Suggested topics for oral presentations

- Discovery of the neutrino: the Reines-Cowan experiment
- Helicity of the neutrino: The Goldhaber-Grodzins-Sunyar experiment (see sample presentation plan and bibliography below)
- The mass of the neutrinos[1]
- Neutrino oscillations
- The story of the transuranic elements
- Your own research project related to nuclear physics
- Natural nuclear reactors (Oklo)
- Fun things to do with ultra-cold neutrons (bottles, etc.)
- Superthermal process of UCN production
- Electric dipole moment (EDM) of the neutron
- How Chadwick discovered the neutron

Sample presentation plan and bibliography:
The Goldhaber-Grodzins-Sunyar experiment

- Basic idea of the experiment: find a situation where the helicity of ν is the same as that of a γ-ray. The latter can be measured. Why use resonance scattering?
- Properties of $_{63}Eu^{152m}$ and its decay chain. What is a nuclear isomer? Why was this nuclide chosen?
- The energy of the J=1 excited state of the ^{152}Sm nucleus is 960 keV. Taking into account the recoil effect, what should be the energy of the γ to resonantly excite the nuclear transition from the ground state?
- The excited state of the $_{62}Sm^{152}$ nucleus (1^-) decays by γ-ray emission with a lifetime $\approx 3 \cdot 10^{-14}$ sec. The γ-ray energy is ~ 1 MeV. Explain, why even in a solid source, most of γ-ray emission takes place before the momentum of the recoil nucleus has changed appreciably.
- The radioactive source intensity was ~ 100 mCi (milliCurie). How many decays/sec is that? Using the fact that the weight of the source was 10 mg, estimate which fraction of Eu nuclei in the sample was activated (the half-life of $_{63}Eu^{152m}$ is $\approx$9 h).
- Measurement of gamma ray polarization with polarized iron. Explain why the gamma ray absorption cross-section depends on relative orientations of electron spin and the circular polarization of γ. Why is this not a 100% effect (in the experiment of Goldhaber et al the gammas traveled about 3 absorption lengths in fully polarized iron and the asymmetry was only ~ 2 %)?

[1] See, e.g., H.V. Klapdor-Kleingrothaus and A. Staudt, **Non-accelerator particle physics**, Bristol ; Philadelphia : Institute of Physics Pub., 1995 or 1998. UCB Physics QC793.412 .K53.

1. R. N. Cahn and G. Goldhaber. *The experimental foundations of particle physics*. Cambridge University Press, 1989, chapter 6 (weak interactions)., pp.162-163; 180-182.
2. C. S. Wu and S. A. Moszkowski. *Beta decay*. Interscience, 1966., chapter 4-6.
3. D. H. Perkins. *Introduction to High-Energy Physics*. Addison-Wesley, 1982, chapter 6.5.2.