TRIUMF

Canada's national laboratory for particle and nuclear physics
Laboratoire national canadien pour la recherche en physique nucléaire
et en physique des particules

ISAC Facility Report

January 23, 2015

- **ISAC performance**
- **Beam development activities**
- **Backlog and current proposals**

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Professor of Physics | University of British Columbia

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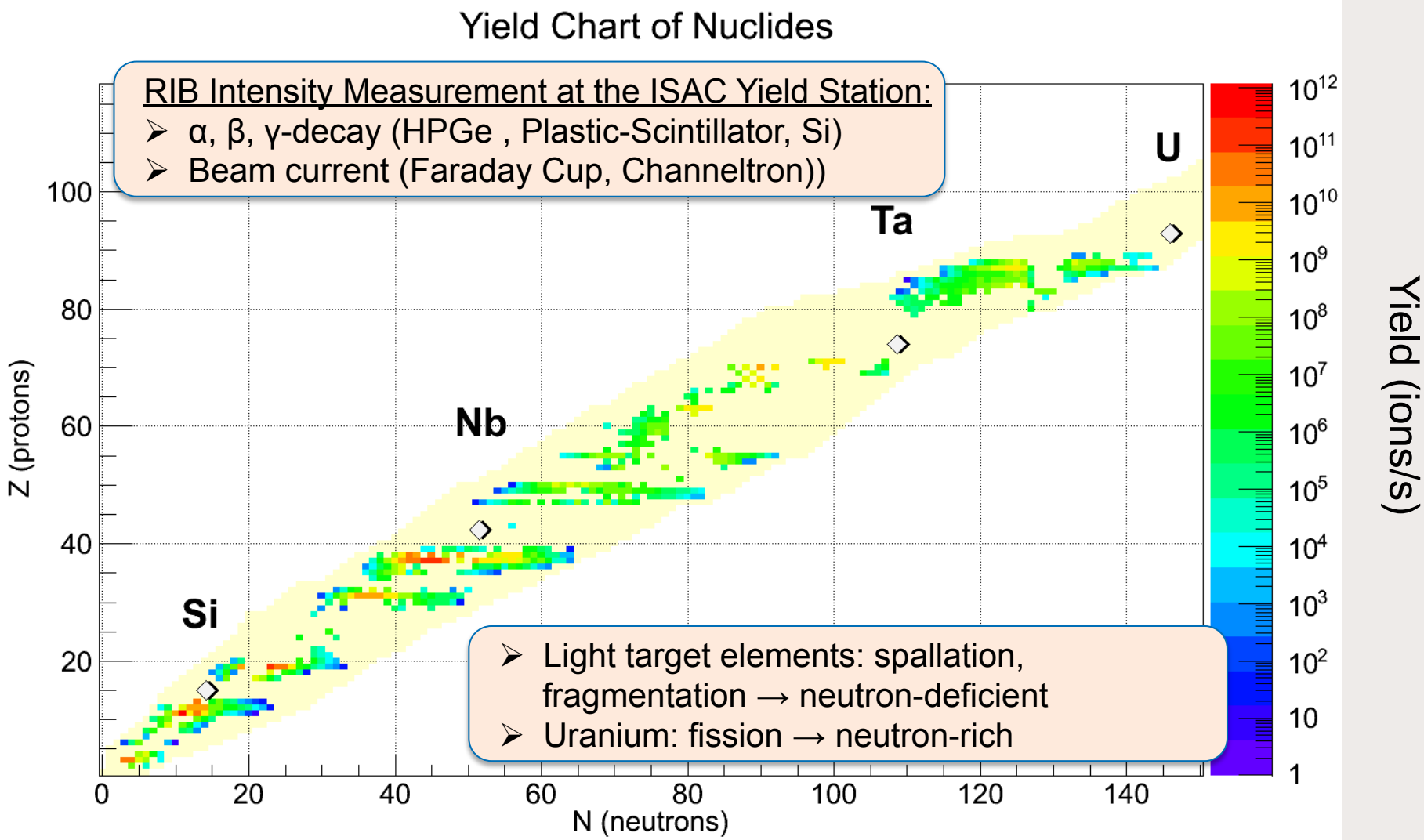
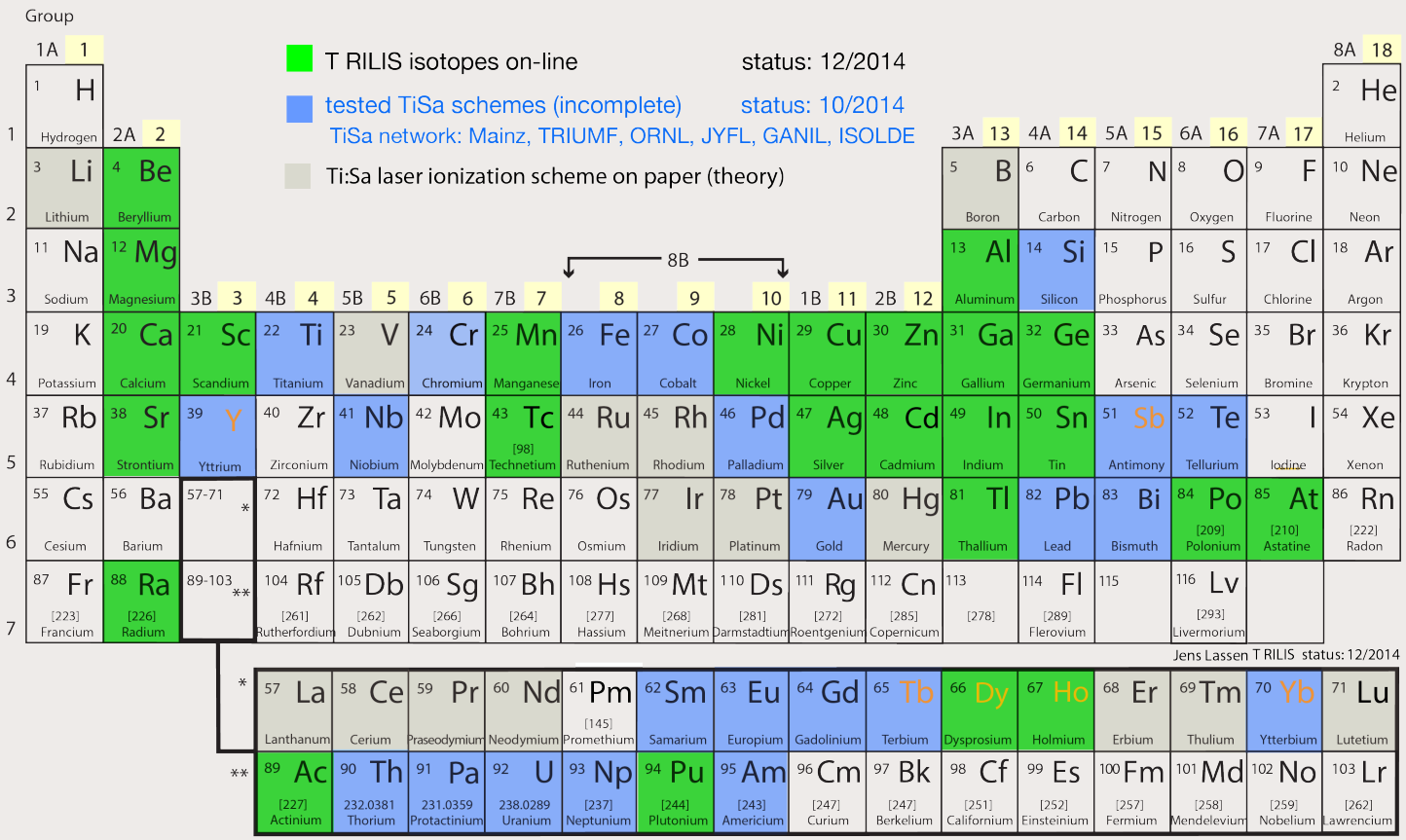
ISAC performance

Isotope Landscape at ISAC



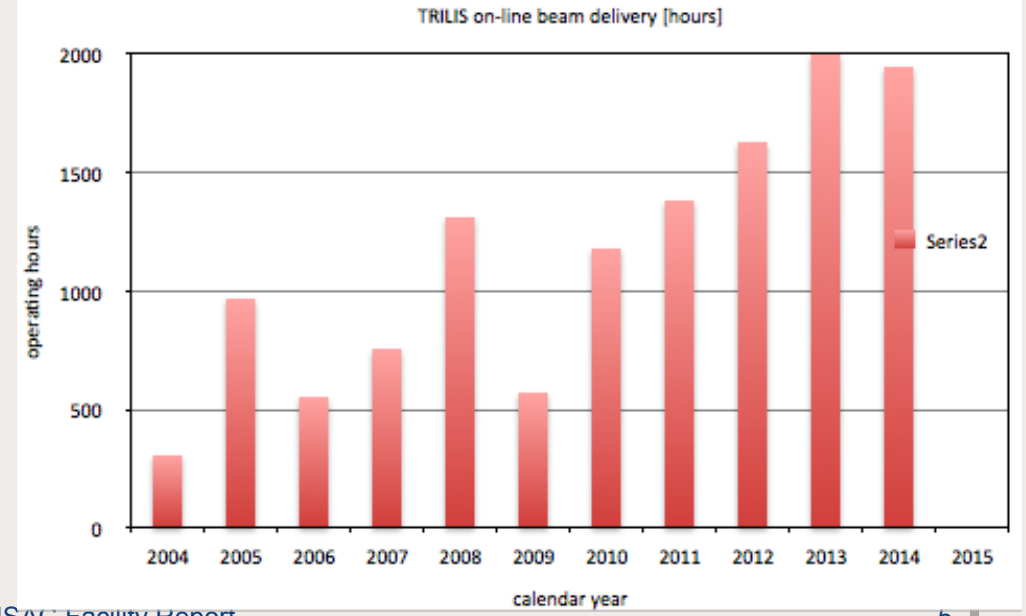
Update on TRILIS beams



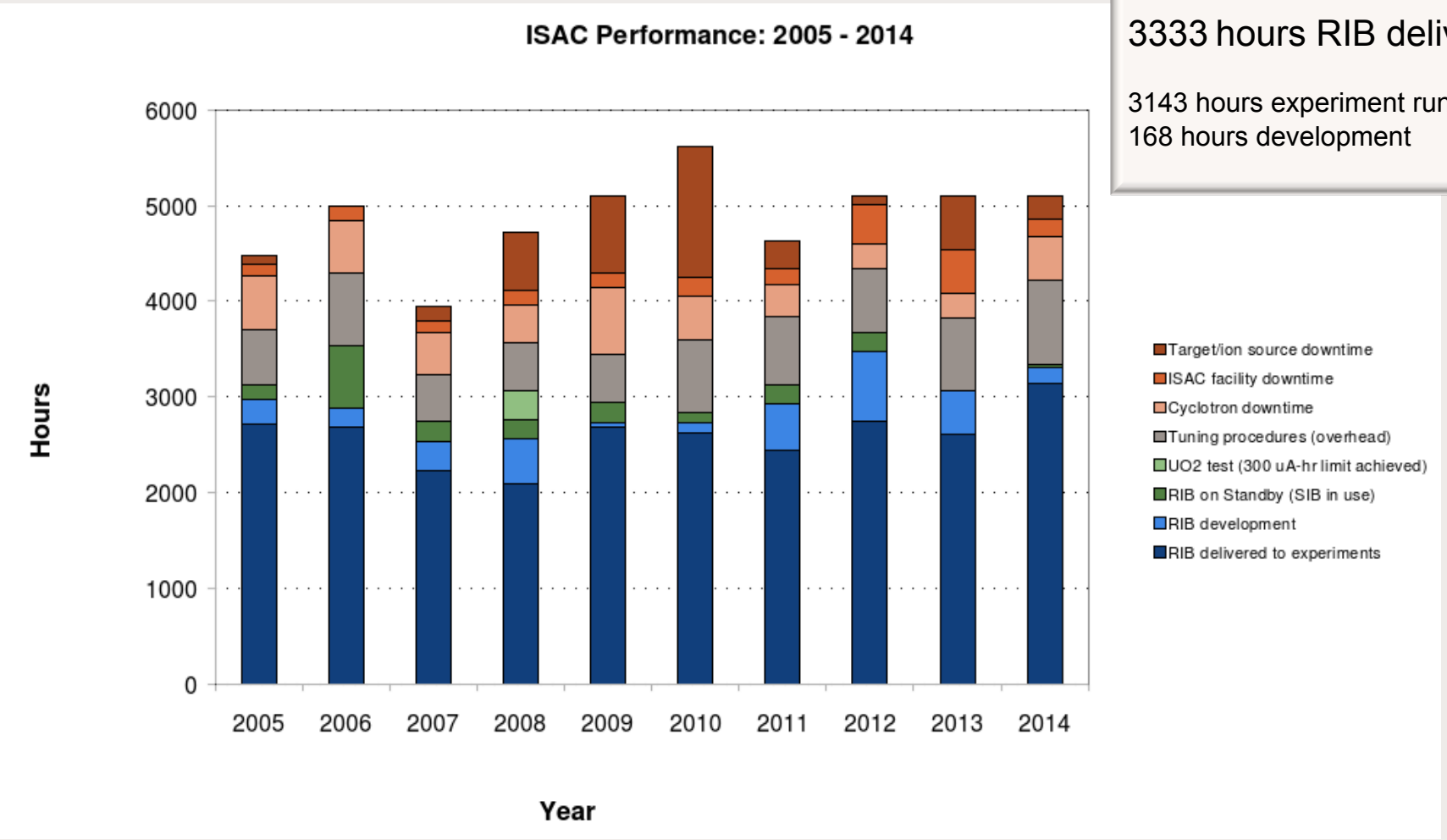
orange denotes elements ready to go online

TRILIS beam delivery

- TRILIS ITW laser beam transport system upgraded
- TRILIS beams (2014):
  - Be, Sn, Ca, Sr, Ac, Al, Mg, Ga, Ag, At
  - Ca: higher efficiency laser scheme - more than x10 yield increase from lasers
  - Ag: successful spin-isomer separation with lasers
- beam development:
  - Ti, Y, Sb, Tb, Yb: ready for online test & yield with proper target ion source combination



ISAC performance



3333 hours RIB delivery

3143 hours experiment run time
168 hours development

ISAC targets 2014

LP Ta LIS/SIS TM4 ITW	**First run of LIS after laser transport upgrade to ITW** ^{12}Be to IRIS LIS development for Sn
HP TiC LIS/SIS TM3 ITE	**First charge bred beam to DRAGON ^{38}K** **New laser scheme for Ca**: increase by factor 100 compared to Ta target and old laser scheme
LP UCx LIS/SIS TM1 ITW	**Charge bred $^{95/96}$Sr beams to TIGRESS**, yields about 1-2 orders of magnitude higher than in previous runs
HP SiC FEBIAD TM3 ITE	**^{8}He to new TAMU chamber** Problems with high voltage stability of target module
LP Ta LIS/SIS TM1 ITW	^{11}Be to TIGRESS, ^{8}Li to BMNR

ISAC targets 2014 (cont.)

LP UCx LIS/SIS TM4 ITE	**^{31}Na to OSAKA**, exceptionally high yield Mg isotopes to TITAN, Fr isotopes to collinear spectroscopy **^{213}Fr implantation for nuclear medicine**
LP ZrC LIS/SIS TM1 ITW	**GRIFFIN commissioning with ^{26}Na** No LIS beams (Ga) possible due to blockage of extraction electrode
HP Ta LIS/SIS TM4 ITE	^{8}Li to BMNR, 21Na to GPS3
LP ThO LIS/SIS TM1 ITW	Test target
LP UCx LIS/SIS TM4 ITE	**^{32}Na, ^{46,47}K to GRIFFIN**, ^{211}Fr to Fr trap Stable Mg to collinear spectroscopy Broken target container after a few days of running reduced yields by factor 100

Target problems (and recovery)

- LP ZrC/TRILIS failure
  - ➔ cancelled 3 experiments
    - S1518 - 11 shifts of ^{62}Ga (GRIFFIN)
    - S1332 - 8 shifts of ^{62}Ga (Laser Spectroscopy)
    - S1326 - 2 shifts of ^{76}Sr (Laser Spectroscopy)
  - delivered 39 shifts to βNMR from HPTa/SIS

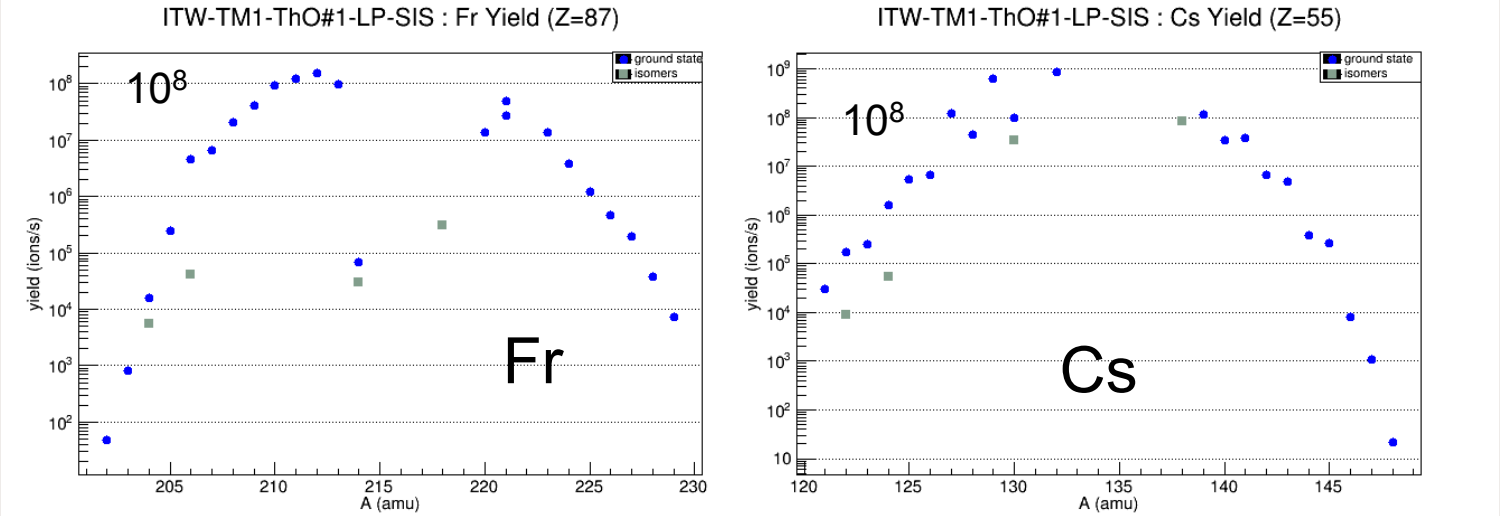
- LP UCx/TRILIS broken target container
  - ➔ dramatically lower beam intensities:
    - GRIFFIN's S1507
      - received only 5/11 shifts of ^{32}Na
      - delivered $^{46\text{-}47}$K instead
    - Francium S1218 ran for 1 day but was cut short by internal problem, demonstrated transfer from collection to science trap
    - Laser spectroscopy S1329's of exotic Mg isotopes not feasible but methodological developments carried out with ^{26}Mg

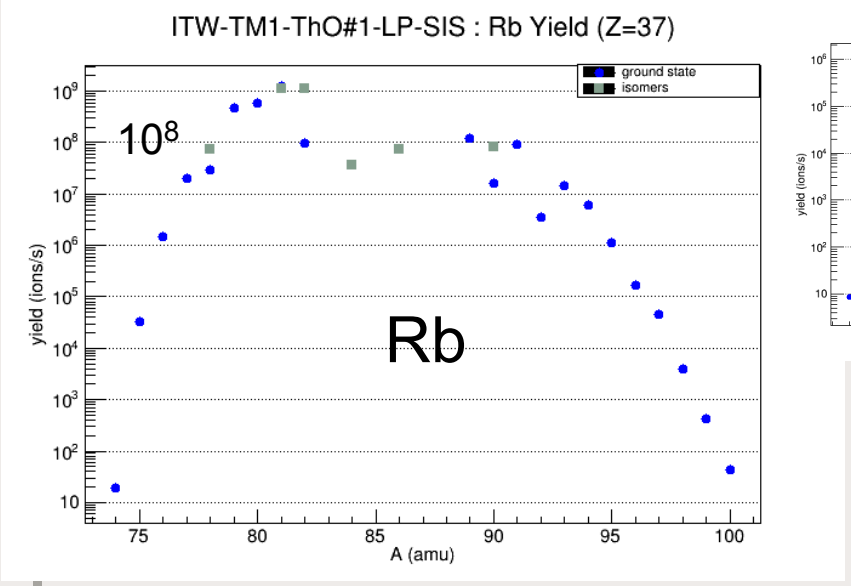
Beam Development Activities

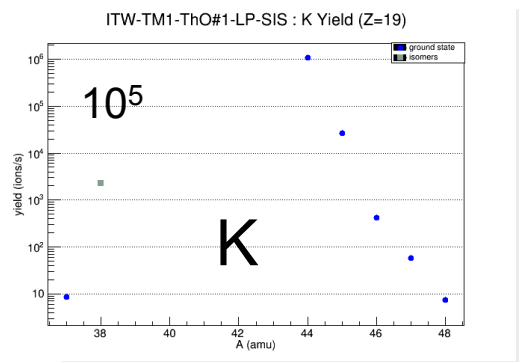
ITW-TM1-ThO#1-LP-SIS

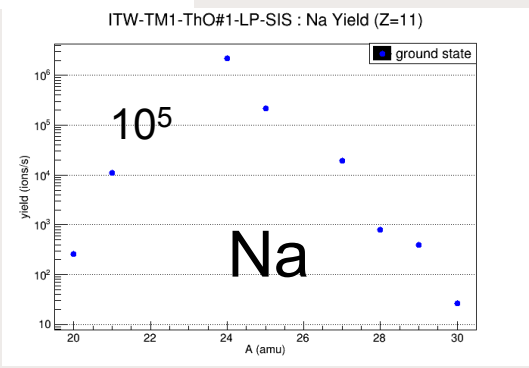
- 240 composite ThO_2/Nb foils
- 12.0 g/cm^2 ThO_2 /5.2 g/cm^2 Nb total thickness
- Max. Beam current 10 µA p+
- Total beam charge on target 2053 µAh p+
- Max. Core Temperature 1800 ^{o}C

ThO target - Alkali metal yields



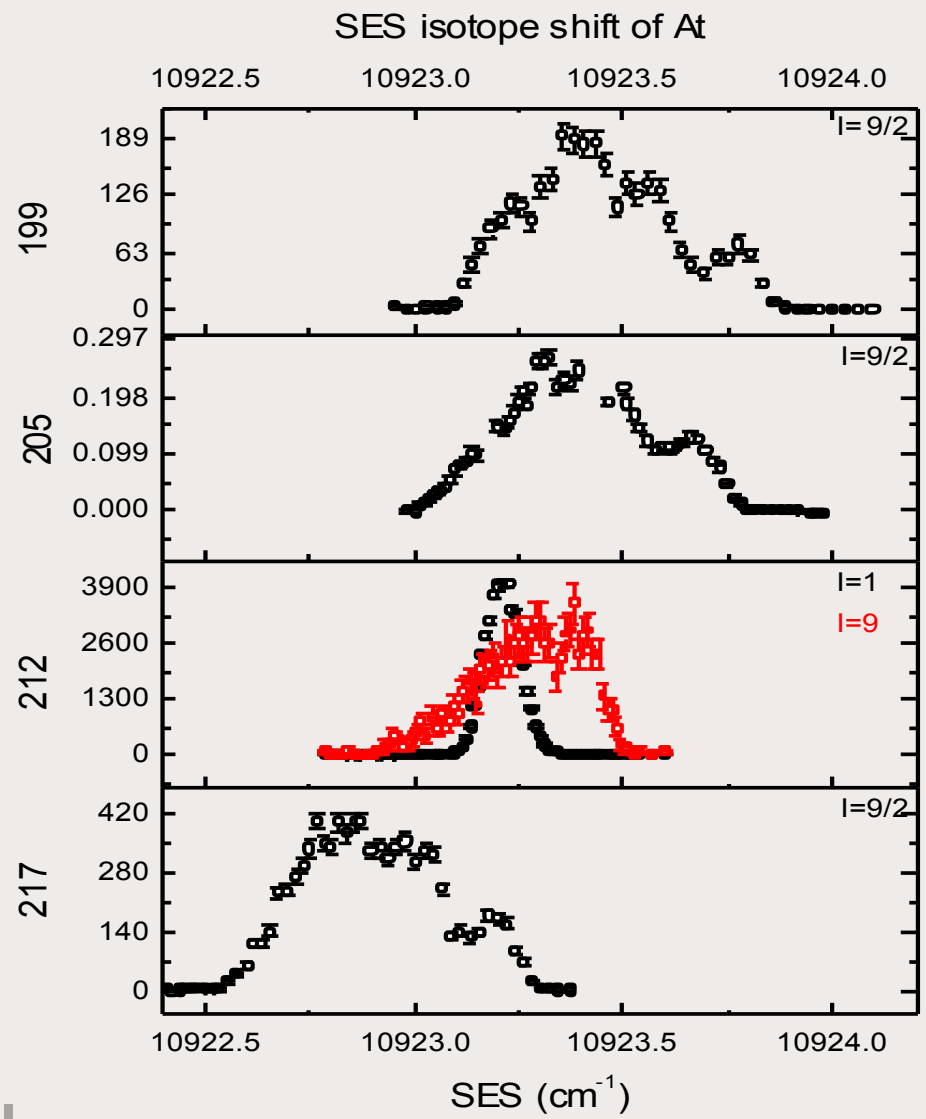


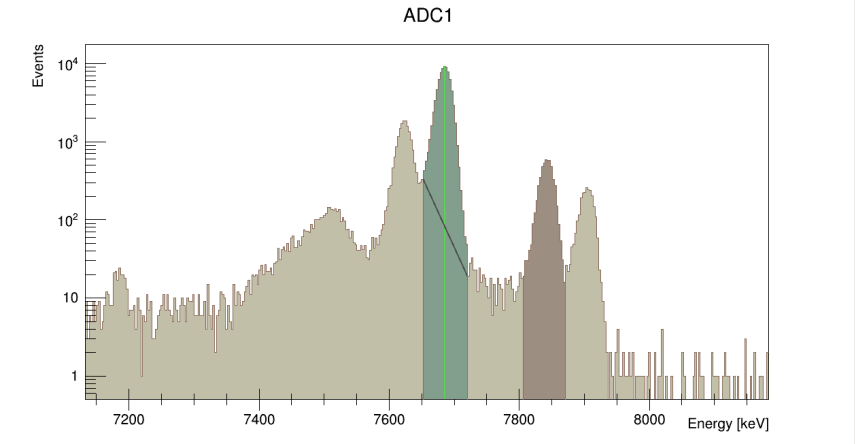




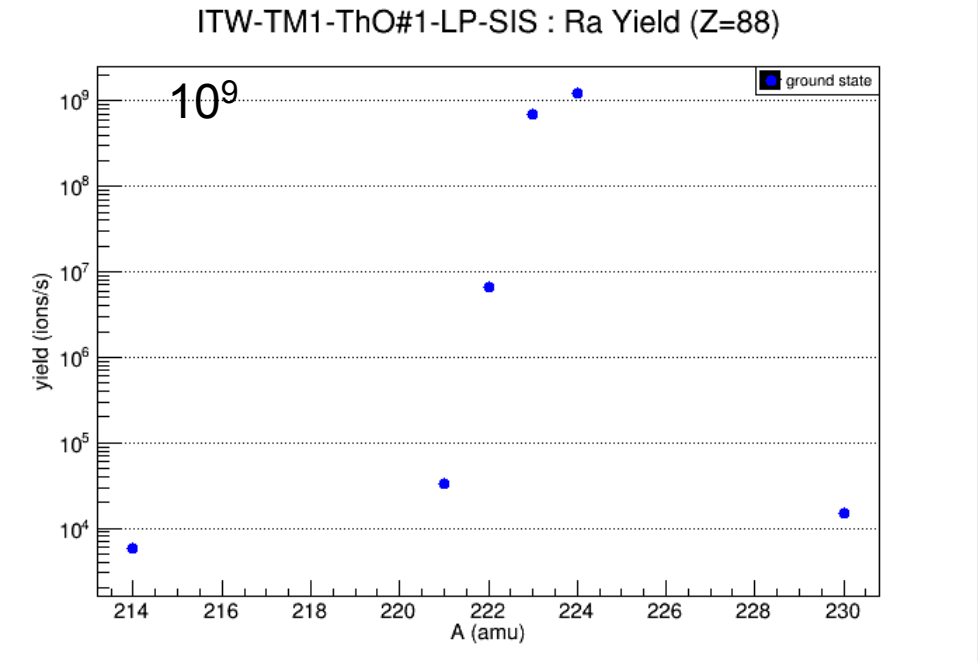
Yields similar to regular UCx target

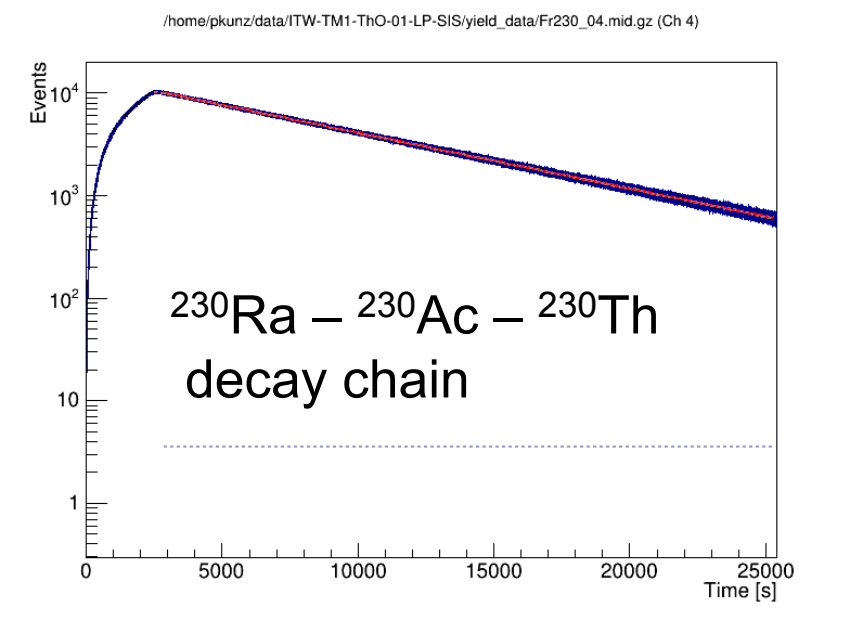
ThO target
Astatine – Isotope shift and HFS





ThO target - Ra yields



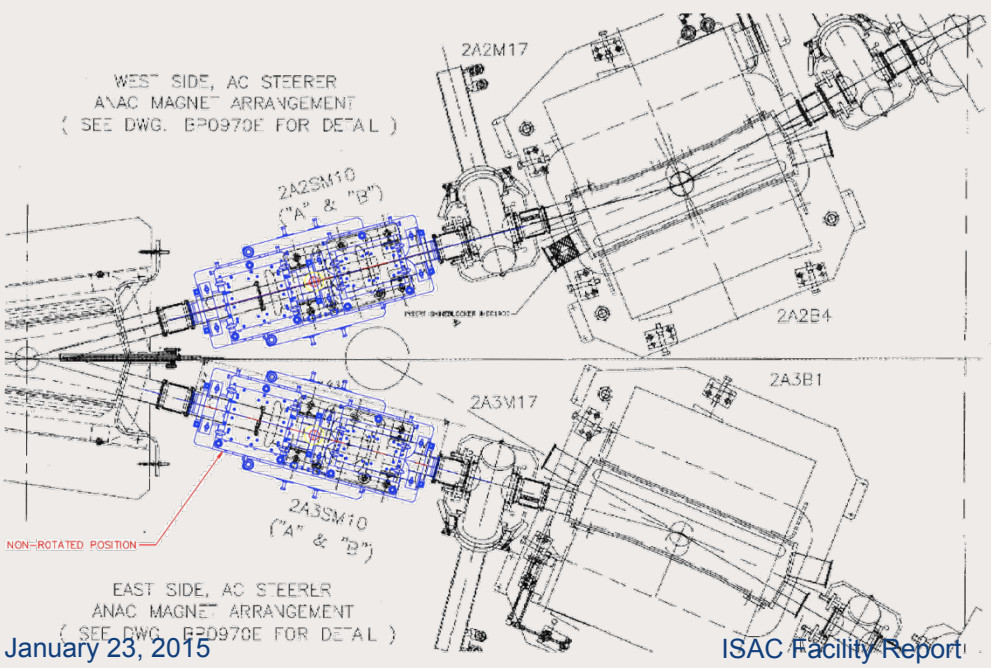


- High yields for ^{223}Ra and ^{224}Ra
- Actinium isotopes are not released from the target
- half-life of ^{230}Ra measured with unprecedented accuracy.

ISAC – AC Raster Magnet

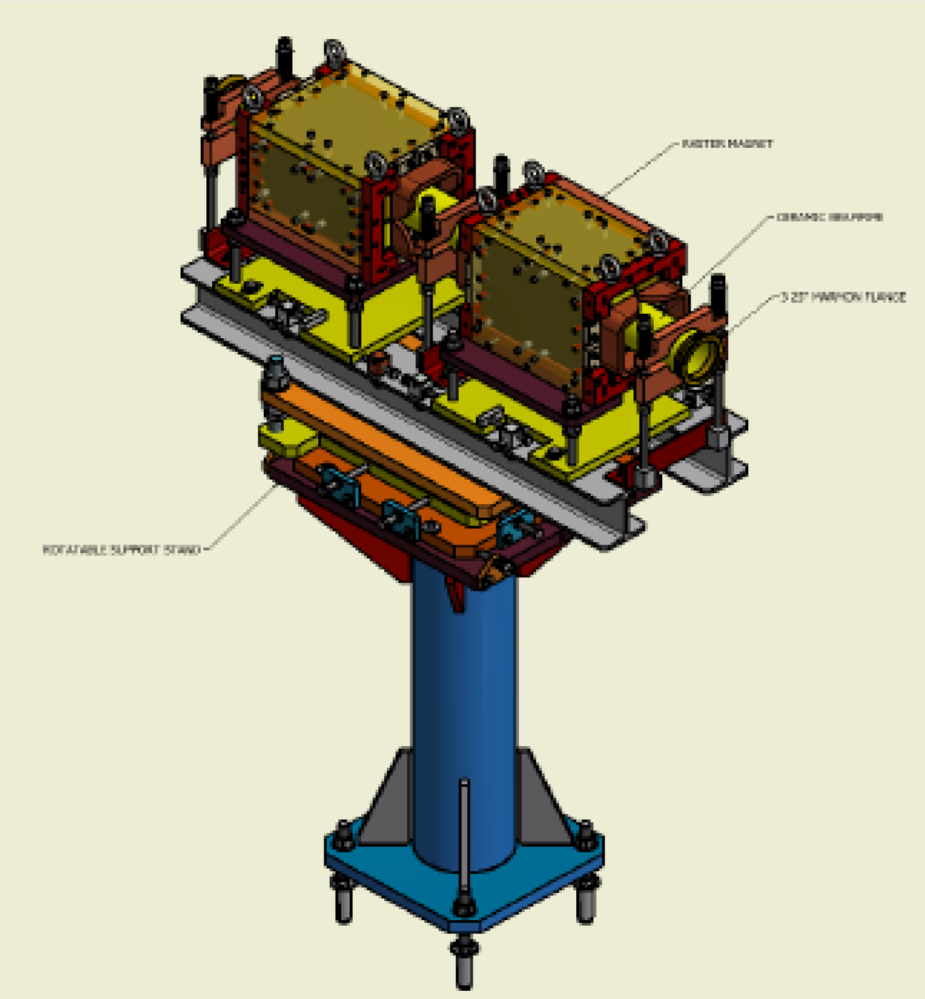
- Rotating a proton beam of reduced width (and smaller tails) on the ISAC high power targets would contribute to a more homogeneous temperature distribution across the target and enable operating at higher average temp.
  - Expected to allow beam current increase up to 50% of present levels*
- Increased temperature => enhance diffusion and effusion of the isotopes
- Higher currents will boost production

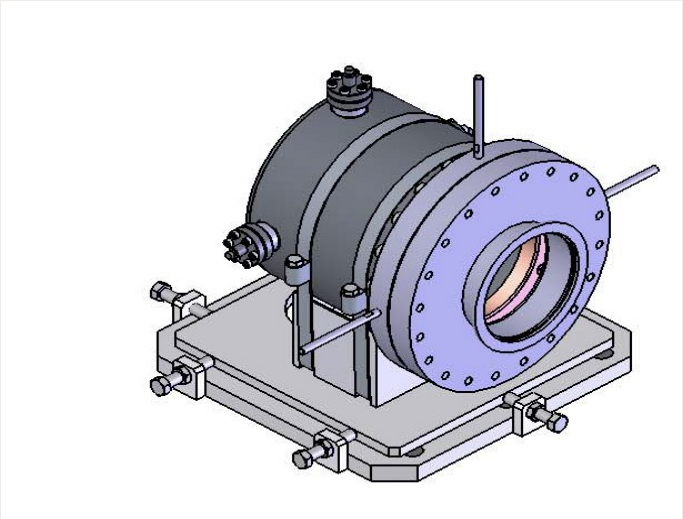
  => *both will contribute to higher yields of radioactive ion beams*.



*TRI-DN-08-19 `Rotating proton beam simulations for optimization of the ISAC target temperatures' – P. Jones, M. Trinczek, R. Laxdal

ISAC – AC Raster Magnet





- magnets and power supplies installed at ITE
- Tested locally

- Beam Profile Monitor installed
- Tests with beam done December 2014
  data analysis ongoing

Implementation plan

- Install controls for magnets in shut down
- Proposed targets for development: (~1 week each)

1. Low power Ta with surface source D (or egg shaped) foils can be used for non rotating beam

    - Develop parameters for beam rotation
    - Test diagnostics
    - Implement and test interlocks
    - Measure yields

2. Ta or SiC target annular shaped foils only useful for rotating beam

    - Optimize parameters
    - Measure yields

Target ion source development for 2015 (proposal)

1. Rotating beam development
2. Graphite target container/insert for UC
   - Off line tests to be done in January, February
3. Modified center block for low power target containers
   - Can be combined with 2nd target for rotating beam

Modified Centre Block for low power targets

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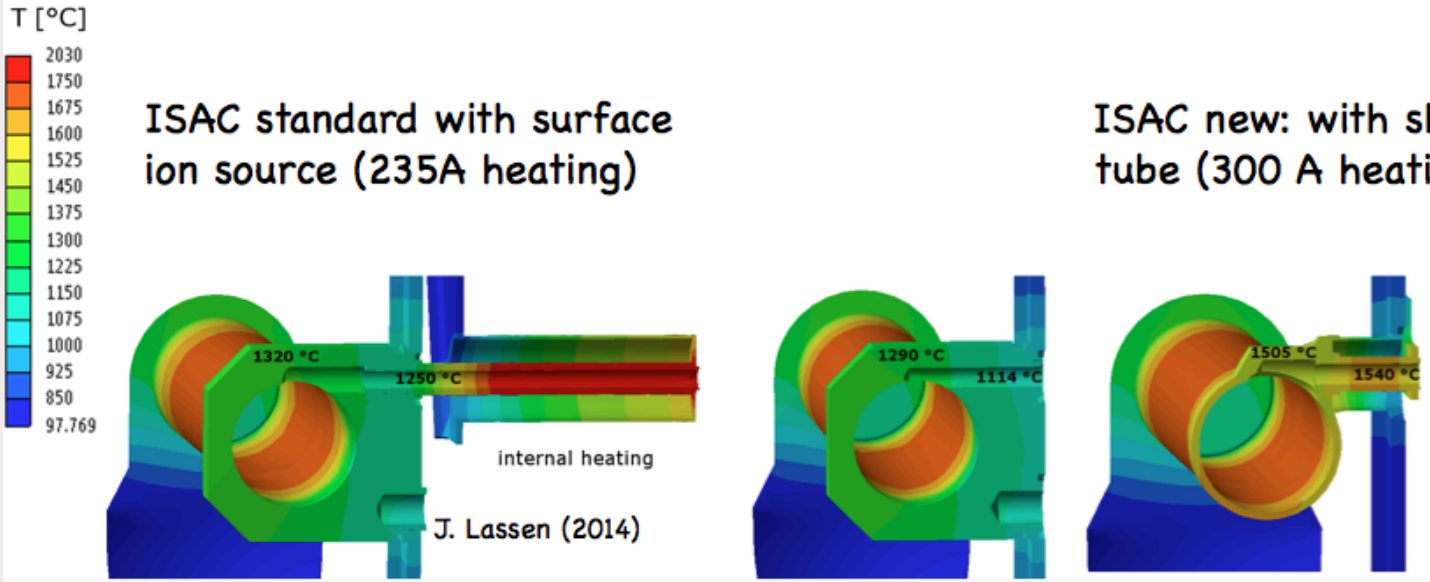
continued dev.: temperature modeling for target ion sources

thermal simulations for standard target (2.5kW internal heating)



ISAC standard with surface ion source (235A heating)

ISAC new: with short, heated transfer tube (300 A heating) for IG-LIS

under development:

ISAC new with surface ion source

-> better release for short lived isotopes

Target ion source development for 2015 (proposal)

1. Rotating beam development
2. Graphite target container/insert for UC
   - Off line tests to be done in January, February
3. Modified center block for low power target containers
   - Can be combined with 2nd target for rotating beam
4. (IG)LIS Lanthanides
   - High powerTa target
   - Other elements depending on target schedule
5. New UCx processing technique
   - Shorter processing time
6. High temperature W target design
   - For short lived isotopes
7. FEBIAD beams
   - requires TM2
   - Cold transfer line (depending on failure analysis review)
8. n – converter target
   - Concept to be reviewed
   - requires contributions from ISOLDE collaborators

Backlog and current proposals

ISAC target modules January 2015

TM	HV	Sources	availability
1	24 kV	SIS/LP	ready
2	~57 kV	FEBIAD/SIS/HP	End of June 2015
3	15 kV	FEBIAD/SIS/HP	Not ready (broken steerers, unstable HV)
4	>50 kV	SIS/IGLIS/HP	ready

Backlog by Target / Ion Source combination

High

Target	RILIS	SIS	IGLIS	FEBIAD
Nb	4	0	0	0
NiO	0	0	0	10
SiC	48	0	7	58
Ta	4	98	5	0
TiC	0	19	0	0
UC	27	46	34	10
ZrC	14	0	0	12

Medium

Target	RILIS	SIS	IGLIS	FEBIAD
Nb	0	5	0	0
NiO	0	0	0	20
SiC	4	0	0	0
Ta	0	4	0	0
TiC	0	0	0	15
UC	0	8	11	9
ZrC	0	0	0	13

- Ta SIS/RILIS: 106 shifts (8 weeks + bNMR) ➔ 2-3 targets
- UC SIS/RILIS: 106 shifts (8 weeks) ➔ 2 targets
- UC IGLIS: 45 shifts (3 weeks) ➔ 1 target
- ZrC SIS/TRILIS: 23 shifts (incl. Nb) + bNMR ➔ 1 target
- SiC SiS/RILIS:
  - ^{28}Mg TIGRESS needs 56kV ➔ TM 2
  - Al Implantation possible w/ TM4 (12 shifts approved, under review)
  - Additional shifts being requested (^{26}Al implantation, ^{20}Mg IRIS)
- SiC FEBIAD:
  - needs optimal FEBIAD performance ➔ TM2 (at the earliest in Fall Schedule)

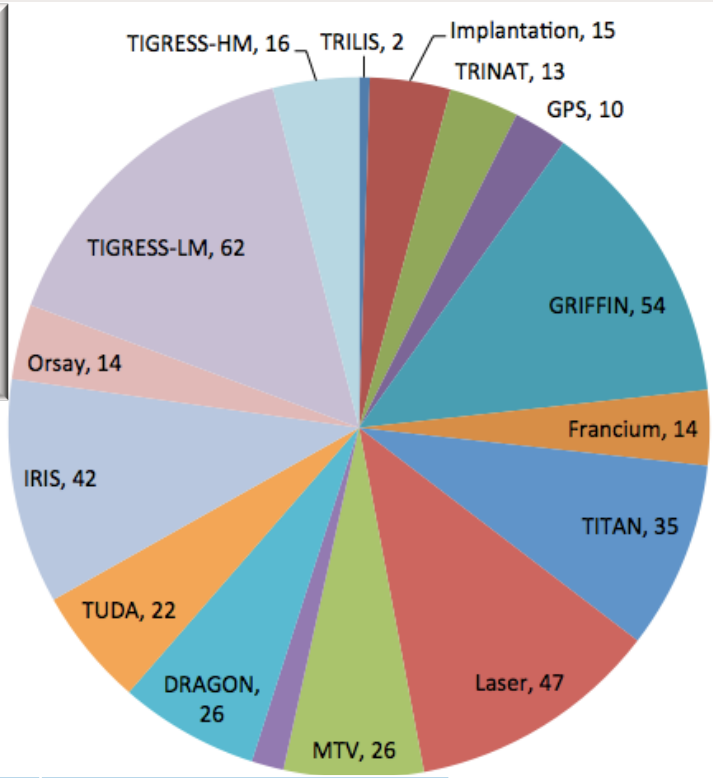
ISAC Backlog and requests

Operational plan:
8 months operation per year
(240 days, 8 targets, 5 days ovhd/tgt)

- ➔ 176 days RIB delivery (4224 hours)
- ➔ 35 days Materials Science (20%)
- ➔ 15-20% beam development
- ➔ **~ 105-110 days RIBs for SAP**

Dec 2014:
404 RIB shifts with H priority
(1.9 yrs)

89 RIB shifts with M priority
(0.5 yrs)



ISAC-RIB shifts quota: 105 shifts

➔ RIB oversubscription factor 1.5

	ISAC-RIB	ISAC-SIB
Status Reports/Addenda	24	0
New Proposals	120	58
Sum	**148**	**58**

Thank you!
Merci

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