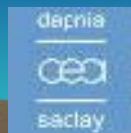


Baseline ${}^6\text{He}$ & ${}^{18}\text{Ne}$ ion production for β beams*

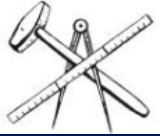
* *What is new since last meeting in Grenoble 2 months ago*

Thierry.Stora@cern.ch

Target and Ion Source Development
EN-STI (ISOLDE)



+ GANIL & Weizmann
inst



“CERN based” Layout



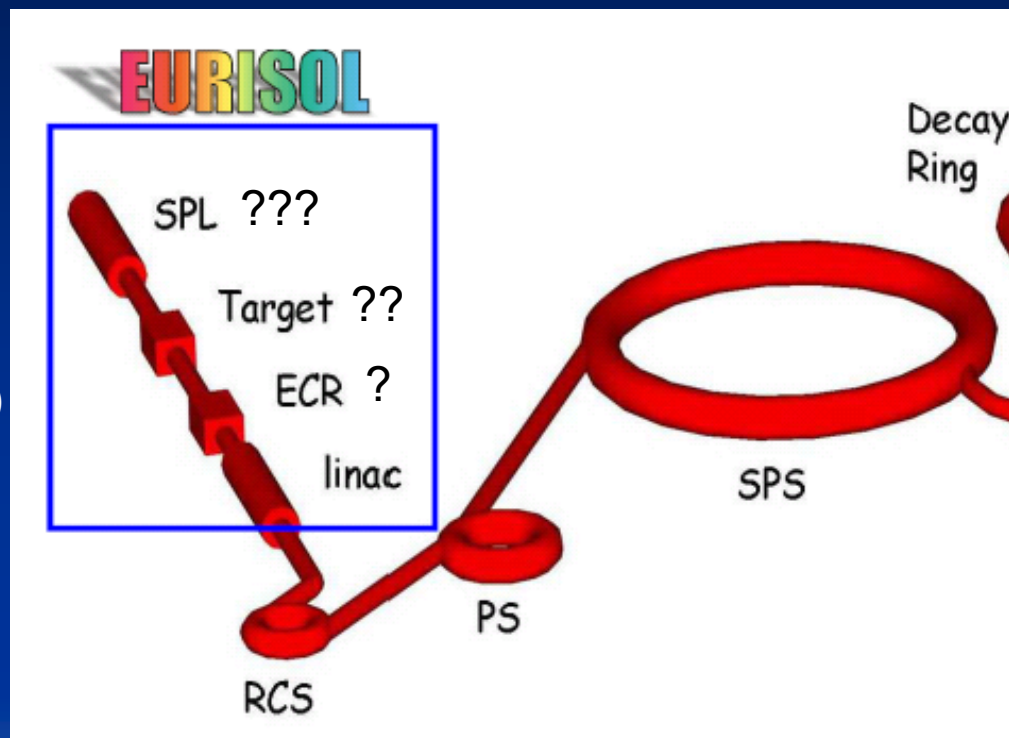
Production of $\bar{\nu}_e$ & ν_e :

$3(.3) 10^{13} \text{ } ^6\text{He/s}$

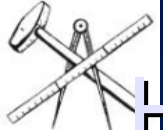
$2(.1) 10^{13} \text{ } ^{18}\text{Ne/s}$

out of the primary target

(Final report, FP6 EURISOL-DS)

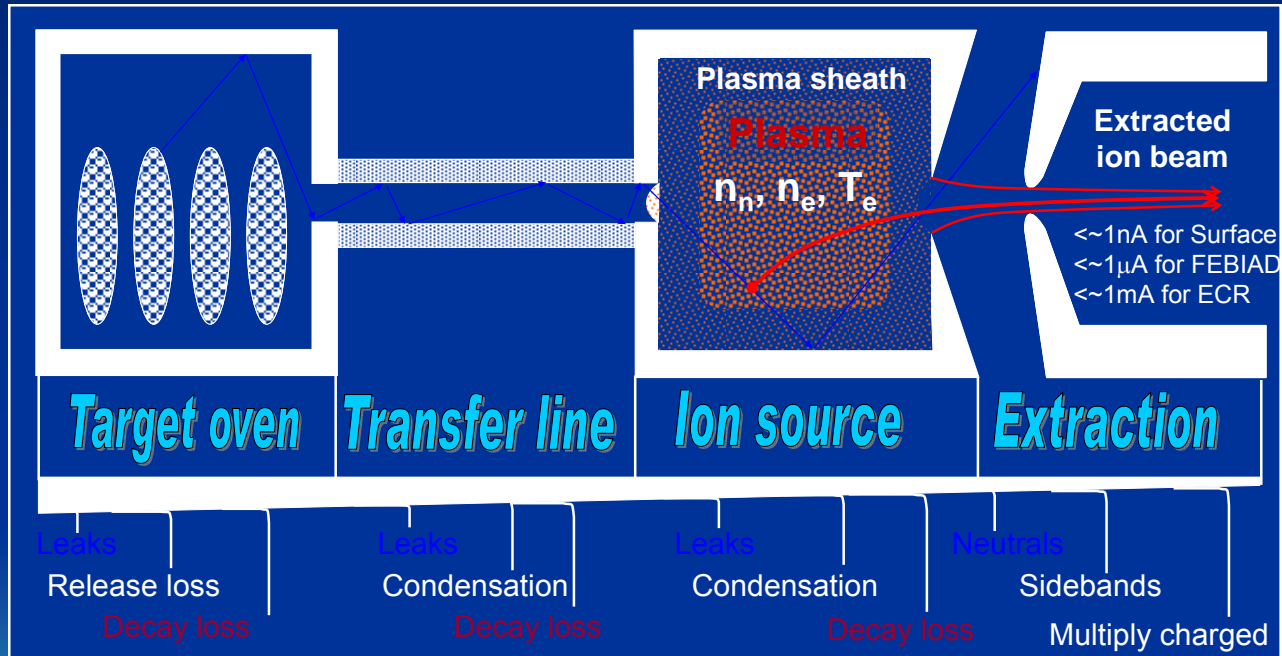


New proposal for future LHC injectors out of Chamonix workshop !!
Consequently CERN is reviewing plans for its future low energy complex,
especially with respect to SPL.

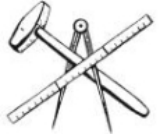


How to produce a radioactive ion beam with the "ISOL" technique

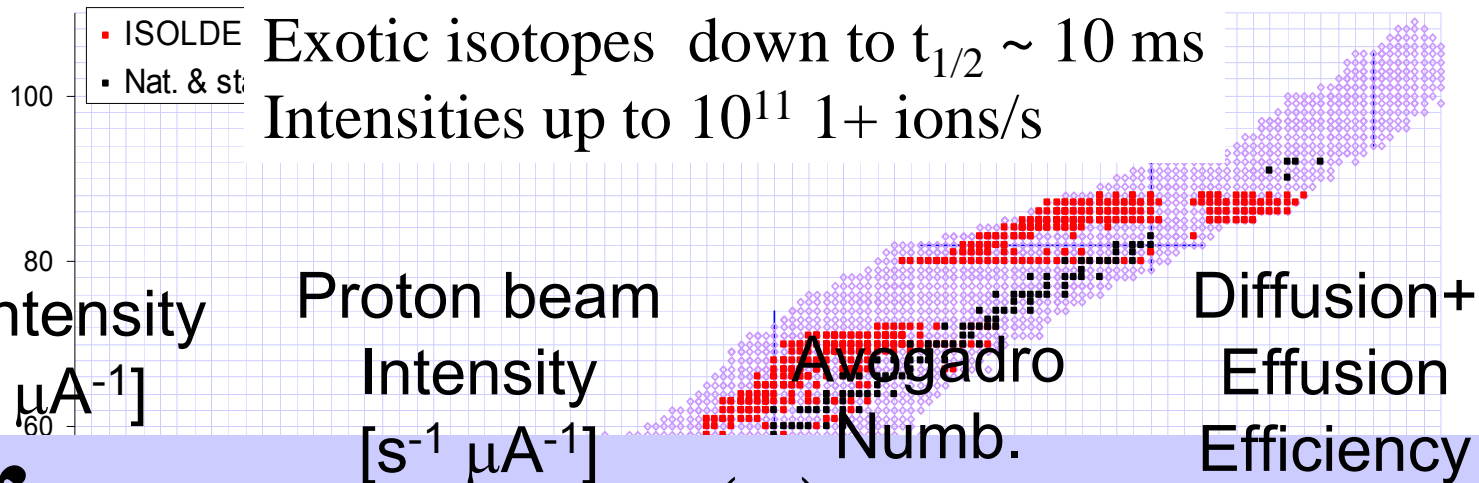
Thick target (1-200g/cm²)



Primary beam
(MeV/u-GeV/u)

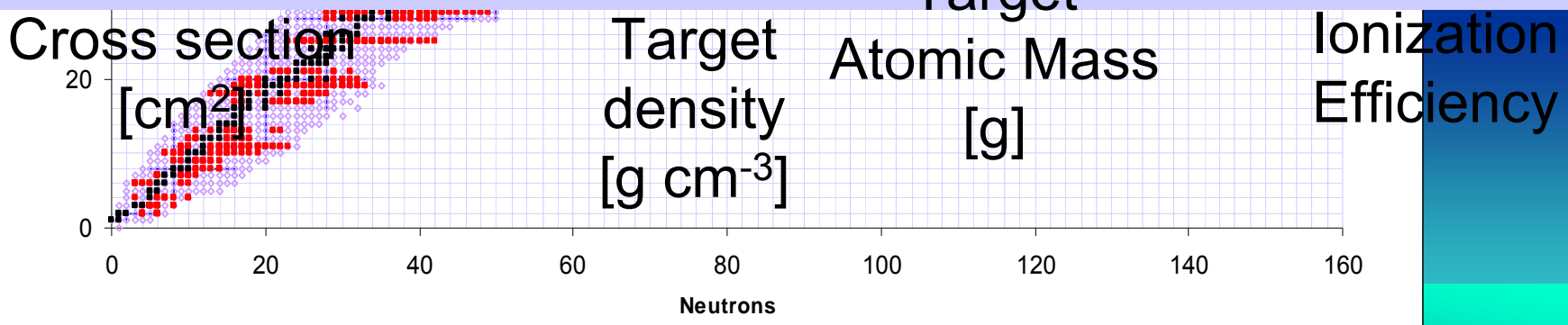


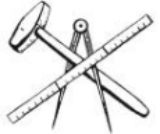
800 isotopes (70 elements) Radioactive Ion Beams



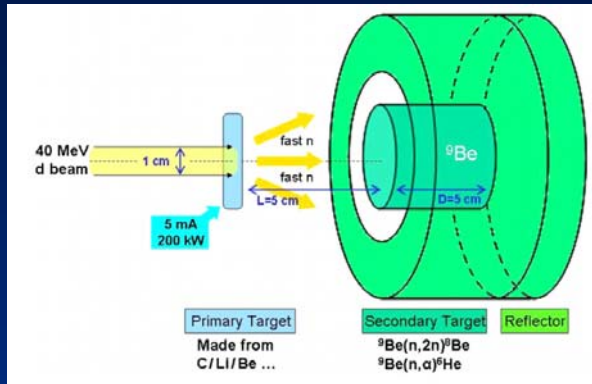
$$I = \int \sigma(E) \Phi(E, x) \rho(x) N/A dx \epsilon_{diff+eff} \epsilon_{ion}$$

Target

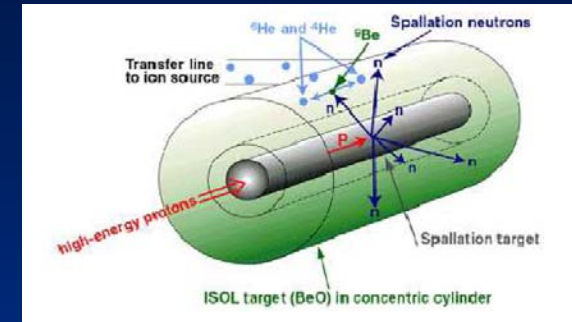




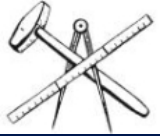
Production of ${}^6\text{He}$



M. Hass et al

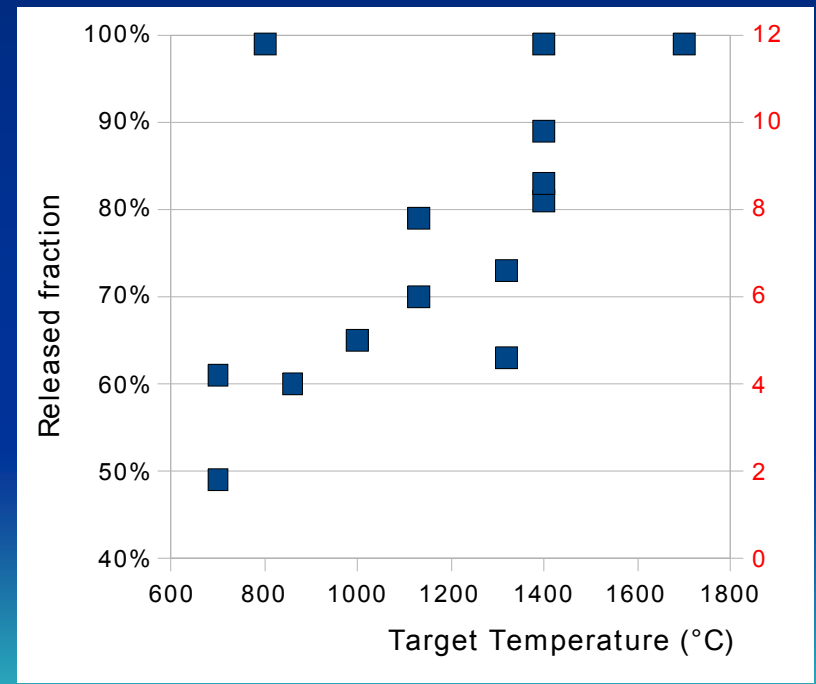
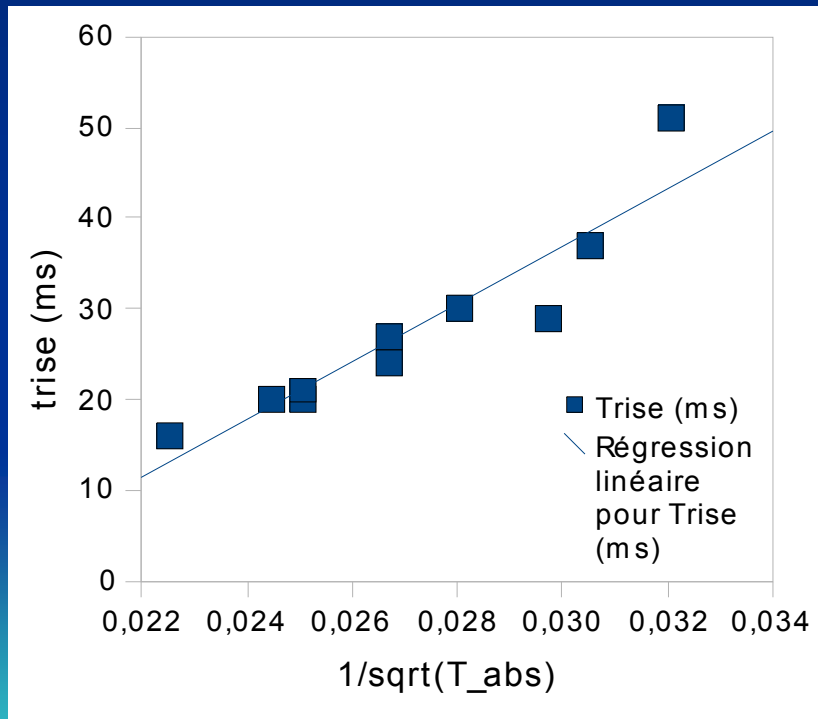


- 10^{14} ${}^6\text{He}/\text{s}$ 200 kW, 2 GeV proton beam in-target production. 50-90% extraction efficiency from realistic big targets (reduced scale experiment done at CERN-ISOLDE to confirm these numbers; Weizmann, GANIL and CERN collaboration).
- Article in preparation.
- Numbers have now been carefully checked. 1kW of 1-2GeV protons produces more ${}^6\text{He}$ than 1kW of 40 MeV deuterons.

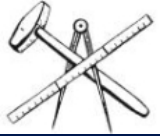


BeO release properties

- Effusion characteristics
- 1st order evaluation: $t_{\text{eff}} \sim t_{\text{rise}} \sim V T^{-0.5}$



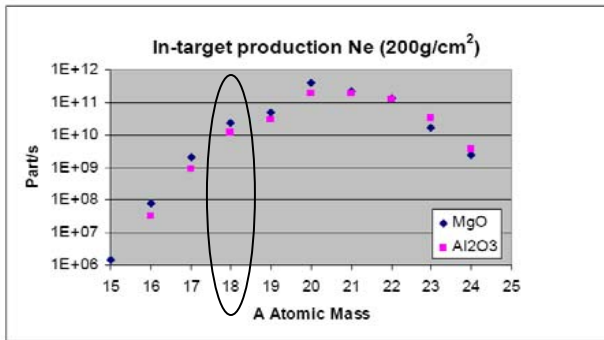
Online tests team



Production of ^{18}Ne ions for ν_e



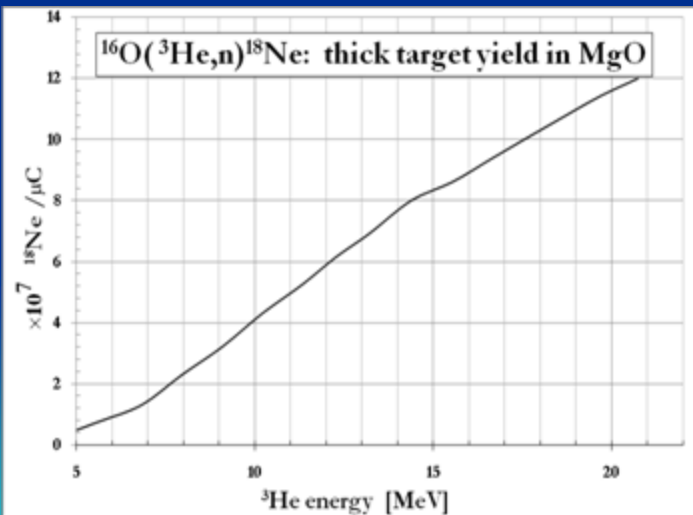
- Direct spallation of 1 GeV protons onto thick oxide targets Al (p,X) ^{18}Ne



Silberberg-Tsao,
Thin target approx.

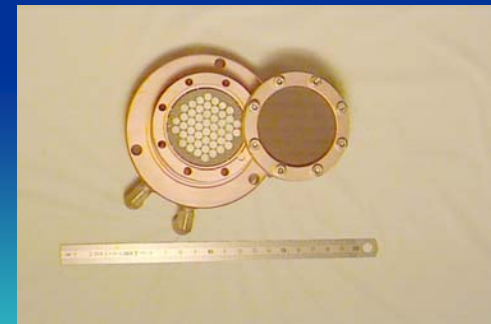
Nominal parameters:
 $3 \cdot 10^{10}$ part/s (Fluka)

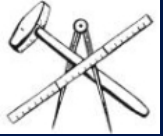
Production of ν_e
 $2 \cdot 10^{13}$ $^{18}\text{Ne}/\text{s}$



Validated at 9kW at LLN.
Needs $\sim 200\text{mA}$, ^3He 21MeV, $\varnothing 86\text{cm}$ target

S. Mitrofanov,
M. Loiselet et al.





Production of ^{18}Ne ions for ν_e



Other reactions (mainly coming from ^{18}F production for PET imaging):

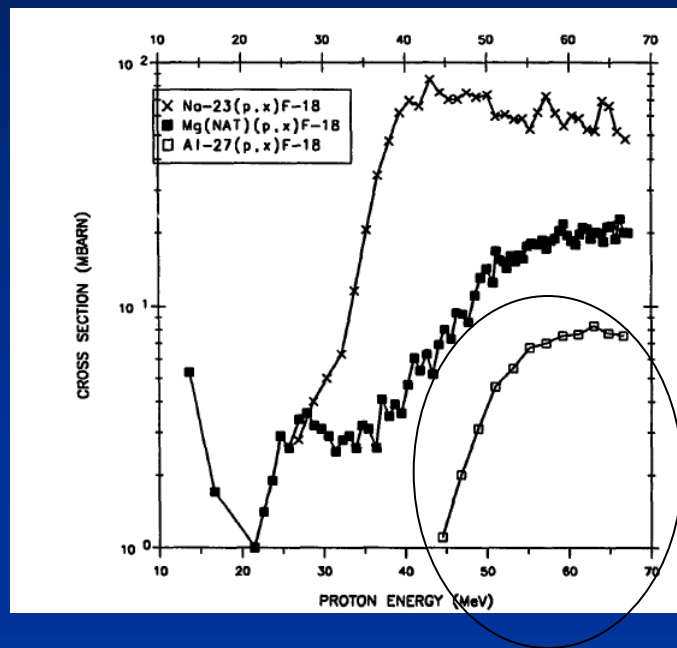
$^{19}\text{F}(p,2n)^{18}\text{Ne}$: threshold 16MeV, peak at 1.6mbarn @ 30MeV, 0.8mbarn @ 45 MeV (M. Loiselet)

$^{24}\text{Mg}(p,\alpha p2n)^{18}\text{Ne}$: threshold 39 MeV, contradictory data on cross-sections

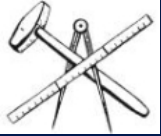
$^{27}\text{Al}(p,X)^{18}\text{Ne}$: ~ 4 mbarn @ 50-70 MeV (Lanulas-Solar, 1988&1992)

We need about 30mA, 70MeV p, and target technologies yet to be invented ($\sim 600\text{kW}$ to be dissipated)

Production of ν_e
 $2 \cdot 10^{13} \text{ }^{18}\text{Ne/s}$



From workshop at CERN last year



Production of ^{18}Ne ions for ν_e



Exploring around 70 MeV protons

Production of ν_e
 $2 \cdot 10^{13} \text{ }^{18}\text{Ne/s}$

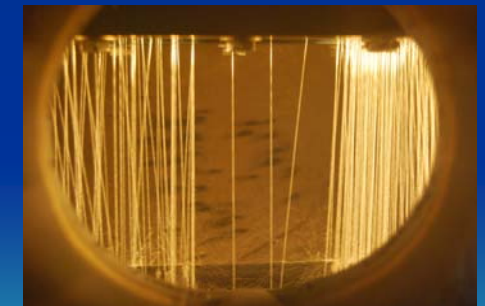
In the 100kW's – MW range

Solid targets for ISOLDE RIBs are at the limit (proven at 50kW, 500MeV p, prototyped to demonstrate feasibility for EURISOL at 100kW)

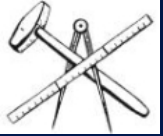


Use molten metal loop, proven at 1 MW for molten Pb/Bi.

Prototyped for ISOL targetry



E. Noah @ IPUL Lab



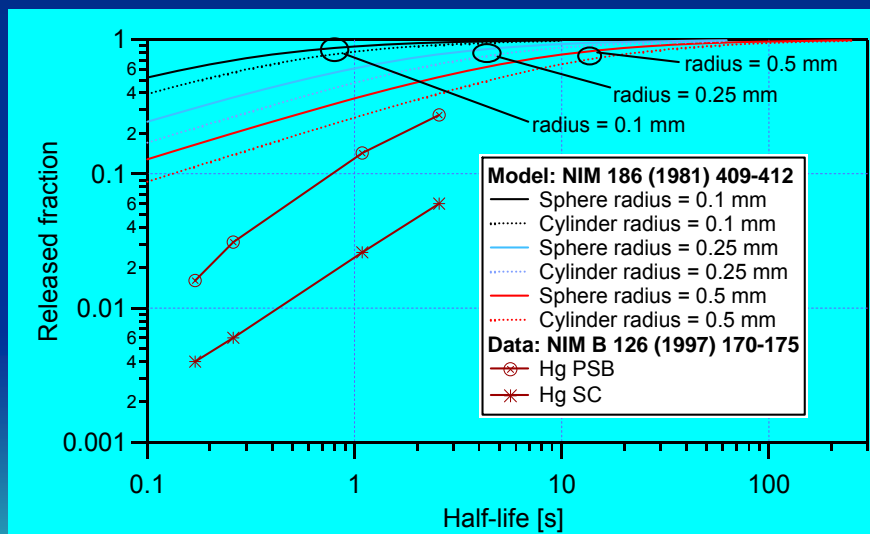
Production of ^{18}Ne ions for ν_e



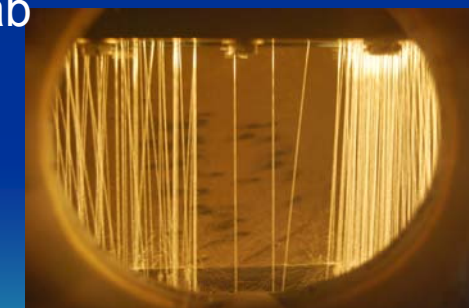
Use molten metal loop, proven at 1 MW for molten Pb/Bi.

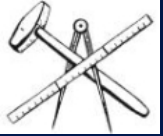
Prototyped for ISOL targetry

Production of ν_e
 $2 \cdot 10^{13}$ $^{18}\text{Ne}/\text{s}$



E. Noah @ IPUL Lab





Production of ^{18}Ne ions for ν_e

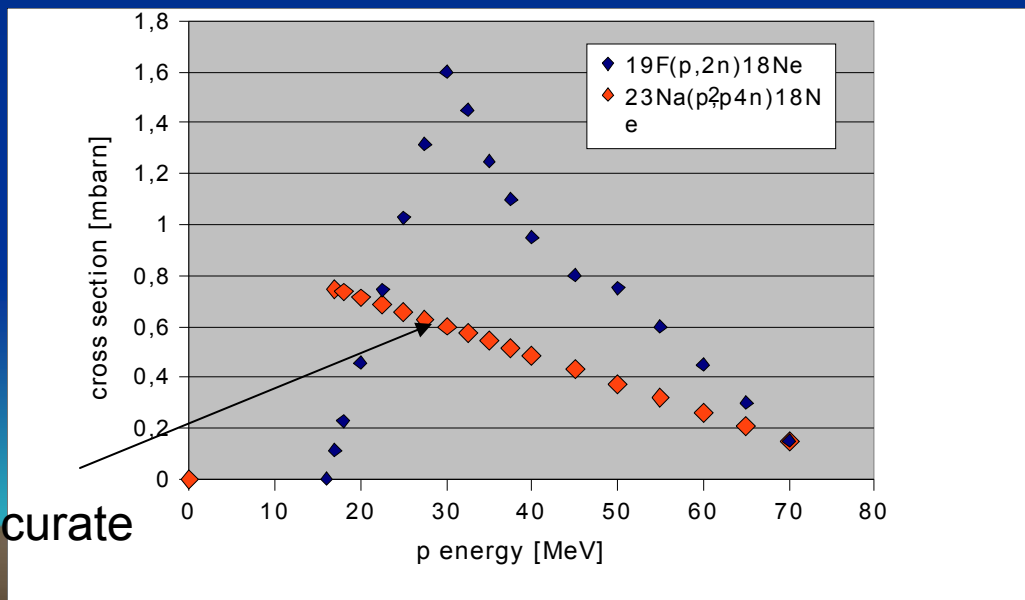


Use molten NaF salt, studied at ORNL for reactor coolant.

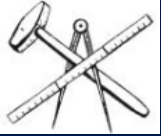
Production of ν_e
 $2 \cdot 10^{13}$ $^{18}\text{Ne}/\text{s}$

Other alternatives are eutectics comprising Na, Mg, F, Al, etc

Cross sections from ABRABLA code and M. Loiselet and S. Mitrofanov



Probably not accurate



Production of ^{18}Ne ions for ν_e



70 MeV penetrate about 26mm in 2g/cm³ NaF.

Production of ν_e
 $2 \cdot 10^{13}$ $^{18}\text{Ne}/\text{s}$

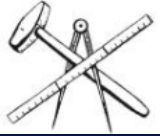
Production rate for 10mA, 70 MeV protons

dump thickness (mm)	prod rate	power in NaF (kW)	dump (kW)
2,1	4,5E+ 12	530	170
2,3	4,5E+ 12		
2,7	4,4E+ 12		
3,4	4,3E+ 12		
4,1	4,2E+ 12		
4,8	4,0E+ 12		

New numbers with σ from simulations published in IAEA report

dump thickness	prod rate	power in NaF (kW)	power in dump
2.1	2.078E+13	530	170
2.3	2.077E+13	520	180
2.7	2.077E+13	500	200
3.4	2.073E+13	475	225
4.1	2.064E+13	450	250
4.8	2.051E+13	425	275

If this is confirmed, we are back on tracks



Outlook

P. Valko from Bratislava will work 6 months on ^{18}Ne production (production cross section, thermal dissipation, extraction losses, windows effects, known chemistry and corrosion effects with molten salts nuclear loops). We will explore up to 160 MeV to be see if Linac4 would be a possible injector for β beams.

The goal is to provide a proposal with as close as possible technologies which are realistic. In particular, 100's kW rather than MW target dimensioning.

Other future options for 8B studies will be envisaged at CERN-ISOLDE. INTC is getting interest.