Production of ^{6}He for Beta-Beam Experiments via a Two Target Irradiation Setup

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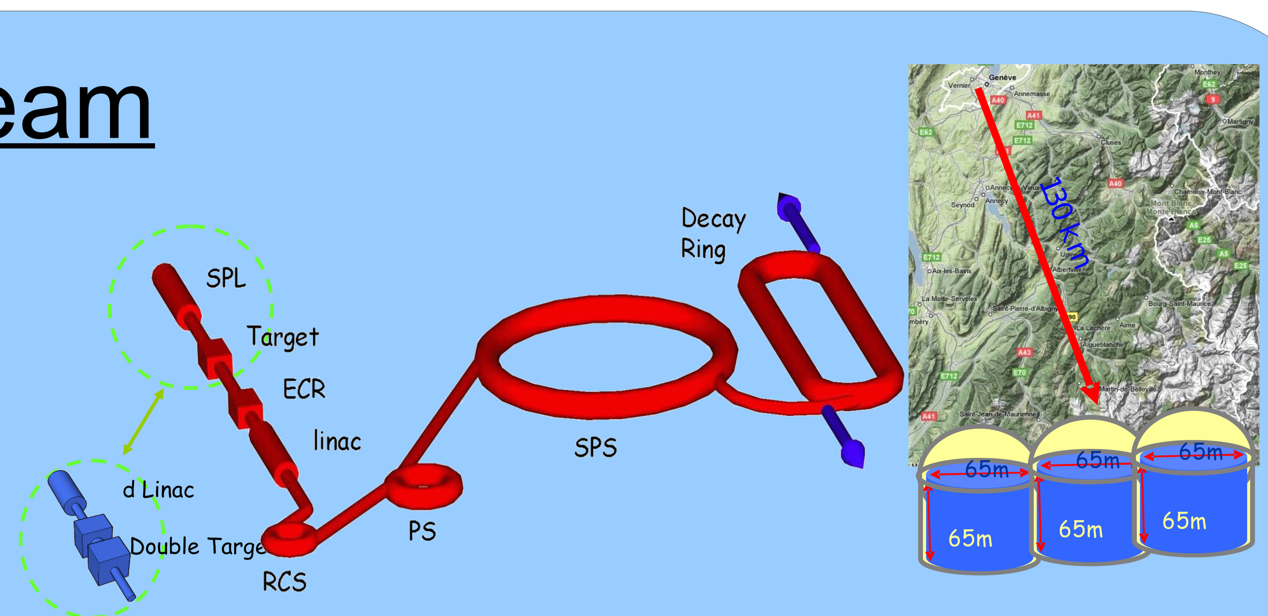
Beta-Beam

$^{9}Be(n,\alpha)^{6}He$
$^{6}He \rightarrow \beta^{-}$
$t_{0.5}$= 807 ms

$^{11}B(n,\alpha)^{8}Li$
$^{8}Li \rightarrow \beta^{-}$
$t_{0.5}$= 838 ms



Upcoming Beta-Beam experiments need of intense source of ions such as ^{6}He and ^{8}Li. One way of realizing such a source is currently being explored at the SARAF facility at the Soreq Nuclear Research in Israel.
This poster will try to give an overview of the production concept, the specifics of the SARAF condition as well the general aspects of the project.

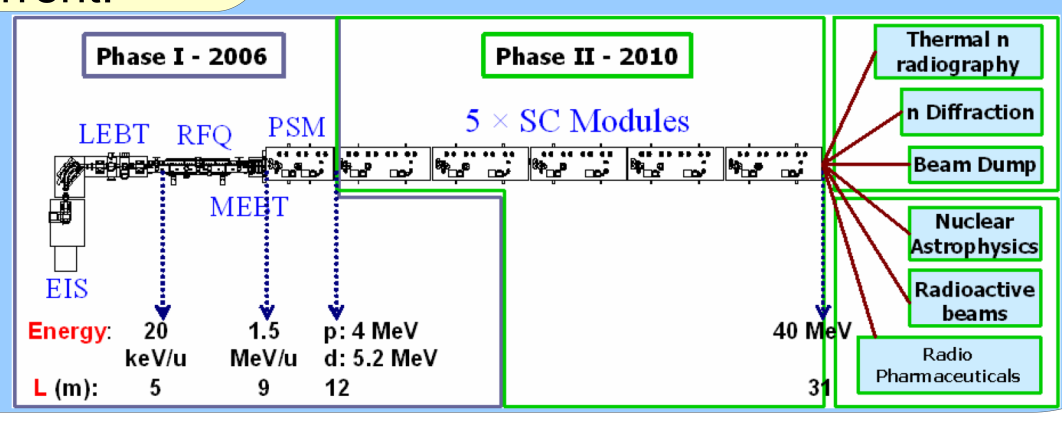
Saraf

Core of the Saraf Facility is a proton/deuteron LINAC which is being commissioned in two phases.

2008/9 Phase I : 5.2 MeV deuteron beam with 2mA beam current

20013 Phase II : 40 MeV deuteron beam with 2mA beam current.

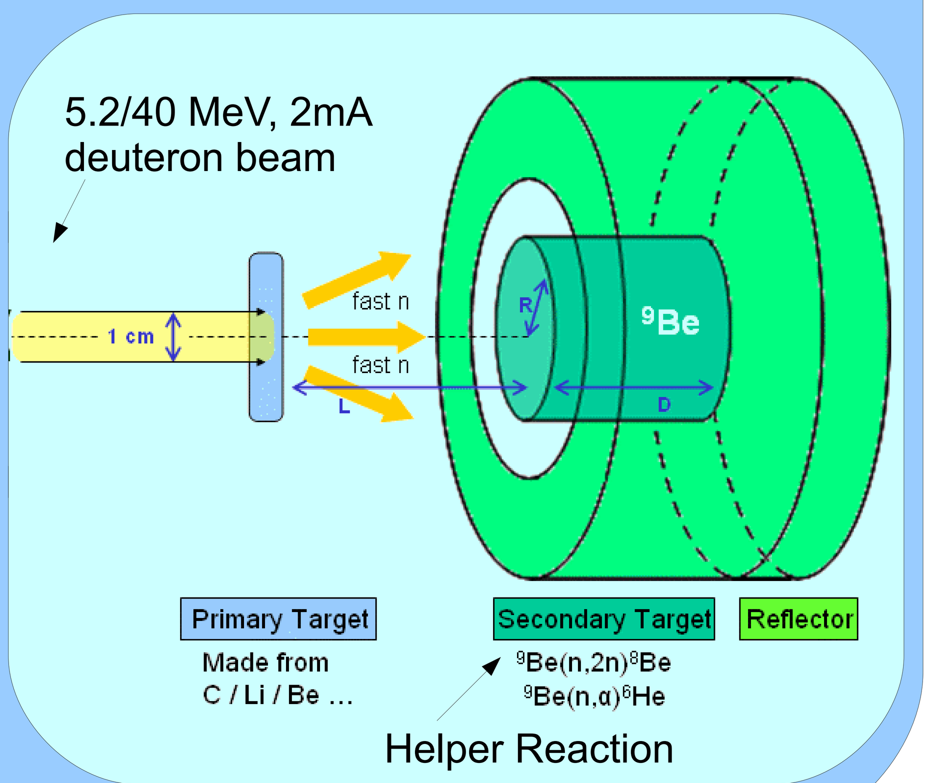
One research aspect will be the production and extraction of ^{6}He and ^{8}Li using the deuteron beam.



Production Concept

Deuterons impinging on the light, primary target produce fast neutrons, which subsequently produce the desired ^{6}He in the ^{9}Be-cylinder via the $^{9}Be(n,\alpha)^{6}He$ reaction.

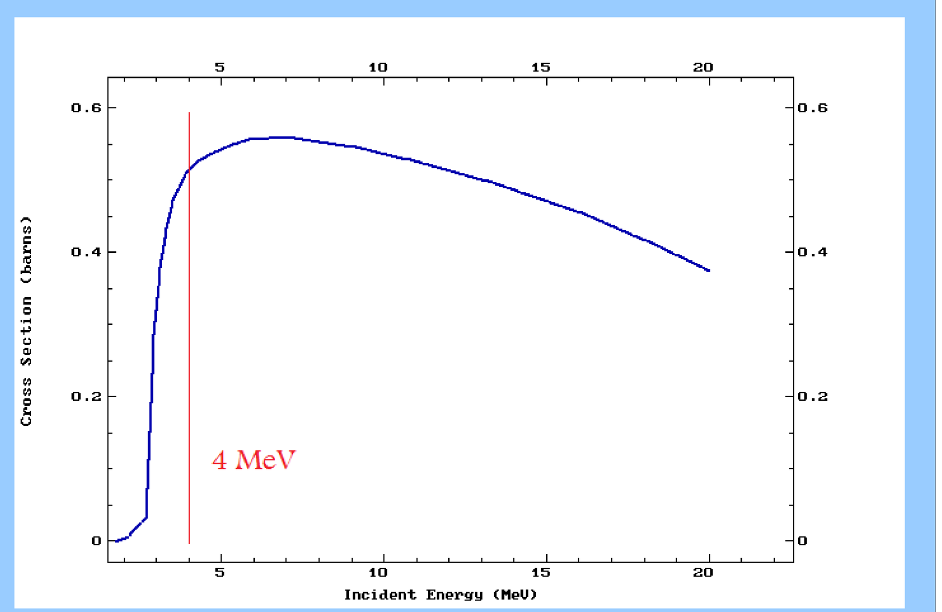
By exchanging the ^{9}Be-cylinder with a ^{11}B-cylinder ^{8}Li can be produced via the $^{11}B(n,\alpha)^{8}Li$ reaction.



The $^{9}Be(n,2n)^{8}Be$ reaction is very useful since it moderates and multiplies the incoming neutrons.
As one can see fast neutrons with an energy above 4 MeV are required.
This is a problem especially for phase I where only 5.2 MeV deuterons are available.

Thus a primary target with a high Q-Value for (d,xn) reactions is required.
Also of interest is the angular distribution of the neutrons since only forward-headed neutrons reach the secondary target.

Cross-Section: $^{9}Be(n,2n)^{8}Be$



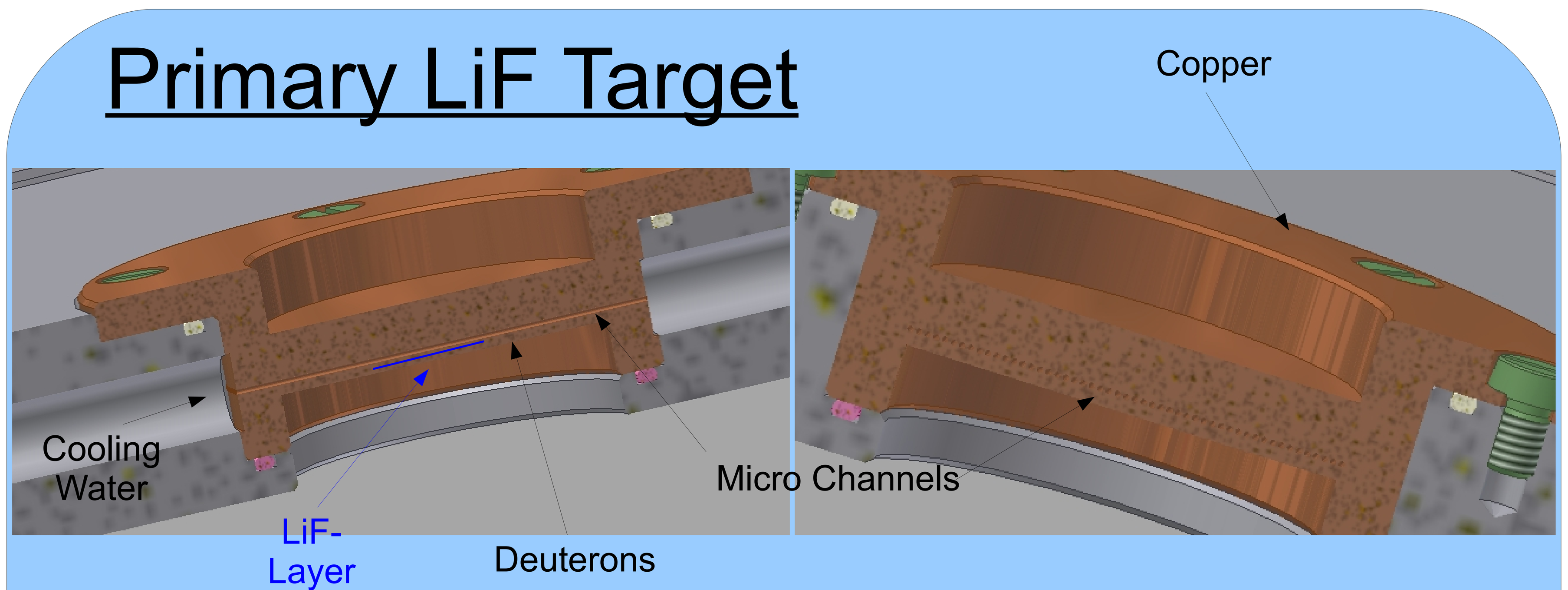
Phase I : Fast Neutron yield

Cutline: (N/s): fast neutrons per second (40°: regarding d-beam); MP: melting point

Isotope	(N/s)	(N/s) under 40°	Nat. Ab.	Q-Val.(MeV),	MP. (°C)
^{7}Li	$8,37 \cdot 10^{12}$	$1,27 \cdot 10^{12}$	92,41	15,03	181
^{9}Be	$2,75 \cdot 10^{12}$	$4,89 \cdot 10^{11}$	100	4,36	1287
^{11}B	$2,08 \cdot 10^{12}$	$3,44 \cdot 10^{11}$	80,1	13,73	2075
^{13}C	$1,45 \cdot 10^{12}$	$2,78 \cdot 10^{11}$	1,07	5,32	4489
^{7}LiF	$4,00 \cdot 10^{12}$	$6,29 \cdot 10^{11}$	-	-	848
^{11}BN	$1,24 \cdot 10^{12}$	$2,12 \cdot 10^{11}$	-	-	2967

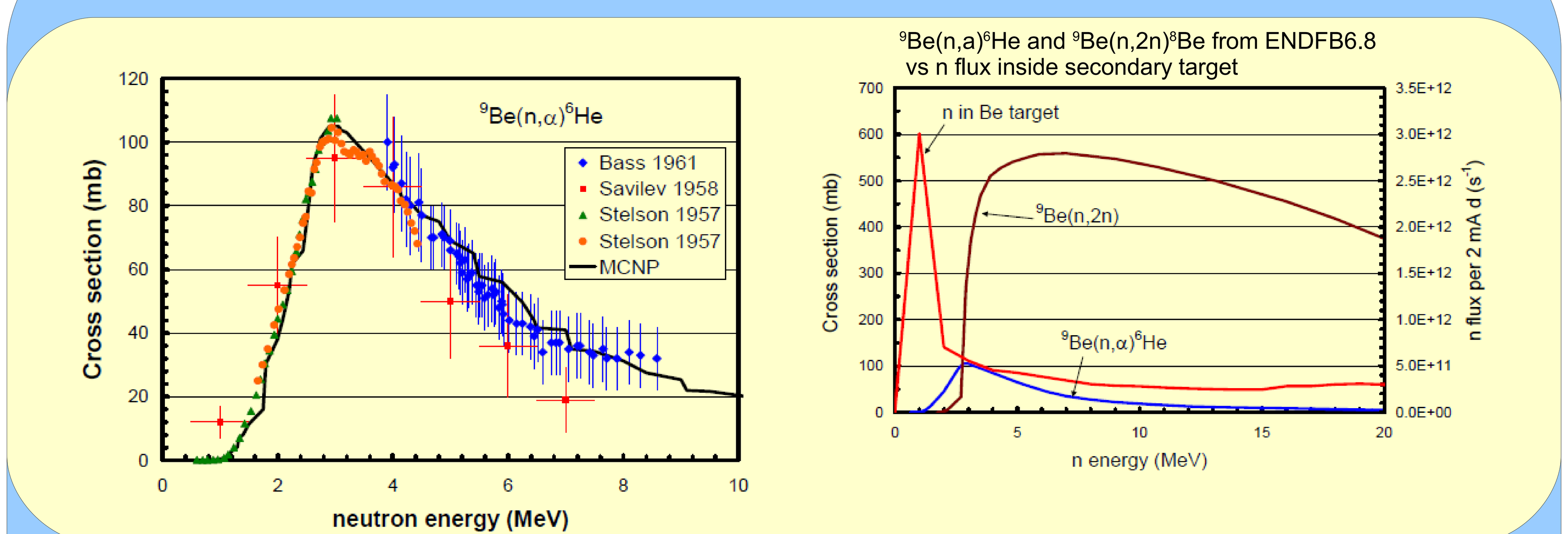
The neutron yield was calculated using TALYS[4].
^{7}Li has the highest yield however the low melting point makes it unsuitable as a solid target, a liquid jet target could be used.
Among the suitable materials for a solid target are LiF , ^{9}Be and BN.
In all cases sufficient cooling is required.

Primary LiF Target



This is a blueprint of the solid LiF target which is to be tested. Vapor deposited on the copper is a thin LiF layer.
The target is cooled by pressured water flowing through micro-channels perpendicular to the beam direction.

MCNP™



Using MCNP4b the yield of Phase II (40 MeV) is calculated for a BeO and BN (porous, for better extractability) secondary target with a primary target made of ^{7}Li. The high yields are extremely promising provided an efficient extraction can be realized. SPIRAL2 is a similar facility in Ganil, France but with a primary carbon target.

Phase II : 40 MeV ^{6}He yield

Expected Yields for a BeO target:
SARAF (40 MeV, 2 mA): **$8 \cdot 10^{12}$** [^{6}He/sec]
SPIRAL2 (40 MeV, 5 mA): **$2 \cdot 10^{13}$** [^{6}He/sec]
Expected Yields for a BN target:
SARAF (40 MeV, 2 mA): **$2 \cdot 10^{12}$** [^{8}Li/sec]

Hass et al., J. Phys. G: Nucl. Part. Phys., 35, 014042 (2008) .

Magnitude of 10^{13} ^{6}He/s!

Upcoming

-Production and extraction measurements in the 5.2 MeV Phase.

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