Alternative production scenarios for He-6 and Ne-18

Marc Loiselet [a], *Semen Mitrofanov* [a,b]

[a]*UCL, Centre de Recherches du Cyclotron*

Louvain-la-Neuve (Belgium)

[b]*JINR, Flerov Laboratory of Nuclear Reactions*

Dubna (Russia)

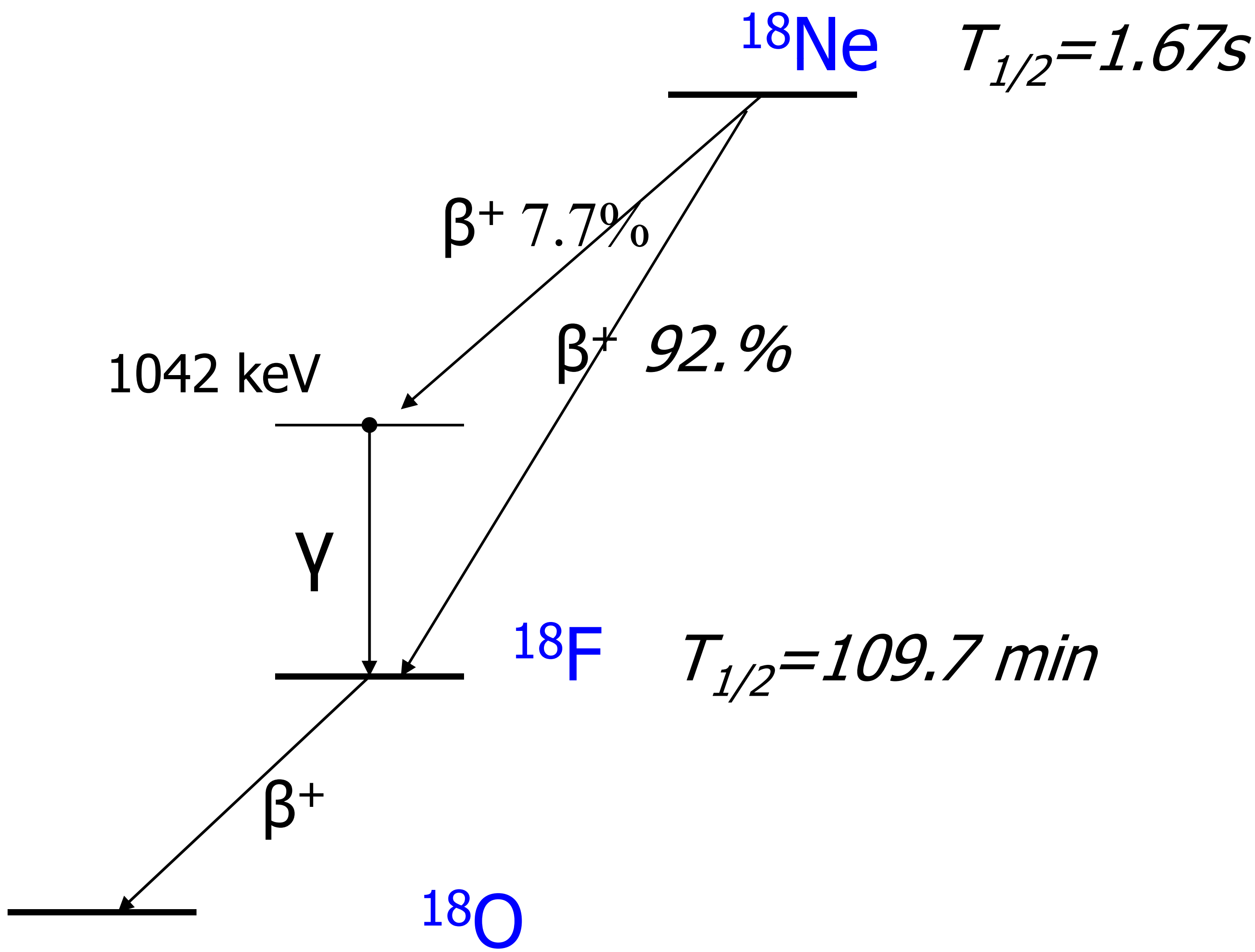
Baseline scenario (Eurisol-DS)

- Driver: 1.0 GeV protons 100μA
- Production of He-6
  - ^{9}Be (n,α) ^{6}He
  - Spallation neutrons produced by protons on a metal converter
  - BeO fiber around the converter
- Production of Ne-18
  - Spallation of Mg
  - MgO target

Alternative scenarios with low energy beams for Ne-18

- ^{19}F (p,2n)^{18}Ne threshold: 16 MeV
- ^{16}O (^{3}He,n) ^{18}Ne threshold: 3 MeV
- Cross-section measurements at LLN with:
  - protons: 23->52 MeV target: LiF powder
  - He-3: 8 -> 22 MeV target: O_2 gas-cell
- -> + Thick target yield measurements (Ne-18 produced per projectile)

Experimental method



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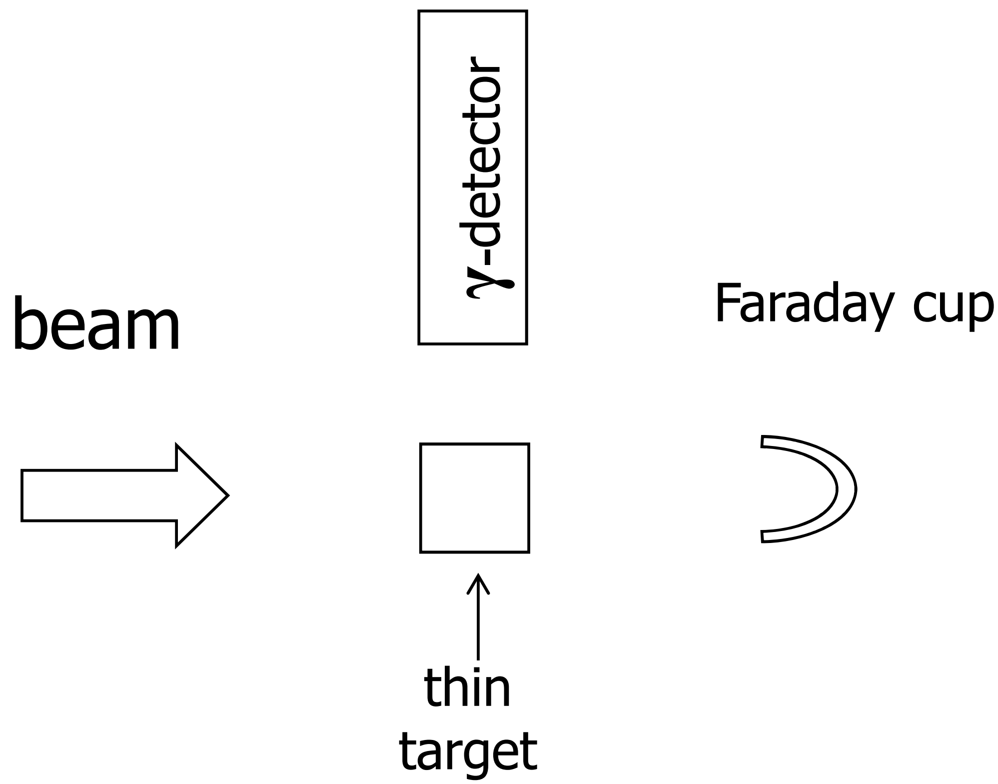
Experimental method



- produced IN the target
- thin target:
  - LiF powder
  - O_2 gas cell
- decay measurement
- pulsed beam

Experimental method

- SIMPLE, …BUT:

High background level :

γ rays + neutrons

high production of Ne-19 (17s)

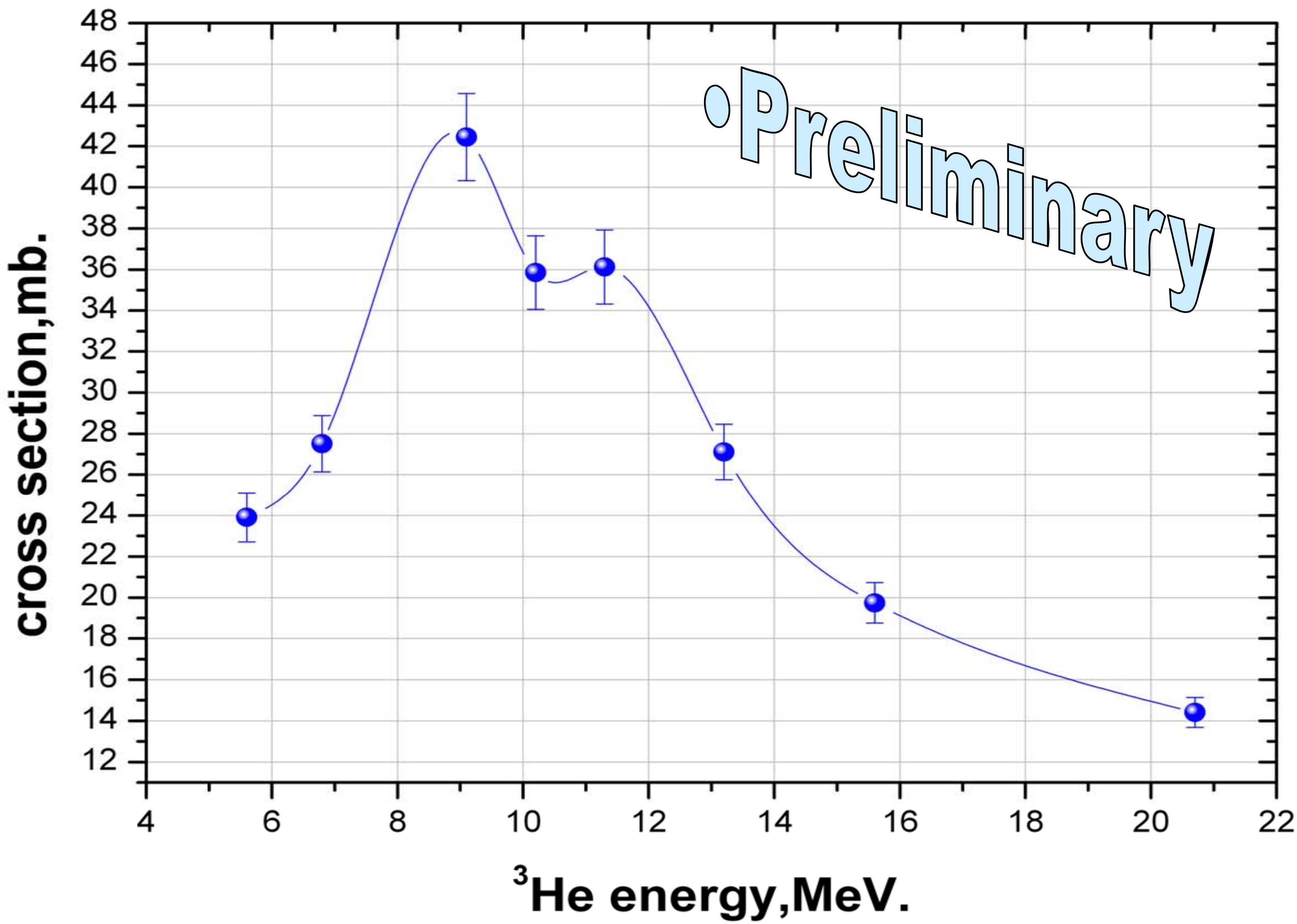
511 keV annihilation γ

->low intensity beam 1 nA

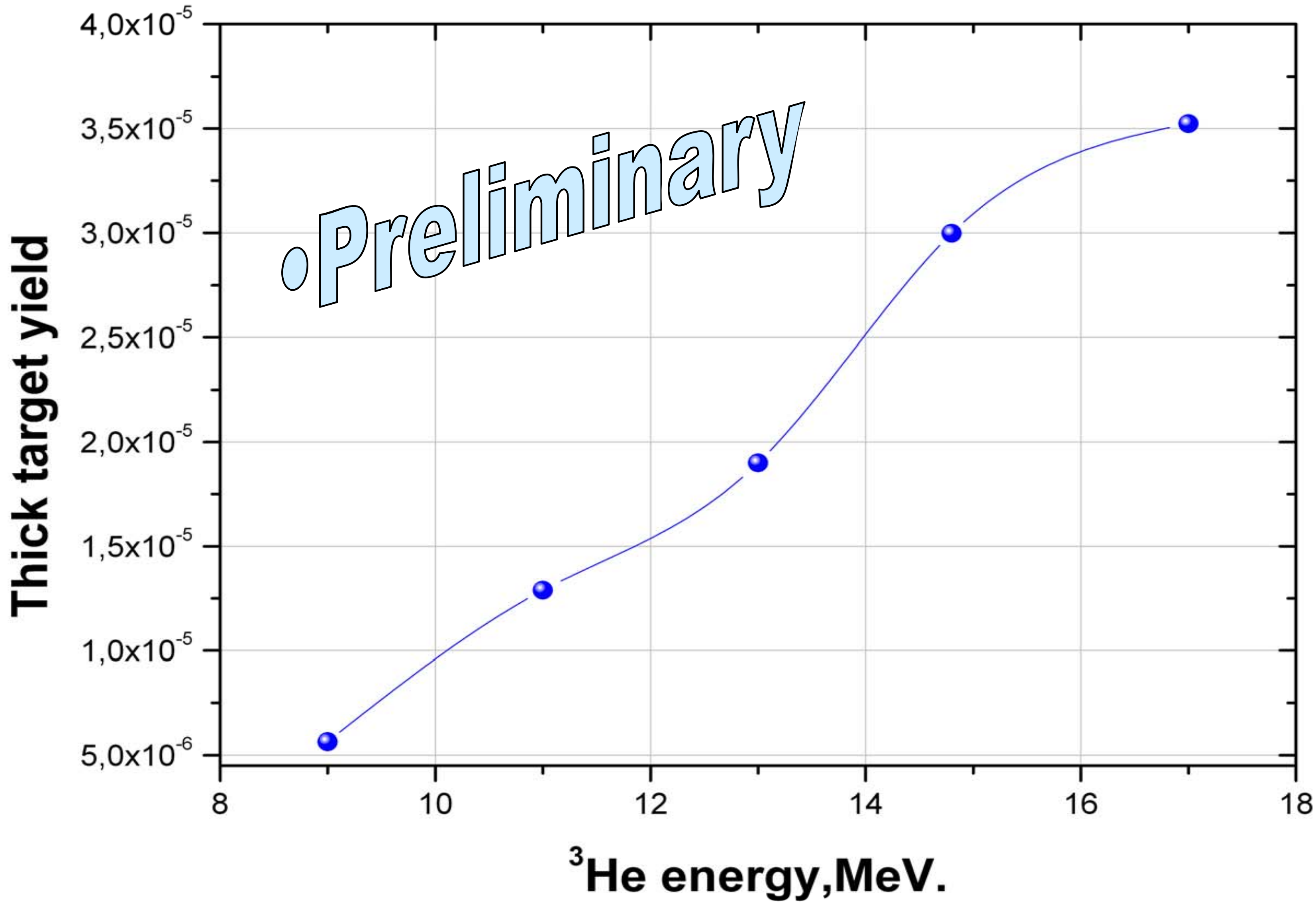
->pulsed beam (4s ON, 26s OFF)

->shielding …

^{16}O (^{3}He,n) ^{18}Ne



$^{16}O(^3He,n)^{18}Ne$ thick *(O_2)* target yield



Consequences for the β-beams

- Production yield with ^{3}He at 17 MeV in a MgO target:

$9\ 10^7\ \ 18Ne/\mu C$

- Rough estimation: to produce

10^{12} ^{18}Ne/s : 12 mAp of ^{3}He at 17 MeV (~200 kW)

(Eurisol: ~10^{12} ^{18}Ne/s)

..10^{13} ^{18}Ne/s: 120 mAp of ^{3}He at 17 MeV (~2 MW)

How unrealistic is this?

- Driver:

  12 mAp of ^3He at ~20 MeV should be ok (see GANIL)

  120 mAp ...why not?

  several (identical) small linacs at 20 MeV will be less expensive than 1 GeV linac

- Ion(s) source(s): $^3He^{1+}$ ...20 mA...200mA..

  to be developed... but should be ok

  (see the ECR proton source from Saclay)

How unrealistic is this?

- Targetry:

  -completly different from Eurisol GeV target !

  .range of 20 MeV 3He : ~0.3 mm

  .closer to the production target at LLN

  -LLN: 9 kW proton beam is spread by a

  wobbling magnet over a disk of 4cm (diameter)

  water cooled by the back-side of the target

  relevant value: power density kW/cm^2

How unrealistic is this ?

- targetry

9 kW -> target diameter : 4 cm

200 kW -> power: factor of 22 -> √22: < ~5

target diameter: 20 cm

2 MW -> power: factor of 220 -> √220: < ~15

target diameter: 60 cm

seems feasible (or ..probably not impossible...)

with a wobbling magnet for 20 MeV He-3

How unrealistic is this ?

- targetry

radioprotection, neutron activation,...

-should be simpler than with 1 GeV protons

-dedicated reaction

-neutron activation of the surrounding

-less expensive..

Alternative scenario for ^{6}He

- reaction mechanism: same as Eurisol

$$^{9}Be\ (n,\alpha)\ ^{6}He$$

- neutrons produced by a primary beam of deuterons on a converter or primary target (graphite, beryllium, lithium jet...) ->see also SPIRAL2, SARAF

Alternative scenario for ^{6}He

$^{9}Be\ (n,\alpha)\ ^{6}He$

- From Dan Berkovits, SARAF project
- primary beam: 40 MeV deuterons, 2mA (80 kW)
- (secondary) target: Be, BeO

  typical dimension: ~...10 cm...

- production rate: ~2 10^{13} $^{6}He/s$ with 2mA

  comparable to Eurisol....

Qui ne sait rien,ne craint rien...

Where is the devil hidden?

DRIVER (ion source, RFQ, LINAC) ?

TARGET ?

ION SOURCE FOR RIB ?

- For what concerns the target
  - we are not interested by what is produced IN the target, but what comes OUT

    extraction efficiency from the target ?
  - CHEMISTRY in the target: radiolysis of MgO ! behaviour of the windows?
  - COUPLING TO THE ION SOURCE

    gas load... !!! He3, O_2 !!!

    ->effect on the ionization efficiency

BUT....

With a low energy driver,

- synergies are possible with SPIRAL2, SARAF, LLN
- experimental tests can be done even at low intensity (but the same power density)

    -optimum geometry for the production and extraction of He-6 (Be, BeO?)

    -chemical behaviour of the MgO target...

    -gas load to the ion source...
- R&D should be less expensive...

REMEMBER...

- If the production of Ne-18 is too small to compensate the underestimated values (ionization efficiency, acceleration efficiency, ...)

•The production yield of Ne-19 is a factor of 50 larger !!!