Superheavy Element Search Campaign at TASCA

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for the *TASCA and* TASISpec collaboration

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"Nuclear Fission and Decay of Exotic Nuclei"
JAEA, TOKAI, Japan
March 21-22, 2013

The *TASCA* Collaboration

LBNL/UCB Berkeley (USA)
LLNL Livermore (USA)
Vanderbilt U (USA)
ORNL Oak Ridge (USA)
U Liverpool (UK)
U Surrey (UK)
U Lund (Sweden)
JAEA Tokai (Japan)

U Jyväskylä (Finland)
U Oslo (Norway)
Chalmers U Gothenburg (Sweden)
PSI Villigen/U Berne (Switzerland)
ITE Warschau (Poland)
SINP Kolkata (India)
IMP Lanzhou (China)
ANU Canberra (Australia)

Courtesy of Ch.E. Düllmann

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- Search for new elements with Z>118
- Experimental setup
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    - X-ray spectroscopy of element 115
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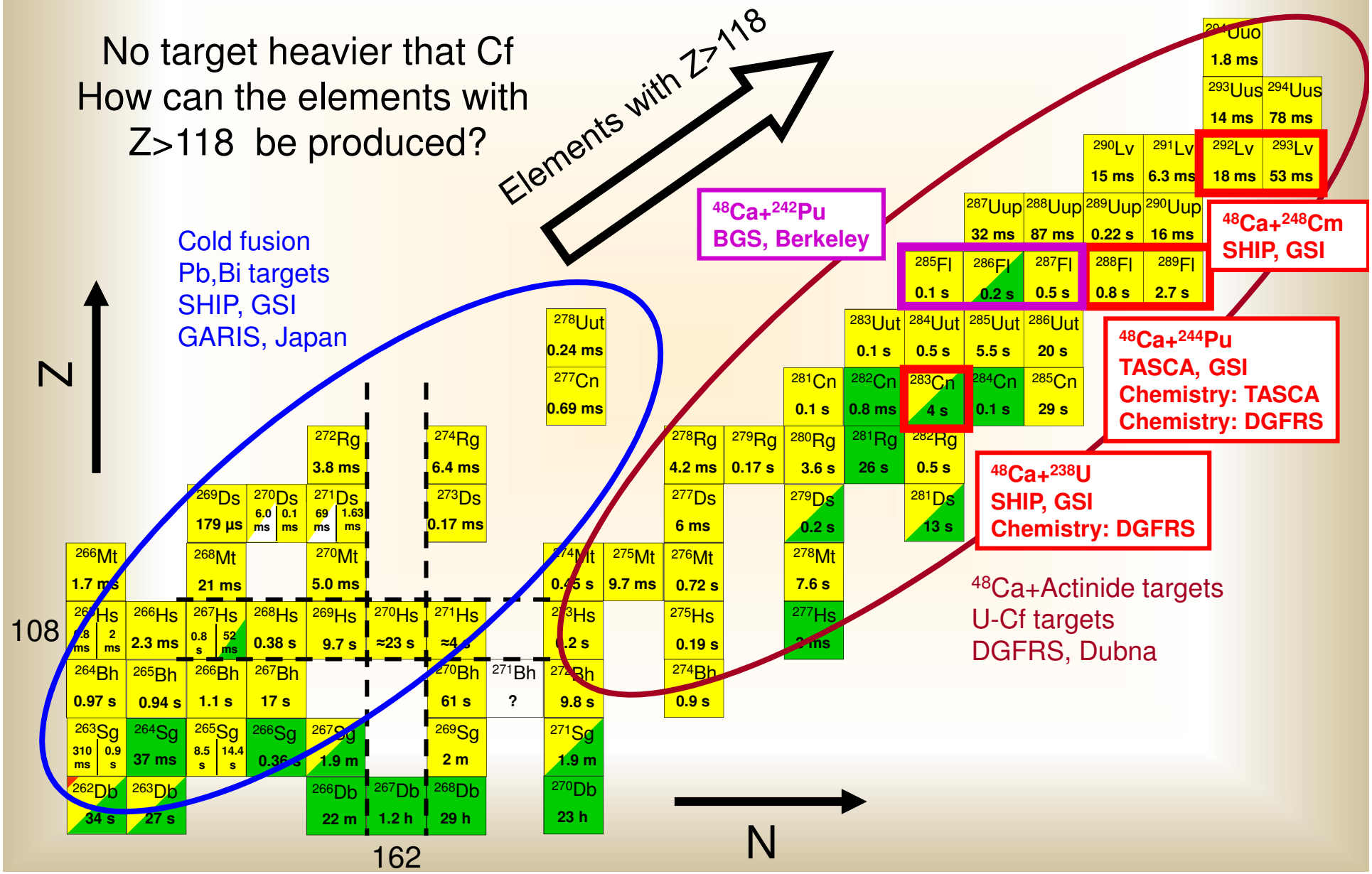
Present status on SHE

Theory: Spherical nuclei
N=184 and Z=114,120,126 ?



Reactions for formation of element 119/120

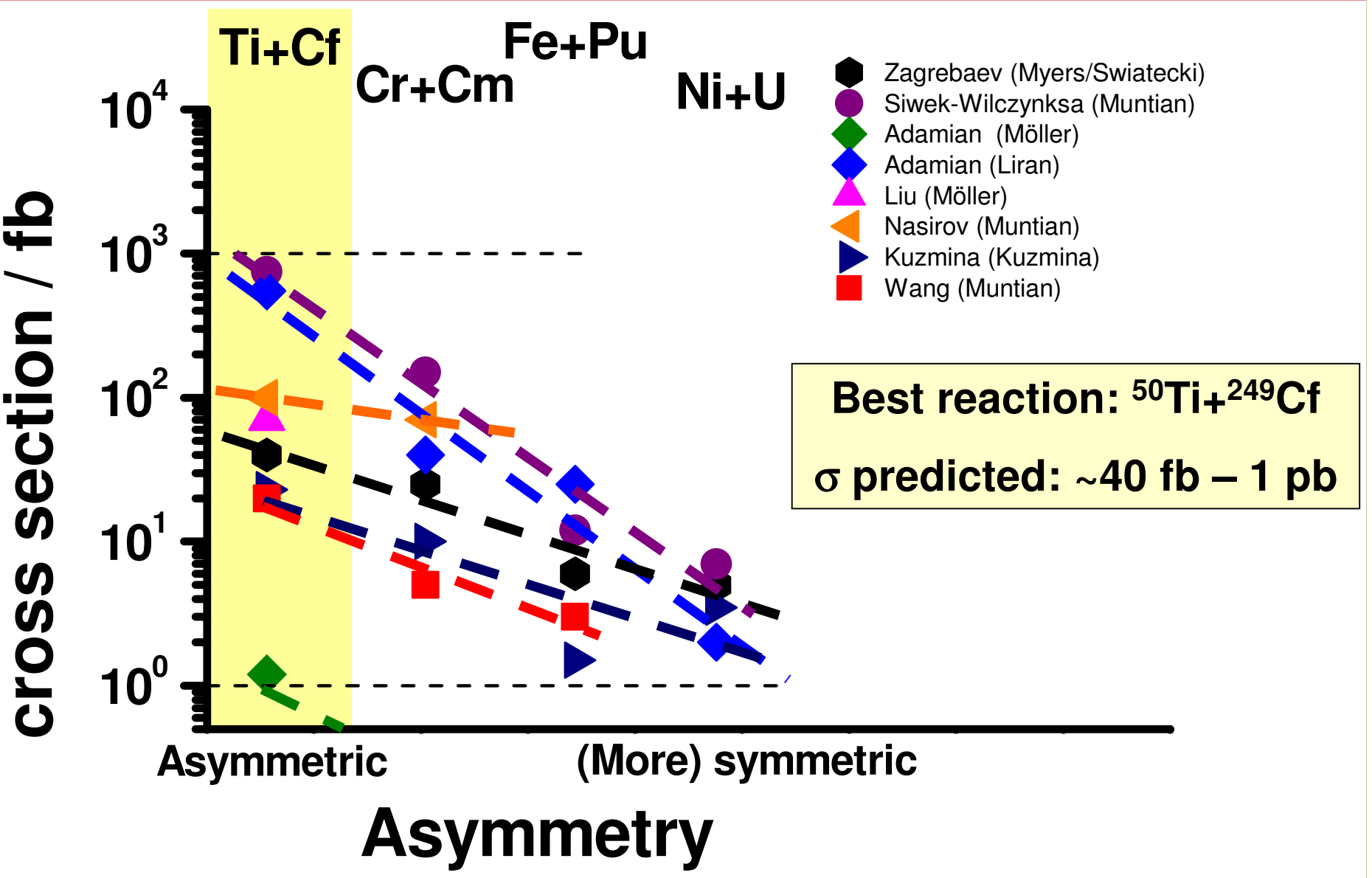
Element 119

Z_{Beam}	Beam	Target	$E^*@B_{Bass}$
21	^{45}Sc	^{249}Cf	41.7
22	^{50}Ti	^{249}Bk	32.4
23	^{51}V	^{248}Cm	36.8
24	^{54}Cr	^{243}Am	31.5
25	^{55}Mn	^{244}Pu	37.7
26	^{58}Fe	^{237}Np	29.9
27	^{59}Co	^{238}U	36.7

Element 120

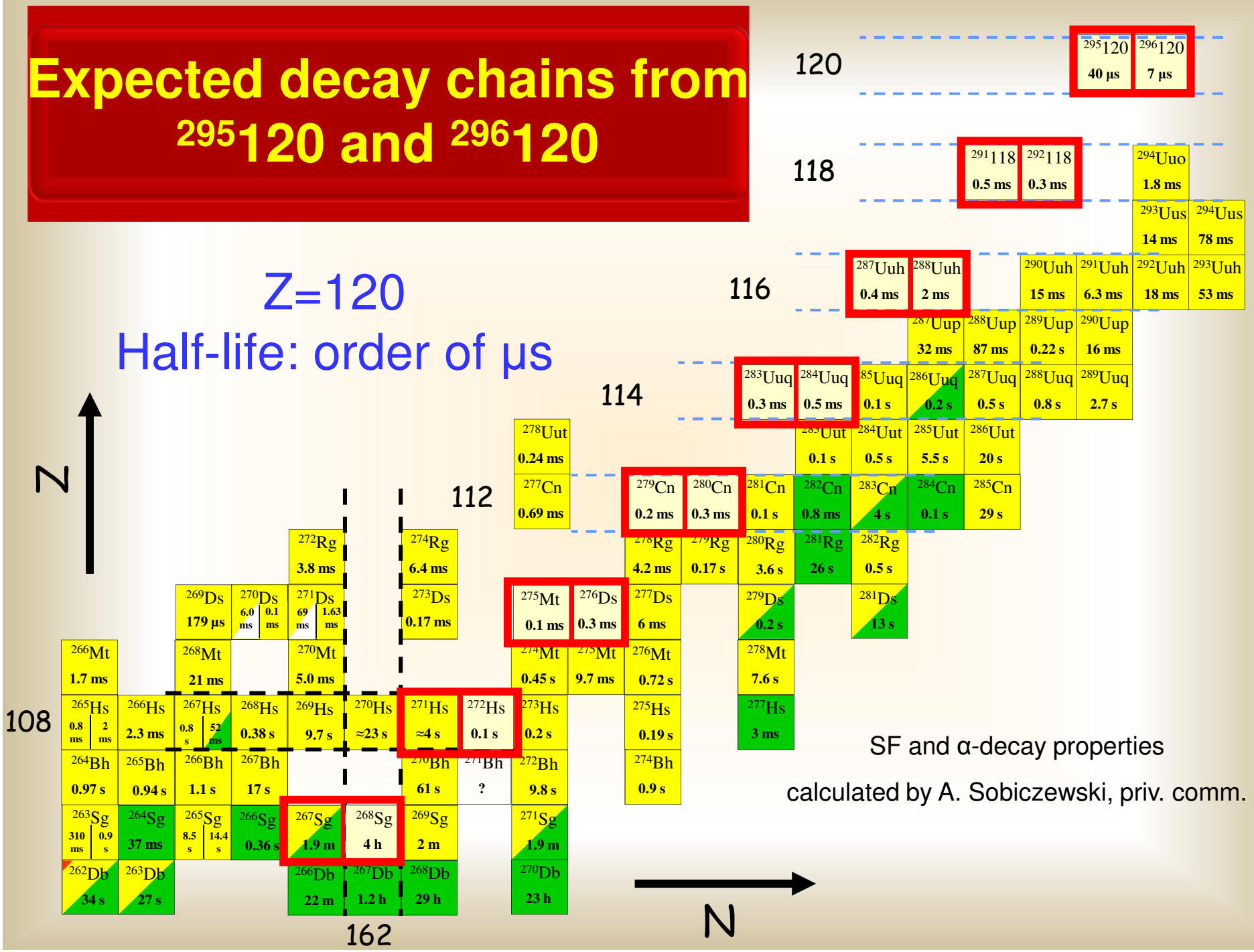
Z_{Beam}	Beam	Target	$E^*@B_{Bass}$
21			
22	^{50}Ti	^{249}Cf	31.7
23	^{51}V	^{249}Bk	35.9
24	^{54}Cr	^{248}Cm	33.0
25	^{55}Mn	^{243}Am	34.5
26	^{58}Fe	^{244}Pu	33.9
27	^{59}Co	^{237}Np	32.9
28	^{64}Ni	^{238}U	27.3

The reactions for production of the element 120



Courtesy of Ch.E. Düllmann

Expected decay chains from $^{295}120$ and $^{296}120$

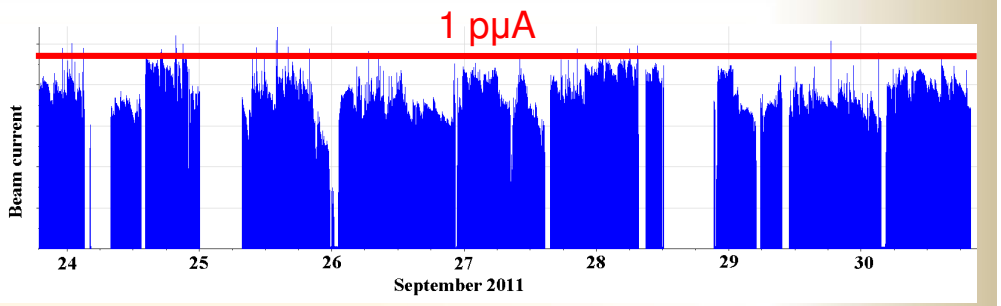


Experimental setup

Experimental challenges

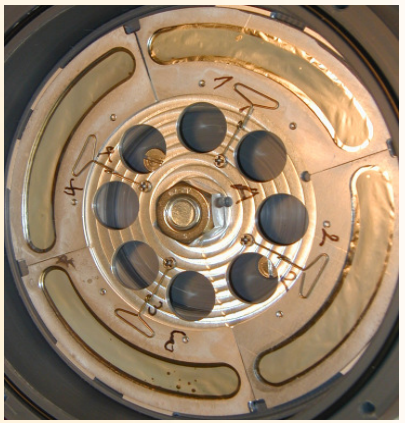
✓ 1) Stable and reliable ^{50}Ti beam

Ion source + UNILAC groups, Target lab GSI + HIM



✓ 2) New target wheel for high intensity beam

TASCA, GSI experimental electronics



Ø Target Wheel: 100 mm
Ø Beam Spot: 8 mm

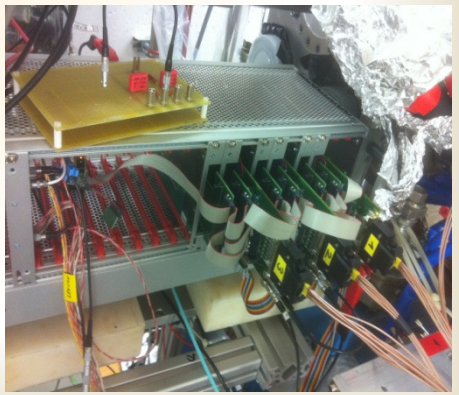
Tested with ^{40}Ar up to 2500 particle·nA on ^{nat}Gd

✓ 3) Production of ^{249}Cf and ^{249}Bk targets

LBNL, Berkeley; ORNL, Oak Ridge;
Inst. Nuclear Chemistry Uni Mainz; GSI target lab

✓ 4) New „fast“ electronics for μs-activities

GSI experimental electronics, Univ. Lund, Sweden, HIM



✓ 5) Improved background suppression and charge state predictions of heavy ions at ***TASCA***

TASCA, GSI and LBNL, Berkeley, USA

Preparatory experiments

Preparatory experiments

$^{50}Ti + ^{204}Pb \rightarrow ^{254}Rf^*$

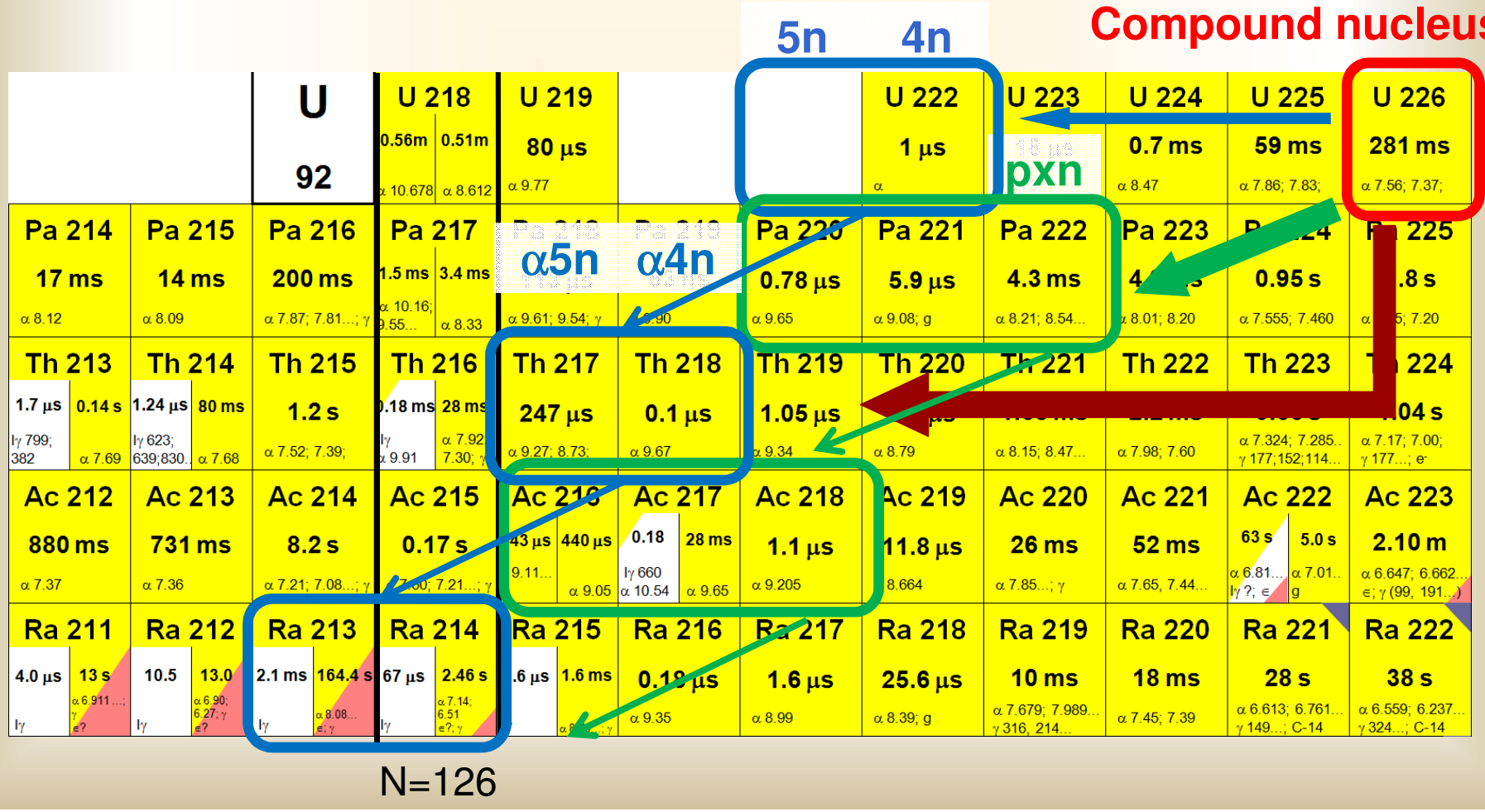
$^{50}Ti + ^{206}Pb \rightarrow ^{256}Rf^*$

$^{50}Ti + ^{208}Pb \rightarrow ^{258}Rf^*$

$^{50}Ti + ^{175}Lu \rightarrow ^{225}Np^*$

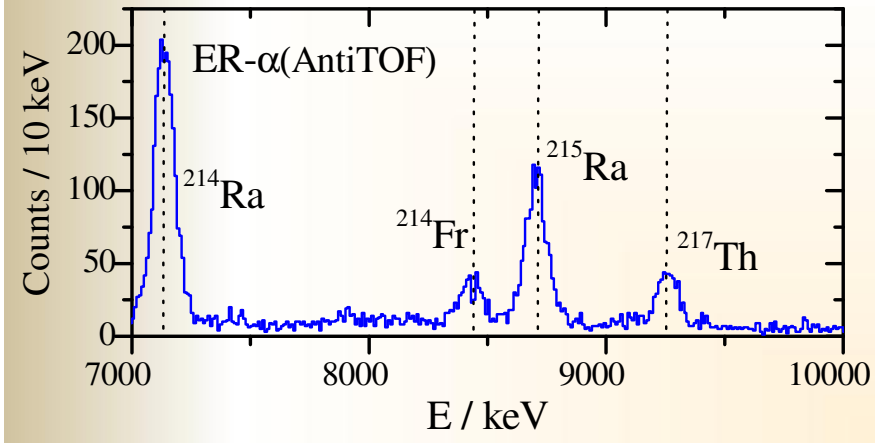
$^{50}Ti + ^{176}Yb \rightarrow ^{226}U^*$

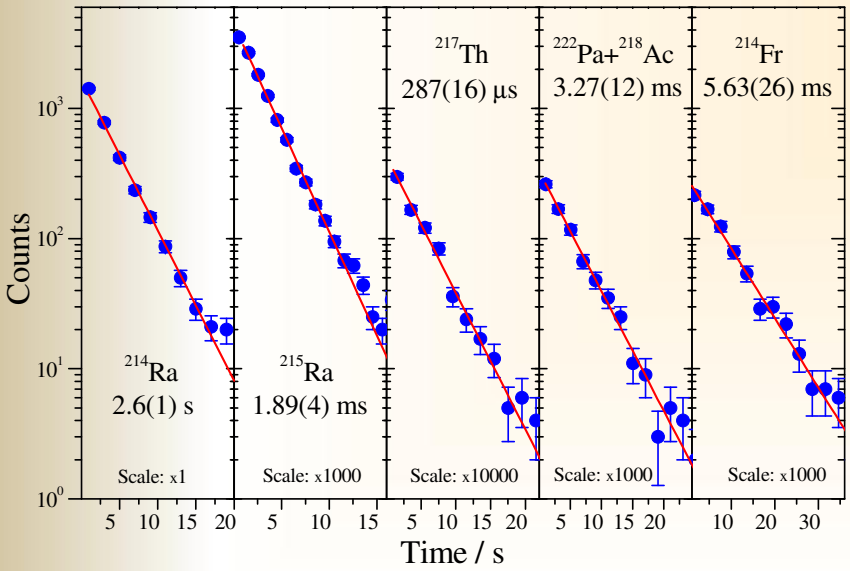
$^{50}Ti + ^{181}Ta \rightarrow ^{231}Am^*$

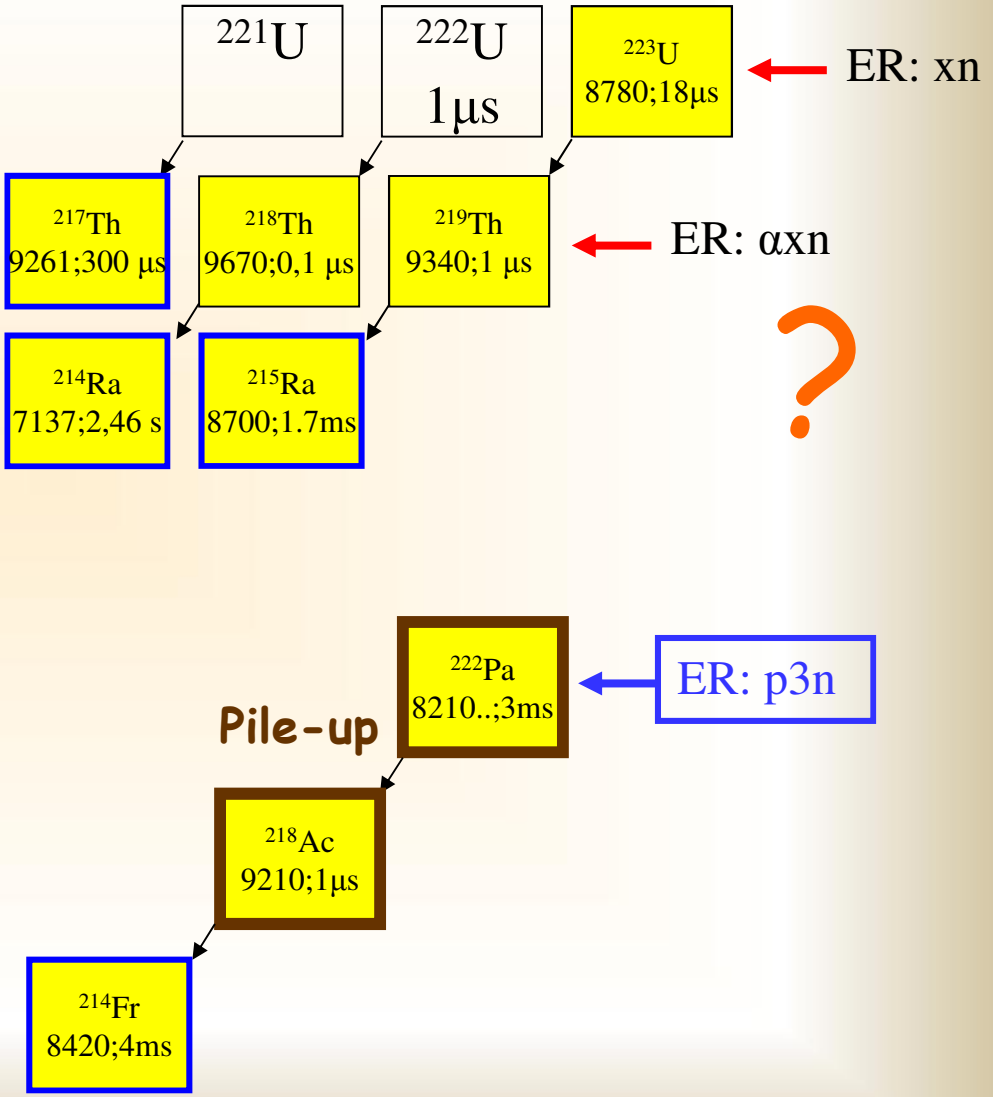


The reaction $^{50}Ti+^{176}Yb$: Analog part of data

Correlation analysis: Analog electronics





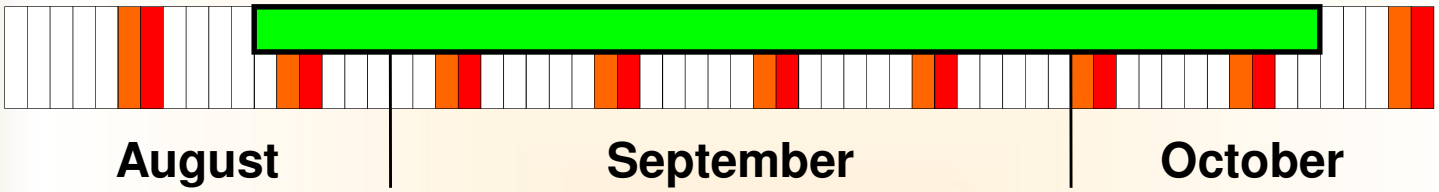


Search for element 120

$^{50}Ti+^{249}Cf$

Seach for element 120 (2011)

$^{50}Ti+^{249}Cf->^{299}120^{*}$

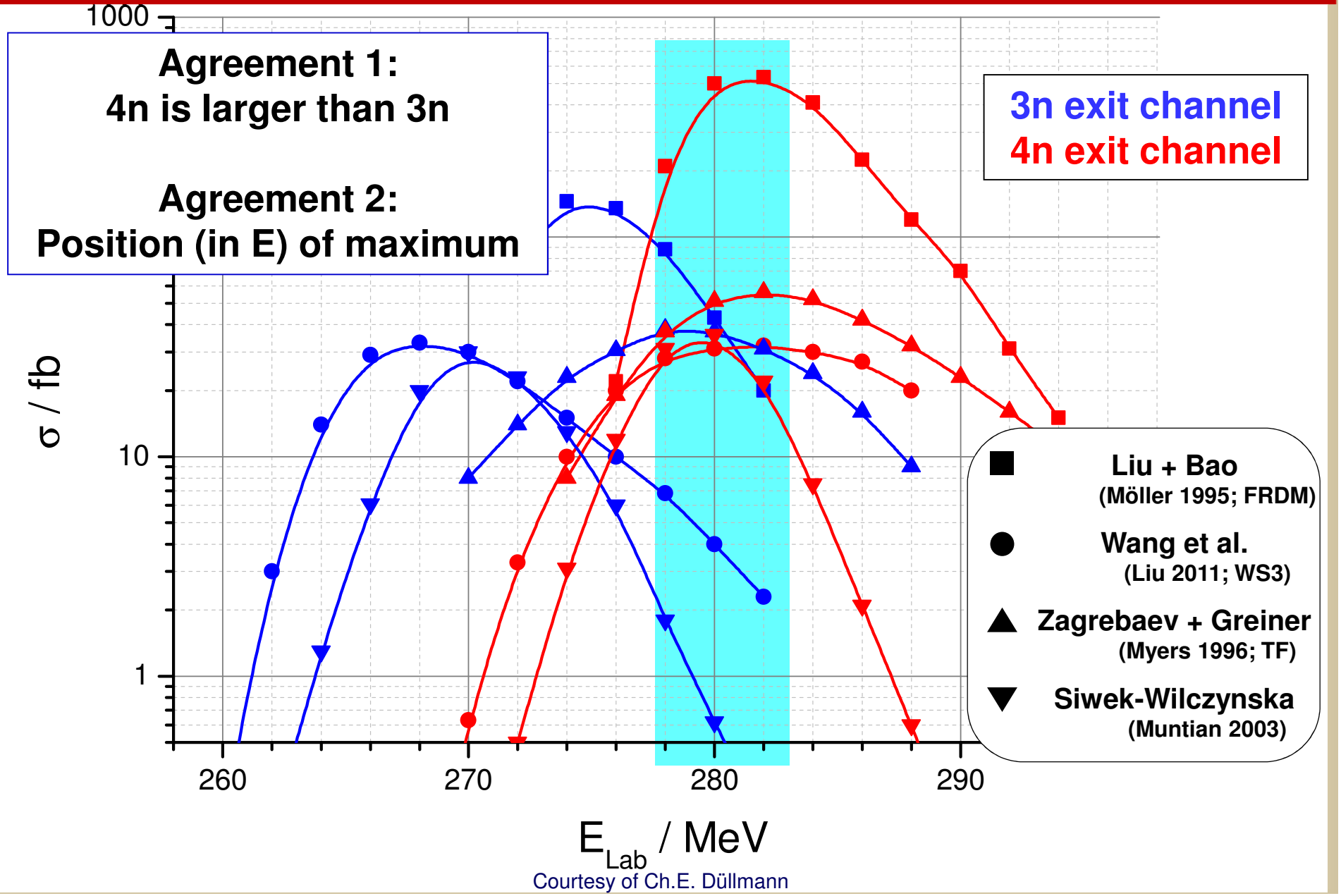


UNILAC operational for Cf ~39 days

Search for element 119

$^{50}Ti+^{249}Bk$

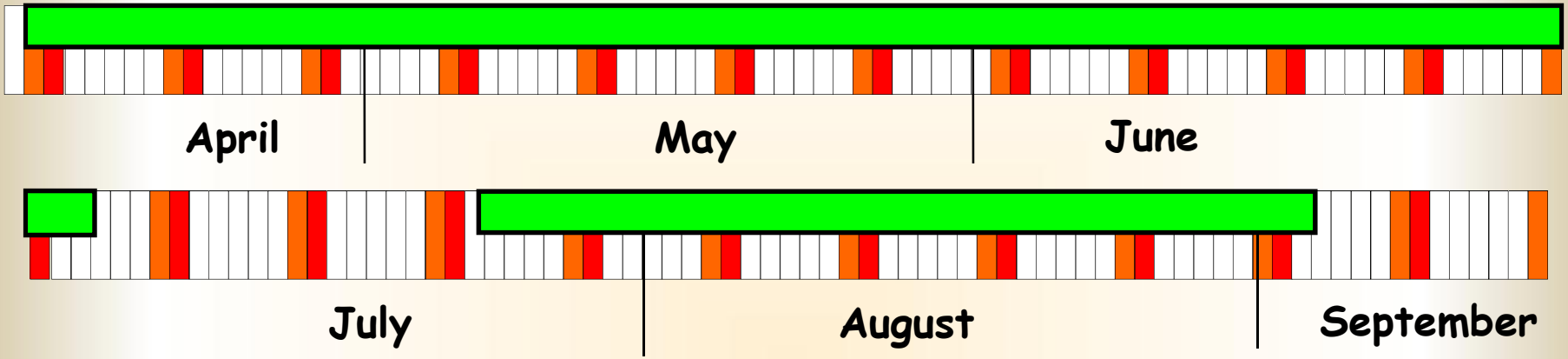
$^{50}Ti+^{249}Bk$ Excitation Function



Courtesy of Ch.E. Düllmann

Seach for element 119 (2012)

$^{50}Ti + ^{249}Bk -> ^{299}119^{*}$

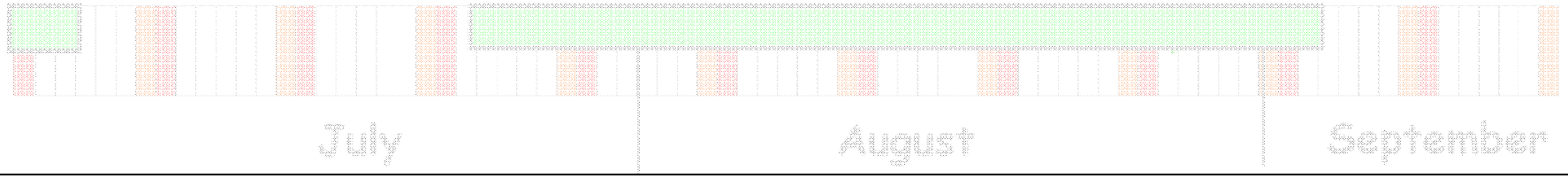


Production of element 117

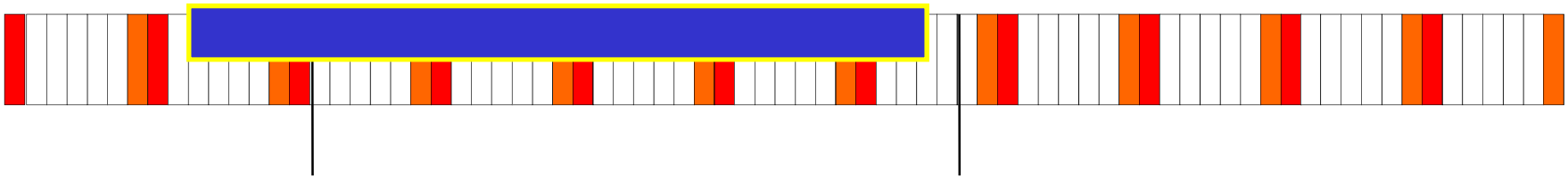
$^{48}Ca+^{249}Bk$

Production of element 117

$^{50}Ti + ^{249}Bk -> ^{299}119^*$



$^{48}Ca + ^{249}Bk -> ^{297}117^*$



X-ray spectroscopy of element 115

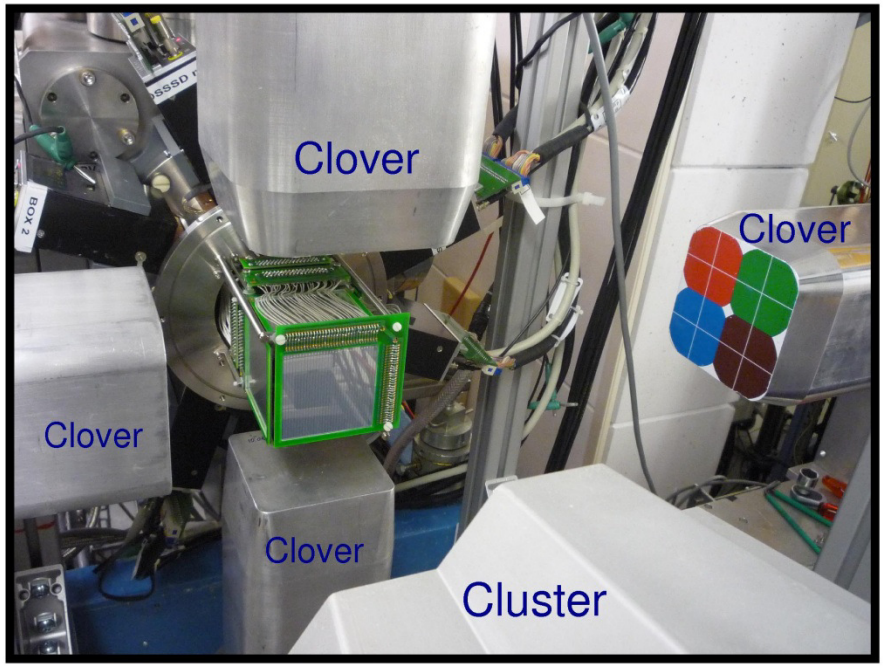
$^{48}Ca+^{243}Am$

TASISpec

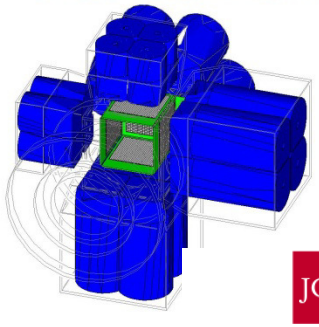
Highly efficient multi–coincidence spectroscopy set–up for TASCA's very compact focal plane image

1 Implantation DSSSD (1024 pixels)
4 box–DSSSDs (1024 pixels)
=> ~80% α–detection efficiency

4 Ge Clover (4*4 crystals)
1 Ge Cluster (7 crystals)
=> ~40% γ–detection eff. at 150 keV



L–L Andersson et al., NIM A 622, 164 (2010)
L.G. Sarmiento et al., NIM A 667, 26 (2011)

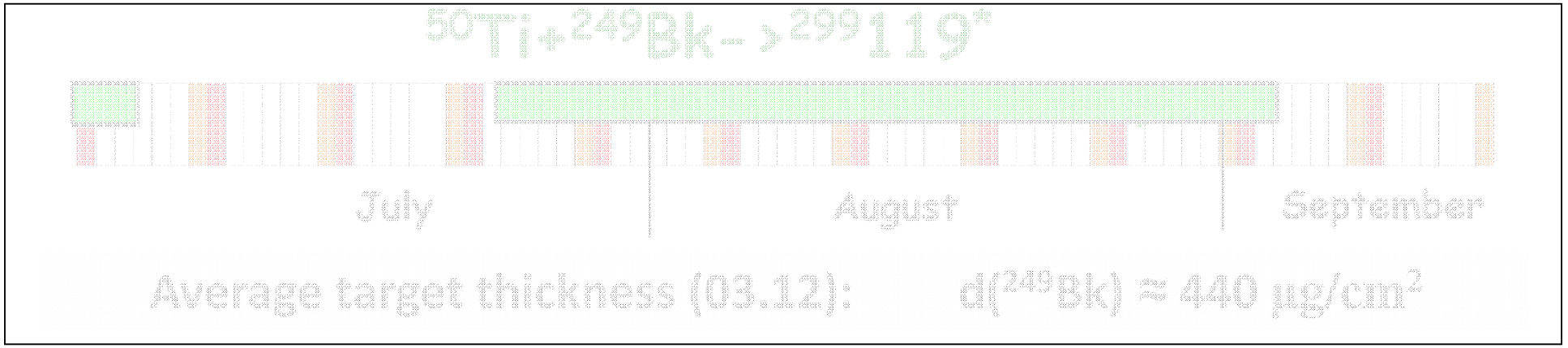


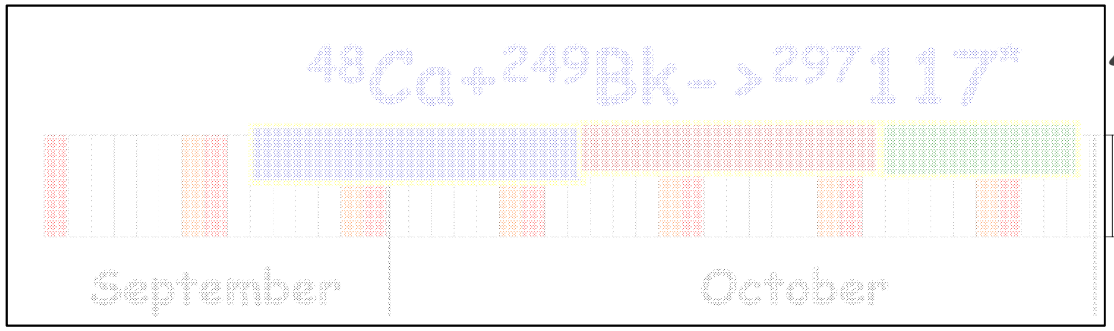
Virtually constructed with GEANT4 simulation package

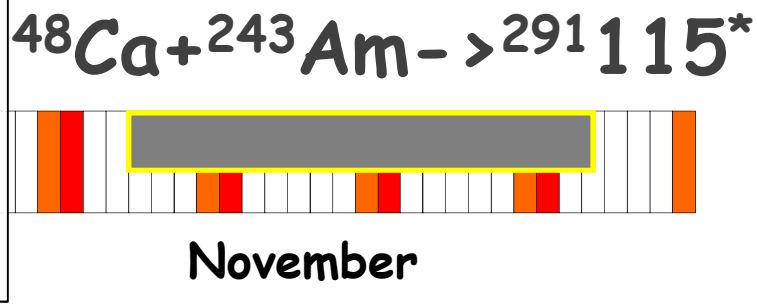
243Am target

Courtesy of D. Rudolph

Production of the element 115







Summary and Outlook

- **Superheavy** experiments 2011/12:
  - -focus: **search for elements 119 / 120** in ^{50}Ti induced reactions
  - -check **element 117**
  - -direct **Z measurement of ^{48}Ca+^{243}Am** chains (TASISpec)