

HIBEAM

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HIBEAM

Baryon number violation is expected and interesting!

- Accidental symmetry of SM at perturbative level
- BNV in SM (non-perturbative EW sphaleron processes).
- BNV in SM extensions, eg SUSY.
- Necessary for baryogenesis.
- Symbiosis with neutrino sector (eg $0\nu 2\beta$ for neutrino mass)

Very hard to find sensitive observables in which BNV is the only hitherto conserved quantity to be violated (eg p decay requires lepton number to be violated).

HIBEAM (High intensity Baryon Extraction and Measurement) to search for:

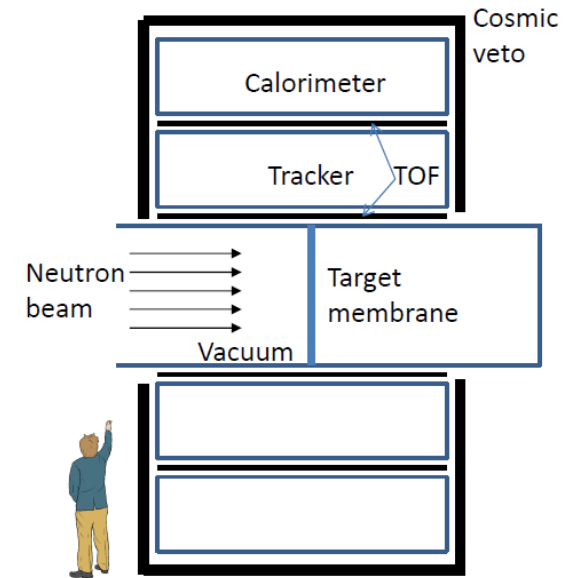
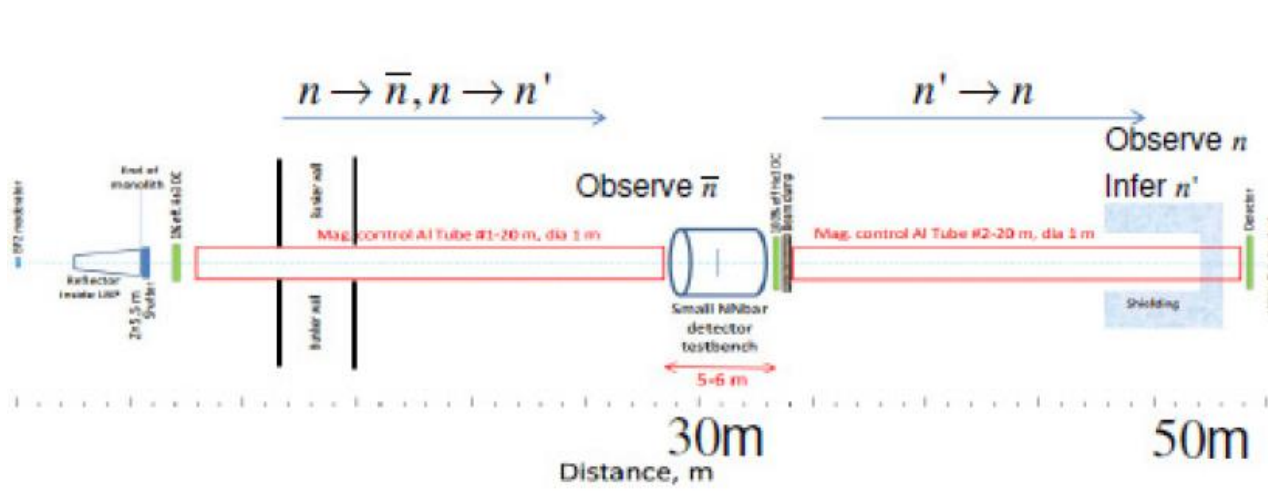
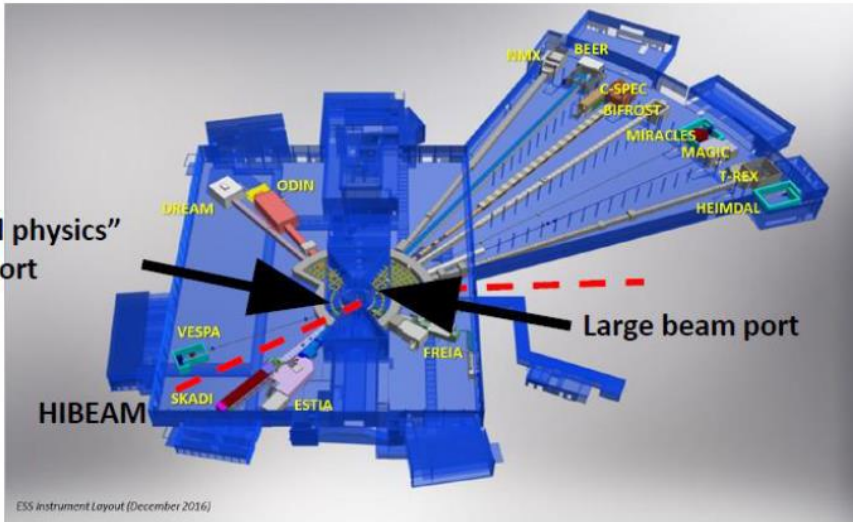
$$n \rightarrow \bar{n} \quad (\Delta B = 2) \quad ; \quad n \rightarrow n' \quad (\Delta B = 1) \quad \text{at the ESS.}$$

$n' \equiv$ mirror neutron in a dark sector which can also account for DM

HIBEAM first stage in experiment to gain sensitivity increase of 10^3 in BNV conversion probability and reach from TeV-GUT scale in NP sensitivity.

The European Spallation Source and HIBEAM

“fundamental physics”
beam port



The proposed program

Stage 1

HIBEAM - high intensity baryon extraction and measurement

Early to late 2020s

- Match or improve sensitivity to $P(n \rightarrow \bar{n})$ wrt previous search at ILL
- Search for mirror neutrons (regeneration)
- R&D for full experiment (*NNBAR*)

Stage 2

NNBAR experiment

Late 2020's + 5 years

- Improve sensitivity to $P(n \rightarrow \bar{n})$ by $\sim 10^3$
- Further mirror neutron searches

HIBEAM/nnbar and ESS

HIBEAM/nnbar

Six workshops (CERN, Lund, Gothenburg, Copenhagen)
Expression of Interest 2015.

26 institutes, 8 countries.

Co-spokespersons: G. Broojimans, D. Milstead

Lead scientist: Y. Kamyshkov

Sweden: SU,UU,LU,Chalmers

ESS

No fundamental physics instrument from first call

Wish from ESS management for fundamental physics –
new call 2018

Plan to submit a joint proposal with ANNI collaboration
in 2018.

Successful application → 10-14 Meuros.



Neutron-Anti-Neutron Oscillations at ESS
Lund, Feb 18-19, 2015

Recent particle physics have proven to be extremely sensitive probes of fundamental physics. Rare oscillations predicted to arise via first flight into \bar{n} particles, first in neutrinos provided the first indication that the equipment is extremely heavy. It is believed that the observed fields provide the theoretical basis of \bar{n} particles and various conditions suggest the existence of a new, important energy scale well below the GUT scale. Neutrino oscillation experiments could offer a comprehensive picture of the neutrino sector.

The construction of the ESS (European Spallation Source) with ESS beam expected in 2015 together with modern neutron capture techniques, offers an opportunity to conduct an experiment with at least three orders of magnitude improvement in sensitivity to the neutrino oscillation probability.

After conducting the physics case for such an experiment with the ESS beam, together with the main experimental challenges and possibilities, we hope to establish an international collaboration to design, build and perform a collaboration to build and perform the experiment.

Organizing committee:

- 1. Anders Brannstrom
- 2. Christoffer Lundberg
- 3. Erik Lindner
- 4. Gennady Grib
- 5. Gennady Grib
- 6. Gennady Grib
- 7. Gennady Grib
- 8. Gennady Grib
- 9. Gennady Grib
- 10. Gennady Grib

Register online
at www.ess.eu

2013 Strategy Update

h) Experiments studying quark flavour physics, investigating dipole moments, searching for charged-lepton flavour violation and performing other precision measurements at lower energies, such as those with neutrons, muons and antiprotons, may give access to higher energy scales than direct particle production or put fundamental symmetries to the test. They can be based in national laboratories, with a moderate cost and smaller collaborations. *Experiments in Europe with unique reach should be supported, as well as participation in experiments in other regions of the world.*

Existing strategy statement is almost fine.

- Is ESS a “national” laboratory ?
- HIBEAM is a search and not a precision measurement. Dipole moments are also more of a search than a measurement. “Investigating” isn’t the right word.