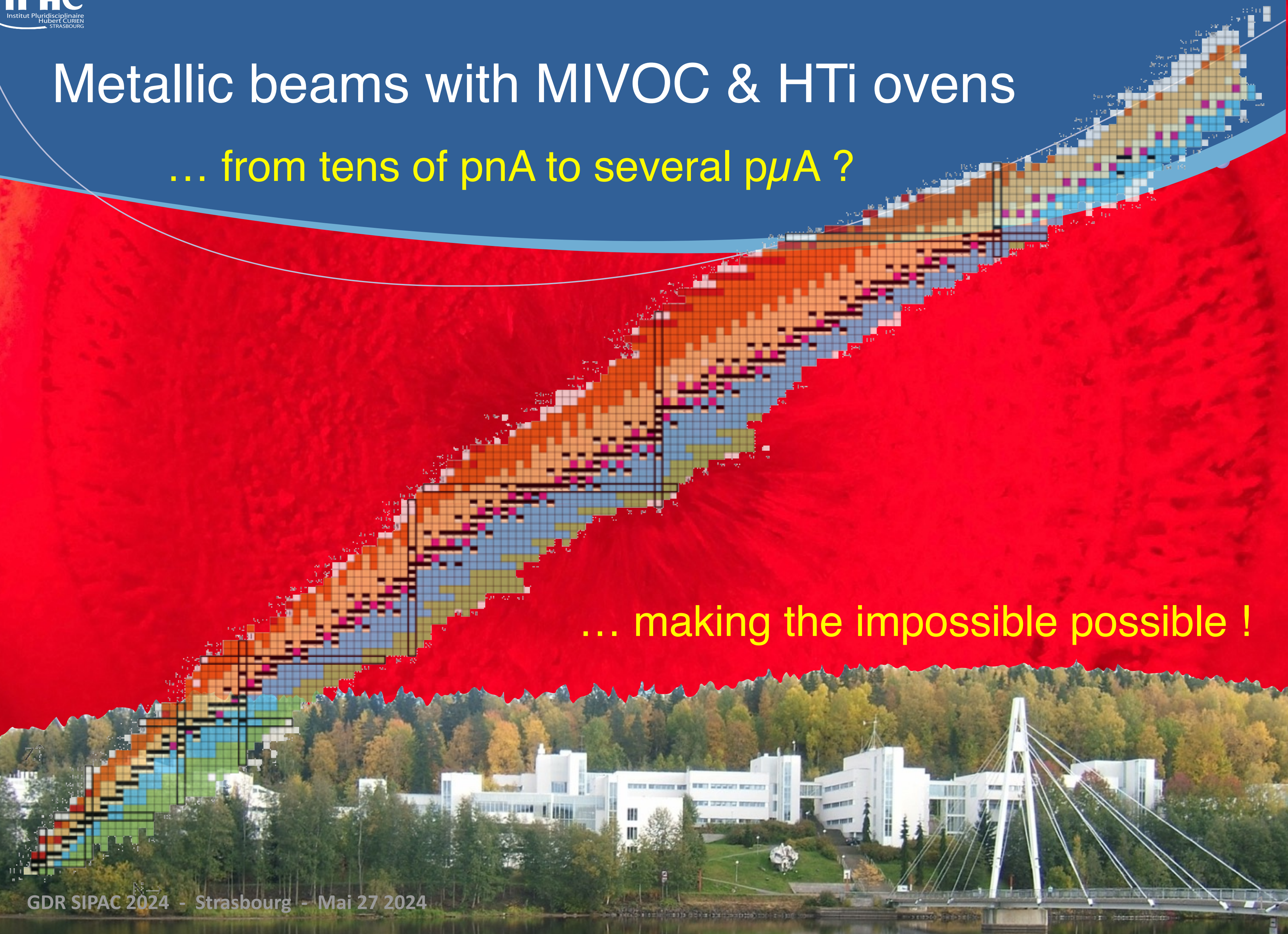
Metallic beams with MIVOC & HTi ovens

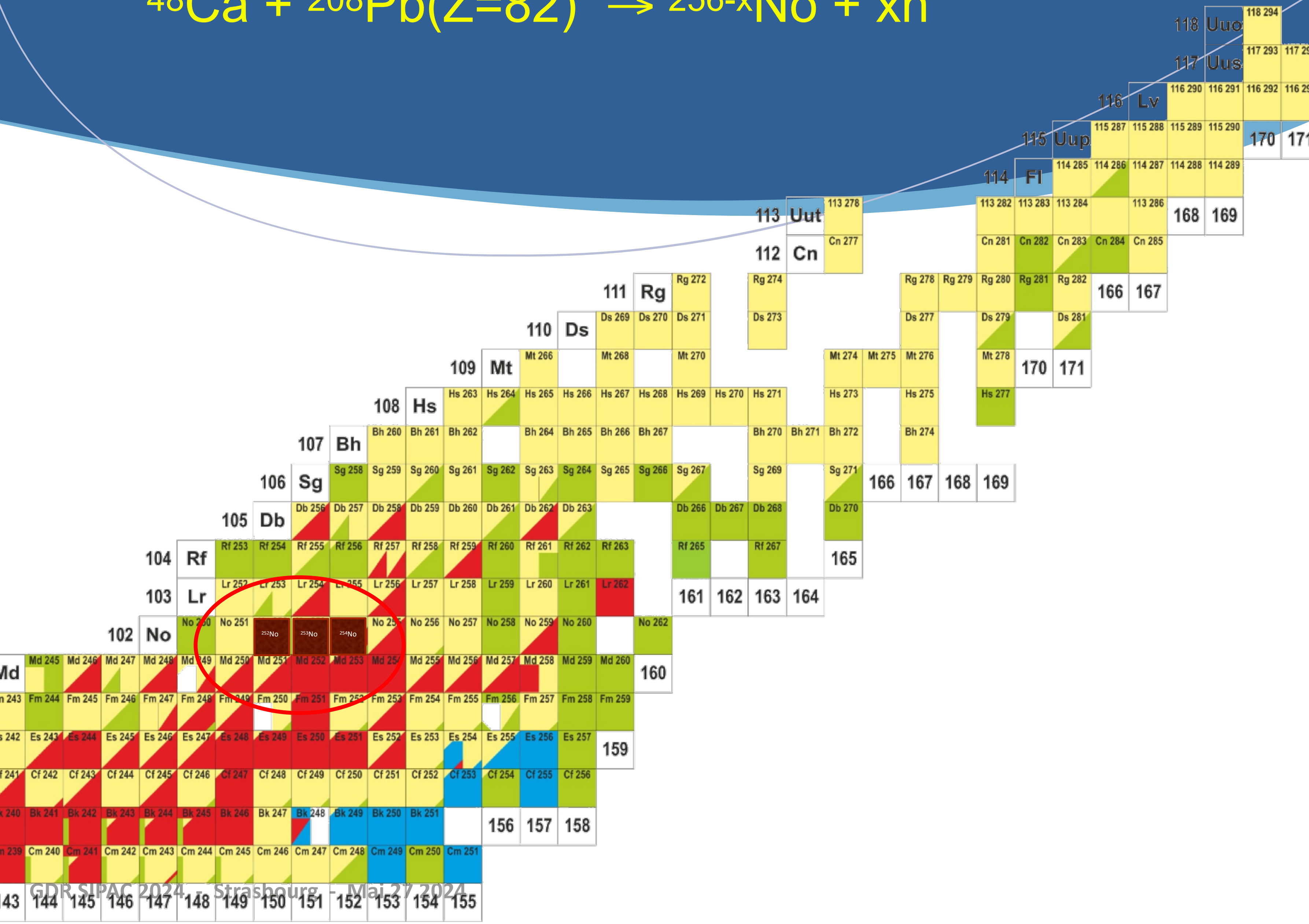
… from tens of pnA to several pμA ?



… making the impossible possible !

Cold fusion $^{208}Pb/^{209}Bi + ^{48}Ca$

$^{48}Ca + ^{208}Pb(Z=82) \rightarrow {}^{256-x}No + xn$

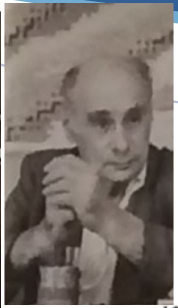


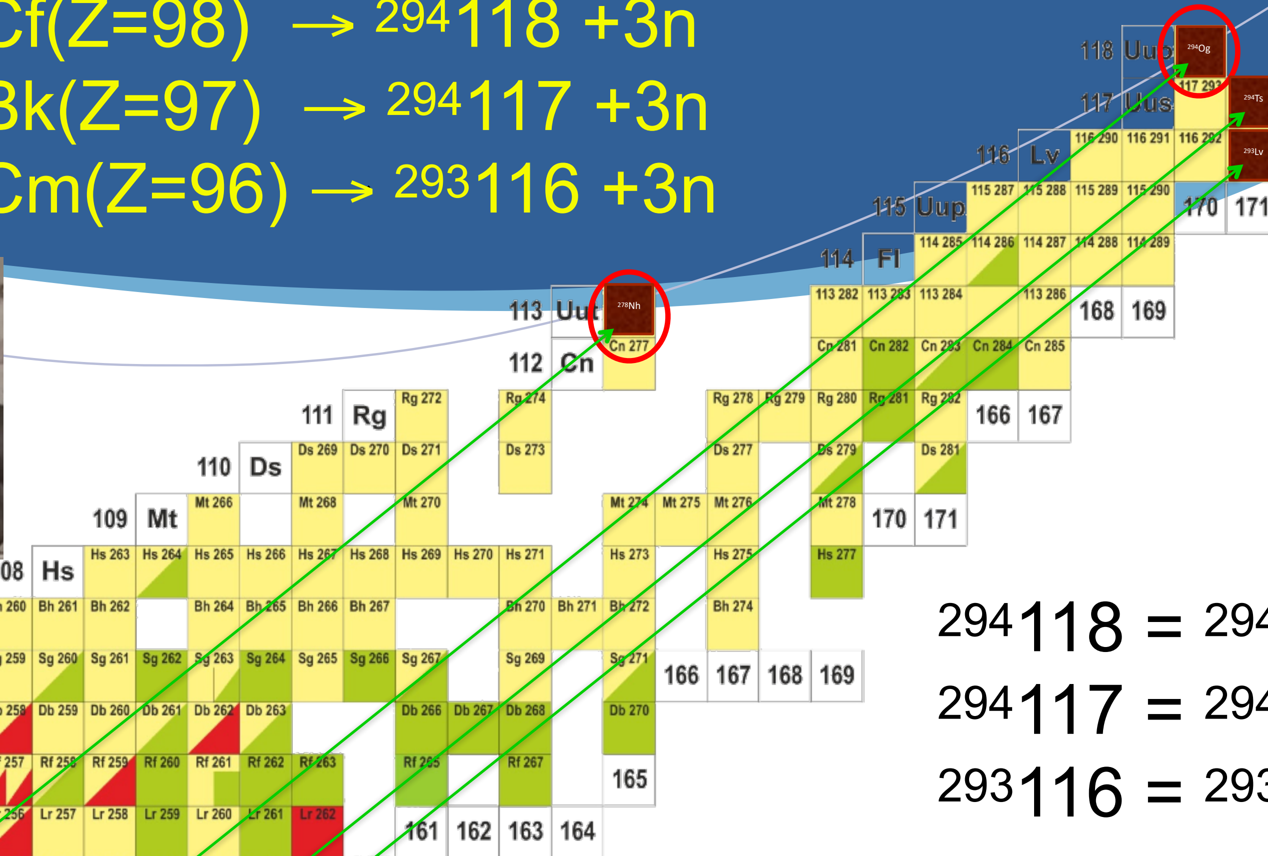
Cold fusion $^{208}Pb/^{209}Bi$ / hot fusion ^{48}Ca

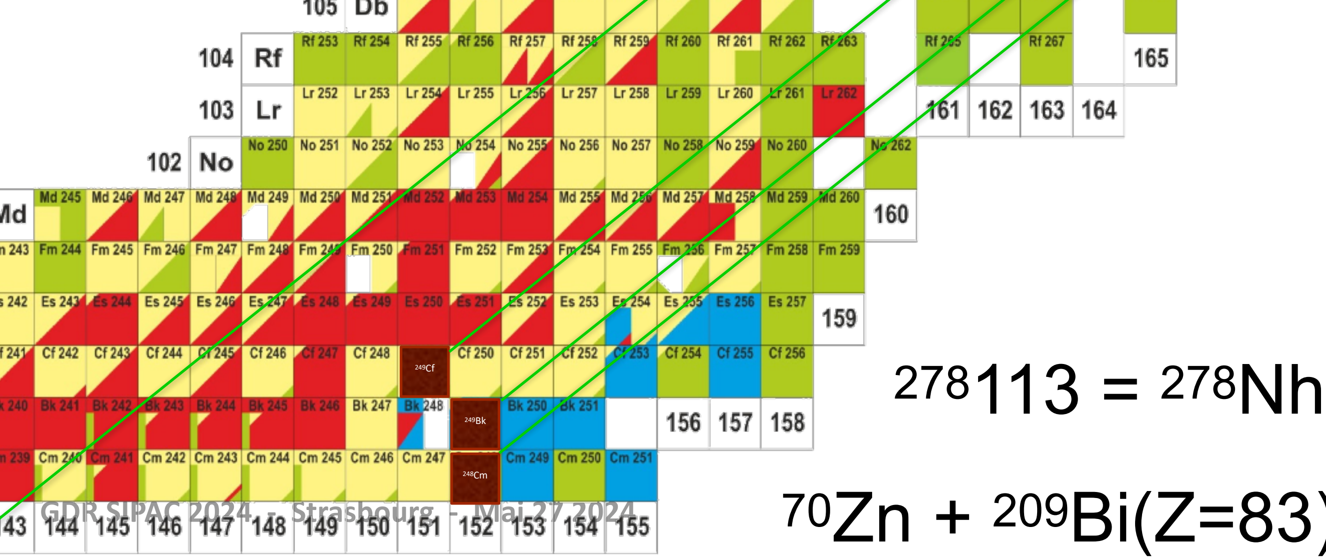
$^{48}Ca + ^{249}Cf(Z=98) \rightarrow ^{294}118 + 3n$

$^{48}Ca + ^{249}Bk(Z=97) \rightarrow ^{294}117 + 3n$

$^{48}Ca + ^{248}Cm(Z=96) \rightarrow ^{293}116 + 3n$





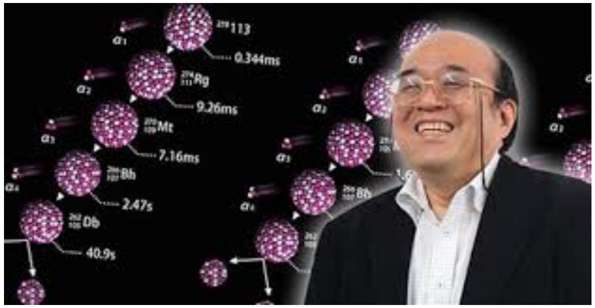


$^{294}118 = ^{294}Og$

$^{294}117 = ^{294}Ts$

$^{293}116 = ^{293}Lv$

$^{278}113 = ^{278}Nh$



$^{70}Zn + ^{209}Bi(Z=83) \rightarrow ^{278}113 + 1n$

Cold fusion $^{208}Pb/^{209}Bi$ / hot fusion ^{48}Ca & Co

^{48}Ca ...

Key: atomic number **Symbol** name conventional atomic weight standard atomic weight

1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 **H** hydrogen 1.008 [1.0078, 1.0082]																		2 **He** helium 4.0026
3 **Li** lithium 6.94 [6.938, 6.997]	4 **Be** beryllium 9.0122												5 **B** boron 10.81 [10.806, 10.821]	6 **C** carbon 12.011 [12.009, 12.012]	7 **N** nitrogen 14.007 [14.006, 14.008]	8 **O** oxygen 15.999 [15.999, 16.000]	9 **F** fluorine 18.998	10 **Ne** neon 20.180
11 **Na** sodium 22.990	12 **Mg** magnesium 24.305 [24.304, 24.307]												13 **Al** aluminium 26.982	14 **Si** silicon 28.085 [28.084, 28.086]	15 **P** phosphorus 30.974	16 **S** sulfur 32.06 [32.059, 32.076]	17 **Cl** chlorine 35.45 [35.446, 35.457]	18 **Ar** argon 39.95 [39.792, 39.963]
19 **K** potassium 39.098	20 **Ca** calcium 40.078(4)		21 **Sc** scandium 44.956	22 **Ti** titanium 47.867	23 **V** vanadium 50.942	24 **Cr** chromium 51.996	25 **Mn** manganese 54.938	26 **Fe** iron 55.845(2)	27 **Co** cobalt 58.933	28 **Ni** nickel 58.693	29 **Cu** copper 63.546(3)	30 **Zn** zinc 65.38(2)	31 **Ga** gallium 69.723	32 **Ge** germanium 72.630(8)	33 **As** arsenic 74.922	34 **Se** selenium 78.971(8)	35 **Br** bromine 79.904 [79.901, 79.907]	36 **Kr** krypton 83.798(2)
37 **Rb** rubidium 85.468	38 **Sr** strontium 87.62		39 **Y** yttrium 88.906	40 **Zr** zirconium 91.224(2)	41 **Nb** niobium 92.906	42 **Mo** molybdenum 95.95	43 **Tc** technetium	44 **Ru** ruthenium 101.07(2)	45 **Rh** rhodium 102.91	46 **Pd** palladium 106.42	47 **Ag** silver 107.87	48 **Cd** cadmium 112.41	49 **In** indium 114.82	50 **Sn** tin 118.71	51 **Sb** antimony 121.76	52 **Te** tellurium 127.60(3)	53 **I** iodine 126.90	54 **Xe** xenon 131.29
55 **Cs** caesium 132.91	56 **Ba** barium 137.33	57-70 lanthanoids	71 **Lu** lutetium 174.97	72 **Hf** hafnium 178.49(2)	73 **Ta** tantalum 180.95	74 **W** tungsten 183.84	75 **Re** rhenium 186.21	76 **Os** osmium 190.23(3)	77 **Ir** iridium 192.22	78 **Pt** platinum 195.08	79 **Au** gold 196.97	80 **Hg** mercury 200.59	81 **Tl** thallium 204.38 [204.38, 204.39]	82 **Pb** lead 207.2	83 **Bi** bismuth 208.98	84 **Po** polonium	85 **At** astatine	86 **Rn** radon
87 **Fr** francium	88 **Ra** radium	89-102 actinoids	103 **Lr** lawrencium	104 **Rf** rutherfordium	105 **Db** dubnium	106 **Sg** seaborgium	107 **Bh** bohrium	108 **Hs** hassium	109 **Mt** meitnerium	110 **Ds** darmstadtium	111 **Rg** roentgenium	112 **Cn** copernicium	113 **Nh** nihonium	114 **Fl** flerovium	115 **Mc** moscovium	116 **Lv** livermorium	117 **Ts** tennessine	118 **Og** oganesson

57 **La** lanthanum 138.91	58 **Ce** cerium 140.12	59 **Pr** praseodymium 140.91	60 **Nd** neodymium 144.24	61 **Pm** promethium	62 **Sm** samarium 150.36(2)	63 **Eu** europium 151.96	64 **Gd** gadolinium 157.25(3)	65 **Tb** terbium 158.93	66 **Dy** dysprosium 162.50	67 **Ho** holmium 164.93	68 **Er** erbium 167.26	69 **Tm** thulium 168.93	70 **Yb** ytterbium 173.05
89 **Ac** actinium	90 **Th** thorium 232.04	91 **Pa** protactinium 231.04	92 **U** uranium 238.03	93 **Np** neptunium	94 **Pu** plutonium	95 **Am** americium	96 **Cm** curium	97 **Bk** berkelium	98 **Cf** californium	99 **Es** einsteinium	100 **Fm** fermium	101 **Md** mendelevium	102 **No** nobelium

For notes and updates to this table, see www.iupac.org. This version is dated 1 December 2 018.

Cold fusion ^{208}Pb/^{209}Bi / hot fusion ^{48}Ca & Co

^{48}Ca, ^{50}Ti, ^{51}V, ^{52,54}Cr, …

Key: atomic number / **Symbol** / name / conventional atomic weight / standard atomic weight

1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 **H** hydrogen 1.008 [1.0078, 1.0082]																		2 **He** helium 4.0026
3 **Li** lithium 6.94 [6.938, 6.997]	4 **Be** beryllium 9.0122												5 **B** boron 10.81 [10.806, 10.821]	6 **C** carbon 12.011 [12.009, 12.012]	7 **N** nitrogen 14.007 [14.006, 14.008]	8 **O** oxygen 15.999 [15.999, 16.000]	9 **F** fluorine 18.998	10 **Ne** neon 20.180
11 **Na** sodium 22.990	12 **Mg** magnesium 24.305 [24.304, 24.307]												13 **Al** aluminium 26.982	14 **Si** silicon 28.085 [28.084, 28.086]	15 **P** phosphorus 30.974	16 **S** sulfur 32.06 [32.059, 32.076]	17 **Cl** chlorine 35.45 [35.446, 35.457]	18 **Ar** argon 39.95 [39.792, 39.963]
19 **K** potassium 39.098	20 **Ca** calcium 40.078(4)		21 **Sc** scandium 44.956	22 **Ti** titanium 47.867	23 **V** vanadium 50.942	24 **Cr** chromium 51.996	25 **Mn** manganese 54.938	26 **Fe** iron 55.845(2)	27 **Co** cobalt 58.933	28 **Ni** nickel 58.693	29 **Cu** copper 63.546(3)	30 **Zn** zinc 65.38(2)	31 **Ga** gallium 69.723	32 **Ge** germanium 72.630(8)	33 **As** arsenic 74.922	34 **Se** selenium 78.971(8)	35 **Br** bromine 79.904 [79.901, 79.907]	36 **Kr** krypton 83.798(2)
37 **Rb** rubidium 85.468	38 **Sr** strontium 87.62		39 **Y** yttrium 88.906	40 **Zr** zirconium 91.224(2)	41 **Nb** niobium 92.906	42 **Mo** molybdenum 95.95	43 **Tc** technetium	44 **Ru** ruthenium 101.07(2)	45 **Rh** rhodium 102.91	46 **Pd** palladium 106.42	47 **Ag** silver 107.87	48 **Cd** cadmium 112.41	49 **In** indium 114.82	50 **Sn** tin 118.71	51 **Sb** antimony 121.76	52 **Te** tellurium 127.60(3)	53 **I** iodine 126.90	54 **Xe** xenon 131.29
55 **Cs** caesium 132.91	56 **Ba** barium 137.33	57-70 lanthanoids	71 **Lu** lutetium 174.97	72 **Hf** hafnium 178.49(2)	73 **Ta** tantalum 180.95	74 **W** tungsten 183.84	75 **Re** rhenium 186.21	76 **Os** osmium 190.23(3)	77 **Ir** iridium 192.22	78 **Pt** platinum 195.08	79 **Au** gold 196.97	80 **Hg** mercury 200.59	81 **Tl** thallium 204.38 [204.38, 204.39]	82 **Pb** lead 207.2	83 **Bi** bismuth 208.98	84 **Po** polonium	85 **At** astatine	86 **Rn** radon
87 **Fr** francium	88 **Ra** radium	89-102 actinoids	103 **Lr** lawrencium	104 **Rf** rutherfordium	105 **Db** dubnium	106 **Sg** seaborgium	107 **Bh** bohrium	108 **Hs** hassium	109 **Mt** meitnerium	110 **Ds** darmstadtium	111 **Rg** roentgenium	112 **Cn** copernicium	113 **Nh** nihonium	114 **Fl** flerovium	115 **Mc** moscovium	116 **Lv** livermorium	117 **Ts** tennessine	118 **Og** oganesson

57 **La** lanthanum 138.91	58 **Ce** cerium 140.12	59 **Pr** praseodymium 140.91	60 **Nd** neodymium 144.24	61 **Pm** promethium	62 **Sm** samarium 150.36(2)	63 **Eu** europium 151.96	64 **Gd** gadolinium 157.25(3)	65 **Tb** terbium 158.93	66 **Dy** dysprosium 162.50	67 **Ho** holmium 164.93	68 **Er** erbium 167.26	69 **Tm** thulium 168.93	70 **Yb** ytterbium 173.05
89 **Ac** actinium	90 **Th** thorium 232.04	91 **Pa** protactinium 231.04	92 **U** uranium 238.03	93 **Np** neptunium	94 **Pu** plutonium	95 **Am** americium	96 **Cm** curium	97 **Bk** berkelium	98 **Cf** californium	99 **Es** einsteinium	100 **Fm** fermium	101 **Md** mendelevium	102 **No** nobelium

For notes and updates to this table, see www.iupac.org. This version is dated 1 December 2018.

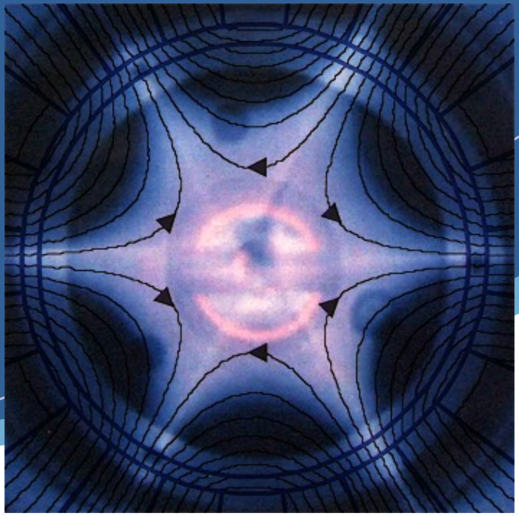
Magic beams for SHE… $^{40,48}Ca$, ^{50}Ti, ^{51}V, $^{52,54}Cr$

- Z=20
- N=20,28

Calcium	Scandium	Titanium	Vanadium	Chromium
Z=20	Z=21	Z=22	Z=23	Z=24
Isotopes	Isotope	Isotopes	Isotopes	Isotopes
^{40}Ca 96,9 % N=20				
^{42}Ca 0,6 % N=22				
^{43}Ca 0,1 % N=23				
^{44}Ca 2,0 % N=24	^{45}Sc 100 % N=24	^{46}Ti 8,0 % N=24		
		^{47}Ti 7,3 % N=25		
^{46}Ca 0,004 % N=26		^{48}Ti 73,8 % N=26		^{50}Cr 4,3% N=26
		^{49}Ti 5,5 % N=27	^{50}V 0,25 % N=27	
^{48}Ca 0,2 % N=28		^{50}Ti 5,4 % N=28	^{51}V 99,75 % N=28	^{52}Cr 83,8% N=28
				^{53}Cr 9,5 % N=29
				^{54}Cr 2,4 % N=30
T_{fusion} = 842 °C	T_{fusion} = 1541 °C	T_{fusion} = 1668 °C	T_{fusion} = 1910 °C	T_{fusion} = 1907 °C
$T_{boiling}$ = 1484 °C	$T_{boiling}$ = 2836 °C	$T_{boiling}$ = 3287 °C	$T_{boiling}$ = 3407 °C	$T_{boiling}$ = 2671 °C

Intense metallic beams

- Bring titanium in the ECR plasma
- Generate high charge states



Différentes techniques

Penning Ion Gauge

ionization by an electric discharge (metal titanium)

TiO_2 — Ti (M)

Sputtering

TiO_2 — Ti (M)

tear away out of an enriched rod (metal titanium)

Inductive Oven

high temperature sublimation from a metallic or oxyde pellet

TiO_2 — Ti (M)

MIVOC

sublimation of organometallic compounds

$TiCl_4$ — TiO_2

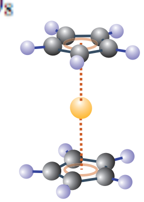
First Titanium MIVOC beams

- Need stable organometallic compound
- with enough vapor pressure

ABLE I. The MIVOC compounds that have been used for the production metal ion beams.

Element	Compound
Mg	$Mg(C_5H_5)_2$
Si	$Si\{Si[(CH_3)_3]\}_4$
Cr	$Cr(C_5H_5)_2$ or $Cr(CO)_6$
Fe	$Fe(C_5H_5)_2$
Co	$Co(C_5H_5)_2$ or $Co_2(CO)_8$
Ni	$Ni(C_5H_5)_2$
Ge	$Ge(C_2H_5)_4$
Mo	$Mo(CO)_6$
Ru	$Ru(C_5H_5)_2$
I	I_2CH_2
W	$W(CO)_6$
Os	$Os(C_5H_5)_2$

H. Koivisto et al., NIM B 187 (2002)111



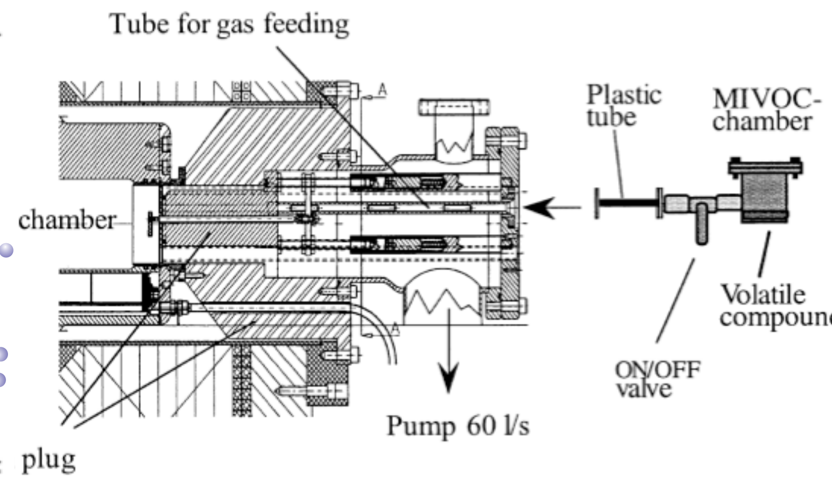
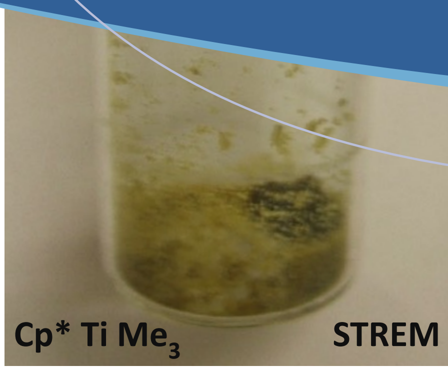
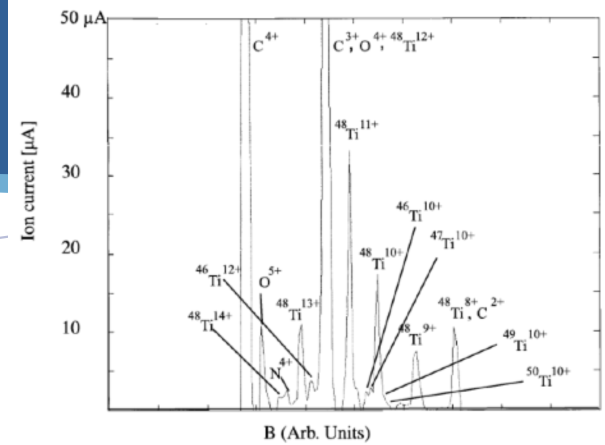


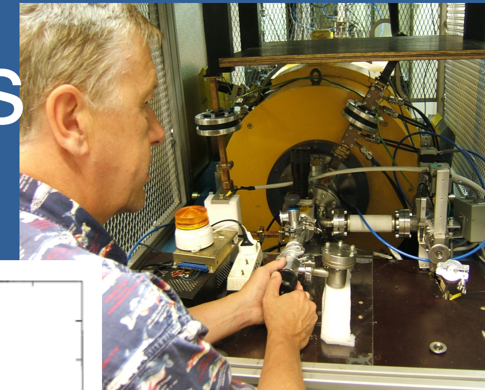
Fig. 2. The MIVOC chamber connection to the injection side of the JYFL 14 GHz ECRIS.

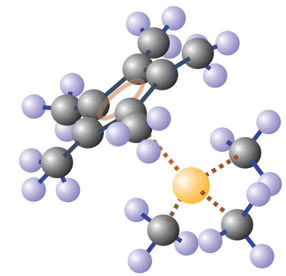
First titanium MIVOC beams

- test all commercial available
- Oxygen-free (Ti getter)









Intensities of measured Ti ion beams from H. Koivisto et al., NIM B 187 (2002)111

Isotope/charge	8+	9+	10+	11+	12+	13+
^{46}Ti 7.9%	3.6*	4.7 *	4.8 *	4.8 *	3.9	1.6 *
^{47}Ti 7.3%	3.3 *	4.3 *	4.4 *	4.4 *	3.6 *	1.4 *
^{48}Ti 73.9%	33	43	44	45	36 *	14.3
^{49}Ti 5.5%	2.5 *	3.2 *	3.3 *	3.3 *	2.7 *	1.1 *
^{50}Ti 5.3%	2.5 *	3.2 *	3.3 *	3.3 *	2.7 *	1.1 *

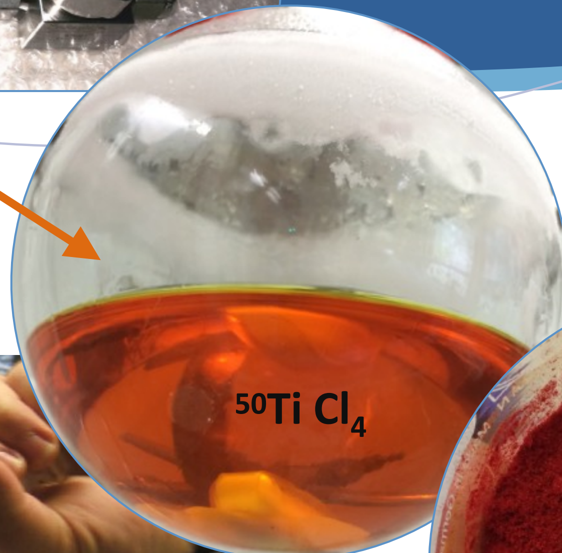
The abundance of the titanium isotopes in natural titanium is also shown. The asterisk denotes intensities estimated from the intensity of the same charge state of a different isotope. The extraction voltage was 10 kV.

92% Enriched ^{50}Ti MIVOC

Total efficiency can go up to

- 95% per step
- 86% total

-Step 0: Vacuum extraction

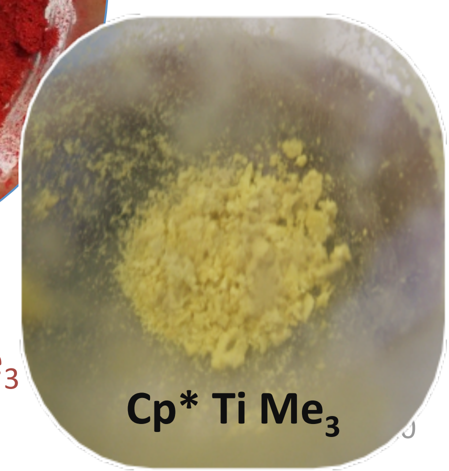


- Synthesis step 1 :

Preparation of Cp*$TiCl_3$ from $TiCl_4$

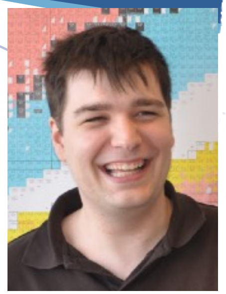
- Synthesis step 2 :

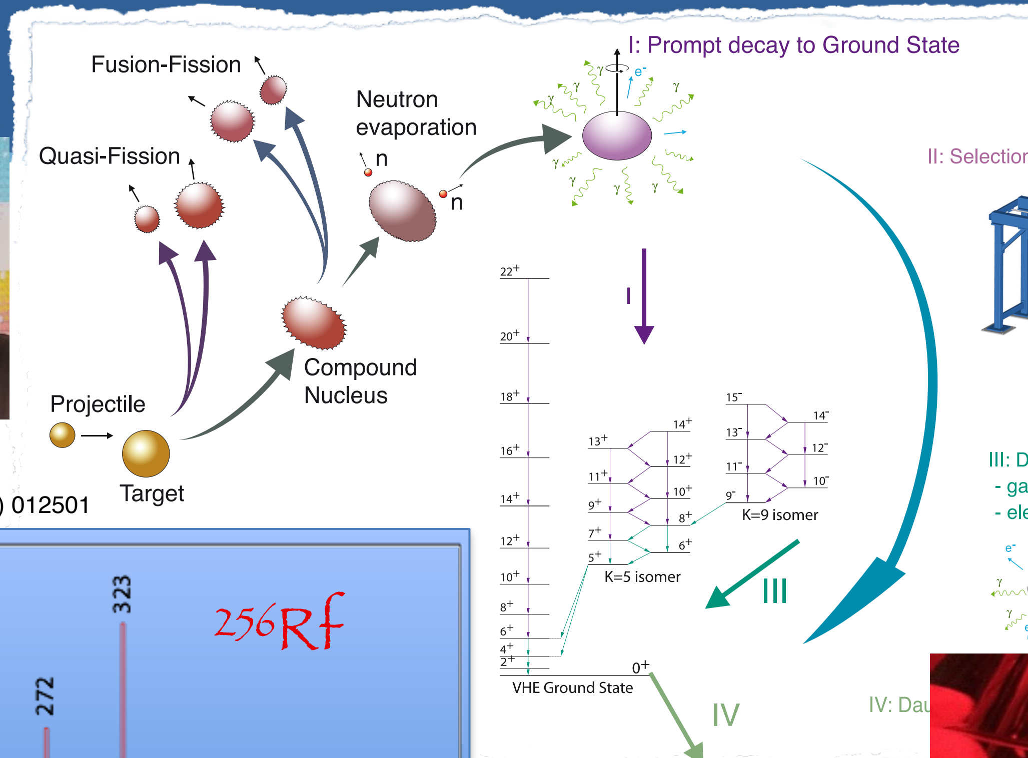
Preparation of Cp*$TiMe_3$

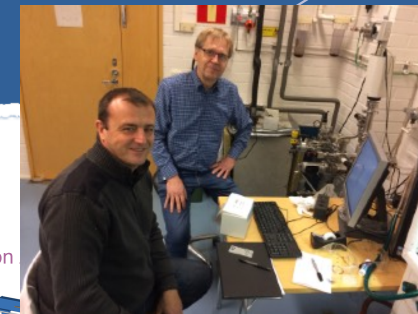


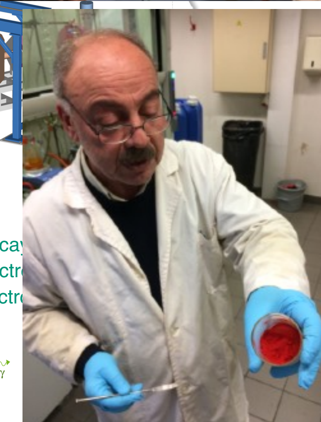
Initial aim: ^{256}Rf prompt spectroscopy

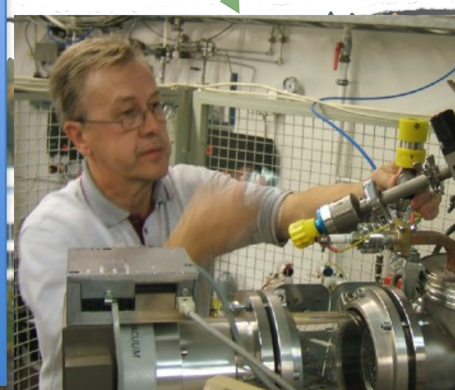
Needed 50 pnA of ^{50}Ti beam … ???



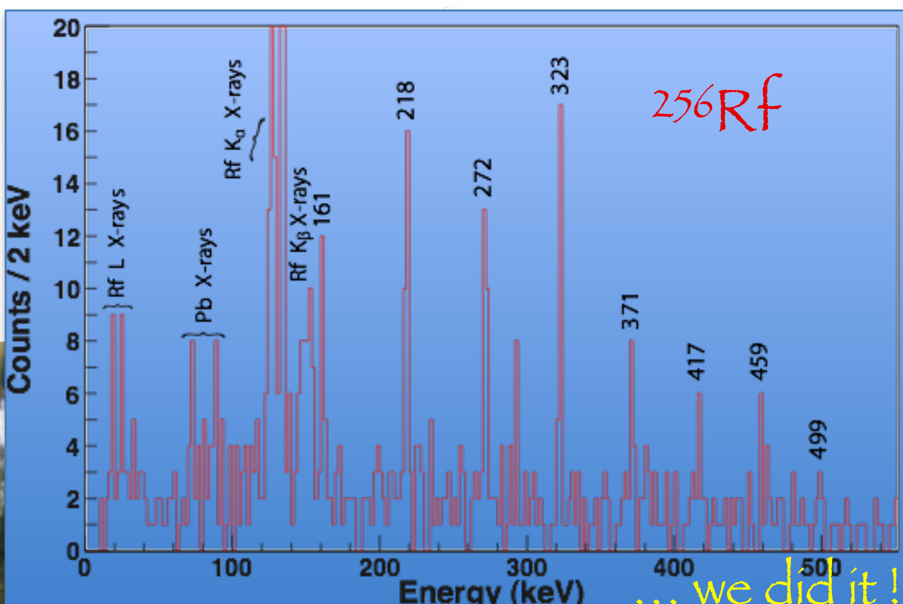








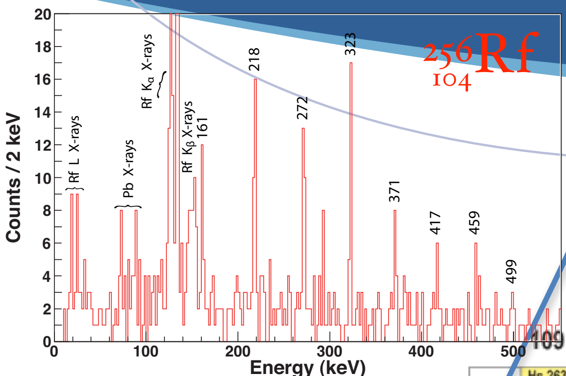
Greenlees, Rubert et al., PRL 109 (2012) 012501



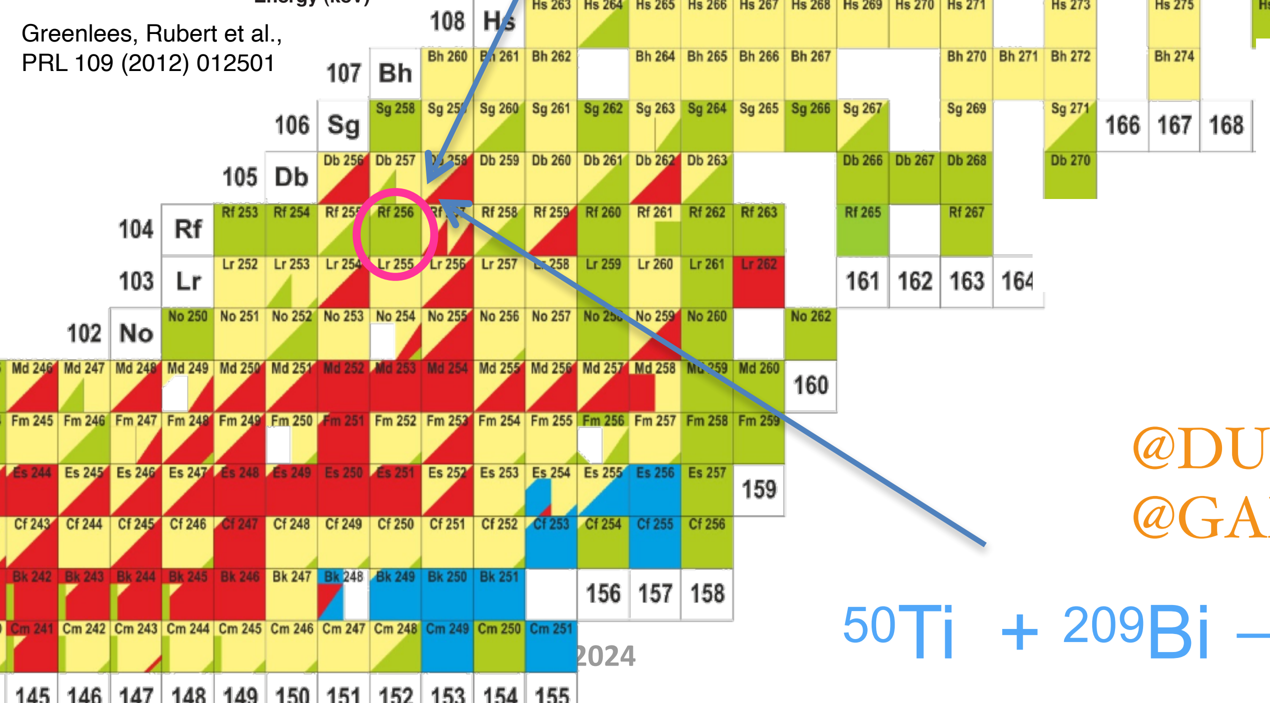
Detailed spectroscopy of SHE with MIVOC ^{50}Ti

$^{50}Ti + ^{208}Pb \rightarrow ^{256}104 + 2n$

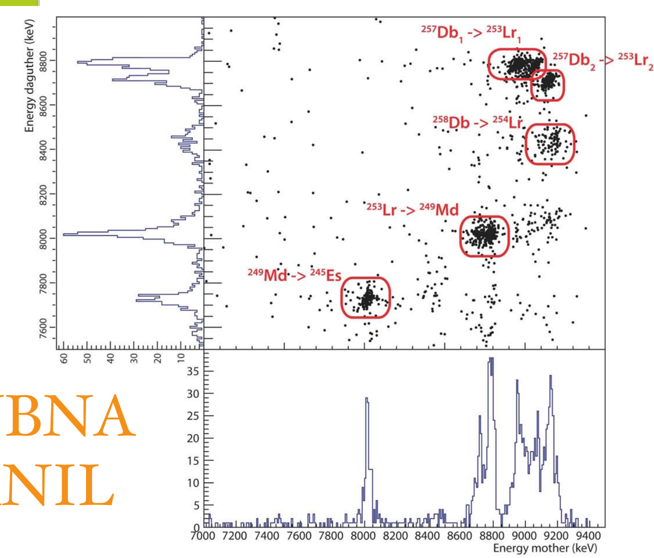
@JYFL



Greenlees, Rubert et al.,
PRL 109 (2012) 012501



P. Brionnet PhD thesis IPHC 2017



@DUBNA
@GANIL

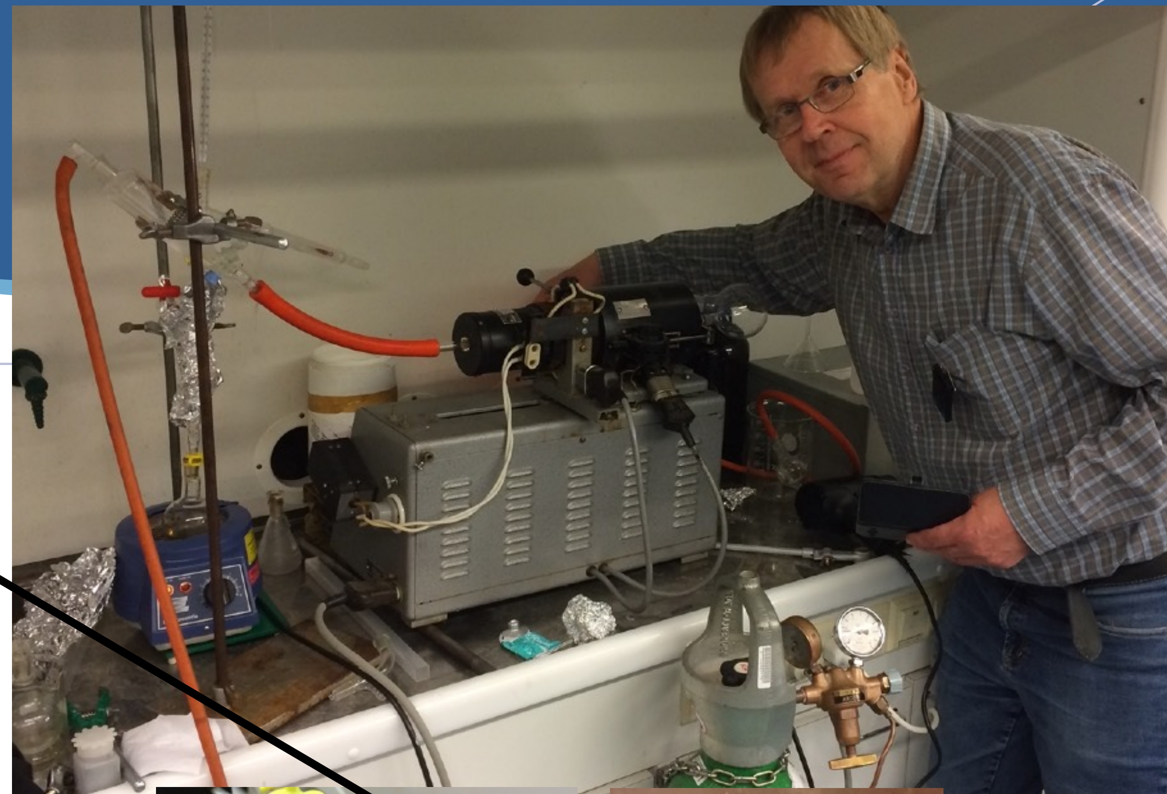
$^{50}Ti + ^{209}Bi \rightarrow ^{257}105 + 2n$

2024

Magnesocene MIVOC

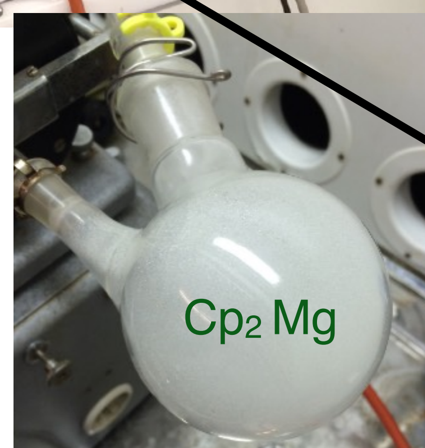
2015 ...

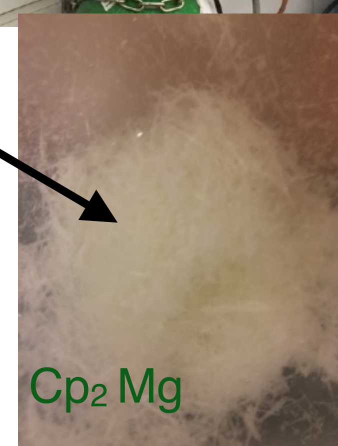
Synthesis @JYFL

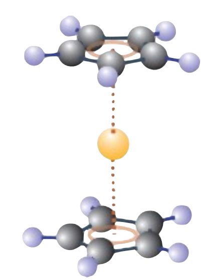


from Mg (M)

and dicyclopentadiene



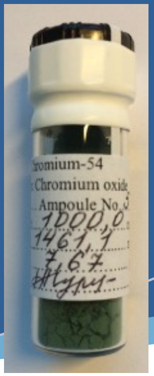




Chromocene: Cp_2Cr

Synthesis @IPHC Strasbourg from Cr_2O_3

2018 success



$Cr_2\,O_3$

Very pure compound (recristalized Cp2Cr)

$Cp_2\,^{54}Cr$

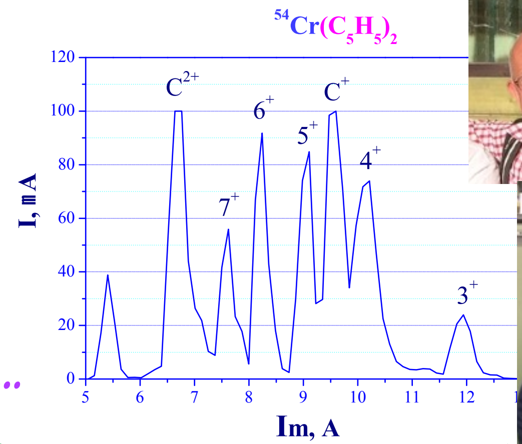
Process efficiency ~87% , but we work on process & reprocess

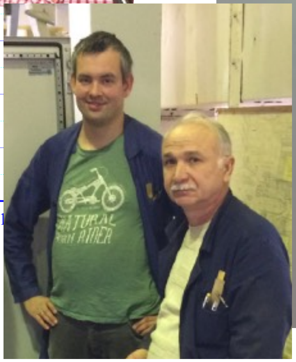
Tested on DUBNA ECR ion sources

Successfully extracted

5+ --> 95 µA

=> 19 pµA ...





~1 pµA on target expected

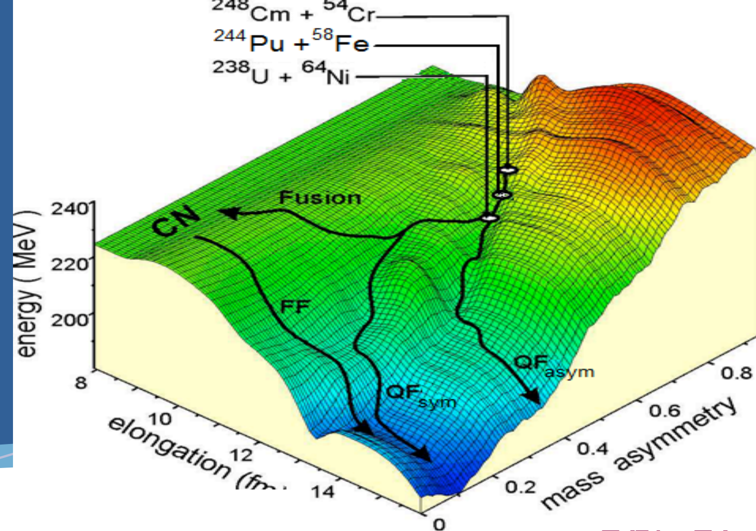
Cr Cl_3

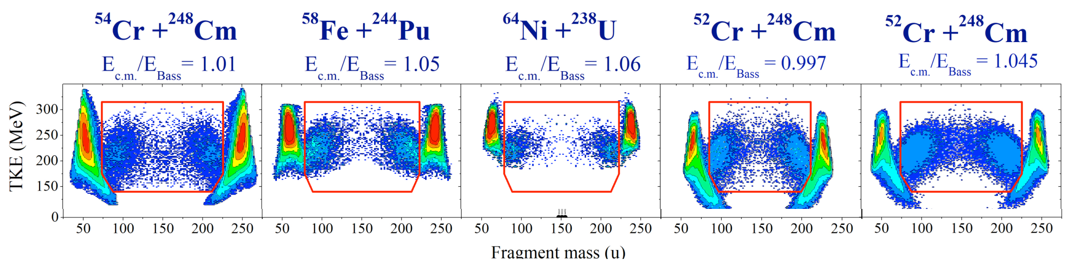
$Cp_2\,^{54}Cr$

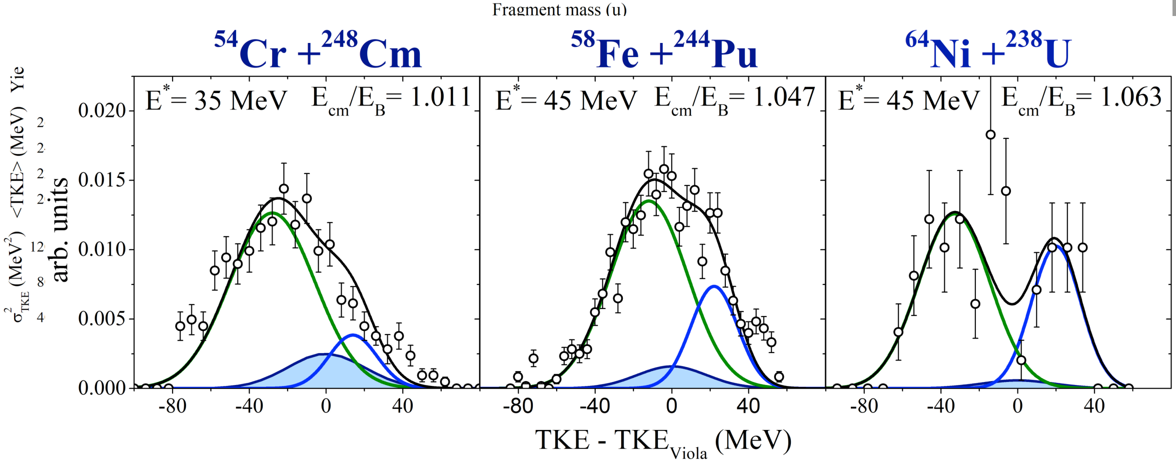
Study of fission of E120 in Dubna 2019

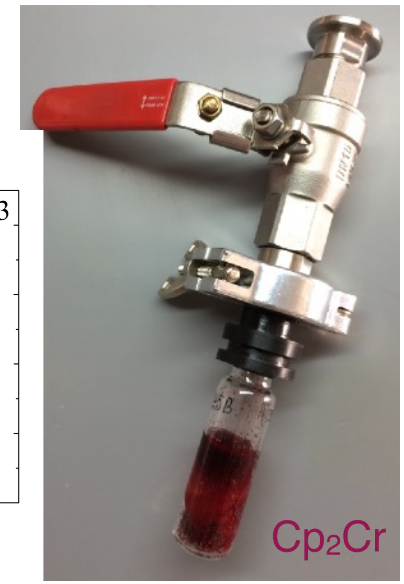
Chromocene: Cp_2Cr

Synthesis @IPHC Strasbourg from Cr_2O_3









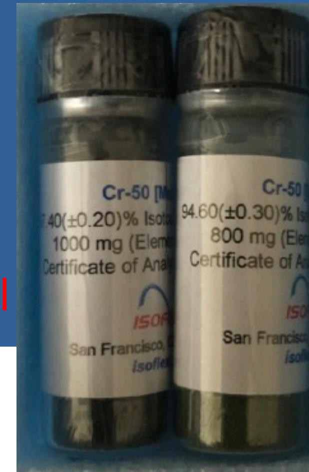
Cr Cl_3

Study of fission of E120 in Dubna 2019

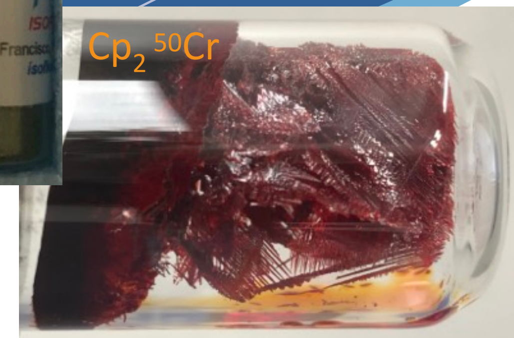
Chromocene: Cp_2Cr

Study of p-n pairing in ^{46}V
300h of beam

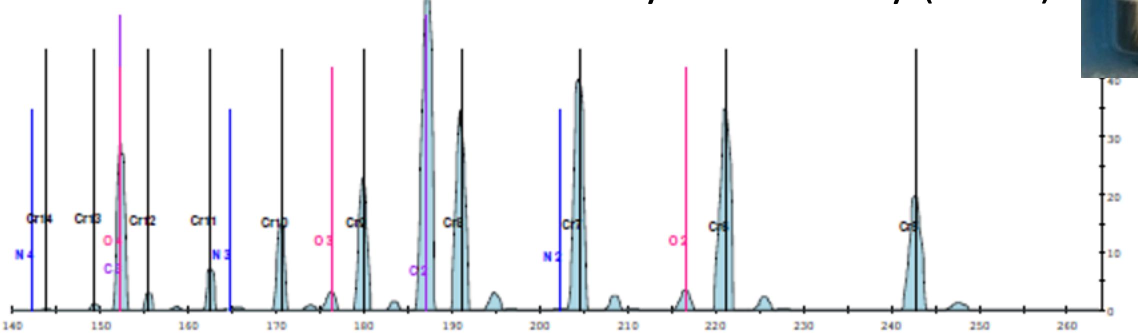
E805_20 @GANIL, April



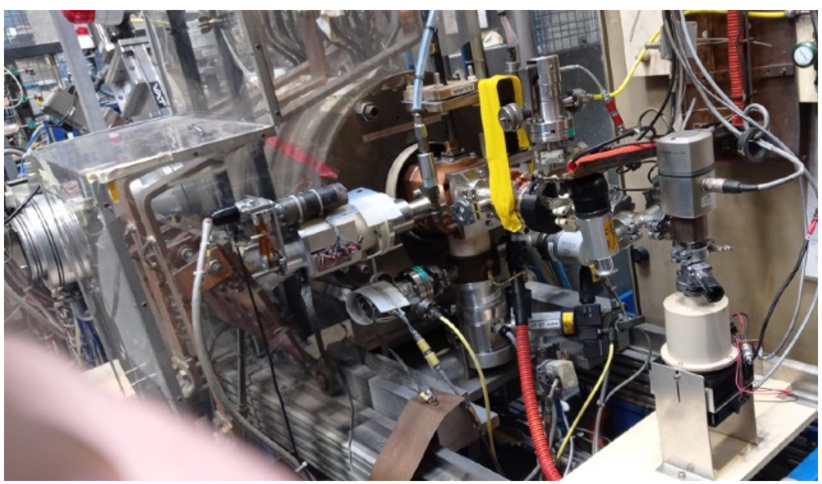
Isotopic synthesis
C. Charpentier,
@IPHC Strasbourg



ECRIS analyzed intensity ($^{50}Cr^{x+}$)



$Cp_2\,^{50}Cr$ installed on the ion source



^{50}Cr (10^{13} pps) is accelerated 70 MeV/u
—> fragmented on a 1mm ^{9}Be target
—> Selection of ^{48}Cr with LISE (10^5 pps @ 30 MeV/u)

then run ^{48}Cr (p, ^{3}He) ^{46}V

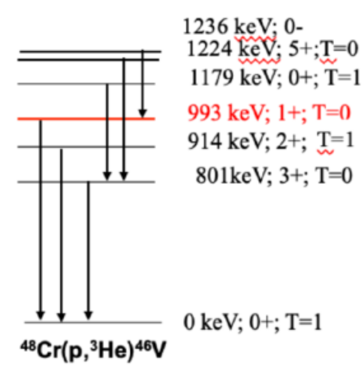


Figure 7: Level scheme of ^{46}V.

Nickelocene: Cp_2Ni

Retirement
Z Asfari

Isotopic synthesis
C. Charpentier,
@IPHC Strasbourg

$Cp_2\,^{58}Ni$

Study of multi-nucleon transfert

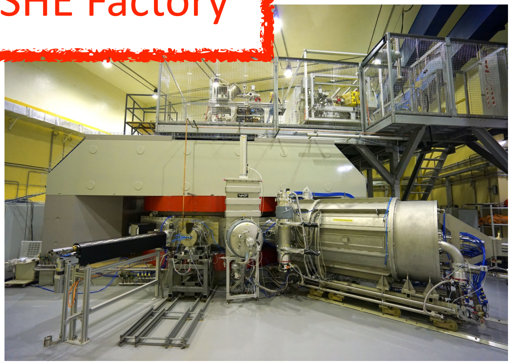
Experiment @ JYFL April 2024

NEW MACHINES for SHE

2020 …

SHE-Fact. commissionned
DGFRS2 commissionned
synth 50Ti …
+ runs SHELS

SHE Factory



-> *New machine (SHE Factory)*
-> *No more foil extraction*
-> *Higher beam transport efficiency*
-> *New ECR sources (DECRIS-PM & DECRIS-SC)*

n RILAC

-> *Upgrade of RILAC to nRILAC (SC sections)*
-> *New ECR sources (28GHz SC ECRIS)*
-> *High charge state (^{295}Og run) no more necessary*

n RILAC commissionned
GARIS II commissionned
E119 restarted 2-4 m beam/Y

also LINAC + S3 @ GANIL

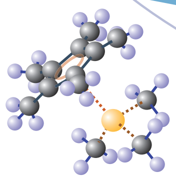
-> *New machine (LINAC)*
-> *New instrument (S3)*

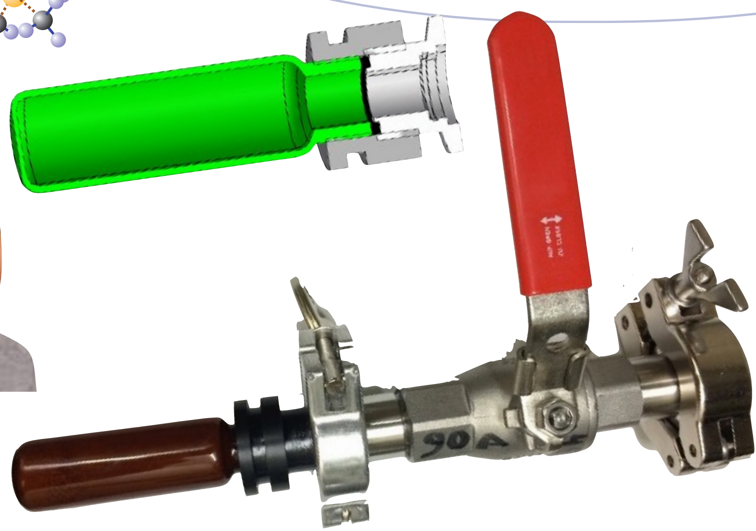
+ EURO-LABS !!!

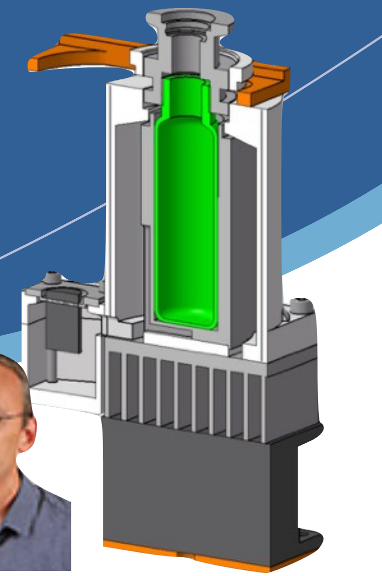
+ NEWGAIN !!!

Beams from Cp* ^{50}Ti Me_3

IPHC (Z. Asfari, B. Gall, J. Piot, J. Rubert, H. Faure, M. Filliger)
JYFL (J. Ärje, R. Seppälä, H Koivisto, P. Greenlees)
GANIL (F. Lemagnen, P Leherissier, C. Barue B. Osmond, J. Piot)
JINR (S. Bogomolov, V. Loginov, A. Yeremin)
RIKEN (M. Kidera, K. Morimoto, K. Morita)



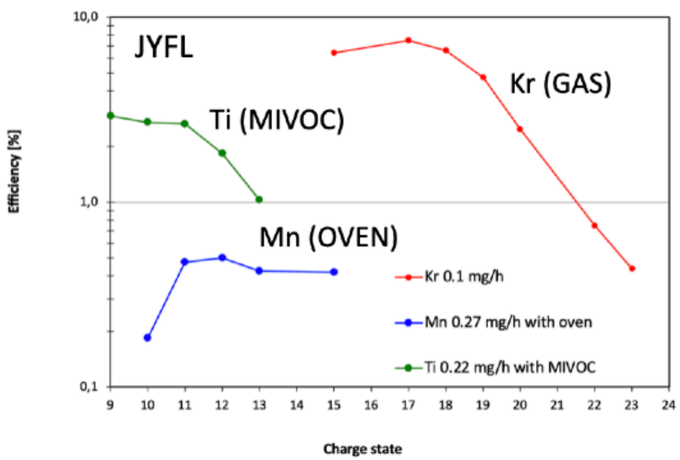


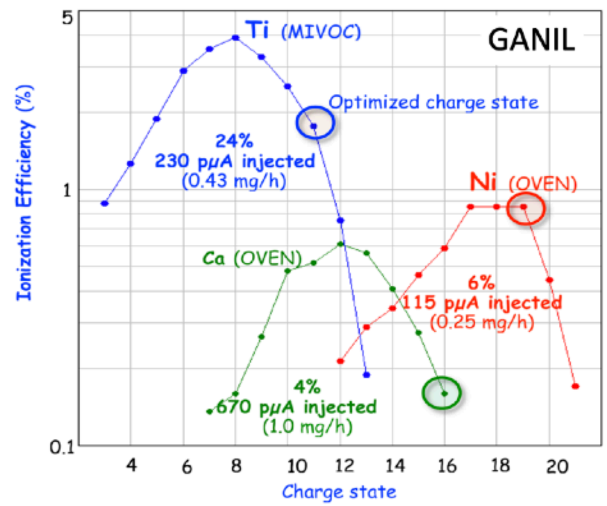


Control MIVOC flow with temperature under high vacuum

Task 1: Improved ion beam variety and production efficiency

Production efficiency comparison: gaseous element vs MIVOC vs oven





According to the experimental data:

- MIVOC compound behaves ≈ like normal gas until the molecule dissociates in plasma.
- We may assume that the efficiency of evaporation oven should be comparable to MIVOC if capture efficiency of evaporated metal atoms is improved → one focus point of ERIBS.

ICIS'23, 17-22 Sept. 2023, Victoria, Canada

(c) H. Koivisto ICIS'23, 17-22 Sept. 2023, Victoria, Canada

Task 1: Improved ion beam variety and production efficiency

During ERIBS:

- MIVOC technology will be transferred to new laboratories
- New MIVOC beams will be developed :

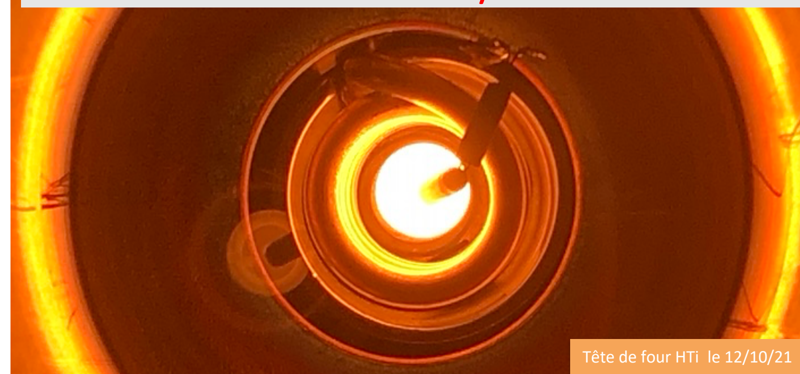
Element	Proposer	Interest
238U	GANIL	INFN
70Zn	GANIL	INFN, JYFL
Ba	INFN	
Ca	INFN	JYFL/GANIL
93/94Nb	INFN	
Cr	JYFL: enriched compounds as a service	
Fe		INFN
Ni		
Ti		
Sr	JYFL	

Institut national de physique nucléaire
& de physique des particules

Fiche projet de R&T

Faisceaux Métalliques Intenses

LEMAGNEN Frédéric / GALL Benoît

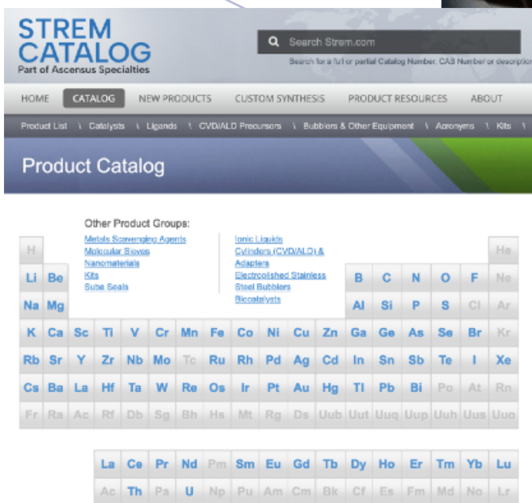


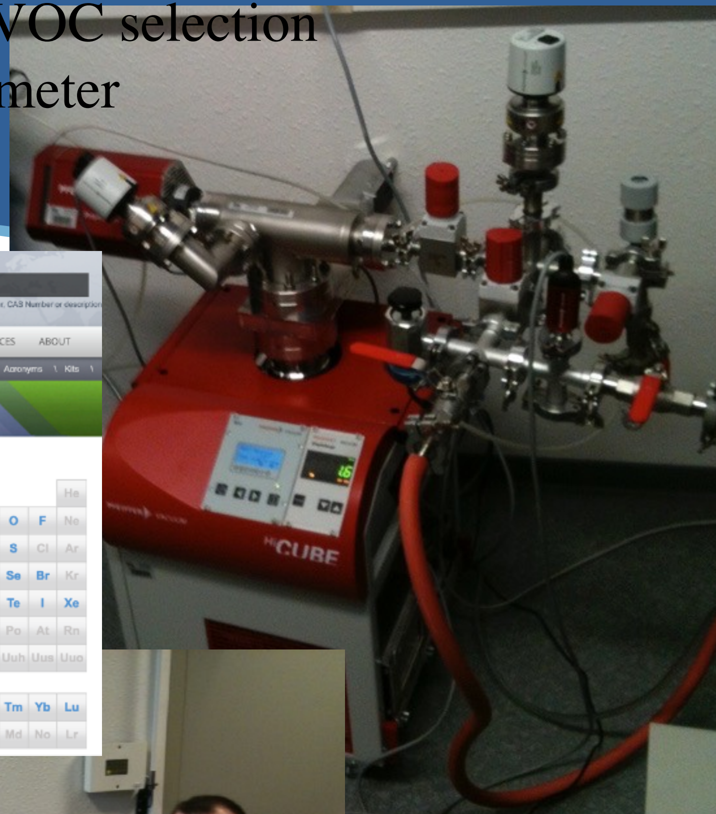
Réf Interne :	FMI
Réf ATRIUM :	ATRIUM-XXXX
Titre / *Title* :	Fiche Projet « Faisceaux métalliques intenses » *« Intense metallic beams »*
Résumé / *Summary*:	Les faisceaux métalliques intenses de calcium, titane, vanadium, chrome et d'uranium sont d'une importance capitale pour la physique nucléaire au niveau mondial et particulièrement au GANIL avec S³. L'objectif est d'arriver à délivrer des faisceaux de 5 à 7 MeV par nucléons avec des intensités de 10 pµA et plus ! Certains d'entre eux sont difficiles à réaliser avec les méthodes habituelles du fait de leur haute température de vaporisation. Ce projet propose de développer les outils et méthodes nécessaires pour arriver aux intensités souhaitées au travers de fours spécifiques ou de méthodes d'évaporation. Pour l'IN2P3 il est co-porté par le GANIL et l'IPHC. *The intense metallic beams of calcium titanium, vanadium chromium and uranium are of paramount importance for nuclear physics worldwide and particularly for GANIL with the S³ project. The objective is to deliver to physics experiments beams of 10 pµA and more at 5-7 MeV per nucleon. Some of them are difficult to achieve with the usual methods due to their high vaporization temperature. This project proposes to develop the tools and methods needed to achieve the desired intensities through specific furnaces or evaporation methods. For IN2P3 it is co-carried by GANIL and the IPHC.*

MIVOC molecule selection

Non enriched MIVOC selection
—> Mass Spectrometer
—> MIVOC use

Non enriched MIVOC
—> synthesis training
—> transport protocol

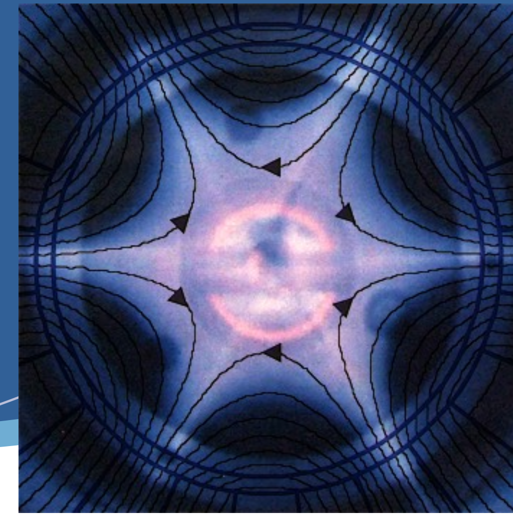




Then synthesis of isotopic equivalent need to be done

Titanium beams

- Bring titanium in the ECR plasma
- Generate high charge states



Différentes techniques

Penning Ion Gauge

ionization by an electric discharge (metal titanium)

TiO_2 Ti (M)

Sputtering

TiO_2 Ti (M)

tear away out of an enriched rod (metal titanium)

Inductive Oven

high temperature sublimation from a metallic or oxyde pellet

TiO_2 Ti (M)

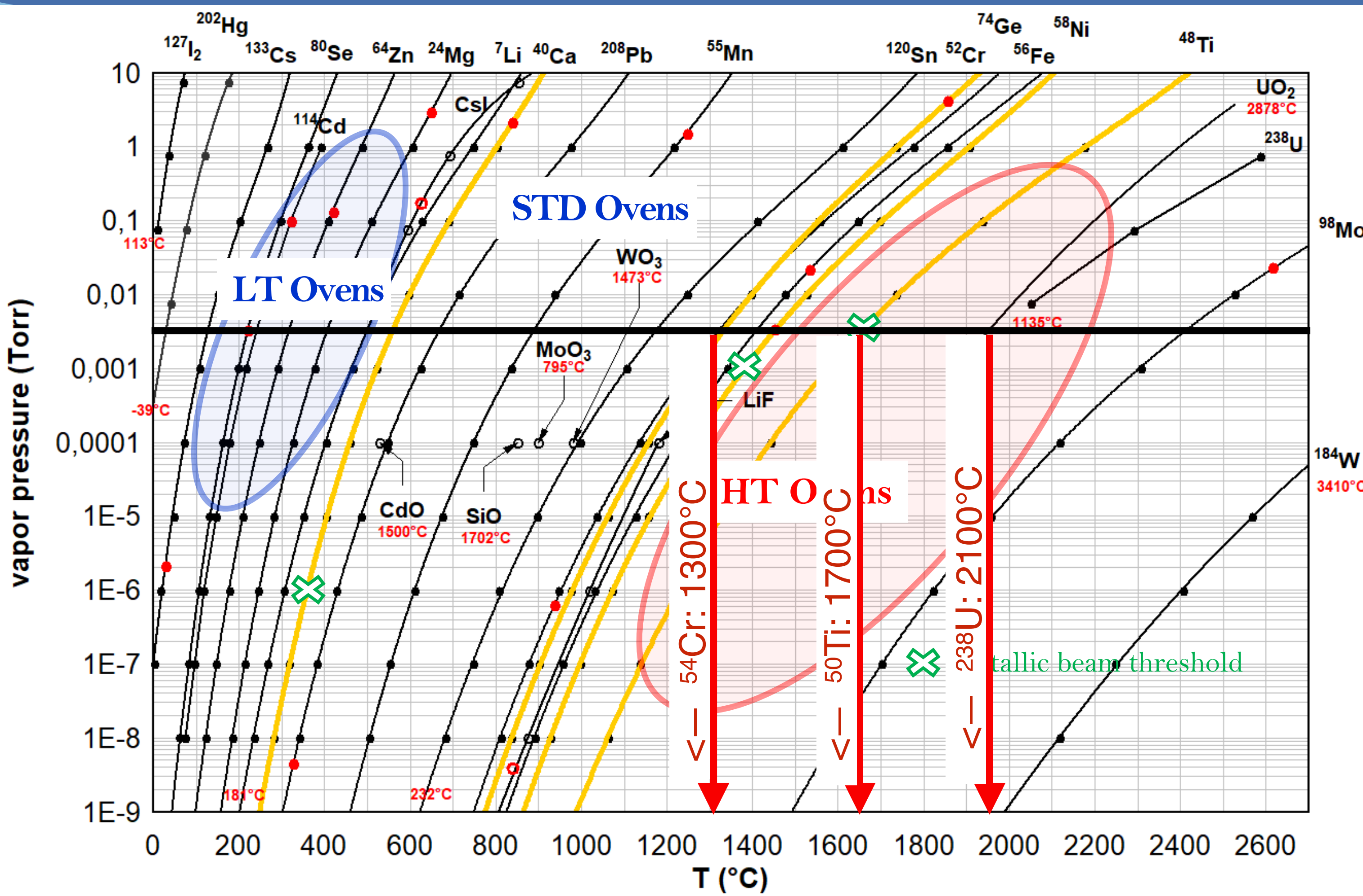
MIVOC

sublimation of organometallic compounds

$TiCl_4$ TiO_2

HIGH INTENSITY METALLIC BEAMS

—> ^{50}Ti & ^{238}U need HT ovens



—> ^{54}Cr: 1300°C

—> ^{58}Fe: 1400°C

—> ^{64}Ni: 1450°C

—> ^{50}Ti: 1650°C

—> ^{238}UO$_2$: 1950°C

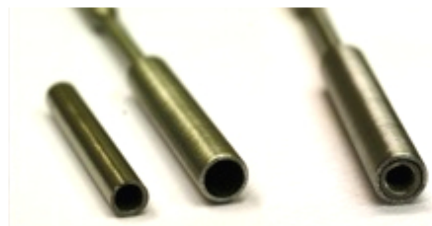
—> ^{238}U(M): 2050°C

Titanium beams

- Bring titanium in the ECR plasma
- Generate high charge states

Inductive oven (JYFL)

- Heating up to 2000°C
- Induction in Mo
- W crucible (IPHC)



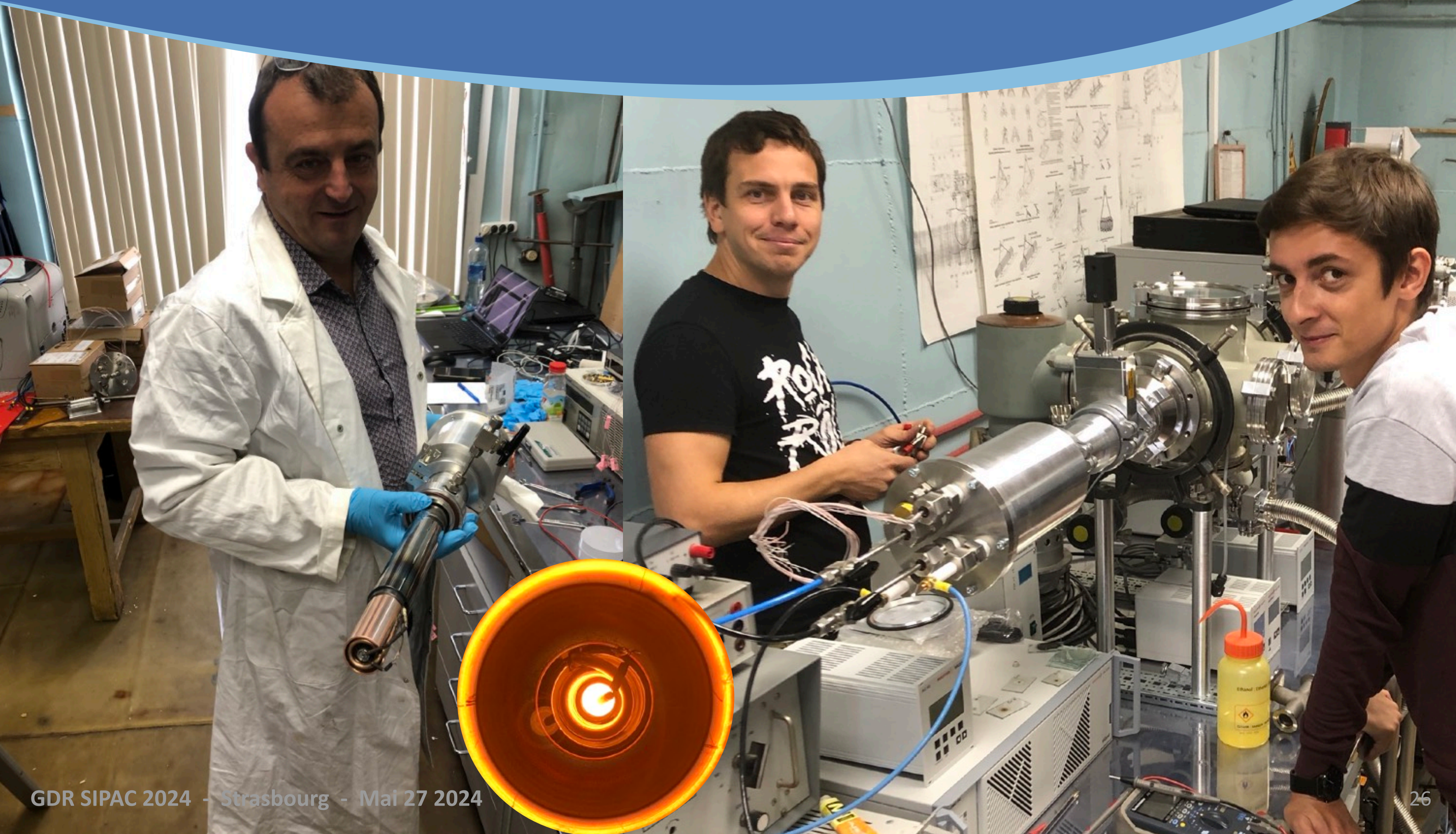
©M. Savonen

J. PIOT PhD Thesis

Ti (M) pellets	TiO_2 pellets
M.P. 1668°C	M.P. 1885°C
Needs reduction of TiO_2	Direct use

one got 4.5 eμA out of ECRIS2 @JYFL

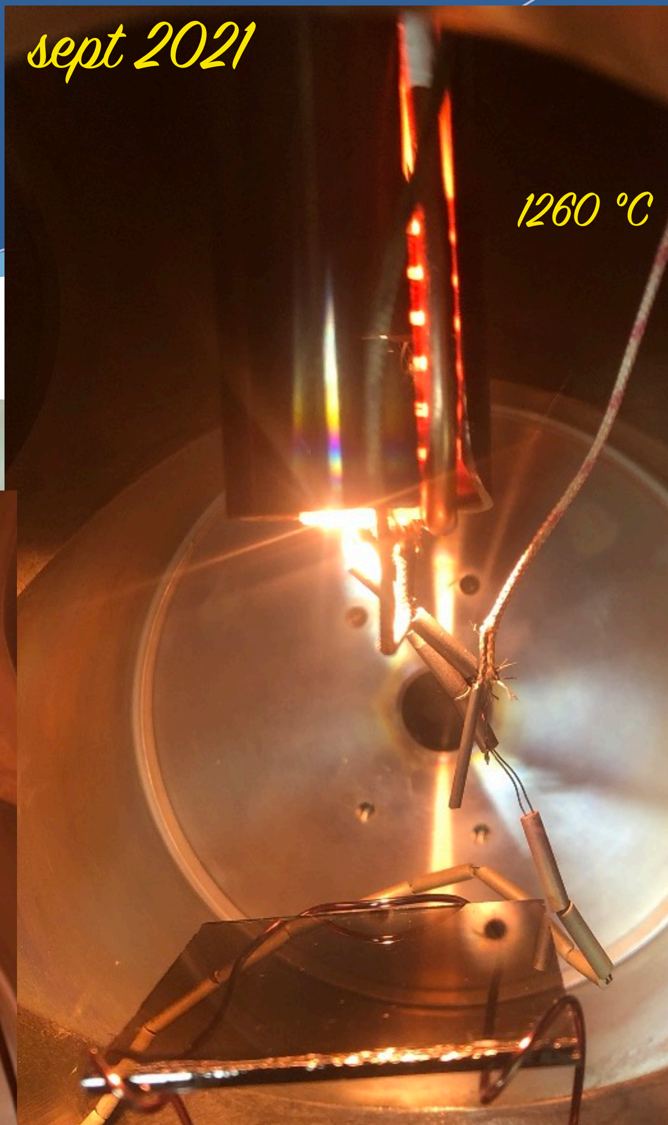
STATUS OF THE INDUCTIVE OVEN DEVELOPMENT



HIGH INTENSITY METALLIC BEAMS

—> Tests @ FLNR

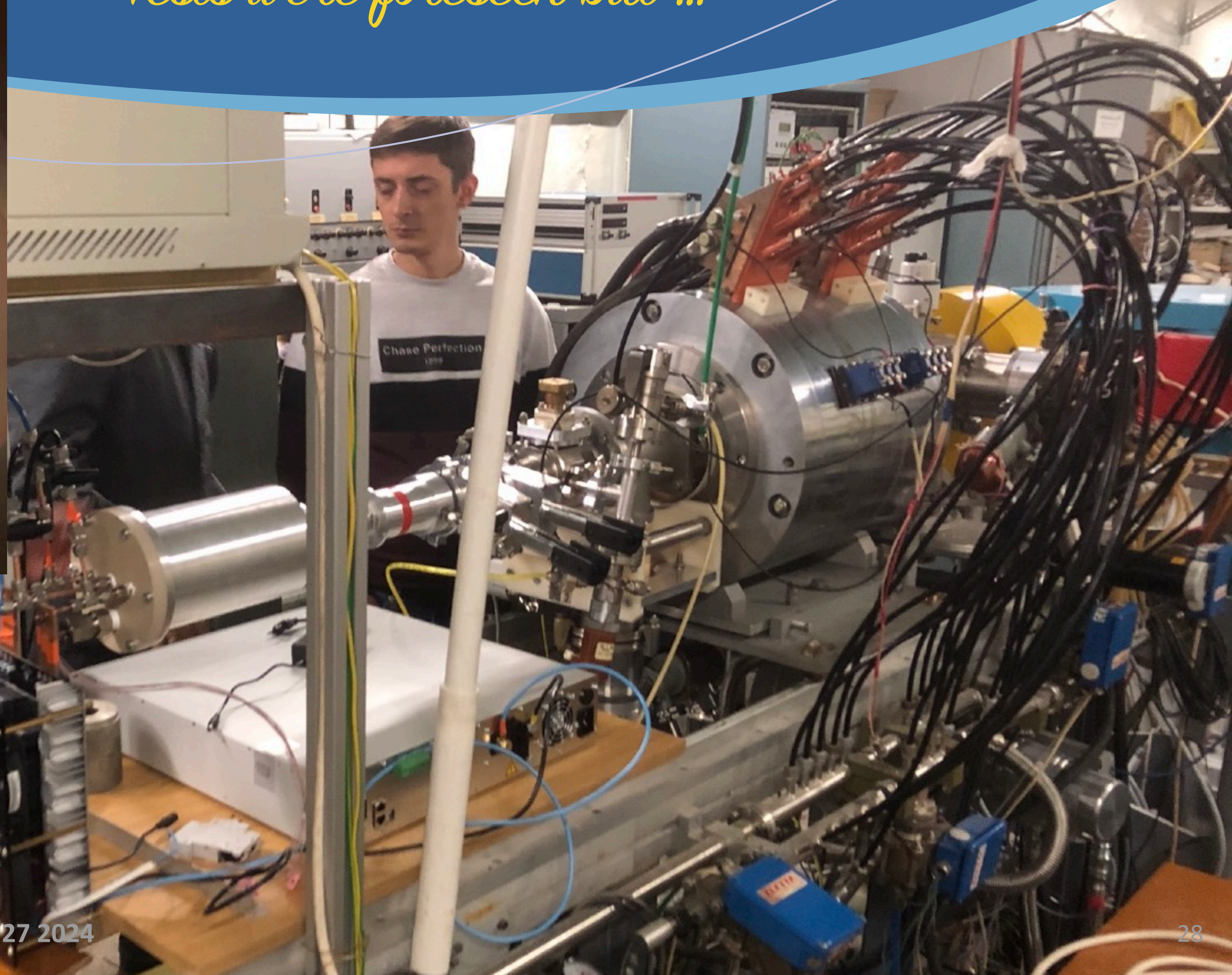
First Chromium & titanium depositions



PROJECT FROZEN @ DUBNA !

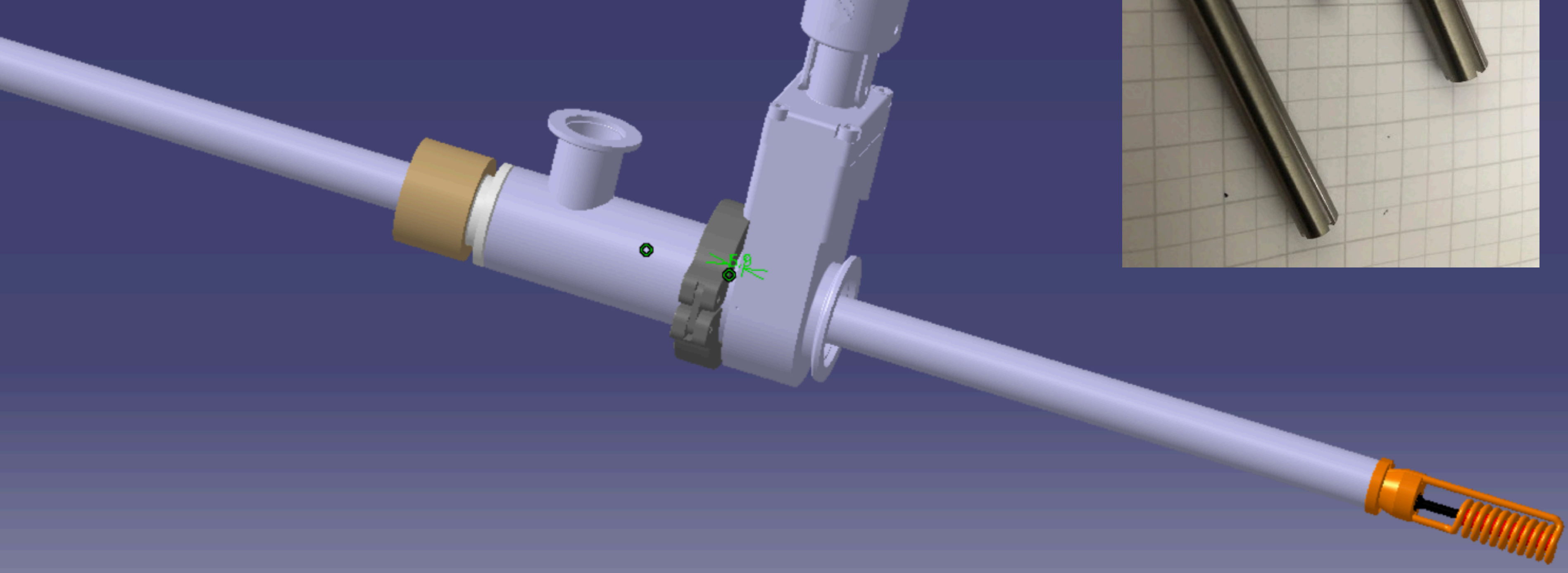
2500 °C

Tests were foreseen but ...



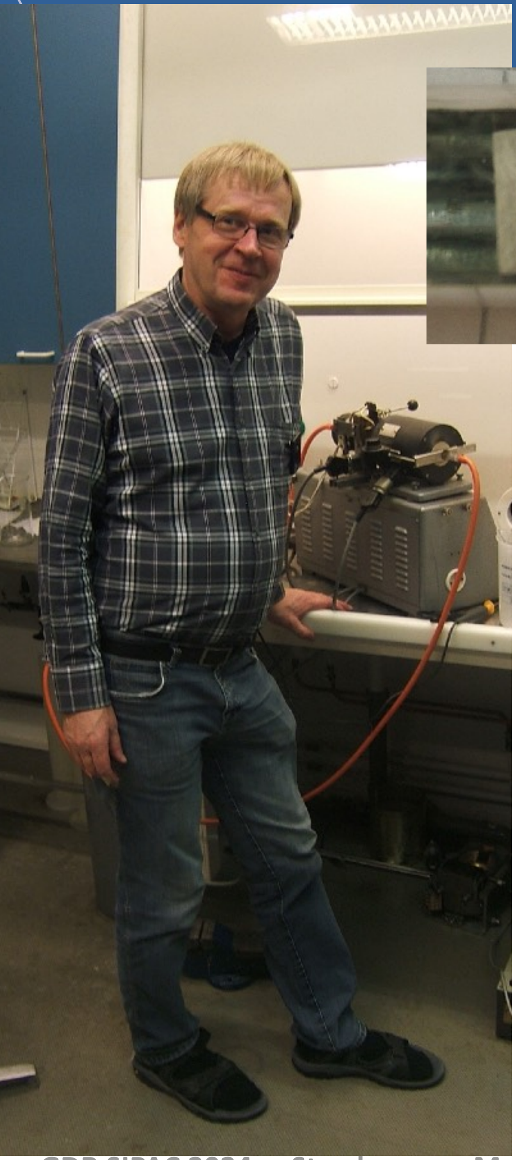
VERSION FOR PHENIX

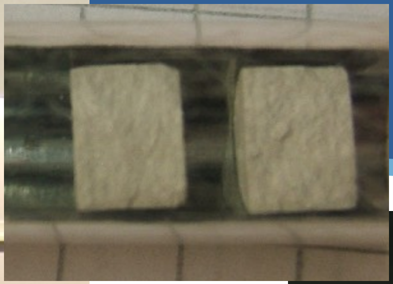
Tests foreseen @ LPSC Grenoble…

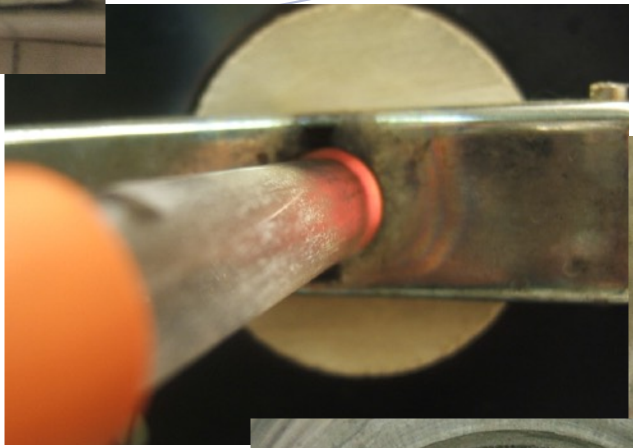


ISOTOPIC PELLETS PREPARATION

Titanium reduction @JYFL





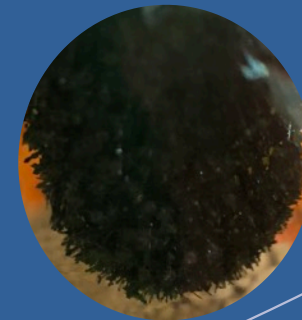
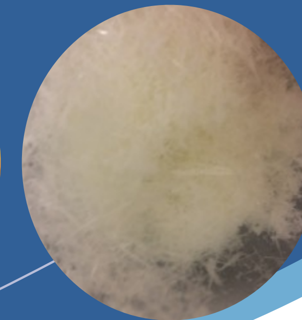


ISOTOPIC PELLETS PREPARATION

Chromium with same method as Ti

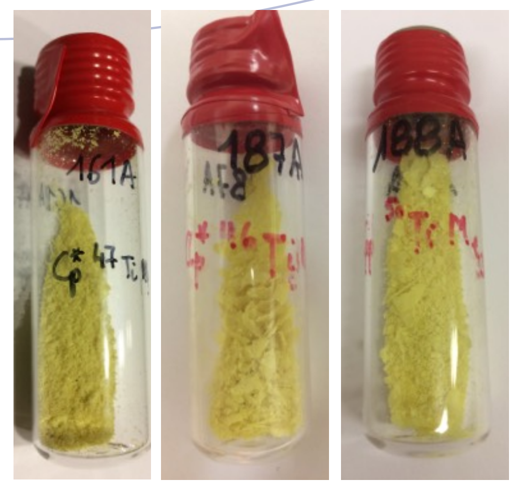
SUMMARY



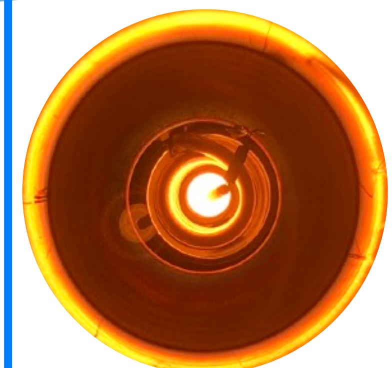
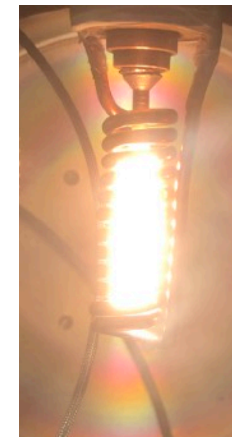
Enabled MIVOC from

- ^{50}Ti (JYFL Sept 2011)
- ^{47}Ti (JYFL April 2017)
- ^{46}Ti (Dubna Sept 2017)
- ^{54}Cr (Dubna Sept 2018)
- ^{50}Cr (GANIL April 2023)
- ^{58}Ni (JYFL April 2024)



2-3 pμA reached

R&D Uranocene

R&D HTi oven

- ø20 oven tested
- 2500 °C reached
- new ø20 oven

good way to 10 pμA