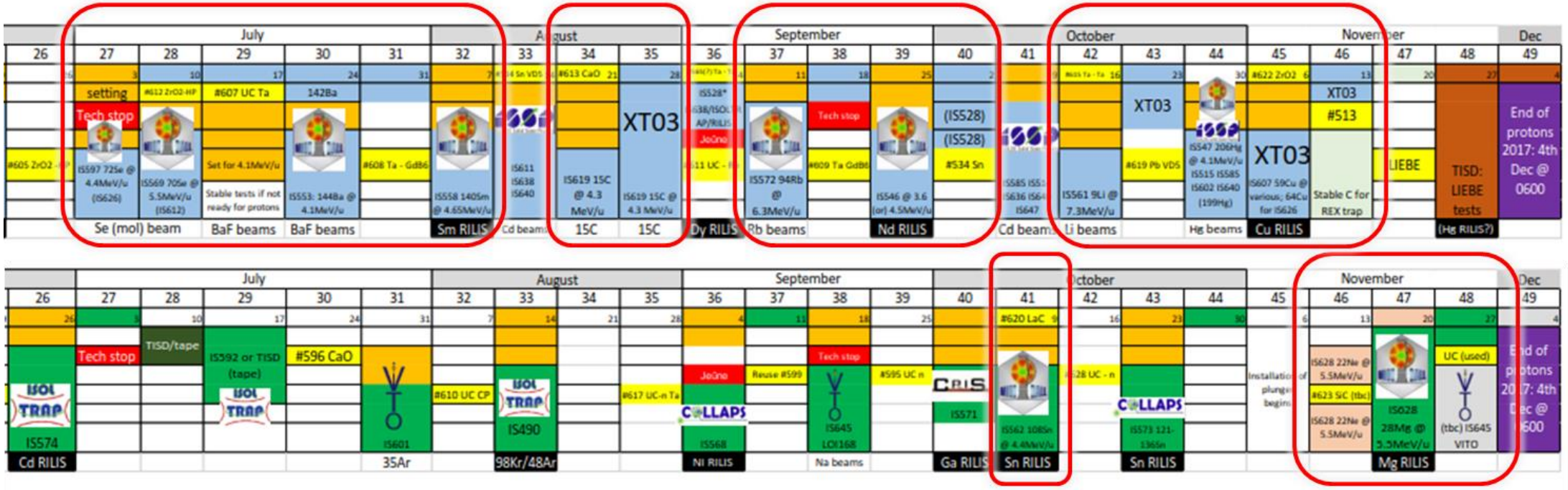
CERN holiday

Setting up/proton scan/yield

Physics GPS

Physics HRS

KJ: 06.10.17



12 HIE ISOLDE experiments

9 at Miniball : 8 Coulomb excitation; 1 multi-nucleon transfer; 3 at XT03

→ Still to come: 59Cu (this week) and 28Mg (plunger)

Experiment #	IS597	IS659	IS553	IS558	IS619	IS572	IS546	IS562	IS561	IS547	IS607	IS628
Isotopes	72Se19+	66Ge16+, 70Se17+	142Ba33+, 144Ba33+	140Sm34+	15C5+	94Rb23+	140Nd33+, 142Sm33+	108Sn26+	9Li3+	206Hg46+	59Cu20+	28Mg9+
Energies [MeV/u]	4.4	4.4	3.4, 4.2	4.65	4.35	6.21	4.62	4.5	8.04	4.19	3.6, 4.0, 4.3, 4.7, 5.0, 5.3	5.5
Target	GPS	GPS	GPS	GPS	GPS	GPS	GPS	HRS	GPS	GPS	GPS	HRS
HEBT	XT01	XT01	XT01	XT01	XT03	XT01	XT01	XT01	XT03	XT01	XT03	XT01
Target installation	Fri - AM	Wed - AM	Tue - PM	Mon - AM (-1)	Mon - AM	Mon - AM	Fri - AM	Tue - AM	Mon - AM	Fri - AM	Mon - PM	
Ionization	Molecular	Molecular	Molecular	RILIS	Molecular	Surface	RILIS	RILIS	RILIS Tried	RILIS	RILIS	RILIS
RIB ready					Thu - 14:30				Thu - 23:50			
RIB first delivery	Fri - 23:00	Thu - 19:45	Thu - 18:40	Tue - 18:00	Sat - 17:00	Wed - 17:30	Wed - 17:15	Thu - 20:00	Sat - 00:45	Thu - 21:40		
	2017/07/07	2017/07/13	2017/07/20	2017/08/08	2017/08/26	2017/09/13	2017/09/27	2017/10/12	2017/10/21	2017/11/02		

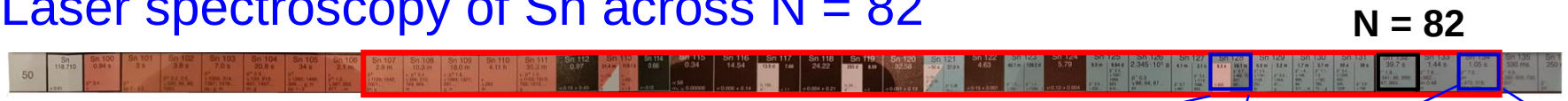
(Thanks for Jose Alberto Rodriguez)

Coulomb excitation
- 108Sn
  - IS562
- 140Nd; 142Sm
  - IS546
- 140Sm
  - IS558
- 144Ba; 142Ba
  - IS553
- 206Hg
  - IS547
- 70Se
  - IS569
- 72Se
  - IS597
- 94Rb
  - IS572

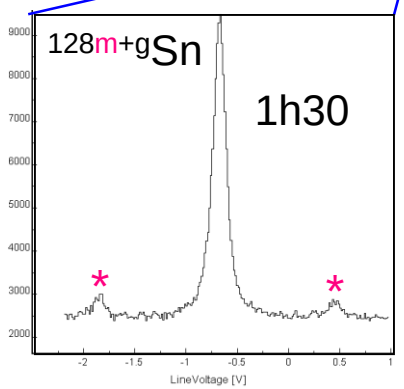
Scattering Chamber
- 15C beams to XT03
  - IS619
- 9Li
  - IS561

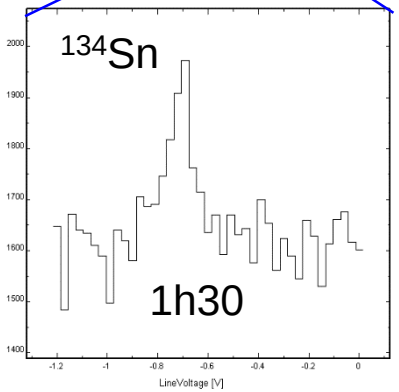
The year 2017 for COLLAPS

Laser spectroscopy of Sn across N = 82

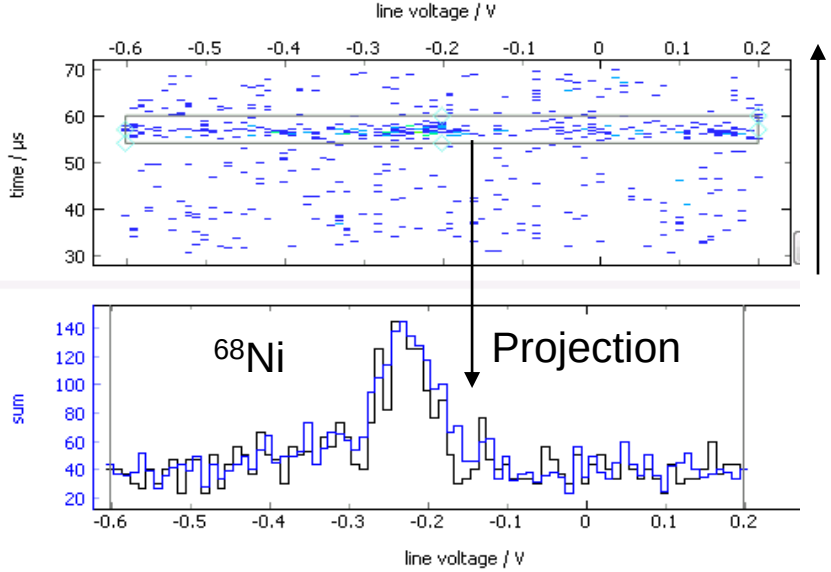


- Atomic transition complementary to the one used in 2016:
  - Combining both gives firm μ, Q, radii
  - Resolve weakly produced isomers
- > 20 isotopes in 3 days!
  - N = 57 up to N = 84





New data acquisition



Photon timing wrt bunch extraction

Line voltage (freq)

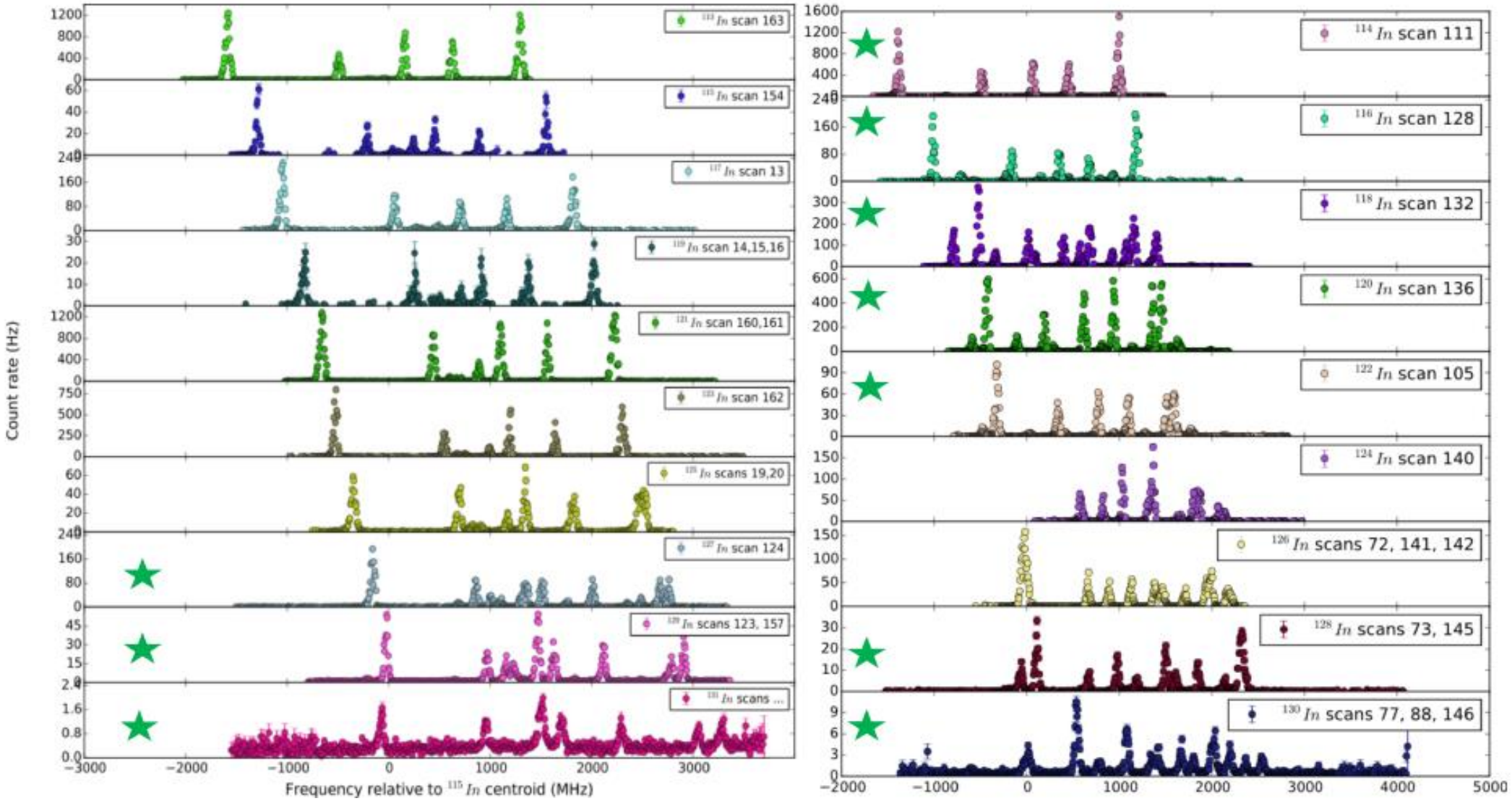
Problems ☹

- Unexpectedly low Al and Ni yields: key cases out of reach
- Long ISOLDE set-up times despite (<u>much appreciated!</u>) efforts of technical teams

RESULTS CRIS Experiments on neutron-rich In

From ^{113}In up to ^{131}In

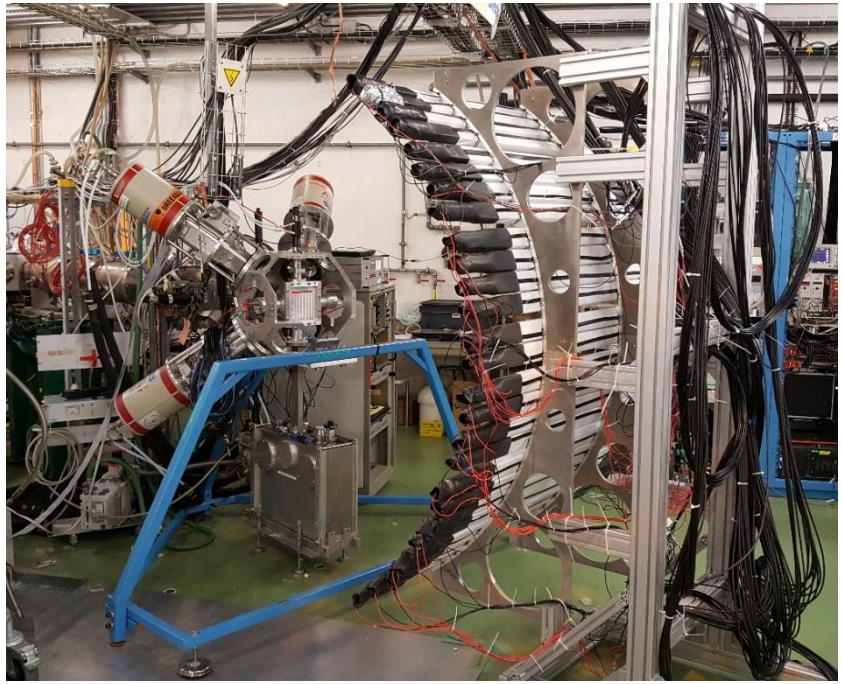
(New results ★)

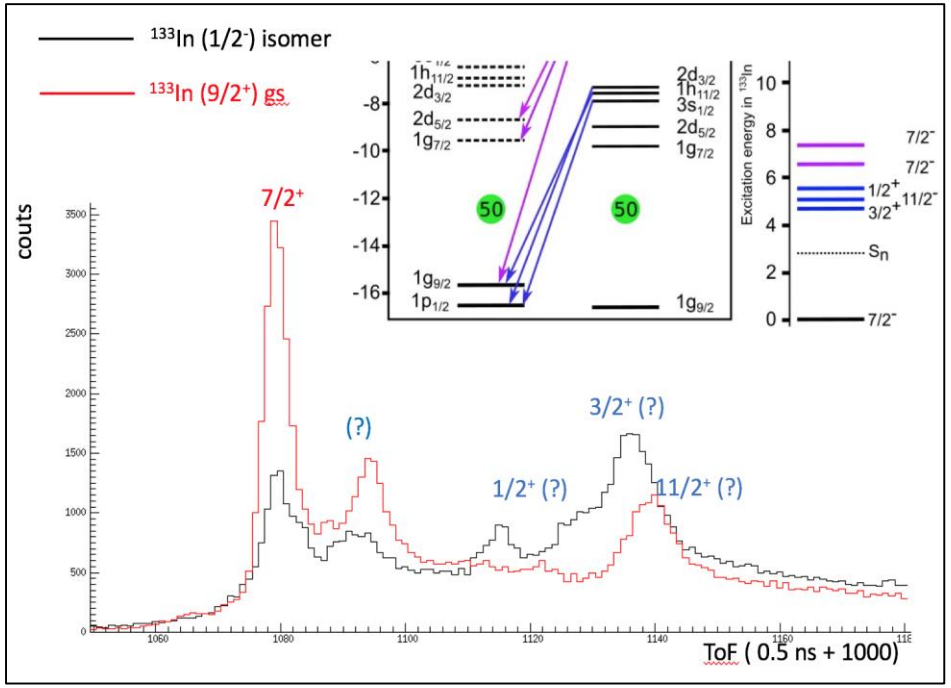


IS632 at IDS: Neutron unbound single particle states in ^{133}Sn from the beta decay of ^{133}In

- The IDS Neutron Detector and HPGe Clovers were used
- ToF calibrations with ^{17}N from the HRS CaO target.
- Production of ^{133}In ~ 900 ions/uC (~70% transmission from GPS)
- Using RILIS, both isomer and gs in ^{133}In were selectively ionized

- Clear resonances were observed, to be clarified in the offline analysis using neutron-gamma coincidences

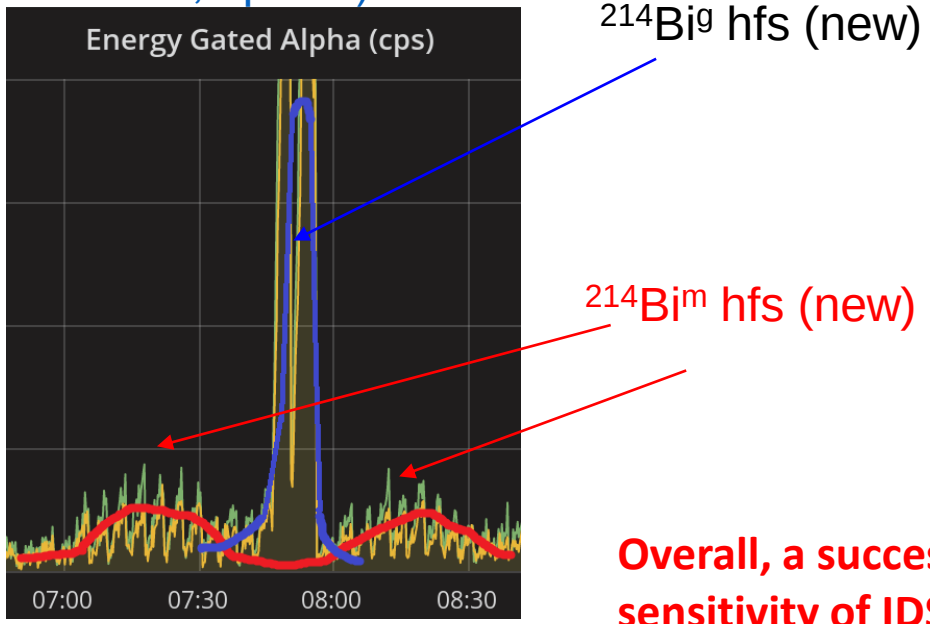




IS608-II, Laser spectroscopy of Bi isotopes a GPS (21-26 June 2017)
Windmill-IDS-RILIS Collaboration

- First collaboration between Windmill and IDS teams
- Demonstrated unique power of IDS for HFS studies
- ^{188m1,193,193m,195,195m,197,197m,200m2,203m,214,214m,215,215m}Bi were measured (many new results!)
- **Issue 1: the target could not deliver $^{216-218}$Bi (which were 'easily' produced in IS608 in 2016)**
- **Issue 2: Mass-contaminating tails at many masses of interest due to abundantly-produced Fr's, need to preferentially use HRS for this region**

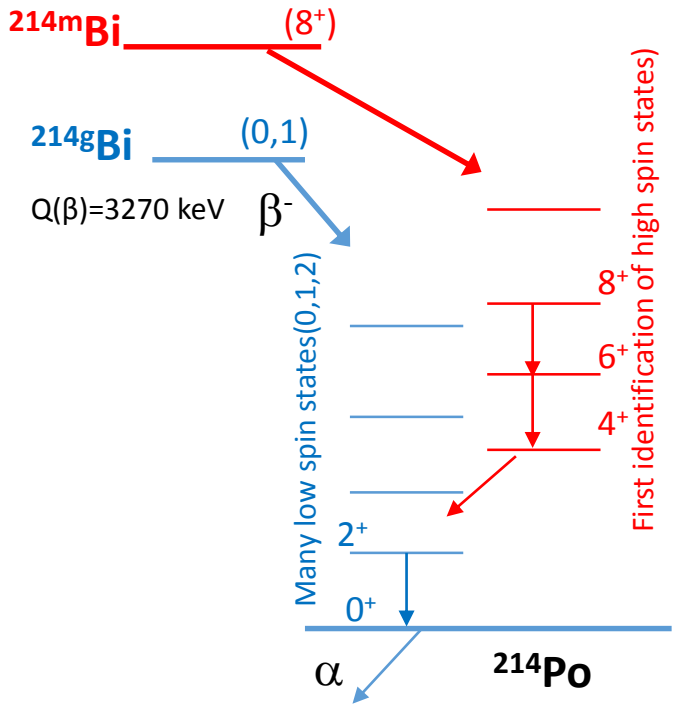
An example: Direct identification and spectroscopy of high-spin isomer in ^{214}Bi (including HFS/isomer shift measurements, spin…)



^{214}Bi^{g} hfs (new)

^{214}Bi^{m} hfs (new)

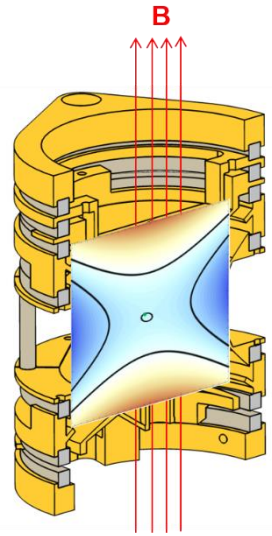
Decay pattern and $T_{1/2}$ for IS measured for the 1st time, identifies new band in ^{214}Po



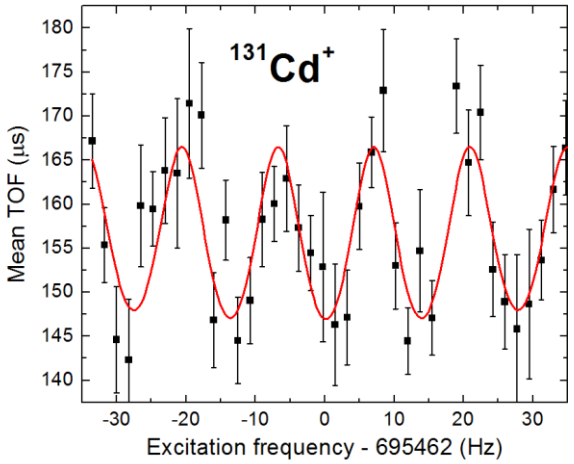
Overall, a successful run, due to very strong sensitivity of IDS to long-lived, β-decaying isotopes

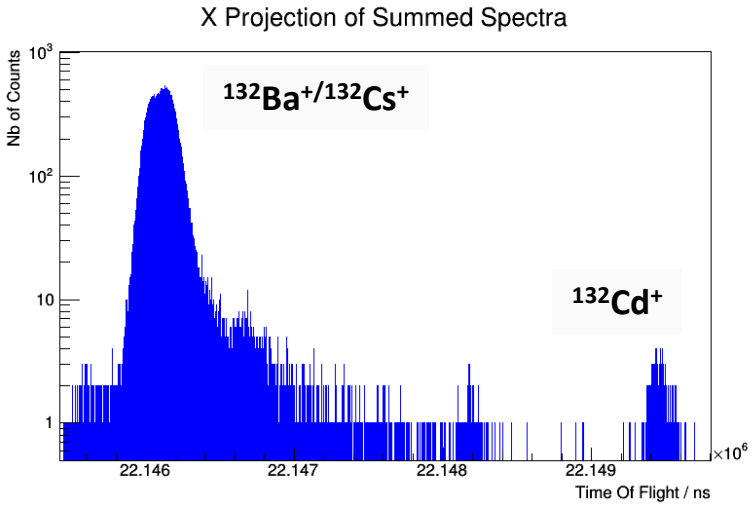
Precision mass spectrometry of ^{131,132}Cd

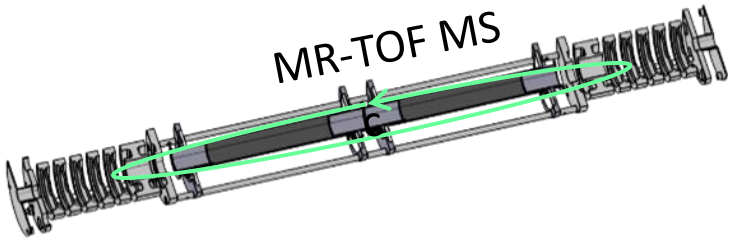
June 2017 – UC_x-converter + quartz + RILIS: high-quality cadmium beams.



Precision Penning trap





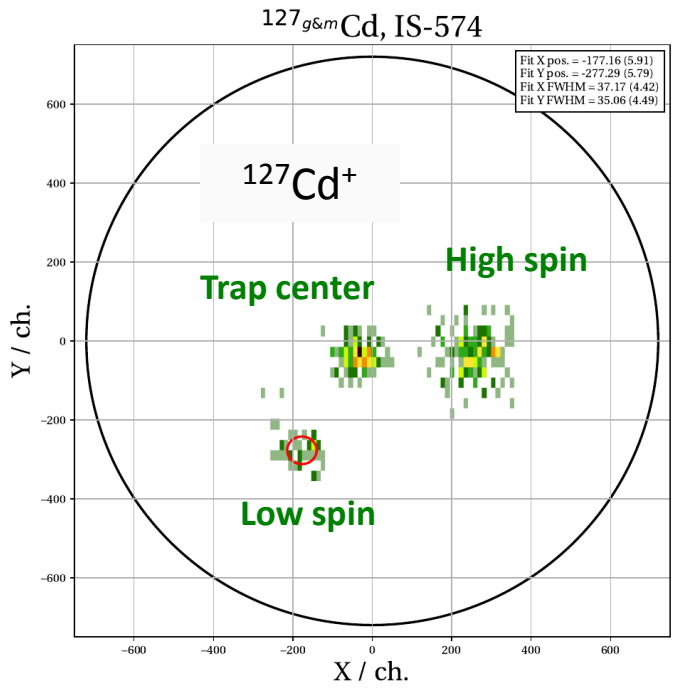


Penning trap confirms and improves the MR-TOF mass of ^{131}Cd from 2014.

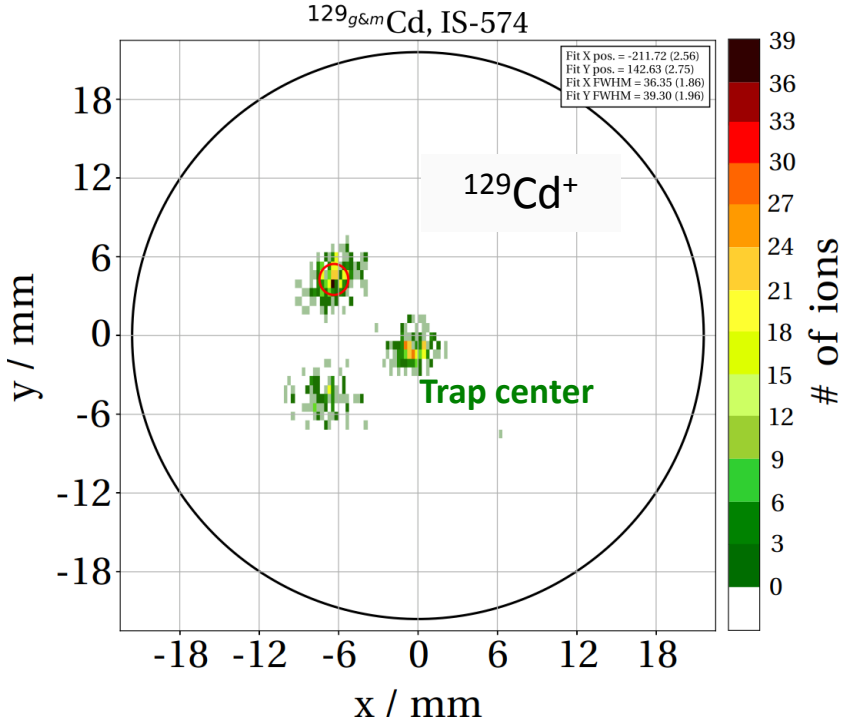
MR-TOF MS allows first mass measurement of ^{132}Cd.

Isomer separation in ^{127,129}Cd with PI-ICR

The PI-ICR technique allowed fast and optimal separation of the isomeric states in the odd-A cadmium isotopes.



Measurement time
209 ms

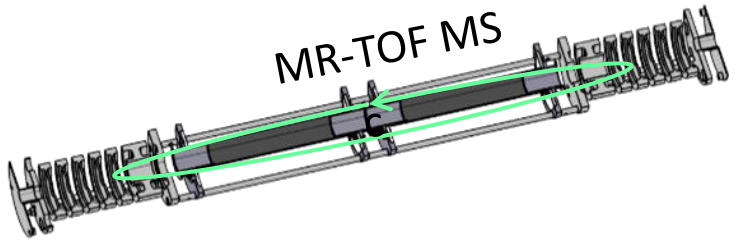


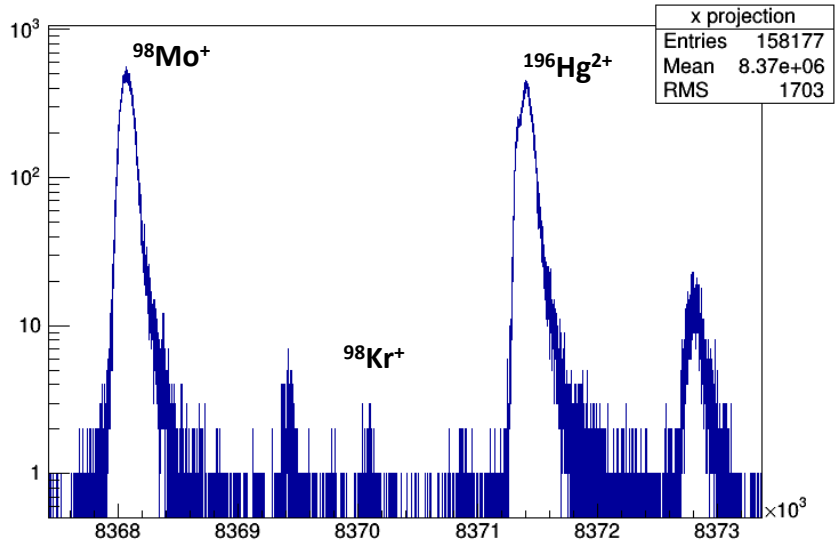
Measurement time
106 ms

J. Karthein, master thesis 2017.

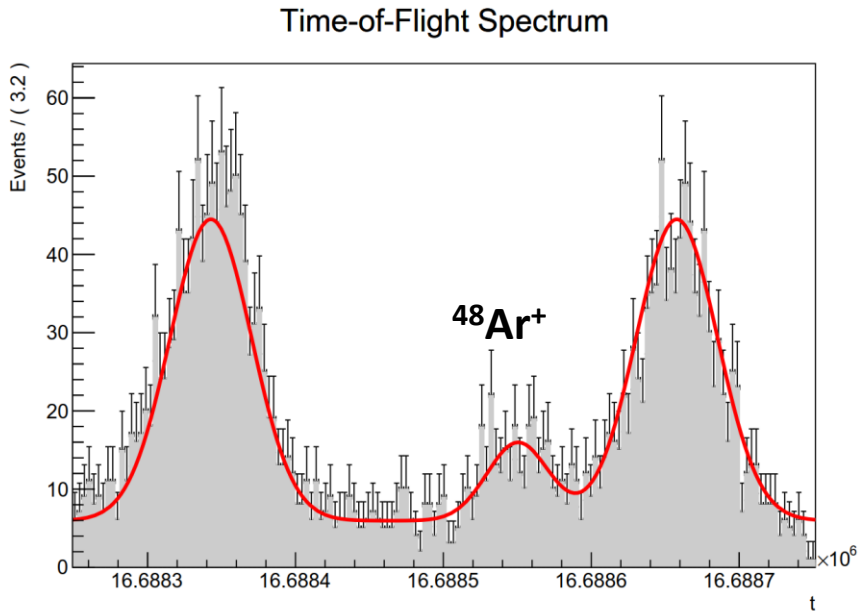
MR-TOF mass measurements of ^{48}Ar and ^{98}Kr

August 2017 – UC_x with cold plasma: a challenge for the MR-TOF MS sensitivity





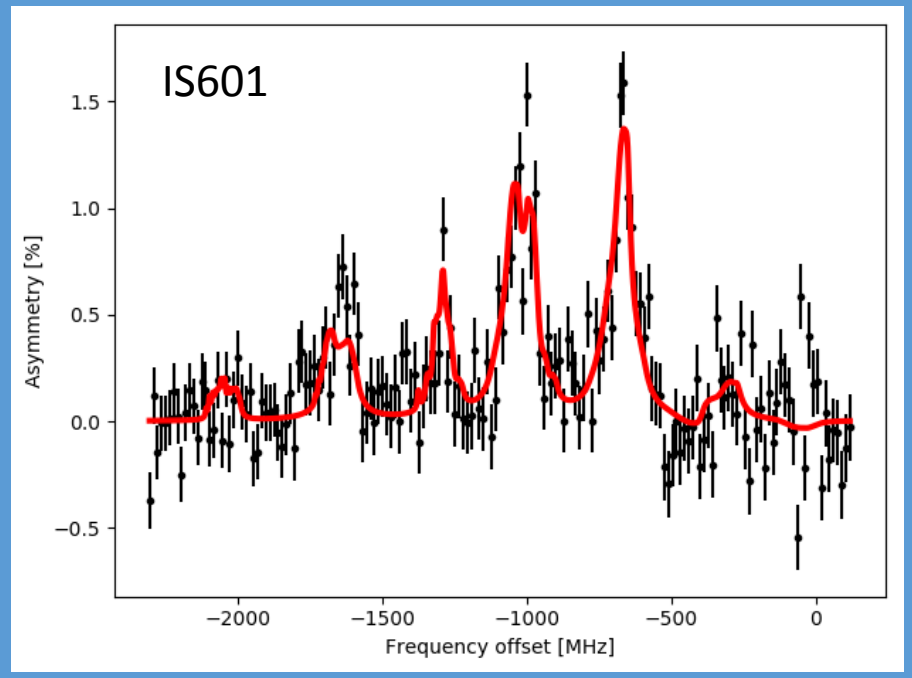
Onset of deformation in the A≈100 region



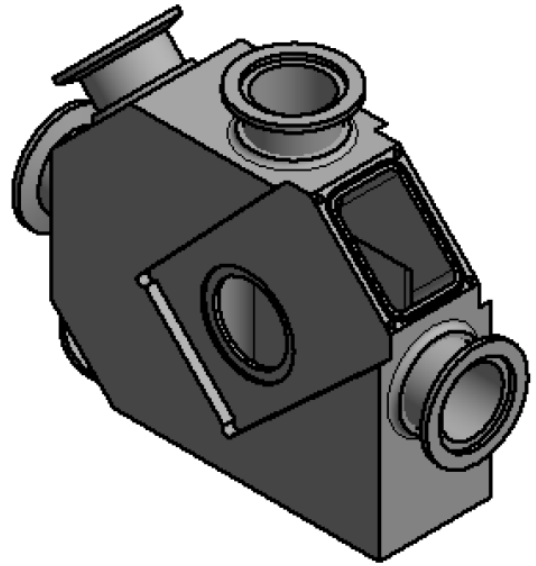
Strength of the N = 28 shell closure

Since last meeting:

2 beamtimes with 35Ar – looking for implantation host for β-asymmetry studies:
1st use of multiple laser pumping



VITO



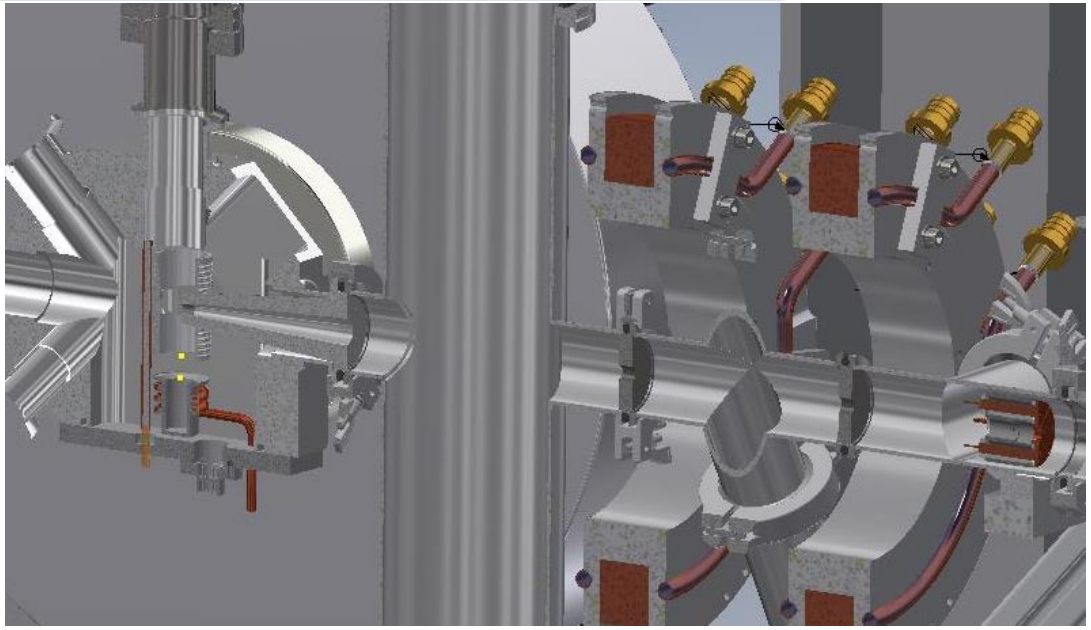
1 beamtime on liquid β-NMR (2nd in December):

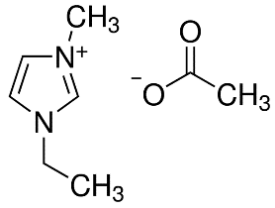
Compact β-detectors with Si PMTs (U Tennessee)

New liquid b-NMR chamber, differential pumping and transitional field system

Liquid handling system

1st NMR signal at VITO!

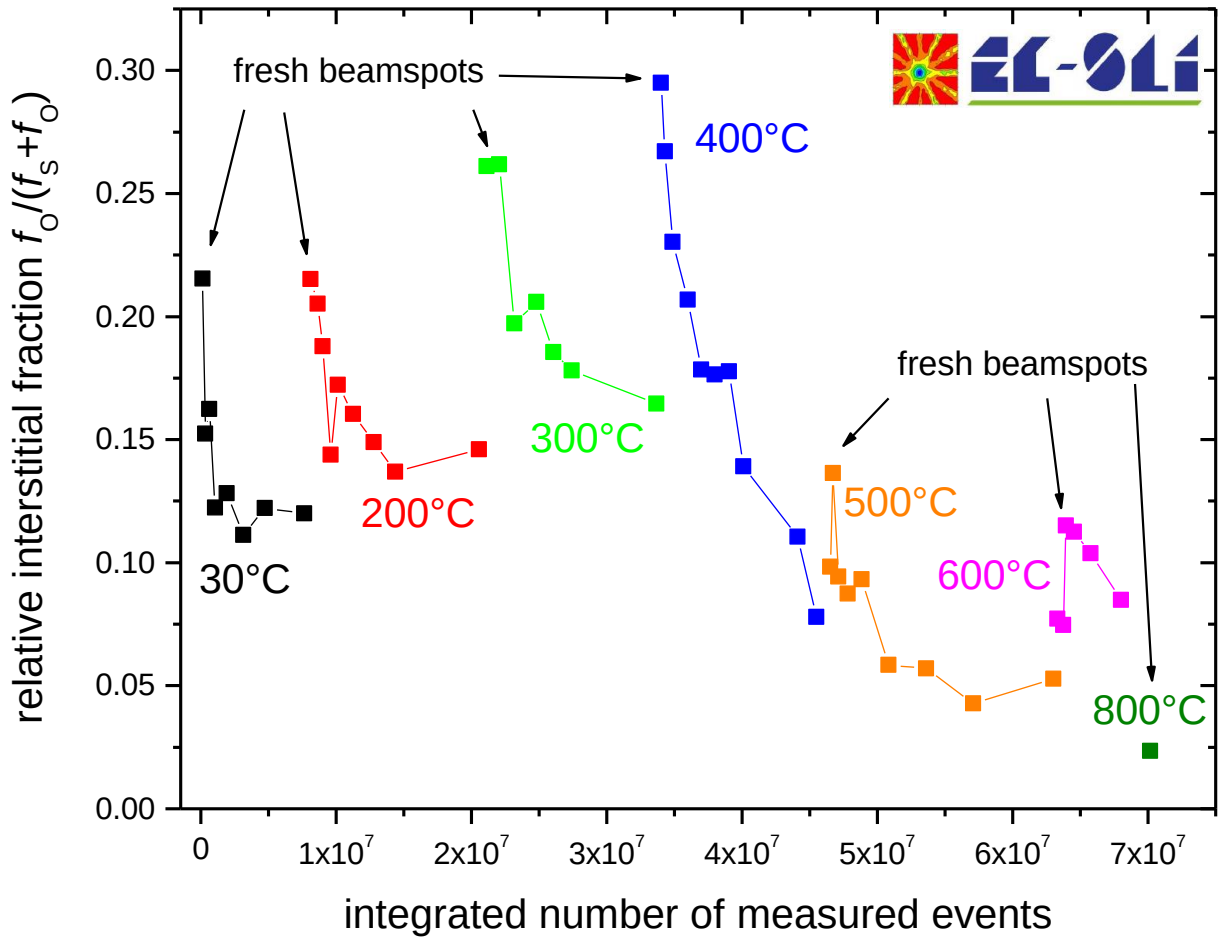




IS645

Thanks to Magda Kowalska

IS634: Fluence dependence of interstitial ^{27}Mg in GaN



- Continuing our work initiated in *Phys. Rev. Lett.* **118**, 095501(2017)

- Complex balance of interstitial vs substitutional Mg as function of temperature, doping type and implanted fluence

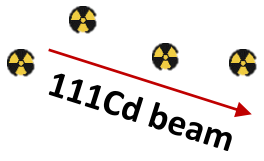
- reason: amphoteric character of Mg and its interaction with Ga vacancies
  $Mg_i + V_{Ga} \rightarrow Mg_{Ga}$

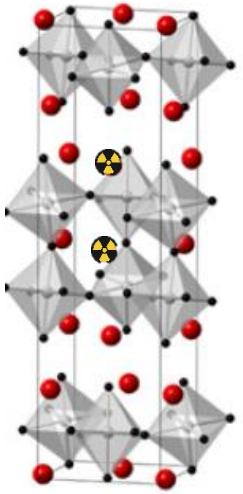
- Impact: prospects for more efficient *p*-type doping of GaN
  (high-power electronics, optoelectronics…)

- Also extremely successful Mn beamtime..follow-up proposal at tomorrow's INTC

Perturbed Angular Correlation measurements

PAC measurements were performed successfully for the $Ca_3Mn_2O_7$ in CERN-ISOLDE by beam implantation of ^{111m}Cd run 10/2017.





424 K

400 K

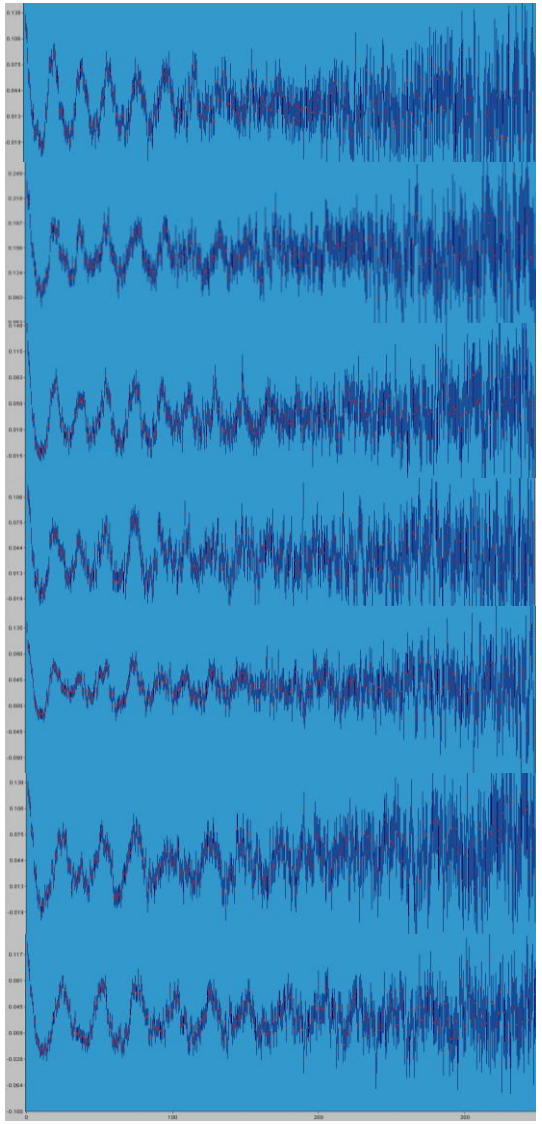
380 K

368 K

358 K

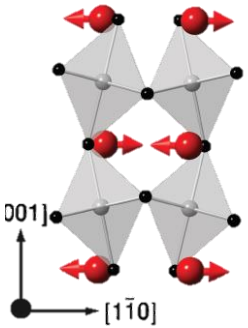
330 K

300 K



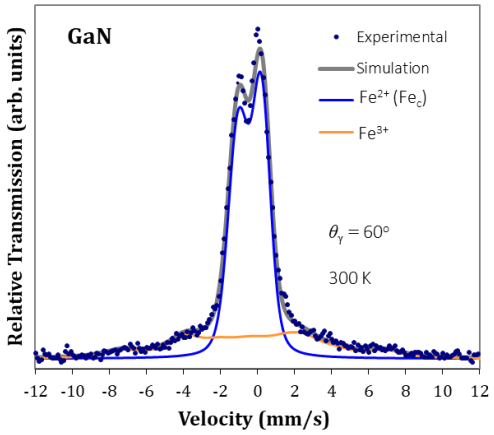
Orthorhombic
Cmca – non polar

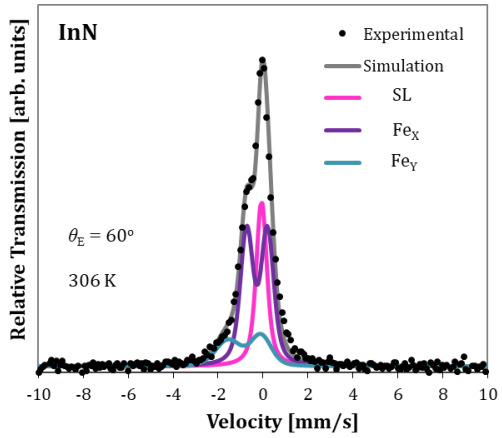
freeezing of the **MnO_6 octahedral tilting** and **Ca^{2+} displacement** phonon modes



Orthorhombic
$Cmc2_1$ polar

PAC allows us to probe the local atomic environment behind Hybrid Improper Ferroelectricity - the coupling of the MnO_6 octahedral rotation and the polar displacement of the Ca^{2+} ion's

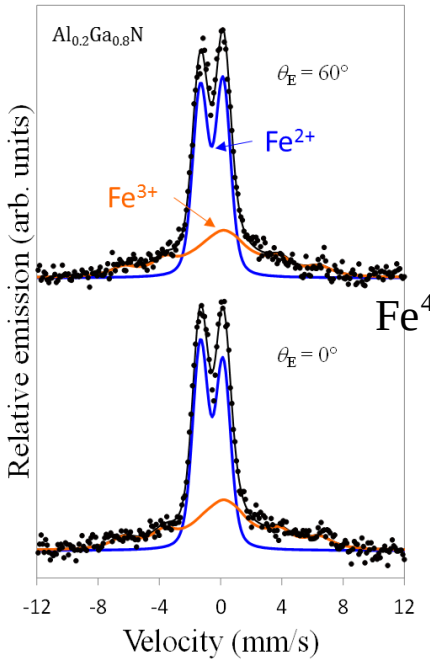


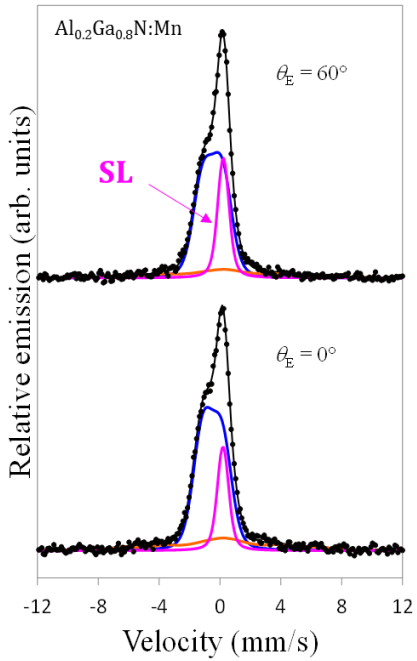


No magnetic feature, no Fe^{3+}

$Fe^{2+}_{Ga/Al} - V_N$ $\quad$ $Fe^{3+}\,(S = 5/2)$

When doped with Mn





SL

..doping with Mn results in acceptors that make the Fe^{4+} state stable →*p*-type

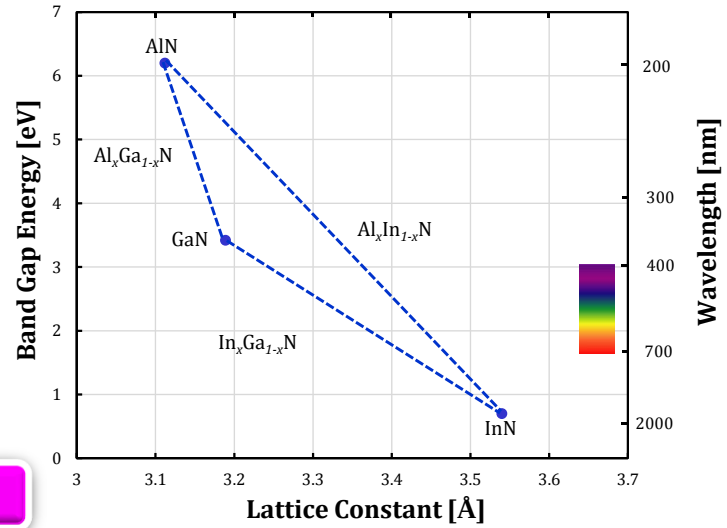
- **Concentration of Fe^{3+} decreases, New Single Line?? δ_{RT} ~ -0.25 mm/s**

….but single line (SL)…
→ Fe^{4+} as in Mn doped $Al_xGa_{1-x}N$

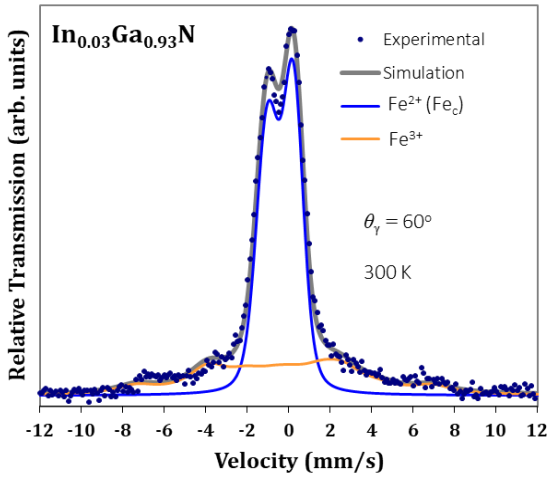
p-type doping without Mn incorporation?

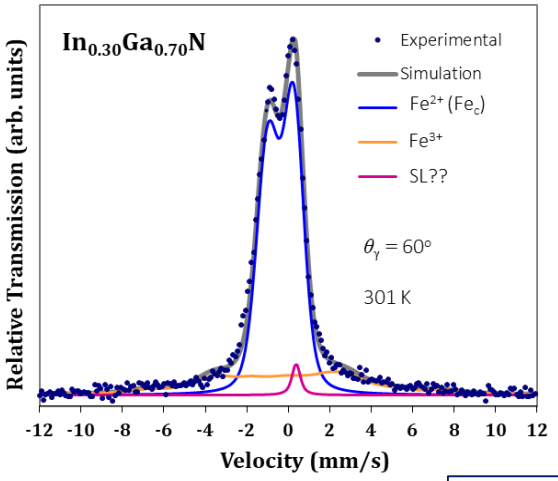
InN and GaN → $In_xGa_{1-x}N$

…development SL as a function of *x*



eMS June 2017 – preliminary analysis [IS630]



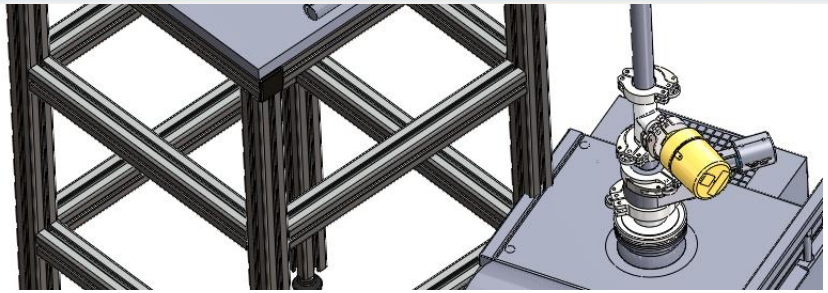


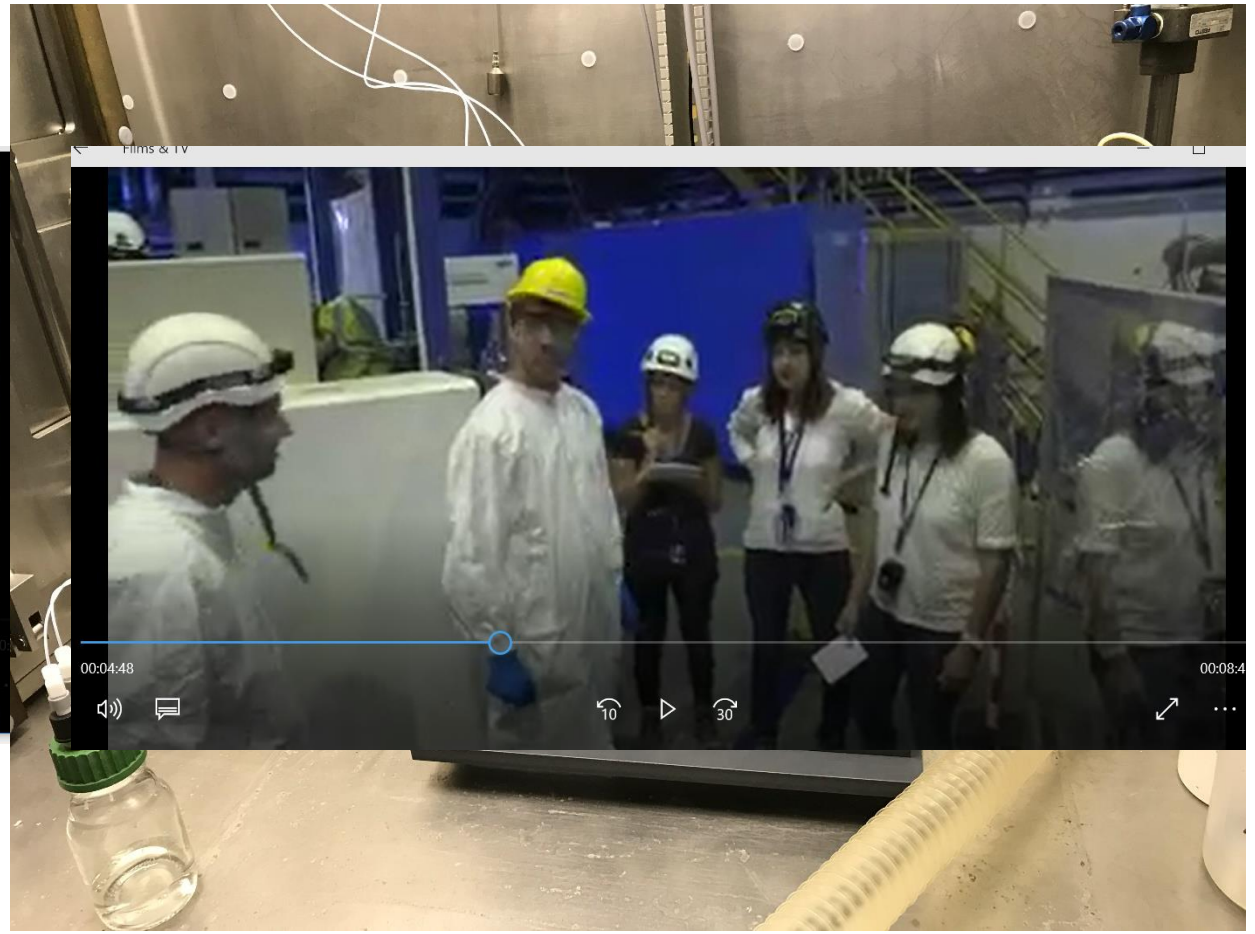
- Decrease in Fe^{3+} with increasing *x*
- Development of a SL?? – possibility of *p*-type doping without Mn
  …data analysis of temperature series underway

InN
- Fe_X
- Fe_Y

…further measurement on higher In concentration planned for 2018

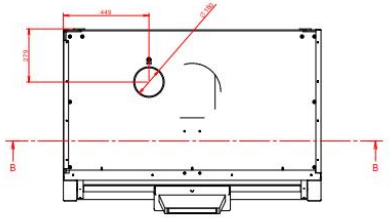
IS528: new collection chamber and separation system

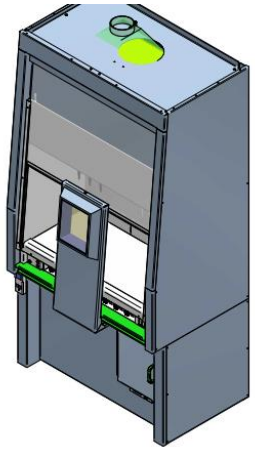


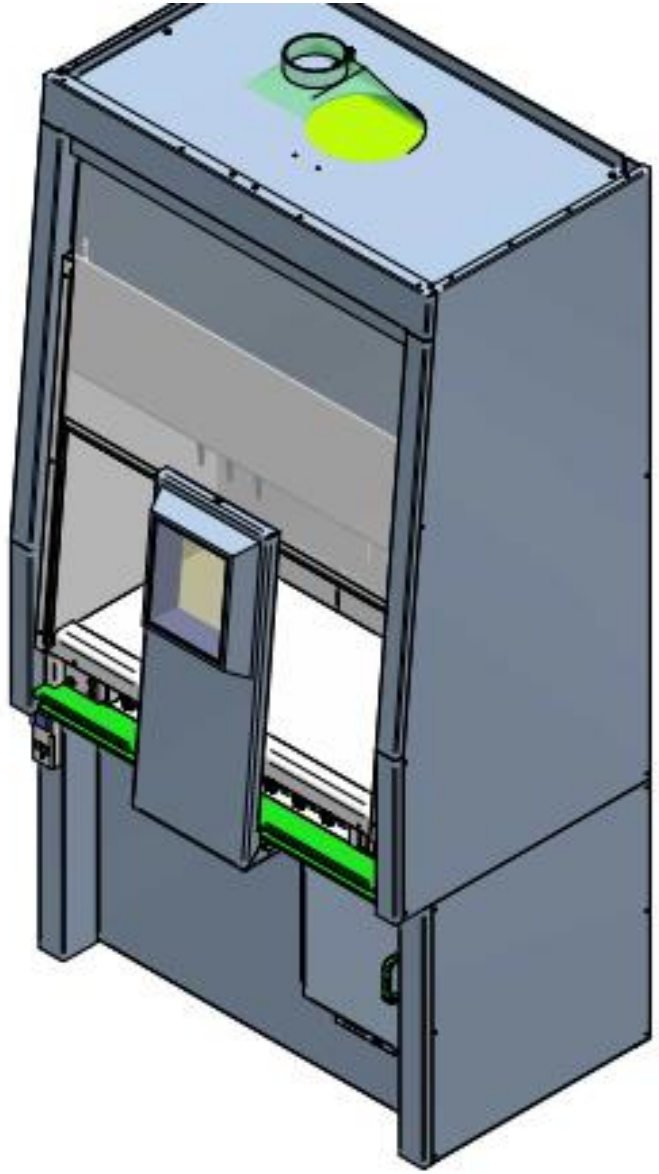


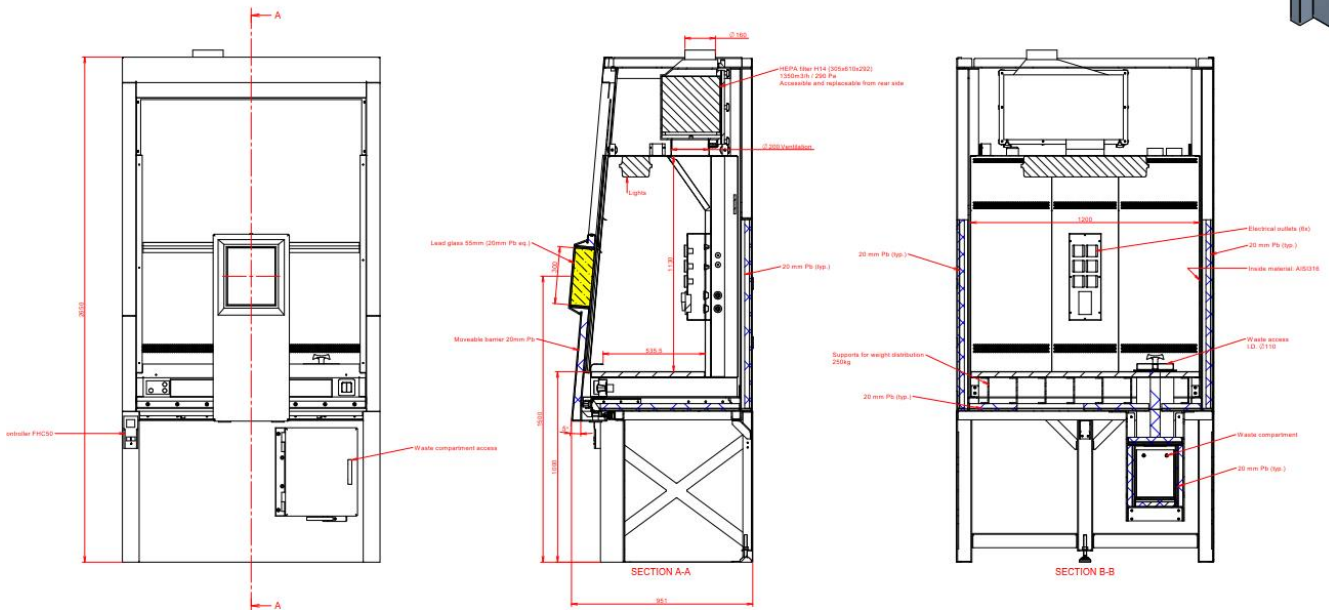
Ergonomy around GLM/GHM area

New working group to optimise the space. New shielded fume cupboard ordered (paid by EP)

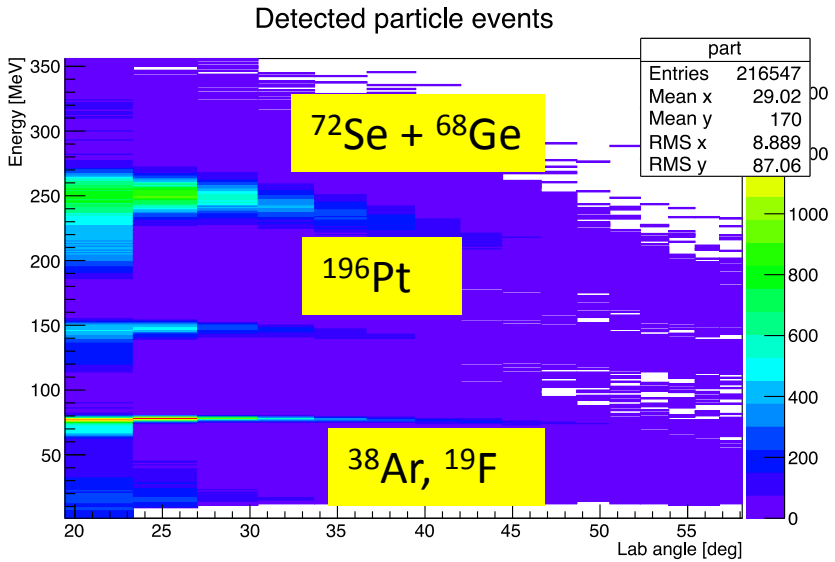


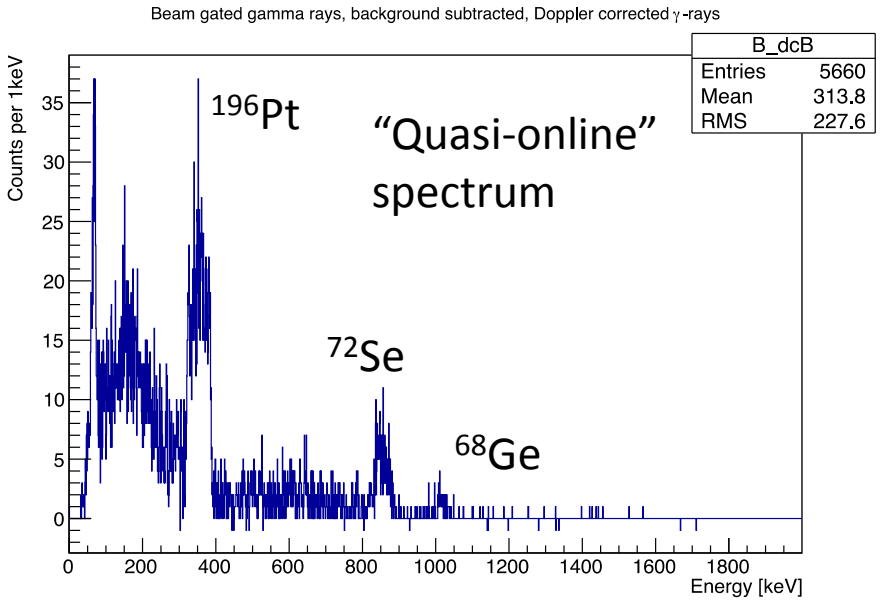


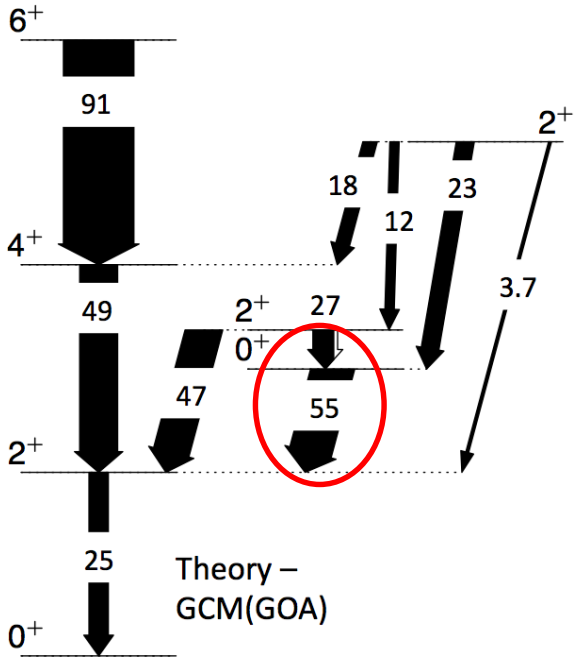


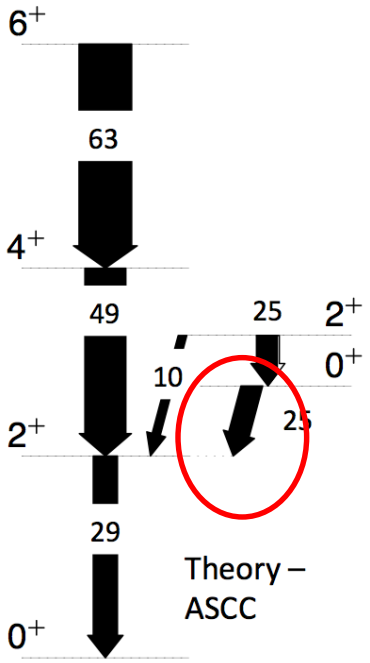


^{72}Se Coulomb Excitation (IS597)









~5% of requested ^{72}Se delivered to Miniball but some evidence that we observe the critical transition from the excited 0^+ state.

- 1st information about coexisting shapes
- Analysis still preliminary

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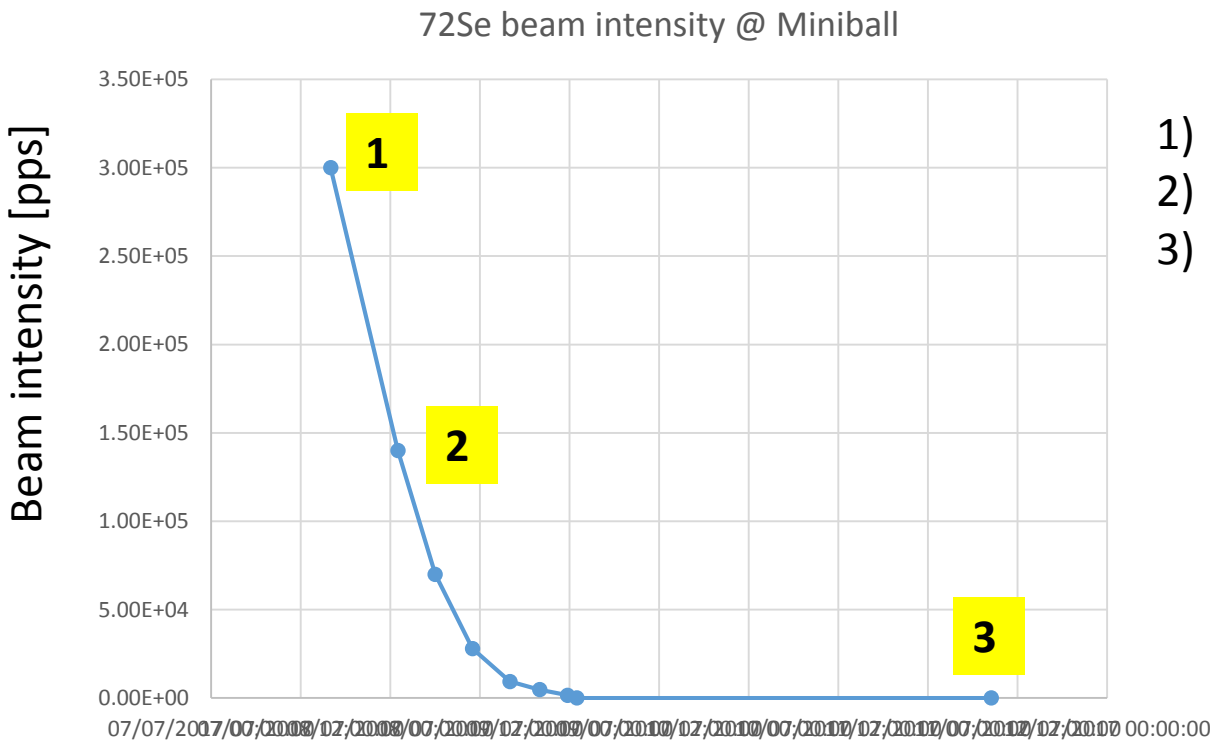
Beam and Target



1) Prior to us taking beam
2) First ~1 hour of running
3) End of the run (Tues 8am)

- Molecular extraction of $^{72}SeCO$
- Used a VADIS ion source (molybdenum) rather than a FEBIAD (carbon) one.

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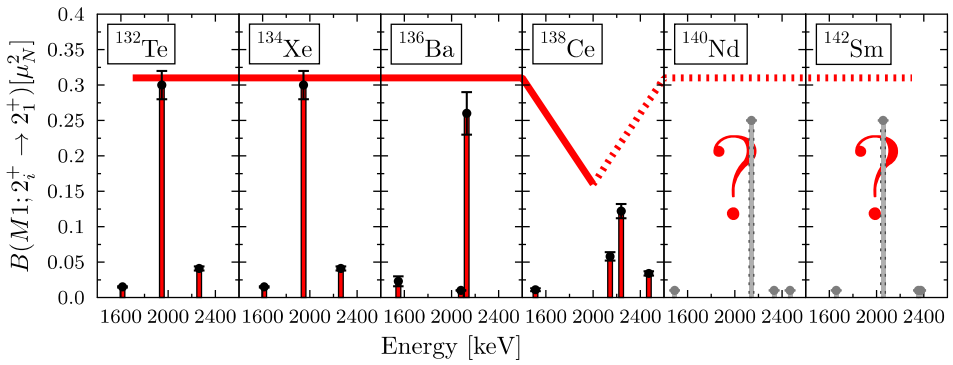
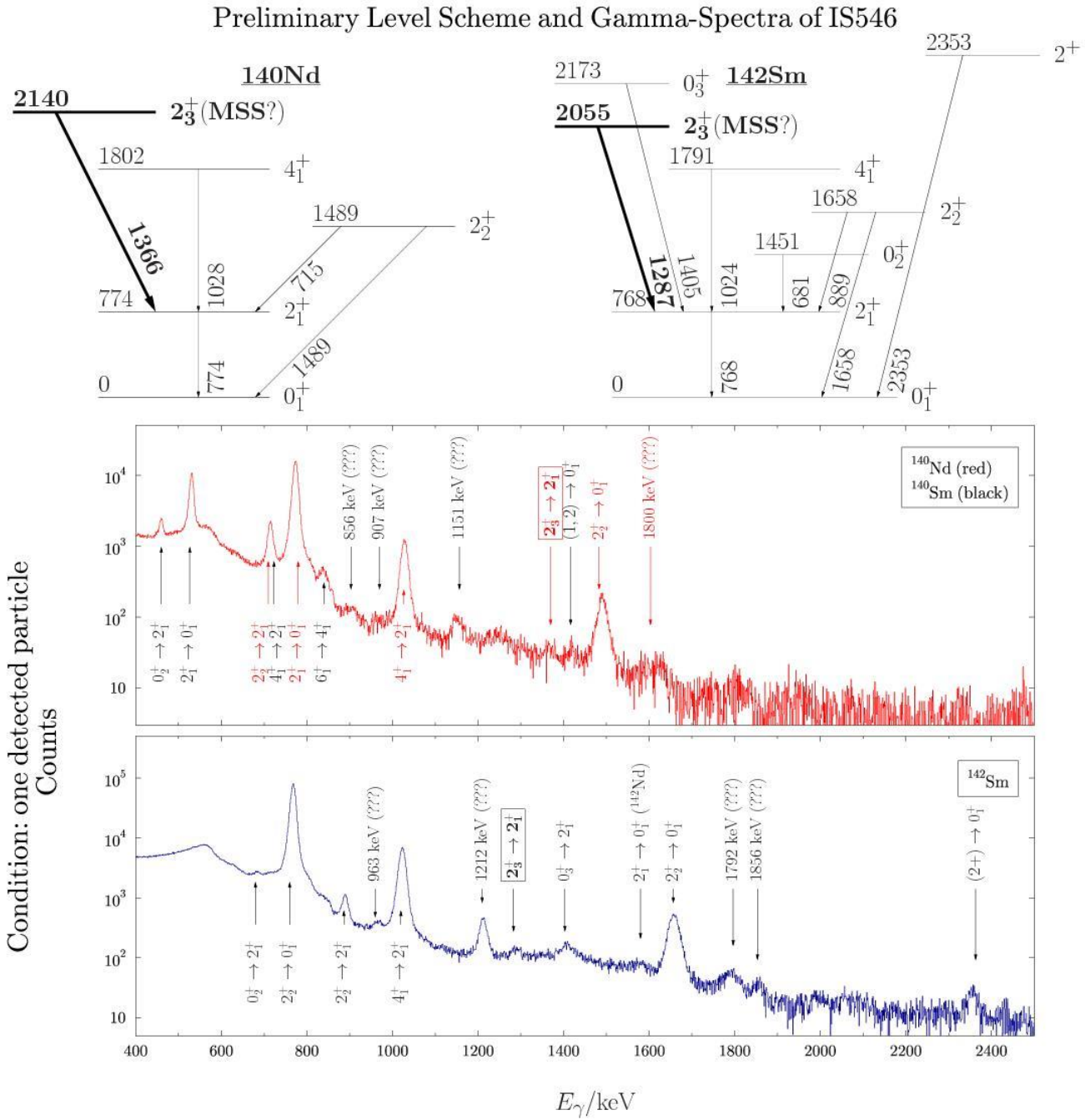
IS546



What is the predictive power?

- QPM: single 2^+ MSS of ^{140}Nd
- SM: fragmented 2^+ MSS of ^{140}Nd

Need to identify and quantitatively study MSSs of ^{140}Nd and ^{142}Sm

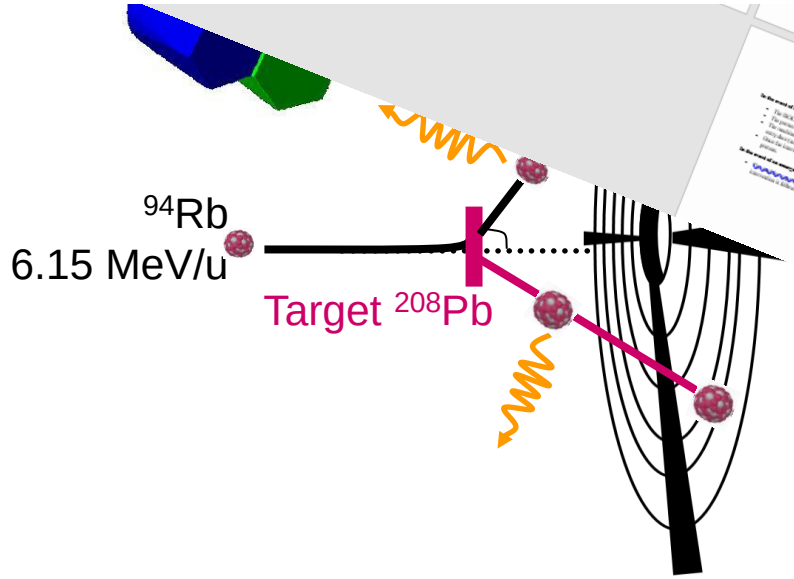


IS572 – Multi Nucleon Transfer Experiment @ MINIBALL

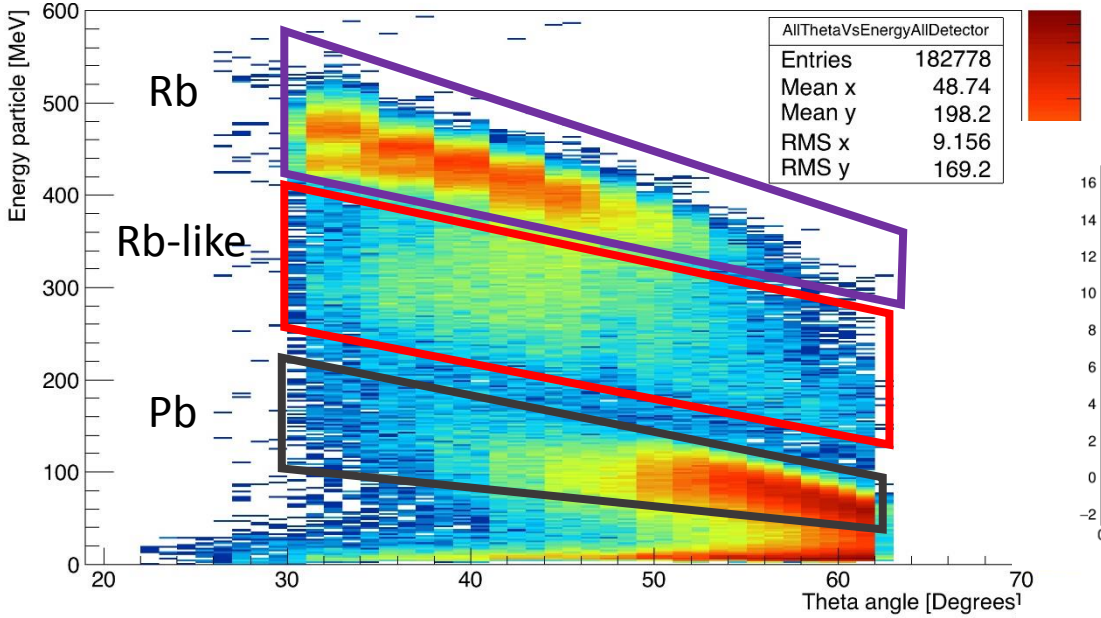
Problems during the run:

- Low beam intensity (> factor 10).
- Some technical problems after the TechStop.

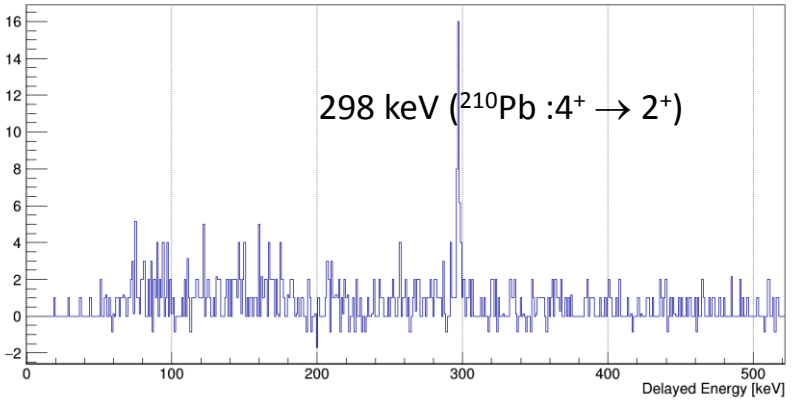
Patrol procedure to be defined at upcoming CSAP



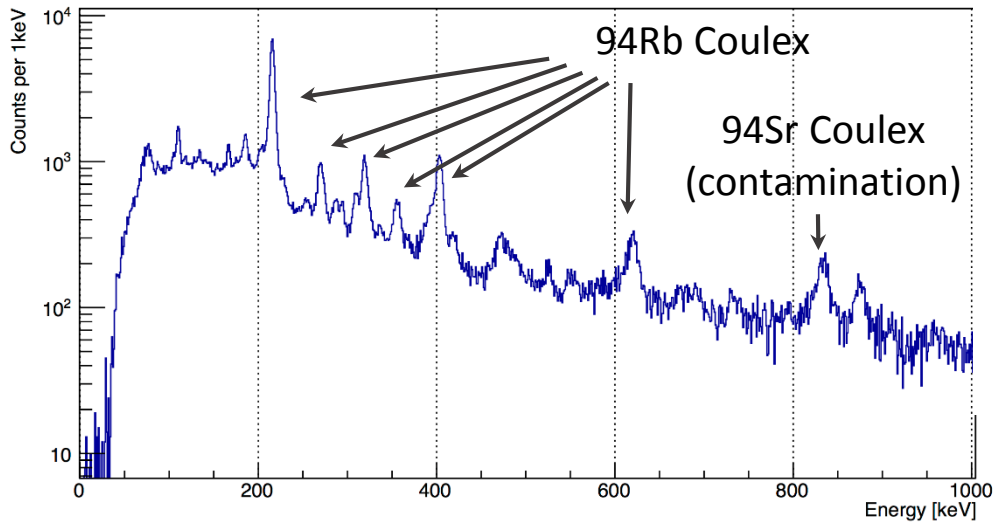
IS572 – Multi Nucleon Transfer Experiment @ MINIBALL



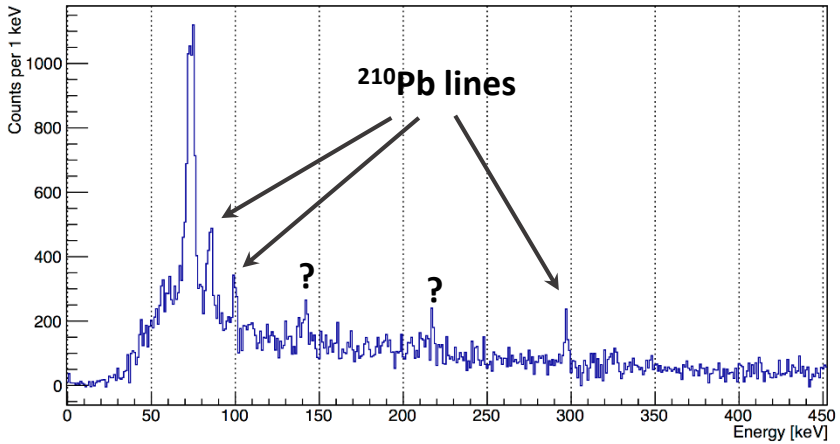
Gate in 799 keV (^{210}Pb :$2^+ \rightarrow 0^+$)

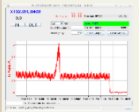


Beam gated gamma rays, background subtracted, Doppler corrected γ-rays



Delayed minus random

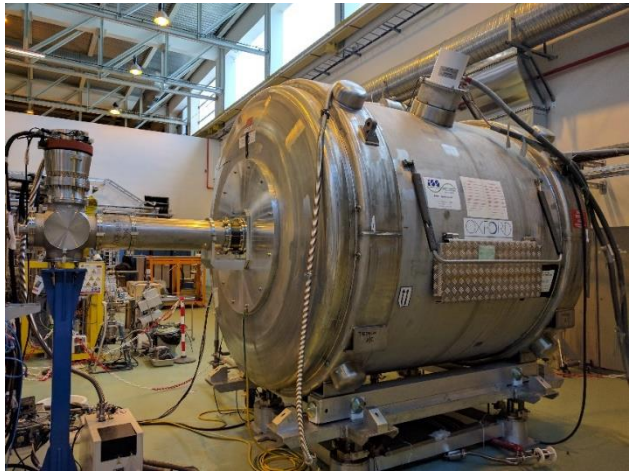


	/FW/OP  name: 20171102210822.png desc:
21:40	First 206Pb46+ to Miniball  name: 20171102214022.png desc:
22:15	Icoll=203 mA, Igun=990-1000 uA, Ugun=-3800 V, Uanode=300 V, 2.8E-10 mbar O2 injected. /FW
22:36	Tried to optimize the RF frequency of the REX-TRAP. The current setting (227.8 kHz) seems to be the optimum. /MLB/JAR
22:41	XT01.BFC.900 zero-error: 0.025 40Ar9+ after correcting for zero-error: 0.45 epA = 0.3E6 pps Total current (206Hg46+ and 206Pb46+): 16 epA = 2.1E6 pps /JAR/MLB/EF
03:38	LHC took two pulses for about 15 minutes at 3am. Lost about 10% of proton current, increased target heating from 251 A to 275 A and this worked well - the target temperature stayed around 475 K. From our rough rate calculations we didn't lose a significant amount of mercury during this time. /TB /NL /LPG

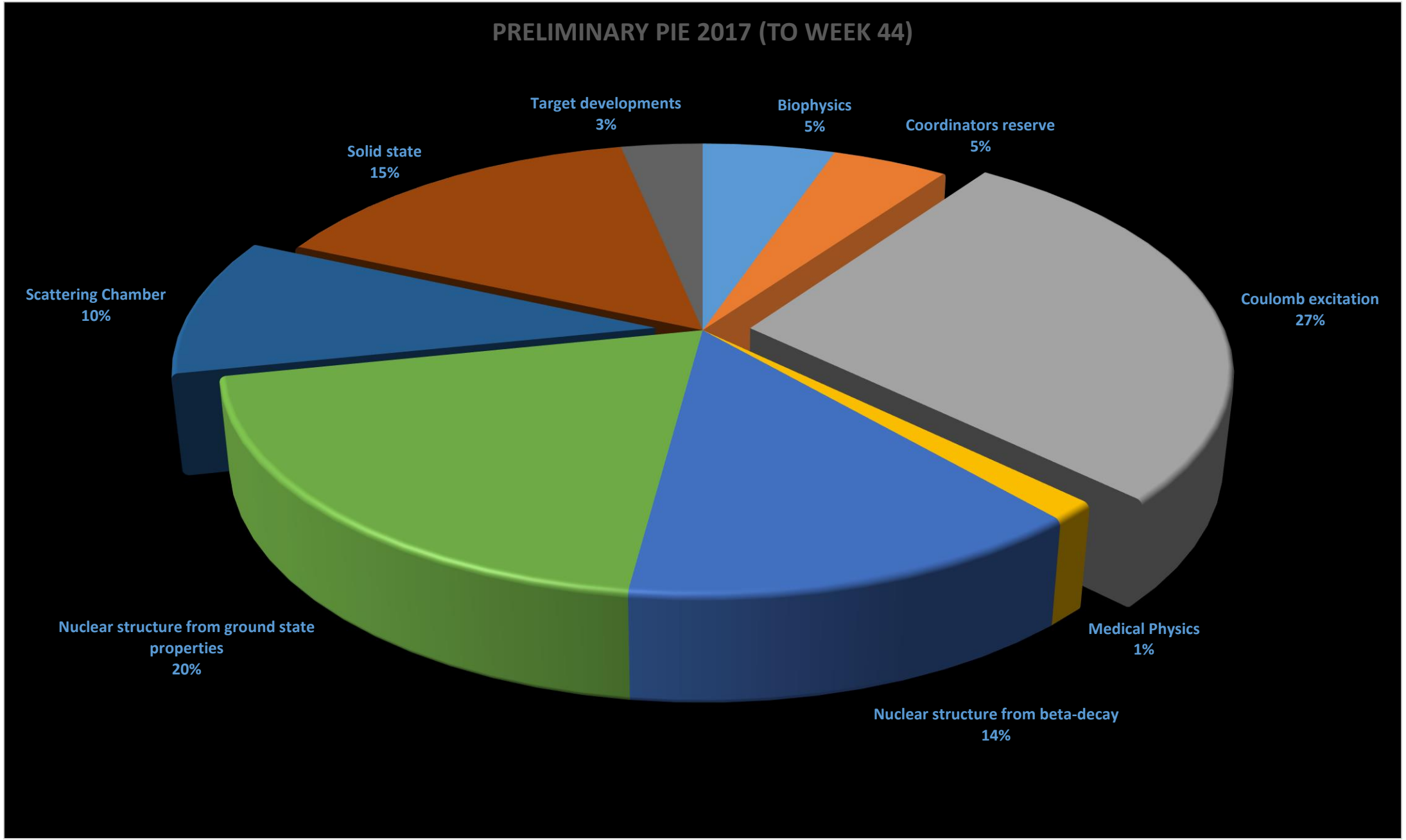
FAULTS

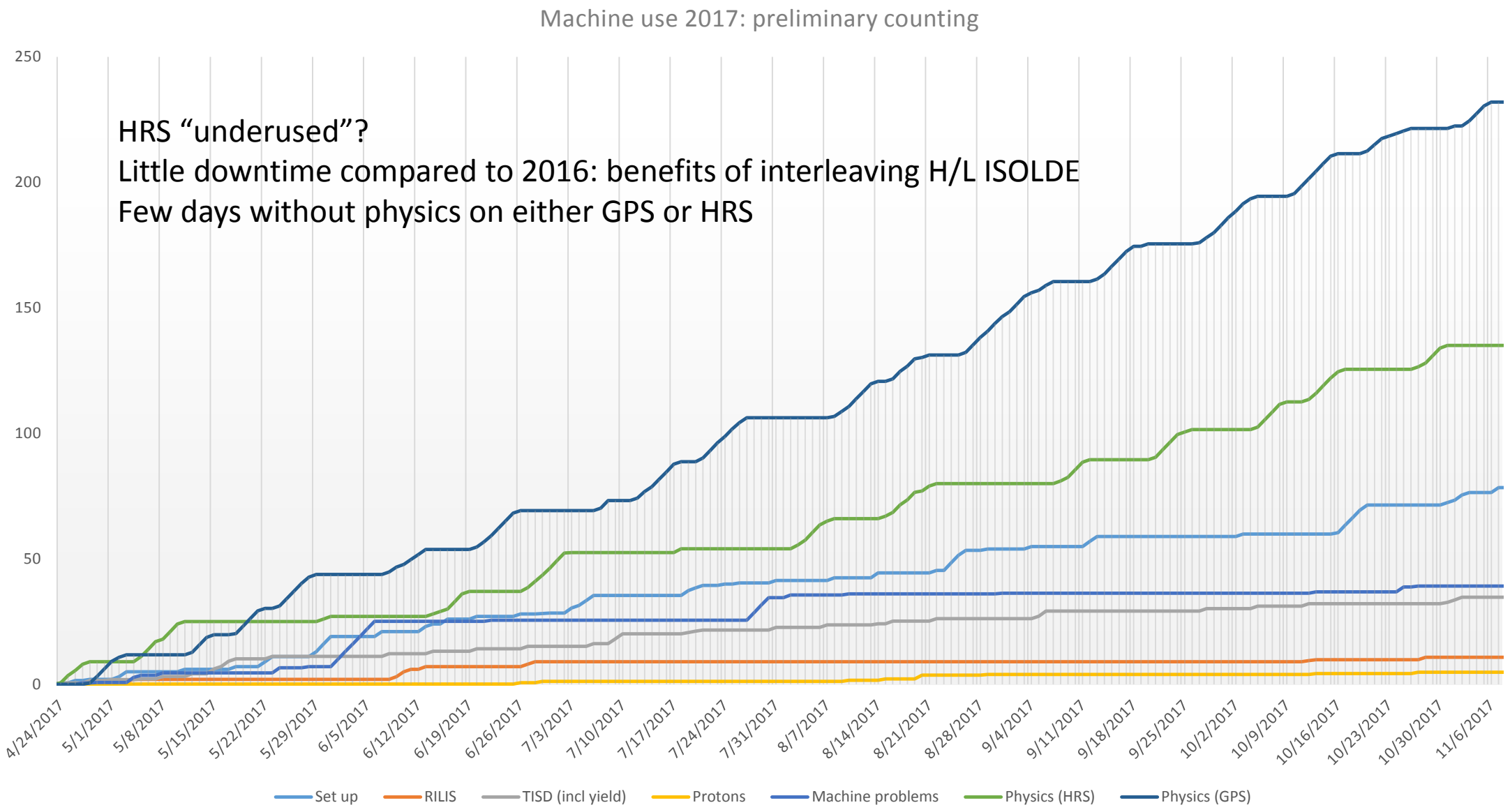
#	Group	Fault	Element	Description	Begin	End	Duration
1	Radio Frequency > Hardware	VOID	IH	Not Specified	2017-11-02 07:11:30	2017-11-02 07:25:00	0:13:30

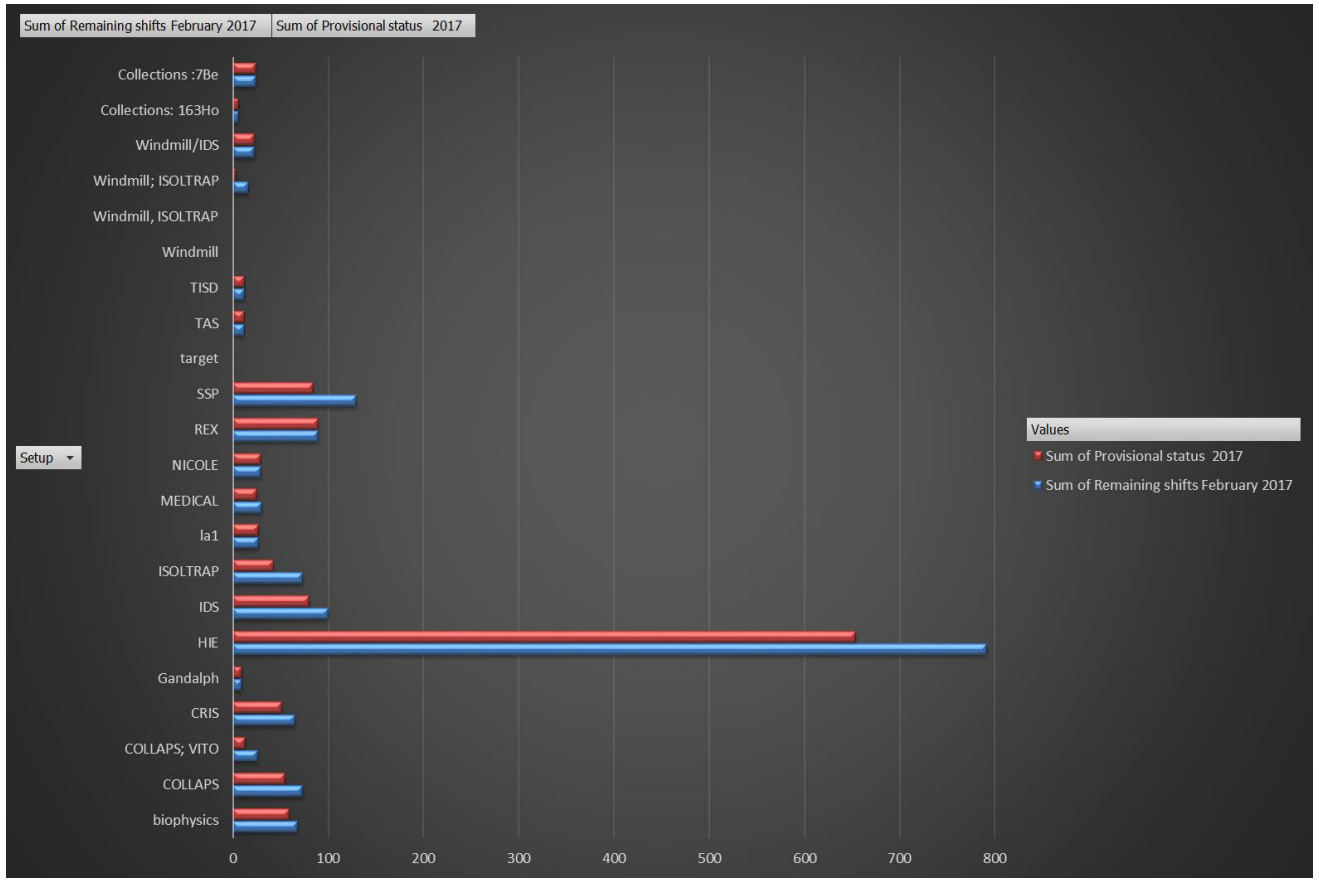
ISS: tests in week 49



Also, successful re-energising of the WISARD magnet to 9T… stable beams in 2018


PRELIMINARY PIE 2017 (TO WEEK 44)
Target developments
3%
Biophysics
5%
Coordinators reserve
5%
Solid state
15%
Scattering Chamber
10%
Coulomb excitation
27%
Nuclear structure from ground state properties
20%
Medical Physics
1%
Nuclear structure from beta-decay
14%


Machine use 2017: preliminary counting
HRS “underused”?
Little downtime compared to 2016: benefits of interleaving H/L ISOLDE
Few days without physics on either GPS or HRS
250
200
150
100
50
0
4/24/2017
5/1/2017
5/8/2017
5/15/2017
5/22/2017
5/29/2017
6/5/2017
6/12/2017
6/19/2017
6/26/2017
7/3/2017
7/10/2017
7/17/2017
7/24/2017
7/31/2017
8/7/2017
8/14/2017
8/21/2017
8/28/2017
9/4/2017
9/11/2017
9/18/2017
9/25/2017
10/2/2017
10/9/2017
10/16/2017
10/23/2017
10/30/2017
11/6/2017
Set up
RILIS
TISD (incl yield)
Protons
Machine problems
Physics (HRS)
Physics (GPS)



Row Labels	Sum of Delivered shifts
Biophysics	19.5
Coordinators reserve	17
Coulomb excitation	102
Medical Physics	5
Nuclear structure from beta-decay	50
Nuclear structure from ground state properties	73
Scattering Chamber	37
Solid state	56
Target developments	12
Grand Total	**371.5**

HIE	Sum of Remaining shifts February 2017	Sum of Provisional status 2017
biophysics	68	58.5
COLLAPS	73	55
COLLAPS; VITO	26	13
CRIS	65	51.5
Gandalph	9	9
HIE	791.5	654
IDS	100	80
ISOLTRAP	73	42
la1	27	27
MEDICAL	30	25
NICOLE	29	29
REX	89	89
SSP	129.5	84
target	0	0
TAS	11.5	11.5
TISD	12	12
Windmill	0	0
Windmill, ISOLTRAP	0	0
Windmill; ISOLTRAP	16	3
Windmill/IDS	22.5	22.5
Collections: 163Ho	6	6
Collections :7Be	24	24
Grand Total	**1602**	**1296**

Safety and training etc

Required training for **ISOHALL**

Online:

- Safety at CERN
- RP supervised (changed since last year)
- Basic electrical awareness

Hands-on:

- Electrical awareness
- RP hands-on → going to be linked in December

Every Tuesday @ 1300 – 1700), training centre Prevessin.

External trainer: Recent cancellations have been a problem. Meeting soon to discuss this.

2018

Beam requests sent out just after Christmas

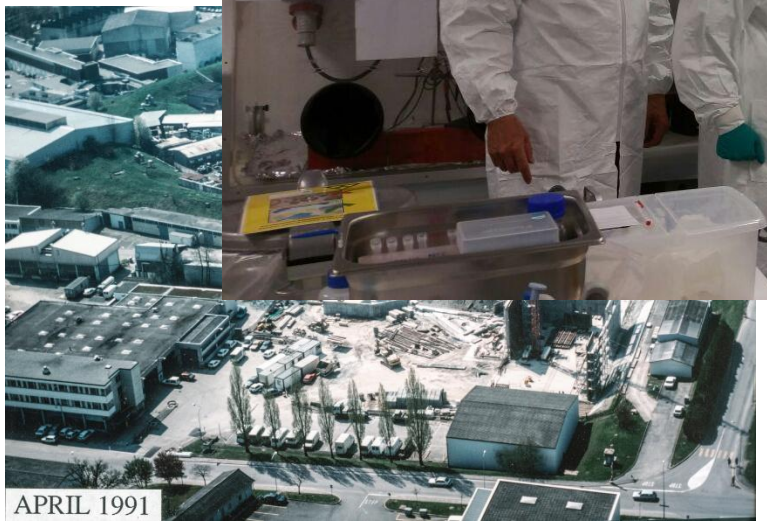
Protons from ~ Easter/end of March

HIE ISOLDE from ~ end of June

4 cryomodules: transfer reactions

Continue with interleaving low and high…

Oct 16th 2017: 50 years of beams at ISOLDE



1975


SOCAR
ivatech