Experiments on the chemistry of element 114 at TASCA

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for GSI-TUM-Uni Mainz-Uni Oslo-LBNL-FLNR -.....collaboration

Motivation

- Status of the theory and experiment (V. Pershina & R. Eichler)
- Further experiments can bring valuable data
- Physisorption vs. Chemisorption

  Volatility ↔ Volatility + chemical bonding

  Adsorption on an inert surface ↔ Adsorption on a noble metal surface

- Isotopes of element 114 available for chemical studies

Nuclear reaction		Isotope
$^{48}Ca + ^{242}Pu$	→(-3n)	$^{287}114$(0.5 s, α)
$^{48}Ca + ^{244}Pu$	→(-3n)	$^{289}114$(2.7 s, α)
$^{48}Ca + ^{244}Pu$	→(-4n)	$^{288}114$(0.8 s, α/SF)

Purity against counting rate

Use	or	don‘t use pre-separation
Pure measurement conditions are important (No Rn/Po background)		No simultaneously produced lighter homologs
Windowless operation (higher intensity is possible)		Lower production rate because of thinner targets

Very fast transport to a detector and high detection efficiency are very important because of short lifetimes

Expected Overall Efficiencies
I. Transport from RC/RTC to a detector

	Chemistry only	TASCA + chemistry	
Recoils in gas	100%	HTM: 60%	SIM: 35%
(from produced 100%)			
RC volumen / flush time			
in pure He	30 cm³/0.9 s	150 cm³/4.5 s	24 cm³/0.7 s
in He:Ar(70:30)	6 cm³ /0.2 s	50 cm³/1.5	8 cm³/0.25 s
Transport line / flush time			
4 m with 2 mm i.d.	12.5 cm³ / 0.4 s		
5 cm with 4 mm i.d.		0.63 cm³ / 0.02 s	
Total flush time			
in pure He	> 1.3 s	> 4.5 s	> 0.7 s
in He:Ar(70:30)	> 0.6 s	> 1.5 s	> 0.25 s

Expected Overall Efficiency
II. Production and losses

		Chemistry only	TASCA + chemistry	
Target thickness		~ 1 mg/cm²	~ 0.5 mg/cm²	
Production, atoms		100	50	
Recoils in gas		100	HTM: 30	SIM: 17
Window in RC		no: 100	80%: 24	14
Total flush time in He:Ar(70:30)		> 0.6 s	> 1.5 s	> 0.25 s
Decay during the transport time	^{288}114:	> 40%	> 73%	> 23%
	^{289}114:	> 14%	> 32%	> 7.5%
Detection efficiency		~ 90%	~ 90%	
Overall efficiency	^{288}114:	< 50%	< 6.0%	< 10%
	^{289}114:	< 70%	< 14%	< 11%

Expected production / detection rate

	Chemistry only	TASCA + chemistry
^{48}Ca beam intensity	2x10^{12} 1/s (vacuum window!)	5x10^{12} 1/s (no window)
^{244}Pu target	2.4x10^{18} at/cm^2	1.2x10^{18} at/cm^2
Overall efficiency	50-70%	10-14%
Detection rate	~ 1 /day	~ 1 /4 days
with existing ^{244}Pu target (400µg/cm^2)	~ 1 / 2 day	~ 1 /5 days

TASCA + COMPACT

2 detector types are available :

Au-covered

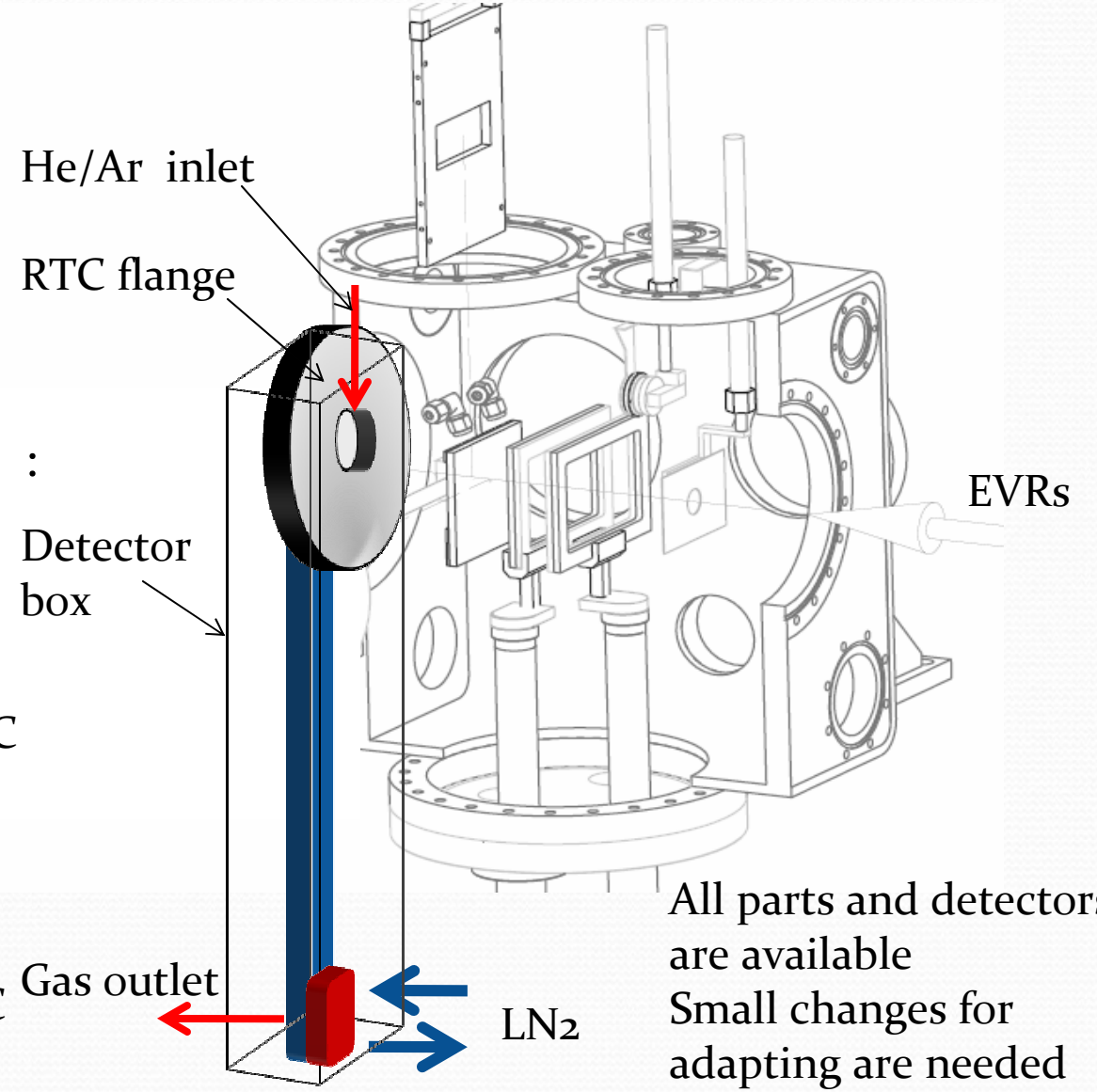
←E114→

+30 -160°C

SiO_2-covered

←E114→

+30 -160°C



All parts and detectors are available
Small changes for adapting are needed

Conclusion

- Chemistry of E114 w/o pre-separation is 2-2.5 times more efficient than with pre-separation
  The price for this is very high Po background (also SF?)
- Combination of TASCA Small Image Mode with COMPACT directly connected to the RTC allows detecting short-lived isotopes of E114
- Using Au-covered and SiO_2 covered detectors, measurement of both, the volatility of E114 and reactivity with noble metals is possible
- For the first stage experiments 3-4 weeks of beamtime are needed