

# Preparation of $^{249}\text{Cf}$ targets for the synthesis of element 120

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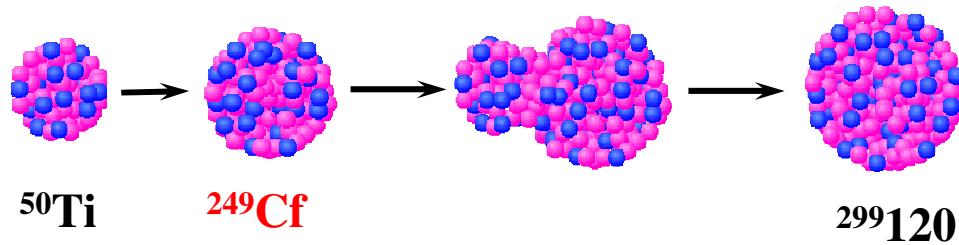
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# Synthesis of element 120



## Target production requirements:

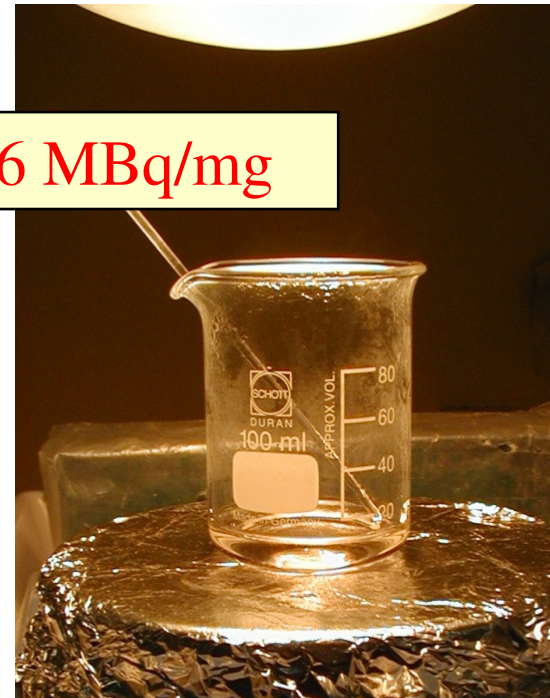
- Chemical purification of  $^{249}\text{Cf}$  prior to deposition
- Small and simple set-up
- High deposition yields

- 4 arc shaped segments form a target wheel
- Wheel diameter: 100 mm
- Active area: 6 cm<sup>2</sup> per segment
- Material consumption:  
12 mg per wheel @ 500 μg/cm<sup>2</sup>
- Beam spot: 8 mm diameter

# Purification of $^{249}\text{Cf}$

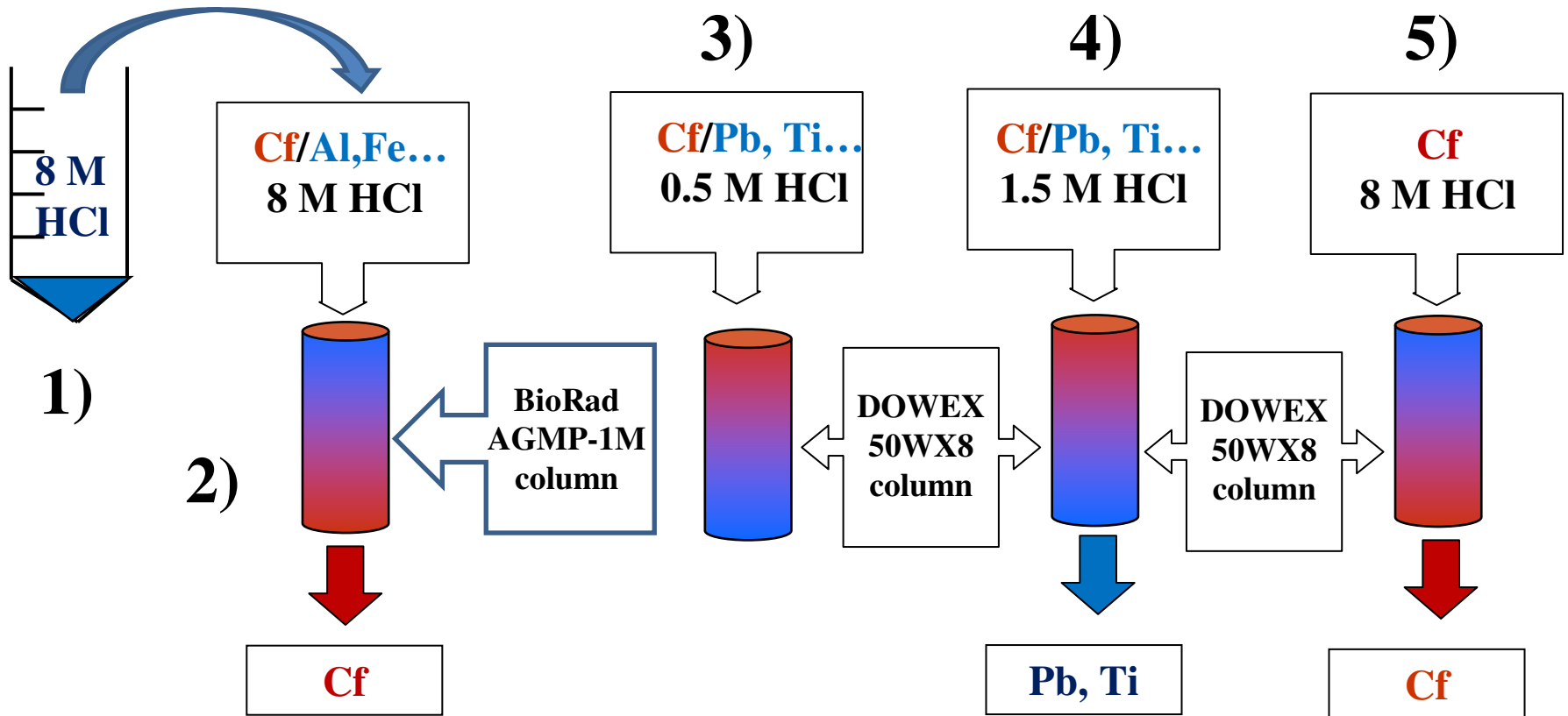
- Chemical form: Chloride, Nitrate or Oxide
- Dissolution in 8 M HCl
- Evaporation to dryness several times

Activity of  $^{249}\text{Cf}$ : 151,6 MBq/mg

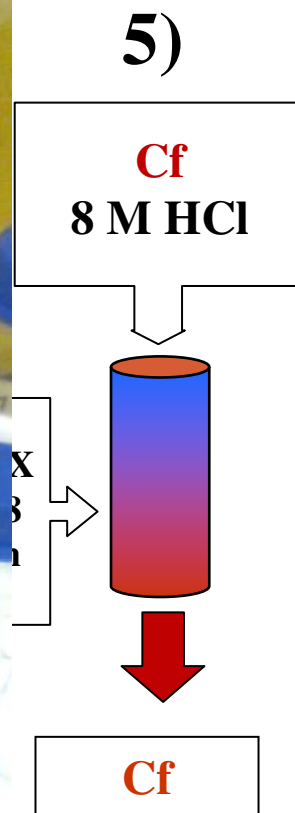
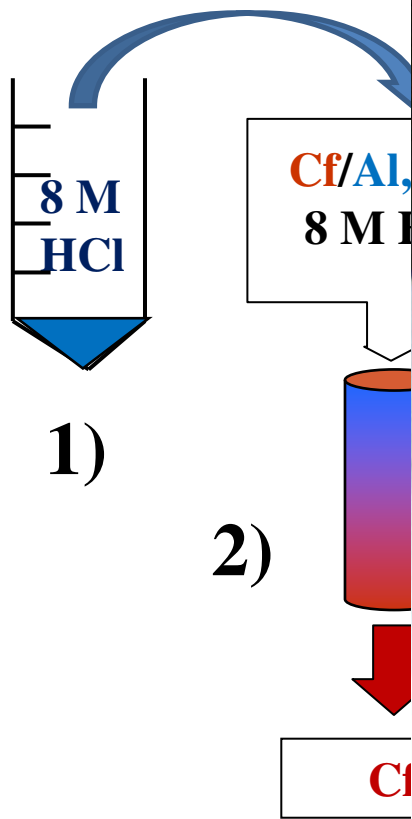


$^{249}\text{Cf}$  as delivered by LBNL

# Purification of $^{249}\text{Cf}$



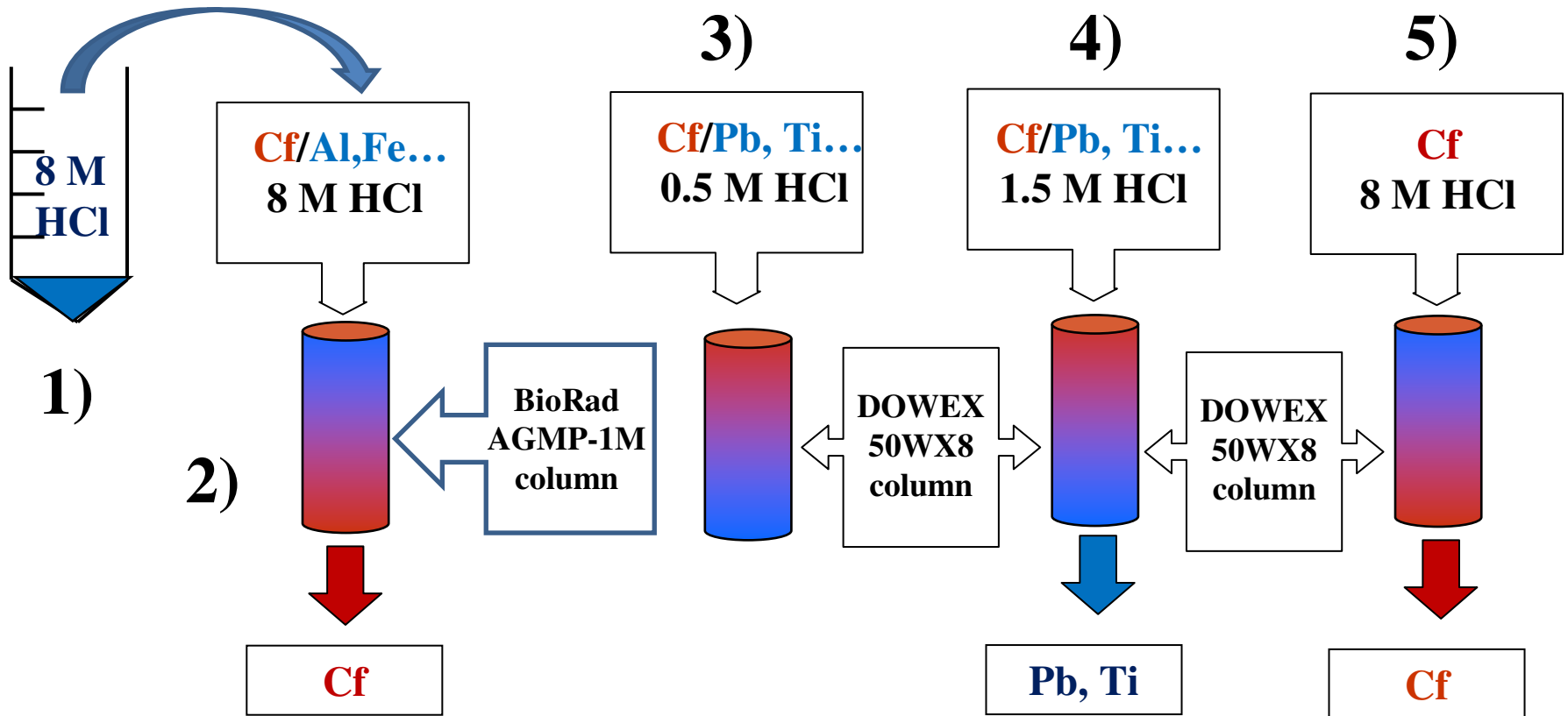
- 1) Dissolve  $^{249}\text{Cf}$  in 8 M HCl
- 2) Purification step with anion-exchanger BioRad AG MP-1M
- 3) Evaporate to dryness and dissolve  $^{249}\text{Cf}$  in 0.5 M HCl
- 4) Removal of Pb, Ti... with 1.5 M HCl
- 5) Elution of  $^{249}\text{Cf}$  with 8 M HCl. Almost 100% recovery



- 1) Dissolve  $^{249}\text{Cf}$
- 2) Purification st
- 3) Evaporate to c
- 4) Removal of Ph
- 5) Elution of  $^{249}\text{Cf}$



# Purification of $^{249}\text{Cf}$



Conversion of  $^{249}\text{Cf}$  chloride into nitrate with  $8\text{ M HNO}_3$

# Deposition of $^{249}\text{Cf}$ by Molecular Plating



**Evaporate  $^{249}\text{Cf}$ -solution (8 M  $\text{HNO}_3$ ) to dryness in a teflon beaker**



**Re-dissolve residue in 100  $\mu\text{l}$  0.1 M  $\text{HNO}_3$  and transfer it to the plating cell**



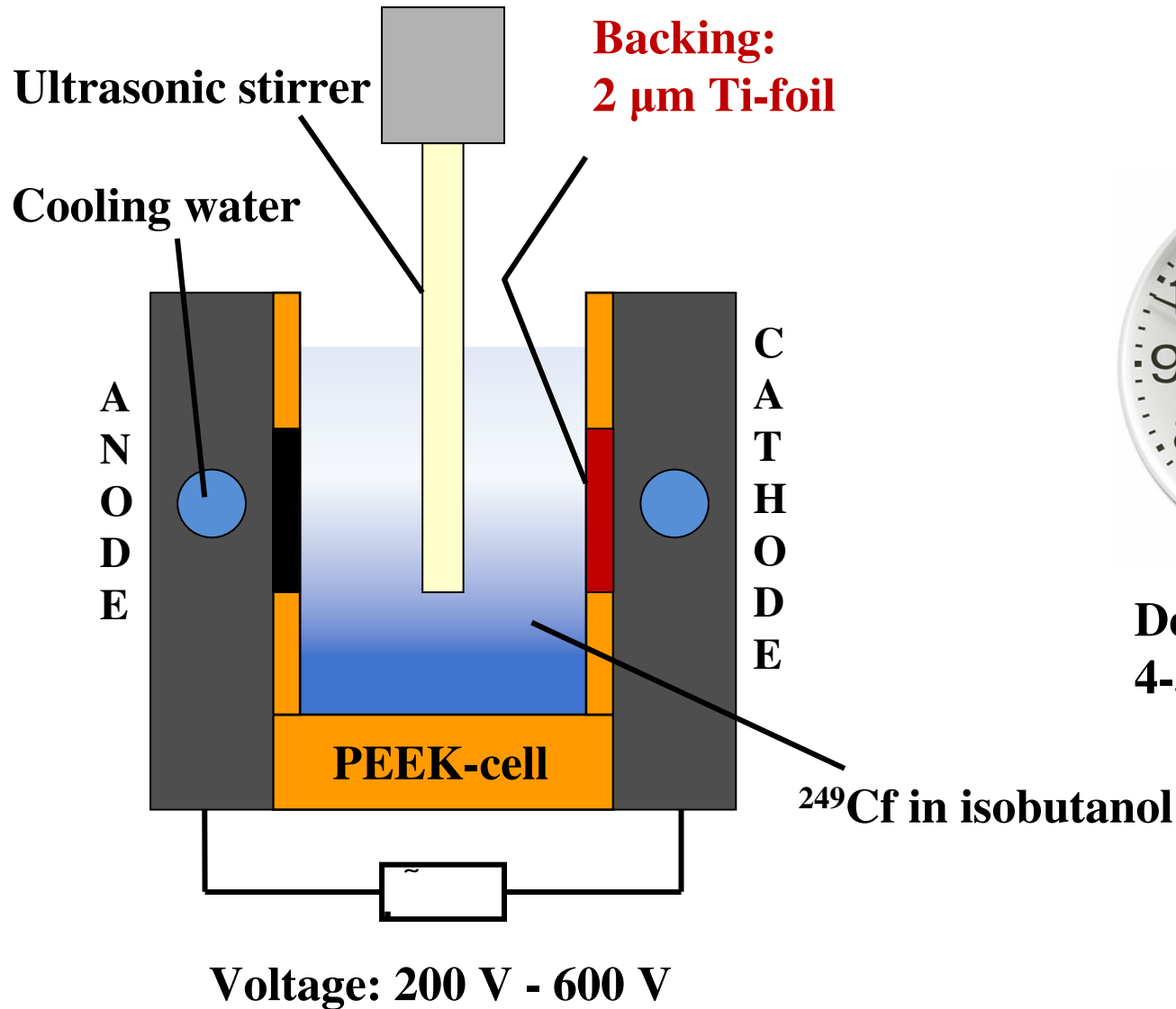
**Wash teflon beaker with 3 x 300  $\mu\text{l}$  isopropanol and transfer it to cell**



**Fill cell with 51 ml isobutanol**



# Deposition of $^{249}\text{Cf}$ by Molecular Plating



**Deposition time:  
4-5 hours**



# Deposition of $^{249}\text{Cf}$ by Molecular Plating

## Deposition of Cf:

- Yield > 90%
- Yield determination by  $\alpha$ -spectroscopy

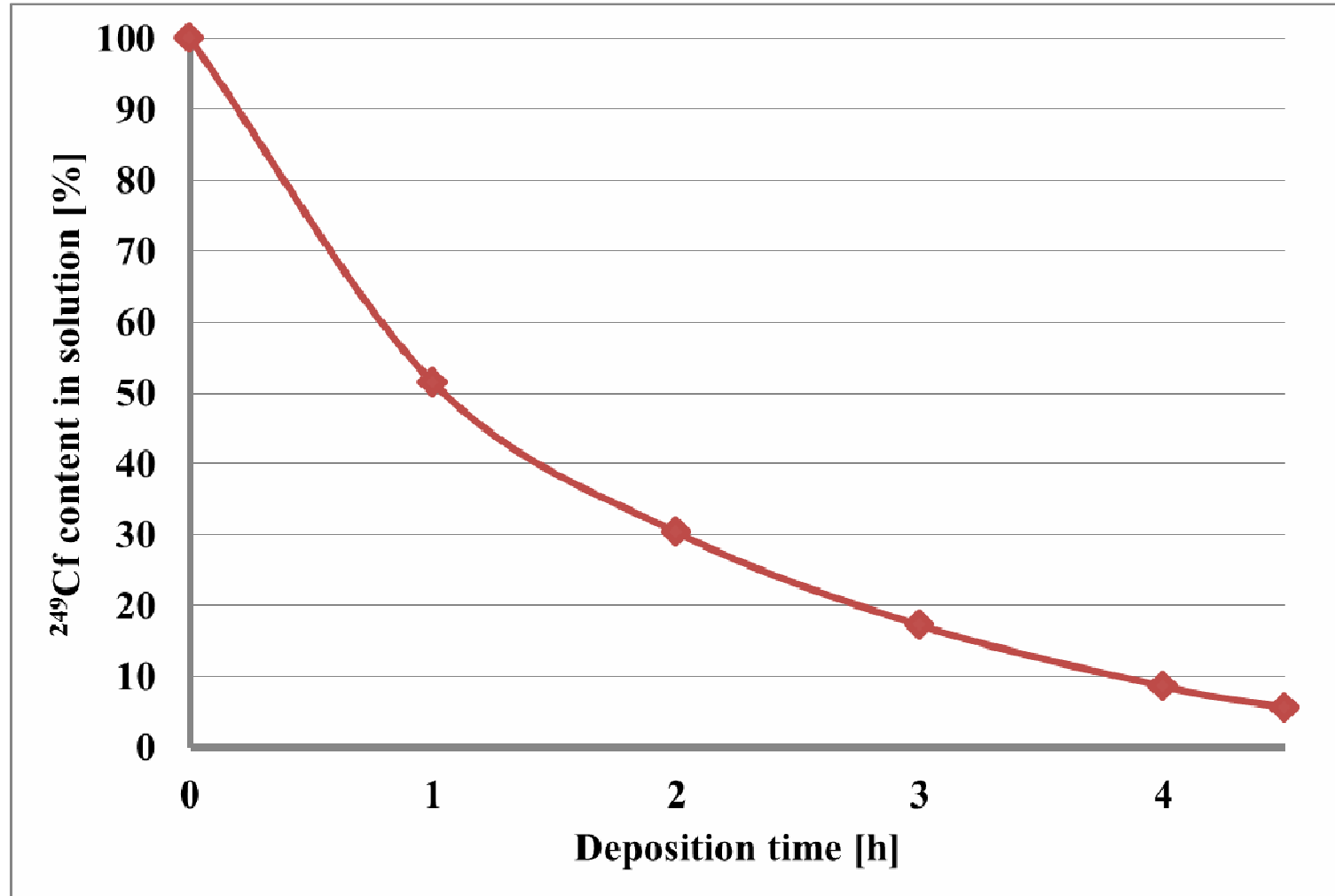
Cf	Thickness [ $\mu\text{g}/\text{cm}^2$ ]
$^{249}\text{Cf}$	70
$^{249}\text{Cf}$	484
$^{249}\text{Cf}$	537
$^{249}\text{Cf}$	514
$^{249}\text{Cf}$	501
$^{249}\text{Cf}$	497
$^{249}\text{Cf}$	508
$^{249}\text{Cf}$	454

Prior to production of thick targets a thin target was prepared:

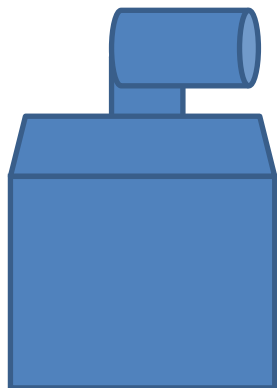
- deposition test
- reference sample for yield determination by  $\alpha$ -spectroscopy

# Deposition kinetics of $^{249}\text{Cf}$

Prior to deposition and in 1-h steps 10  $\mu\text{l}$  aliquots of the  $^{249}\text{Cf}$ -solution were evaporated to dryness for  $\alpha$ -particle spectroscopy



# Yield determination by $\gamma$ -spectroscopy



$\gamma$ -Detector

3 m



Measuring time: 5 min  
Dead time: ~ 5 %



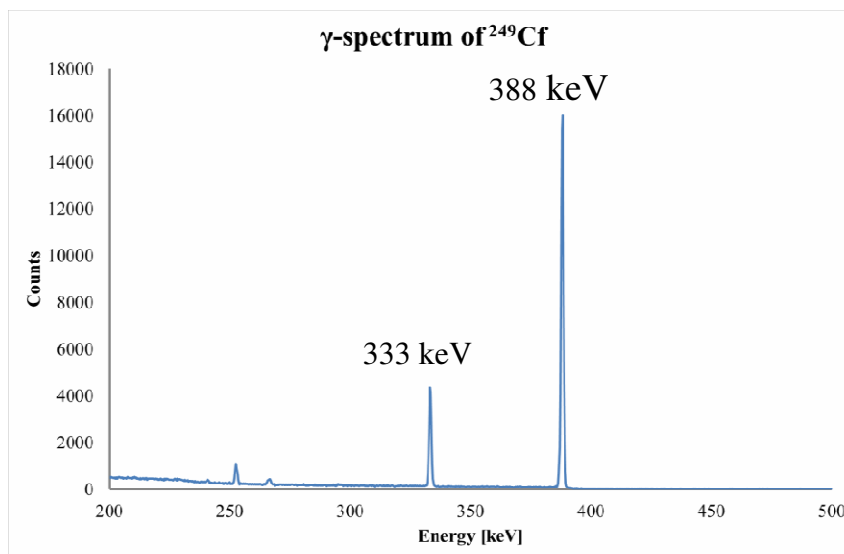
Thin  $^{249}\text{Cf}$  target  
used as reference

$^{245}\text{Cm}$

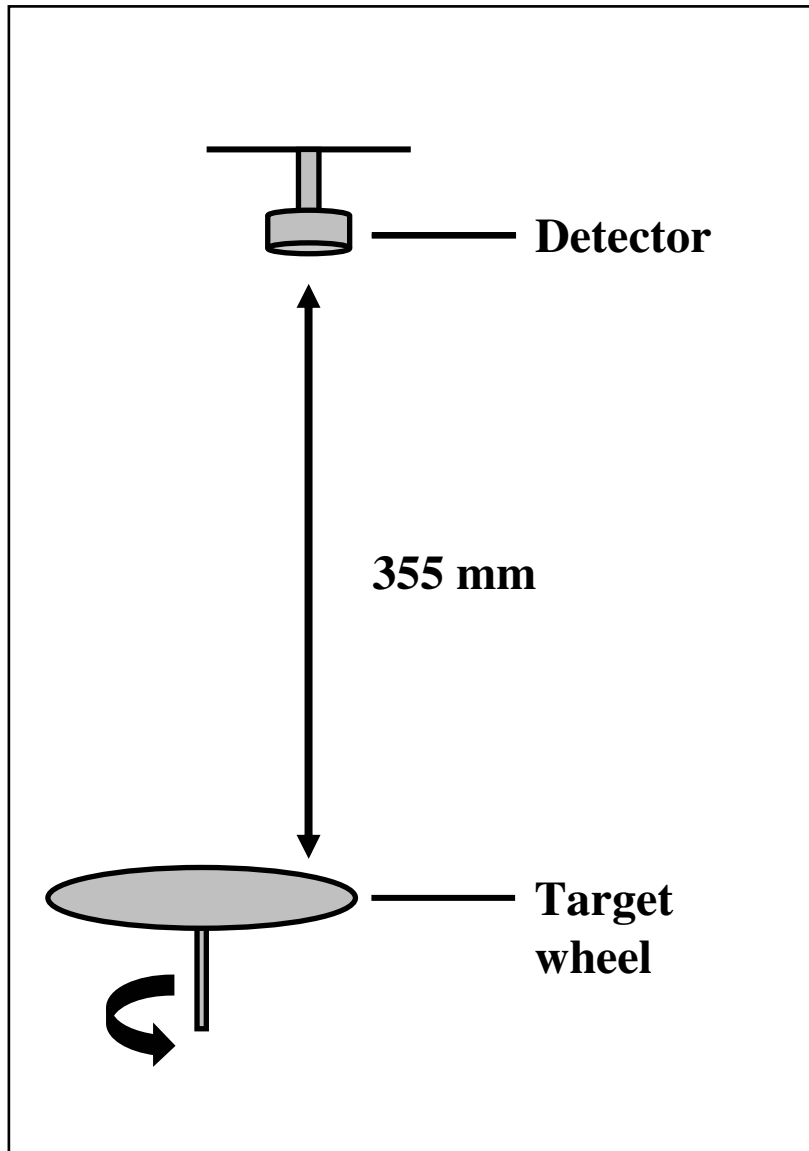
8500 a  
a 5.361, 5.304  
 $\gamma$  175, 133

$^{249}\text{Cf}$

350.6 a  
a 5.812, 5.758  
 $\gamma$  388, 333



# Yield determination by $\alpha$ -measurements



- cover with five 10 mm holes for each target segment
- 8 mm collimator ca. 2.5 to 3 mm above the target wheel
- 5 x 180 s measuring time per segment
- efficiency determined with a  $^{241}\text{Am}$  reference source



# Summary

- **Purification of  $^{249}\text{Cf}$**
- **Deposition of  $^{249}\text{Cf}$  by Molecular Plating**
- **Deposition kinetics of  $^{249}\text{Cf}$**
- **Yield determination:  $\gamma$ -measurements  
 $\alpha$ -measurements**

# Thanks to:

**Lawrence Berkeley National Laboratory for providing  $^{249}\text{Cf}$**

**Robert F. Fairchild II, Naomi E. Reeves, John A. van Wart and LBNL's entire Radiation Protection Group of the Environmental Health and Safety Division for their leadership and active support with the preparation and execution of the  $^{249}\text{Cf}$  shipment to Germany.**

**The Target Laboratory at GSI for providing the Ti-backing foils**

**The Mechanical Workshop of the Institut für Kernchemie in Mainz for the construction of the deposition cell**



JOHANNES GUTENBERG  
UNIVERSITÄT MAINZ

**....and you for your attention**