Un sommario personale sulla riunione della Commissione Scientifica Nazionale II Ferrara 15-19 Settembre 2014

A. Garfagnini

Padova University and INFN

30 Ottobre 2014

Le nuove proposte

Nel pacchetto WHAT . . .

- LSPE
- QUAX
- FISH
- COSMO_WNEXT

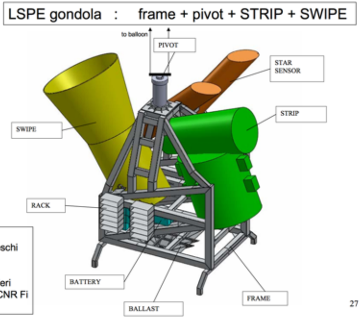
. . . e di Commissione

- JUNO

Esperiment WNEXT

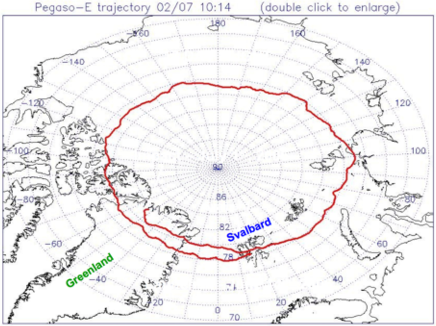
LSPE / SWIPE

- Large-Scale Polarization Explorer e' uno strumento dedicato alla misura della polarizzazione del CMB a grande scala angolare and in particolare per la ricerca dei modi B previsti dal modello inflazionario (Rif. Presentazione P. de Bernardis CSN2 Luglio 2104)
- Due strumenti: STRIP (ricevitori coerenti a 44 e 90 GHz), SWIPE(bolometri TES in cavità integratici multimodo da 90, 140, 220 GHz)
- Risoluzione angolare: 1.5-2.3° FWHM
- Copertura: 20-25% del cielo
- Volo di lunga durata su pallone stratosferico: si sfrutta il vortice stratosferico polare invernale per realizzare un volo circumpolare da 1 a 3 settimane. Base: Svalbard (ASI/Sapienza); Palloni da 800000 m3 per carichi di 2.5 t a quote medie di 37 Km.



Fiorineschi
DIM Fi

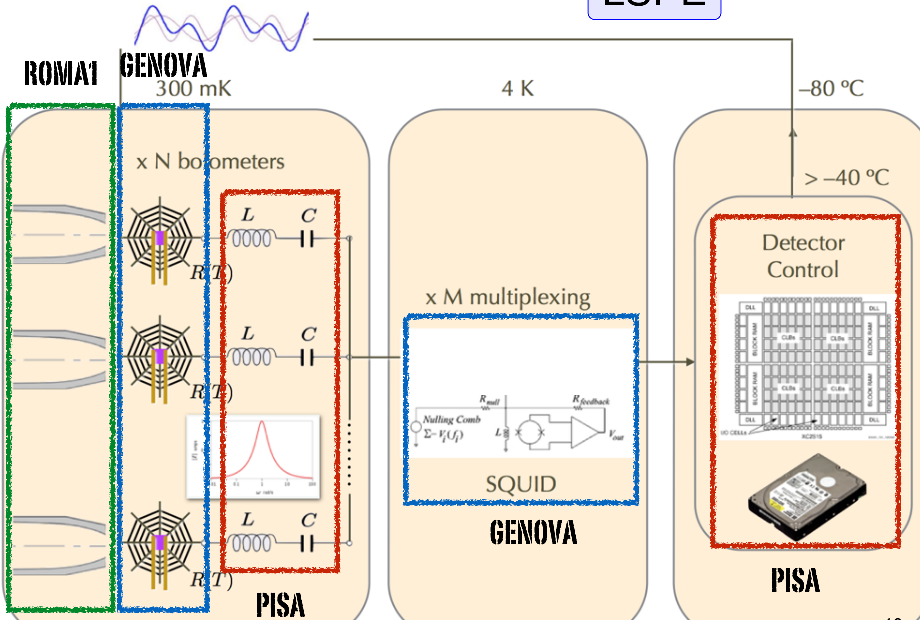
Boscaleri
IFAC-CNR Fi



LSPE/SWIPE

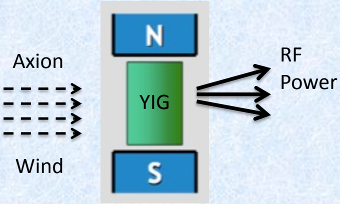
- Progetto finanziato da ASI con 3,5 M€ (Criostato, Sistema Ottico, Rivelatori-Non Bolometrici, Navicella, Controllo d' Assetto, Processori di Bordo) a Sapienza, IASF-INAF-Bologna, IFAC-CNR-Firenze, UniMI e Bicocca (attività in corso da 2 anni), con la PI-ship di P. de Bernardis.
- Il volo non e' stato ancora finanziato da ASI (circa 1.5 M€)
- SWIPE (responsabile P. de Bernardis)
- **Il contributo INFN: "Bolometric Detection Chain" 1.5 M€**
  - **Ottica di piano focale (horn e cavita') e test con calibratori (testbed) (Roma1)**
  - **Bolometri TES a grande area per 350 mK (Genova)**
  - **Elettronica di FE a SQUID (Genova)**
  - **Risuonatori LC superconduttivi (Pisa)**
  - **Elettronica per il Frequency Division Multiplexing e DAQ (Pisa)**
  - **Facility di integrazione e test dello strumento (Roma2)**

LSPE


ROMA1
GENOVA
300 mK
4 K
–80 ºC
x N bolometers
L
C
R(T)
x M multiplexing
Nulling Comb
SQUID
GENOVA
> –40 ºC
Detector Control
PISA
PISA

New proposal: QUAX (QUearere AXion)

- A new proposal tries to exploit the axion electron coupling
- Due to the motion of the solar system in the galaxy, the axion DM cloud acts as an **effective magnetic field on electron spin**
- The **ferromagnetic transition in a magnetized sample** can be excited and thus **emits microwave photons**



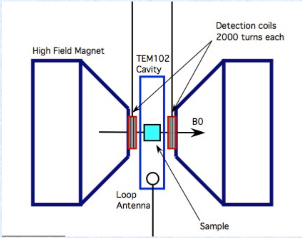
Idea come from **several old works**:

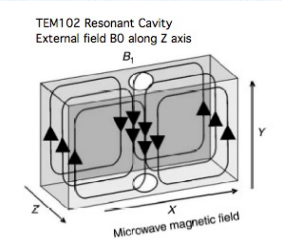
- L.M. Krauss, J. Moody, F. Wilczeck, D.E. Morris, "Spin coupled axion detections", HUTP-85/A006 (1985)
- L.M. Krauss, "Axions .. the search continues", Yale Preprint YTP 85-31 (1985)
- R. Barbieri, M. Cerdonio, G. Fiorentini, S. Vitale, Phys. Lett. B 226, 357 (1989)
- A.I. Kakhizde, I. V. Kolokolov, Sov. Phys. JETP 72 598 (1991)

QUAX

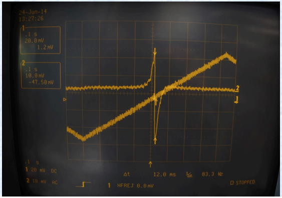
FMR magnetometry

- We exploit the Ferromagnetic Resonance (FMR) inside a magnetized ferrimagnetic material





EPR/FMR resonances inside a magnetic media can be tuned by an **external magnetizing field** and lies in the **multi GHz range** (radio frequency)



Bohr magneton $\mu_B = \frac{e\hbar}{2m_e} = 9.27 \cdot 10^{-24}$ J T^{-1}

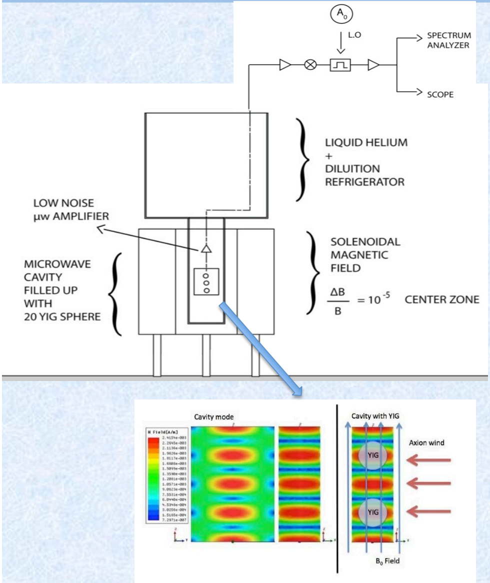
Gyromagnetic ratio $\gamma_e = ge/(2m) = g_e\mu_B/\hbar = 1.76 \cdot 10^{11}$ rad s^{-1} T^{-1}

Larmor frequency $\omega_L = \gamma_e B_0$

1 T -> 28 GHz

Detection scheme

QUAX



- Detection performed in a **high Q microwave resonator**
- **Ferrimagnetic material** placed in **antinodes** of the resonator
- Resonator in an **homogenous axial magnetic field**
- **Cryogenic system** to avoid black body photons and to enhance properties of magnetic material
- **Low noise detector** chain (Quantum limited?)
- Cavity to **enhance SNR**

FISH

Ultracold atoms: successful quantum simulators for important cond-mat problems…

Quantum phase transitions	M. Greiner et al., Nature (2002)
Fermi-Hubbard model	R. Jördens et al., Nature (2008)
Disordered systems	G. Roati et al., Nature (2007)
Low-dim many-body physics	T. Kinoshita et al., Science (2004)
Quantum magnetism	J. Simon et al., Nature (2011)
Graphene physics	L. Tarruell et al., Nature (2012)

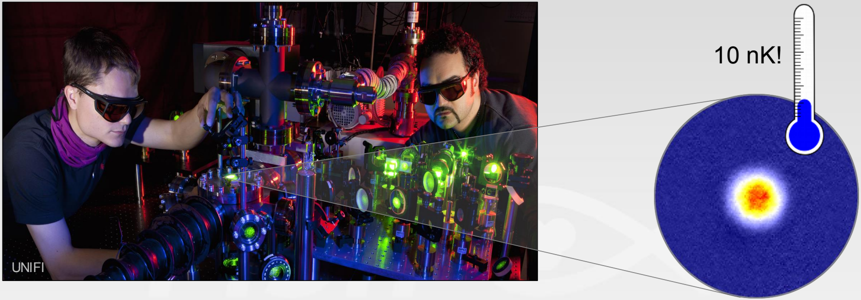
…and for fundamental physical effects

Fermionic superfluidity	M. Zwierlein et al., Nature (2005)
Higgs mechanism	M. Endres et al., Nature (2012)
SU(N) fermions	G. Pagano et al., Nat. Phys. (2014)
Kibble-Zureck mechanism	G. Lamporesi et al., Nat. Phys. (2014)

...so “what next”? Ultralow-energy simulators of high-energy physics!!!

FISH

Ultracold atoms: quantum engineering in a table-top setup



Many control knobs for realizing Hamiltonians in the lab!

fermions and bosons
interactions
dispersion (also relativistic)
temperature

topology / dimensionality
disorder
gauge fields
dynamics

I. Bloch et al., Rev. Mod. Phys. **80**, 885 (2008)
M. Inguscio and L. Fallani, Atomic Physics (Oxford, 2013)

FISH

Scientific goal of the FISh experiment:

engineer the interactions in ultracold quantum gases in order to realize quantum simulators for some aspects of high-energy physics, connected to the colour symmetry and to the quark confinement in QCD

- **strong interconnections between HEP and atomic physics**
- **highly-innovative project**
- **ambitious goal, with a lot of interesting physics at hand on the way**

Disclaimer:

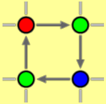
We don't (and cannot!) promise to perform a full quantum simulation of QCD

We plan to realize certain simplified models to make cold atoms behave as quark matter, to learn something new about basic phenomenology of QCD.

Sezioni coinvolte

Firenze

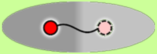
Leonardo Fallani



Multi-component **fermions**
with SU(N)-symmetric interactions

Trento

Gabriele Ferrari



Topological defects in **BECs**
Simulation of quark confinement

EUCLID

WMAP → PLANCK → EUCLID

- Explore DARK ENERGY in an unprecedented way
- Validity of General Relativity against modified-gravity theories
- Measure Σm_ν with 0.03 eV sensitivity, Σn_ν with 0.1 sensitivity

A Telescope with 2 instruments:

- VIS (550 – 900 nm)
- NISP (900 – 2000 nm)

10 years preparation, cost ≈ 0.7 G€, collaboration 900 physicists

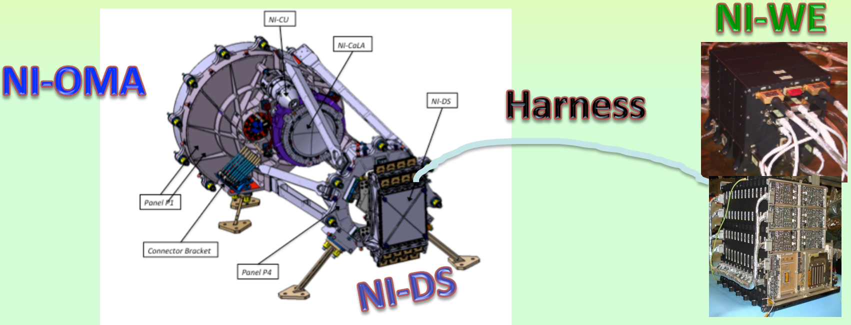
Soyuz launch in year 2020, 7 years duration including commissioning

Up to 850 Gbit/day data flow

EUCLID

Stefano-Dusini@July-2014-CSN2

- **NISP is a Large Field Photometer & SlitLess Spectrograph [0.9-2.0]μm**
- 0.55Deg^2; MASS < 160Kg ; POWER < 200W; TELEMETRY < 240 Gbit/day; 1mx0.5mx0.5m
- 3 main assemblies :
  - **NI-OMA** : **Opto Mechanical Assembly in the satellite Cold PayLoad Module**
  - **NI-DS** : **Detection System mounted on NI-OMA**
  - **NI-WE** : **Warm Electronics in the warm satellite Service Module**



Cold Payload Module **Warm Service Module**

EUCLID

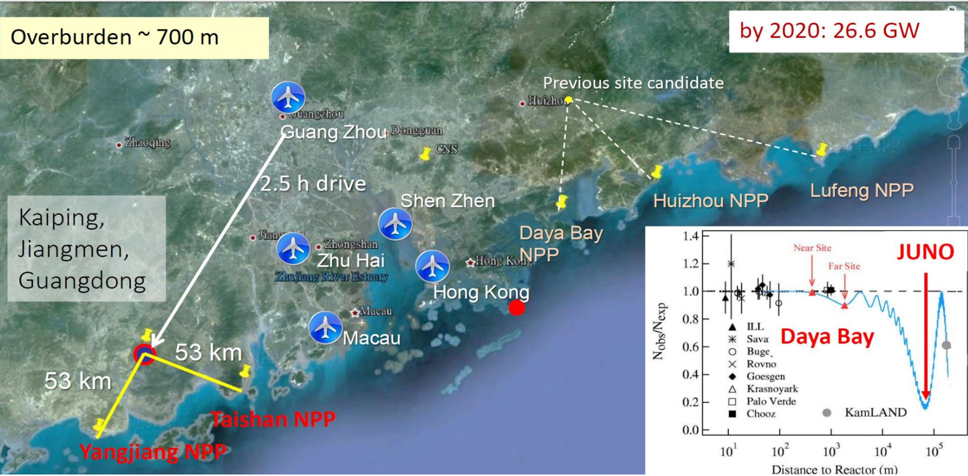
Stefano-Dusini@July-2014-CSN2

Individuate alcune aree per un possibile contributo INFN nell'ambito delle responsabilità italiane in Euclid

- integrazione SW di bordo nell'HW delle unità di qualifica e di volo per Data Processing Unit (DPU) e per Instrument Control Unit (ICU) del Near Infrared Spectro-Photometer (NISP)
- integrazione e test delle unità di warm electronics di NISP con qualifica funzionale e verifica delle performance presso laboratori INFN
- contributo alle attività di sviluppo del SW di bordo
- attività di system engineering della warm electronics del NISP
- possibile contributo al Science Ground Segment con la partecipazione allo sviluppo degli algoritmi di riduzione e analisi dati e contributo alla gestione dei dati.

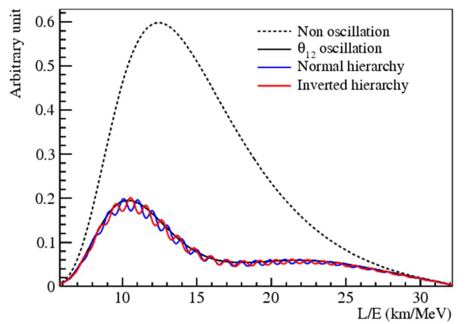
JUNO

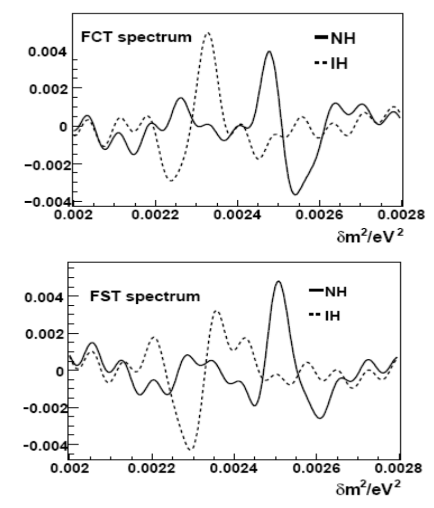
NPP	Daya Bay	Huizhou	Lufeng	Yangjiang	Taishan
Status	Operational	Planned	Planned	Under construction	Under construction
Power	17.4 GW	17.4 GW	17.4 GW	17.4 GW	18.4 GW



Spectral information

JUNO





How the interference happens?

Fourier transform to L/E spectrum:

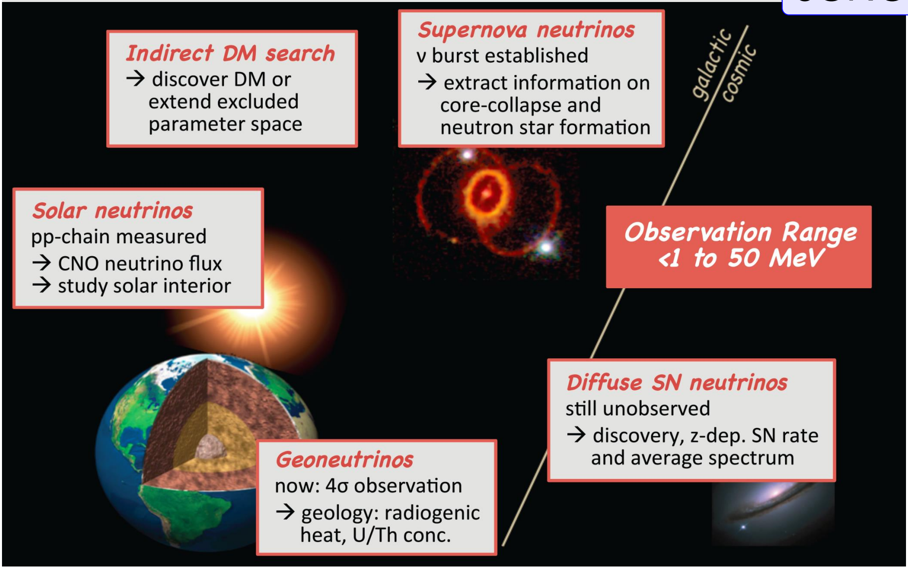
L/E spectrum←→Δm^2 spectrum(oscillation frequency)

J. Learned *et. al.* hep-ex/0612022

L. Zhan *et. al.* 0807.3203

Observatory of astrophysical sources

JUNO

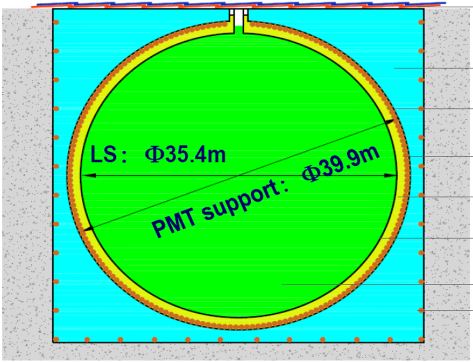


Detector concept

JUNO

Requirements:
Large detector: **20 kt LS**
Energy resolution:
3%/√E → 1200 p.e./MeV

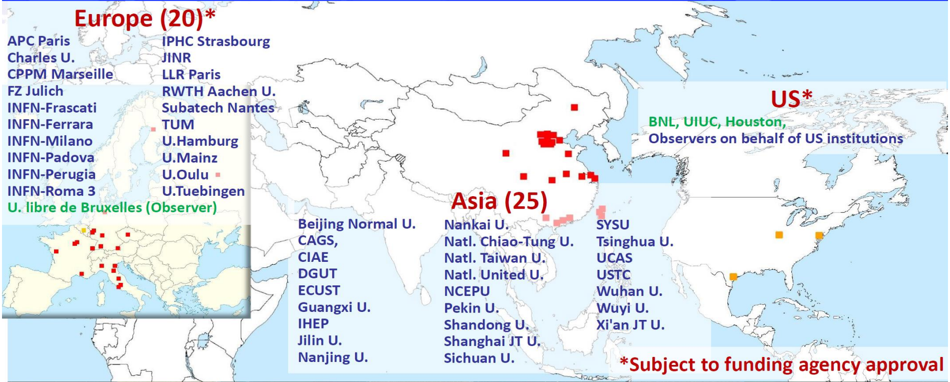
	KamLAND	JUNO
LS mass	**~1 kt**	**20 kt**
Energy Resolution	**6%/√E**	**3%/√E**
Light yield	**250 p.e./MeV**	**1200 p.e./MeV**



Top muon detector
Water cherenkov detector
Buffer container or PMT support
~15000 20" PMTs, coverage:~80%
Buffer
LS container
20 kton LS
~1500 20" veto PMTs

Collaboration Established

JUNO



Europe (20)*

APC Paris
Charles U.
CPPM Marseille
FZ Julich
INFN-Frascati
INFN-Ferrara
INFN-Milano
INFN-Padova
INFN-Perugia
INFN-Roma 3
IPHC Strasbourg
JINR
LLR Paris
RWTH Aachen U.
Subatech Nantes
TUM
U.Hamburg
U.Mainz
U.Oulu
U.Tuebingen
U. libre de Bruxelles (Observer)

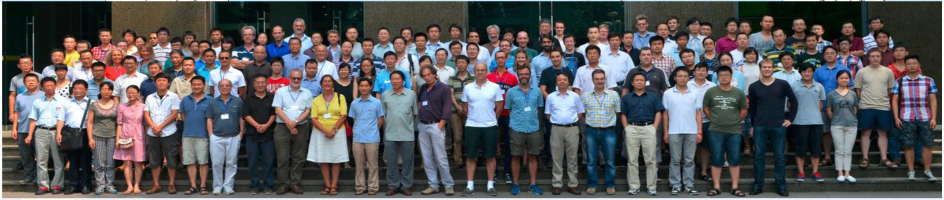
US*

BNL, UIUC, Houston,
Observers on behalf of US institutions

Asia (25)

Beijing Normal U.
CAGS,
CIAE
DGUT
ECUST
Guangxi U.
IHEP
Jilin U.
Nanjing U.
Nankai U.
Natl. Chiao-Tung U.
Natl. Taiwan U.
Natl. United U.
NCEPU
Pekin U.
Shandong U.
Shanghai JT U.
Sichuan U.
SYSU
Tsinghua U.
UCAS
USTC
Wuhan U.
Wuyi U.
Xi'an JT U.

*Subject to funding agency approval

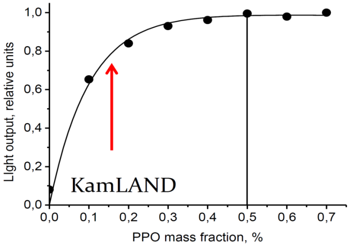


Liquid scintillator

JUNO

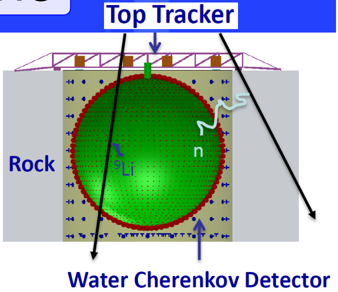
- Recipe: LAB + PPO + bisMSB
  - Attenuation length 15 m → ~30m
  - No Gd-loading for low radioactivity
- R&D efforts:
  - Low background: → No Gd-loading
  - Improve raw materials
  - Improve the production process
  - Purification
    - Distillation, Filtration, Water extraction, Nitrogen stripping…
  - Optimization of fluor concentration
- Other works:
  - Rayleigh scattering length
  - Energy non-linearity
  - Aging
  - Material selection: BKG & purity issues
  - Engineering for 20kt mass production

Linear Alky Benzene	Atte. L(m) @ 430 nm
RAW	14.2
Vacuum distillation	19.5
SiO_2 column	18.6
Al_2O_3 column	22.3
LAB from Nanjing, Raw	20
Al_2O_3 column	25



Veto system

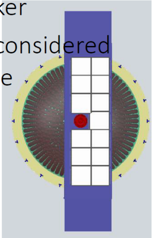
JUNO



- Goals of veto
  - Cosmogenic isotopes rejection
  - Neutron background rejection
  - Gamma background passive shielding
  - ...

- Water cherenkov detector
  - ~1500 20” PMT
  - 20~30 kton ultrapure water with a circulation system
  - Earth magnetic field shielding
  - Tyvek reflector film
  - PMT support frame
  - Water pool sealing

- Top tracker
  - Use OPERA Target Tracker
  - Additional options are considered to increase the coverage



Notizie recenti sugli esperimenti WNEXT

QUAX

Il progetto è approvato dalla Giunta con un finanziamento aggiuntivo di 213 kEuro per il 2015. Questi fondi saranno messi a disposizione a Novembre 2014 e sranno assegnati a QUAX in quella data. Se la fase di R/D proposta dai referees avrà esito positivo, la Giunta coprirà le spese di costruzione per gli anni successivi

COSMO_WNEXT

Il progetto recentemente discusso con la Giunta, (non ragioni scientifiche) per la necessità di aumentare l'impegno in termini di FTE e definire un accordo con ASI e INAF. La discussione è in corso e molto probabilmente il progetto sarà finanziato dalla Giunta per il 2015. La cifra precisa non è ancora disponibile ma si pensa che coprirà la proposta dei referees per il 2015 e le spese di costruzione per i prossimi anni.

LSPE

Il progetto è approvato dalla Giunta con un finanziamento aggiuntivo di 447 kEuro per il 2015. Questi fondi, già assegnati in commissione, saranno messi a disposizione a Novembre 2014. La Giunta si impegna a coprire le spese di costruzione per i prossimi anni.

FISH

Il progetto ha referee della CSNI e CSNII. Giudizio pienamente positivo da parte dei referee; la CSNII aveva deciso un approfondimento, per verificare la tempistica dei risultati. INFN ritiene strategica l'approvazione di FISH in tempi rapidi. La Giunta INFN mette a disposizione la cifra di 364 kEuro proposta da referee e si impegna a coprire le spese di costruzione per i prossimi anni.

Fisica delle oscillazioni dei neutrini

Esperimenti in presa dati

- T2K
- KM3
- LVD
- BOREX

R&D, nuove proposte, ed exp in costruzione

- ICARUS@CERN
- NESSIE
- BOREX-SOX

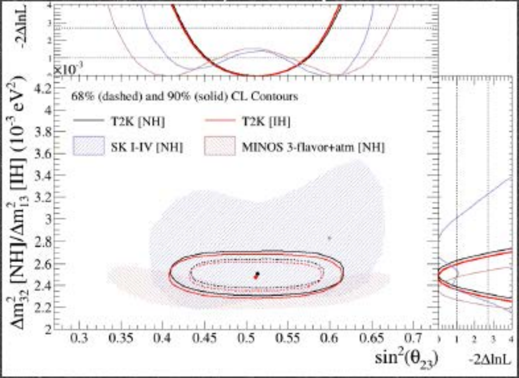
Esperimenti in chiusura

- ICARUS@LNGS
- OPERA

T2K Highlights 2013-2014

ν_μ disappearance analysis

PRL. 112, 181801 (2014)



- For the first time the mixing angle θ_{23} is better constrained by an accelerator experiment than by atmospheric neutrinos
- $\sin^2(\theta_{23}) = 0.514 \pm 0.055$ (NH) → 10% uncertainty corresponding to an uncertainty of 3° on the angle

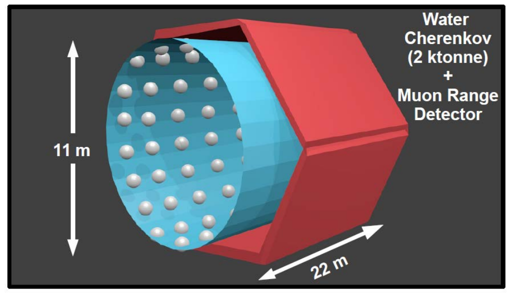
Upgrade di T2K → Toward T2HK

Motivazioni:

- alta intensita' > 2016
- Misura di precisione di sezioni d'urto
- Misure di sezione d'urto in acqua

Possibile interesse INFN:

TiTUS



T2K Upgrade/ HyperK

Detector intermedio a 1-2 Km (WC)

Gruppo Europeo T2HK/TITUS gia' attivo:

- Londra Dicembre 2013
- CERN Giugno 2014

Motivazioni per un rivelatore a 2 km

T2K

- The detector at 280 m don't use the same technology and target as SK
- The flux seen at 280m is not the same as that seen by SK.
- In addition the poor knowledge of the neutrino cross section in water represent one of the largest uncertainties of the T2K measurement.

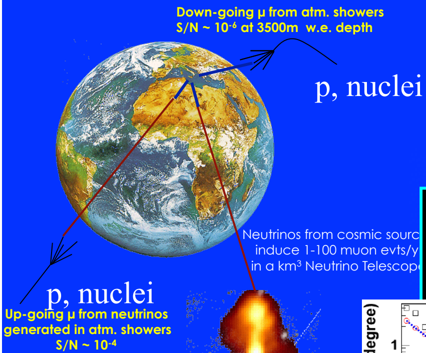
Cosa vorremmo proporre come INFN

- Di utilizzare i Multi-PMT system with small PMTs (DOM), sviluppati a Napoli nell'ambito di KM3NET
- Di realizzare un prototipo da laboratorio per studiarne le caratteristiche.
- Di sviluppare la simulazione di un DOM-T2K per studiarne le performances
- Piu' in generale di partecipare allo sviluppo della simulazione e ricostruzione dati per questo detector (richieste calcolo)

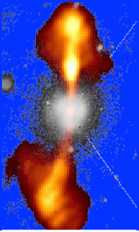
Detection principle

KM3

Search for neutrino induced events, mainly $\nu_\mu N \rightarrow \mu X$, deep underwater



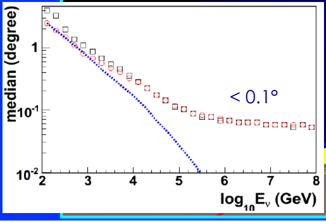
Neutrinos from cosmic sources induce 1-100 muon evts/y in a km³ Neutrino Telescope

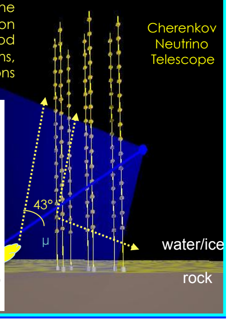


- Atmospheric neutrino flux ~ E_ν^{-3}
- Neutrino flux from cosmic sources ~ E_ν^{-2}
  - Search for neutrinos with E_ν>1÷10 TeV
- ~TeV muons propagate in water for several km before being stopped
  - go deep to reduce down-going atmospheric μ backg.
  - long μ tracks allow good angular reconstruction

$$For\ E_\nu \geq 1TeV \quad \theta_{\mu\nu} \sim \frac{0.7°}{\sqrt{E_\nu[TeV]}}$$

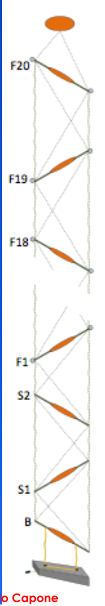
μ direction reconstructed from the arrival time of Cherenkov photons on the Optical Modules: needed good measurement of PMT hits, σ(t)~1ns, and good knowledge of PMT positions (σ ~10cm)

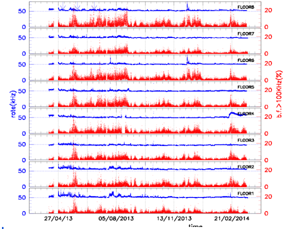


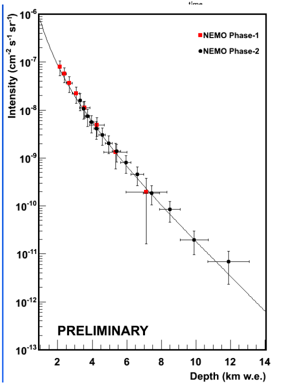


Detectors operational at KM3NeT-It site, May 2014

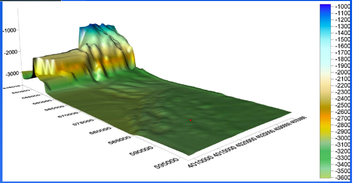
March 2013-August 2014 - NEMO-Phase2 Tower







Since May 8th 2014:
Prototype KM3NeT detection unit with 3 DOMs



Antonio Capone

Km3 - presentazione richieste 2015 alla CSN2 - Ferrara, 16/09/2014

ARTICLE

Nature, August 28

doi:10.1038/nature13702

Neutrinos from the primary proton–proton fusion process in the Sun

Borexino Collaboration*

In the core of the Sun, energy is released through sequences of nuclear reactions that convert hydrogen into helium. The primary reaction is thought to be the fusion of two protons with the emission of a low-energy neutrino. These so-called *pp* neutrinos constitute nearly the entirety of the solar neutrino flux, vastly outnumbering those emitted in the reactions that follow. Although solar neutrinos from secondary processes have been observed, proving the nuclear origin of the Sun's energy and contributing to the discovery of neutrino oscillations, those from proton–proton fusion have hitherto eluded direct detection. Here we report spectral observations of *pp* neutrinos, demonstrating that about 99 per cent of the power of the Sun, 3.84 × 10^{33} ergs per second, is generated by the proton–proton fusion process.

Detection of the pp fundamental flux (we observe the engine of the Sun at work!) possible thanks to the very stable and clean data accumulated in the first 2 years of the Borexino Phase-II data taking

Irreducible background to cope with : ^{14}C and its pile-up→ detector response understood down to ~ 150 keV

Milestone result in experimental solar neutrino physics: first spectroscopic and real time observation of the neutrinos from the key fusion reaction which powers the Sun

What makes the Sun shine

Neutrinos produced in the nuclear reaction that triggers solar-energy generation have been detected. This milestone in the search for solar neutrinos required a deep underground detector of exceptional sensitivity. SEE ARTICLE P.383

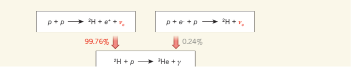
WICK HAXTON

A remarkable detector of solar neutrinos called Borexino has operated for the past seven years in Italy's Gran Sasso Laboratory, shielded by more than a kilometre of rock from the cosmic rays that bombard Earth's surface. A prolonged effort has reduced background signals from radioactive elements present in the detector that would otherwise obscure the neutrino signal. On page 383 of this issue, the Borexino Col-

Aston's measurements in 1920 of the mass difference between four protons and a helium-4 (^{4}He) nucleus, Arthur Eddington proposed that the source of solar energy is the fusion of

criticism that the Sun is not sufficiently hot to sustain nuclear fusion, Eddington invited his critic to "go and find a hotter place".

This dispute was resolved by George Gamow, who showed that quantum tunnelling would allow two solar protons to approach one another within the range required for nuclear fusion to occur. The detailed reactions leading to the synthesis of ^{4}He were then deduced[3]: the proton–proton (*pp*) chain (Fig. 1) in the case of small, slowly evolving stars such as the Sun, and the carbon–nitrogen (CN) cycle in more-massive, rapidly evolving stars. Steady nuclear-energy release in the solar core keeps the temperatures high, ionizing hydrogen (H) and ^{4}He and producing a plasma in which the electrons act as a gas. The Sun burns in a

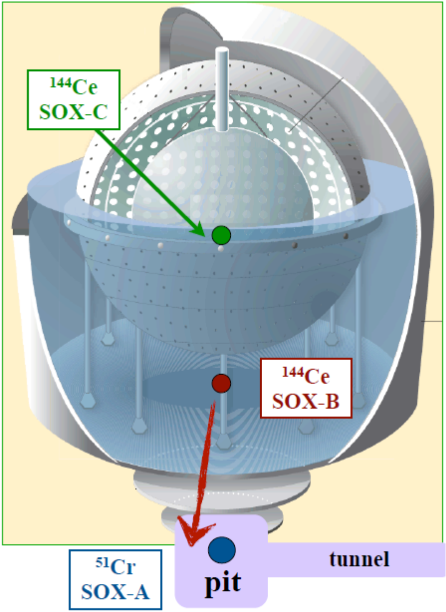


Sterile search with radioactive sources – update

Reminder: two sources were considered in our baseline proposal Cr51 & Ce144

Most important news over the past six months:
The Saclay group pursuing the production of the Cerium-144 source abandoned the idea to deploy it in KamLAND (main reason insurmountable transportation problems) and asked us to deploy it in Borexino.

This makes the idea to proceed with SOX-B in addition to SOX-A (sketched in our paper JHEP 08 (2013) 038) a concrete plan



BOREX

We are outlining a global Borexino program after the end of phase II for additional three-four years

Pillars of the plan being sketched: SOX-A (Chromium) and SOX-B (Cerium) projects, and a thorough purification campaign targeted to suppress the ^{210}Bi to the negligible level (very close to 0) → **ambitious goal of a real CNO measurement, and not only an upper limit - this would be the ultimate solar neutrino accomplishment of Borexino**

Throughout the entire period of its remaining lifetime, Borexino will continue to be a powerful supernova observatory.

Timing scenario: SOX-B from November 2015 (1.5 years of data taking) - purification campaign fully compatible with SOX-B – later SOX-A

MoU between INFN and CEA Saclay for SOX-B (Cerium) (now called SOX-Ce) almost completed

NESSiE

Summary

- CERN and USA, following the outcomes by ESP (European Strategy) and P5 (strategy in USA), agreed to make R&D for neutrino at CERN and experiments at FNAL
- NESSiE Collaboration has submitted a Technical Report to CERN-SPSC and a Physics Proposal to FNAL (PAC, Physics Advisory Committee, number P-1057)
- FNAL is undergoing a strategic plan for the Short-Baseline projects
- Our FNAL proposal will be scrutinized in autumn
- **The CERN Neutrino Platform has been approved and funded at the last CERN Council (5% of CERN budget for research)**
- The approved experiments WA104-Icarus, WA104-NESSiE and WA105 are expecting to have their own MoU released soon

CSN2-NESSiE, September 15th 2014
***Luca Stanco** for the **NESSiE** Collaboration*

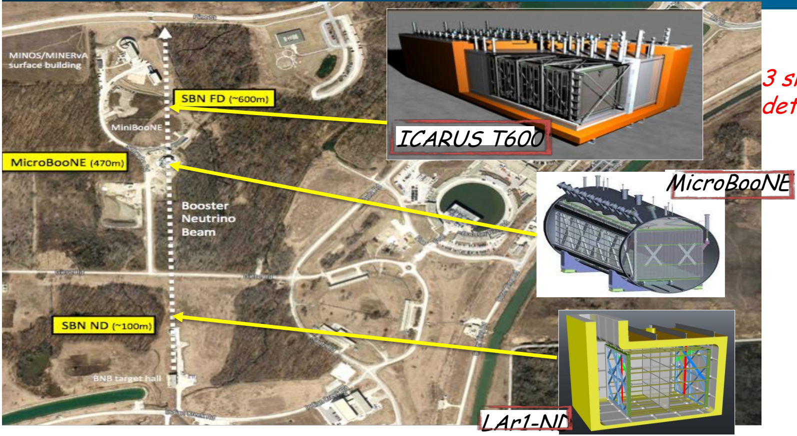
Prospects for the measurement of ν_μ disappearance at the FNAL-Booster

The NESSiE Collaboration

NESSIE

Submitted to FNAL-PAC:
FNAL-P-1057 and arXiv:1404.2521

SBL at the FNAL ~ 0.8 GeV ν Booster Beam



3 shallow depth detectors!

- A joint ICARUS/LAr1-ND/MicroBooNE effort is taking place to develop:
  - A coherent international program featuring 3 detectors at different baselines by 2018: near: LAr1-ND, mid: MicroBooNE, far: ICARUS;
  - A common Conceptual Design Report discussing cosmic ray induced background, beam/detector systematics and logistics.

Double Beta Decay and Dark Matter searches

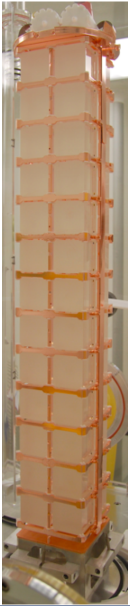
Esperimenti in presa dati

- CUORE
- GERDA
- DAMA
- XENON

R&D e nuove proposte

- DARKSIDE
- LUCIFER
- MARE-RD
- SABRE
- MOSCA-B

CUORE-0



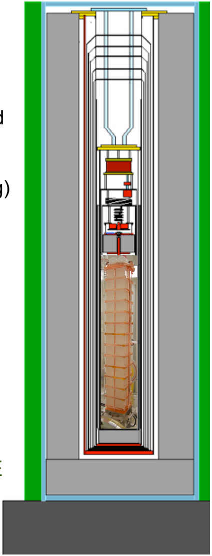
1 CUORE tower

- 52 TeO_2 5x5x5 cm^3 bolometers
- 13 floors of 4 crystals each
- **total mass:** 39 kg (11 kg of ^{130}Te)

- All detector components manufactured, cleaned and stored with same protocols defined for CUORE
- Assembled with the same procedures of CUORE:
  - dedicated class 1000 clean room (underground building)
  - all steps of the assembly (crystal gluing, mounting, cabling, bonding) performed under nitrogen inside special glove boxes.
- Operated inside the 25-year-old Cuoricino cryostat at LNGS.
- Low temperature roman lead shield

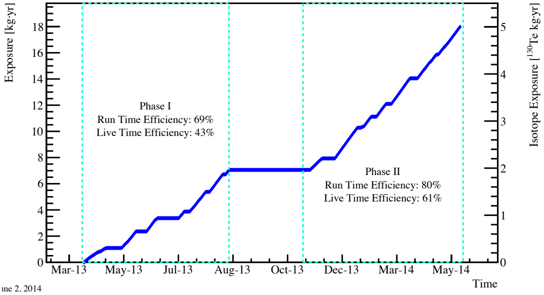
Goals:

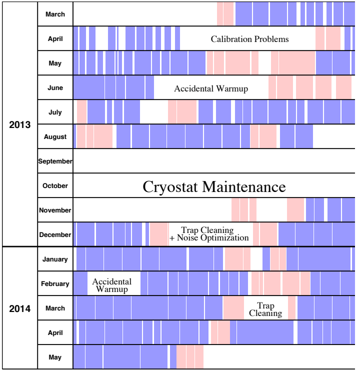
- Proof of concept of CUORE detector in all stages
- Test and debug of the CUORE tower assembly line
- Test of the CUORE DAQ and analysis framework
- Operating as independent experiment while CUORE is under construction
- Demonstrate potential for DM detection



CUORE-0 data taking

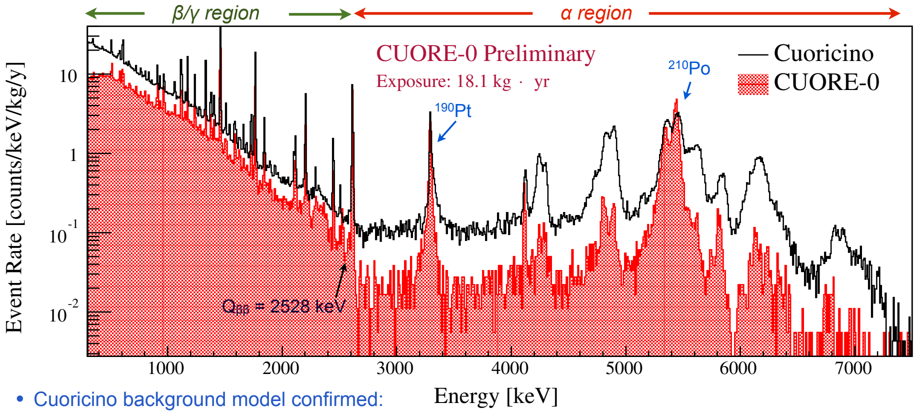
- **August 2012**: base T reached
  ... problems with old Cuoricino cryostat
- **March 2013**: start data taking (Phase I)
- **September 2013**: first results are released (→ arXiv:1402.0922)
- **October 2013**: long maintenance stop
- **November 2013**: background data taking restarted (Phase II)
  → **improved conditions**
  - Longer system lifetime (no warm-up required so far)
  - Better noise conditions
    - Improved energy resolution
    - Lower Threshold
  - Data analysis tools optimization
  - Stable background values





- Background measurements
- Calibration runs

CUORE-0 background



- Cuoricino background model confirmed:
  - environmental gamma's from material bulk contaminations
  - surface radioactive contaminations of close materials
- Evident reduction with respect to Cuoricino
  - factor of 6 for surface contaminations
  - factor ~2.5 in the ROI

	0νββ region cnts/(keV kg y)	**2700-3900 keV**	**ε(%)**
Cuoricino	0.153 ± 0.006	0.110 ± 0.001	83
CUORE-0	**0.063 ± 0.006**	**0.020 ± 0.001**	78

Status of CUORE: cryogenics

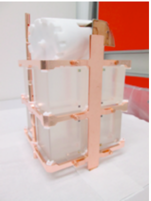
Phased commissioning program

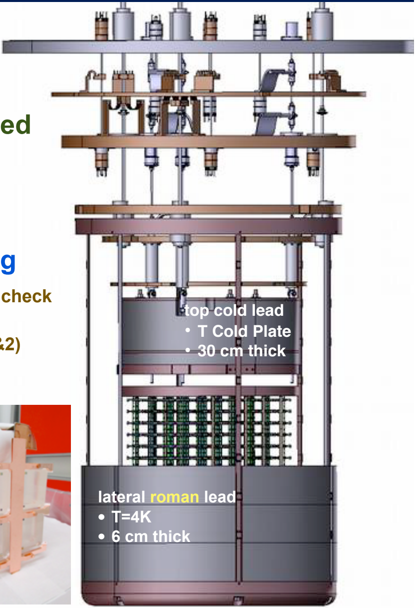
→ add complexity gradually

- **Phase 1: 4 K subsystem → completed**
  - OVC and IVC vacuum tightness
  - Cooldown to 4K
- **Phase 2: full system test → ongoing**
  - **cryogenic system fully assembled → new vacuum check**
  - **Run I: first cool-downs with no additional load:**
    - ✳ **initial problems (reached 14 mK in cooldown 1&2)**
    - ✳ **recent successful cooldown: T below 10 mK !**
  - **next steps:**
    - **Run II:**
      - wiring system (and test detector)
    - **Run III:**
      - Cold Pb shield + FCS
      - DCS + Suspensions
      - Towers support plate

Expected completion:

→ spring 2015





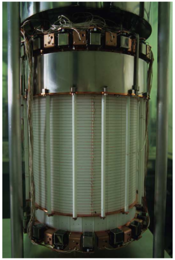
XENON program

XENON10

2005-2007
15 cm drift TPC – 25 kg

Achieved (2007)
$\sigma_{SI} = 8.8 \times 10^{-44}$ cm^2

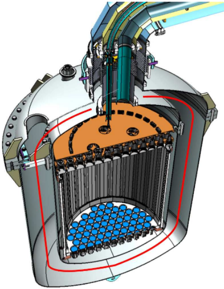
XENON100



2008-2015
30 cm drift TPC – 161 kg

Achieved (2011)
$\sigma_{SI} = 7.0 \times 10^{-45}$ cm^2
Achieved (2012)
$\sigma_{SI} = 2.0 \times 10^{-45}$ cm^2

XENON1T / XENONnT

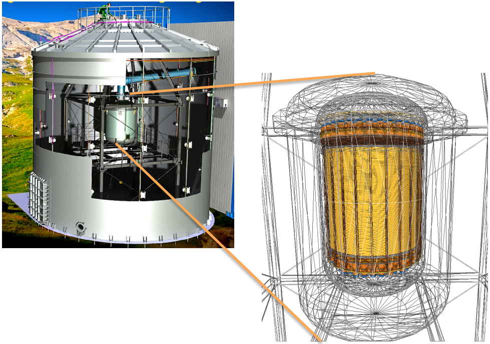


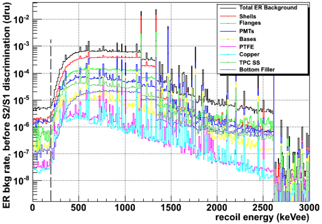
2012-2017 / 2017-2022
100 cm drift TPC - 3300 kg / 7000 kg

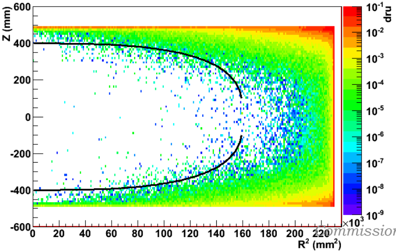
Projected (2017) / Projected (2022)
$\sigma_{SI} = 2 \times 10^{-47}$ cm^2 / $\sigma_{SI} = 3 \times 10^{-48}$ cm^2

Background prediction from MC: γ

Full Monte Carlo simulation in GEANT4 of the Water Tank, Support structure, Cryostat, TPC, PMTs.







Gamma background:
Single scatter, 1 ton fiducial volume, [2-12] keVee, 99.75% S2/S1 discrimination.

0.05 ev/y

Mainly from the Cryostat (50%), PMTs (30%) and TPC components (< 10%)

Commissione 2, Ferrara, 15 settembre 2014 33

Il Working Group

- Interesse di gruppi di ricercatori teso alla conferma della misura di DAMA/LIBRA (DL).
- Working group per attivita' preliminare:
  - nasce da ricercatori di DarkSide:
    - Milano, Napoli, LNGS.
  - si aggiungono ricercatori ROMA1.

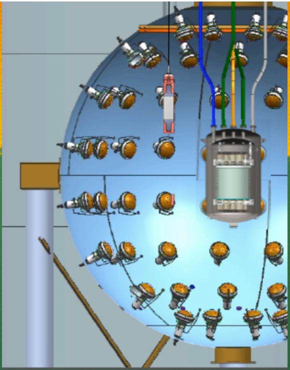
SABRE

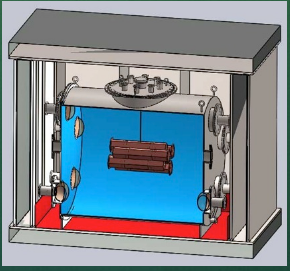
Sodium iodide with Active Background REjection

Nasce in DarkSide. Goals:

- Cristalli di NaI(Tl) con radiopurezza ≤ DL.
- High-QE PMTs or SiPM -> soglia inferiore a DL.
- Veto attivo di scint. liquido -> full tagging del ^{40}K.

A Princeton R&D sulle polveri di NaI (ottimi risultati) e processo di crescita del cristallo (risultati da valutare) con aziende americane. Test dei primi cristalli nel veto di DarkSide, esperimento finale indipendente.





Astronomia gamma

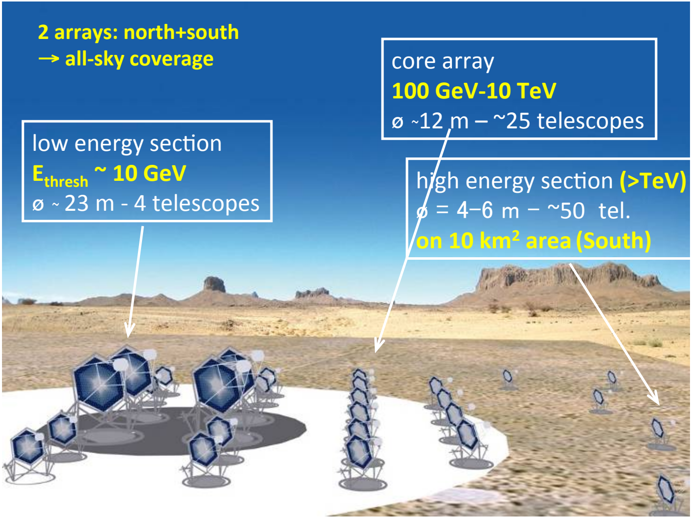
Esperimenti in presa dati

- AUGER
- AGILE
- FERMI
- WIZARD
- AMS-2
- MAGIC

R&D e nuove proposte

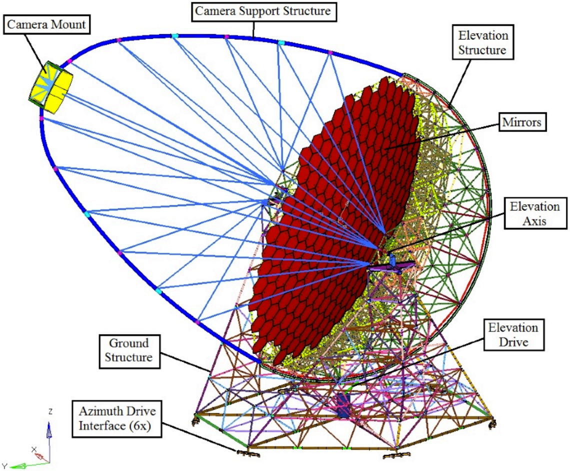
- JEM-EUSO-RD
- GAMMA-400-RD
- CTA-RD

The CTA concept (a possible design)



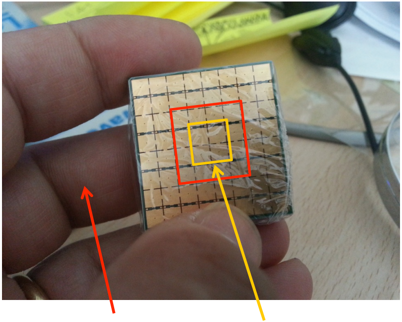
LST camera support structure

Reference design

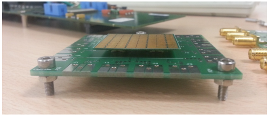


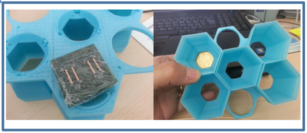
SiPM Holder PCB (Pi,Pg,Pd...)

- **Carfeful PCB design necessary to maximize the geometric efficiency**
- **Produced 10 PCBs to hold a matrix of up to 64 (8x8) SiPM 3mm x 3mm**
- **5 PCB sent to PG for NUV sensor bonding**
- To be used for
  - **LST cluster study (sum circuit of 16 or 64)**
  - **SST camera demonstrator**
  - **Characterization studies**
- Can be interfaced to
  - SUM circuit for LST
  - Preamplifier test
  - Readout board
- Light concentrators
  For SST (full?) (RM1, TO)



e.g. 50 NUVs = 2 x 16 + 2 x 4 + 10 single





Onde gravitazionali

Esperimenti in presa dati

- AURIGA
- NAUTILUS
- LISA-PF
- VIRGO
- GGG
- G-GRANSASSO
- PVLAS
- MAGIA
- MICRA
- MIR

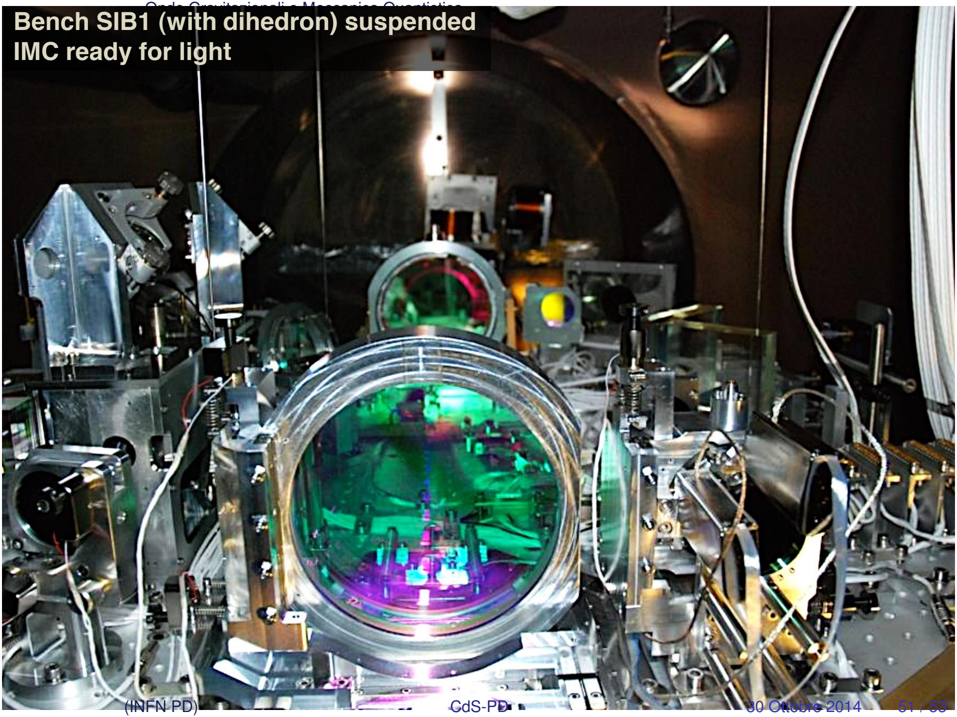
R&D e nuove proposte

- ADV-VIRGO
- RARENOISE
- MOONLIGHT-2
- LARASE
- HUMOR

Last news

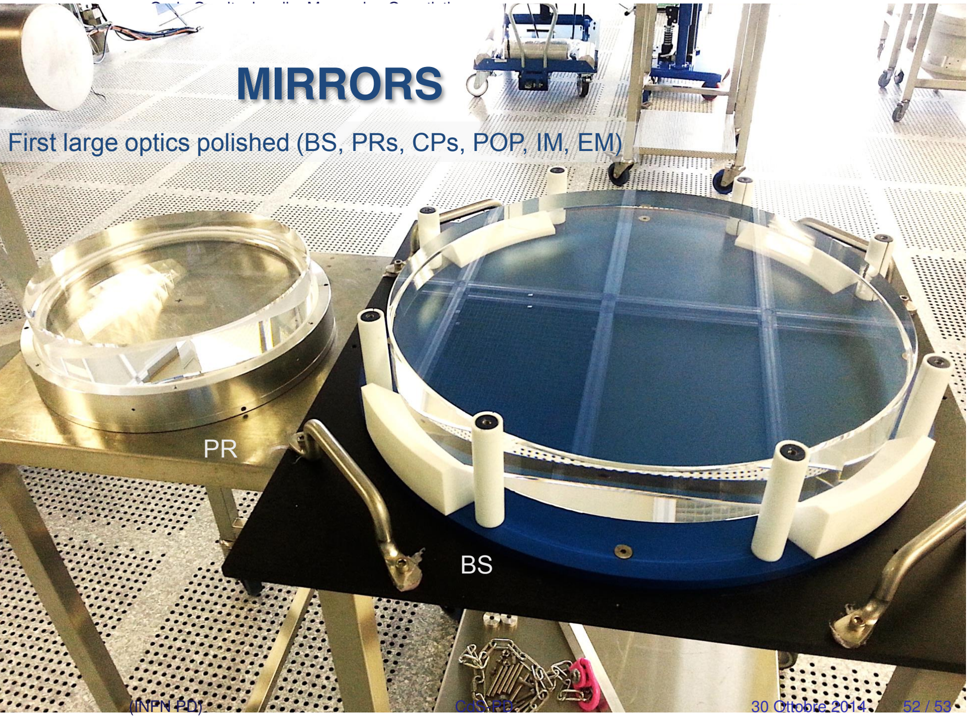
- Renewal of the MoU between LIGO and Virgo
  (1 April 2014 – 31 March 2017)
  - data exchange
  - Source localization
- Election of the new spokesperson (F. Ricci)
  (on duty since May 2014)
- Election of the new DA coordinator and of the Physics group coordinators
- Kick-off of the AdV squeezing group
  (Chairs: J.-P. Zendri, P.F. Cohadon)

Bench SIB1 (with dihedron) suspended
IMC ready for light



MIRRORS

First large optics polished (BS, PRs, CPs, POP, IM, EM)



VIRGO

Advanced Virgo

Commissioning start and future steps

- July 2014: commissioning of IMC ***started
- October 2104: SIB2 installed, finish commissioning of INJ
- Early 2015: mirrors in the central building installed ⇨ lock of the CIFT
- Summer 2015: first end mirror installed ⇨ 1-arm test
- Fall 2015: full interferometer ⇨ lock in the power recycling configuration
- 2016: commissioning of the full interferometer ⇨ noise hunting and science run