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Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA
INFN

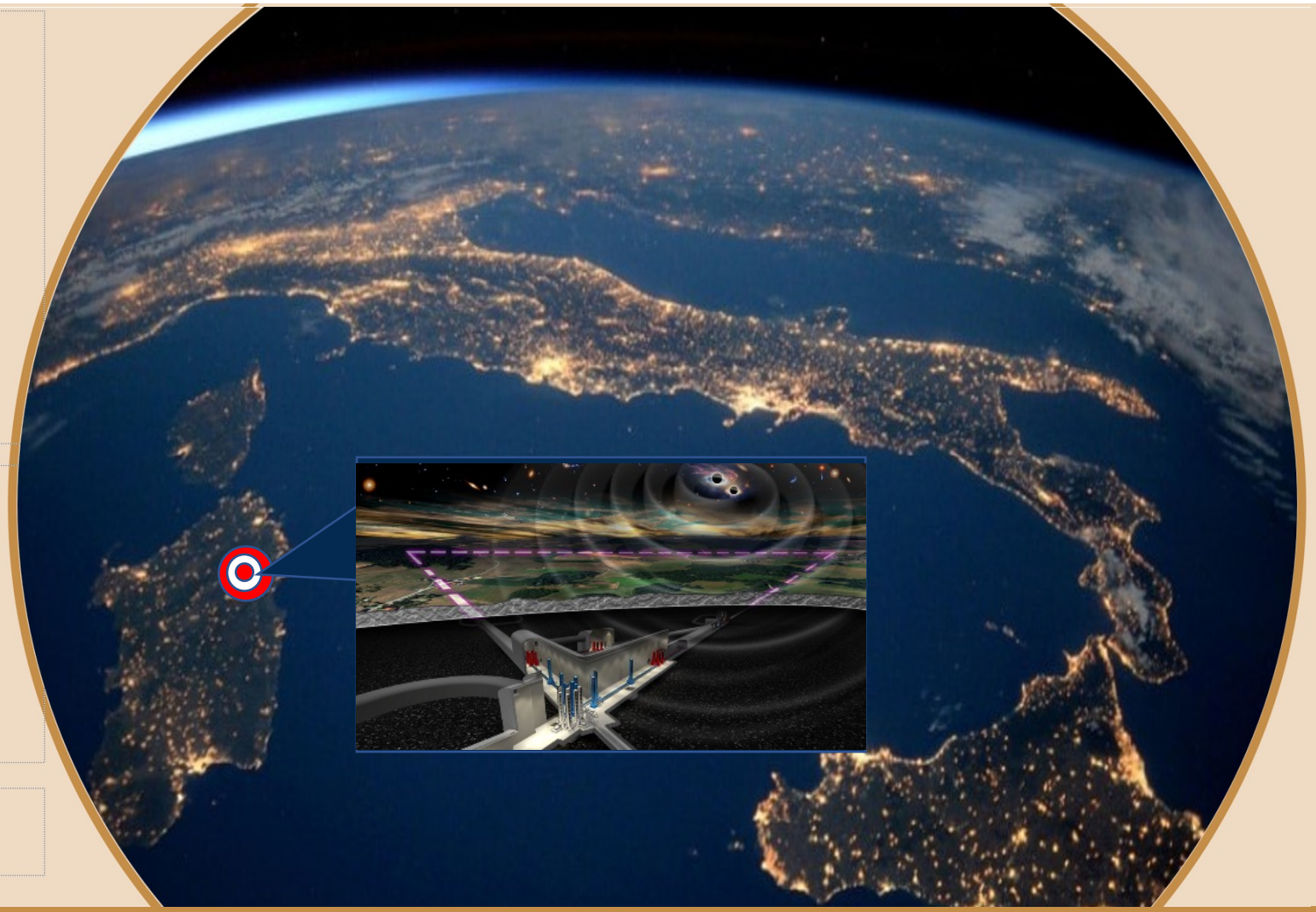
ALMA MATER STUDIORUM UNIVERSITÀ DI BOLOGNA

DIFA-ET

Università di Bologna

Dipartimento di Fisica e Astronomia "Augusto Righi«

Michele Moresco
On behalf of DIFA-ET



Team

Membri ETIC

Andrea Cimatti (contact person), Michele Moresco (deputy contact person), Beatrice Fraboni, Daniele Bonacorsi, Maria Giovanna Piazza (amministrazione DIFA), Federico Bellavita + HelpDesk PNRR (amministrazione Ateneo)

Reclutati ETIC

Sara Cepic (PhD)

Membri ET (dentro BoET)

Marco Baldi, Maria Elina Belardinelli, Nicola Borghi, Federico Boscherini, Marcella Brusa, Mario Cadelano, Enrico Campari, Roberto Casadio, Michele Cicoli, Tobias Cramer, Alexander Kamenshchik, Annarita Margiotta, Federico Marulli, Raffaello Mazzaro, Robert Benton Metcalf, Francesco Minardi, Lauro Moscardini, Massimo Nespoli, Carlo Nipoti, Cristina Pallanca, Silvia Pascoli, Luca Pasquini, Antonello Piombo, Francesca Pozzi, Marco Prevedelli, Clelia Righi, Francisco Soares, Giorgio Spada, Maurizio Spurio, Matteo Tagliazucchi, Margherita Talia, Christian Vignali

Target

Coating and computing facilities

WP2_UniBO_T013: Magnetron sputtering upgrade
WP2_UniBO_T014: Upgrade of the mechanical and mophological characterization apparatus

WP5_UniBO_T003: Phase A: Storage+Server A
WP5_UniBO_T004: Phase B: Server B

WP7_UniBO_T004: PhD UniBO

Timeline e cronoprogramma

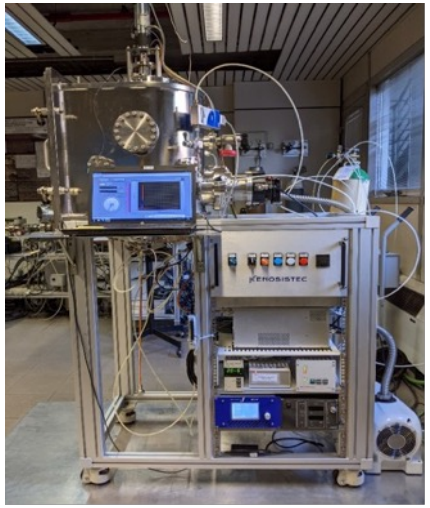
✅ Tutti gli acquisti sono stati effettuati, ed il dottorato è iniziato il 1 Marzo 2023.
⏳ In attesa della consegna dei vari apparati (attesi entro giugno 2024).

Stato delle attività WP2

Optics coating

Magnetron sputtering for thin film deposition

- Three confocal cathodes for multi-layer deposition or co-deposition
- Power supplies: 1 RF, 1DC,
- Mass flow controllers for Ar and O2 or N2) (reactive sputtering)
- Base pressure 1x10-7 mbar
- Can be adapted for combinatorial deposition



Micro-nano fabrication laboratory

- Solution deposition of thin films in glove box and controlled atmosphere (blade coaters)
- Laser direct writing and 2D patterning on 10x10cm2 area
- Surface treatments (oxygen plasma, chemical functionalization and SAM)
- Parylene thin film coater (on purchase)
- Thermal thin film deposition (metal, NaI, BCO)

Structural characterization

- X-ray Diffraction (GI and XRR on purchase)
- EXAFS characterization of local structure
- Atomic force microscopy /Scanning Probe microscopy
- UV/Vis/NIR spectrophotometer (on purchase)
- Spectral Photo current analyses UV/Vis and Xe lamp (EG, band tail states)
- DLTS/PICTS and SPV for defective states analyses

Deliverables and milestone

- All purchase orders have been activated and two out of the 4 apparatuses have already arrived and have been installed. The other two items are expected to arrive in a couple of months
- Sara Cepic (PhD student) has been trained for thin film deposition and is participating to the ET-Italia workshop

Stato delle attività WP5

Computing

Aim: build and manage an agile computing cluster to boost the R&D and prototyping phase in the design and testing of innovative ET applications, via an heterogeneous computing platform; CPU/GPU-enabled testbed for algorithm design and testing, training and inference of ML/DL models, limited-scale processing and simulation tasks, and pre-production test of the complete workflows.

Hub in synergy with BETIF resources as part of a federated DIFA-INFN joint lab in Bologna: investment in storage space and GPU-based servers. Possibile connection to FPGA resources locally also hosted.

Storage server. ThinkSystem SR665, arrived at DIFA on 13/2/24, to be installed and configured.
GPU server. Rack server with spaces for GPUs. Server ready, but waiting to install the GPU to be delivered (estimated mid-June 2024)
GPU. Purchase in sinergy with INFN-Bologna (BETIF, contact: R. Travaglini)

Deliverables and milestone

- Next activities: install, configure and test. In the meanwhile, organization of scientific activities and training of involved Ph.D. students

Finanziamenti sinergici

- Partecipazione al Centro Nazionale HPC (Spoke 2):

  - 1 PhD **M. Tagliazucchi**: Ottimizzazione di codici di analisi cosmologica con GW in ottica di 3G network GW;

  - flagship UseCase su GW e cosmologia.

- Co-I PRIN2017 “The new frontier of Multi-Messenger Astrophysics: follow-up of electromagnetic transient counterparts of gravitational wave sources” (Responsabile Locale: M. Moresco):

  - 1 PhD (concluso) **N. Borghi**: “Unveiling the Expansion History of the Universe with Cosmic Chronometers and Gravitational Waves”.

- DIFA: banditi 2 posti (1 PA FIS/05 e 1 PO FIS/01) art. 18 comma 4 riservati a esterni per attività GW;

- Stretta sinergia con la missione ESA Euclid (DIFA tra i fondatori della missione e attualmente con ruoli chiave in diversi ambiti della missione):

  - Science case Euclid x ET in fase di studio nella collaborazione Euclid;

  - potenziali sinergie in vista della DR1 Euclid

- Stretta sinergia con INFN-Bo (BETIF) su computing.

Ruolo in ET

Bologna ET (BoET) Research Unit

Università di Bologna - Dipartimento di Fisica e Astronomia "Augusto Righi" + Istituto Nazionale Di Fisica Nucleare - Sezione di Bologna
Attuale Research Unit Leader: M. Moresco (UniBo-DIFA)

(1) Observational Science Board (OSB) – Cosmological exploitation of GW data, development of pipelines for the analysis of simulated GWs, multi-messenger data analysis.

(2) Electronic/Computational Infrastructure Board (EIB) - Development of FPGA-based electronic boards and the relative firmware development, to implement low-latency workflows and parallel algorithms design, real-time/online DAQ and data processing, time synchronization with the White Rabbit technology for very accurate timing and clock stability.

(3) Instrument Science Board (ISB) - Coating studies through well-established expertise in deposition of oxide thin films and multilayers, absorption Fine Structure (XAFS) and X-ray Scattering (XRS) experiments for short (<4 Å) and medium-range (4-10 Å) atomic structure analyses, molecular dynamics simulations to develop a realistic model for the amorphous coating, mechanical loss measurements from the macro to the micro scales.

(4) Site Characterization Board (SCB) - Contribution to site characterization through expertise in seismicity and seismic noise, stability of slopes and landslides, in situ stress studies, high-precision vertical displacements determinations on the basis of new generation gravimetry, deformation models.

(5) Education and Training - DIFA Bachelor, Master, PhD courses (with more than 130 students enrolled every year) + INFN-Bo contribution to DIFA PhD. New GW course activated at DIFA.

Necessità Future

- **Infrastrutture:** costruzione e sviluppo di un laboratorio ET congiunto DIFA-INFN-Bo per calcolo, coating, simulazioni GW, formazione di Ph.D. e studenti/sse presso parte degli spazi CNAF Tier-1.
- **Contributo a Virgo:** in discussione la partecipazione in Virgo nel prossimo periodo.
- **Filiera di formazione DIFA**: aumento dei corsi GW al DIFA, borse Ph.D. e postDoc per sostenere attività di ET.
- **Fondi EU e nazionali:** sviluppo progetti e richieste di finanziamento beneficiando di bandi nazionali/internazionali nel prossimo periodo per espandere e rinforzare le attivita' di ricerca su GW.