^{8}B at ISOLDE

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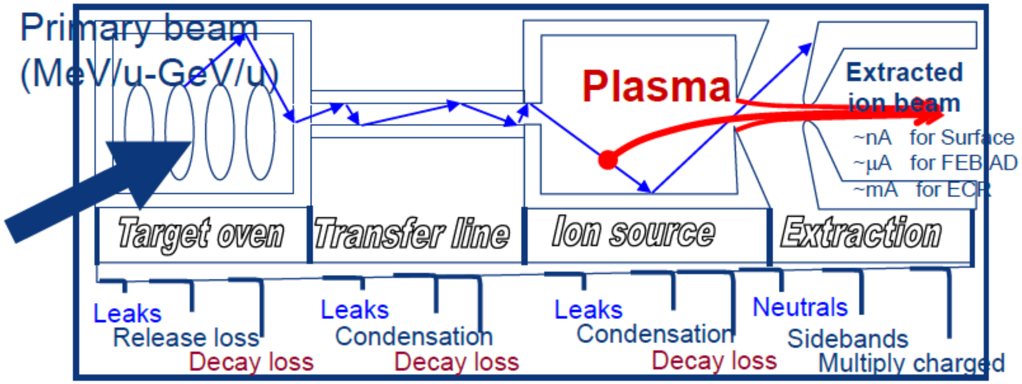
Motivation

- Investigate the structure of 8B, which is expected to be proton halo in ground state, reaction studies, *REX, HIE, 10^3 pps, INTC-I-126*
- Study ^{9}C excited states by resonant elestic scattering of ^{8}B on a thick proton target, *HIE*, *10^4 pps*, *INTC-I-127*
- Decay studies and Reactions induced by a ^{8}B accelerated beam 10^3 - 10^4 ions /s, *REX, HIE, INTC-I-128*
- Study the of ^{8}B using ^{8}B + ^{28}Si, optical model parameters and reaction mechisms , *REX, 10^3 -10^6 pps*, *INTC-I-129*
- Study of diffusion in semiconductors using alpha emission channeling, *2×10^9 particles , INTC-I-130*

Challenges

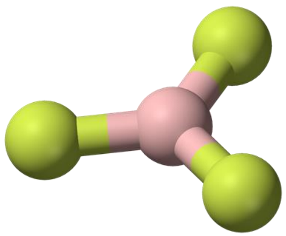
- Boron reacts with many materials the ion source is made of
- Volatility of boron is low



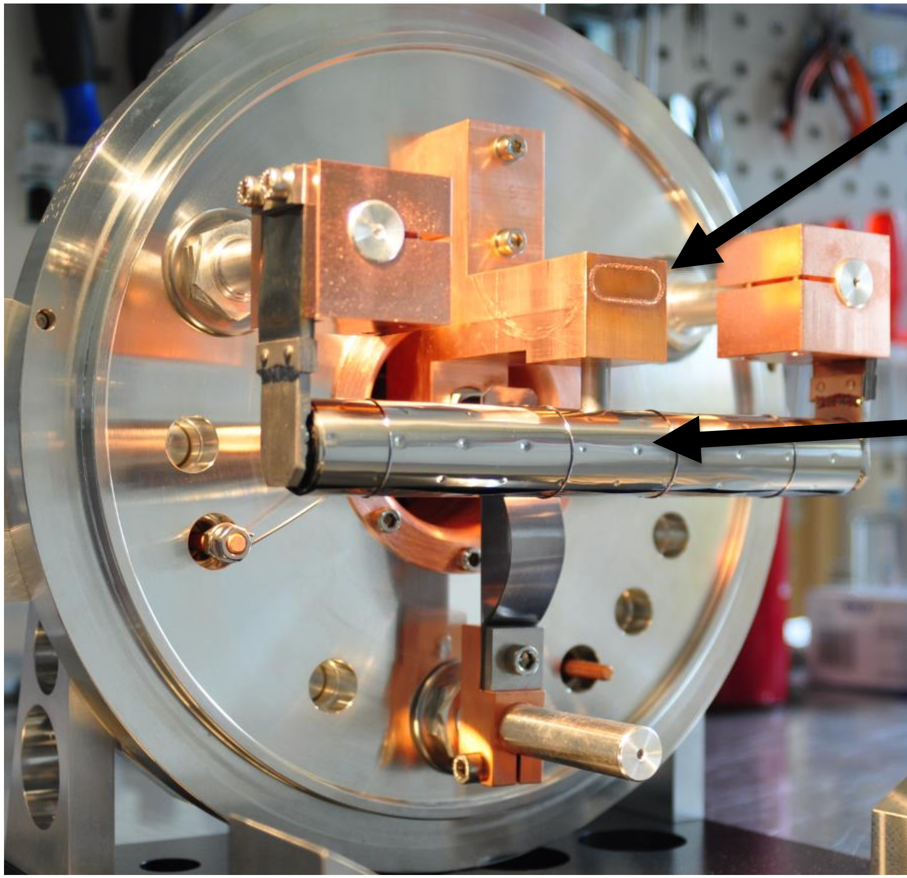
➔ Extraction of atomic ^{8}B is expected to be difficult

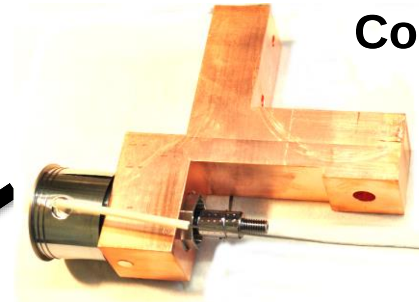
Solution: Form volatile compounds of ^{8}B in-situ, which are easy to extract:

$$^{8}B \xrightarrow{SF_6\ (g)} {}^{8}BF_3\ (g)$$



The Target unit #513

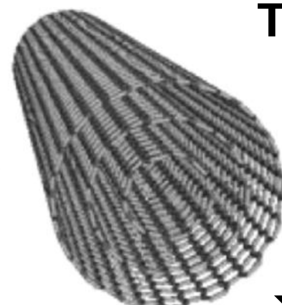




Cooled Cu transfer line and

VADIS 7 („Plasma“)

Ion Source



Target container with pellets of

Multi Walled Carbon Nanotubes

14.85 g

➔ Surface area = 4455 m²

Calibrated Leak

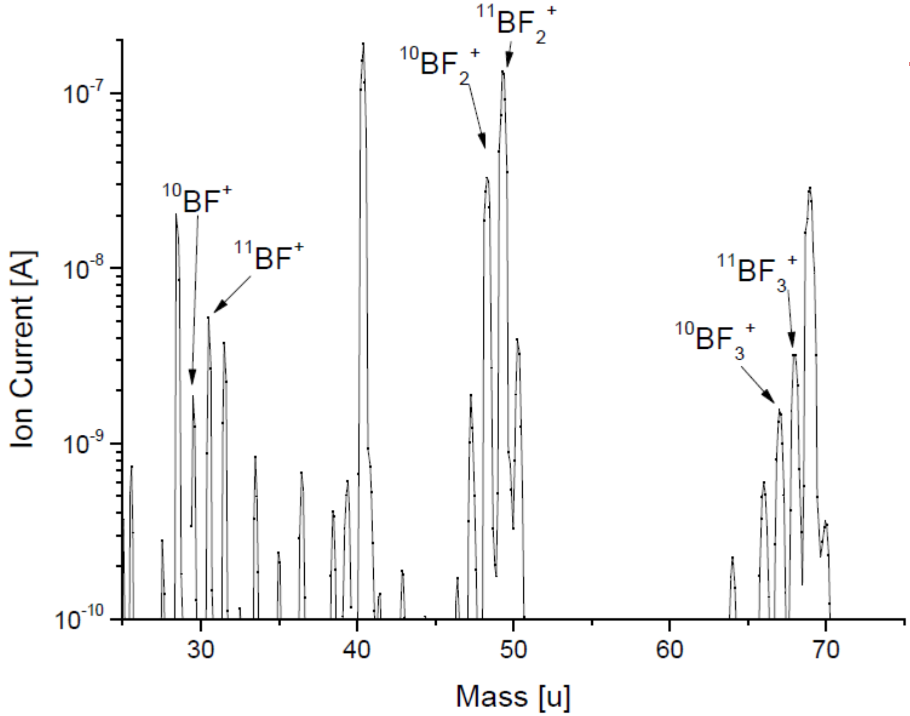
For the injection of $\mathbf{SF_6}$ (2 bar)

$1.85 \cdot 10^{-4}$ mbar L / s

Ionization of BF_x

Offline Studies

Boron powder placed in VADIS ion source and SF_6 injected



- Formation of BF_3 is thermodynamically favoured at lower temperatures

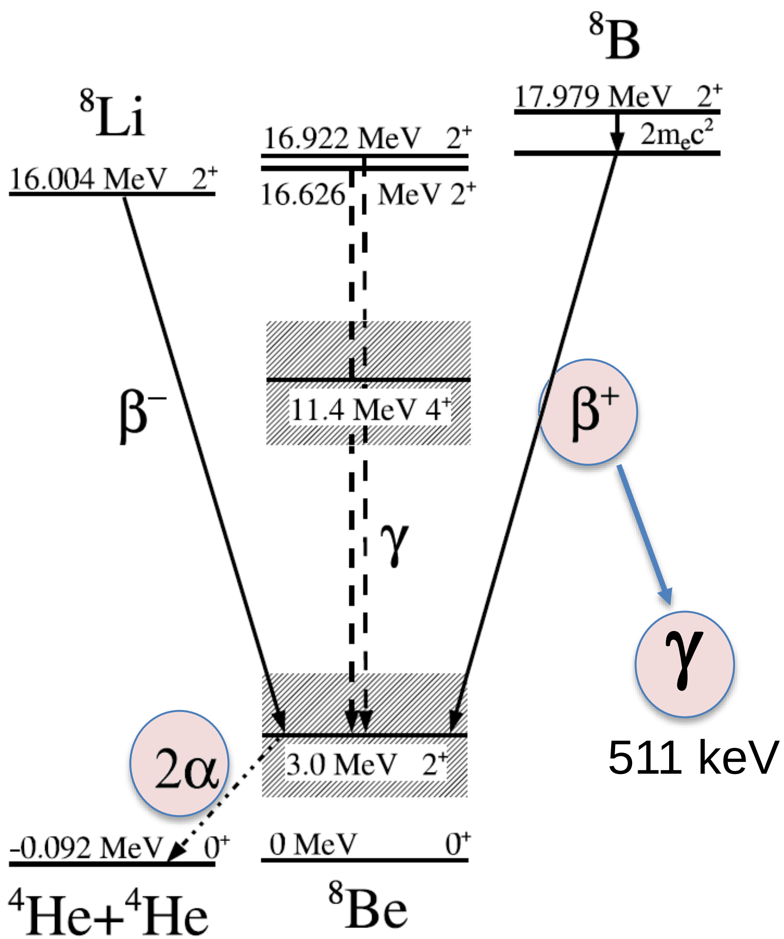
Ionization yields:

$$BF_2^+ > BF^+ > BF_3^+$$

➔ Dissoziative ionization predominant

Ch. Seiffert, 2014

Decay and Detection of ^8B



^8B undergoes $\beta^+2\alpha$ decay

Resulting radiation:

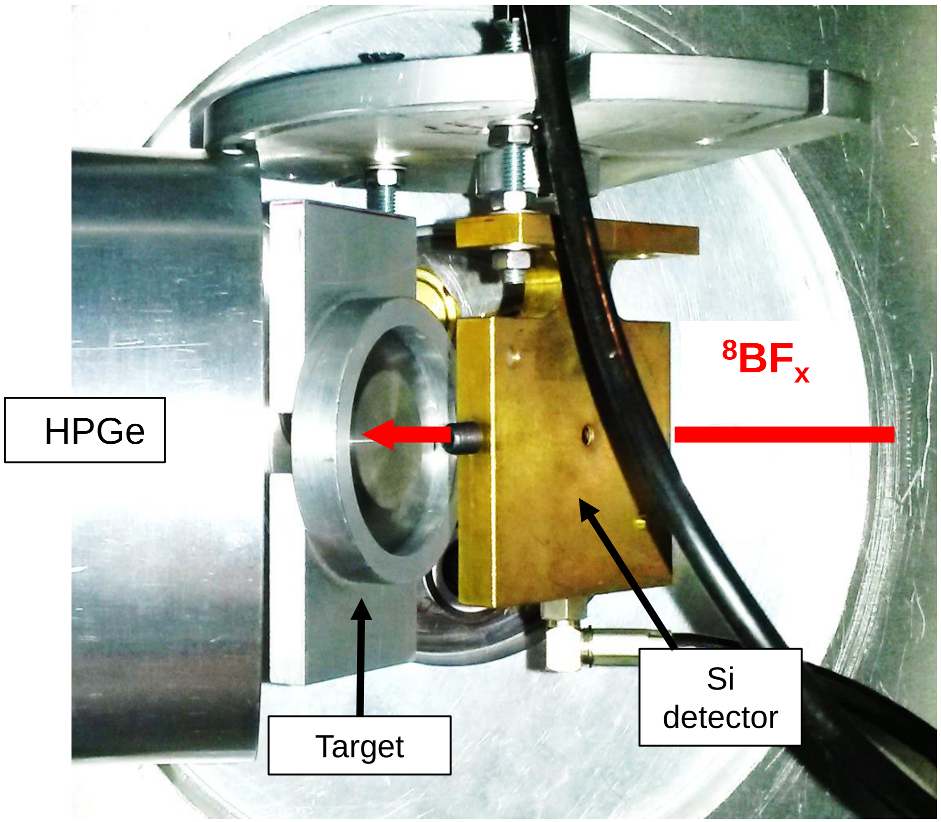
- Alpha with continous spectrum (-> Silicon)
- Positrons (-> Scintillator)
- Annihilation radiation (-> Germanium)

How to distinguish between ^8B and ^8Li?

- Annihilation radiation in coincidence with alphas
- Chemical separation
- Retention of non volatile compounds on cold transfer line

Detection Setup

Evacuated chamber flanged to LA1



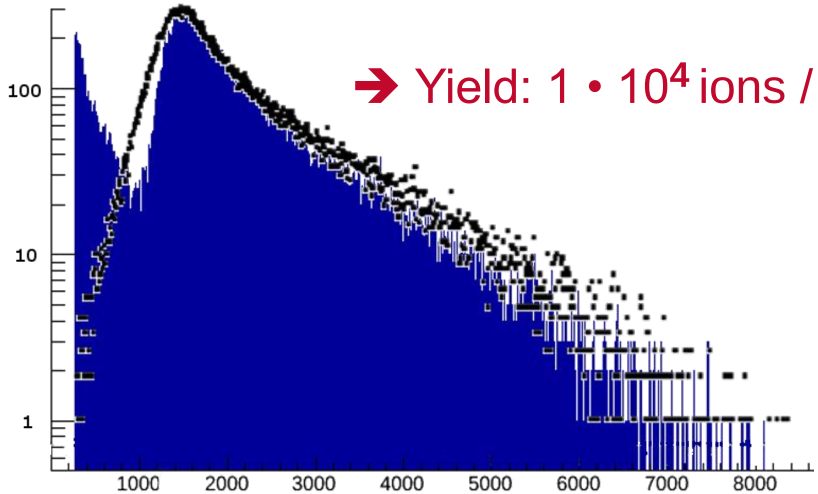
- Beam is implanted in aluminium target
- Alpha detector (Si) facing the target
- Germanium detector for gamma radiation
- Coincidences between alpha and gamma (15 µs window)

Additionally measurements with the **tape station:**

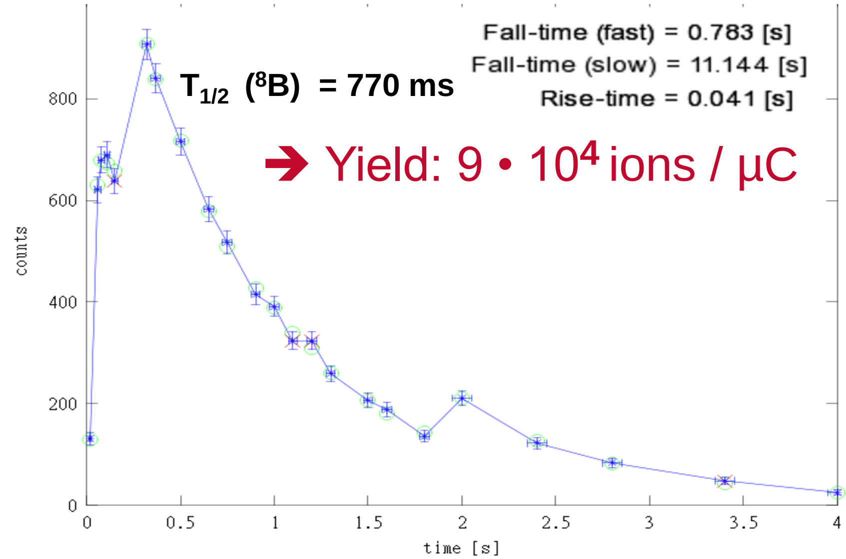
- Beta detector (plastic scintillator) and
- Germanium detector

Results – Spectra mass 46 (BF_2)

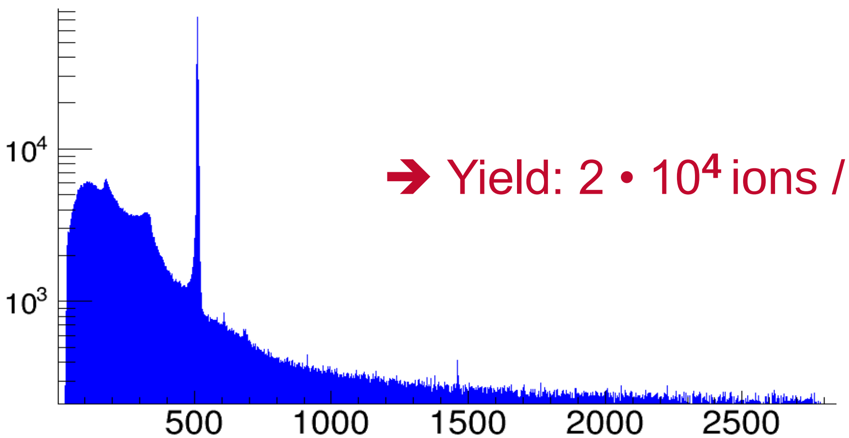
Alpha Spectrum (LA1)



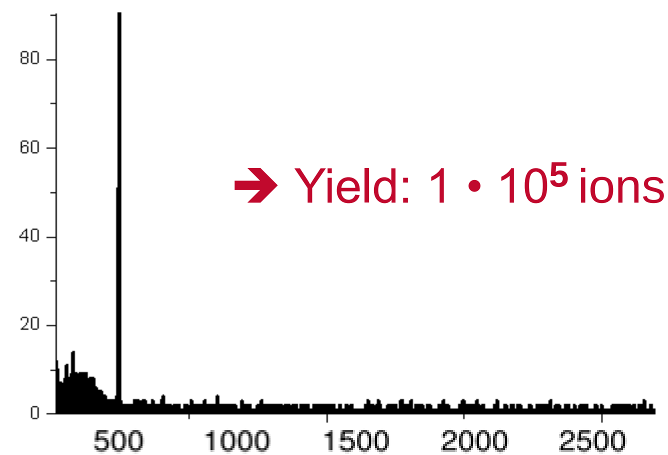
Release Curve (Beta activity)



Gamma Spectrum (LA1)

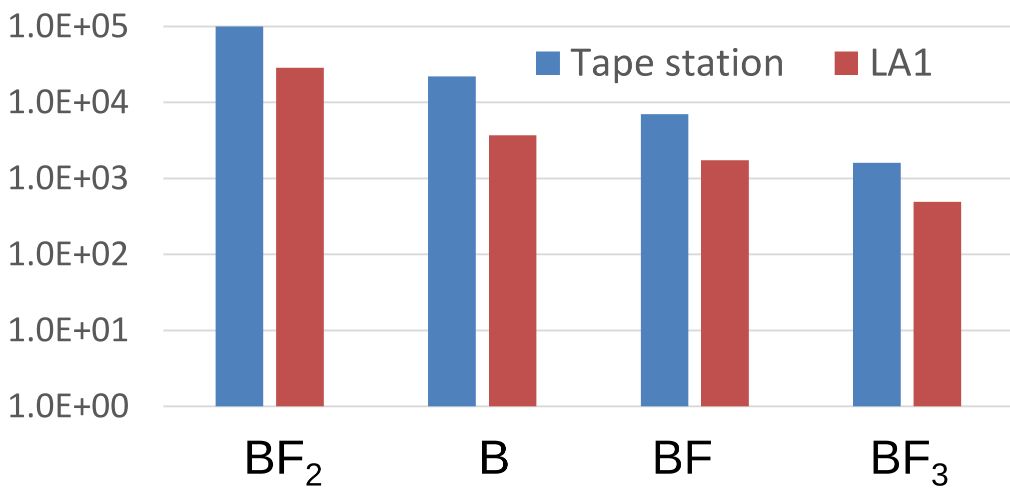


Gamma Spectrum (Tapestation)



Results

Yields from annihilation radiation (ions / µC)

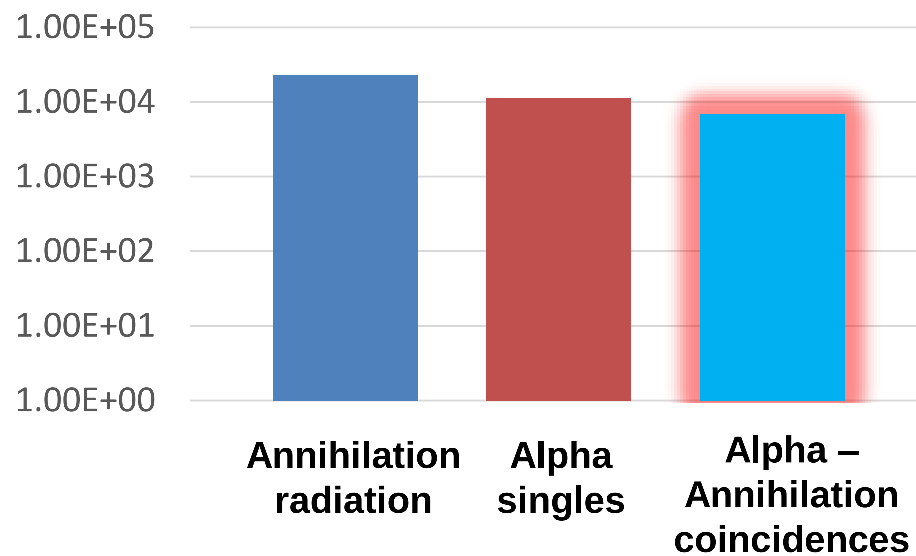


- ✓ Tapestation in agreement with beta yields
- ✓ Resembles offline trend:

BF_2^+ > BF^+ > BF_3^+

- Yields on LA1 about 5 times lower

Yields on mass 46 (BF_2) at LA1 (ions / µC)



- ✓ Annihilation radiation is in coincidence with alphas
- ✓ Yields in agreement within factor 3

Summery and Outlook

✓ Molecular boron beams could be produced at ISOLDE with an intensity of 10^4-10^5 ions / μC

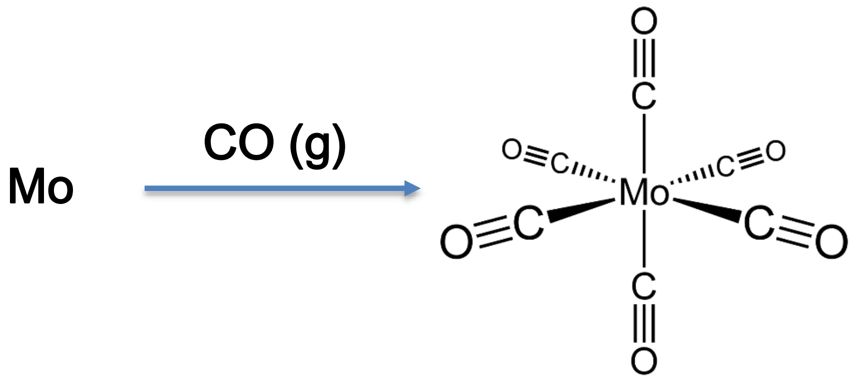
Open issues

- Gas injection into the target unit needs to be verified
- Stable contaminants on mass 46
- Most letters of intend request accelerated beam

...and a longer-range outlook:

Carbonyle beams of refractory elements

Principle:



1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	71 La...	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn

Carbonyle compounds
$V(CO)_6$
$Cr(CO)_6$
$Mo(CO)_6$
$W(CO)_6$
$Tc_2(CO)_{10}$
$Re_2(CO)_{10}$
$Ru(CO)_5$
$Os(CO)_5$
$Co_2(CO)_8$
$Rh_2(CO)_8$
$Ir_4(CO)_{10}$
$Ni(CO)_4$

Thank you!