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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

July 7, 2014

- **ISAC Performance**
- **Beam Development Activities**
- **Backlog and current proposals**

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TRIUMF | SCIENCE DIVISION

ISAC performance

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2013 Cyclotron & ISAC Availability

	Beam time (hours)		Availability (%)	
	Scheduled	Actual	Actual	Goals
Cyclotron	5508	5271.5	**95.7**	>90
RIB	5200	3827	**73.6**	>75 (accelerated) >80 (non-accel.)
SIB	6079	5531	**91.0**	> 90%

Cyclotron availability highest ever

ISAC RIB performance

	2012 (hours)		2013 (hours)		2014 (week 22) (hours)	
	Expect.	Actual	Expect.	Actual	Expect.	Actual
RIB (experiment)	2450	2745	3920	2607	540	482
RIB (development)	1500	734	350	457	72	~70
Overhead (tuning, etc.)	750	672	930	759	?	?
Scheduled maintenance	340	245	450	475	?	?

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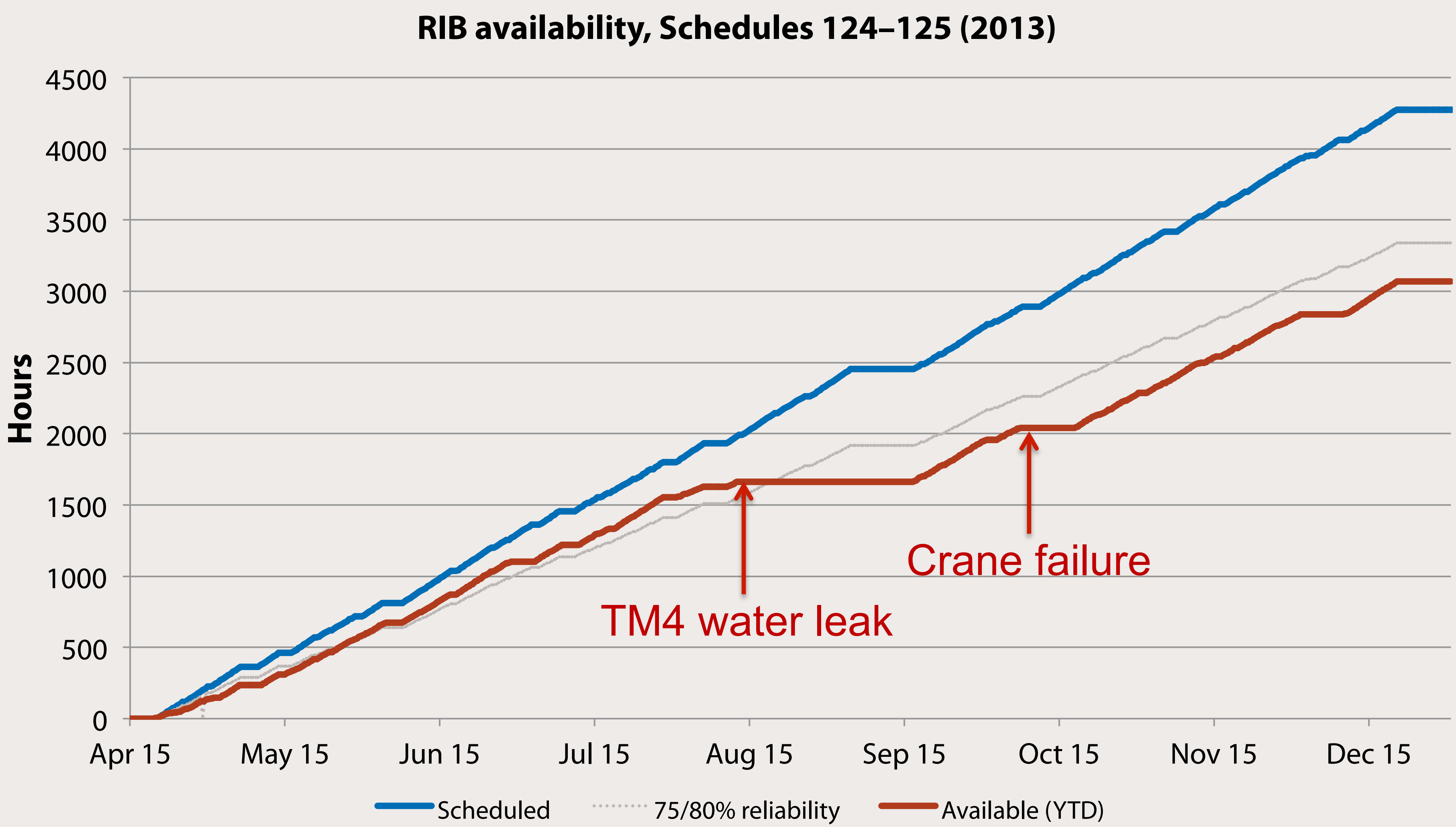
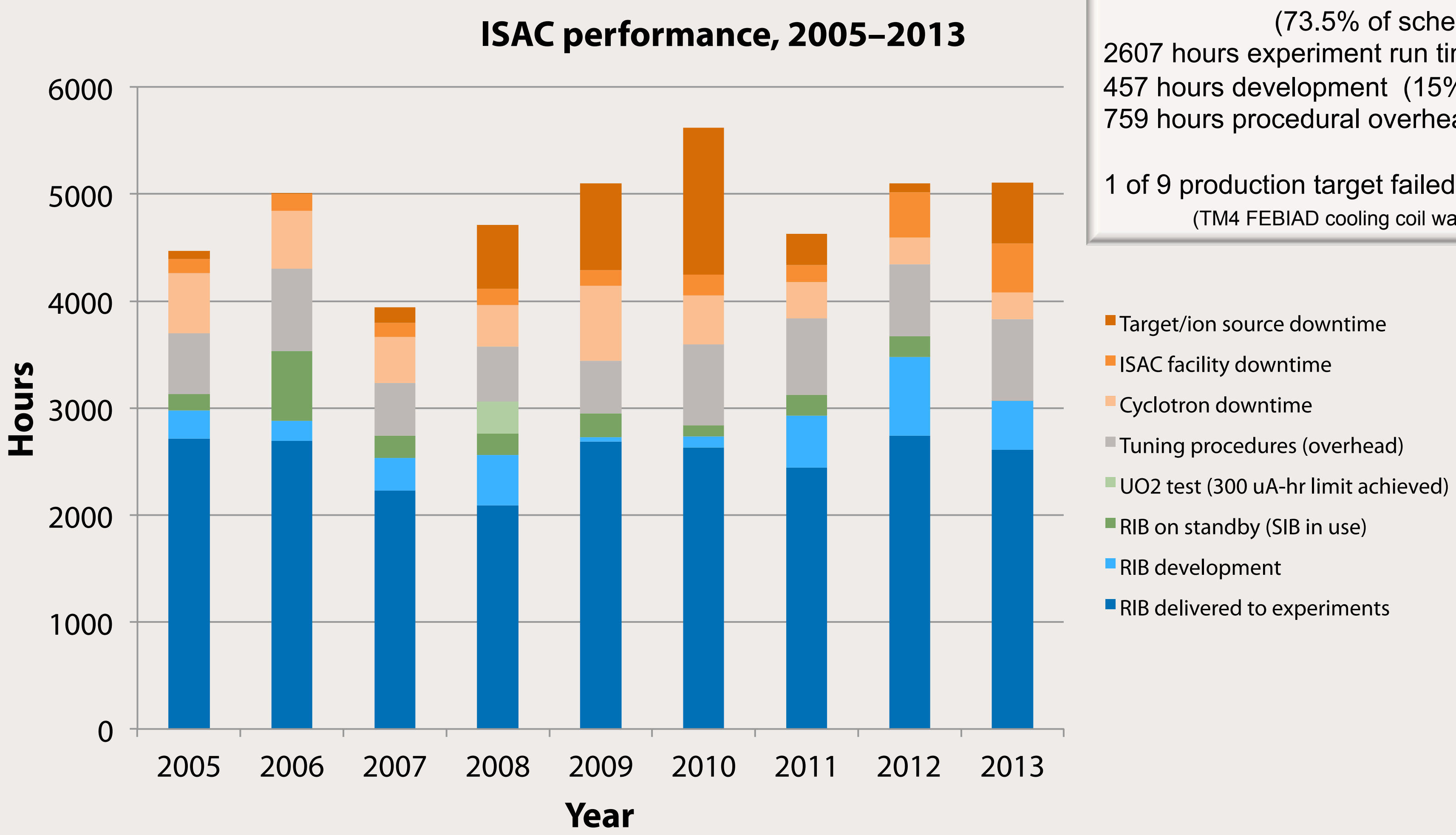
RIB availability in 2013



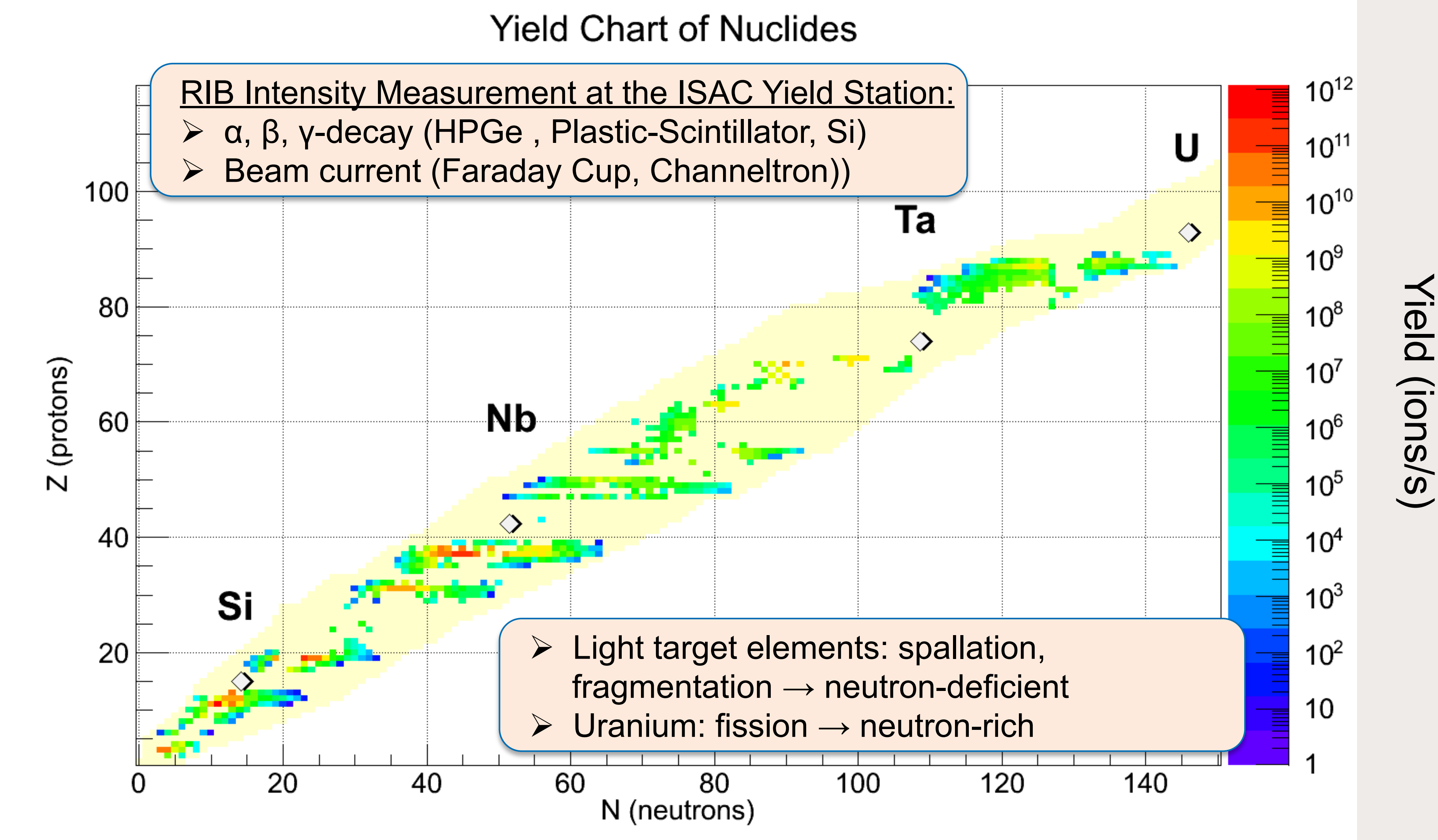
ISAC performance



3064 hours RIB delivery
(73.5% of scheduled)
2607 hours experiment run time
457 hours development (15%)
759 hours procedural overhead

1 of 9 production target failed
(TM4 FEBIAD cooling coil water leak)

Isotope Landscape at ISAC



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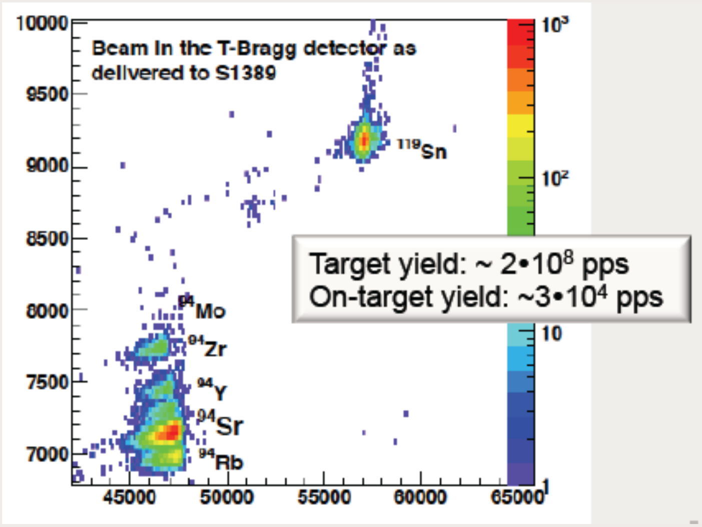
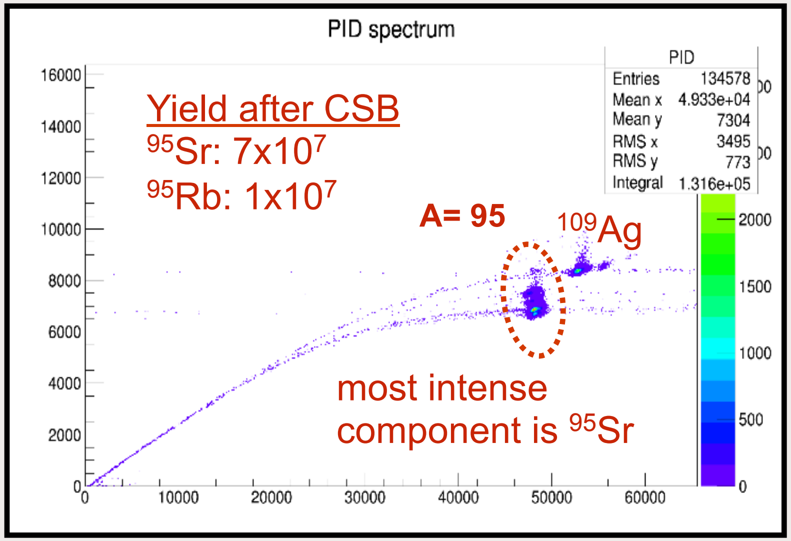
Beam Development Activities

High-mass beam delivery

accelerated beams from CSB:

Isotope	Facility	$T_{1/2}$	Q	ISAC Yield [pps]	Expt. Yield [pps]
^{38g}K	DRAGON	7.64 m	7^+	6×10^9	2×10^7
^{94}Sr	TIGRESS	1.25 m	15^+	2×10^8	5×10^4
^{95}Sr	TIGRESS	23.9 s	16^+	1×10^9	2×10^7
^{96}Sr	TIGRESS	1.1 s	17^+	1×10^7	3×10^5

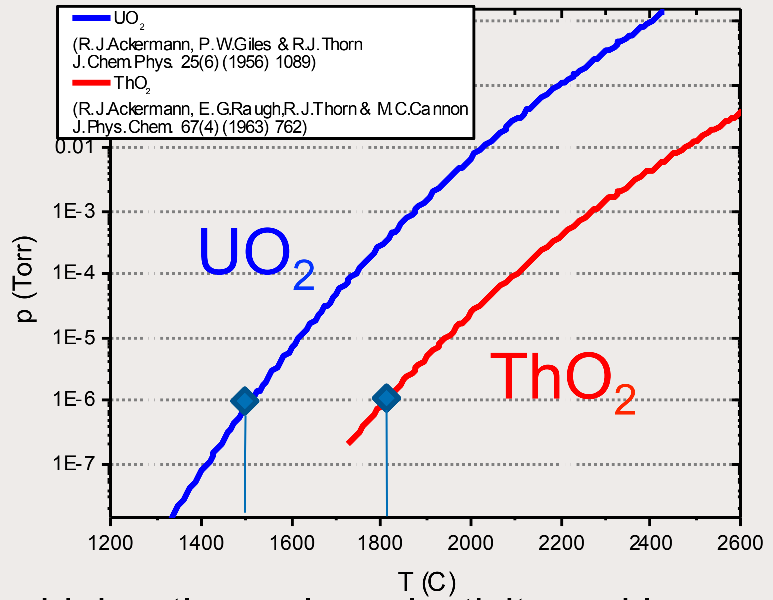




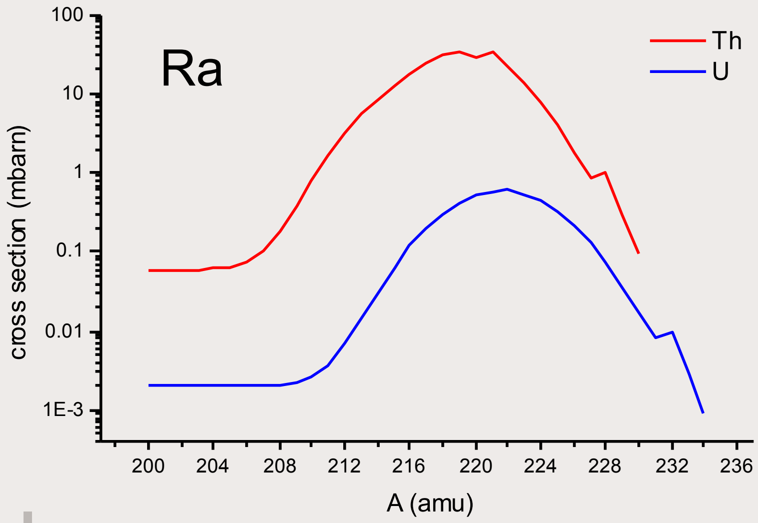
ThO_2 Development Target

- High production rates for some heavy and neutron-rich elements (Ac, Ra, At)
- Investigating the release of volatile oxides (NOx, YO, SO, VO, ...)
- Yield measurements of neutron-rich lanthanides and lanthanide oxides

Vapor Pressure - UO_2 / ThO_2



Th / U calculated production cross-sections for 500 MeV protons (Silberberg-Tsao Model)



The higher thermal conductivity and lower vapor pressure of ThO_2 allows significantly higher operating temperatures than UO_2

- Target production: mostly identical to already established procedures for UO2 targets
- CNSC operating license revision is in progress
- **Test in 2014 fall schedule**

ISAC – AC Raster Magnet (1)

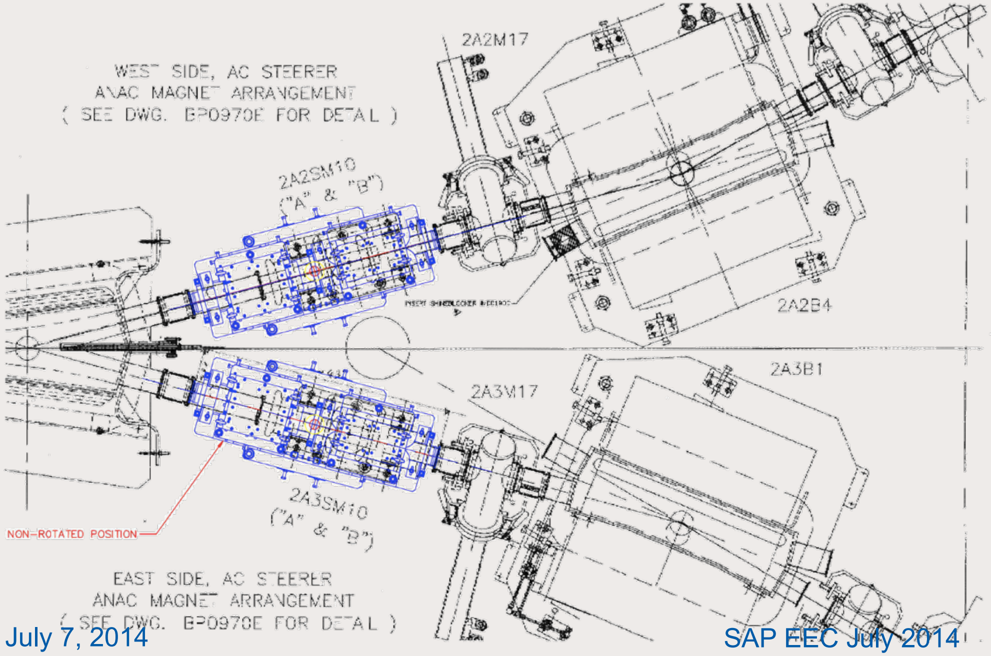
• Rotating a proton beam of reduced width (and smaller tails) on the ISAC high power targets would contribute to a more homogeneous temperature distribution across the target and enable operating at higher average temp.

  • 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

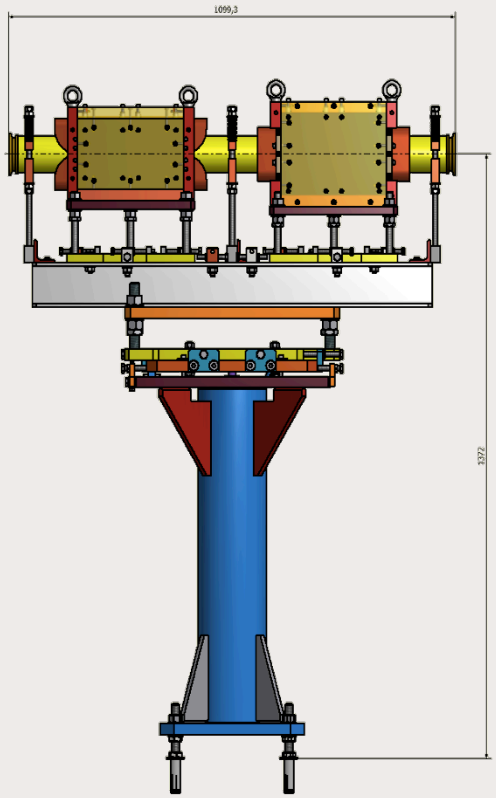
  => *both will contribute to higher yields of radioactive ion beams*.



*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 (2)

The raster magnet is a ferrite H-frame type magnet - designed and manufactured by ACSI (local Canadian company)



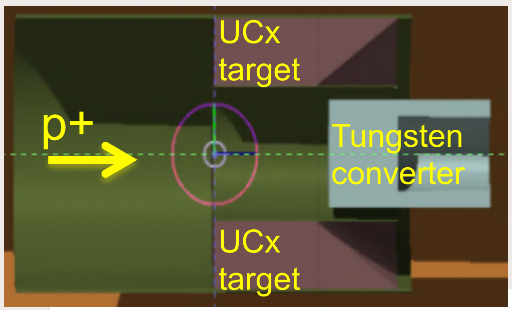
- Two magnet components for X and Y movements
- Two independent power supplies with adjustable frequencies: up to **400 Hz.**
- Integral field up to 150 G-m
- Ceramic vacuum tube
- Rotatable stand, for easy maintenance access
- **By adjusting the phases and amplitudes of the X and Y magnets a variety of rastering patterns can be achieved**

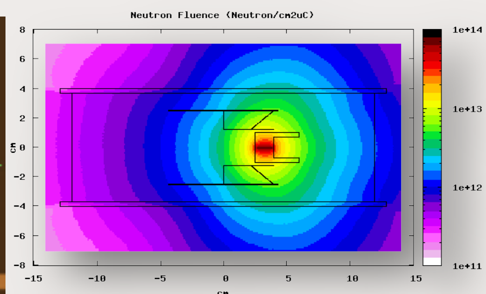
Schedule:

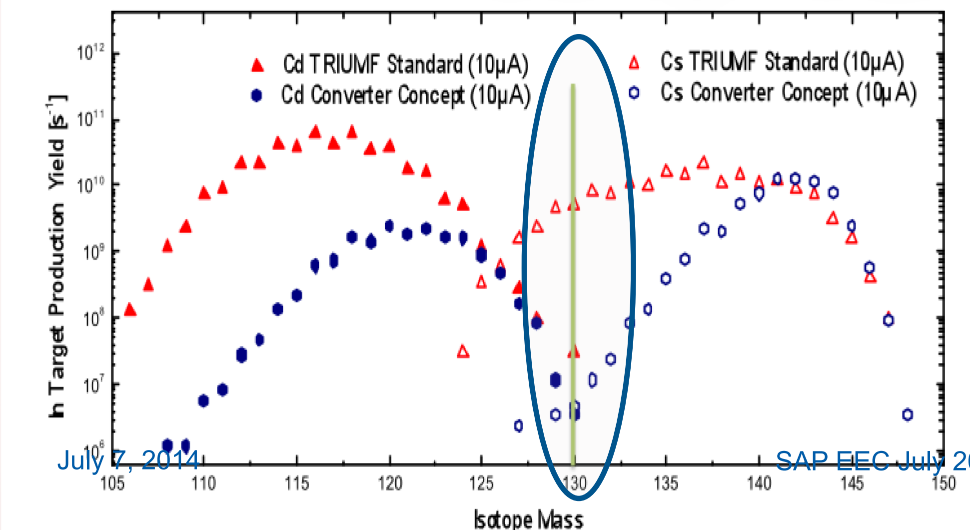
Drawings approved for manufacture – May 15, 2014
Factory tests – August 1, 2014 (likely delayed)
Delivery to TRIUMF – Fall/Winter 2014
Installation – 2015 shutdown
First test of rotating proton beam on ISAC target - Spring 2015

Neutron Fission Target Design – TRIUMF•CERN collaboration

- Neutron-rich fission products around Ni-78 and Sn-132
- Less spallation and fragmentation products (cleaner beams)
- Less primary beam power deposition in target material







Current Status:

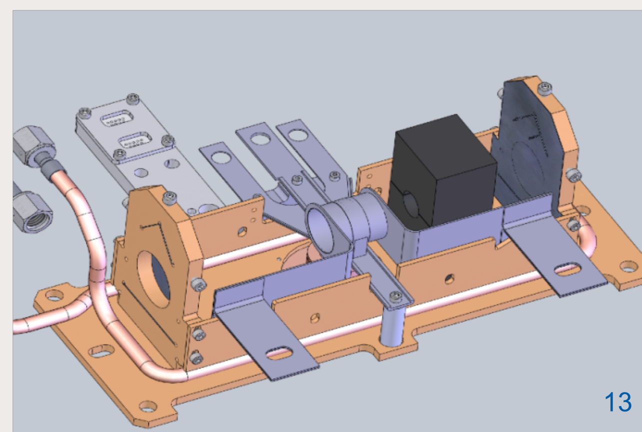
- MOU TRIUMF – ISOLDE

In progress:

- Target and converter design
- FLUKA simulations for power deposition, neutron flux, production rates
- Thermal calculations (ANSYS) of heat dissipation

To do:

- Target /UC target discs fabrication
- Test of target assembly
- CNSC approval/Revision of Safety Analysis Report
- Online Test ➔ possible in 2015



Backlog and current proposals

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High-demand targets

		Isotopes		Comments / Questions
Ta	SIS/RILIS	$^{8,9,11}Li$, ^{11}Be	IRIS, MTV, TIGRESS	HP (Li), LP (Be) betaNMR (28kV)
SiC	SIS/RILIS	^{26}Al (53kV), ^{28}Mg (57kV)	Impl./ DRAGON/ TIGRESS	TM4 marginal for Al, Mg only possible with TM2 when repaired
TiC	SIS	$^{37,38m}K$ (20kV)	DRAGON (CSB), TRINAT	
UC	SIS/RILIS	$^{32,34}Mg$, $^{30\text{-}34}Al$, K,Sr,Fr,Ac	TITAN, FrPNC, TIGRESS, Nucl.Med.	
SiC	FEBIAD	^{18}F, ^{18}Ne, $^{14,15}O$	TUDA, DRAGON, TITAN	Challenging intensity requirements, need optimal performance
Nb	SIS/RILIS	$^{74,76}Rb$, ^{70}Sr, Y	TITAN,TIGRESS, Laser,	20-8 kV for laser, CSB

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Target modules

TM	HV	Sources	availability
1	24 kV max	SIS/LP	ready
2	~57 kV	FEBIAD/SIS/HP	Spring 2015
3	~ 20 kV	FEBIAD/SIS/HP	ready (broken steerer)
4	50 kV	SIS/IGLIS/HP	ready

refurb.in progress -> Dec 2014

➔ refurbishing -> 2014-2015

Tgt/Src	Voltage need	TM	Availability for approved priority experiments
HP SiC-FEBIAD	53/57kV	2	2015 due to requirement on FEBIAD performance
HP SiC-SIS	53/57 kV	4 (53kV?)/ 2	TM4 risky, TM2 not in Schedule 127
HP (LP) Ta-SIS	20-30 kV	4 / 3 / (1)	Ready for Schedule 127
LP TiC-SIS	20-30 kV	4 / 3 / 1	Ready for Schedule 127
LP ThO/UC-SIS	20-30 kV	4 / 3/ 1	Ready for Schedule 127
LP UC-FEBIAD	20-30kV	3	Ready for Schedule 127
HP Nb-SIS	20-30 kV	4 / 3	Ready for Schedule 127
LP Zr-SIS	20-30 kV	4 / 3 / 2	Ready for Schedule 127

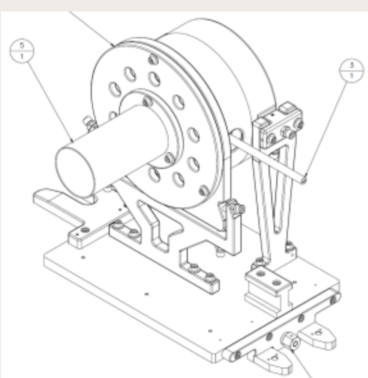
Target Module 2: Source Tray & Einzel Lens Refurbishment

~85% of machined components for 3 source trays complete and inspected

Ultrasonic cleaning & bench assembly of new TM2 source tray sub-components underway

Source tray fastener inventory complete and 95% replenished

Einzel lens tray sub - assembly redesign complete, drawings submitted to shop



Remaining: precision assembly, alignment & cooling line soldering

Upcoming milestones (based on current resource assumptions):

- Source tray parts – May 2014
- Einzel lens parts – June 2014
- Completion of source tray assembly – Aug 2014
- Completion of Einzel lens tray assembly – Sept 2014
- Installation into TM2 (Hot Cell) – Oct thru Nov 2014
- Testing and commissioning – Dec 2014

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Schedule 126 / 127

#	TM	Target	Ion Source	Delivery goals	Development goals
1	TM4	Ta-LP	SIS/RILIS	^{12}Be (IRIS), ^{8}Li (bNMR, MTV)	$^{101-106}$Sn, ^{7}Be
2	TM3	TiC-LP	SIS	^{38}K (DRAGON), ^{37m}K(TRINAT)	$^{35-37}$Ca
3	TM1	UC-LP	SIS/RILIS	^{95}Sr (TIGRESS) ^{34}Mg (TITAN), Fr,Ac	$^{30-33}$Na,
4	TM3	SiC-HP	FEBIAD	^{14}O (GPS, TITAN), ^{8}He (TAMU)	^{7}Be
5	TM1	Ta-LP	SIS/RILIS	^{11}Be (TIGRESS), , ^{8}Li (bNMR)	^{78}Y, ^{7}Be
6	TM4	UC-LP	SIS/RILIS	^{34}Al (TITAN), ^{31}Na (OSAKA), Fr, Ac, $^{202-208}$Fr (Laser)	FEBIAD: Ar, Ne, Kr, Xe, I
	Mini-Shutdown				
	TM3/4	Ta-HP	SIS/RILIS	^{11}Li (IRIS), ^{9}Li	
	TM3/4	Nb-HP	SIS/RILIS	^{74}Rb (TITAN?) ^{76}Rb (TIGRESS), ^{70}Sr, Y (LASER)	
	TM1	UC-LP	SIS/RILIS	^{32}Na GRIFFIN,	
	TM1/3/4	ZrC-LP	SIS/RILIS	^{62}Ga GRIFFIN, would also work for Rb, Sr Y beams and could replace Nb-HP	
	TM3	ThO-LP	FEBIAD	Ar?	Establish broad spectrum of yields

SAP ISAC Backlog

Target	H	M	
Nb-SIS/LIS	4	13	βNMR capability
NiO-FEBIAD	2	20	
SiC-FEBIAD	**56**		
SiC-SIS/IGLIS	14		
SiC-SIS/LIS	**57**	4	
Ta-SIS/IG-LIS	5		
Ta-SIS/LIS	**112**	15	βNMR capability
TiC-FEBIAD		20	
TiC-SIS	**54**		
UC-FEBIAD	30	3	
UC-SIS/LIS	**123**		
ZrC-FEBIAD	12	13	
ZrC-SIS/LIS	14		comparable to Nb
Total shifts:	**485**	**99**	

as of June 1, 2014

~ 60 shifts per target

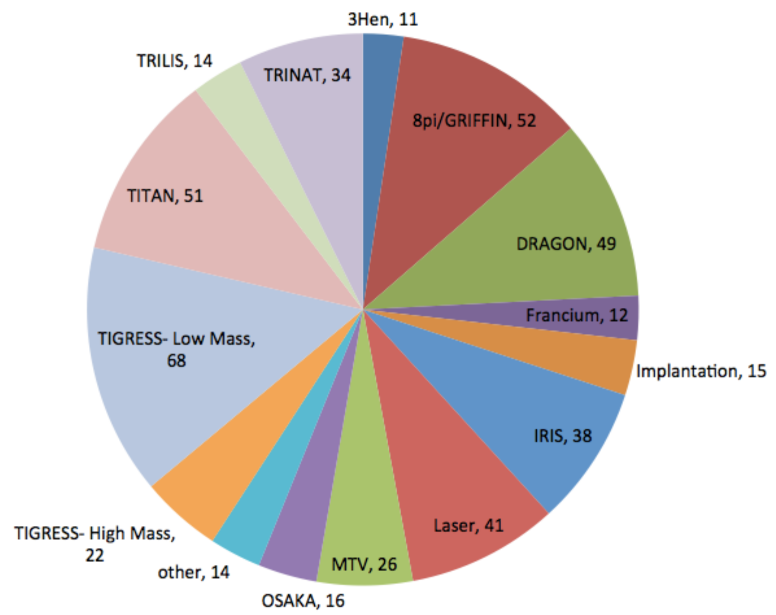
ISAC Backlog and requests

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**

June 1, 2014:
485 RIB shifts with H priority (2.3 yrs)

99 RIB shifts with M priority (0.5 yrs)



ISAC-RIB shifts quota: 105 shifts

➔ RIB oversubscription factor 2.54

	ISAC-RIB	ISAC-SIB
Status Reports/Addenda	150	0
New Proposals	117	26
Sum	**267**	**26**

Thank you!
Merci!

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