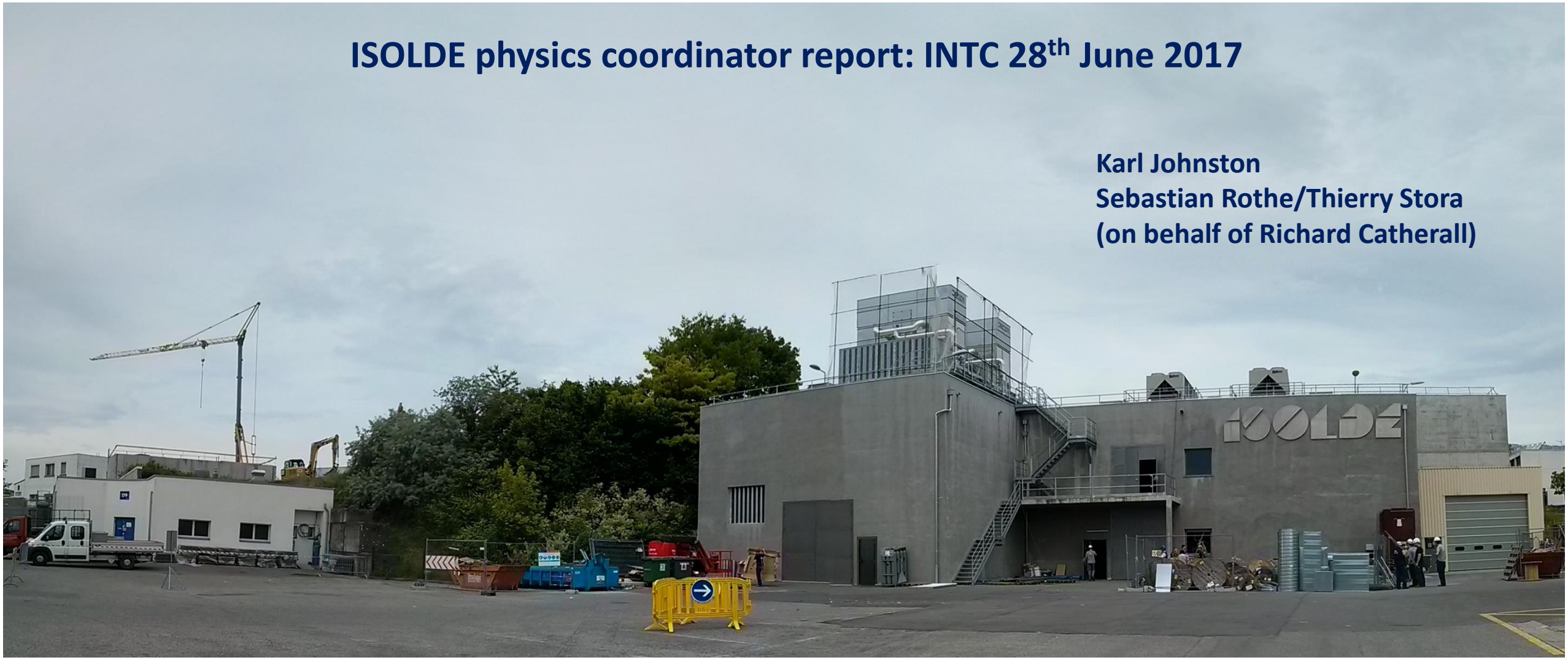
ISOLDE physics coordinator report: INTC 28th June 2017

Karl Johnston
Sebastian Rothe/Thierry Stora
(on behalf of Richard Catherall)



- Technical developments/MEDICIS
- Planning for 2017
- Schedule so far: preparation for HIE-ISOLDE
- Safety/collections

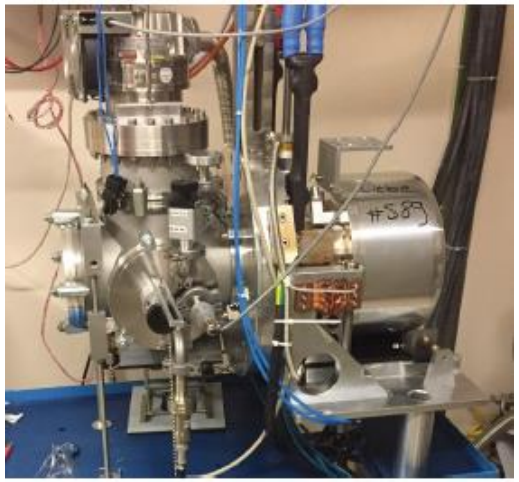
Nanolab

Option 1

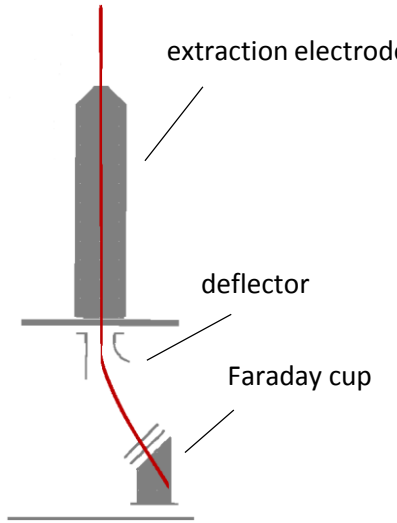
Option 2

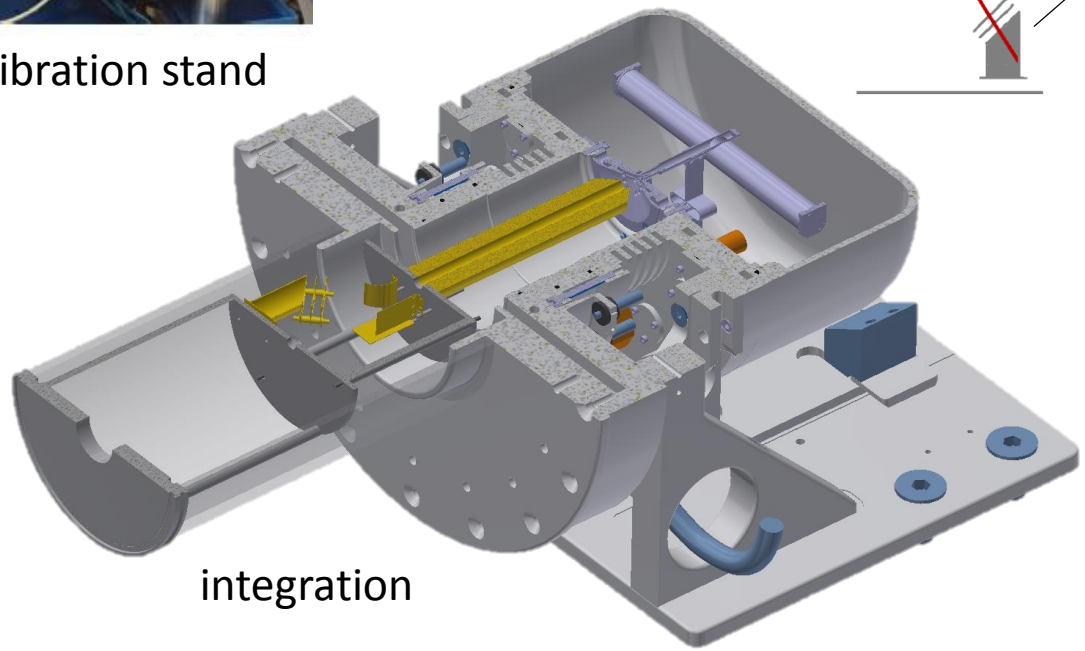
- Funding secured for dedicated nanolab for production of nanostructured materials (including actinides)
- Connection of ventilation foreseen in 2019

Dedicated test stand for ion source development



ISOLDE calibration stand





integration

Main features:

- ion beam extraction and detection
- residual gas analyzer (RGA)
- automated control and data recording

First application:

- **negative ion source development**
- investigation of source poisoning and regeneration

Future plans:

- long-term performance studies
- thermal stress tests
- destructive tests -> operational limits & failure mode analysis

David Leimbach

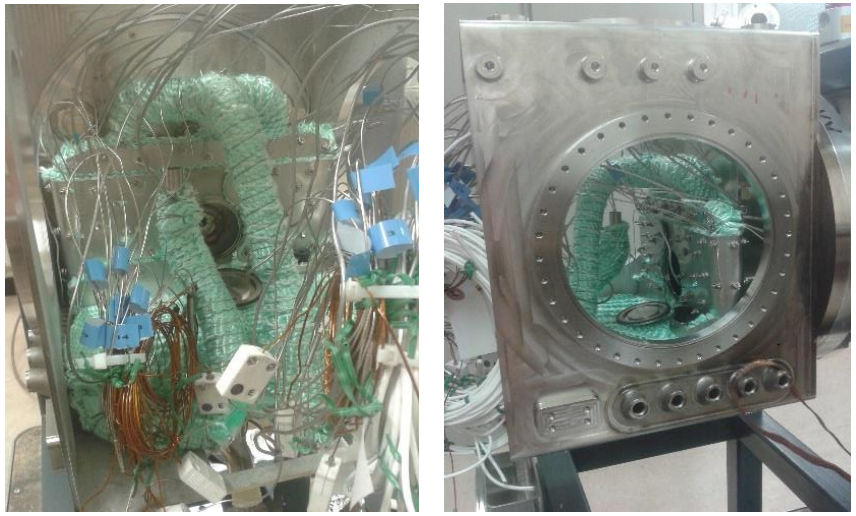
LIEBE Project

Present activities	Description	Schedule
HEX test	Experimentally confirm the power extracted by the heat exchanger.	Under preparation, starting 2nd week of July
Diffusion chamber vacuum test	Te en ch	
Pump vibration tests at IPUL		Ongoing: finishing by end of July

Offline tests starting mid-August

LIEBE target ready to go online mid-November

Image of the installation to test the HEX



Actual state of the LIEBE target ongoing vacuum tests

Slide curtesy of Ferran Boix Pamies

Dedicated oven for CaO production

Target unit building

Material production

→ Glove's box for material transfer into unit (very sensitive to CO2 and H2O) → Calibration Target + Ion Source → Offline tests → ISOLDE

$CaCO_3 \rightarrow CaO + CO_2$ About a week to produce material in pump stand

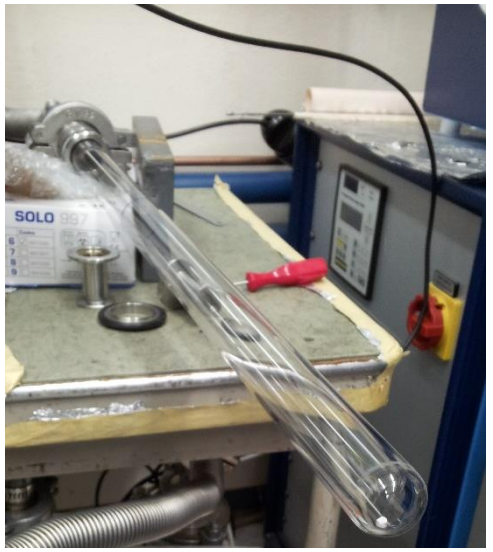
Current issues:

- Thermocouple positioning difficult (can't trust readout)
  - Use pyrometer but readout is difficult in the 700 – 800 °C range
- Thermal gradient in the container makes process much longer than should
- CaO production unit difficult to handle in gloves box

- Precise control of temperature
- Temperature uniformity

Higher quality CaO

- Quartz tube easy to handle in glovesbox
- Production will be reduced to half-day.



J.P. Ramos, et al.

The facility today and the remaining Work Packages

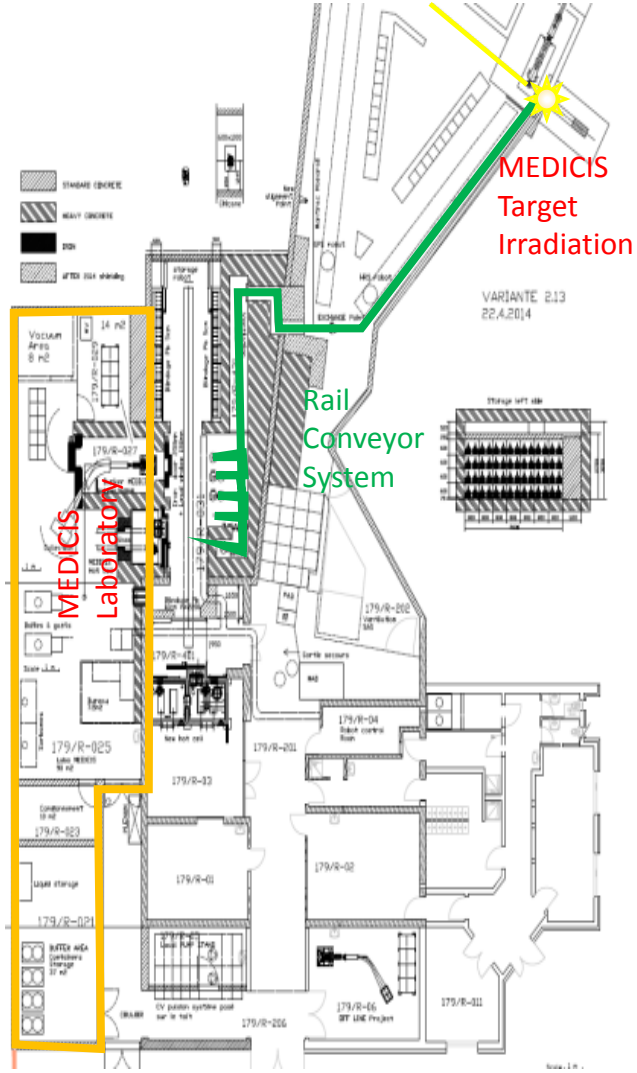
Groundbreaking ceremony
3rd September 2013

Building reception
15th October 2014

Installation of beamline and laboratory:
ongoing

Commissioning & start-up end 2017 *

**Pending budget, management and safety clearance*



Some MEDICIS milestones

Ventilation and cooling

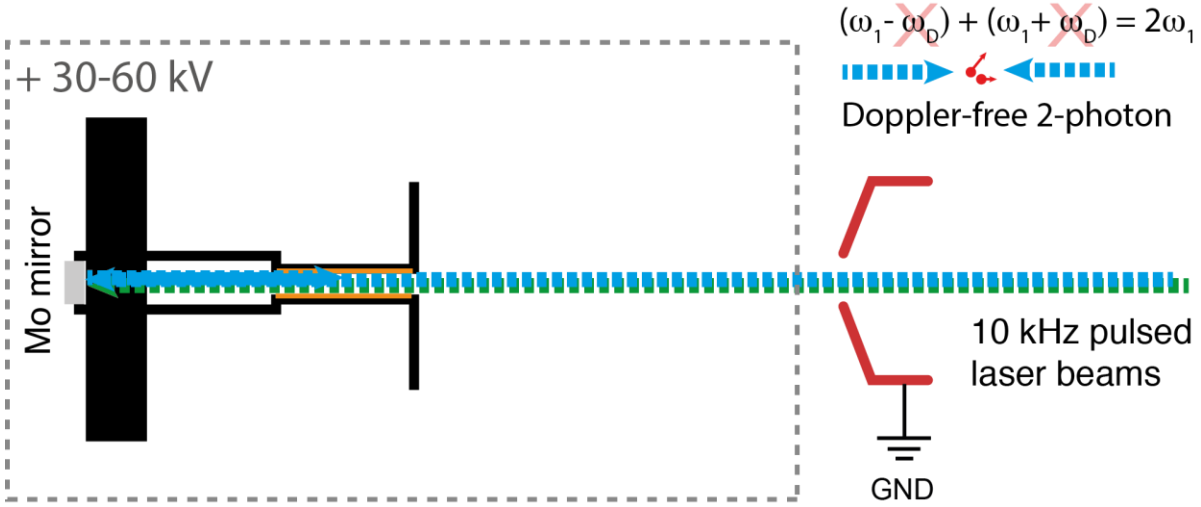
Magnet from Leuven refurbished

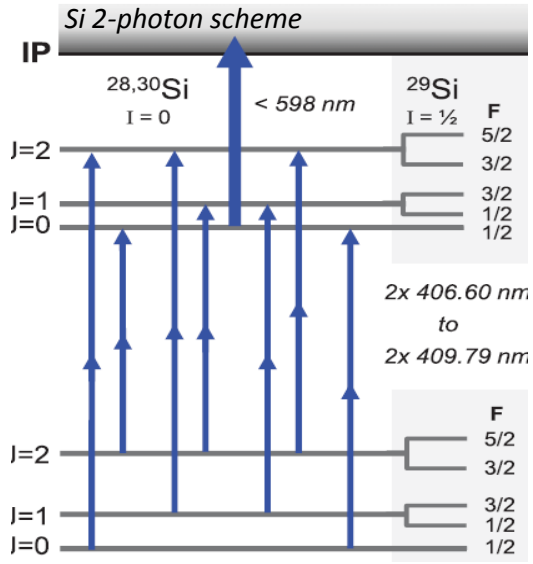
Personal Protection System (PPS):
Commissioned last week

Remote handling : Robot + Rail Conveyor

		/MLB
14:48	UNSEL	Target #596 removed from the HRS Front End. Target #597 installed on the HRS Front End. Thanks to all no access in the target area as the target as been delivered from MEDICIS by the MONTRAC /JLG/CM/GL/AM

Towards high resolution 2-photon spectroscopy





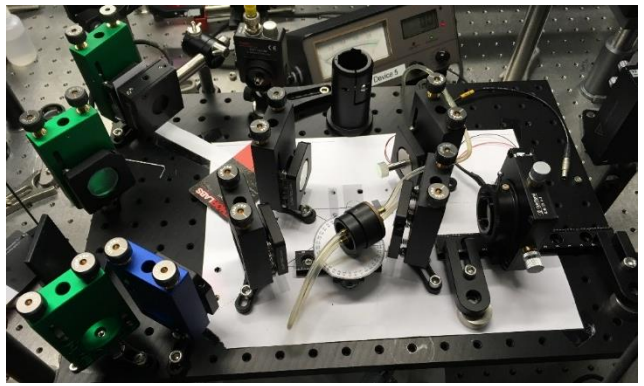
Status:

- Feasibility demonstrated in Mainz for Rb
- First broadband tests at ISOLDE:

  1 and 2-photon schemes demonstrated

  - Seeded NB TiSa cavity constructed and under further development
  - Target unit was successfully operated with Mo ‘mirror’ installed at the back of the transfer line.

New TiSa bow-tie (ring) cavity for high resolution

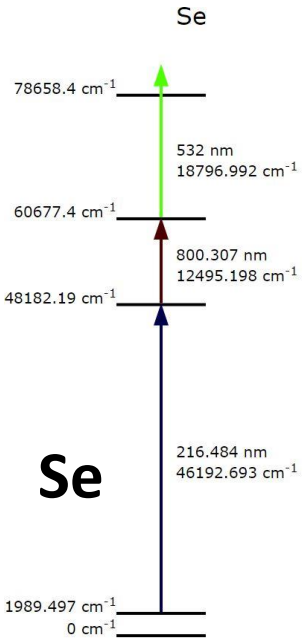


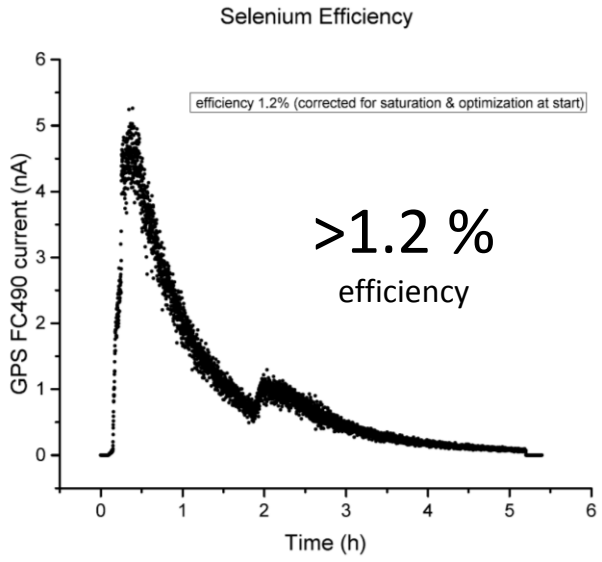
Kati Chrysalidis – PhD work

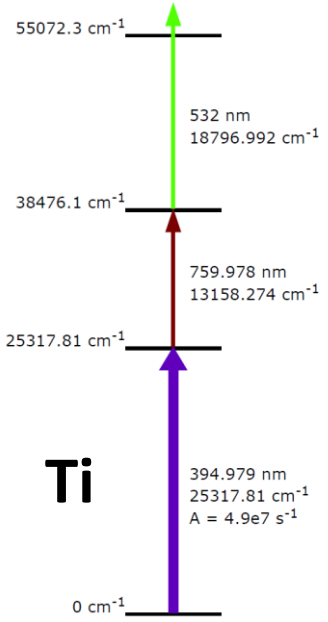
Scheme development 2017 (so far)

Selenium: first laser ionized Se at ISOLDE
→ Yield tests will be done during HIE-ISOLDE period

Titanium: new scheme tested successfully on stable Ti
→UCx was not ideal target material for radioisotope production
→ More tests with other foil target to follow







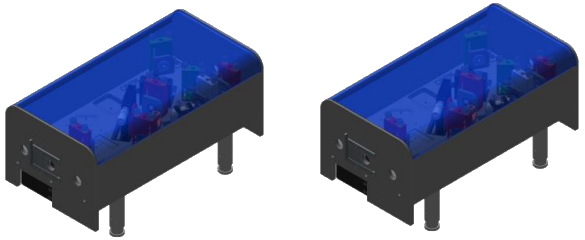
Kati Chrysalidis – PhD work

RILIS hardware consolidation and upgrades

ONLINE

Consolidation budget from EN-Dept:
280 kCHF available now

- RILIS dye pump laser replacement in 2017
- Spare BLAZE laser in 2017 (delivery March)
- 2 new TiSa cavities delivered
- Pulse amplified CW lasers for PI-LIST
- Test picosecond laser for molecular breakup



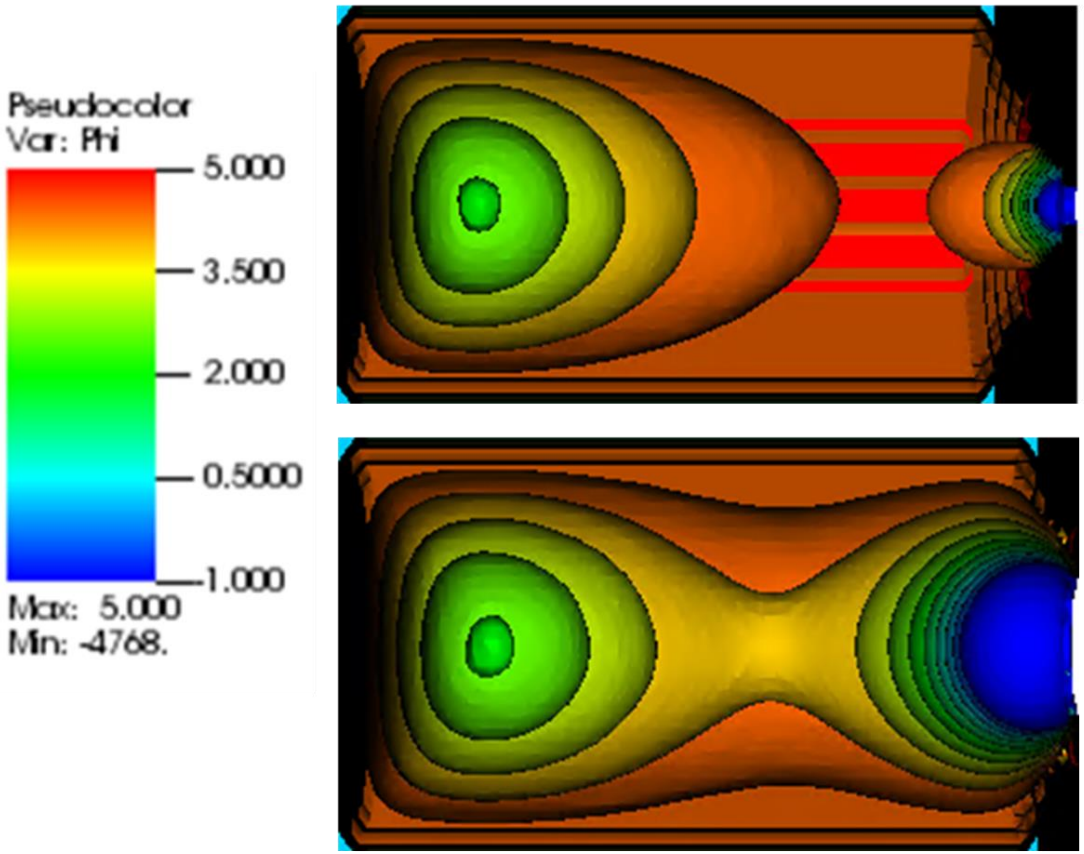
OFFLINE (+ MEDICIS)

- ~275 kCHF required to equip RILIS @offline-2
- Offline-2 can also be considered a RILIS@MEDICIS test bench

VADLIS with adjustable extraction voltage

Particle-in-cell model using VSim

Yisel Martinez– PhD work



Standard VADIS in
RILIS mode (ANODE = 5V)

Extractor = 0V

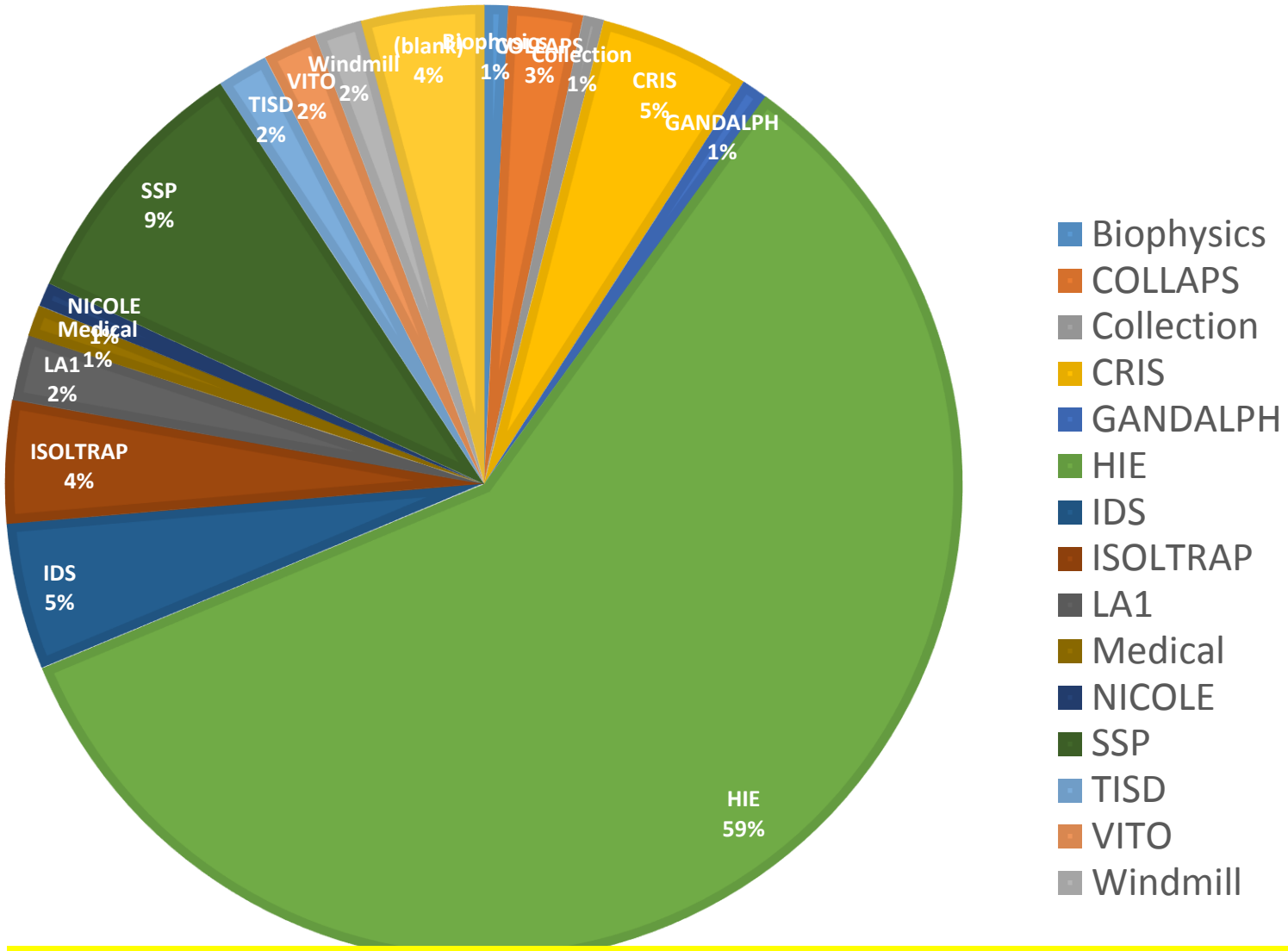
Adjustable-extraction VADIS
RILIS mode (ANODE = 5V)

Extractor = -150V

Several Ga RILIS tests have been performed at OFFLINE 1

Significant improvement in VADIS and VADLIS performance

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 17 - 36

GPS	April			May					June				July					August				
Week	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Monday	10	17	24	1	8	15	# 513 MWNC 22	29	5	IS576 IS578 IS580 IS611 IS612 IS492 12	19	26	3	10	17	24	31	7	Sn VD5 14	#610 CaO 21	28	Ta - Ta 4
Tuesday				(IS611)									setting	Test colls	#607 UC Ta	142Ba						IS528* IS638
Wednesday		SEMgrid				#599 Ti foils		Tech stop					Te									Jeûne
Thursday							Ascension		IS576										IS514		XT03	
Friday	Easter	#595 UC - n		#575 UC - CP		IS453		# 601 UC - n	IS578	#603 UC - n	(Windmill)	#605 ZrO2 -HP	IS597 72Se @ 4.4MeV/u (IS626)	IS569 70Se @ 5.5MeV/u (IS612)	Set for 4.1MeV/u	IS553: 144Ba @ 4.1MeV/u	#608 Ta - GdB6	IS558 140Sm @ 4.65MeV/u	IS585 IS611 IS636 IS638 IS640	IS619 15C @ 4.3 MeV/u	IS619 15C @ 4.3 MeV/u	
Saturday	Easter					IS634			IS580		IS608				Stable tests if not ready for protons							
Sunday	Easter		IS632		IS490		IS633		IS630													
			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

Good runs for:

- I
- V
- C
- S
- V

- ~ 100 shifts delivered so far
- Need to check earlier re-used targets, allocate time in cold check-out.
- New control room can lead to distance from machine…

*IS528: pending safety clearance

HRS																						
Week	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Monday		17	24	1	8	15	22	29	5	12	19	26	3	10	17	24	31	7	14	21	28	4
Tuesday		#596 CaO	IS601											TISD/tape								
Wednesday						TISD	TISD	Tech stop					Tech stop		IS592 or TISD (tape)	#596 CaO						
Thursday	SEMgrid		(IS632)				Ascension															Jeûne
Friday	Easter		#597 UC - n		#597 remains		#600 UC - Ta		#602 UC - W		#604 UC q n		tbc (used)					UC (q?) CP			UC Ta	
Saturday	Easter	Stable tests for IS601		IS639				IS617		IS620		IS574					IS601		IS490			IS568
Sunday	Easter																					
			35Ar	In RILIS	In RILIS			Al RILIS		51-53K		Cd RILIS					35Ar		98Kr/48Ar			Ni RILIS

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

KJ: 27.06.17

Some RILIS issues in 2017

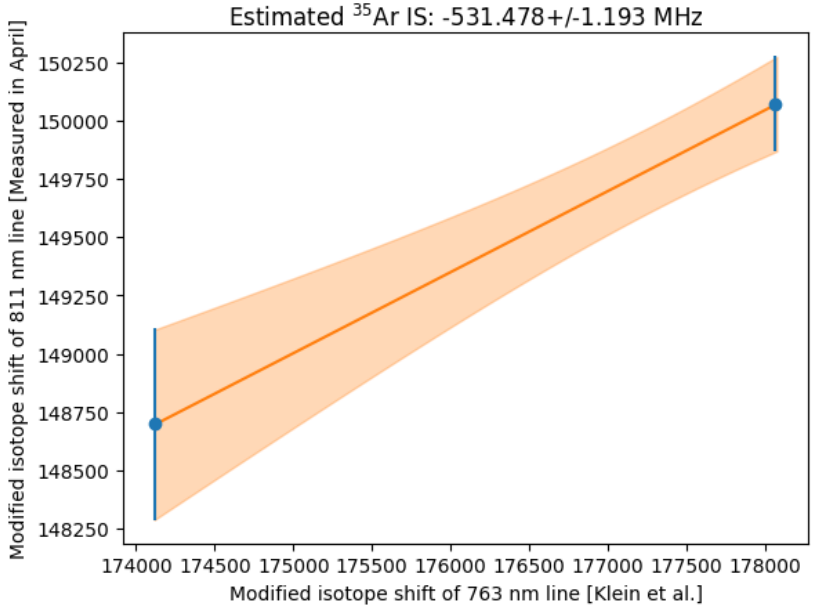
- **TiSa chiller failure:** Friday June 9th @ Midnight

  Consequence:
  Temporary loss of Tisa beam for Mn ionization
  Solution:
  Quick intervention from on-call RILIS member (Dima) who was able to replace the chiller and regain RILIS operation during the night
  A replacement pump for the chiller will be installed in July

- **RILIS air conditioning failure**

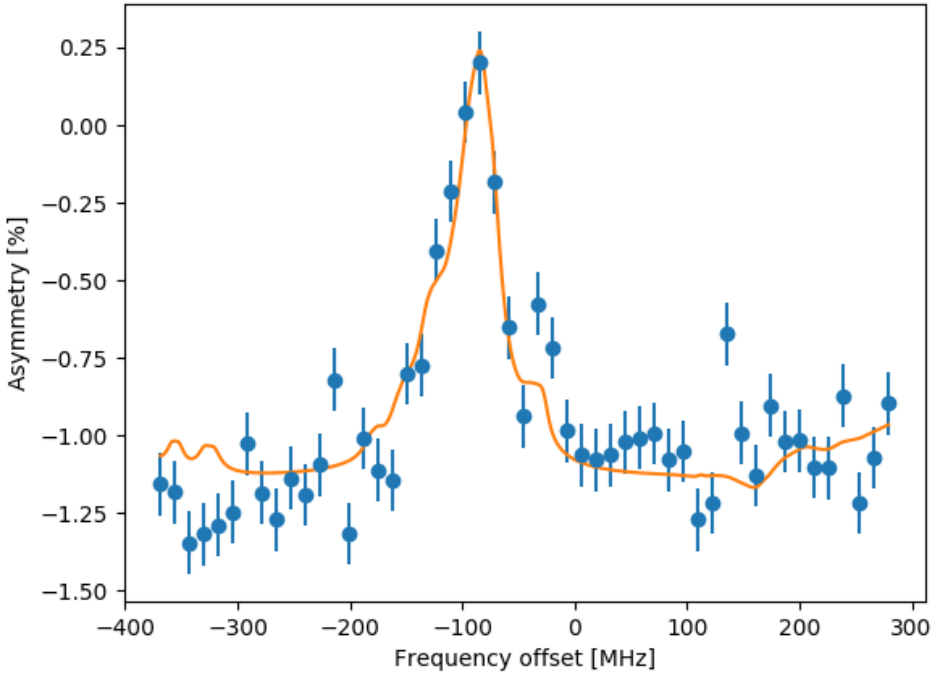
  Consequence:
  Extremely difficult to maintain stable RILIS conditions during the Mn/In run in June
  Solution:
  RILIS team provided round-the-clock on-site assistance during the weekend of 10 June
  Technical operation team repaired the Air conditioning system during the weekend.

First run on ^{35}Ar at laser polarization beamline



Final aim of the experiment:
measure beta decay asymmetry parameter of 35Ar mirror decay using spin polarized beam
-> determine Fermi to Gamow-Teller ratio
-> contribute to determination of Vud CKM matrix element

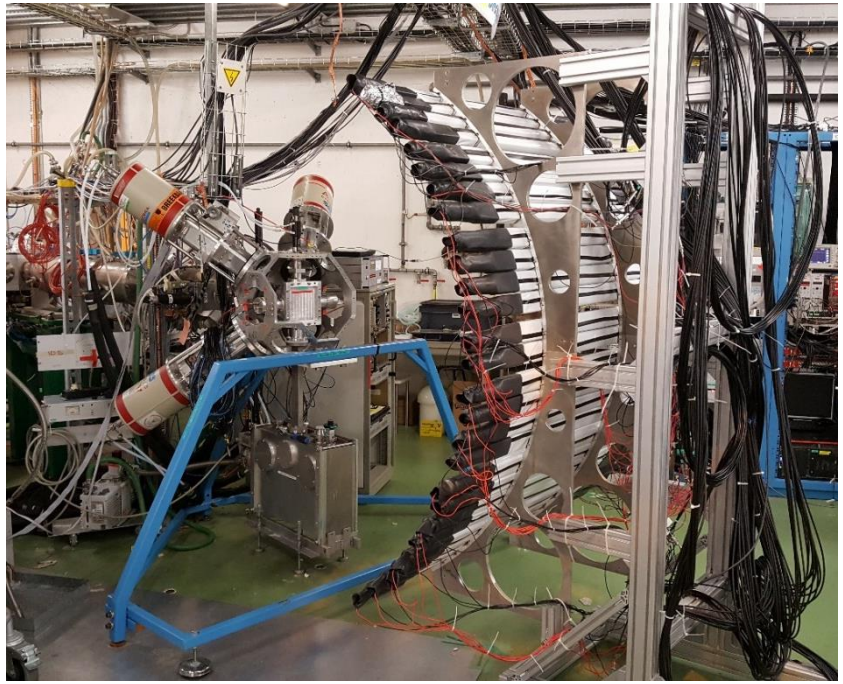
- **Aim of May beamtime**: identify host material with longest relaxation time for final experiment
- **Stable beam**: bunched beam laser spectroscopy on ^{36,40}Ar
- **Radioactive beam**: β-asymmetry scans, relaxation time and decoupling curve measurements for several crystals

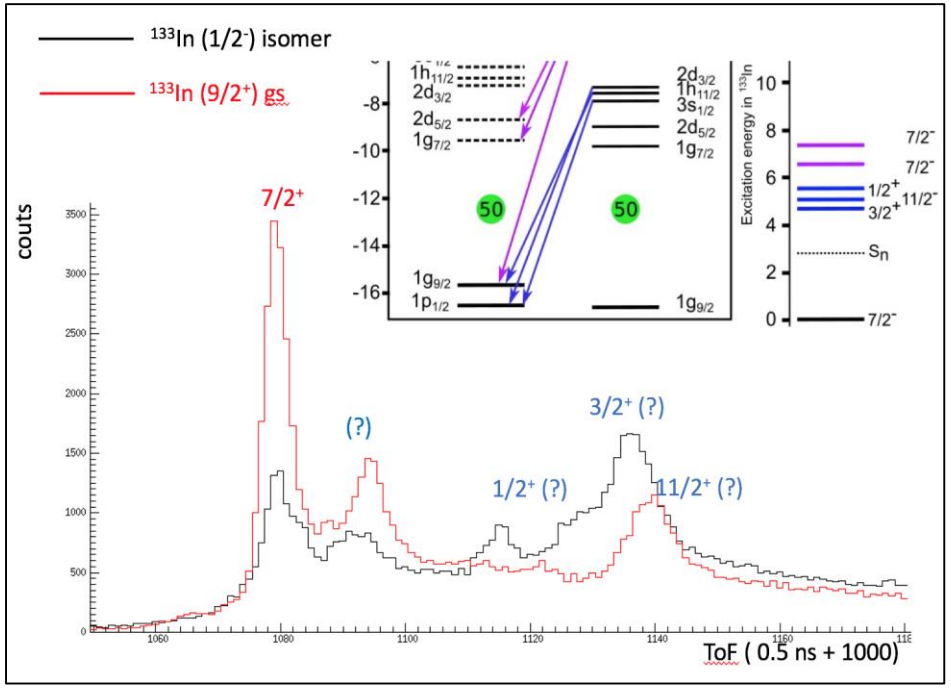


IS632 at IDS: Neutron unbound single particle states in ^{133}Sn from the beta decay of ^{133}In

- 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

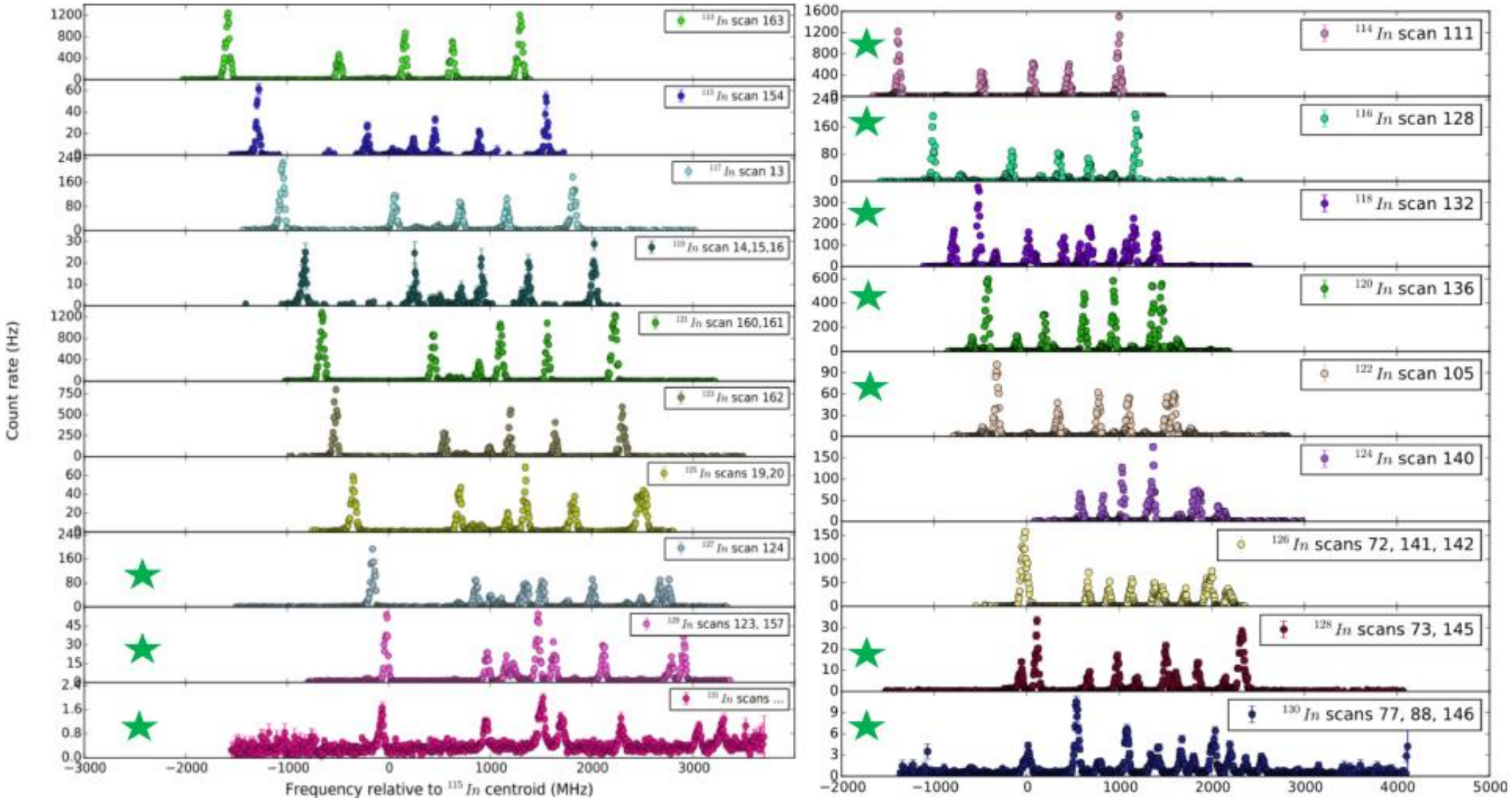




RESULTS CRIS Experiments on neutron-rich In

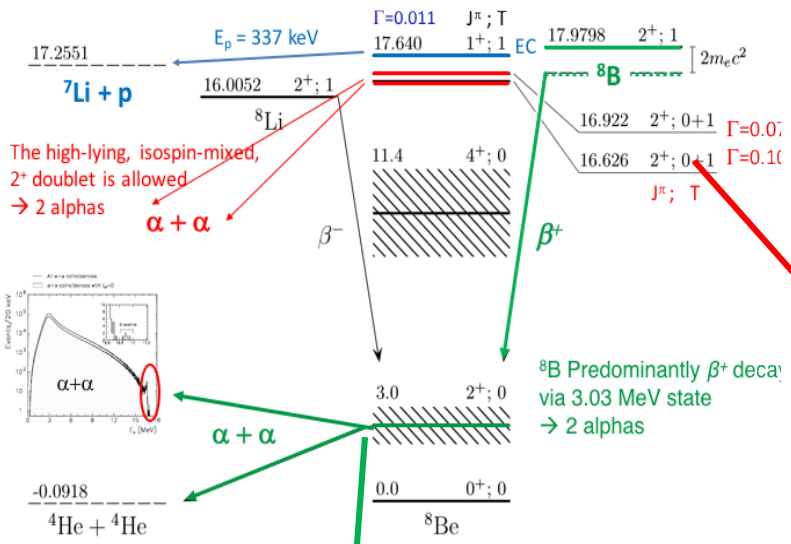
From ^{113}In up to ^{131}In

(New results ★)

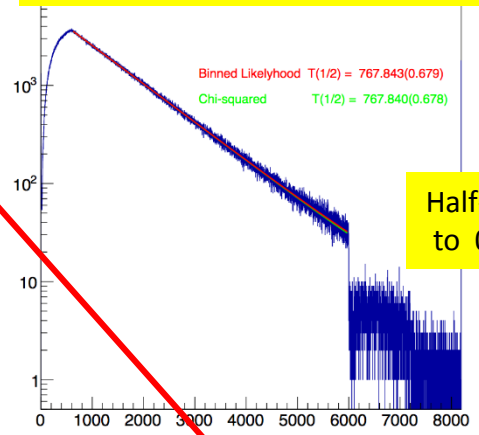


Electron capture of ^{8}B into highly excited states in ^{8}Be. IS633@IDS

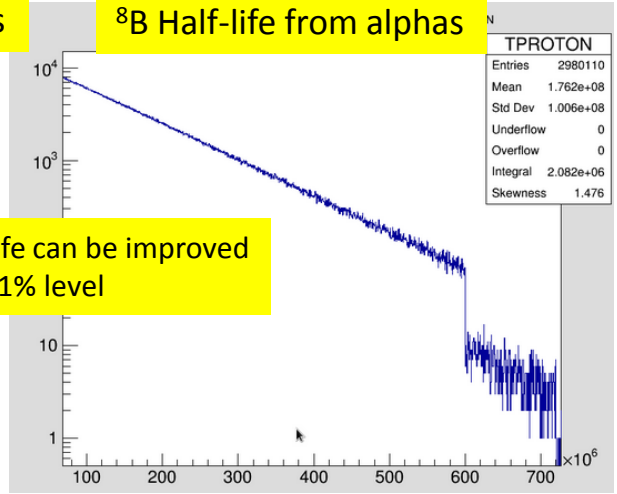
9 shifts 26-29 May 2017



^{8}B Half-life from 511 in glovers

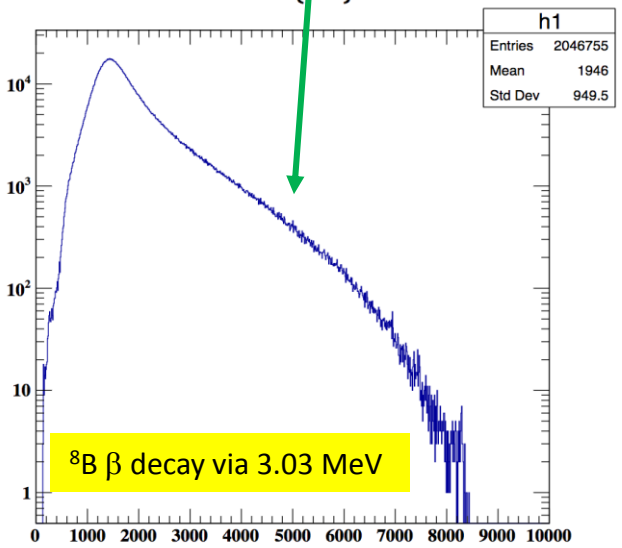


^{8}B Half-life from alphas



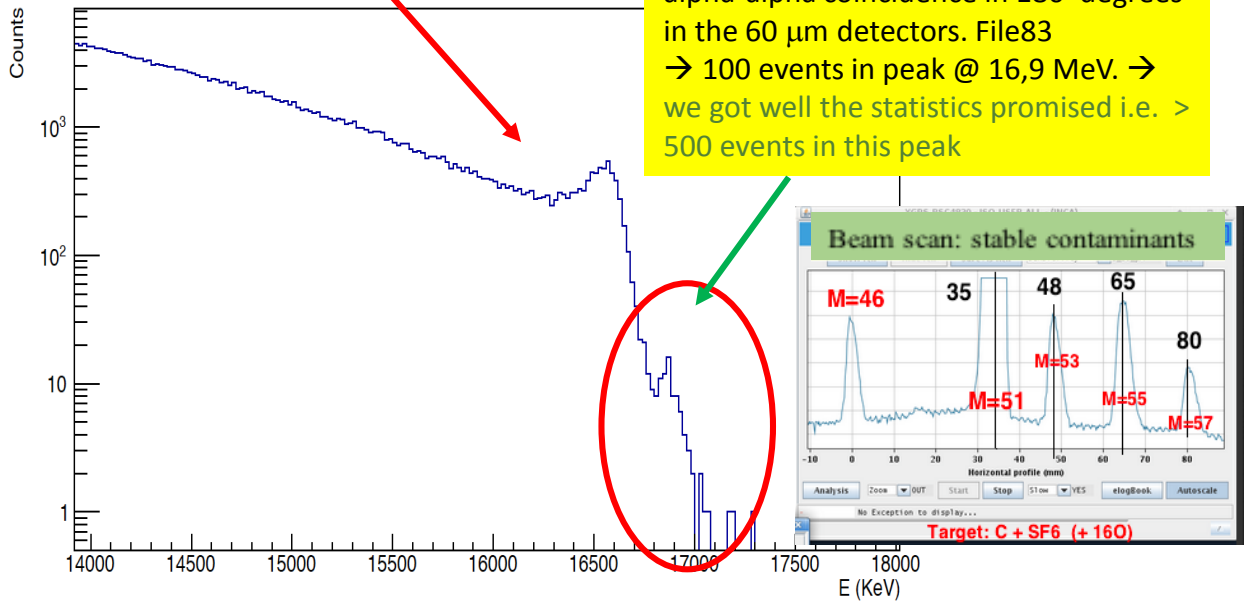
Half-life can be improved to 0.1% level

FE {U2}



^{8}B β decay via 3.03 MeV

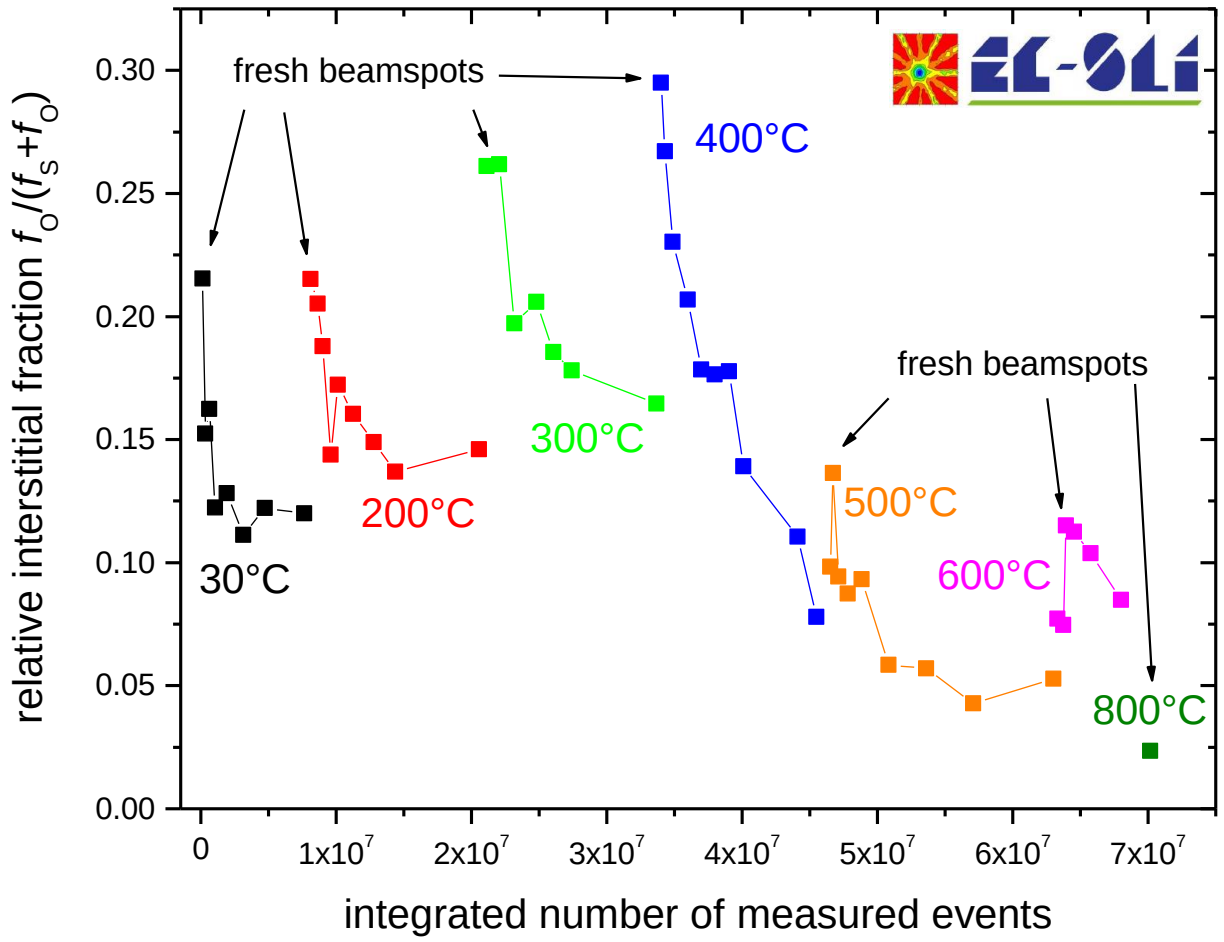
Coinc180_60um



alpha-alpha coincidence in 180 degrees in the 60 μm detectors. File83
→ 100 events in peak @ 16,9 MeV. → we got well the statistics promised i.e. > 500 events in this peak

M46: BF_2 yield about 40k ^{8}B/μC

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



- 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…)

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

K experiment at CRIS - IS620

Goal of the experiment:

- Measuring the hyperfine structure of ^{52,53}K
- Investigating the proposed shell closers at N=32,34

Experiment could only access long-lived K isotopes $^{38\text{-}48}$K

--due to the unusual performance of the target

However,

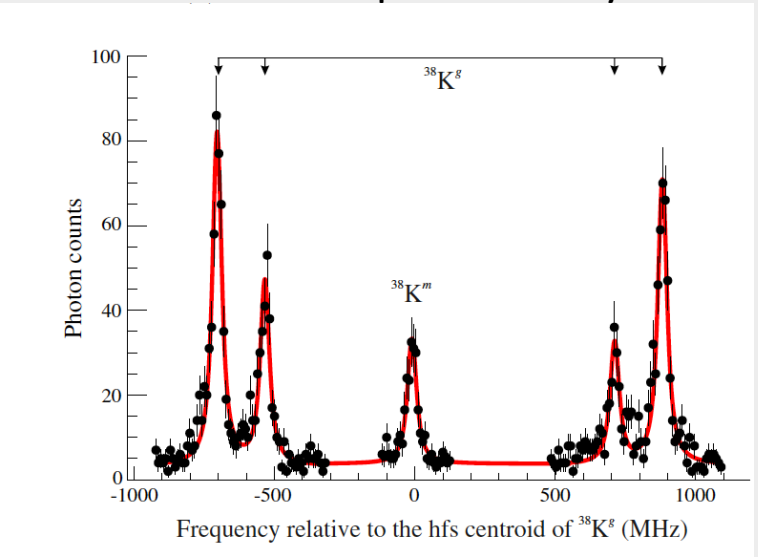
- CRIS measured the hyperfine structure of $^{38\text{-}48}$K
  - Using the new laser stabilization system
  - With one spectrum of ^{49}K (only at the beginning of run)

- Performed systematic studies – the effect of:
  - Laser power
  - Timing of laser pulses

  on the resolution/line shapes in hyperfine spectra

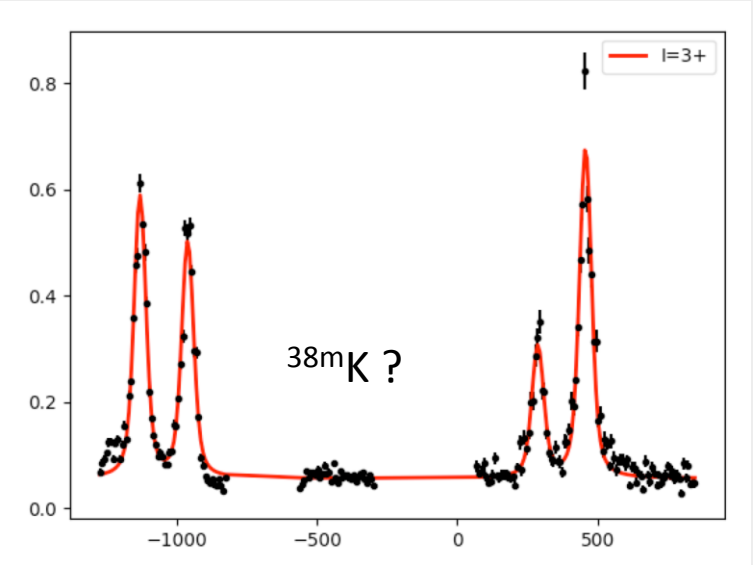
Spectra from COLLAPS 2012

^{38g,m}K similar production yields

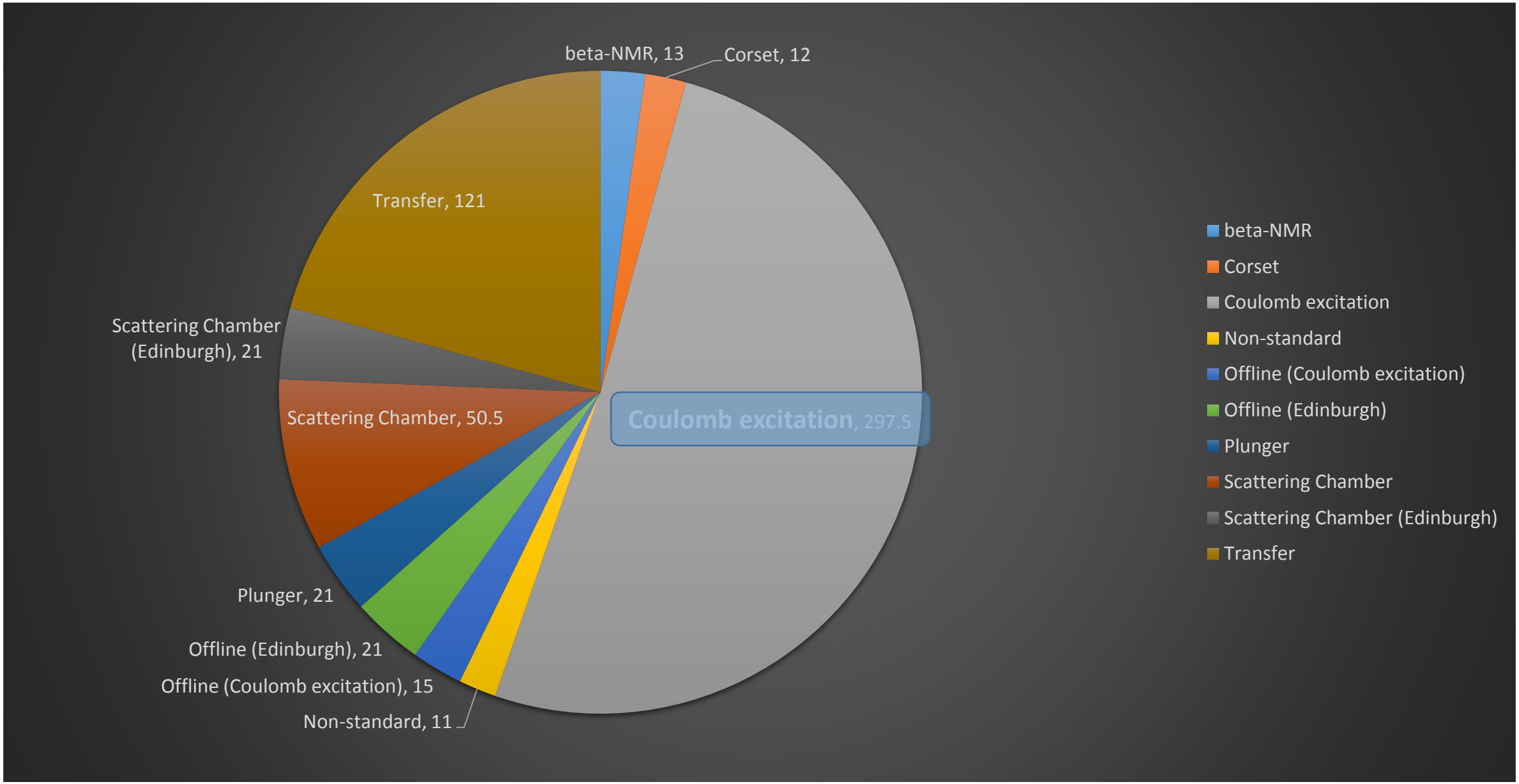


Spectra from CRIS 2016

^{38m}K was not released from target

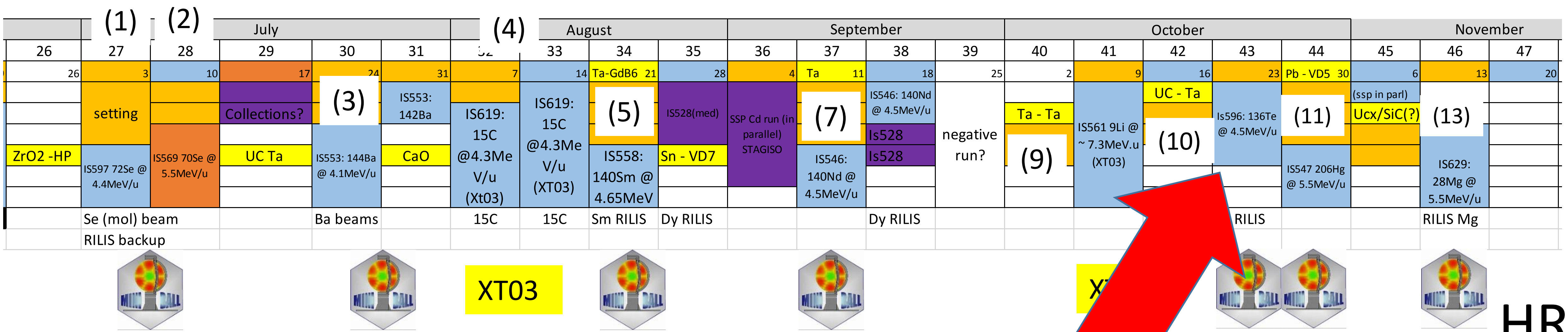


Break down of shift requests for 2017: HIE-ISOLDE



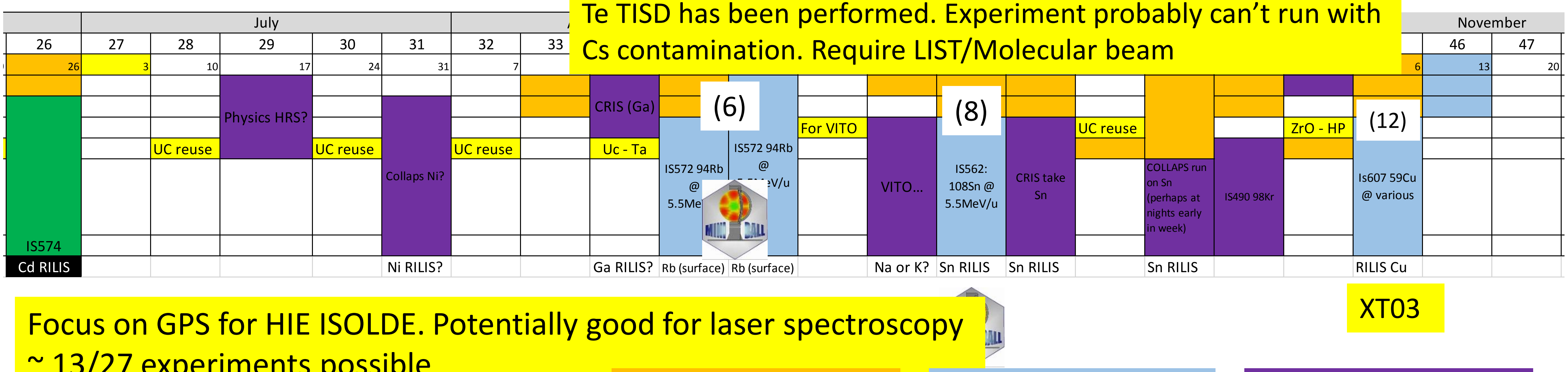
Draft planning 2017 (timetable no longer valid…but experiments essentially the same). Some limits on HIE…(manpower)

GPS



HRS

Te TISD has been performed. Experiment probably can’t run with Cs contamination. Require LIST/Molecular beam



Focus on GPS for HIE ISOLDE. Potentially good for laser spectroscopy

~ 13/27 experiments possible

~ 235 shifts for HIE ISOLDE

Setting up

HIE – ISOLDE physics

Low energy physics

	July					August				
26	27	28	29	30	31	32	33	34	35	36
26	3	10	17	24	31	7	Sn VD5 14	#610 CaO 21	28	Ta - Ta 4
	setting	Test colls	#607 UC Ta	142Ba						IS528*
	Tech stop									IS638
							IS514			Jeûne
#605 ZrO2 -HP	IS597 72Se @ 4.4MeV/u (IS626)	IS659 70Se @ 5.5MeV/u (IS612)	Set for 4.1MeV/u	IS553: 144Ba @ 4.1MeV/u	#608 Ta - GdB6	IS558 140Sm @ 4.65MeV/u	IS585 IS611 IS636 IS638 IS640	IS619 15C @ 4.3 MeV/u	IS619 15C @ 4.3 MeV/u	
			Stable tests if not ready for protons							
	Se (mol) beam		BaF beams	BaF beams		Sm RILIS	Cd beams	15C	15C	Dy RILIS

HIE ISOLDE next week: 72Se followed by 70Se
Miniball took 22Ne last weekend
XT03 campaign in week 34

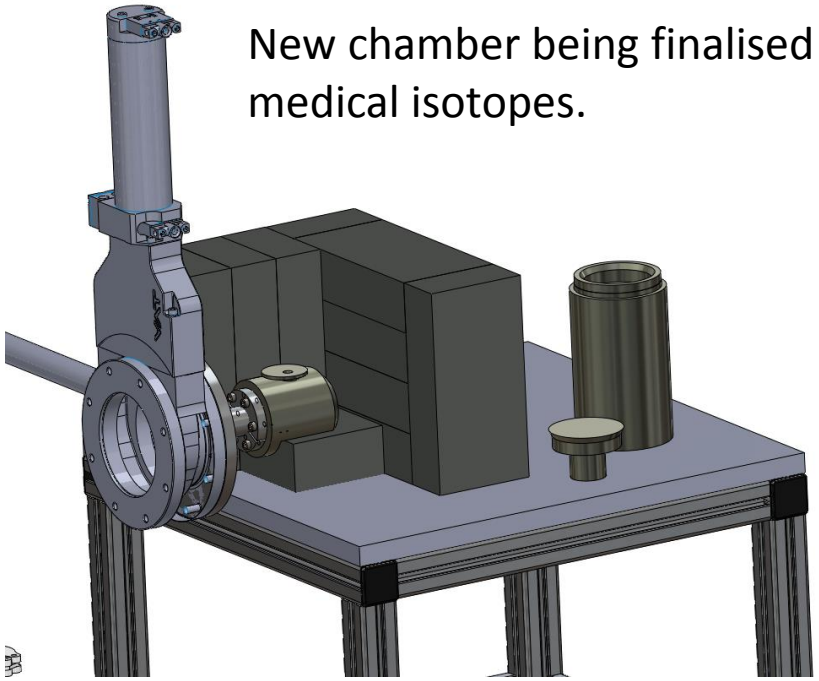
	July					August				
26	27	28	29	30	31	32	33	34	35	36
9 26	3	10	17	24	31	7	14	21	28	4
		TISD/tape	IS592 or TISD (tape)							
	Tech stop			#596 CaO						Jeûne
	tbc (used)					UC (q?) CP			UC Ta	
IS574					IS601		IS490			IS568
Cd RILIS					35Ar		98Kr/48Ar			Ni RILIS

Collections at ISOLDE

2016, monthly finger dose threshold passed during collections of Tb isotopes for medicine

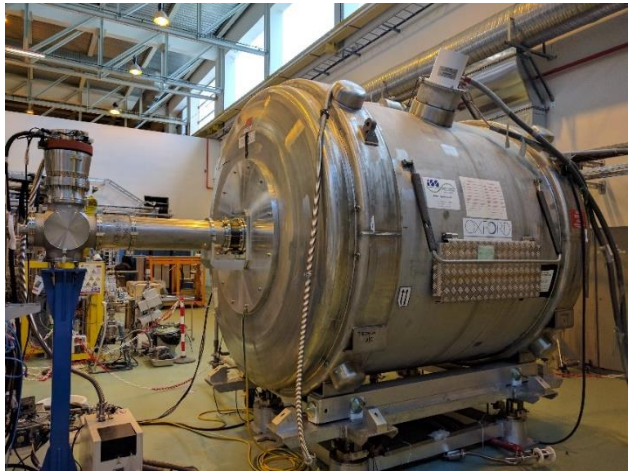
Visit and response from OFSP required improvements in how collections are planned at ISOLDE. (especially for extremity doses)

New chamber being finalised for medical isotopes.



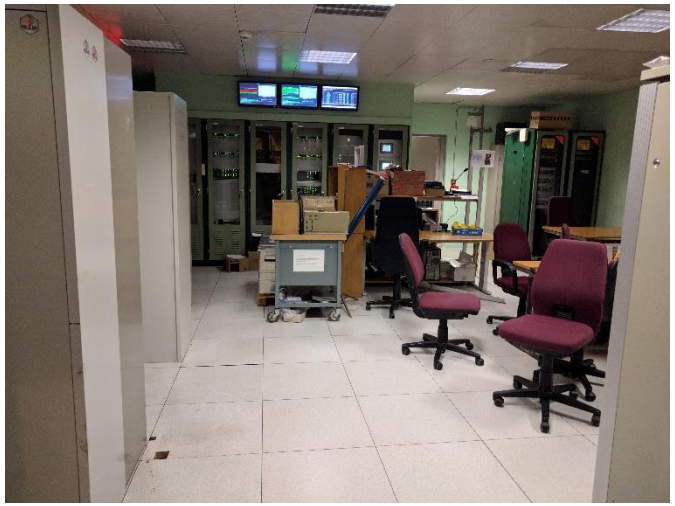
- Restrictions have also affected the solid state programme (even though the dose rates are far below medical collections).
- Currently a very heavy load in terms of preparation, but also for RP.
- Review of the situation may ease some of these issues.

Arrival and installation of ISS: ready for stable beams late in the year?



Also, successful re-energising of the WISARD magnet to 9T….

Installlation of XT03



Old control room: 22 new cabinets on order: re-arrangement in July