Minutes of the LENA meeting at Zeuthen

Michael Wurm and Markus Kaiser

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Participants

TU München:	Lothar Oberauer, Dominikus Hellgartner, Randolph Möllenberg, Franz von Feilitzsch, Marc Tippmann
Universität Hamburg:	Caren Hagner, Michael Wurm, Sebastian Lorenz, Lukas Hoppenau, Markus Kaiser
DESY:	Rolf Nahnhauer, Christian Spiering, Juan Pablo Yanez
RWTH Aachen:	Achim Stahl, Marta Meloni
University of Jyväskylä:	Kai Loo, Wladyslaw Trzaska
Würzburg University:	Jian Tang
University of Oulu:	Timo Enqvist
NPI Petersburg:	Yury Novikov
SOFREGAZ:	Jerome Sialelli

LENA - Status

Organizational matters of the working group

- Coordinator for the LENA working group is Lothar Oberauer, with Michael Wurm as deputy
- Two main divisions: Technical design (contact person: Lothar Oberauer) and Physics and Monte Carlo (contact person: Michael Wurm)
- The group in Munich will set up a mailing list, a webpage and an online repository for documents and Monte Carlo code
- The name "LENA" is kept in use but "LAGUNA-LS" is also adopted to stress the affiliation to LAGUNA-LNBO (LL)
- Next working group meeting will take place in February 2012 in Hamburg. The date will be identified by doodle.
- In addition: regular meetings/Skype conferences for Monte Carlo group are foreseen
- The LL inquiry for a detailed documentation on LENA construction, filling and operation will be treated in a special meeting in Munich at December 15th and 16th. Lothar Oberauer, Michael Wurm and Franz v. Feilitzsch will take part.
- Knowledge transfer between LENA and SNO+ should be increased. A visit of the technical partners to SNOLAB is planned for next year.

LAGUNA-LNBO progress

Wladyslaw Trzaska reported from the LAGUNA-LNBO kickoff meeting at CERN:

- Two main options have been identified by LL: LAr + LSc at Pyhäsalmi (1st Priority) or WC at Frejus (2nd Priority)
- Laguna-LNBO considers an incremental approach for the detector design
- There will be beneficial effects from snyergy if both detector concepts are realized in Pyhäsalmi at the same time
- A new nuclear power plant was decided to be built 130km from Pyhäsalmi, which will roughly double the reactor-neutrino background. However, the new reactor offers the opportunity for a precision measurement of Δm^2_{12}.

- **Overall timetable**

  - February 2012: next LENA meeting in Hamburg
  - March 2012: next LAGUNA meeting in Paris
  - 2013: European Strategy Update for Particle Physics
  - 2014: end of LAGUNA-LNBO
  - 2018: closing of the Pyhäsalmi mine

  LAGUNA in Pyhäsalmi should be part of the European Strategy Update for Particle Physics: The 1st option (LAr + LSc) should be fully investigated by then.

  Lab excavation in Pyhäsalmi should start (preferably be completed) before the mine closes down.

LENA representation in LAGUNA

- The presence of LSc in LL should be increased
- Caren Hagner agrees to stand as a candidate for the Chair of Institution Board
- Lothar Oberauer or Achim Stahl are considering to stand as candidates for the Chair of Technical Board

LENA Whitepaper

- whitepaper deadline: 30.11.2011
- The abstract will be extended. New abstract will include main physic goals. The sentence on "technical maturity" will be erased.
- Some words on calibration will be added based on work of Randolph Möllenberg.
- Part on geoneutrinos will be reviewed, because of revived discussions.
- Missing corrections: Proton decay (Michael Wurm), beam physics (Achim Stahl) and electronics.

Expression of Interest/Letter of Intent for design phase

- Basic idea is to write an abstract and attach the author list of the whitepaper. Michael Wurm will take care of the needed agreement.
- "LAGUNA" should be mentioned within the first lines.
- arguably, German groups should sign; for this, a deadline should be set.

LENA Detector Design - Status and tasks

Incremental approach

For physics reach and cost reduction, the majority of the attendees would prefer to go immediately to 50 kt for LSc. A 2×25 kt version is investigated to assess impact on physics program and costs. At this stage, an relative increase in price of about 15% for the 2×25 kt version is anticipated.

Design of the LENA tank

The outcome of an independent study of Rockplan suggests that the concrete tank should be investigated first. The correct dimensions will be sent to Guido Nuijten by Michael Wurm.

Scintillator(talk by Randolph Möllenberg

- Proton quenching in LAB is studied at the MLL in Garching.
- Wavelength-resolved scattering length still needs to be examined
- Monte Carlo study of Randolph Möllenberg: With LAB, there is a substantially greater capability to discriminate α/β events than with PXE, allowing for an event-by-event discrimination.
- Study of LAB samples from Helm AG in Munich
- Study of LAB from Kirishi Oil in St. Petersburg (Derbin)

PMTs (talk by Marc Tippmann)

- PMTs are favoured, but there are promising alternatives in development
- However: most alternatives are currently only (or not even) at a prototype stage
- The discussion on the potential of SiPMs is on-going
- Different encapsulation designs are tested by Marc Tippmann
- Monte Carlo simulation results reveal that the effective photoactive area increase is smaller than expected: 1.3 instead of 1.7 (for 50° opening angle)

Detector calibration

- Analysis at low-energies already started by Randolph Möllenberg.
- A strategy for high-energy calibration should be developed.

Electronics

- Input from Monte Carlo simulations on tracking is needed to define requirements on pulse shape recording (Dominikus Hellgartner, Sebastian Lorenz)
- Maybe input from SNO+

Top muon veto

- Options will be investigated by CUPP (Timo Enqvist) and the Hamburg group

Nylon vessel

- There are problems with the top/bottom PMTs
- Solution without vessel will be investigated as prioritized option (Monte Carlo studies from Randolph)

Monte Carlo and Analysis - Status and tasks

High Energy

Superbeams

- Priority: CERN-Pyhäsalmi baseline for LENA
- To assess LENA's physics reach, the investigation of complicated deep inelastic scattering vertices and NC background discrimination capabilities is necessary
- Furthermore, shorter baselines such as ESS2CUPP (Lund-Pyhäsalmi, ∼1,100 km) or a 1,500 km baseline from Russia will be explored
- Jian will look into LENA sensitivity for short baselines using results from Dominikus Hellgartner and Sebastian Lorenz.

HE event reconstruction (talks by Dominikus Hellgartner, Sebastian Lorenz)

- Next step: expand Dominikus Hellgartners code beyond 1 GeV and to multi-particle tracking. The fit structure is already present, but start parameters are needed.
- The MVA for π^0-discrimination by Sebastian Lorenz provides first promising results below 1 GeV. Next step: include realistic interaction vertices and extend the MVA for energies above 1 GeV. Furthermore, there will be attempts to perform a similar MVA to obtain the analysis for a number of particles.
- First results of backtracking by Dominikus Hellgartner look promising. Kai Loo will further develop this option. This could either result in an alternative tracking algorithm, or provide input parameters for Dominikus Hellgartners tracking.

Low Energy

SN (talk by Lukas Hoppenau)

- Elastic proton scattering will be implemented in SNOWGLOBES by Lukas Hoppenau
- The time-dependent neutrino rates during a supernova burst will be studied by Lukas Hoppenau
- Efficiency of supernova channel discrimination will be studied by Markus Kaiser. The results will be discussed with A. Mirizzi (Universität Hamburg) to evaluate what can be learned about neutrino parameters and with H.-T. Janka (MPA Garching) to evaluate supernova core collapse.

DSNB

- Randolph Möllenberg will study the NC atmospheric background (← MML data).

Oscillometry (talk by Yuri Novikov)

- Neutrino disappearance and re-appearance within LENA's detector length
- High sensitivity to sterile ν oscillations and CPT violations using ν and $\bar{\nu}$ sources.
- Great potential of quasi-mono-energetic $\bar{\nu}_e$-sources like ^{154}Eu with $Q = 1844\,\mathrm{keV}$, just above inverse beta decay threshold of 1804 keV.

Proton decay

- A new study of atmospheric backgrounds has been started at TUM. NC kaon production should be investigated.
- Beyond $p \to K^+\bar{\nu}$, several other channels should be studied:
  $p \to \pi^0 e^+$, $p \to K^0 e^+$ and $n - \bar{n}$ oscillation

π^+-Decay-At-Rest beams (DAEδALUS, talk by Michael Wurm)

- Investigation of $\bar{\nu}_\mu \to \bar{\nu}_e$ at low energies is complementary to superbeams
- Great sensitivity to the CP-violating phase
- Expected event rates for LENA will be calculated by Jian Tang
- The background by NC atmospheric events will be checked by Randolph Möllenberg

Monte Carlo (talk by Randolph Möllenberg)

- Structure of the simulation chain:
  - Vertices for HE neutrino interactions ($E_\nu > 50\,\mathrm{MeV}$) created by GENIE
  - Final-state particles tracked with the GEANT4-based detector simulation
  - Scintillation light produced and propagated to PMTs in GEANT4
  - PMT hit patterns as input for an electronics simulation (under development)
- The Monte Carlo code and a documentation for starters will soon be made available on the online repository.
- Missing input for the detector simulation has to be collected (scintillator etc.)
- Standard output of simulation will include: energy, position, start time, pulse shape and Monte Carlo truth
- Event samples will be created and made accessible online
- Complex event generators for SN, solar and geoneutrinos will be developed