EURISOL Design Study

Task 3, towards β-beam targets

Production of β^+ emitters

Scenario 1

- Spallation of close-by target nuclides:
  ^{18,19}Ne from MgO and ^{34,35}Ar in CaO
  - Production rate for ^{18}Ne is 1×10^{12} s^{-1} (with 2.2 GeV 100 μA proton beam, cross-sections of some mb and a 1 m long oxide target of 10% theoretical density)
  - ^{19}Ne can be produced with one order of magnitude higher intensity but the half life is 17 seconds!

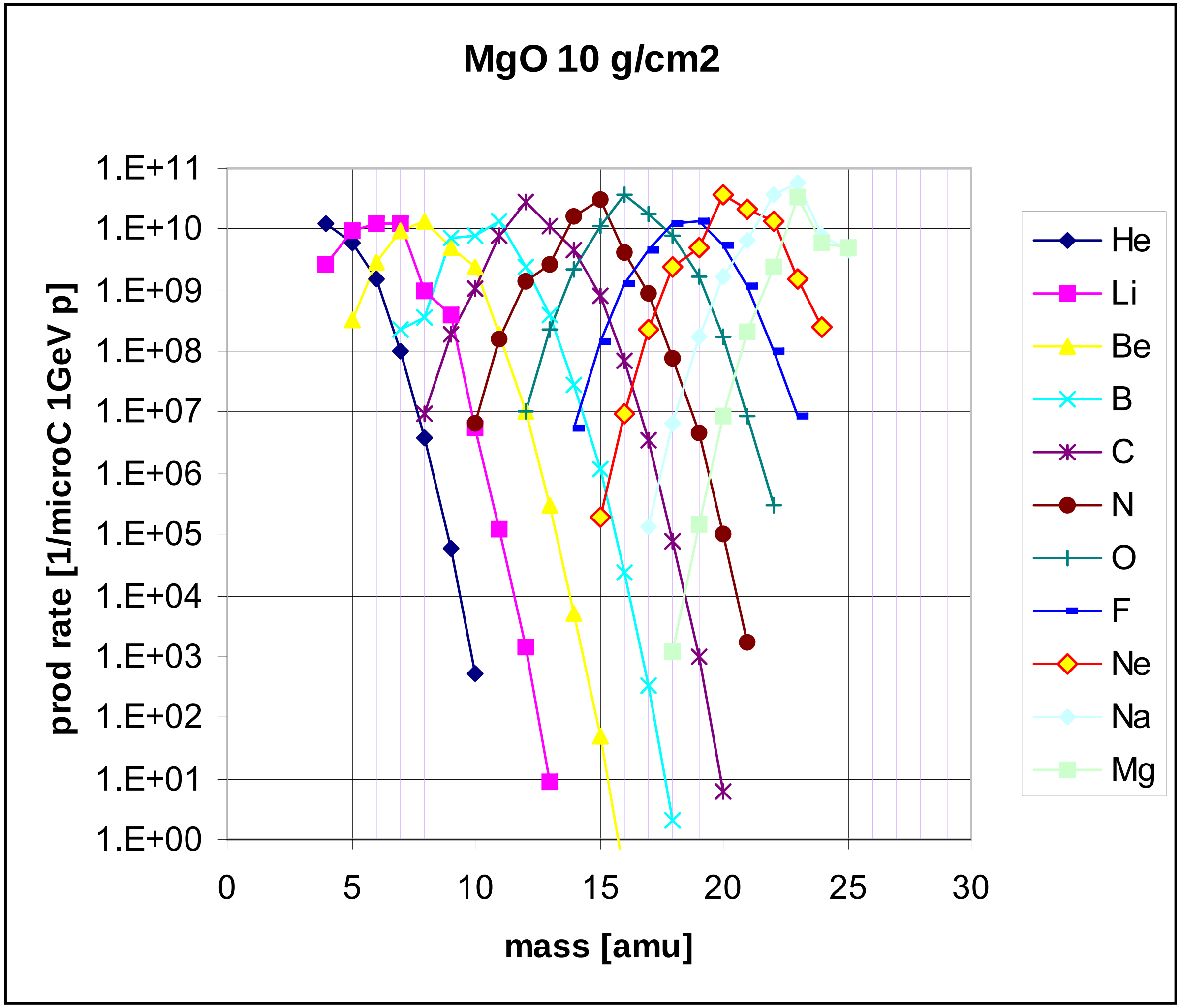
Scenario 2

- alternatively use (α,n) and (^{3}He,n) reactions:
  ^{12}C(^{3,4}He,n)^{14,15}O, ^{16}O(^{3,4}He,n)^{18,19}Ne, ^{32}S(^{3,4}He,n)^{34,35}Ar
  - Intense ^{3,4}He beams of 10-100 mA 50 MeV are required

^{6}He and $^{18-19}$Ne production

- 1 GeV p direct target production rates
- Ionization efficiency
- Release time structure, decay losses
- ISOLDE yields extrapolated to a 100 kW direct target (100 μA 1GeV protons)
- ^{6}He from ^{9}Be(n,α) reaction

$^{18\text{-}19}$Ne $\leq 4\text{-}15\times10^{11}$ [s^{-1}]



Prod rate: $2\text{-}5\times10^{9}$

effective p-current: × 100

thickness ratio: × 2-3

Ionization efficiency ~ 1% < 10%

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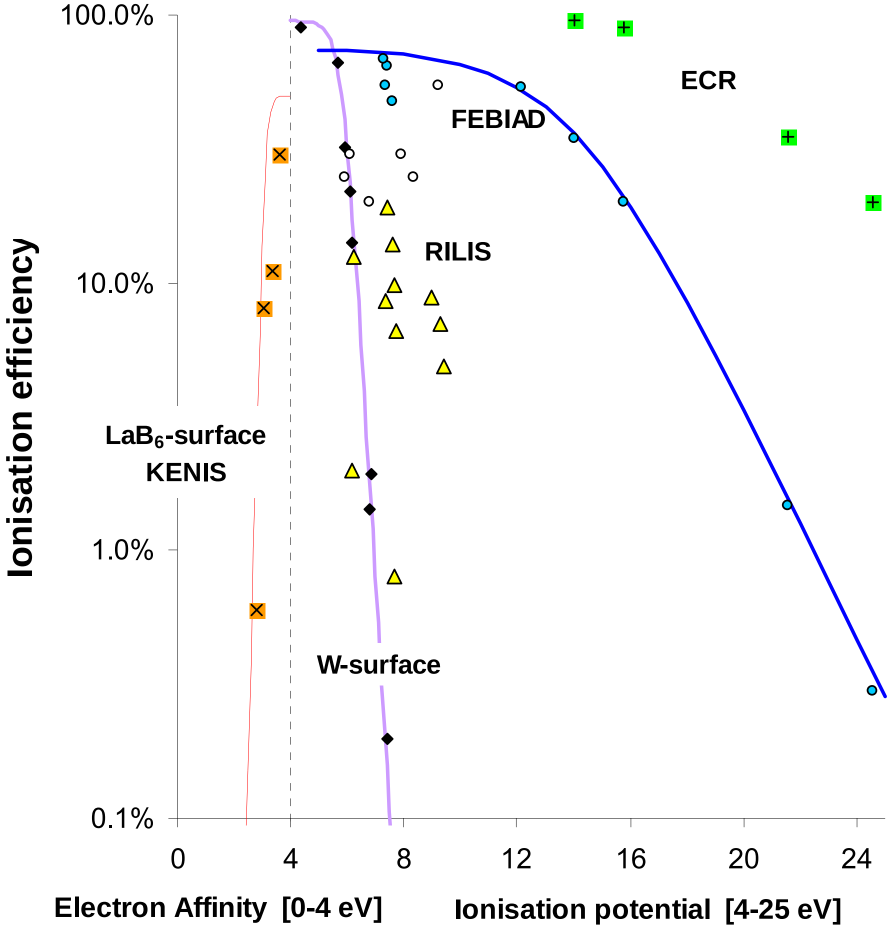
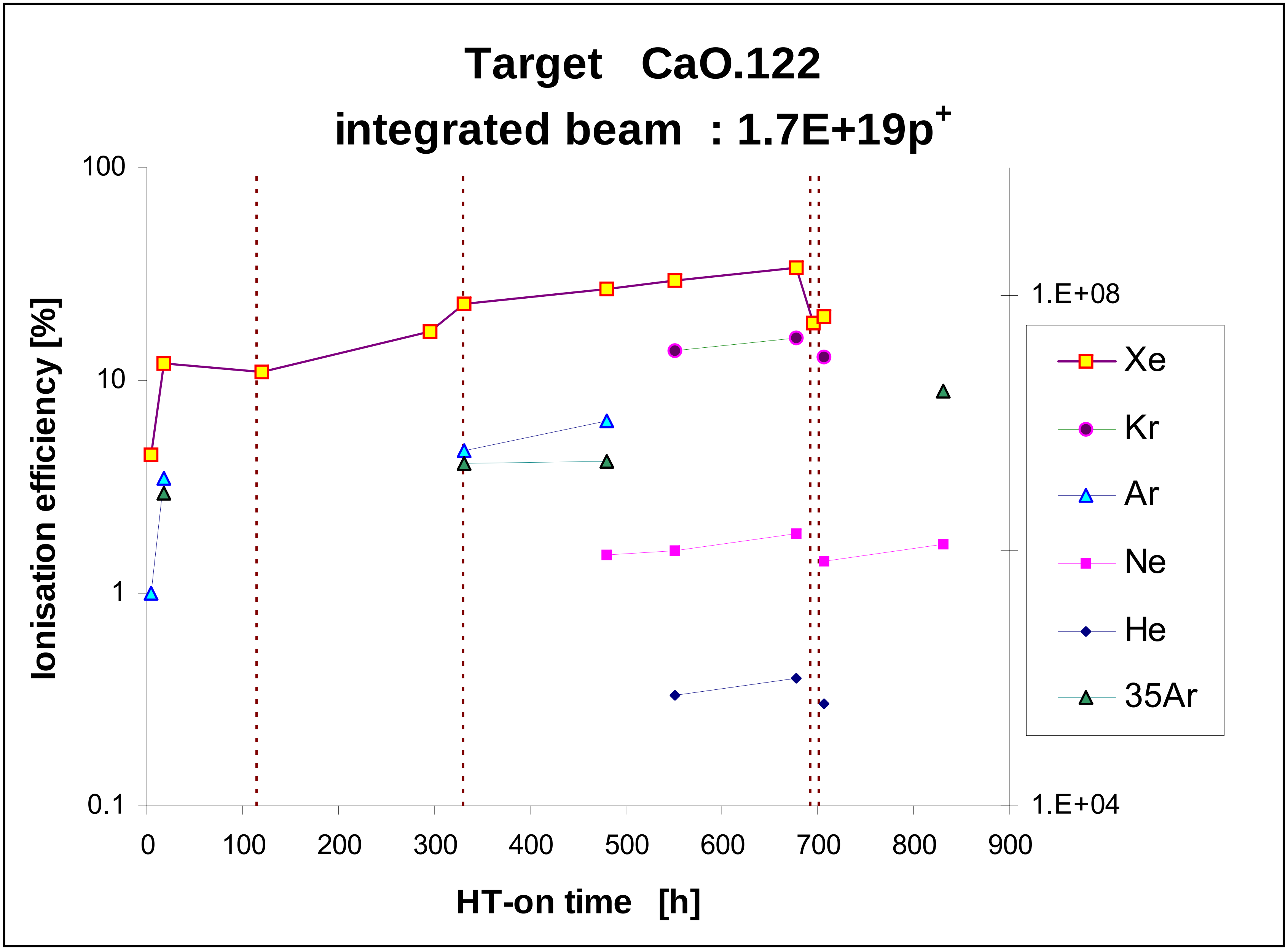


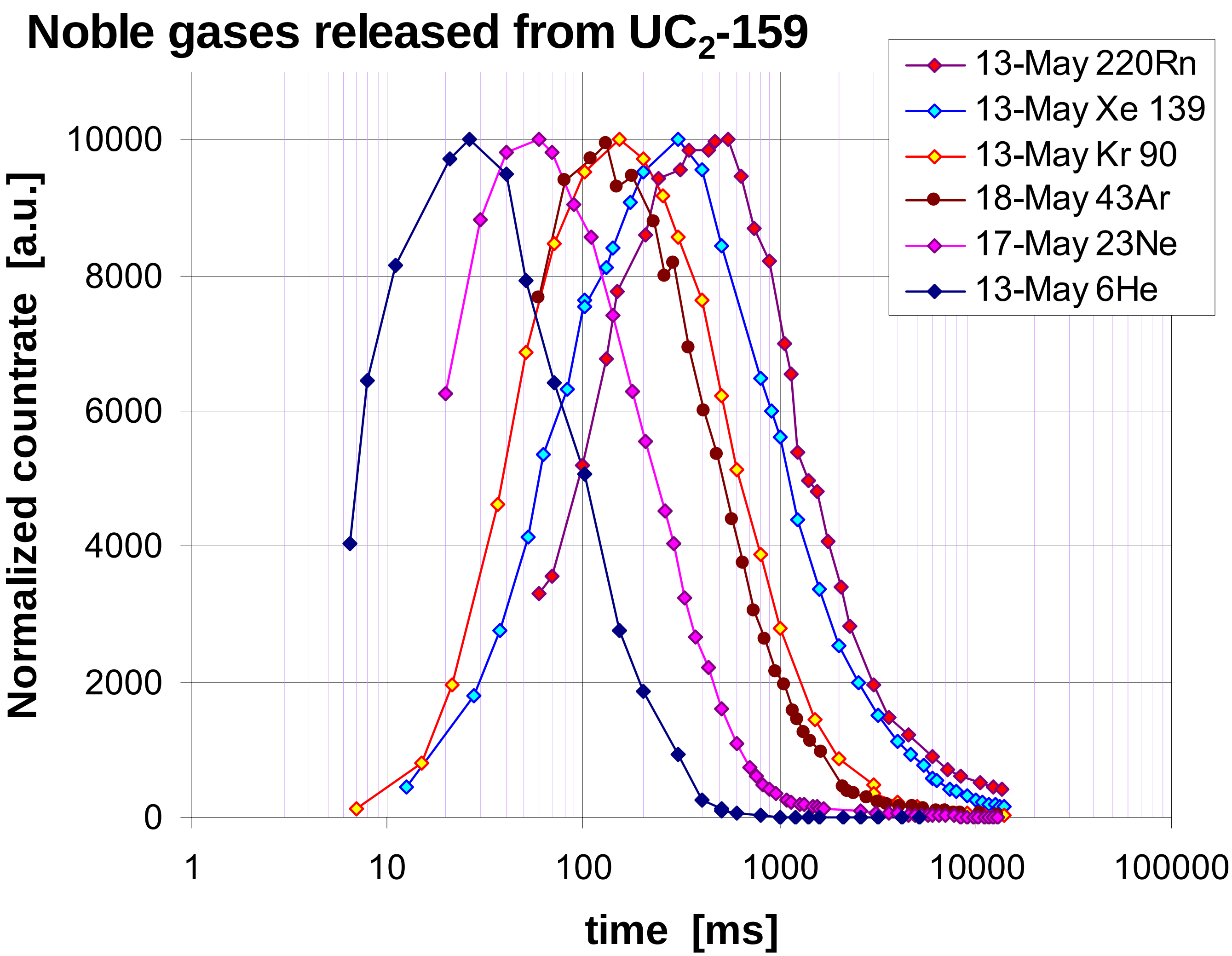
ECR Off-line results read upper limit

He	24.59	eV
Ne	21.56	eV



Target CaO.122
integrated beam : 1.7E+19p+
Ionisation efficiency [%]
100
10
1
0.1
0
100
200
300
400
500
600
700
800
900
HT-on time [h]
1.E+08
1.E+04
Xe
Kr
Ar
Ne
He
35Ar

Release



Noble gases released from UC2-159
Normalized countrate [a.u.]
time [ms]
0
2000
4000
6000
8000
10000
1
10
100
1000
10000
100000
13-May 220Rn
13-May Xe 139
13-May Kr 90
18-May 43Ar
17-May 23Ne
13-May 6He

ISOLDE Yields 600 MeV p [1/μC]

limited by ionization efficiency.

- ^{6}He half live 805 ms

6.60E+03	Mg Oxide
6.60E+05	Th Carbide

- ^{18}Ne half live 1.672 s

2.80E+05	Ca Oxide
3.50E+06	Mg Oxide
6.30E+04	Si Carbide

- ^{19}Ne half live 17.2 s

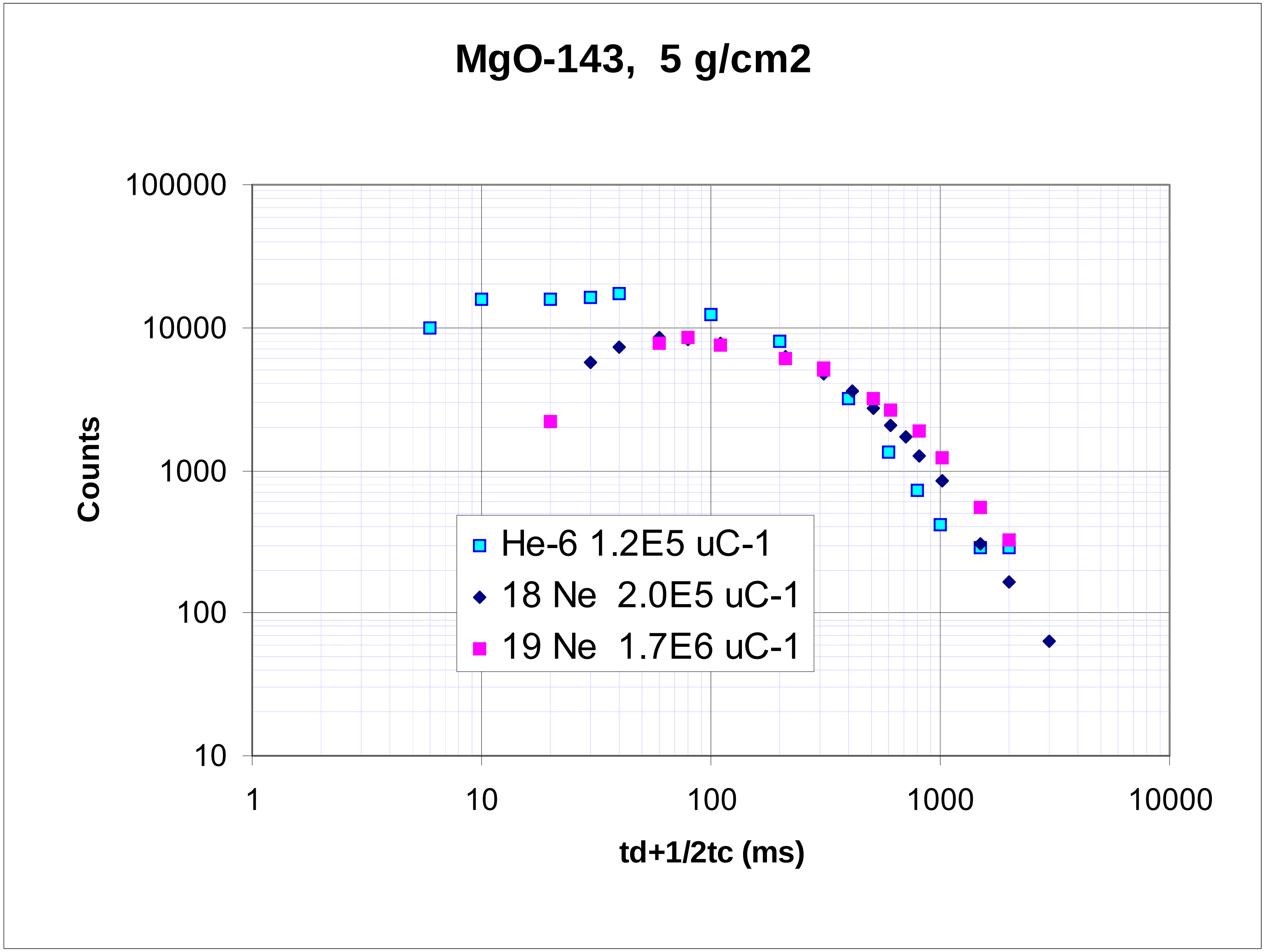
6.90E+06	Ca Oxide
3.00E+07	Mg Oxide
9.20E+05	Si Carbide

Effective p-current: × 100

Thickness ratio: × 2-3

Geometrical factors × …

ISOLDE-PSB yields and release



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Production of He-6: present status

- production of He-6 by high energy protons (ex: 2.2GeV) using spallation neutrons via the Be-9 (n, alpha) He-6

  .Presently, this seems the most promising scheme: 10^{13} atoms/s for 100µA protons at 2.2 GeV, or ~5 10^{10} atoms/s per kW

- production of He-6 by projectile fragmentation with a Li-7 beam

  .For a Li-7 beam at 100 MeV/A on a graphite target, the expected yield corresponds to 2.4 10^{10} atoms/s per kW (A. Villari, Moriond meeting).
  .Are they measurements? Riken, MSU, Dubna, ...?

- production of He-6 with low energy protons

  Li-7 (p, 2p) He-6
  .This reaction is used at Louvain-la-Neuve with 30 MeV protons coming from CYCLONE30. Although the measured yield at 30 MeV is lower than for the previous reactions (1. 10^{9} atoms/s per kW), it could be studied at higher energies (up to 80 MeV) with beam from CYCLONE.

Required R&D

- ECR ion-source R&D
- Measurement / computation of the effusion time through a transfer line.
- Solid converter + BeO target neutronics (D. Ridikas)
- Measurement of the release time on long targets (40 cm) or dense targets.
- Nuclear reaction cross sections for alternative schemes (ML).