

SuperNEMO  
Demonstrator and  
NEMO-3 in the  
ENIGMASS context

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# The neutrino-less double beta decay

$2\nu\beta\beta$  decay:  $(A, Z) \rightarrow (A, Z + 2) + 2e^- + 2\bar{\nu}_e$

- 2nd order process **allowed** in the SM
- Single  $\beta$  decay forbidden (energy & angular momentum)

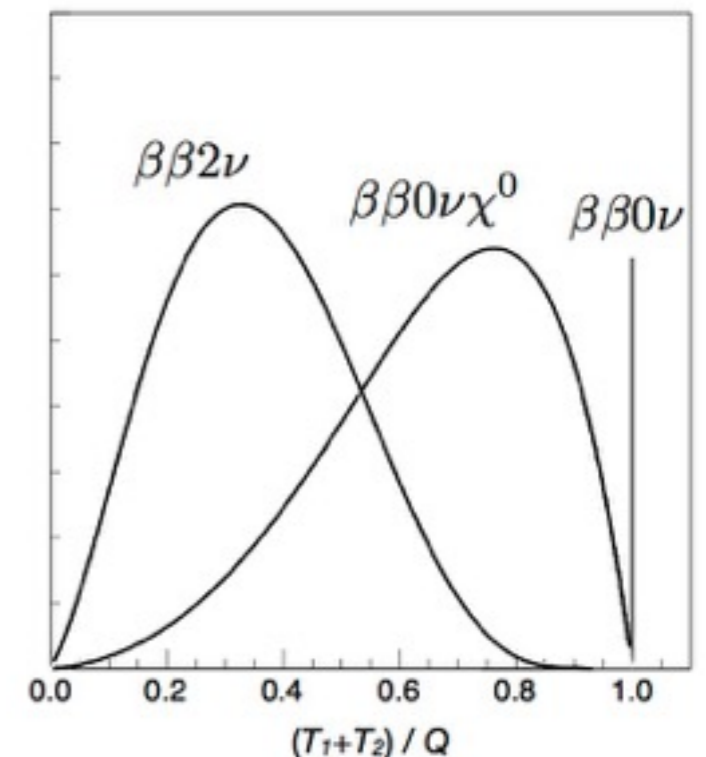
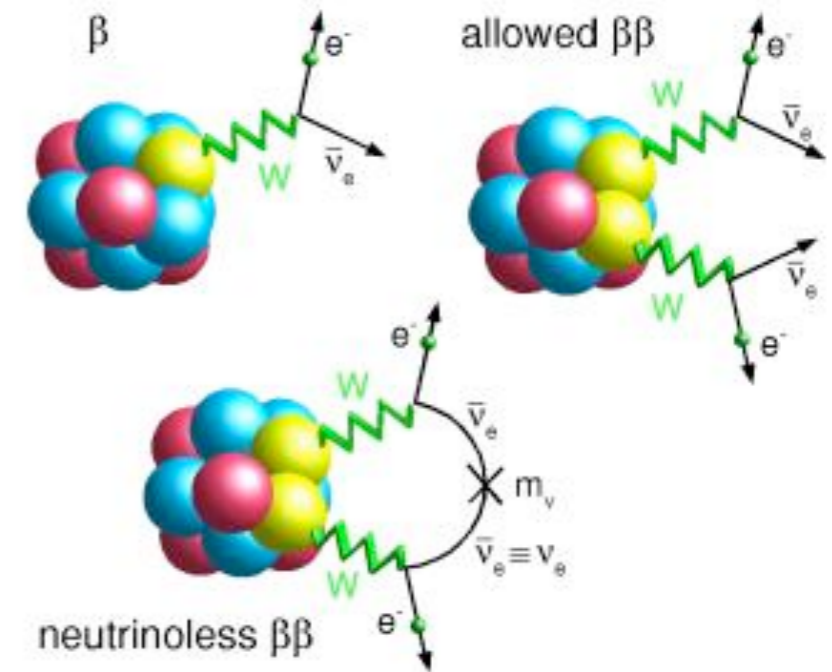
$0\nu\beta\beta$  decay:  $(A, Z) \rightarrow (A, Z + 2) + 2e^-$

- process **forbidden** in the SM

$$(T_{1/2}^{0\nu})^{-1} = G_{0\nu}(Q_{\beta\beta}, Z) |M_{0\nu}|^2 \eta^2$$

- Light Majorana neutrino exchange
- Right-handed current (V+A), SUSY, 1 Majoron, etc.

Different event topology in the final state



# SuperNEMO: the demonstrator module

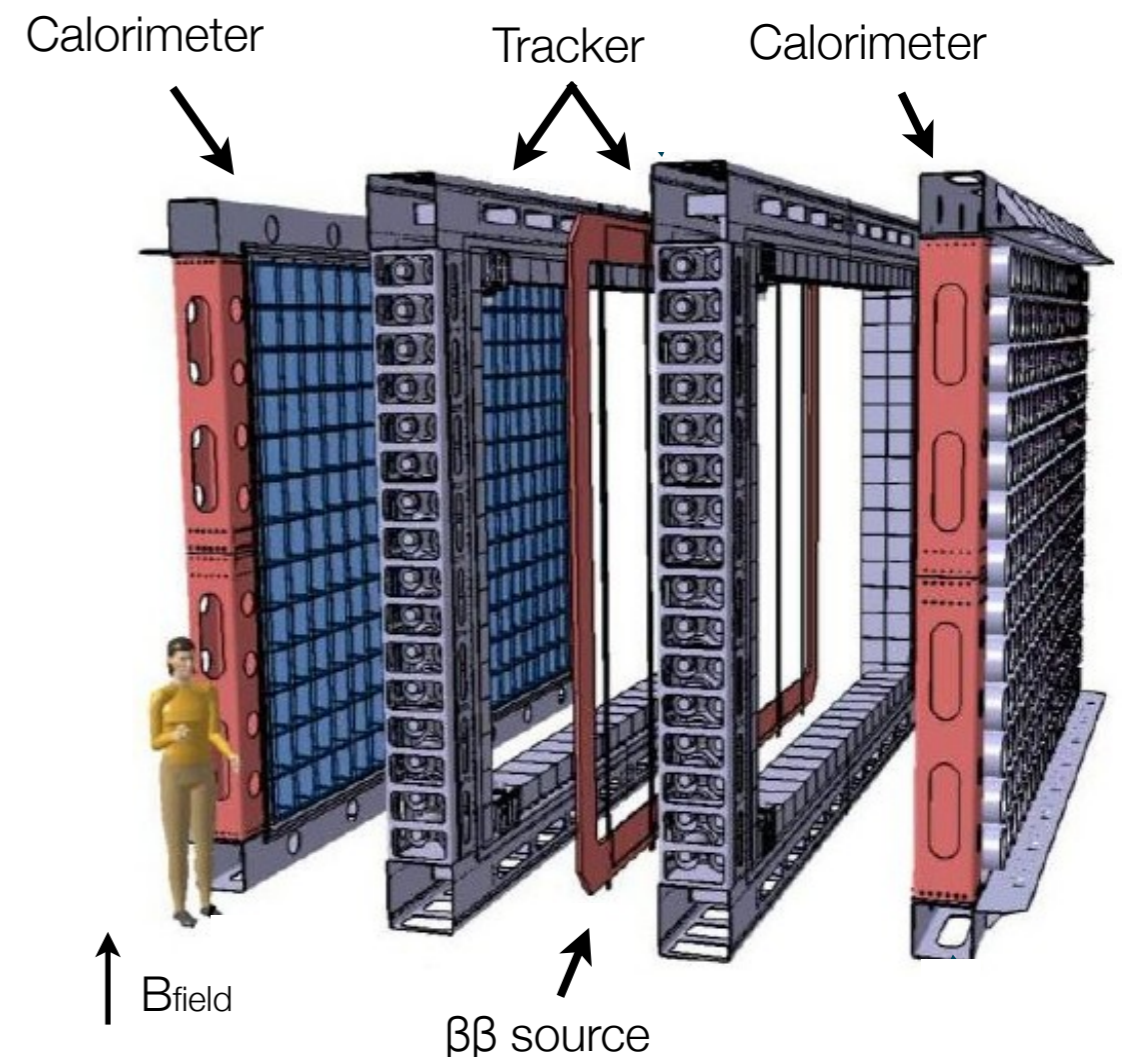
Extrapolate a well known technique (NEMO-3)

One SuperNEMO module  $\rightarrow$  7 kg  $^{82}\text{Se}$  running  $\sim 2.5$  y

- To be installed @ LSM (replacing NEMO-3)

Match SuperNEMO requirements

- Background level  $\sim 10^{-4}$  cts./(keV kg y)
- Background free at high energy ( $^{150}\text{Nd}$ )
- Sensitivity:
  - $\langle m_\nu \rangle \sim 0.20 - 0.40$  eV
  - $\sim 1.5$  better than NEMO-3



# Demonstrator status

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- The detector integration proceeds well:
  - 2 calorimeters ready!
  - half-tracker ready, the second half is being integrated!
  - Source foils installation in March!
  - Shielding, magnetic coil, anti-radon facility and electronics should be installed by the summer
- The detector should be commissioned during the summer
- Physics run should start by the end of 2017



# Contribution from the labex (2014)

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Technical activities  
LAPP/LSM

- R&D and production of  $^{82}\text{Se}$  foil source
  - Development of the Control & Monitoring System
  - Chemical Se purification in collaboration with JINR (Dubna)
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Physics studies

- Simulation/Sensitivity studies
  - NEMO-3 Data analysis
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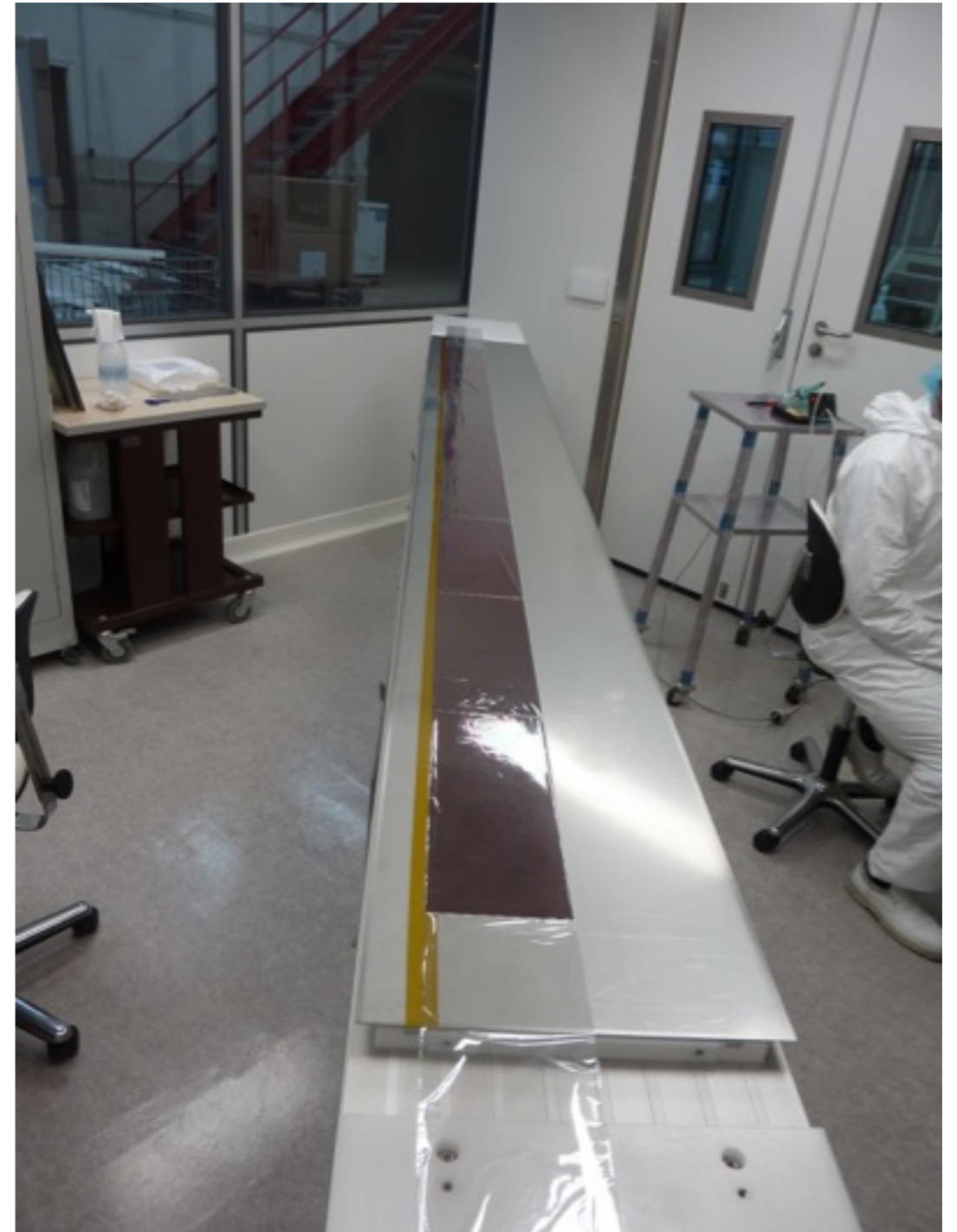
The next step

- Detector installation + commissioning + running
- ~~Physics data analysis~~

# Source foil production

A. Remoto, D. Duchesneau, J.M. Dubois, A. Jeremie, T. Le Noblet

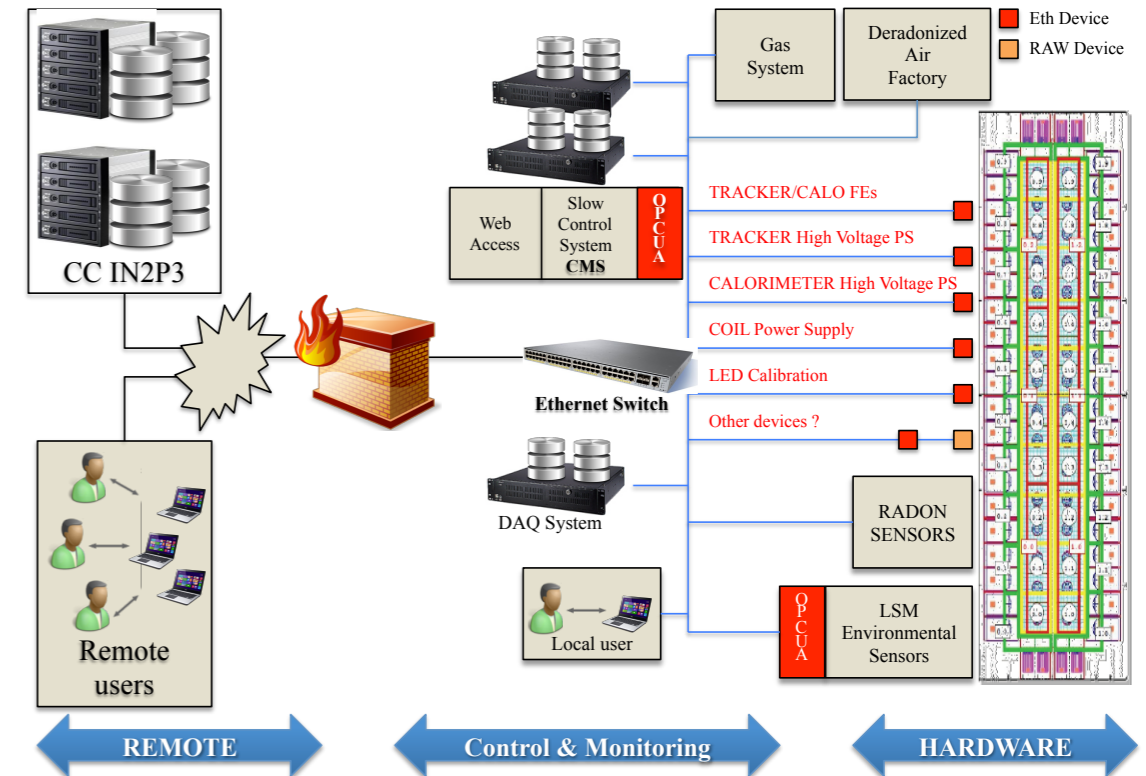
- 2 years R&D allowed to improve the design of the source foil and **reduce the expected radioactivity budget**
- ~5 kg of purified Se-82 are being handled at LAPP to produce 23 foils
- The source foil production is ongoing right now: **a visit of the installation is possible**
- 4 foils will be installed next week in **BiPo for the final radio-purity measurement**
- All foils will be installed in the detector in March



# Control and Monitoring System

E. Chabanne, D. Duchesneau, T. Le Flour, S. Lieunard, J.L. Panazol

- **Control/monitor** environmental parameters, detector subsystems (local & remote)
- Operate **heterogeneous** devices
- Technical choice common with CTA project
- Take advantage of **existing experience**
- Status:



- Half of **subsystems controlled** by Control & Monitoring System. **Ongoing integration** for the second half
- DAQ + Front End Control Board + CMS: **communication validated**
- Run Control Software upper layers interface: **ongoing specification and design**

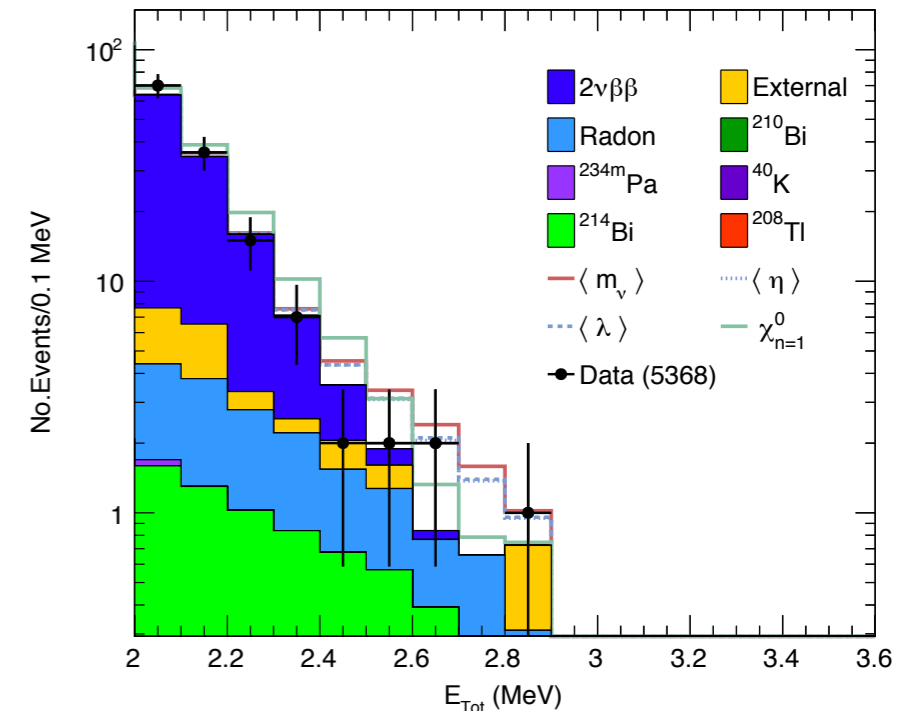
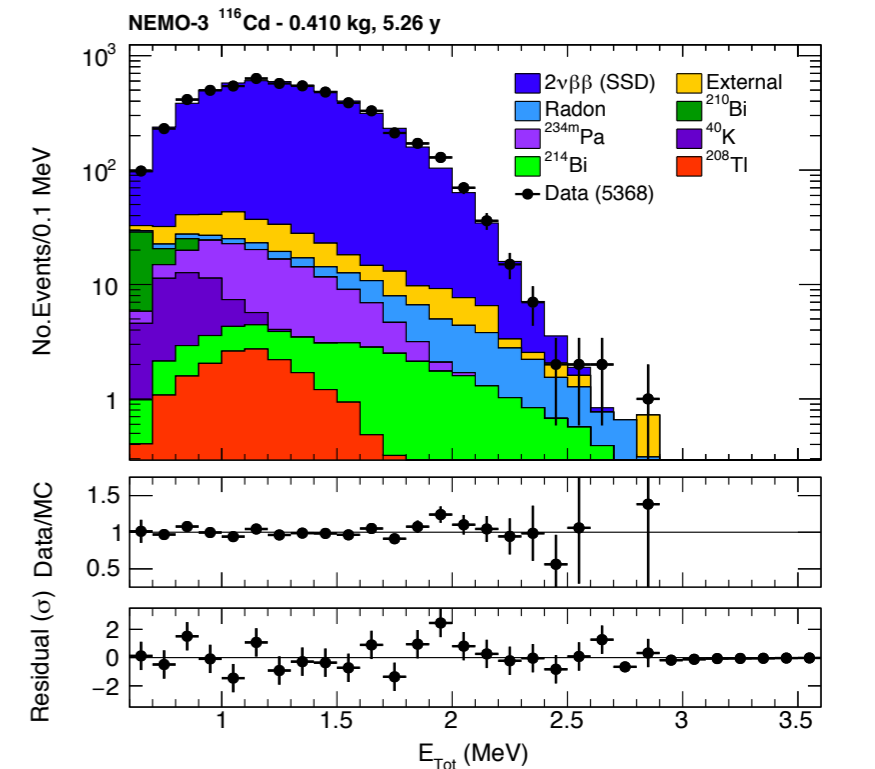
# Double beta decay of Cd-116 with NEMO-3

- Final measurement of  $2\nu\beta\beta$  half-life and search for  $0\nu\beta\beta$  decay process of  $^{116}\text{Cd}$ :

$$T^{2\nu}_{1/2} = [2.74 \pm 0.04(\text{stat.}) \pm 0.18(\text{syst.})] \times 10^{19} \text{ y}$$

$$T^{0\nu}_{1/2} \geq 1.0 \times 10^{23} \text{ y @ 90\% C.L. } \langle m_\nu \rangle \leq 1.4\text{--}2.5 \text{ eV}$$

- **aXiv:1610.03226, Under review by PRD**
- Limits competitive with the best limits set for  $^{116}\text{Cd}$ .
- Excited state analysis ongoing (Ph.D. at LAPP)





# Publications and conferences since 2013

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- Conferences:
  - 3 Talks @ NOW 2014 (Otranto), NeuTel 2015 (Venezia), EPS 2015 (Wien)
  - 4 Poster @ Nu2014 (Boston), 2 x Nu2016 (London), 2 x ICHEP 2016 (Chicago)
- Papers:
  - Phys.Rev. D89 (2014) no.11, 111101
  - Nucl.Phys. A925 (2014) 25-36
  - Phys.Rev. D92 (2015) no.7, 072011
  - **Phys.Rev. D93 (2016) no.11, 112008**
  - **Phys. Rev. D 94, 072003 (2016)**
  - **ArXiv:1610.03226, Under review by PRD**
- K. Lang U. Texas (MINOS+ spokesperson, chair of the SuperNEMO source foil package) in sabbatical year @ LAPP from July 2014 to September 2015

# Conclusions

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- The foil **production is expected to finish** in March 2017, foil installation will start shortly after
- Commissioning and start of data-taking are expected in 2017
- LAPP technical **activities should end in 2017**
- Scientific activity will most likely end in 2017 due to **lack of manpower**
  - My contract will finish in March 2017
  - Ph.D thesis currently ongoing will finish in October 2017