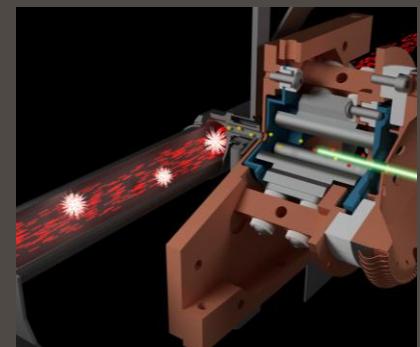
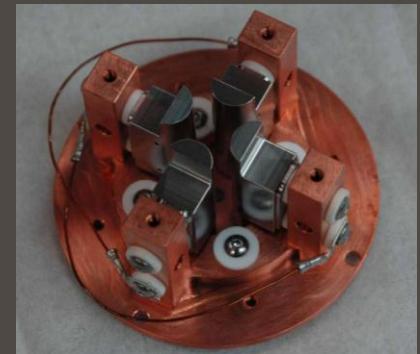
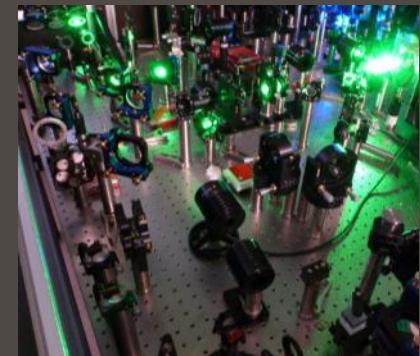


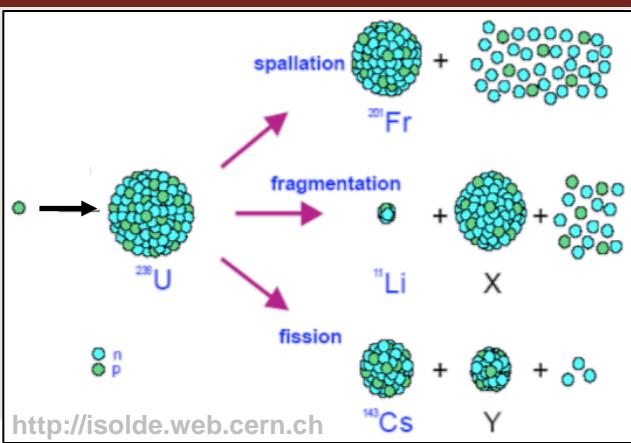
# Maiden run of the Ion Guide - Laser Ion Source (IG-LIS) (Formerly RFQ-LIS)

## Ion source for isobaric clean beams

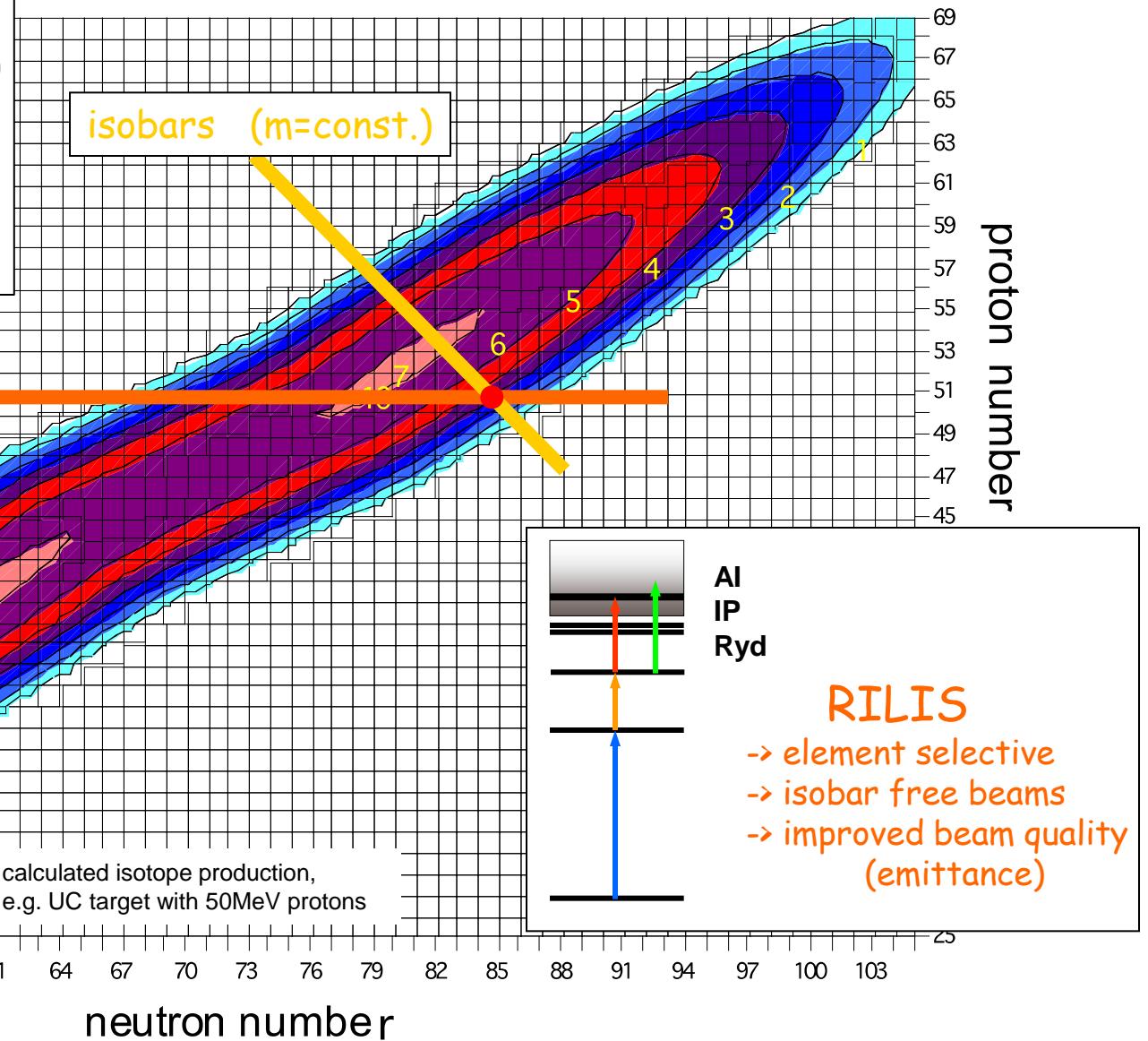
Henning Heggen M.Sc. | Grad. Research Assistant TRILIS | TRIUMF

ISAC Science Forum May 8, 2013

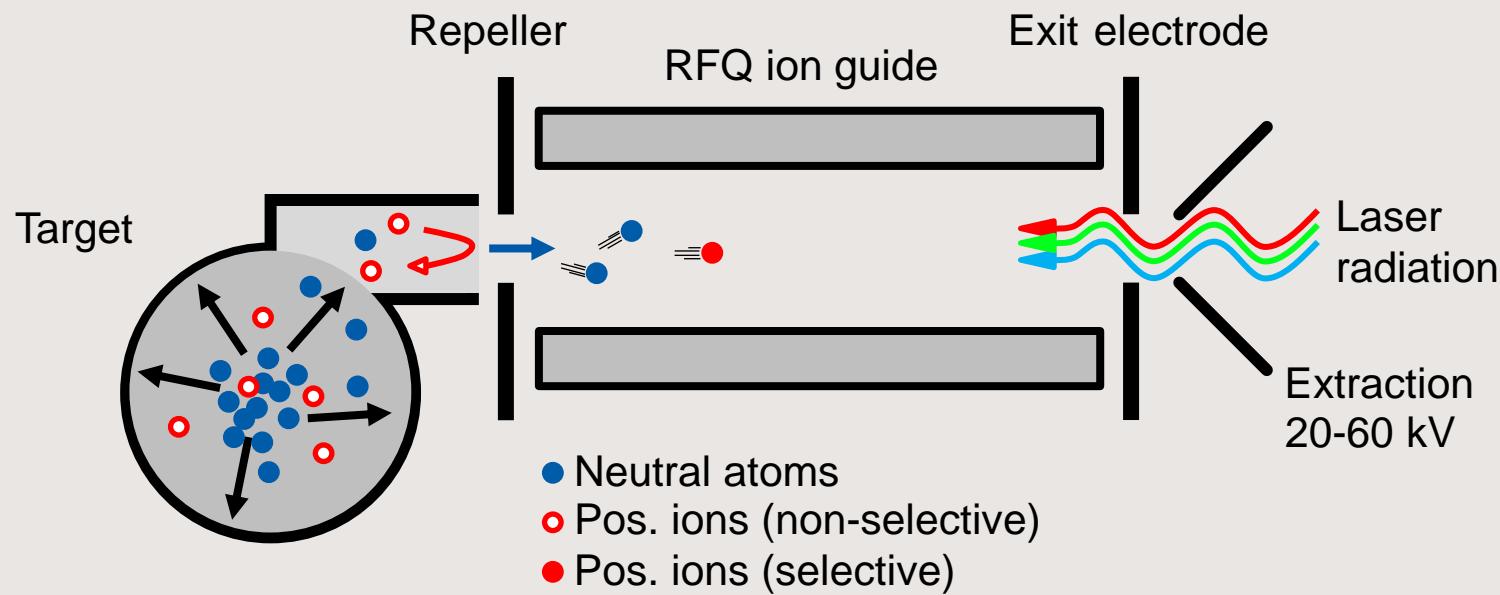




RILIS:  
element selective  
isotopes



- Decoupling of evaporation processes and laser ionization
  - Suppression of surface ions from target
  - Laser ionization in “cold” environment



- Drawback: Decrease of ionization efficiency
  - Shorter interaction time of atoms and lasers
  - Limitation of accepted ionization volume

Proposed by:  
K. Blaum, C. Geppert and H.-J. Kluge et al.,  
*Nucl. Instr. Meth. Phys. Res. B*, 204, 2003

# Technical realization: IG-LIS @ ISAC

Repulsion of ions created inside the target  
(Shifting of target and repeller electrode potentials)

RF quadrupole ion guide for radial confinement of created ions

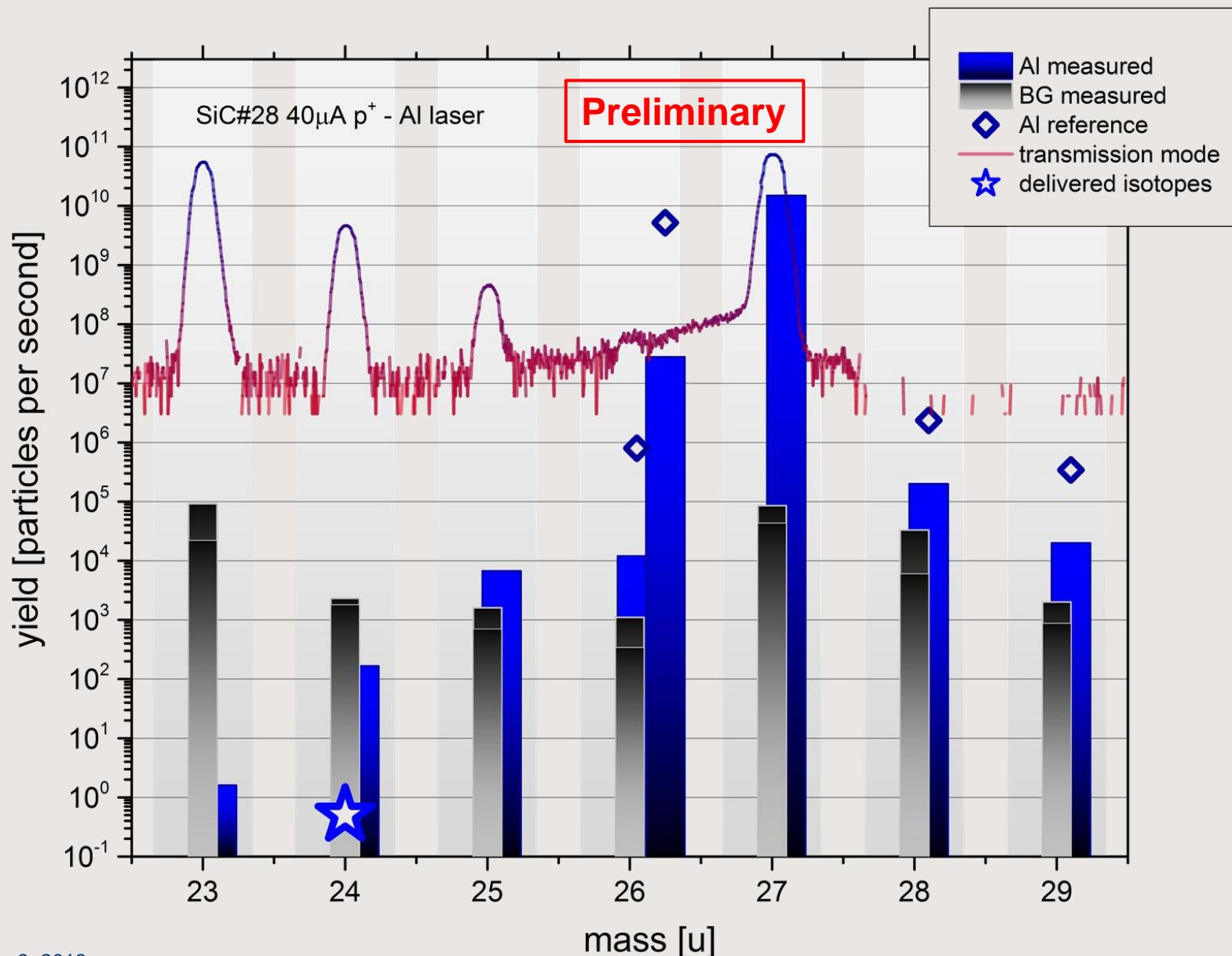
Copper heat shield  
(water cooled)

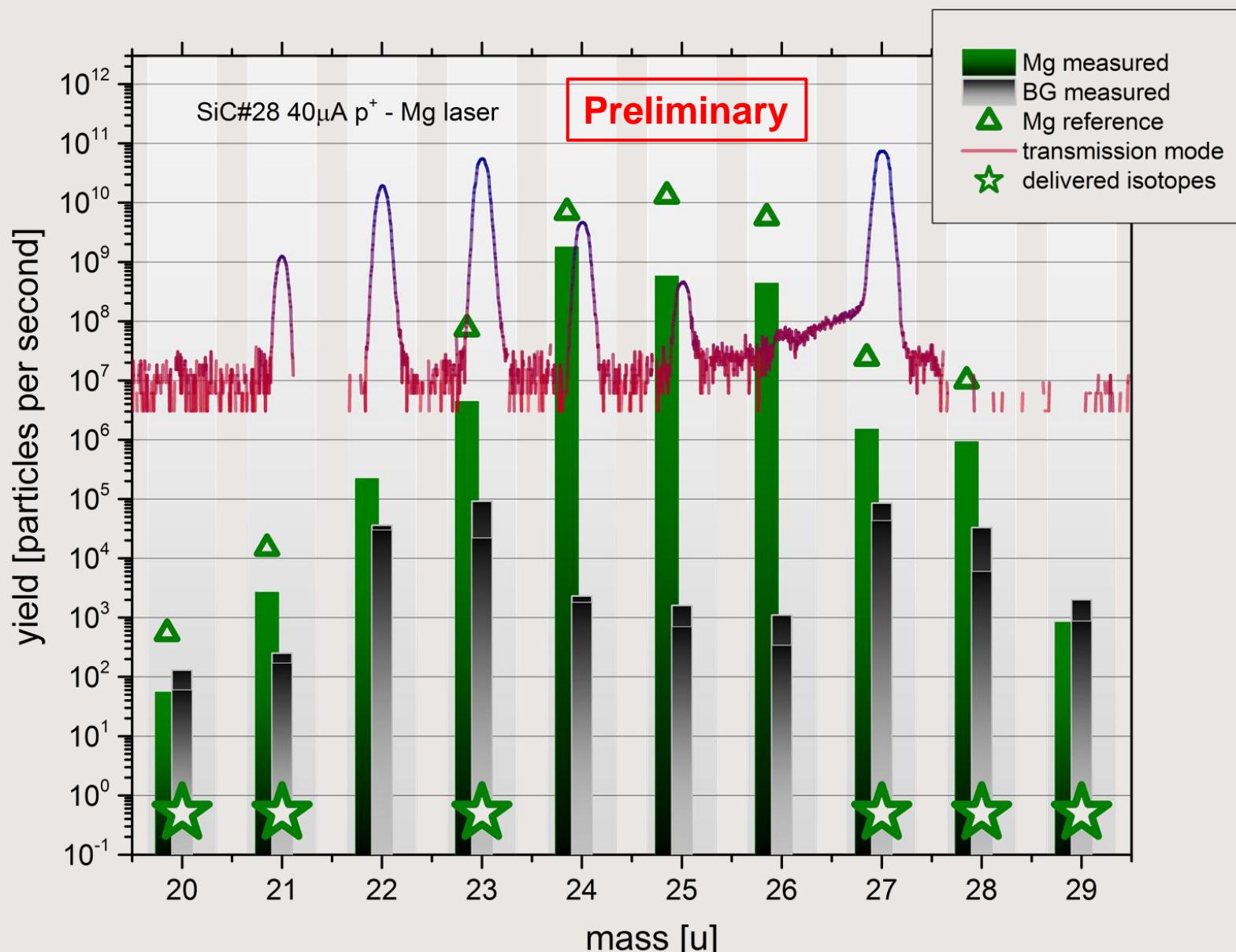
Proton beam

10mm

Element selective laser ionization  
in cold environment

Laser radiation

IG-LIS AI yield overview SiC 40 $\mu$ A

IG-LIS Mg yield overview SiC 40 $\mu$ A

- Problem-free maiden run of new ion source
- Isobar suppression of up to  $10^6$  demonstrated (Na)
- Yield reduction seen typically < 50
- 7 RIBs successfully delivered to experiment
  - Some of which were not accessible before (Na contamination)

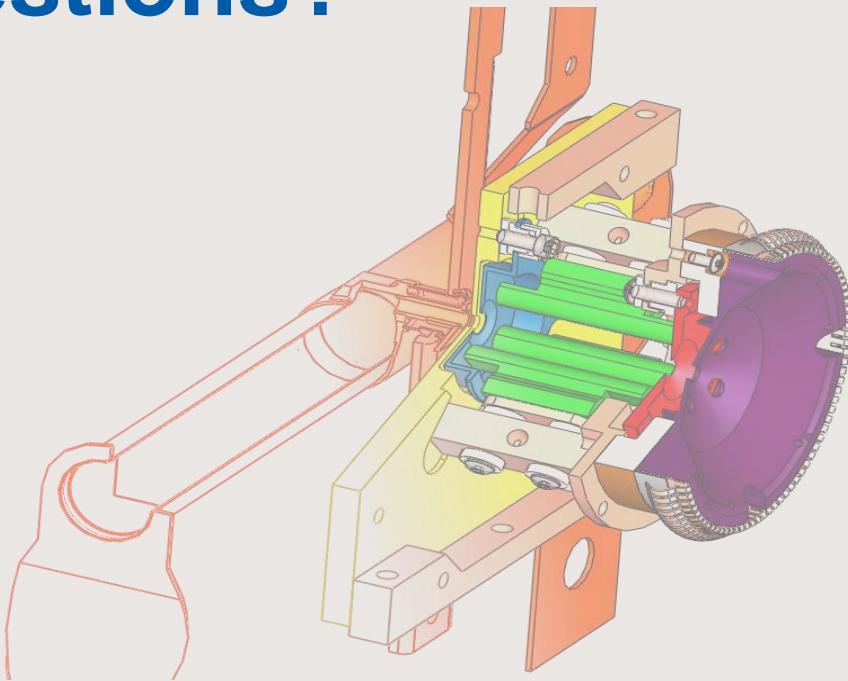
Si 28.0855	Si 22 29 ms	Si 23 42.3 ms	Si 24 140 ms	Si 25 218 ms	Si 26 2.21 s	Si 27 4.16 s	Si 28 92.223	Si 29 4.685	Si 30 3.092	Si 31 2.62 h		
$\sigma 0.166$	$\beta^+$ $\beta p 1.99, 1.83...$	$\beta^+$ $\beta p 2.40, 2.83...$ $\beta p 5.88, 6.18...$	$\beta^+$ $\beta p 1.51, 4.09...$	$\beta^+$ $\beta p 4.09; 0.39, 3.33...$ $\gamma$	$\beta^+ 3.8...$ $\gamma 829; 1622...$	$\beta^+ 3.8...$ $\gamma(2210...)$	$\sigma 0.17$	$\sigma 0.12$	$\sigma 0.107$	$\beta^- 1.5...$ $\gamma(1286)$ $\sigma 0.073$		
Al 26.981538	Al 21 35 ns	Al 22 59 ms	Al 23 470 ms	Al 24 129 ms $\beta^+ 1.2...$ $\gamma 133...$ $\gamma 136...$ $\gamma 142...$ $\gamma 175...$ $\gamma 209...$ $\gamma 234...$ $\gamma 238...$ $\beta p 0.24...$ $\beta p 1.97...$	Al 25 2.07 s $\beta^+ 1.2...$ $\gamma 133...$ $\gamma 136...$ $\gamma 142...$ $\gamma 175...$ $\gamma 209...$ $\gamma 234...$ $\gamma 238...$ $\beta p 0.24...$ $\beta p 1.97...$	Al 25 7.18 s	Al 26 6.35 s $\beta^+ 1.2...$ $\gamma 1809...$ $\gamma 1812...$ $\gamma 1816...$ $\beta^+ 3.3...$ $\gamma(1612...)$	Al 26 7.16-10 <sup>3</sup> s $\beta^+ 1.2...$ $\gamma 1809...$ $\gamma 1812...$ $\gamma 1816...$ $\beta^+ 3.2...$ $\alpha 0.230$	Al 27 100	Al 27 2.246 m	Al 28 6.6 m	Al 29 3.60 s
	p ?											
	Mg 20 95 ms	Mg 21 122.5 ms	Mg 22 3.86 s	Mg 23 11.3 s	Mg 24 78.99	Mg 25 10.00	Mg 26 11.01	Mg 27 9.46 m	Mg 28 20.9 h	Mg 29 1.30 s		
	$\beta^+$ $\gamma 984; 275...$ $\gamma 332; 1384...$ $\gamma 238...$ $\beta p 0.77, 1.59...$ $\beta p 1.94; 1.77...$	$\beta^+$ $\beta p 1.2...$ $\beta p 2.5...$ $\gamma 351...$	$\beta^+ 3.2...$	$\beta^+ 3.1...$			$\beta^- 1.8...$ $\gamma 844; 1014...$ $\sigma 0.038$	$\beta^- 0.9...$ $\gamma 31; 1342...$ $\sigma 0.07$	$\beta^- 0.5; 0.9...$ $\gamma 31; 1342...$ $\beta p 1.942...$ $\beta p 1.960...$	$\beta^- 4.3; 7.5...$ $\gamma 2224; 1398...$ $\beta p 1.942...$ $\beta p 1.960...$		
Na 18 350 keV $1.3 \cdot 10^{-21}$ s	Na 19 40 ns	Na 20 446 ms	Na 21 22.48 s	Na 22 2.603 a $\beta^+ 0.5; 1.8...$ $\sigma_{n,p} 28000$ $\sigma_{n,p} 260$	Na 23 100	Na 24 20 ms $\beta^- 1.4...$ $\gamma 975; 390...$ $\gamma 1275...$ $\sigma_{n,p} 260$	Na 25 14.96 s $\beta^- 1.4...$ $\gamma 975; 390...$ $\gamma 1275...$ $\sigma_{n,p} 260$	Na 25 59.6 s $\beta^- 3.8...$ $\gamma 985; 1698...$ $\gamma 1474...$ $\sigma_{n,p} 260$	Na 26 1.07 s $\beta^- 7.4...$ $\gamma 1809...$	Na 27 304 ms $\beta^- 8.0...$ $\gamma 985; 1698...$ $\gamma 1474...$ $\sigma_{n,p} 260$	Na 28 30.5 ms $\beta^- 13.8...$ $\gamma 1474...$ $\sigma_{n,p} 260$	
$\beta^+$ $\beta^-$ $\gamma$	p	$\beta^+ 11.2...$ $\beta a 2.15, 4.44...$ $\gamma 1024...$	$\beta^+ 2.5...$ $\gamma 351...$		$\sigma 0.43 \pm 0.1$	$\sigma 0.472$ $\sigma^- 6$	$\sigma 0.472$ $\sigma^- 6$	$\sigma 0.472$ $\sigma^- 6$	$\sigma 0.472$ $\sigma^- 6$	$\sigma 0.472$ $\sigma^- 6$		
Ne 17 109.2 ms $\beta^+ 8.0; 13.5...$ $\beta p 4.59, 3.77...$ $\gamma 5.12...$ $\gamma 495, 6129...$	Ne 18 1.67 s $\beta^+ 3.4...$ $\gamma 1042...$	Ne 19 17.22 s $\beta^+ 2.2...$ $\gamma(110, 197; 1357)$	Ne 20 90.48	Ne 21 0.27	Ne 22 9.25	Ne 23 37.2 s	Ne 24 3.38 m	Ne 25 602 ms $\beta^- 2.0...$ $\gamma 440; 1839...$	Ne 26 197 ms $\beta^- 7.3...$ $\gamma 90, 980...$	Ne 27 31.5 ms $\beta^-$ $\gamma 83, 233...$ $\beta n$		
						$\sigma 0.7$	$\sigma 0.00018$	$\sigma 0.051$				

- Next run planned for Dec 2013
  - Heavier isotopes from UCx Target
- Several requested beams require isobaric purification
  - Suppression of surface ionized Cs and Fr
  - Beam requests: TITAN, 8Pi

Ac 213 0.80 s	Ac 214 8.2 s	Ac 215 0.17 s	Ac 216 0.44 ms	Ac 217 0.74 μs	Ac 218 69 ns	Ac 219 1.1 μs	Ac 220 11.8 μs	Ac 221 26 ms	Ac 222 52 ms	Ac 223 63 s	Ac 224 5.0 s	Ac 225 2.10 m	Ac 226 2.9 h	Ac 227 10.0 d	Ac 228 29 h	Ac 229 27.73 s
α 7.36  γ 139; 244...	α 7.215; 7.081...  γ 139; 244...	α 7.600; 7.211...  γ (396...)...	α 9.029; 9.105...  γ 83; 854; 771...	β<sub>000</sub> 486; 382; 10.54...  γ 9.85	β<sub>000</sub> 7.68... 7.68... 10.54...  γ 9.85	α 9.205 g	α 8.664	β<sub>05</sub> 7.85; 7.61; 7.68... γ 134...  γ 7.38...	β<sub>05</sub> 7.65; 7.44; 7.38...  γ 7.14...	β<sub>05</sub> 6.81; 6.75; 6.69... 7.009; 7.009;... γ 9.95...	β<sub>05</sub> 6.647; 6.662; 6.564;... γ 199; 191; 84...  γ 218; 132...	β<sub>05</sub> 6.530; 5.793; 5.732;... γ 100; (150; 188; 63...); e-	β<sub>05</sub> 6.142; 6.142;... 6.060; 6.214... γ 230; 158; 254; 186...	β<sub>05</sub> 0.9; 1.1 e-; 0.534 γ 100; 4.941... γ (100; 4.941... γ 880; σ<0.00035		
Ra 212 13.0 s	Ra 213 2.1 ms	Ra 214 2.46 s	Ra 215 1.67 ms	Ra 216 2.0 ns	Ra 217 0.18 μs	Ra 218 1.6 μs	Ra 219 25.6 μs	Ra 220 10 ms	Ra 221 23 ms	Ra 222 28 s	Ra 223 38 s	Ra 224 11.43 d	Ra 225 3.66 d	Ra 226 14.8 d	Ra 227 1600 a	
α 6.899...  γ 7... (835)	α 6.292; 6.384...  γ 834; 540...	α 7.137; 6.605...  γ (642)	α 6.700; 7.879...  γ 834; 540...	β<sub>000</sub> 344... 11.028...  γ 9.349	β<sub>000</sub> 7.68... 7.68... 11.028...  γ 9.349	α 8.99 g	α 8.39	β<sub>000</sub> 7.679; 7.989... γ 316; 214; 592...  γ 465	β<sub>000</sub> 7.46... γ 465	β<sub>000</sub> 6.613; 6.761;... γ 149; 93; 174... C 14	β<sub>000</sub> 6.559; 6.237... γ 269; 154; 324... C 14; C 14	β<sub>000</sub> 5.7182; 5.6867;... γ 206; 211; 242... C 14; C 14	β<sub>03</sub> 0.4... e-; 0.7 γ 40	β<sub>03</sub> 0.4... e-; 0.7 γ 13 σ<7E-6		
Fr 211 3.10 m	Fr 212 20.0 m	Fr 213 34.6 s	Fr 214 3.35 ms	Fr 215 5.0 ms	Fr 216 0.09 μs	Fr 217 0.70 μs	Fr 218 16 μs	Fr 219 22 ms	Fr 220 1.0 ms	Fr 221 21 ms	Fr 222 27.4 s	Fr 223 4.9 m	Fr 224 14.2 m	Fr 225 21.8 m	Fr 226 3.3 m	Fr 227 4.0 m
α 6.535...  γ 5.918; 918... 281...	α 6.292; 6.384...  γ 540; 340... 1274; 227; 1165...	α 6.775...  γ 847; 8426... 8.356...	α 6.477; 6.426...  γ 834; 540...	α 9.36	α 9.01 g	α 8.315	β<sub>000</sub> 7.815; 7.886... 7.656... m; g γ 7.857; 7.9... γ (352; 517...)	β<sub>000</sub> 7.857; 7.9... γ 7.312... γ (45; 106; 162...)	β<sub>000</sub> 7.857; 7.9... γ 7.312... γ (45; 106; 162...)	β<sub>000</sub> 6.68; 6.63;... 6.58... γ 6.425; 6.425... C 14	β<sub>000</sub> 6.341; 6.126... γ 216; (101; 411...)... C 14	β<sub>000</sub> 1.8... γ 206; 211; 242... C 14	β<sub>000</sub> 1.1... e-; 0.534 γ 50; 80; 235...	β<sub>000</sub> 2.6; 2.6... γ 216; 132; 206; 211; 242... C 14	β<sub>000</sub> 1.6... γ 216; 132; 206; 211; 242... C 14	β<sub>000</sub> 1.6... γ 182; 32... γ 206; 211; 242... C 14
Rn 210 2.4 h	Rn 211 14.6 h	Rn 212 24 m	Rn 213 19.5 ms	Rn 214 2.3 μs	Rn 215 45 μs	Rn 216 0.54 ms	Rn 217 35 ms	Rn 218 3.96 s	Rn 219 35 ms	Rn 220 55.6 s	Rn 221 23 ms	Rn 222 3.825 d	Rn 223 23.2 m	Rn 224 1.78 h		
α 6.040...  γ 458; (571; 649; 73...)...	α 5.783; 5.851...  γ 674; 1363; 678...; g	α 6.264...  γ 540...	α 8.088; 7.252...  γ 540...	β<sub>000</sub> 182; 446; 302... γ 10.46; 9.037...	β<sub>000</sub> 7.686; 7.686... 7.686... γ 9.037...	α 8.67 g	α 8.05	α 7.740...  γ (609)	α 7.133...  γ (609)	α 6.819; 6.553; 6.425;... γ (550) σ<0.2	α 6.288... γ 271; 402;...  γ (609)	α 6.037; 5.788; 5.778... γ (510) γ 186; 150...	β<sub>000</sub> 0.8; 1.1... e-; 0.534 γ 50; 80; 235...	β<sub>000</sub> 1.6... γ 216; 132; 206; 211; 242... C 14	β<sub>000</sub> 2.6; 2.6... γ 216; 132; 206; 211; 242... C 14	β<sub>000</sub> 1.6... γ 182; 32... γ 206; 211; 242... C 14
At 209 5.4 h	At 210 8.3 h	At 211 7.22 h	At 212 119 ms	At 213 314 ms	At 214 0.11 μs	At 215 0.76 μs   0.27 μs   0.58 μs	At 216 0.1 ms	At 217 ?	At 218 ~2 s	At 219 0.9 ms	At 220 ~2 s	At 221 3.71 m	At 222 2.3 m	At 223 54 s	At 224 50 s	At 225 138
α 5.524; 5.524...  γ 545; 782; 1181; 245; 790...; g	α 5.867...  γ 887; 887...; g	α 5.867...  γ 887; 887...; g	β<sub>000</sub> 7.84; 7.62; 7.62... γ 63... e-...  α 9.08	β<sub>000</sub> 7.84; 7.62; 7.62... γ 63... e-...  α 9.08	β<sub>000</sub> 8.762; 8.819... γ 9... γ 1...  γ (405)	α 8.026... γ (405)	α 7.488... γ (703)	β<sub>000</sub> 7.804; 7.991;... γ (115; 418; 595...)...	β<sub>000</sub> 7.069... γ (115; 418; 595...)...	α 6.694; 6.653... γ (259; 334; 595...)...	β<sub>000</sub> 6.27 β<sub>000</sub>	β<sub>000</sub> 5.403 γ 241; 293;... γ (103)	β<sub>000</sub> ?	β<sub>000</sub> ?	β<sub>000</sub> ?	β<sub>000</sub> ?
Po 208 2.898 a	Po 209 102 a	Po 210 138.38 d	Po 210 25.2 s	Po 211 0.516 s	Po 212 45.1 s   17.1 ms   0.3 μs	Po 213 4.2 μs	Po 214 164 μs	Po 215 1.78 ms	Po 216 0.15 s	Po 217 1.53 s	Po 218 3.05 m	Po 219 >300 ns	Po 220 >300 ns			
α 5.1152...  γ (292; 571...)...	α 4.881...  γ (895; 261; 263...)	α 5.30438...  γ (803); σ<0.0005 +<0.030; σ<0.002; σ<0.1	α 7.275; 8.883...  γ (895; 223; 570...)	β<sub>000</sub> 7.65; 7.728; 7.728... γ (104; 800; 298...)	β<sub>000</sub> 7.65; 7.728; 7.728... γ (104; 800; 298...)	α 8.376... γ (779)	α 7.6869... γ (439...)	β<sub>000</sub> 7.6869... γ (800; 298...)	β<sub>000</sub> 7.6783... γ (805)	α 6.543... β<sub>000</sub>	α 6.0024... β<sub>000</sub>	β<sub>000</sub> ?	β<sub>000</sub> ?	β<sub>000</sub> ?	β<sub>000</sub> ?	

# Thank You!

# Questions?



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