

# Beta beams: Ion production status report

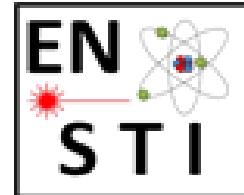
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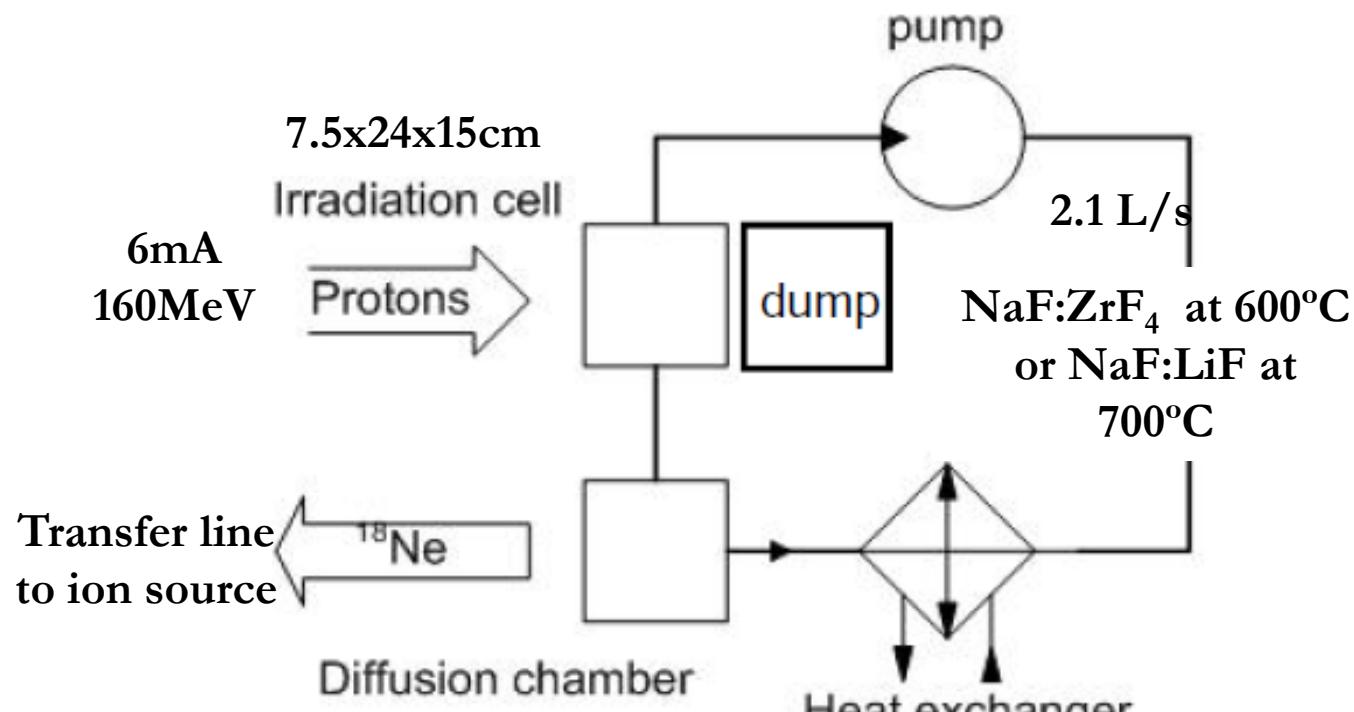
<sup>4</sup>DPN, Univ. Genève



# $^{18}\text{Ne}$ production for the beta beams

A proposal inspired from  $^{18}\text{F}$  production for PET imaging

$\text{NaF}$  target loop ( $^{23}\text{Na}(\text{p}, \text{X})^{18}\text{Ne}$ ,  $^{19}\text{F}(\text{p}, 2\text{n})^{18}\text{Ne}$ )



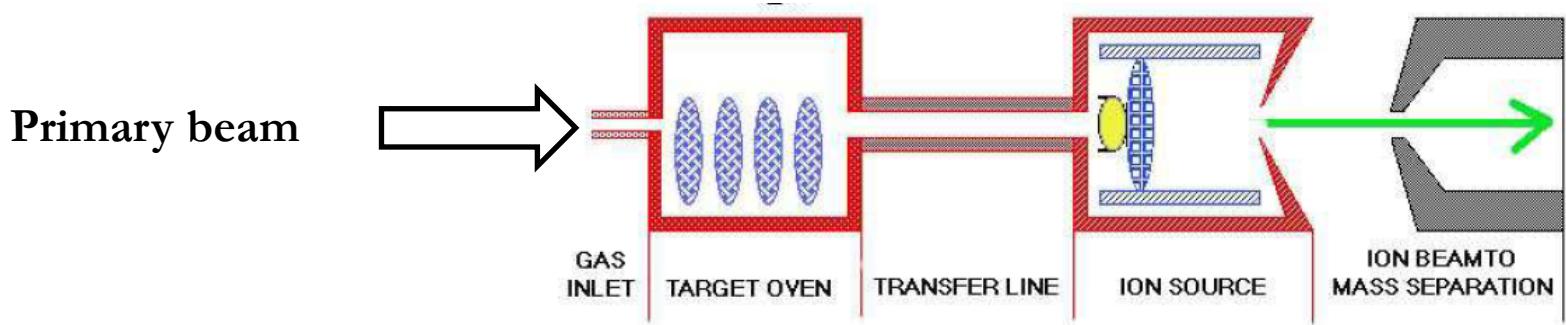
T. Stora, P. Valko

**Validation of the concept:**

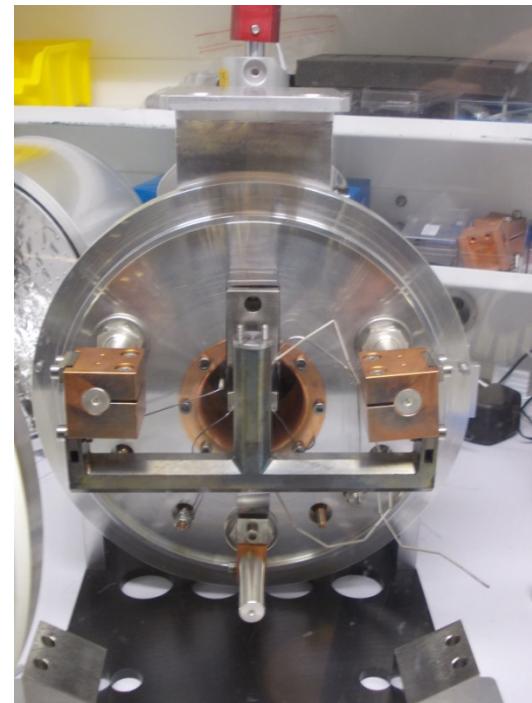
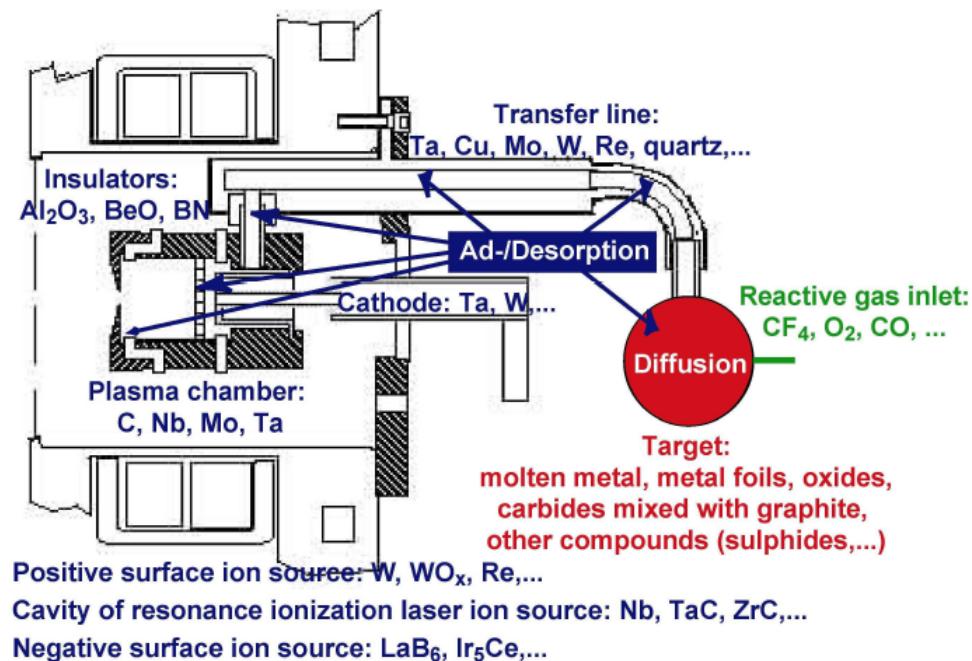
- Static molten salt unit at CERN/ISOLDE (IS509)
- Molten salt loop

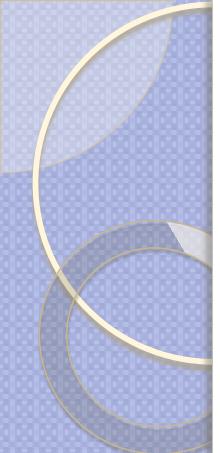
# Static molten salt unit

## Production of $^{18}\text{Ne}$ beams based on the ISOL technique



## Target and ion source unit





**Since the meeting at Cern in April...**

- Static target unit preparation

- Offline calibrations

- Start of online run (on the 11<sup>th</sup> of June)

- Aim of static target tests:

- Identification of proper salt and handling capabilities

- Engineering of simple irradiation chamber with proper material

- Engineering of condensation line to ion source

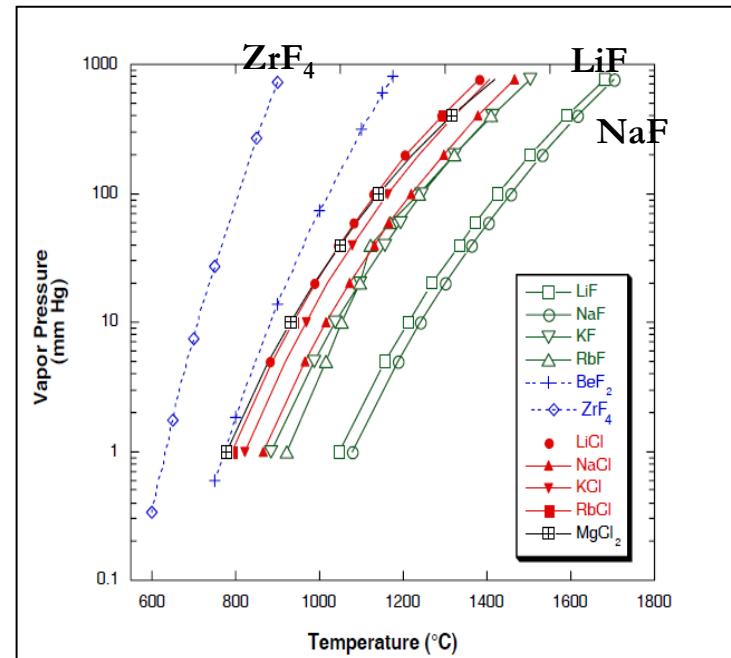
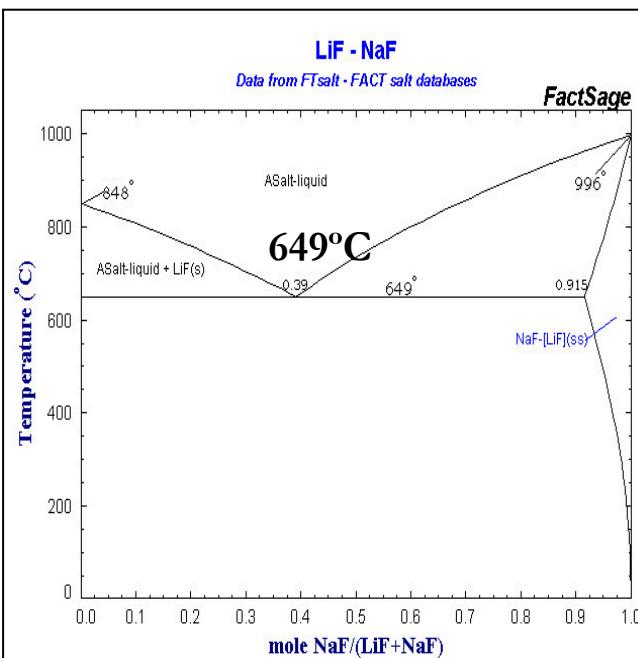
- Monitoring of gas production and release, specifically  $^{18}\text{Ne}$ , under proton beam irradiation

# Salt composition?

Salt	Composition [mol %]	Melting point [°C]	Density [g/cm <sup>3</sup> ] (700 °C)	Vapor pressure [mmHg](900°C)	Yield protons 6mA 60MeV
NaF-LiF	39-61	649	2.59	I	1.0E013* (7 mA)

NaF-LiF chosen due to:

- Lower reactivity with atmosphere
- Stability at temperatures relevant for operating conditions
- 100°C higher operation temperature vs ZrNaF eutectic but lower volatility. Simple phase diagram

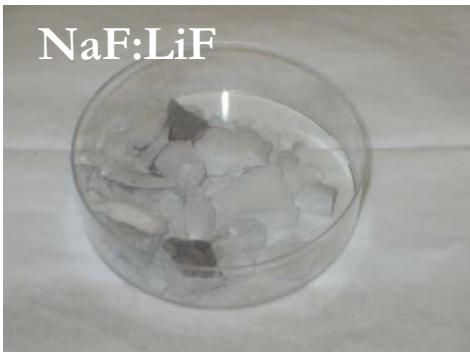


# Synthesis and charge of target container

Mixture of stoichiometric quantities of initial fluorides

Thermal treatment in graphite crucible up to melting point (under vacuum)

All handling and manipulation in gloveboxes under controlled argon atmosphere



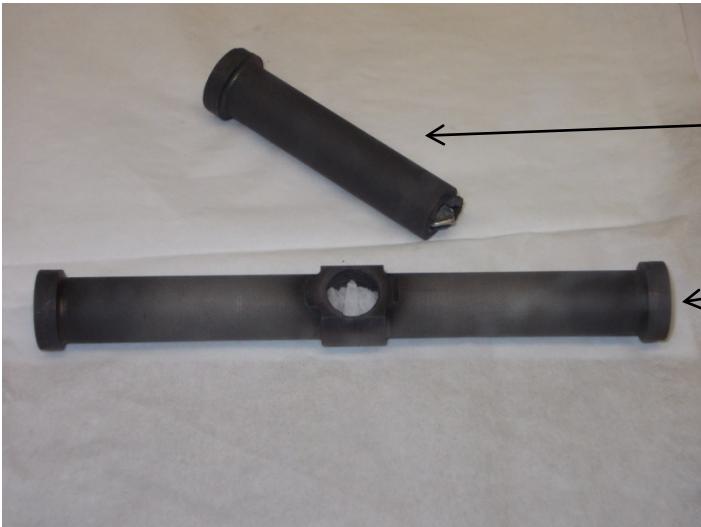
Charge of target container  
with salt in liquid state  
(Collab. LPSC, Grenoble)



SEM/EDS analyses  
(Collab. S. Sgobba, EN-MME-MM)



# NaF:LiF: thermal stability offline tests

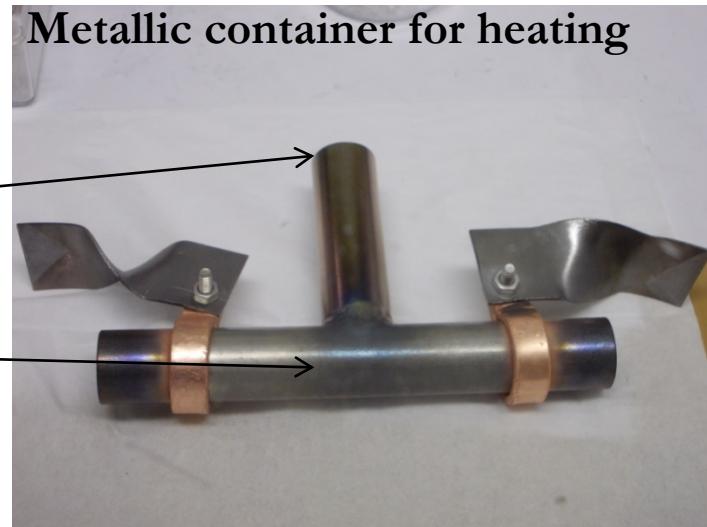


Chimney with condensation helix

Temperature measurement with two thermocouples:

- at the top of the chimney
- at the center of the metal container (external)

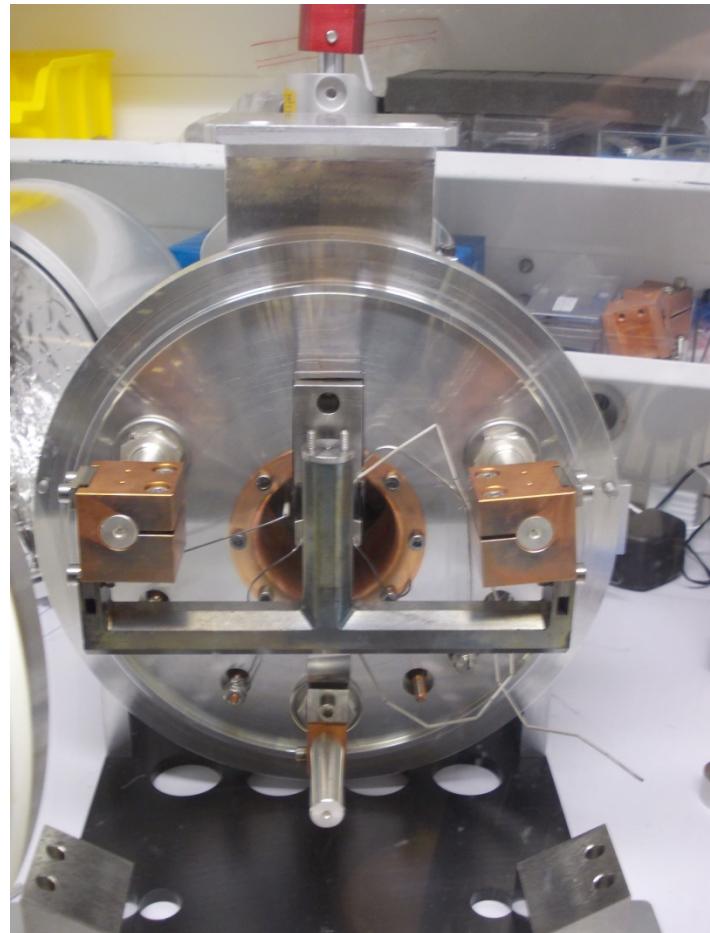
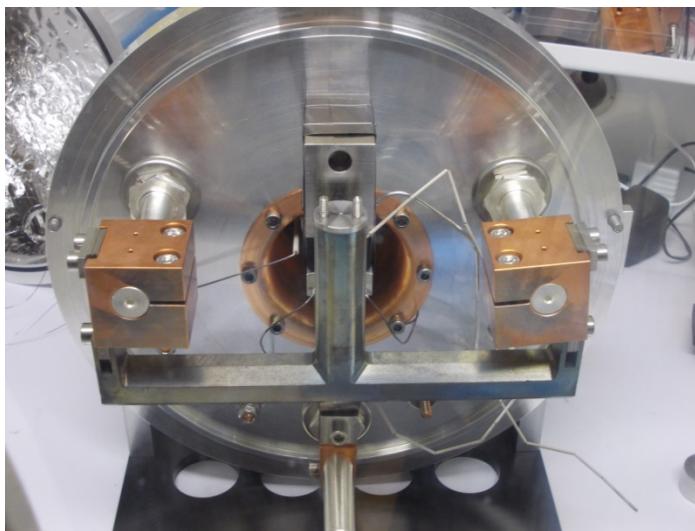
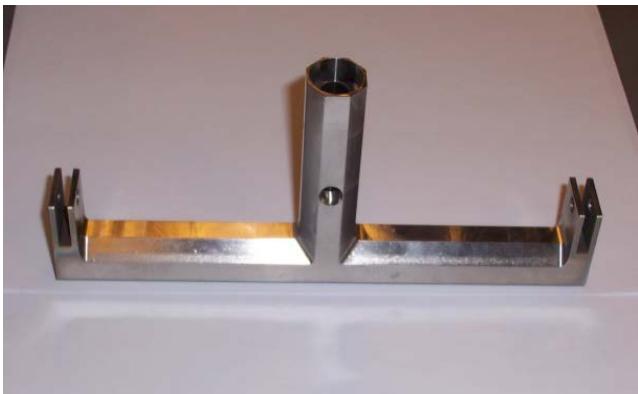
Metallic container for heating



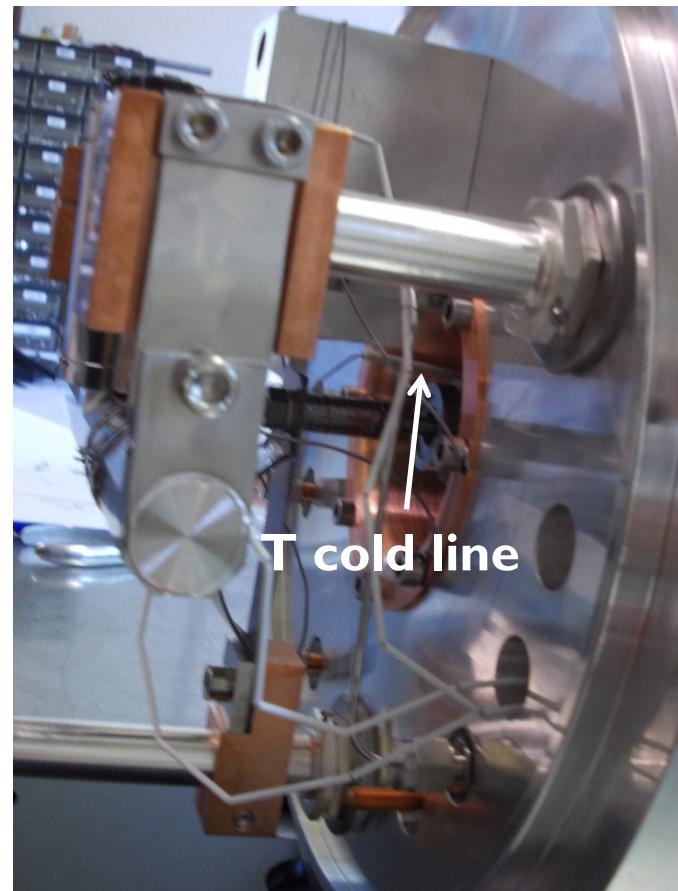
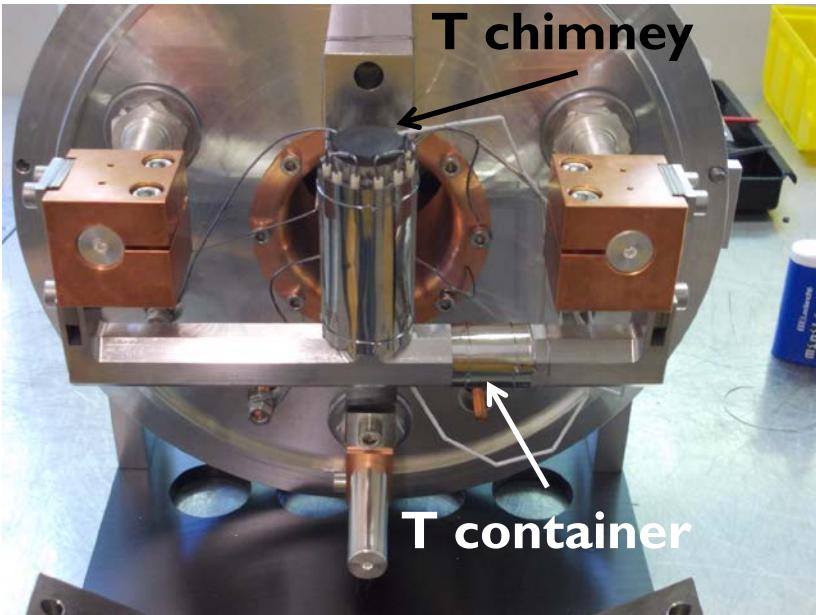
No mass losses at relevant temperatures for operating conditions  
Thermal stability confirmed

## Static target unit preparation

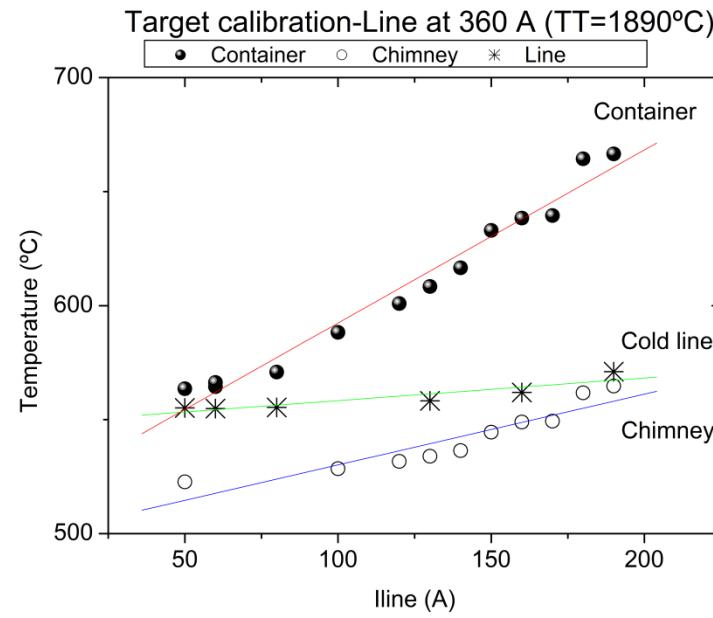
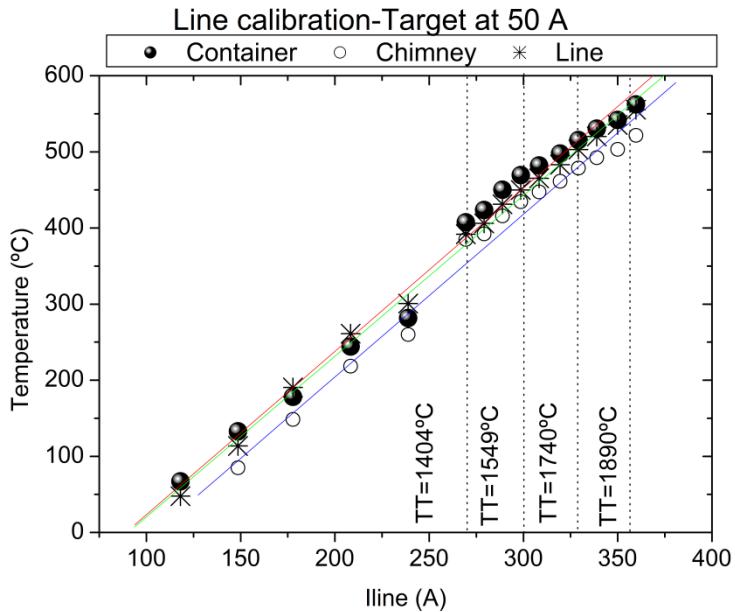
- Container in fluoride resistant alloy (Haynes 242)  
(Cern Main Workshop, EN-MME-MS)
- Improved geometry (including temperature control for selective salt condensation/melting in transfer line)



## Static target unit preparation: thermal offline tests

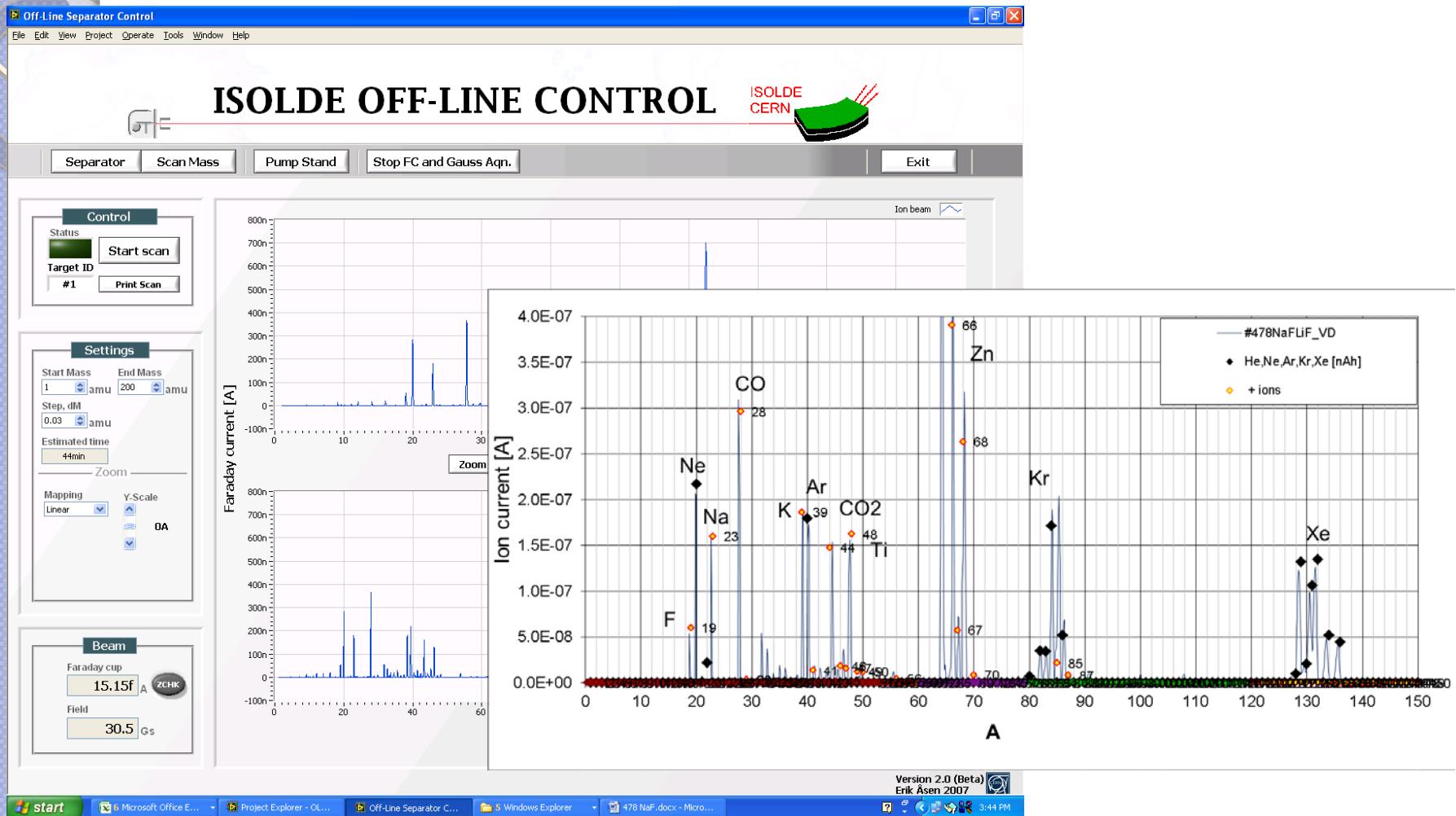


# Static target unit preparation: thermal offline tests



# Static target unit preparation: offline mass scan

Target at 700°C, Ion source at 1890°C



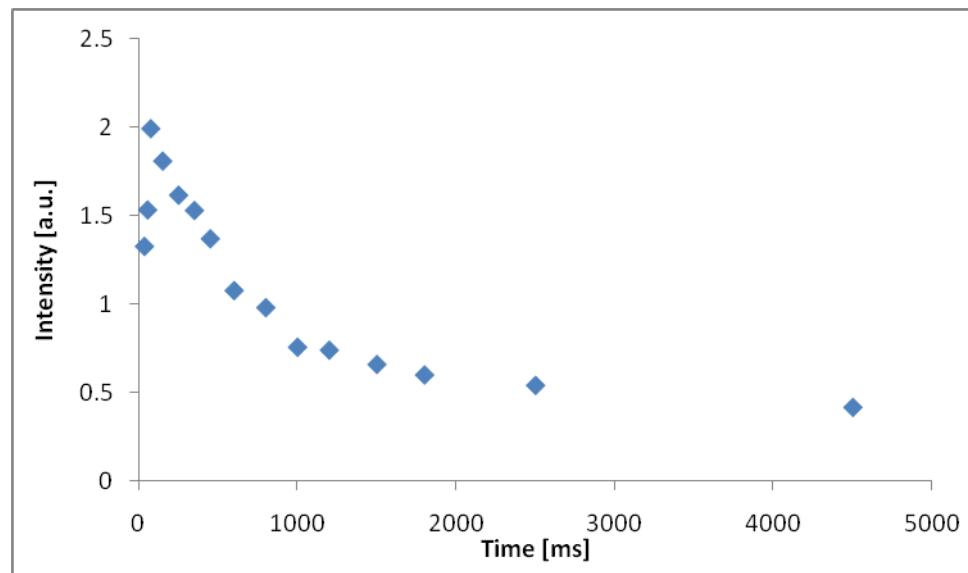
# 1st ISOL Beams of 18Ne and 19Ne from thick molten salt targets produced at ISOLDE (11th June, 7pm)

Element	A	TIME(s)	Tinitial(s)	Tcollection(s)	Ttransport(s)	Tmeas(s)	Counter1	Counter2	Ccounter3	Ion source
18Ne		18.006	1.34E+12	10	1000	1000	1000	170	170	170 478NaFLiF
18Ne		18.006	1.34E+12	10	1000	1000	2000	290	290	290 478NaFLiF
18Ne		18.006	1.34E+12	10	1500	1000	2000	373	373	373 478NaFLiF
18Ne		18.006	1.34E+12	10	1500	1000	2000	14	14	14 478NaFLiF
18Ne		18.006	1.34E+12	10	1500	1000	2000	365	365	365 478NaFLiF

Element	A	TIME(s)	Tinitial(s)	Tcollection(s)	Ttransport(s)	Tmeas(s)	Counter1	Counter2	Ccounter3	Ion source
19Ne		19.002	1.34E+12	100	5000	1000	1000	5106	5127	5109 478NaFLiF
19Ne		19.002	1.34E+12	100	1000	1000	1000	1346	1349	1346 478NaFLiF
19Ne		19.002	1.34E+12	200	1000	1000	1000	1307	1308	1307 478NaFLiF
19Ne		19.002	1.34E+12	200	1000	1000	1000	1313	1313	1313 478NaFLiF
19Ne		19.002	1.34E+12	400	1000	1000	1000	1153	1154	1153 478NaFLiF
19Ne		19.002	1.34E+12	500	1000	1000	1000	1216	1217	1216 478NaFLiF
19Ne		19.002	1.34E+12	700	1000	1000	1000	1445	1445	1445 478NaFLiF

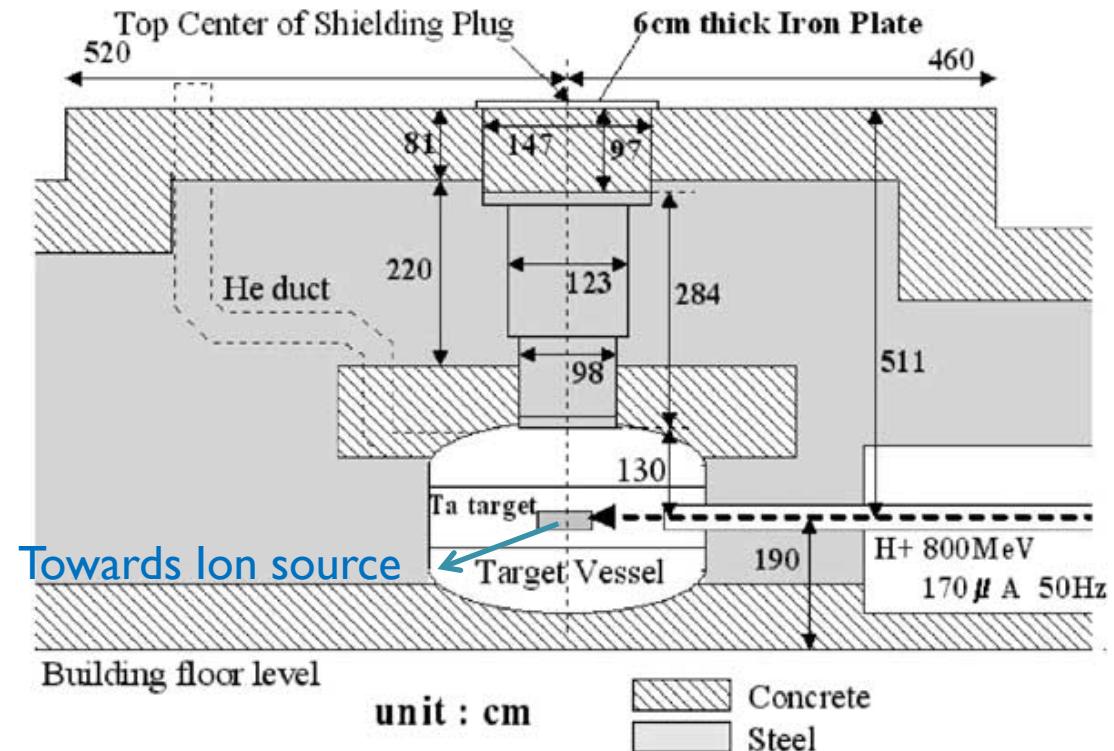
Release of 18Ne  
Target at 750°C,  
Ion source at 1890°C  
( $\varepsilon_{\text{Ne}} = 2\%$ )  
(Done 13th June, 11pm)



# Considerations on target station

For  ${}^6\text{He}$  production with 200kW, 2 GeV protons:

Inspired from ISIS target station



For  ${}^{18}\text{Ne}$  production with 960kW, 160MeV protons:

Inspired from present MW-range spallation neutron sources (SNS, JSNS)

## Outlook

Validation of the design and operation of a low power molten salt target for the production of  $^{18}\text{Ne}$  (rather fresh news: the online beam time at ISOLDE finishes now).

$\text{NaFLiF}$  is the best alternative vs  $\text{NaFZrF}_4$

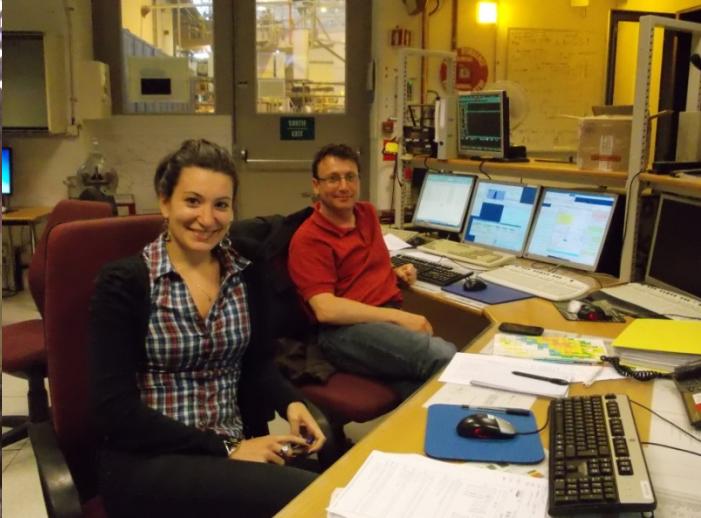
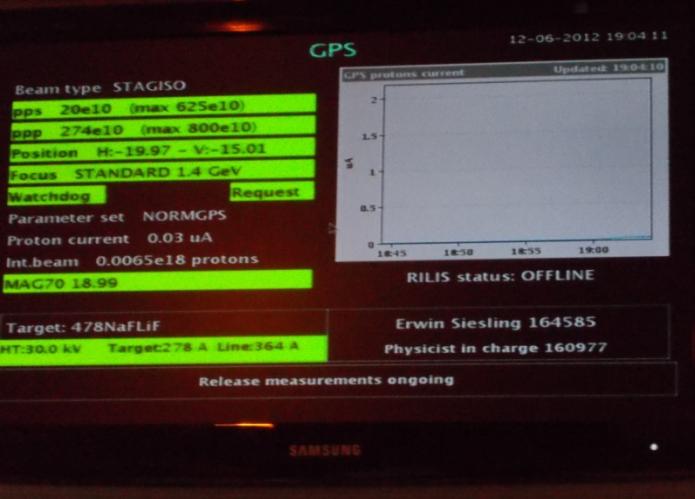
Haynes 242 is suitable as structural material (also graphite)

Salt vapors can be condensed and stable mode of operation can be achieved up to  $770^\circ\text{C}$ (\*)

$^{18}\text{Ne}$  diffusion properties will be deduced from the tests done at CERN (1st estimate  $5 \cdot 10^{-5} \cdot 10^{-4} \text{cm}^2/\text{s}$ )

Design and tests on the diffusion chamber should be the next step.

A full scale sub-MW salt target prototype should be done.



PSB Fixdisplay - W 24

Tue 12 Jun 2012 11:06

Supervisor A Findlay 163961

CCC Tel 76671

BP	User	Pts	Inj	Acc	b	Ej	E10	Ej	E10	Dest
19	LHC50 DB B	14	●●	●●	●●	199	193	LHC DB	50ns	
20	STAG ISOGPS	19	●●●	●●●	●●●	539	537			ISOGPS
	LHC50 DB A	16				0.01	0.22	LHC DB	50ns	
	LHC50 DB B	14				0.02	0.01	LHC DB	50ns	
23	STAG ISOGPS	19	●●●	●●●	●●●	542	577			ISOGPS
	LHC50 DB A	16				0.01	0.13	LHC DB	50ns	
	LHC50 DB B	14				0.01	0.14	LHC DB	50ns	
26	STAG ISOGPS	19	●●●	●●●	●●●	534	551			ISOGPS
	LHC50 DB A	16				0.02	0.09	LHC DB	50ns	
	LHC50 DB B	14				0.01	0.05	LHC DB	50ns	
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Thank you for  
your attention