The LUNA-MV project from 2007 to now

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History of the LUNA-MV Letter of Intent and interactions with the LNGS Scientific Committee, LNGS management and INFN management→ slightly modified and better defined project

Technical details of the evoluted project in the following talks of this session (machine, site, shielding)

The reactions envisaged in the LUNA-MV LoI: astrophysical interest, existing data and open problems in the following session

Why presenting a LoI at LNGS?

1) Background reduction offered by the 1400 m of rock cover

2) Past and present LUNA experiment (knowledge, people, detectors and materials in general)

What are we looking for:

1) Interested people
2) Specific skills (see next session)
3) Money

Laboratory for Underground Nuclear Astrophysics

LUNA MV
2012 ?

LUNA 1
(1992-2001)
50 kV

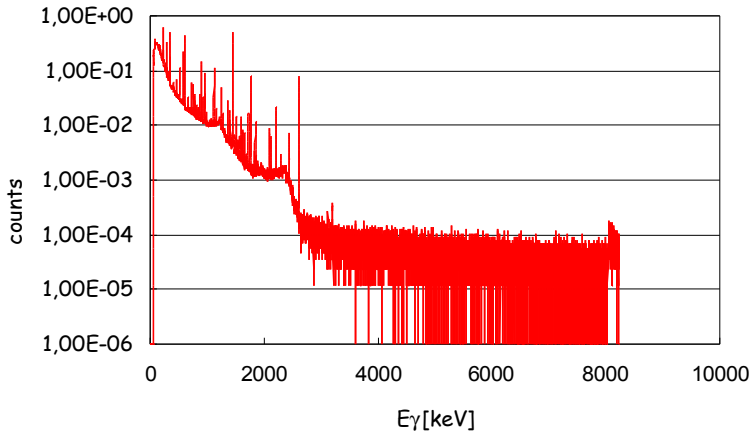
LUNA 2
(2000→...)
400 kV

LNGS
(shielding ≡ 4000 m w.e.)

Radiation	LNGS/surface
Muons	10^{-6}
Neutrons	10^{-3}

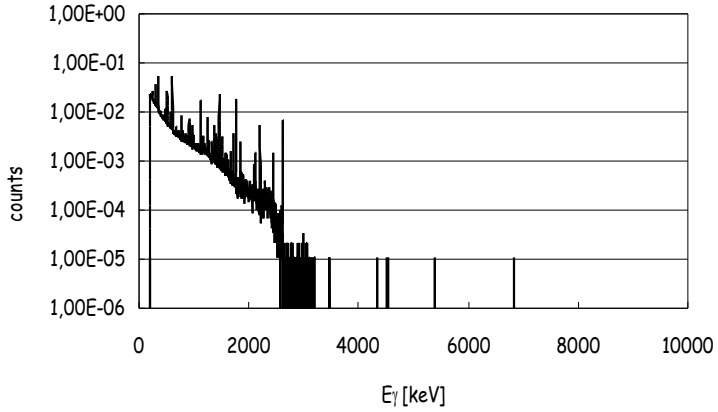
Background reduction in a HPGe

3MeV < Eγ < 8MeV:
0.5 Counts/s

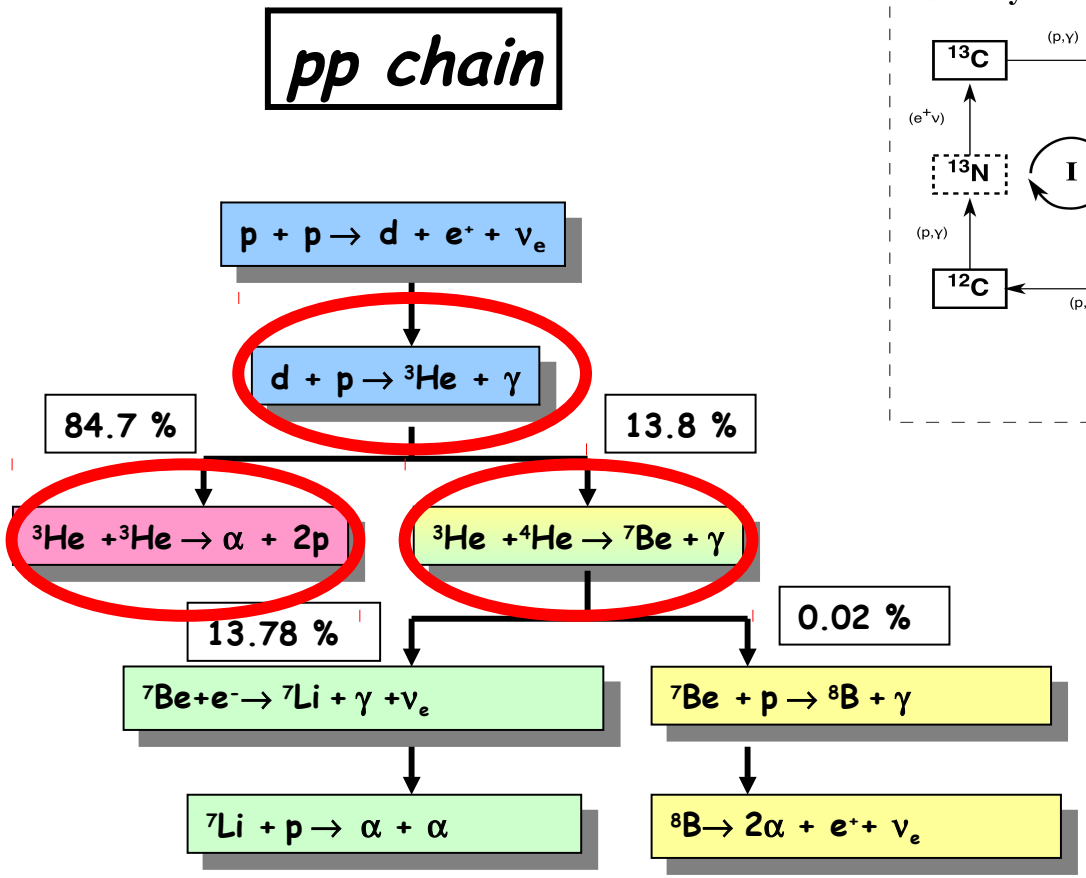


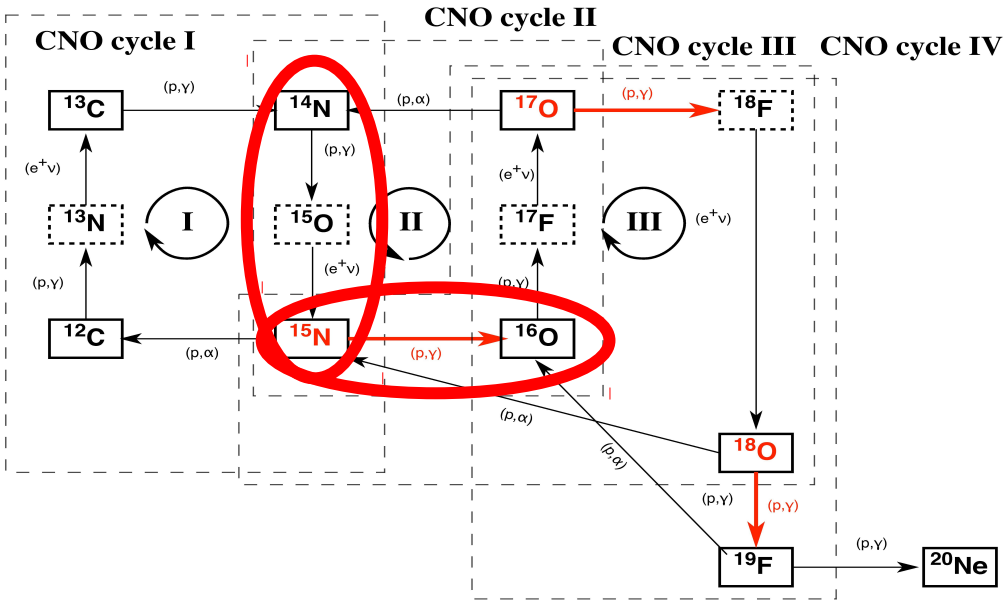
Going underground →

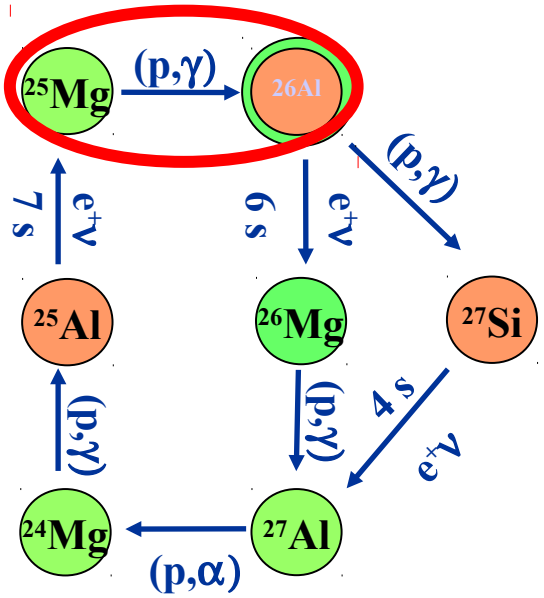
3MeV < Eγ < 8MeV
0.0002 Counts/s



LUNA results







LUNA present program

completed!

In progress

In progress

	reaction	Q-value (MeV)	Gamow energy (keV)	Lowest meas. Energy (keV)	LUNA limit
CNO cycle	$^{15}N(p,\gamma)^{16}O$	12.13	10-300	130	50
	$^{17}O(p,\gamma)^{18}F$	5.6	35-260	300	65
	$^{18}O(p,\gamma)^{19}F$	8.0	50-200	143	89
Ne-Na cycle	$^{23}Na(p,\gamma)^{24}Mg$	11.7	100-200	240	138
	$^{22}Ne(p,\gamma)^{23}Na$	8.8	50-300	250	68
BBN	$D(\alpha,\gamma)^{6}Li$	1.47	50-300	700(direct) 50(indirect)	50

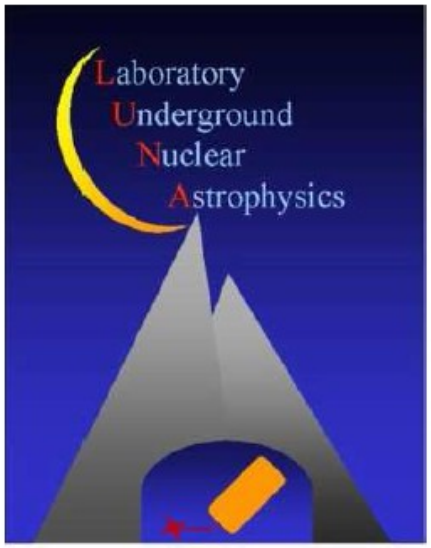
to be completed presumably by 2014

- April 2007: a Letter of Intent (LoI) was presented to the LNGS Scientific Committee (SC) containing key reactions of the He burning and neutron sources for the s-process

$^{12}C(\alpha,\gamma)^{16}O$
$^{13}C(\alpha,n)^{16}O$
$^{22}Ne(\alpha,n)^{25}Mg$
(α,γ) reactions on $^{14,15}N$ and ^{18}O

These reactions are relevant at higher temperatures (larger energies) than reactions belonging to the hydrogen-burning studied so far at LUNA

Higher energy machine



LUNA-MV
LETTER OF INTENT

COLLABORATION

Germany

BOCHUM, Inst. For Experimental Physics, Ruhr-Universitat:
C. Rolfs, F. Strieder, H.P. Trautvetter

DRESDEN, Inst. For Radiation Physics, Forschungszentrum Dreseden-Rossendorf:
D. Bemmerer, M. Marta

Hungary

DEBRECEN, ATOMKI:
Z. Elekes, Zs Fulop, Gy. Gyurky, E. Somorjai

Italy

GENOVA, Università degli Studi and INFN:
F. Confortola, P. Corvisiero, H. Costantini, A. Lemut, P. Prati

LNGS, Gran Sasso:
A. Formicola, C. Gustavino, M. Junker

MILANO, Università degli Studi, Ist. Di Fisica Generale Applicata and INFN:
R. Bonetti, A. Guglielmetti, C. Mazzocchi

NAPOLI, Università, Dip. Scienze Fisiche and INFN:
N. De Cesare, A. Di Leva, A. D'Onofrio, L. Gialanella, G. Imbriani, B. Limata, V. Roca, M. Romano, O. Straniero

NAPOLI, II Università, Dip. Scienze Ambientali and INFN:
F. Terrasi

PADOVA, Università degli Studi and INFN:
C. Broggini, A. Caciolli, E. Conti, R. Menegazzo, C. Rossi Alvarez

TORINO, Università, Dip. Fisica Sperimentale and INFN:
G. Gervino

The first SC answer (april 2007):

...A possible construction of a new LUNA accelerator was also discussed. The SC noted that this project needs a better specification in terms of its physics goals and also stressed that the issue of any neutron pollution was critical in considering deployment in a low background Laboratory like LNGS.

October 2007 : a LoI addendum with an improved study on the neutron pollution and a better specification of the physics goals was submitted to the SC

Addendum to the LUNA-MV Letter of Intent
LNGS-LOI 42/07

The second SC committee answer (October 2007):

The SC analyzed the LUNA-MV Letter of Intent,together with the addendum presented at the last meeting, concerning the construction of a new LUNA accelerator in the underground Laboratory. **The SC recognizes the important physics programme of the proposal, a natural development of the current experiment which gave outstanding results. Nevertheless, the SC noted that the LUNA-MV project has a non-negligible impact on the whole Laboratory's activity, mainly under two respects: (i) the underground space needed and (ii) the possible radio-activity pollution.** The space needed by LUNA-MV can be evaluated to be approximately 1/5 of a main experimental hall. This space, if allocated, will definitively saturate the total available space underground for a substantial time. This scenario has important consequences for the Laboratory, preventing any further development of the approved experiments as well as any new experiment proposal. The second issue concerns the neutron and gamma activity connected with a 3 MV accelerator. This activity, even if properly shielded as discussed in the LOI/addendum, could still seriously increase the Laboratory background, the low level of which is a major advantage of the Gran Sasso Laboratory **Based on these two important points the SC was not able to recommend approval of LUNA-MV to proceed to a full proposal for deployment at Gran Sasso. Nevertheless, the SC reiterates its view that the science of the LUNA-MV project is very important and hopes the collaboration will be successful in finding an alternative location.**

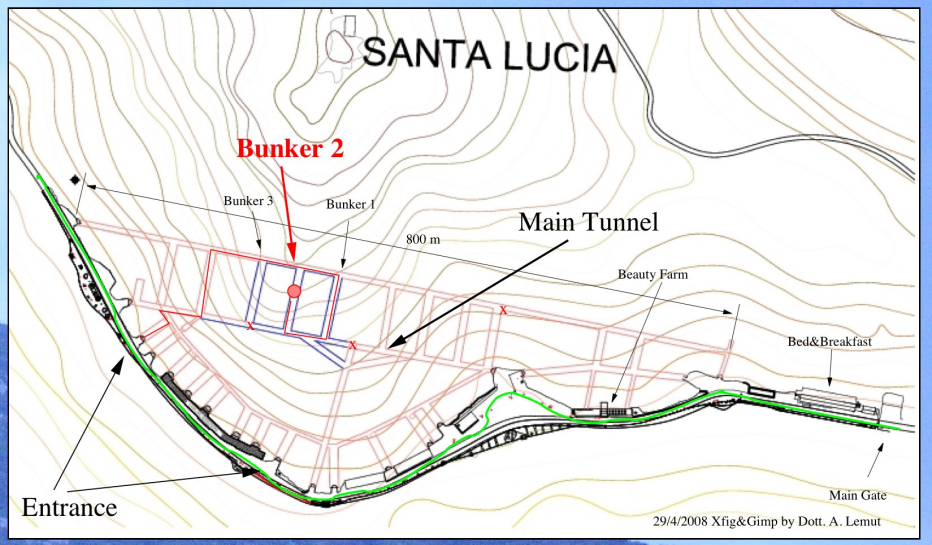
Alternative locations were searched for:

The INFN President and Executive Board suggested to explore the possibility of an underground laboratory under Monte Soratte (close to Roma)

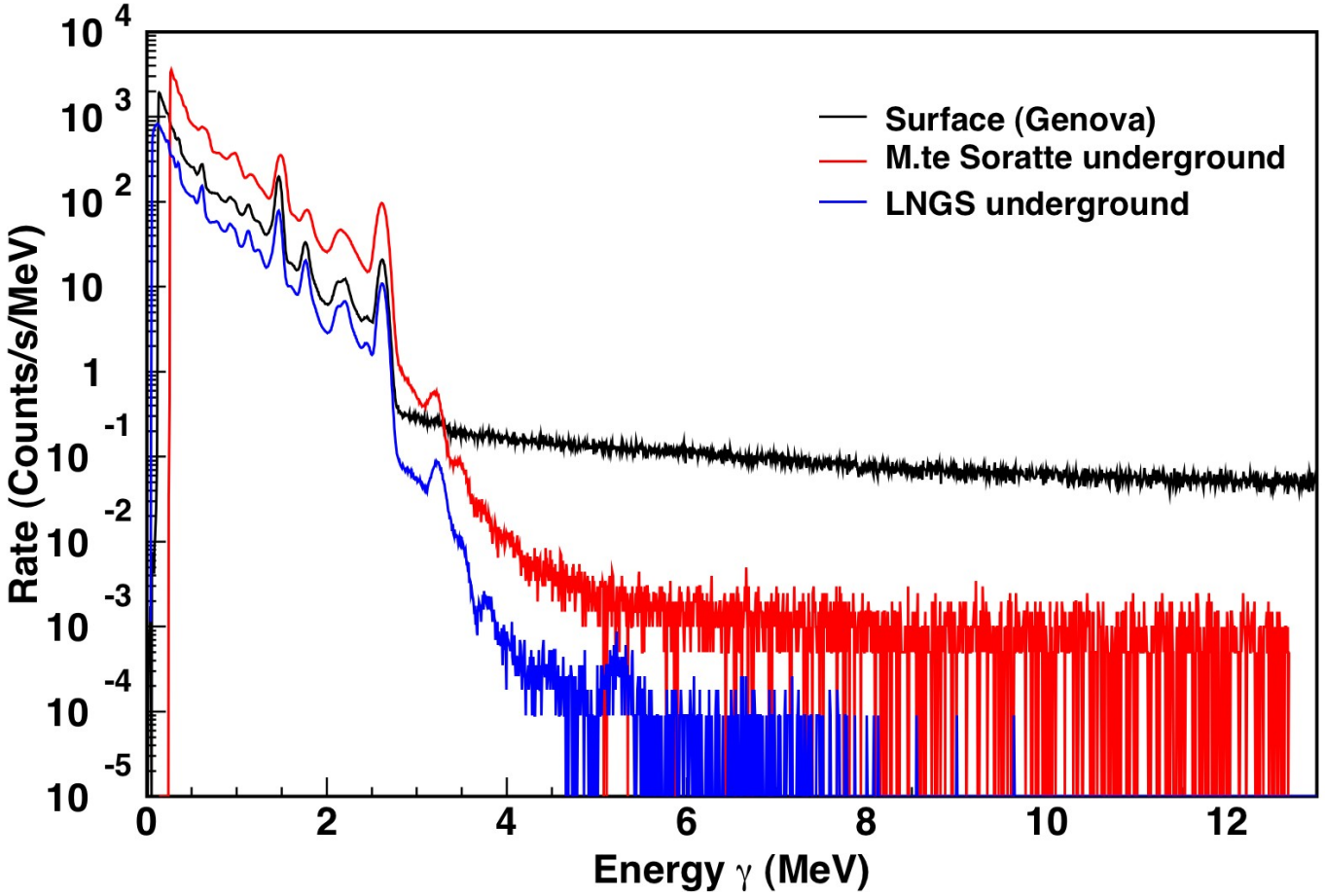
420 m over sea level ~100-200 m of rock cover.

Existing tunnel but NO infrastructure

Mount Soratte bunker



Background measurements :



only a factor 50-80 of background reduction with respect to surface is obtained...and huge effort is needed!

July 2008: meeting with the INFN President and the Executive Board about the future of LUNA

The President and the Board (unanimity) fully agree to continue the LUNA activity with the MV machine in Gran Sasso. A suitable place has been found to host the new accelerator, far from all the other experiments, in the region presently occupied by the interferometer

The third SC committee answer (October 2008):

.... Regarding theLUNA MV project the SC recommends that, in order to prepare a full proposal, the collaboration should discuss the details of the project with the Laboratory management, with a particular attention to the experimental set-up location and the possible neutron pollution.

SC of November 2009

"....the committee recommends that the Director set-up a small committee to address the issue of possible neutron generation and the operation of the experiment, in order to ensure that the neutron backgrounds are at a suitable level"

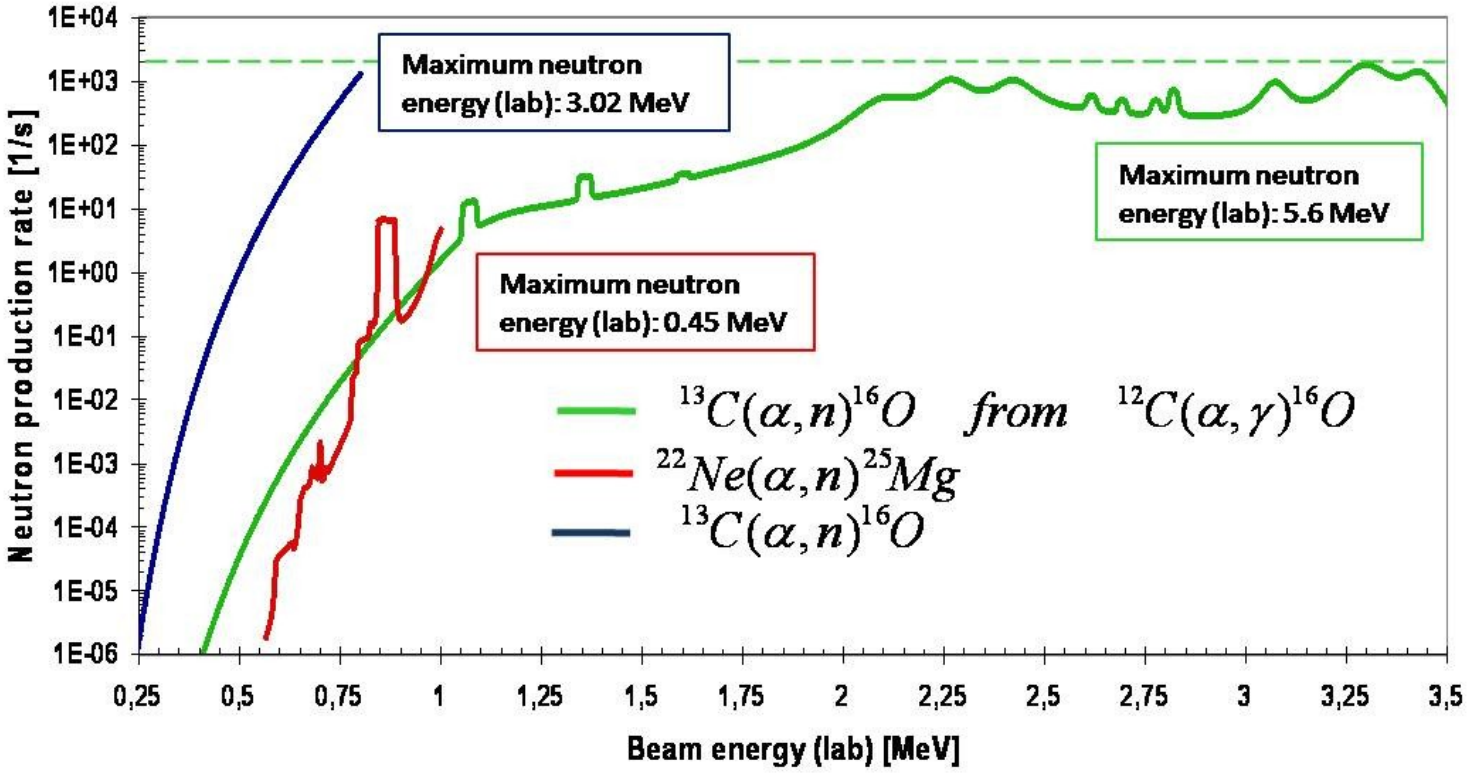
The committee was formed (Prof. Michael Hass, Dr. Adolfo Esposito, Prof. Walter Kutschera, Dr. Luciano Lembo, Prof. Mario Terrani)

The LUNA collaboration produced an update of the LoI where the experimental conditions and neutron production rates were re-evaluated and the machine chacteristics were better specified.

Update on the LUNA MV Letter of Intent 42/07

Alessandra Guglielmetti for the LUNA collaboration
February 26th, 2010

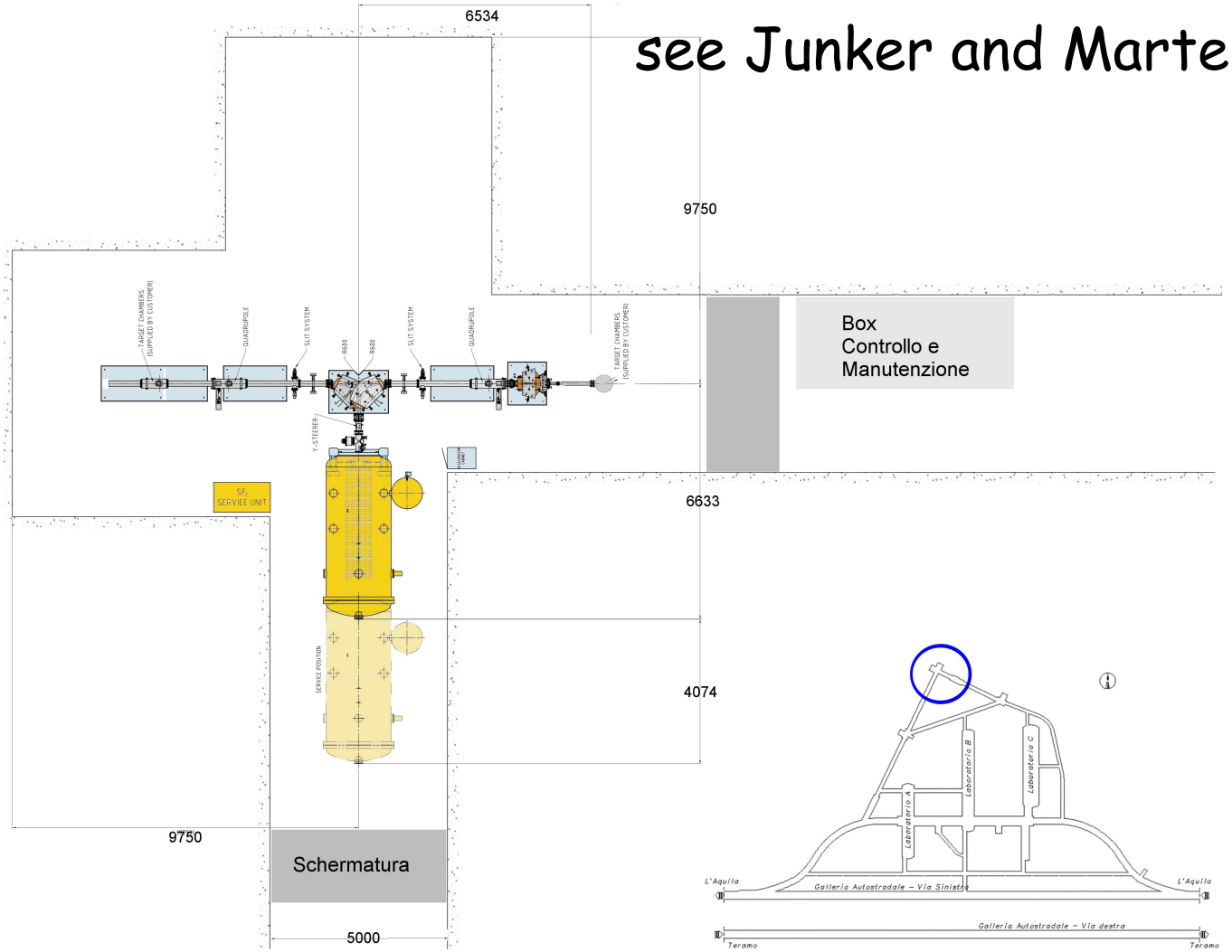
The maximum neutron production rate was evaluated to be: 1800 n/s at the target position:



see Trezzi in this session and Prati and Menegazzo in the following session

Possible location at the interferometric node of a 3.5 MV single-ended positive ion accelerator

see Junker and Martella



SC of May 2010

..Concerning the proposed operation of a high voltage LUNA-MV accelerator, the SC was pleased to hear the conclusions of the review committee which addressed the issue of neutron pollution underground. This careful analysis, performed taking into account also possible activation effects on the ground water, showed a very low increase in the neutron background. The SC recognizes the important efforts made by the collaboration to reduce and characterize this background. The SC recommends close interaction with the Laboratory management to address the specific issue of the underground location of the experimental set-up, particularly in view of possible interference with the ground water. The SC repeats its view that the scientific importance merits the establishment of the new experiment...

A real feasibility study started!!!→ see Martella and Trezzi
The LNGS technical divisions and management are highly involved

SC of October 2010

.. The SC was pleased to see that the collaboration had initiated a technical study of the LUNA Mega Volt (LUNA-MV) project. The SC supports the idea of organizing a roundtable on this topic, foreseen for February 2011 in LNGS, with the aim of involving other European groups in the LUNA-MV activity and the objective of producing a Letter of Intent.

NOW IS UP to YOU!!!

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University of Edinburgh
M. Aliotta and D. Scott