CENNS - ERC and Ricochet:
Probing new physics with Coherent Elastic Neutrino-Nucleus Scattering and the future Ricochet experiment

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CENNS: *The process*

**Coherent Elastic Neutrino-Nucleus Scattering (CENNS)**

- Predicted in 1974, only recently detected (COHERENT collaboration, *Science 2017*)
- The cross section scales as $A^2$ but produces *sub-keV* nuclear recoils
- Largely dominating cross section $<10$ MeV neutrinos: *from ton-scale experiments to kg-scale ones!*
- A new probe for physics beyond SM?: *calls for low-energy and high precision measurement*
CENNS: *searching for new physics*

**Recoil energy distribution**

- Event rate [evts/kg/keV/day]
- Recoil energy distribution
- $\nu$-flux: $10^{12}$/cm$^2$/s
- $\mu_\nu = 10^{-10} \mu_B$
- 1 MeV $Z'$
- Standard Model

**New physics signatures (massive mediators, anomalously large NMM, Non Standard Interactions, ...)** will arise at the lowest energies

**Calls for very low-energy thresholds:** $O(10)$ eV
CENNS: *searching for new physics*

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**Recoil energy distribution**

- **Event rate [evts/kg/keV/day]**
- **Recoil energy [keV]**

- 0(10) eV threshold should not be a problem with 30g Ge EDW-like detector

- 55 eV demonstrated on a 32 g Ge EDELWEISS detector
  - D. Misiak et al, Edelweiss R&D paper in preparation

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**O(10) eV threshold should not be a problem with 30g Ge EDW-like detector**
CENNS: *searching for new physics*

*What about background?*

Expect to be overwhelmed by the backgrounds

*Calls for particle identification to reach background rejection of $\sim 10^2 - 10^3$*

*Detector R&D will focus on this point*
The CENNS - ERC will be funding the CryoCube
1kg of cryogenic Ge and Zn detectors with $O(10)$ eV threshold and $10^3$ rejection

RICOCHET is actively looking for new collaborators
CENNS - ERC / Ricochet: *Timeline*

**CENNS - ERC Research Program**
Principal Investigator: J. Billard (IPNL)

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<td><strong>Single crystal detector design</strong></td>
<td><strong>Scalability</strong></td>
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<td>‘reaching $O(10)$ eV energy threshold with $10^3$ particle identification’</td>
<td>‘From a single 30 g detector to a kg-scale detector array - CRYOCUBE’</td>
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**RICOCHET experiment**
International Collaboration: CNRS, MIT, NU, WU, ++ ?
IN2P3 master project (IPNL, CSNSM, ++ ?)
IN2P3 Scientific coordinator: J. Billard (IPNL)
Local coordinators: S. Marnieros (CSNSM) and J. Billard (IPNL)
Technical coordinator: A. Juillard (IPNL)

- Finalizing design
- Ricochet installation
- Science data

*RICOCHET will be writing a CDR in the coming year*
- To be presented in a IN2P3 CS or Project Review end of 2019
- Help and funding expected from IN2P3 will be detailed
Ricochet: *Nuclear site prospection*

- The Ricochet collaboration is actively looking for its optimal nuclear reactor site with *large signal* and *reasonable overburden* in France and abroad (*decision: end-2019*).
- We have performed in depth studies at MITR (*JINST 2018*) and Double Chooz (*J. Phys. G. 2017*).

**RED20**: 55 eV energy threshold, moderate lead shield (10 cm thick, 70% coverage) and *no discrimination*.

**Event rate [evts/kg/keV/day]**

**Strong source** (Brokdorf) 2.4x10^{13} nu/cm^2/s

**Moderate source** (DC @ 80 m) 1.2x10^{12} nu/cm^2/s

**Weak source** (DC @ 400 m) 5x10^{10} nu/cm^2/s
Conclusion

Since its first detection by the COHERENT collaboration in July 2017, CENNS has become a burgeoning field of research: intense competition expected!

CENNS - ERC is dedicated to develop the next generation cryogenic detector to perform a low-energy percentage-level precision CENNS measurement (CRYOCUBE) and deliver science by 2024 after integration in Ricochet cryostat by 2022.

Key features of the CRYOCUBE are low threshold AND discrimination.

Ricochet is a growing international collaboration dedicated at building the first low-energy neutrino observatory. Site decision by end-2019.

It is an R&D oriented IN2P3 master project (to be upgraded to a regular master project?) with two labs: CSNSM and IPNL, looking for more collaborators.

Ricochet is working on a CDR to be delivered to the institutions by end-2019 to seek fundings and resources for its deployment at an optimal reactor to be ready to host the CRYOCUBE by 2022.

Kick-off meeting will be organized by the French members of RICOCHET in the beginning of 2019.