

5th France China Particle Physics Laboratory Workshop

March 2012, 21-23 - Orsay-Saclay

Jointly organised by Irfu (CEA) and LAL (CNRS-IN2P3)

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Achille (LAL, chair)

Physics in Underground Laboratories Dark Matter / Neutrinos

G Gerbier IRFU-CEA
& slides from Hue Qian (THU)

CHEN Gang (IHEP)
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Underground Labs

Current programs

Status of FCPPL 011 activities

Projects for 2012 : News

CAI JIL CONU

CAO Zhen, IHEP

CHEN Hesheng, BEPC, Co-chair

JIN Shan, IHEP

WANG Qing, THU

WANG Yifang, IHEP

QIAO Zhenshan, MSTC

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5th workshop of FCPPL
LAL-IRFU Saclay
22nd march 2012

2012 AST-CJPL-LSM: DM

Members	French Group			Chinese Group		
	Name	Title	Affiliation (institute)	Name	Title	Affiliation (institute)
	Leader: Gerbier Gilles	Dr	CEA/IRFU	Leader: YUE Qian	Dr	THU (Tsinghua U.)
	Giomataris Iannis DastGheibiFard Ali Michel Gros Patrick Magnier	Dr Student Ing. Tech.	CEA/IRFU	SHANG Rencheng LI Yulan FENG Hua LI Jianfeng	Pr/Dr	THU
	Navick Xavier-Francois Armengaud Eric	Dr	CEA/IRFU	ZENG Zhi MA Hao	Dr	THU
	Piquemal Fabrice	Dr	LSM/IN2P3	WU Yucheng GU Lanmu	Student	THU
	Loaiza Pia Guillaume Warot	Dr	LSM/IN2P3	YANG Changgen	Dr	IHEP
	Tao Charling Busto Jose	Pr/Dr Dr	CPPM/IN2P3	MA Yuqian SUN Xilei YU Boxiang ZHANG Aiwu CHEN Yong WANG Ping XIE Yigang LY Junguang QI Huirong WANG Zhimin DAI Changjiang MA Xinhua GUAN Meng yun	Pr/Dr	IHEP
	Marquet Christine	Dr	CENBG/IN2P3	NI Kaixuan	Pr/Dr	SJTU
	Simard Laurent	Dr	LAL/IN2P3	WANG Xiaolian ZHANG Zhiyong ZHOU Yi	Pr/Dr	USTC
	Gascon Jules	Pr	IPNL/IN2P3	ZHANG Guanghua	Student	SCU (Sichuan U.)
	Santos Daniel	Dr	LPSC/IN2P3			

3rd year

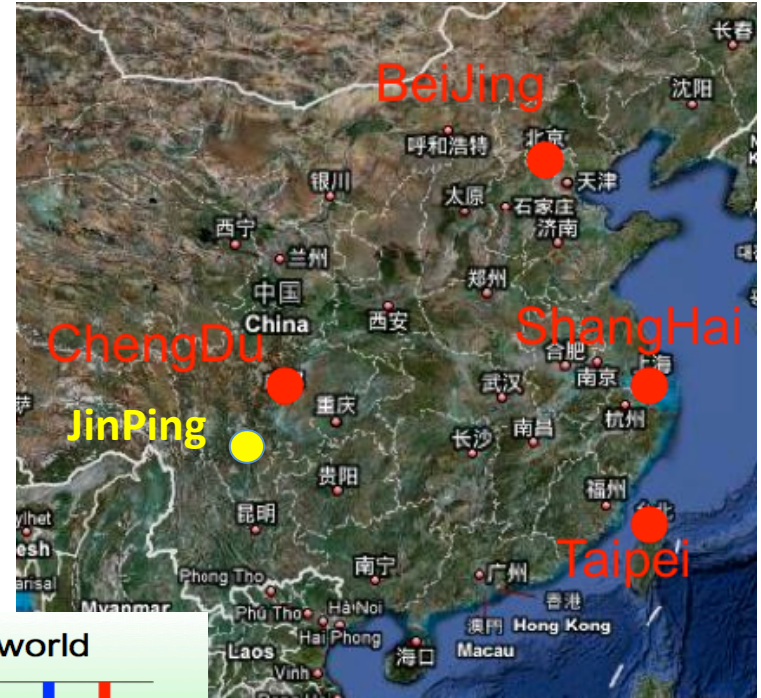
2011 budget :
6 k€ * 2

Two underground labs

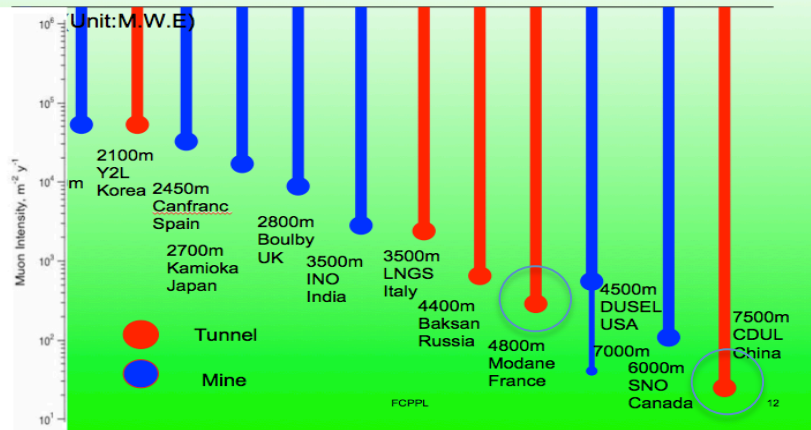
- LSM-Fréjus 1983



- CJPL-Jinping 2010

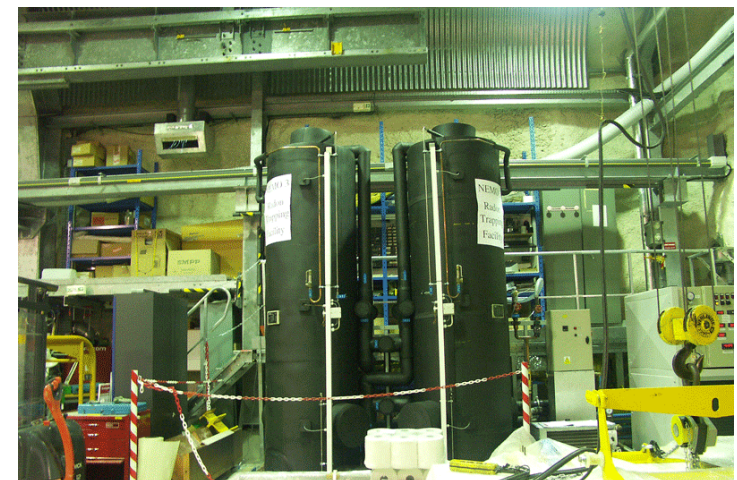
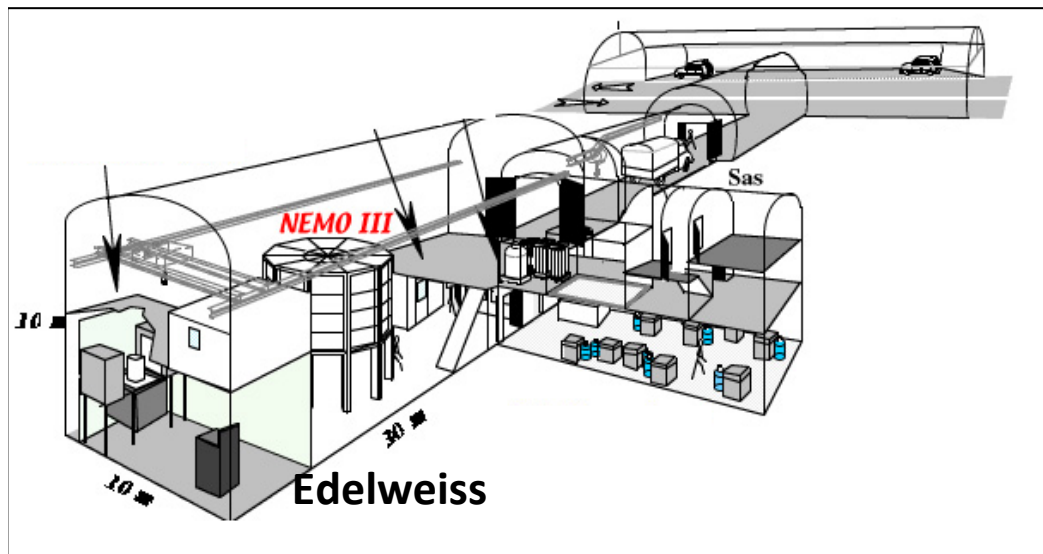


Comparison of main ULs in the world



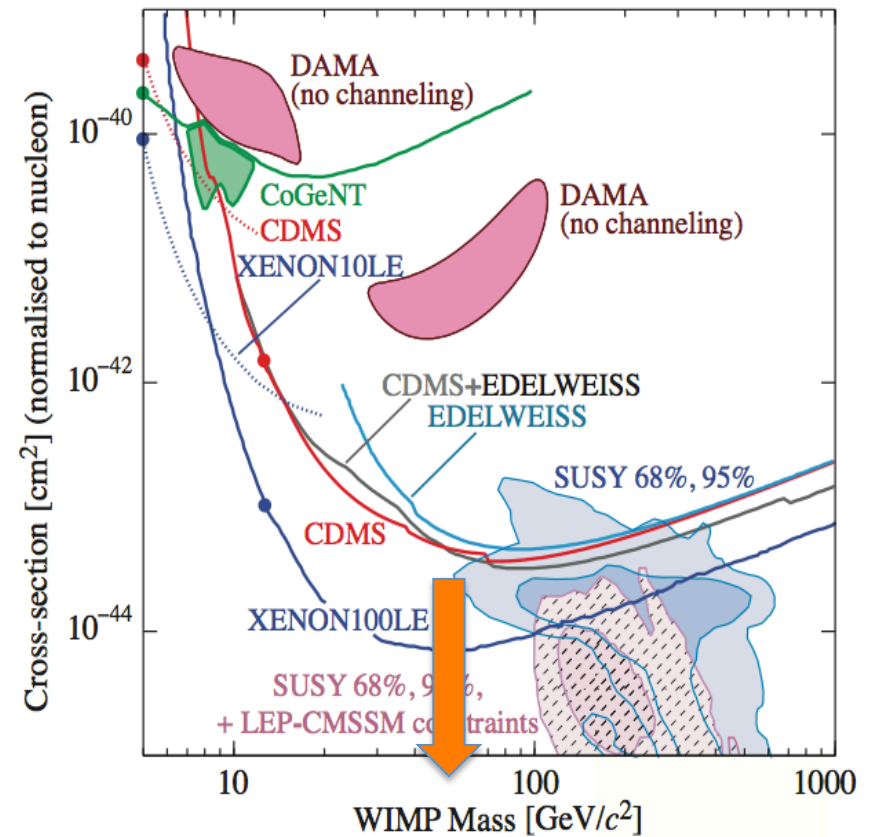
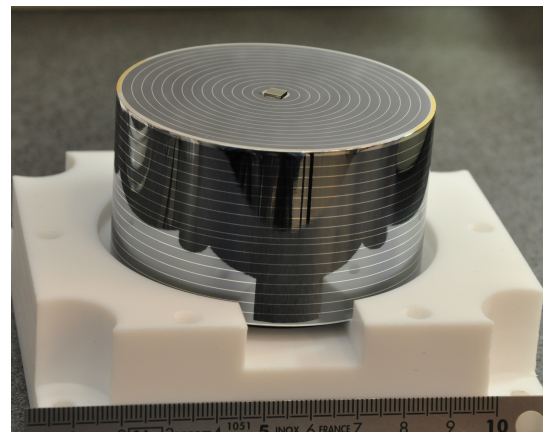
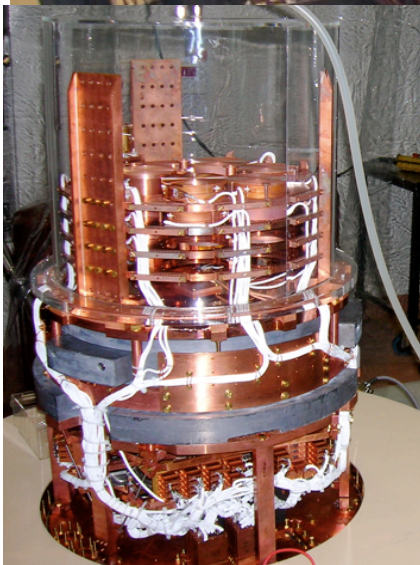
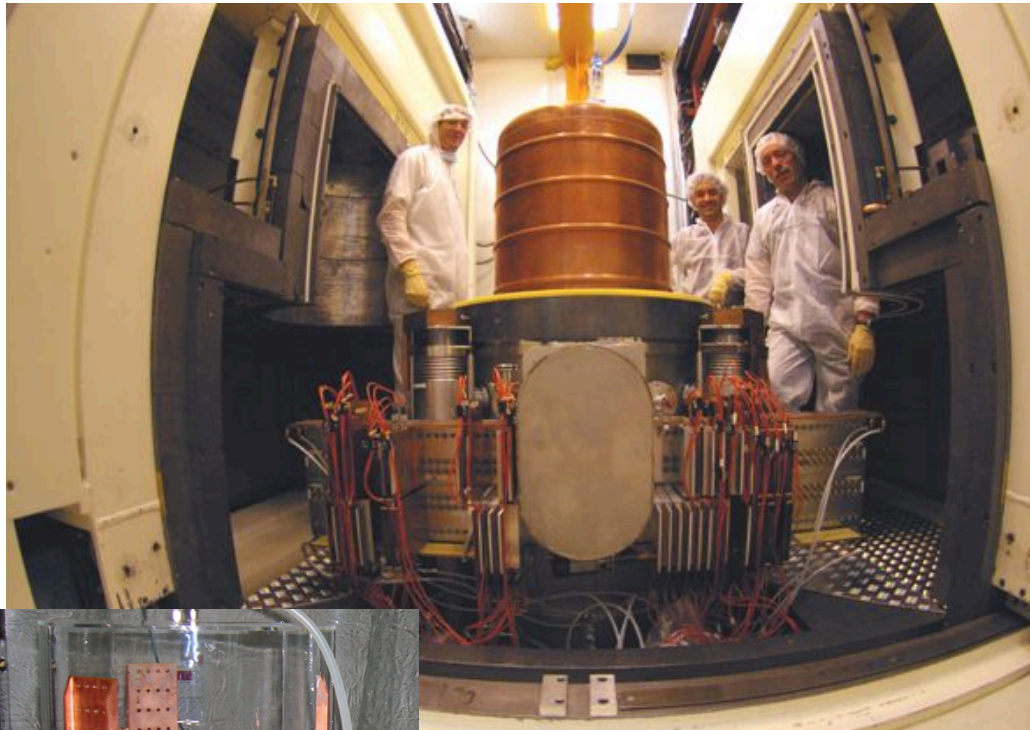
Main actual programs @ LSM

- EDELWEISS III : dark matter search : Ge @ 10 mK
- TGV : double electron capture
- **Spherical gaseous detectors (low activity prototype “SEDINE”)**
- Low background facilities & low level monitors
 - Gamma ray spectroscopy : 12 HPGe
 - Radon trapping facility
 - Neutron (10^{-6} n/cm²/s) & radon (mBq/m³) monitors



150 m³/h air w 15 mBq/m³ Rn (standard 15 Bq/m³)

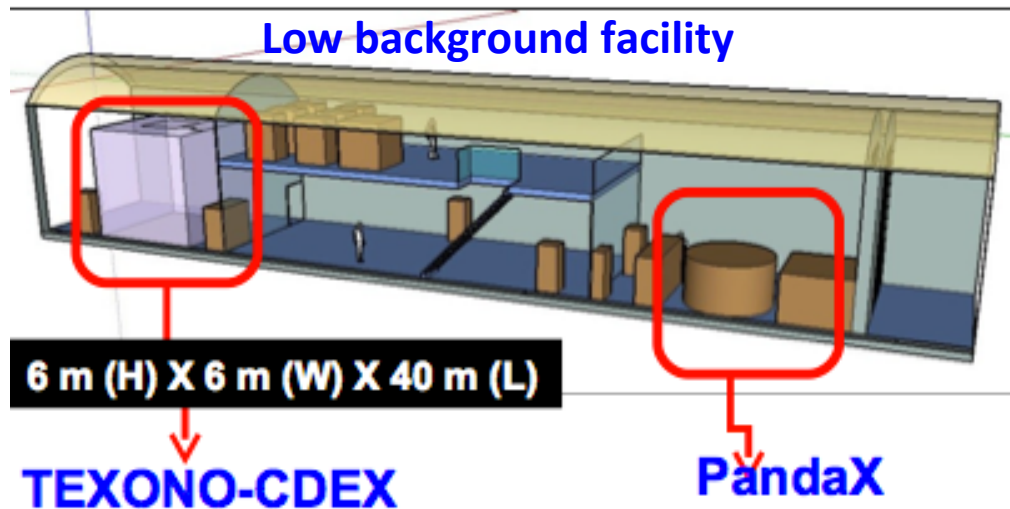
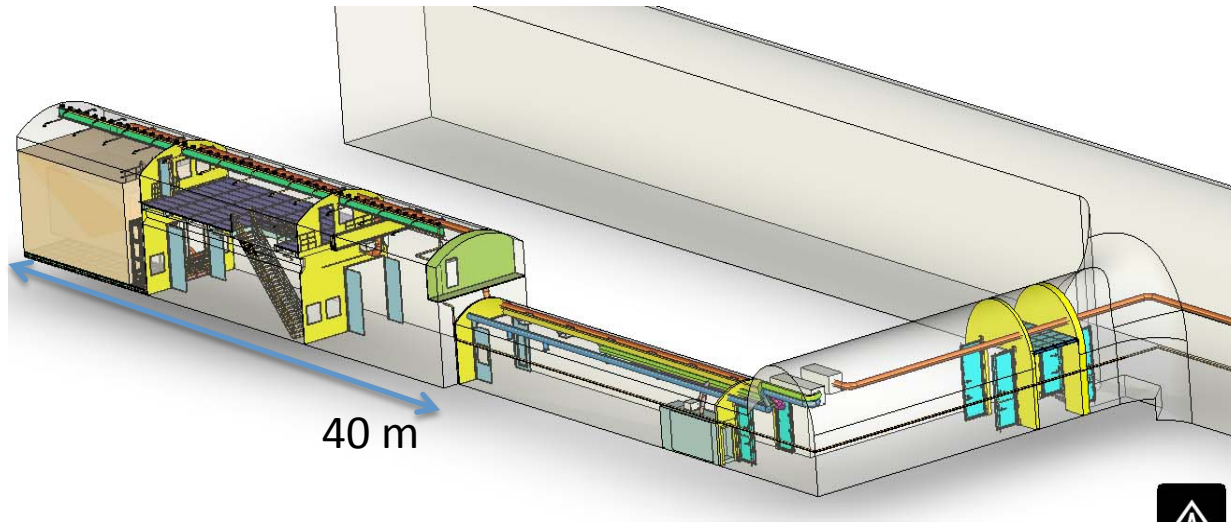
DM search: EDELWEISS



2011 : 10 ID 400 g detectors
 Combined with CDMS=>2nd after Xenon

2013 : 40 FID 800 g detectors
 NB : bckg rate 1 evt/100kg.d

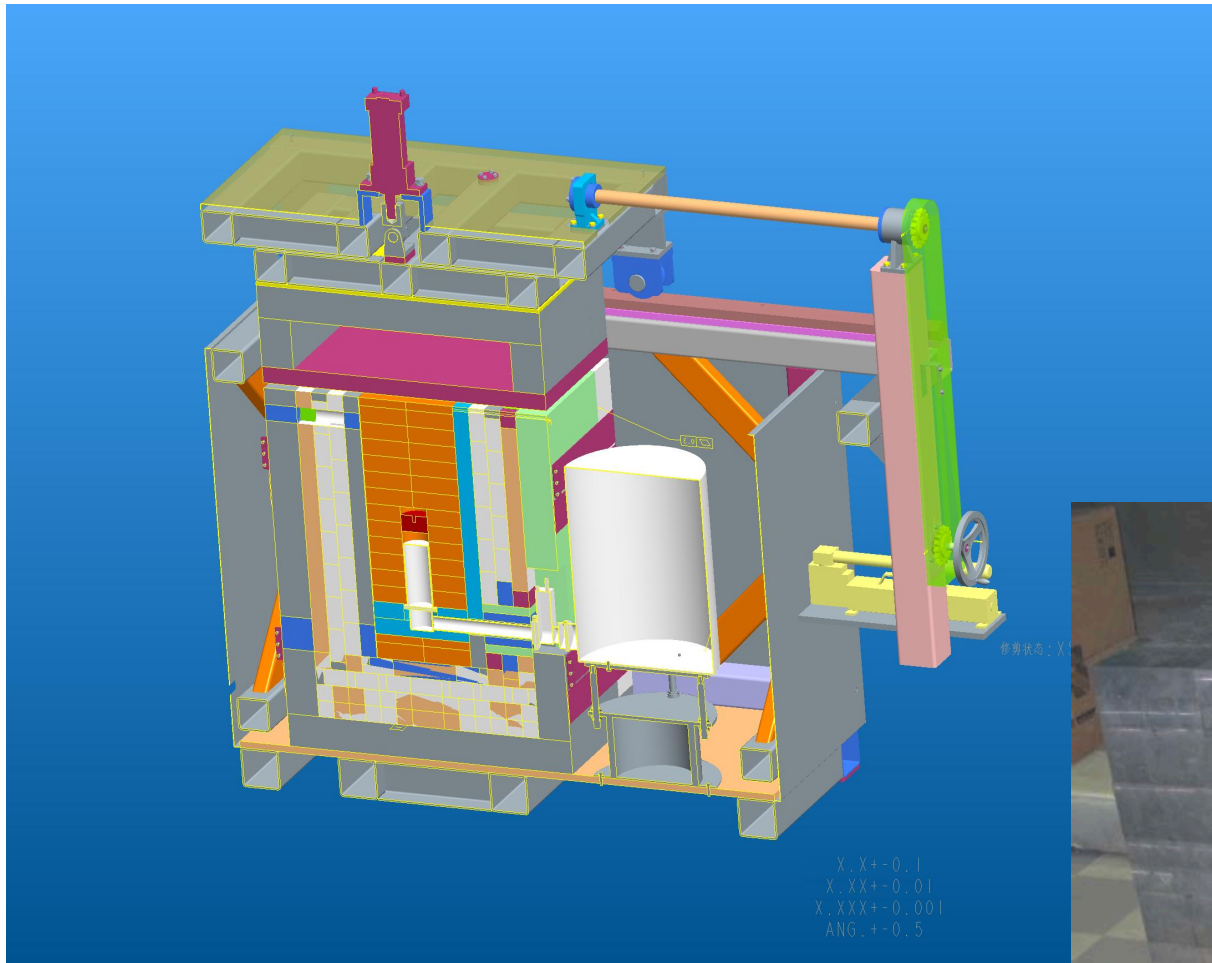
JinPing CJPL : status



2012 : New ventilation installation completed : The fresh air outside has started to supply CJPL.

2012 : Two expts planned : Ge & Xe

The first ULB facility has been installed in CJPL and is under test.



CJPL thermal neutron detection system developed by our group has started to take data in CJPL. The tube has been changed from usually stainless steel tube to OFHC copper tube in order to reduce the background.

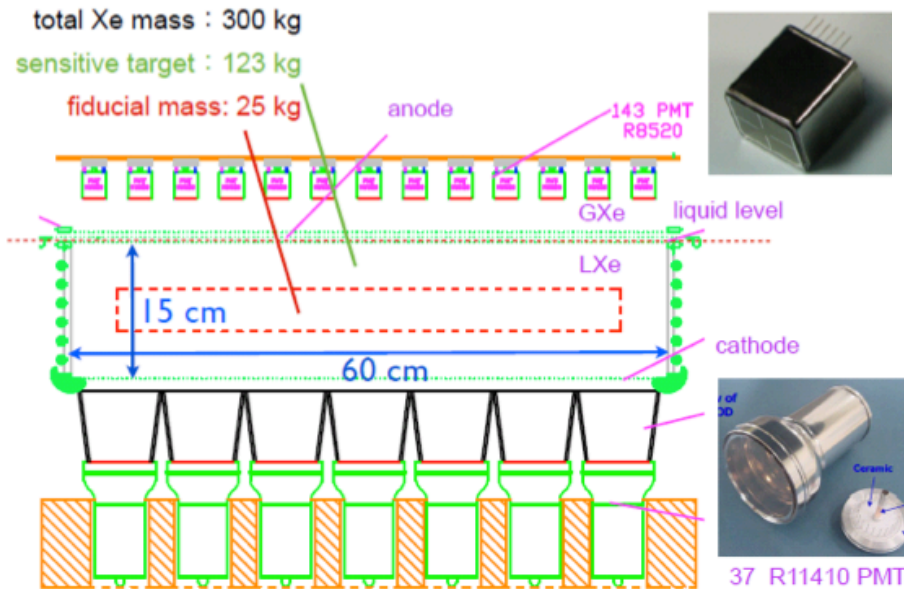


^3He counter



PANDA X

Liquid Xenon



PandaX Stage Ia:

- light yield: 4 -5 pe/keV_{ee} (w/ field)

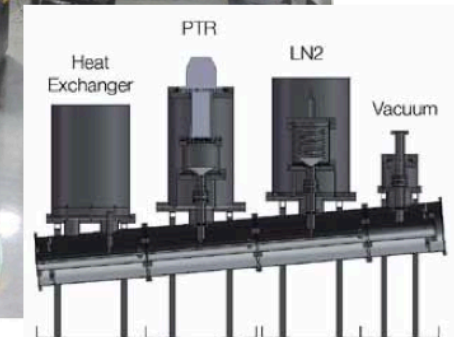
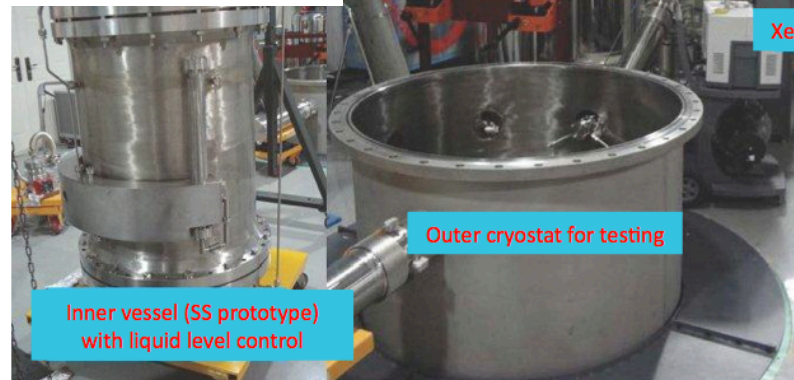
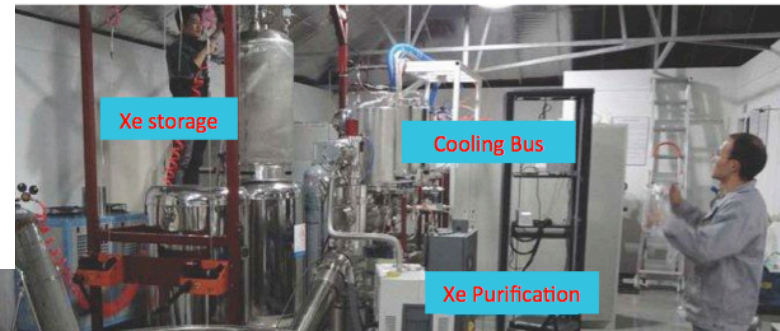
NB : Xenon100

light yield : 2.2 pe/keV_{ee}
(0.5 pe/keV_{nr})

Initiated by Jiao Tong U



- Three stages:
 - Stage Ia: 25 kg fiducial (120 kg sensitive mass) mid-2012
 - Stage Ib: 300 kg fiducial (500 kg sensitive mass)
 - Stage II: Ton-scale sensitive target



CDEX -TEXONO

Physics goals for sub-keV Ge Detectors

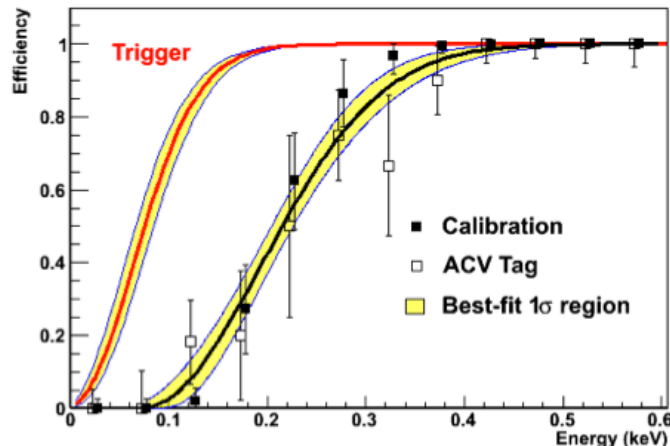
Collaboration

- Taiwan (AS, NTHU, INER, KSNPS)
- Turkey (METU)
- India (BHU)
- China (THU, CIAE, NKU, SCU, EHDC)

mass $\sim 1\text{kg}$: threshold $\sim 100\text{eV}$: bkg $\sim 1\text{cpkcd}$
[count day $^{-1}$ keV $^{-1}$ kg $^{-1}$]

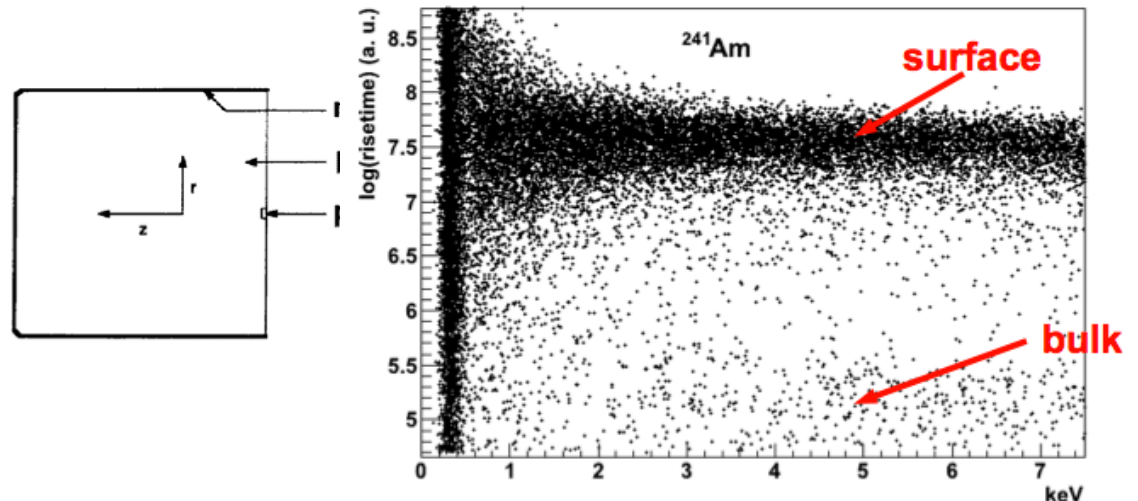
- νN coherent scattering.
- Low-mass WIMP searches.
- Improve sensitivities on neutrino magnetic moments.
- Implications on reactor operation monitoring.
- Open new detector window & detection channel.

4x5 g Ge : performance



trigger $\sim 100\text{eV}$: software threshold $\sim 220\text{eV}$

900g PCGe



Exchanges in 2011

- Visit of LSM in feb2011 by Ma Hao + Hue Qian (THU) for infrastructure @ low background facilities
- Workshop on TPC and gaseous detectors @ THU in nov 2011 :
 - I Giomataris, D Santos, GG from France
 - 15 physicists from Tsinghua Univ, IHEP, Jiao Tong Univ, USTC Hefei



- 3 days : Presentations about gaseous detectors => areas of common work
- => “goals”
- -R&D on directional MiMac (LPSC, Jiao Tong), work on scintillation
- -Development of large Micromegas (USTC, IHEP, Tsinghua, Saclay)
- -Making cheap Micromegas/GEM (Saclay, Jiaotong, IHEP, Tsinghua)
- -Low activity PCB : investigate in China, measurements @ JinPing (Jiaotong)

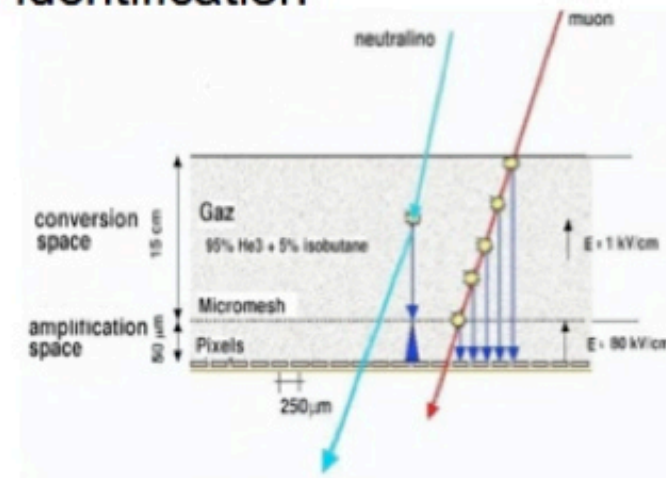
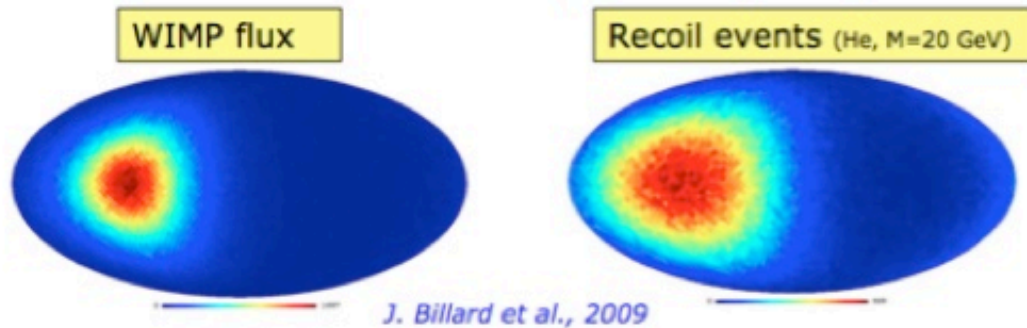
- -Path for a large a “multipurpose” 2000m³ (High P, Low P) TPC for DM and ν ?
- - Spherical detector for neutron detector & ν coherent scattering measure @ reactor (Saclay, LSM, IHEP, Jiaotong)



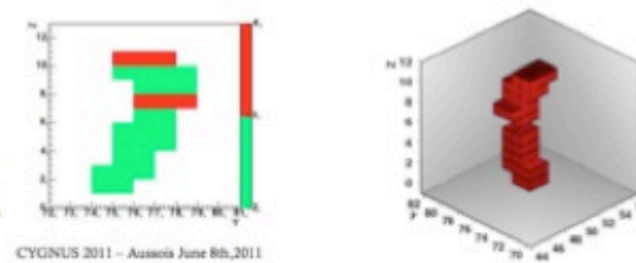
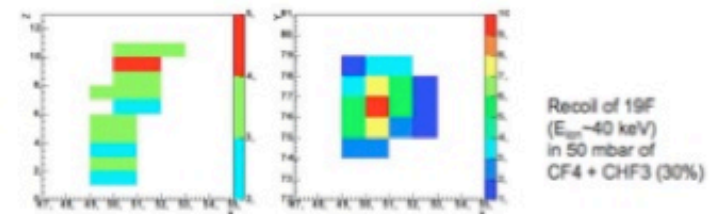
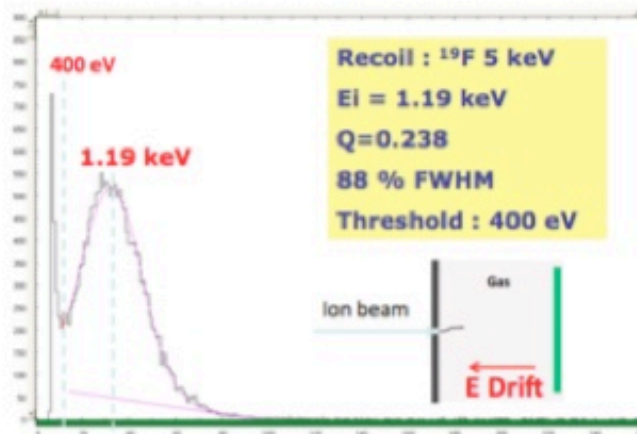
Directional detection

MiMac (Micro-tpc MAtrix of Chambers)

- Directional detector for WIMP galactic origin identification
- Demonstration of proof of principle



5keV ^{19}F Recoil in 60 mbar
 40mbar CF_4 +16.8mbar CHF_3 +1.2 mbar Isobutane

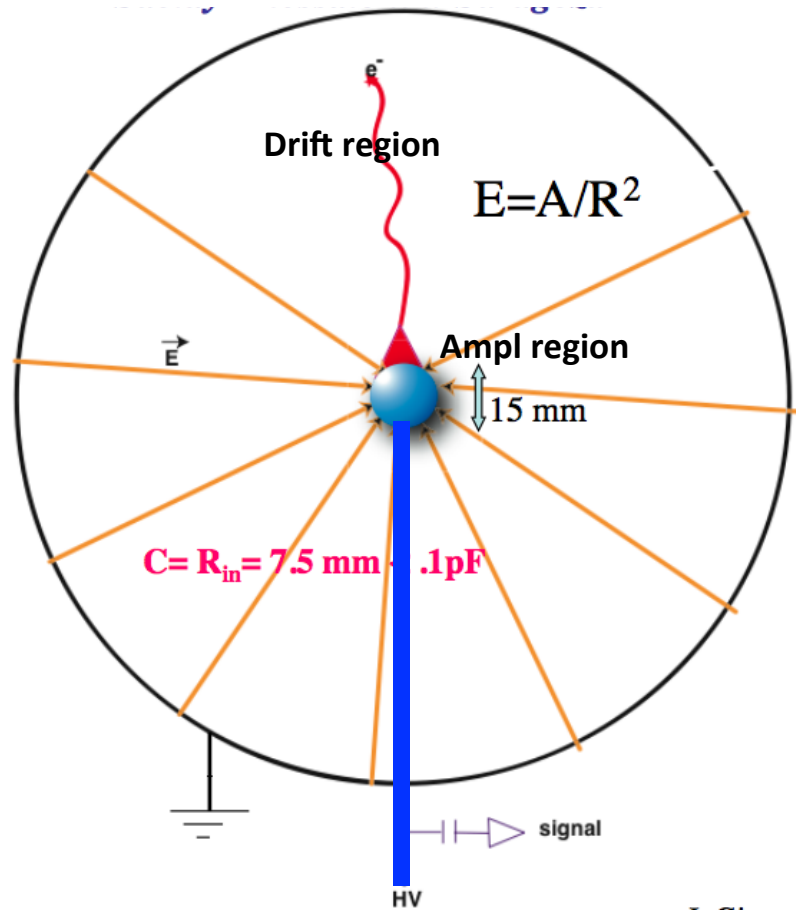


Bi-chamber module (Modane)
 $2 \times (10 \times 10 \times 25 \text{ cm}^3)$

Spherical Proportional Counter SPC plans for 2012

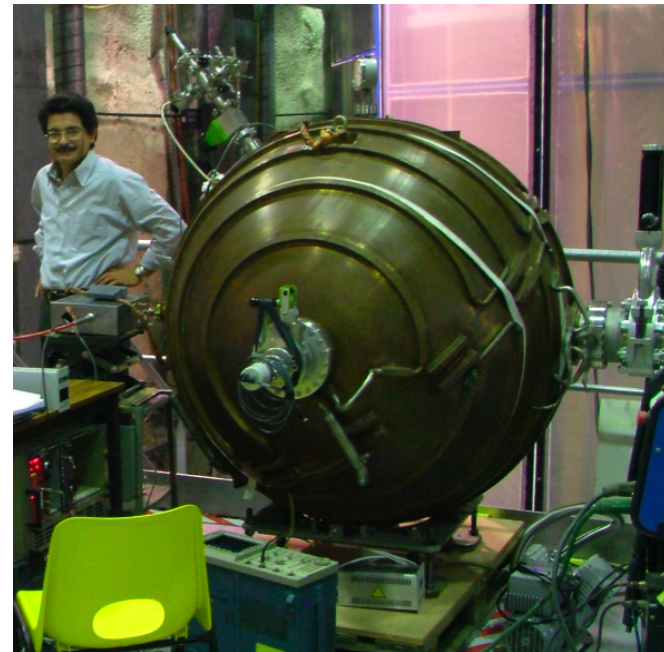
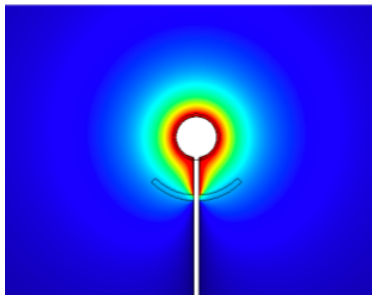
- I Giomataris, G Gerbier (Saclay) + Yang Changgen @ IHEP + F Piquemal (LSM) Kaixuan Ni (Jiaotong)
- YC initiate some investigations for nuclear plant and quotation for large spherical tanks
- IG + GG + FP initiate loan of a prototype 1.3 m diameter to be sent to Tsinghua (paper work on going)
- Wang Zhimin (IHEP) to come 4-5 weeks at Saclay in June to work on handling, acquisition and work on prototype @ IHEP
- IG + GG + FP to work on optimisation at high pressure, calibration (^{37}Ar) and low activity prototype @ LSM
- Next meeting by end 2012/beginning 2013

Spherical Proportional Counter



- Low threshold (low C)
- Fiducial selection (risetime)
- Flexible (P, gaz)
- Robust
- Simple/cheap
- 2 LEP cavity tested

I. Giomataris



Measurement of coherent neutrino scattering : a long unsuccessful search

Why ? *SubkeV threshold & large mass*

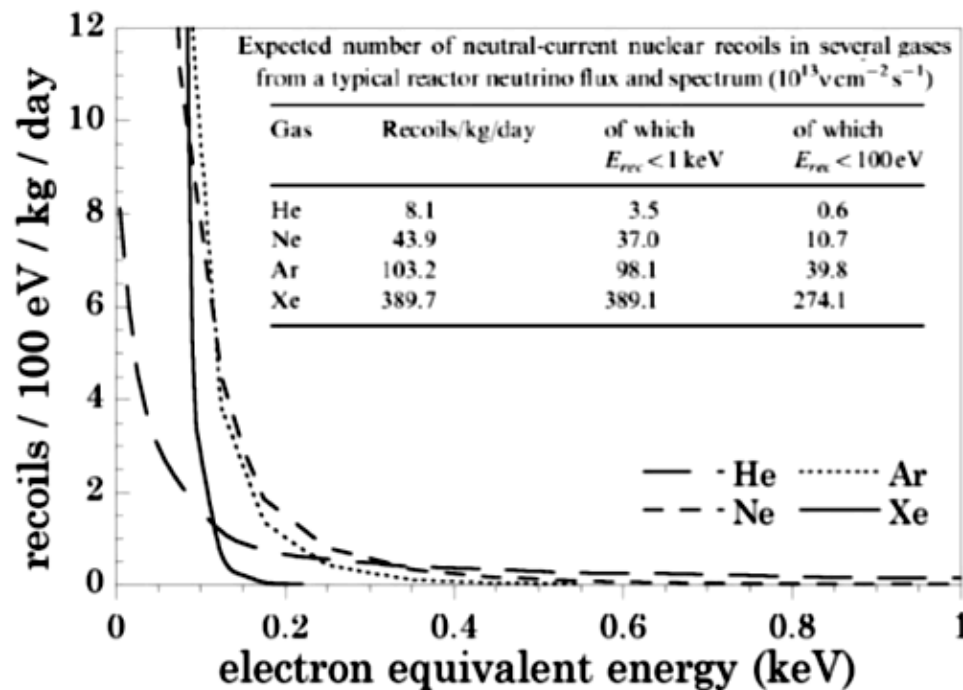


Fig. 1. Detectable signal in different gases from neutral-current nuclear scattering of reactor antineutrinos ($10^{13} \bar{\nu} \text{ cm}^{-2} \text{ s}^{-1}$), obtained by folding of the differential cross section in [8] with the reactor spectrum in [24] and applying quenching factors derived from SRIM [25]. The tradeoff between endpoint energy and rate with increasing atomic mass is evident. *Table*: total coherent recoil rate in different gases under the same conditions.

0.7 GWt @ 10 m $\Leftrightarrow 10^{13} \nu/\text{cm}^2/\text{s} \Leftrightarrow 10\text{-}20 \text{ evts}/\text{kg.d}$

- On Argon : 10 evts/kg.j ≥ 2 electrons, for $10^{13} \nu/\text{cm}^2/\text{s}$ in 50-150 eeV (QF)
- 2m diam @ 5 bars $\Rightarrow 37 \text{ kg} \Rightarrow 400 \text{ evts}/\text{d}$
- In 0.1 eekev bin
- Signal/noise =1 if noise = 100 evts/kg.d.kev @ 1 keV

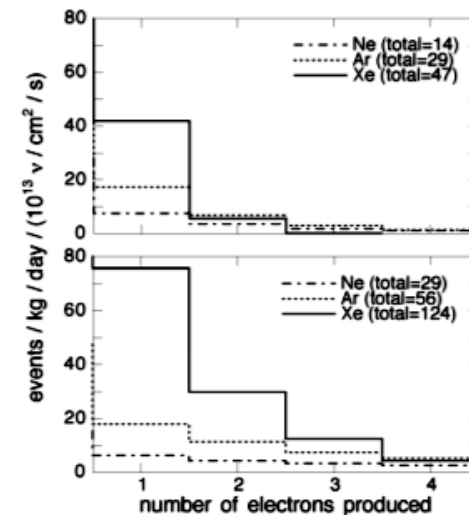
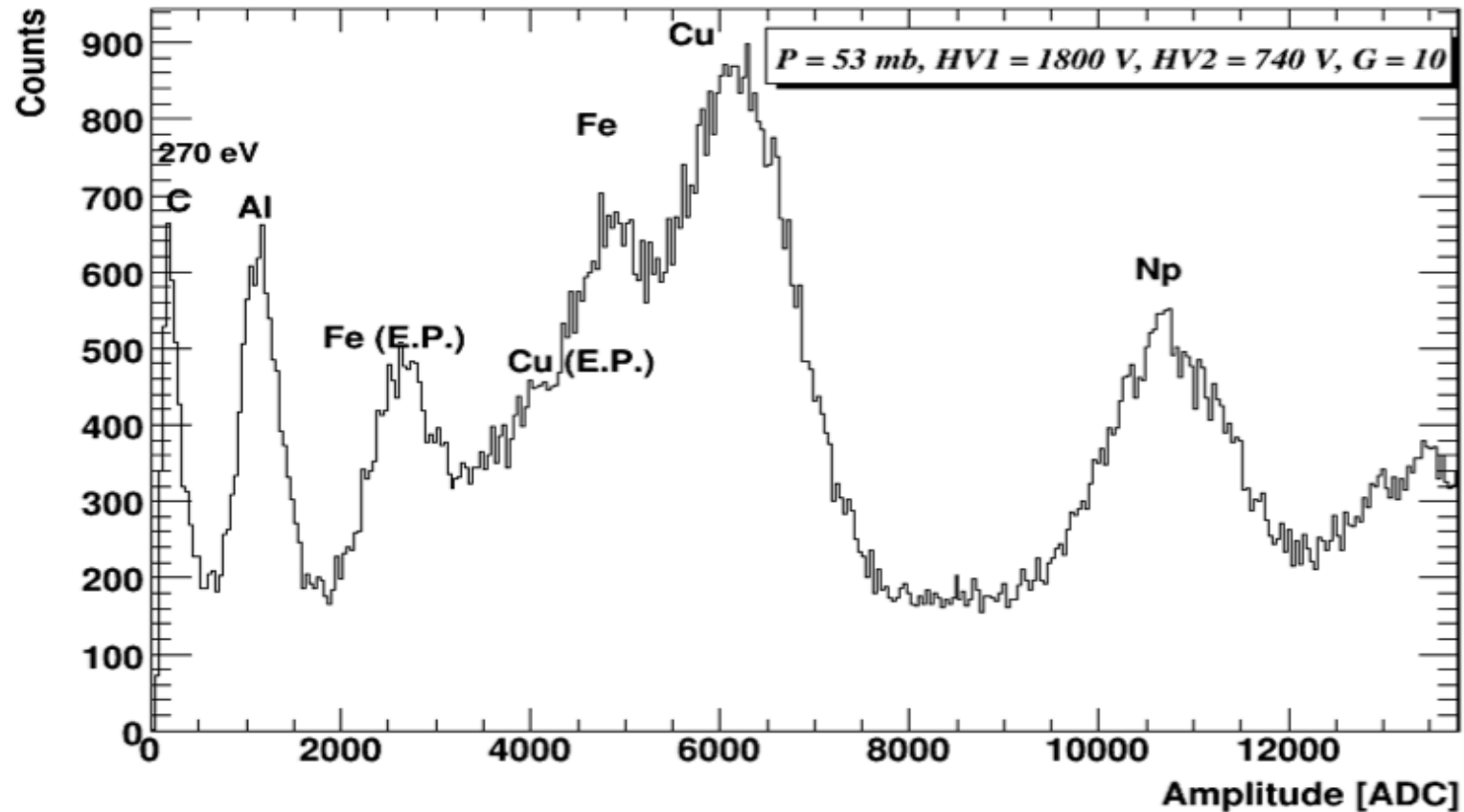


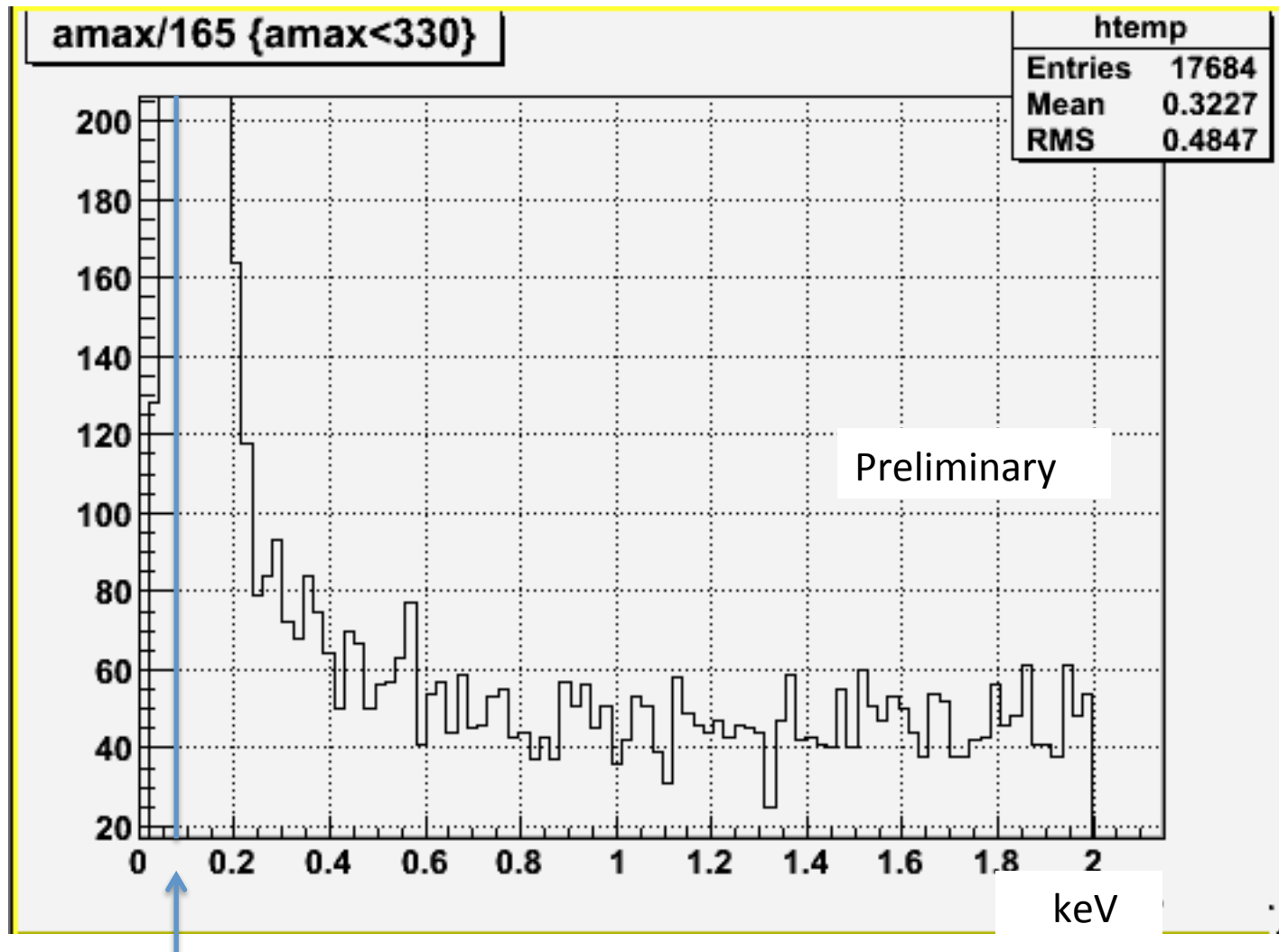
Fig. 2. Distribution in the number of free electrons produced by coherent nuclear scattering in a gaseous detector exposed to a typical reactor antineutrino flux. This estimate includes the reactor emission spectrum [24], differential cross section [8], a theoretical quenching factor derived from Lindhard's theory [25] and the mean ionization energy of the gas mixtures. "Total" denotes here the expected number of recoils/kg/d producing at least one free electron. *Top*: for pure noble gases, *Bottom*: after addition of a small fraction of TMAE vapor which may in principle reduce the ionization threshold to $\sim 6 \text{ eV}$. The effect of gas additives such as TMAE or TEA on energy threshold is to be investigated as part of this work [26].

Calibration at low energies



Journal of Physics: Conference Series **309** (2011) 012023
arxiv_1010.4132

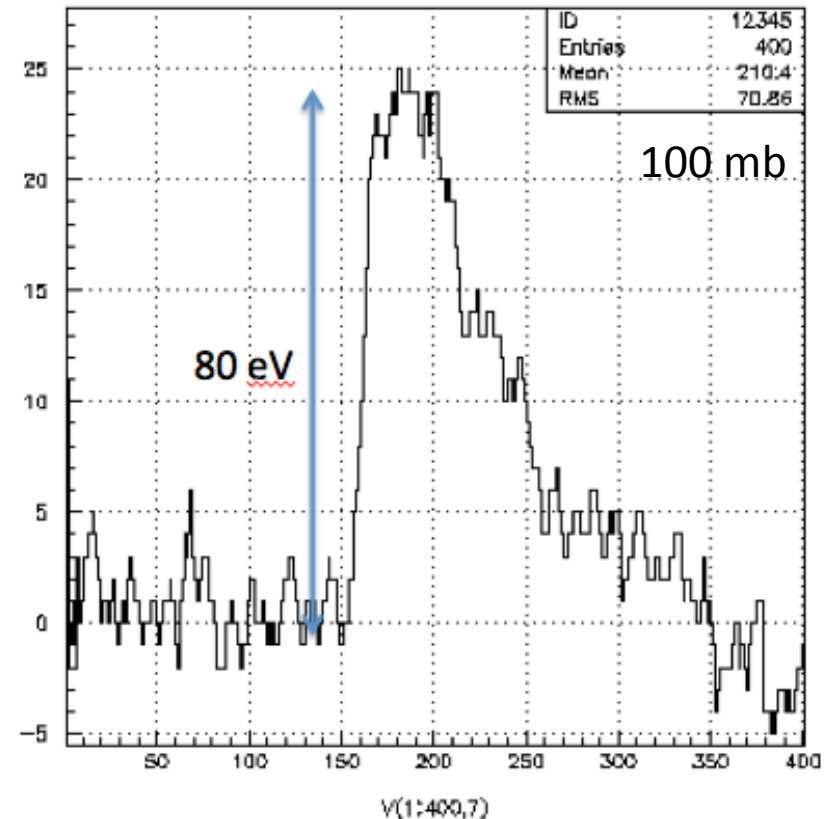
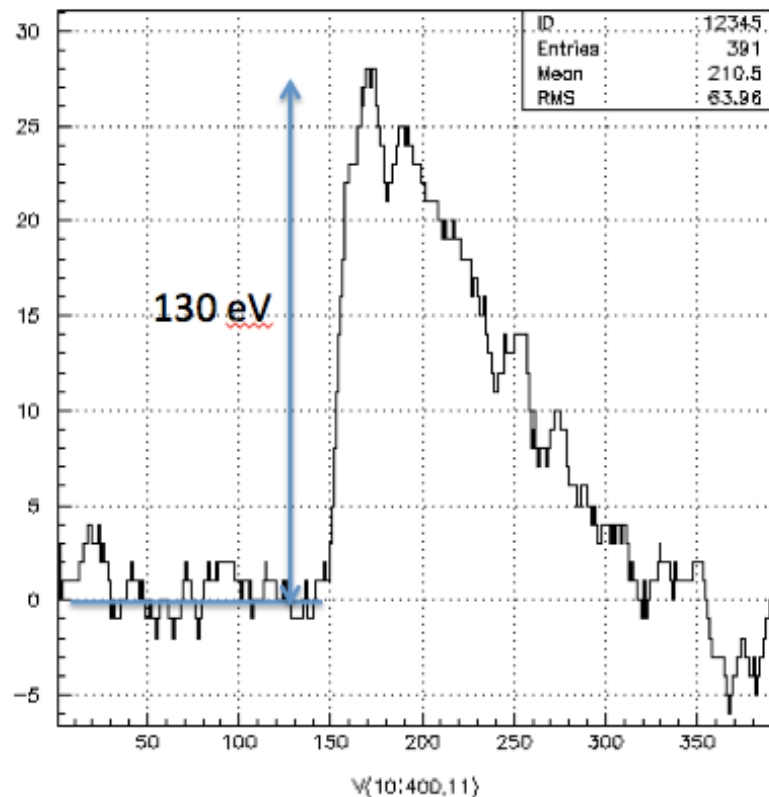
Performances @ Saclay



Software threshold @ 80 eV, all pulses OK

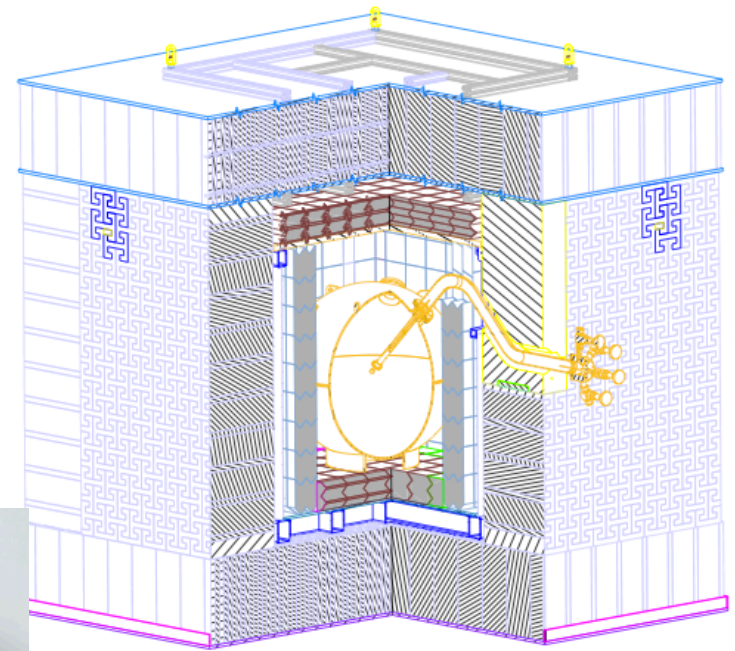
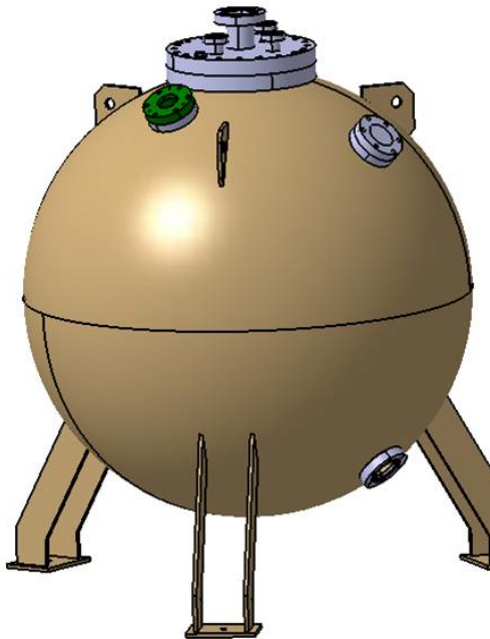
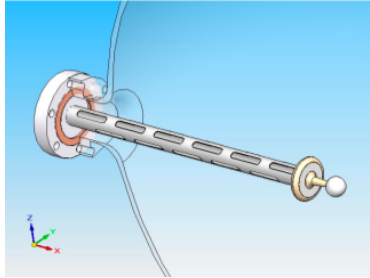
Performances @ Saclay

- Run with 16mm ball + Ne (10% C₂H₆) @ 200 mb, HV 1500V
- Trigger down to 80 eV
- Pulses :



« SEDINE » project for LSM

- Low activity Cu 60 cm diameter in lead/PE shield
 - Study background in « best » conditions
- 2 kg Ar @ 10 bar
-10 g ^3He @ 0.7 bar



Vue isométrique
Echelle : 1:7

Pb (10cm)+ PE (30 cm)

Initiating **NEWS** project & collaboration

Neutrino **E**xperiments **W**ith **S**pheres

France, Greece, China

- ν coherent scattering measurement @ nuclear plant
 - 2m diameter sphere & shield
 - Threshold optimisation @ $P > 1$ bar, calibration
 - Detector characterisation vs gaz ,HV ,P ...
 - Background & shield studies
 - Depleted Ar ?
 - Best site ?
 - Sterile neutrino Expt ?
- Larger sphere underground for ν SN monitoring
 - 5m diameter + large water shield
 - Multi sites ?
- First EVO meetings held since 1/01/2012

Thank you

Merci

谢谢