

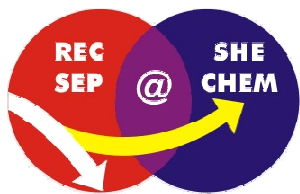
# Investigation of group 8 metallocenes @ *TASCA*

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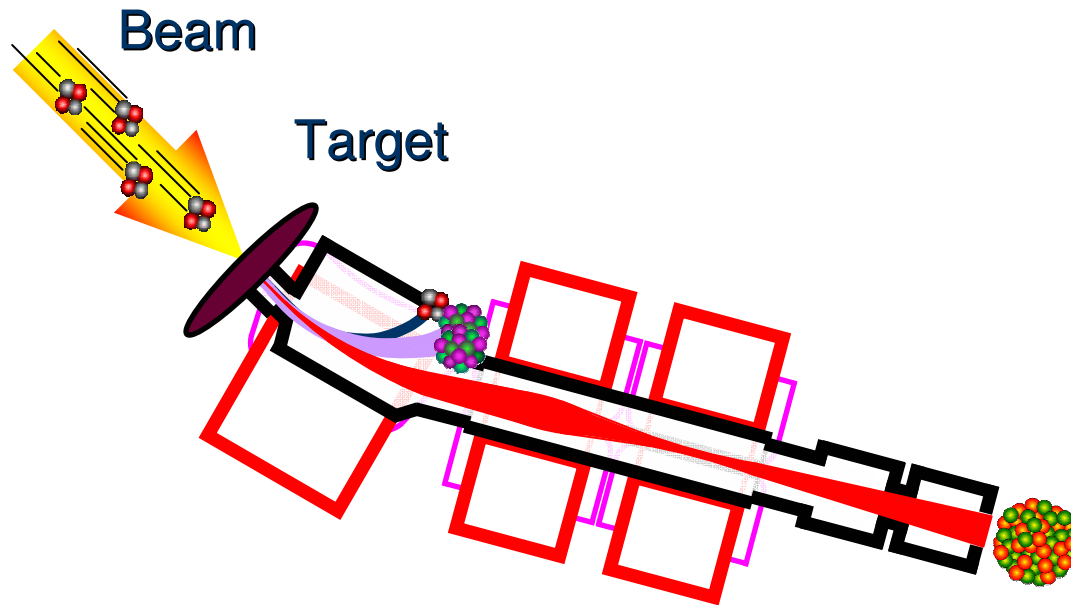
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Presented on the 7<sup>th</sup> workshop on Recoil Separator for Superheavy Element Chemistry *TASCA 08*, October 31, 2008, GSI Darmstadt, Germany

# Transactinide Chemistry

## Preseparation: a New Approach

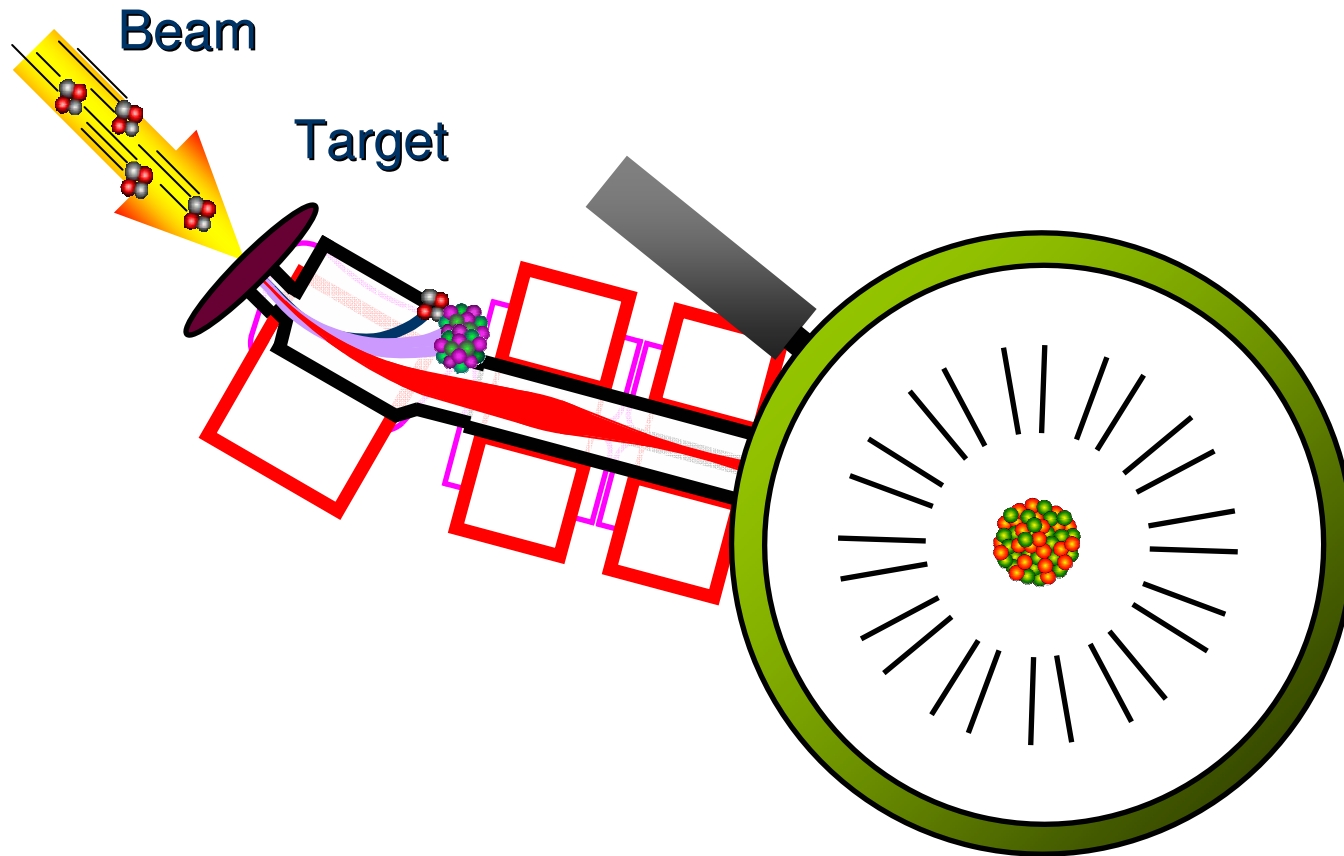


**TASCA** @ GSI

TransActinide Separator and Chemistry Apparatus

# Transactinide Chemistry

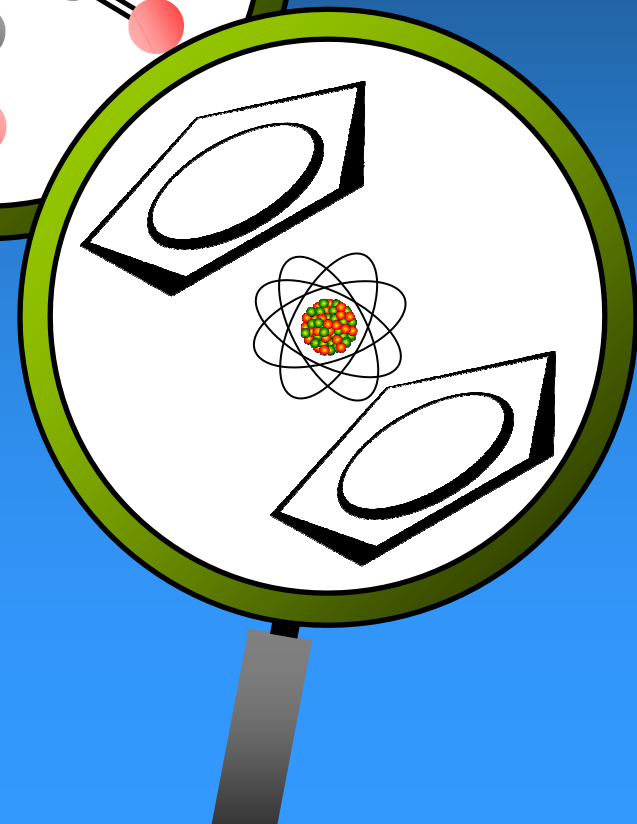
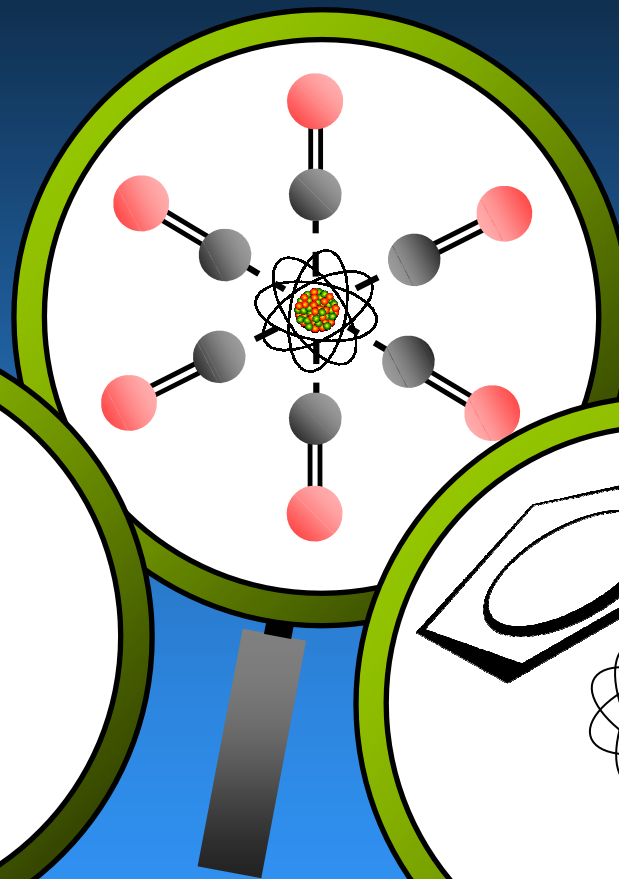
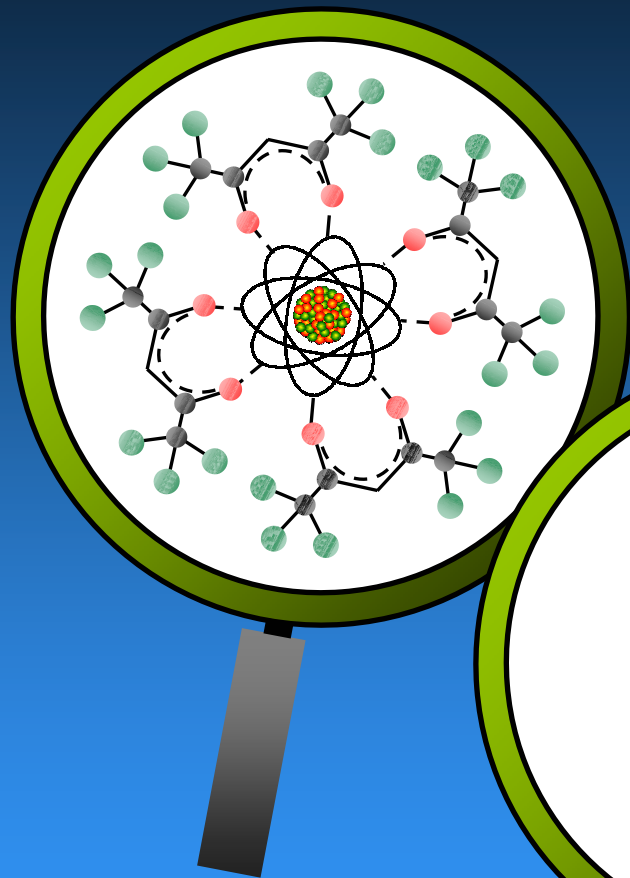
## Preseparation: a New Approach



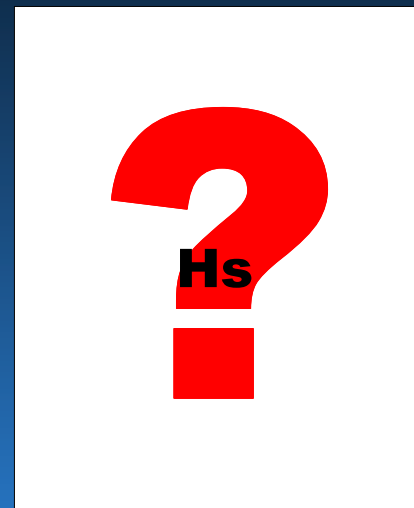
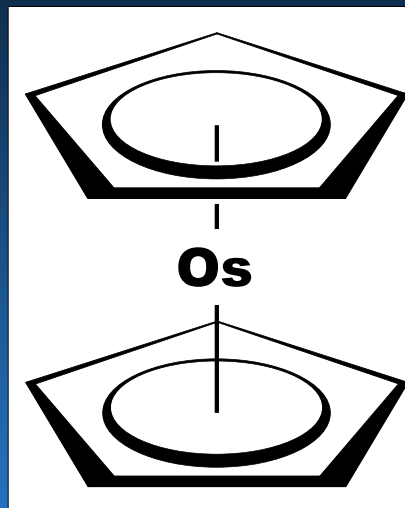
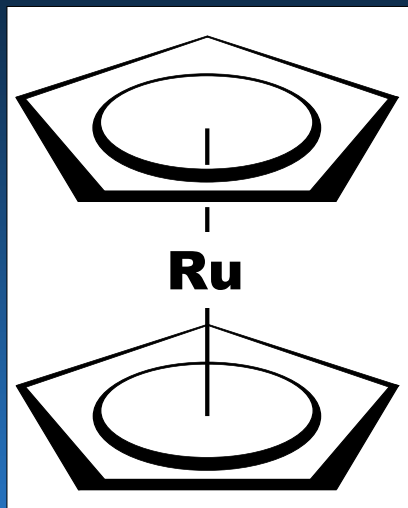
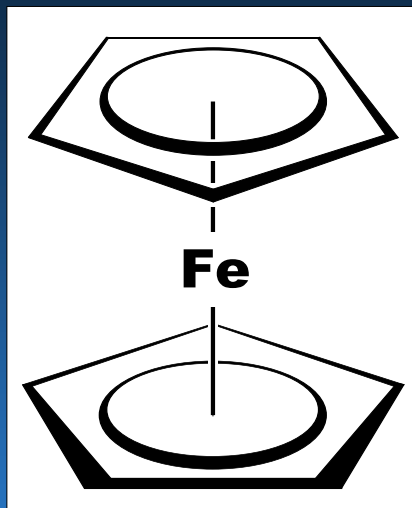
**TASCA** @ GSI

**TransActinide Separator and Chemistry Apparatus**

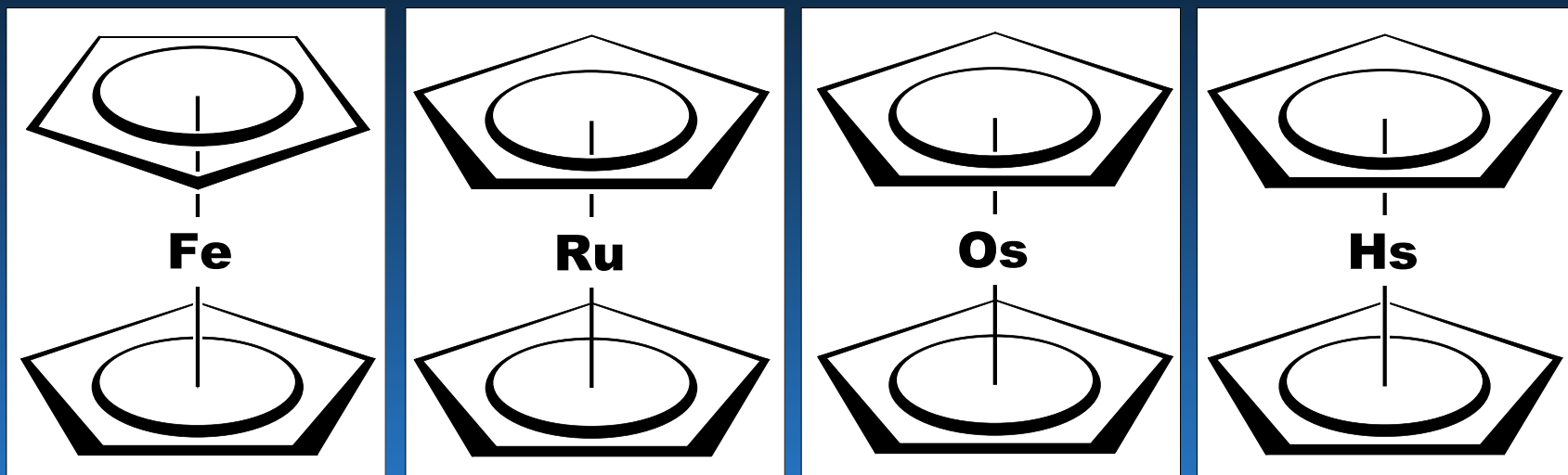
# Potential chemical systems



# Hassocene – Science



# Hassocene – Science



- Group 8 metallocenes: 18 electrons
- Ru(Cp)<sub>2</sub> is the most stable metallocene!
- Metal-ring bond strength: Fe < Ru < Os

$\Delta H_{\text{sub}}$   
[kJ/mol]

73.4±1.1

76-83

73-80

??

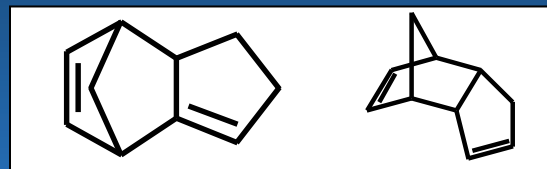
# Hassocene – Science

- **Metallocenes: metal in formal 2+ state (though, ring-metal bonding mainly covalent)**
  - in contrast to past studies, where the metal was in its highest oxidation state
  - influence of relativistic effects better visible?
- **Due to large number of  $M(\text{Cp})_2$ : many effects studied systematically across the Periodic Table**
- **Highly symmetric systems with moderate number of atoms → fully relativistic 4c-DFT calculations under way**

# Hassocene – Technical

## Cp trivia

Cp is commercially available, cheap, comes in dimeric form



For synthesis, the monomeric form is needed

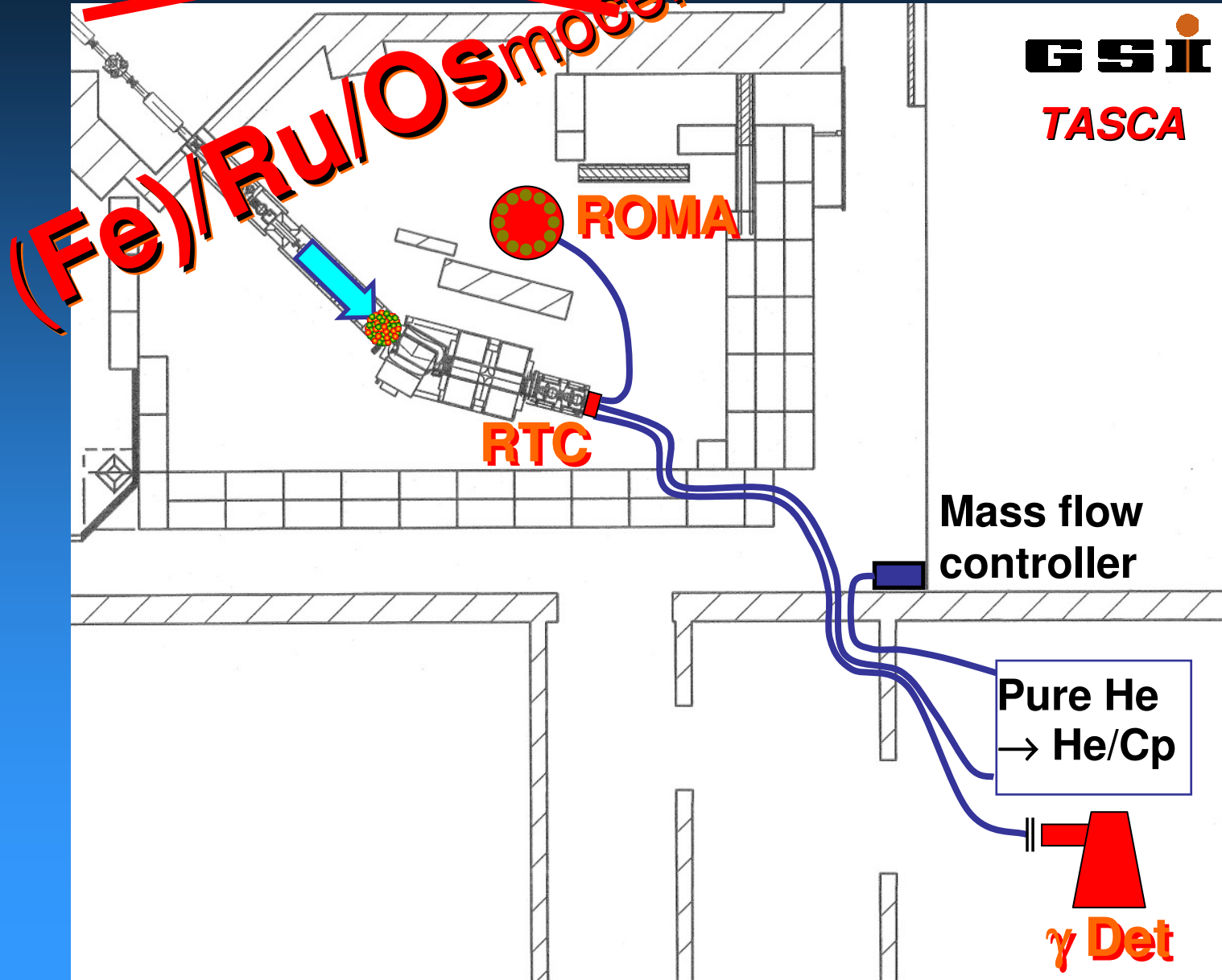
→ Cracking (usually: thermal cracking @  $T > 180^\circ\text{C}$ , or at lower temp. with catalyst)

Once cracked, it dimerizes within hours @ room temperature (Diels-Alder-reaction)

→ **On-line cracking+distillation!!**



# ~~Hassocene~~ - Technical



# Hassium – Timeline

## Early 2009:

Submit proposal to G-PAC, requesting beamtime for preparation experiments with lighter homologs. Alternative: combined "chem. development" proposal ?

## (Hopefully...) later in 2009:

Start with several rather short (3-5 shifts) runs as soon as beamtime is available.  
Initial experiments with  $\gamma$ -decaying isotopes

## 2010

Optimization, Hs preparatory experiments with  $\alpha$ -decaying isotopes

As soon as ready: Hs experiment

# Beamtime request

For test experiments:

2009: 9 shifts parasitic beam

2010 6 shifts main + 6 shifts parasitic

For Hs experiment:

Depends on  $\sigma$  and  $\epsilon_{\text{TASCA}}$  of:

	$\sigma$ (pb)	$\epsilon_{\text{TASCA}}$ (%)
$^{248}\text{Cm}(^{26}\text{Mg},3-5\text{n})$	4-8	?
$^{238}\text{U}(^{36}\text{S},3-5\text{n})$	<1 (?)	?
$^{226}\text{Ra}(^{48}\text{Ca},3-5\text{n})$	~10 (?)	60

# Beamtime request

For test experiments:

2009: 9 shifts parasitic beam

2010 6 shifts main + 6 shifts parasitic

For Hs experiment:

Depend

If formation of  $\text{Hs}(\text{Cp})_2$  is fast,  
1-2 weeks for a Hs experiment  
should be sufficient. Reliable  
final number only after tests.

# Necessary technical developments

For initial studies:

-On-line cracking + distillation

→ Exists on paper, should not take too long

For experiments with  $\alpha$ -decaying isotopes:

-Detection system (ROMA)

→ Fair amount of work (+€?) on DAQ hardware + GO4 implementation needed

# **Manpower**

**Could be an ideal PhD or postdoc project**

**Initial experiments not manpower intensive, but regular presence at GSI necessary**

**ROMA upgrade!!!**

# Conclusions

- **Hs(Cp)<sub>2</sub> is likely stable, preseparation should make its investigation possible**
- **Relatively high volatility expected**
- **4c-DFT calculations under way**
- **Interesting science**
- **Experiments with (Fe)/Ru/Os(Cp)<sub>2</sub> could start in 2009**