SO planning

M. Martinez, 13th June 2025

SO Infrastructures Meeting

Goals of this meeting

- Put all the ideas on the table
- Identify overlaps across groups and synergies
- Try to build a consensus on top-5 short list possibilities considered feasible
  - Focus on small number of items with impact
  - Focus on new capacities
- We will not decide anything here on the spot —
- I will not allow departing from SO spirit & strategic goals —
- SO is here to help —but not to patch known problems that need to come from IFAE

SO2024 strategic goals — as proposed

A. To establish IFAE as a leading European institution in the field of GW research, with ET as flagship project, thus placing IFAE at the center of future discoveries in fundamental physics and the future breakthroughs in our understanding of gravity, cosmology and the evolution of the very early universe, for which the use of GWs is regarded as a new revolutionary area of research.

B. To prepare the Institute for the next generation of experimental challenges (HL-LHC and future colliders, LSST, CTA, Hyper-Kamiokande, and ET), with a renewed leadership, keeping gender and diversity aspects at the core of the considerations, taking affirmative actions to attract scientists and new world-wide recognized young leaders to IFAE, and provide them with the necessary start-up funds, infrastructures, training resources, and scientific networking opportunities. Renewed efforts on education and dissemination activities at IFAE will serve to attract new generations to our field and to promote women in science.

C. To consolidate the applied physics research line. The expertise in cutting-edge instrumentation for state-of-the-art experiments in particle physics and astronomy constitute a key competitive advantage to generate knowledge and technologies in the areas of medical physics, quantum sensing and quantum computing. IFAEs close relationship with the partner BIST centers that work in photonics or nanotechnology further enhance such advantages.

Infrastructure

To be discussed

- Initial considerations
  - Actions would take a clear strategic character building new capacities and follow SO strategic goals
  - If transversal — better
  - For big items we shall add money for covering the technical support
  - Maintenance should come from SO-overheads (10% of declared value over 10 years)
- Big items only possible via Infrastructure co-funding calls — as much as possible
- If co-found calls not successful immediately we need to reconsider the strategy
- And space — we need to have the space

Infrastructure 1M€ — 1.2M€
(maintenance 0.3M€-0.4M€ from overheads)

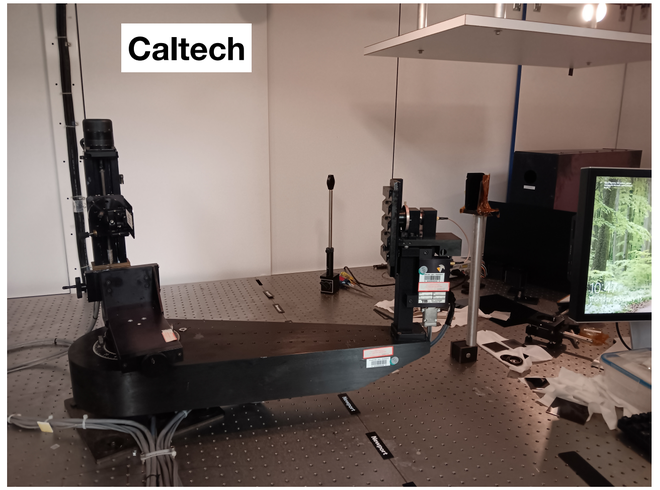
Technical support
(0.3M€ - 0.4M€)

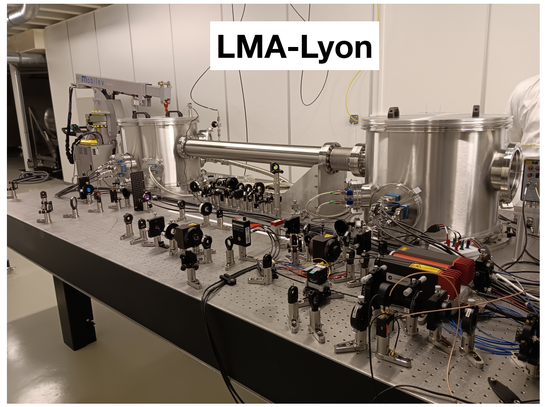
SO investment
(1.3M€ - 1.6M€ — direct cost)

Infrastructure (GWs)

Hardware in precise optics is all very expensive….

- **Possible hardware improvements (just an inclusive list) — we cannot aim for all**
  - **Upgraded existing optical setups / IR lab [50k€ - 80k€] — some overlap with items below**
    - Better and more stable lasers, calibrated photosensors, filters, optical tables, collimators, etc…
  - **Dedicated setups for BRDF , BSDF and TIS measurements - IR Scatterometer Setup [200k€ - 250k€]**
    - Nothing good enough is now in IFAE — we rely on measurements in Madrid, EGO and Padua
    - Caltech setup (great angular precision and robotic/automatic) - serves industries as well
    - Might be of interest for other centers and industries
  - **UHV setup including RGA capacities [150k€ - 200k€]**
    - Totally new capacity — we now rely on voluntary work done at CERN and EGO
    - Might be of interest for other centers and industries
    - Complementary to the TVAC but with higher vacuum requirements — 10^-9 — 10^-11 mbar
  - **Optical table 1m x 3 m with a FP resonating cavity under UHV [150k€ - 200k€]**
    - A capacity to understand whether our detector devices affect the performance of cavities in LVK/ET
    - In combination with the UHV setup allow us to carry out a full characterisation in house
    - Used at LMA to characterise the performance of new mirrors, coatings, etc..
    - Might be of great interest for other centers and industries
  - **3-axes Magnetometers to fully characterise the EM emissions of instrumentation [20k€ - 30K€]**
    - Instrumental to determine our instrumentation does not inject noise to LVK/ET
    - Might be also of global interest for other groups
- **Technical personnel. — mandatory — 300k€**
  - Support for vacuum tests 1FTE
  - Support for optical setups 1FTE





MEDICAL

1-Enlargement and staffing of the micro-electronics CR

Improvements:
-Increase space
-1 FTE technician dedicated to CR
-New flip-chip machine (see after)

Impact:
-Upgraded CR capabilities
-More throughput for internal projects
-Potential to offer services to external institutions

MEDICAL

1.1 Equipment: flip-chip machine

- New flip-chip machine co-funded (450k€ is needed. full price 900k€).

The current flip-chip machine is 18 years old.
Not easy to repair because there is no replacement parts
It is about to die any time. It is urgent to acquire one because it is indispensable equipment for ATLAS and Medical image and possible QC

- 100k€ for repair the rest of the machines in the CR

2-Increase space: Grey Room and CM7

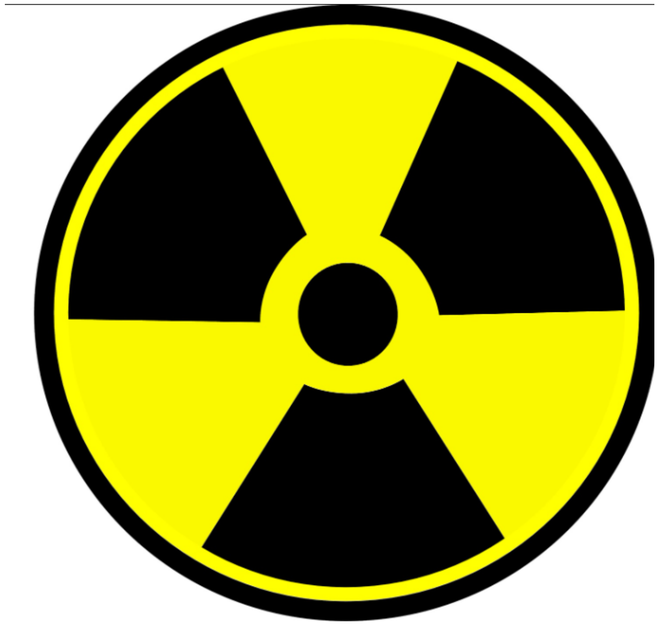
Improvements:
-Enough space, currently not enough
-Strategic overlap of spaces among groups

Impact:
-Sustainable growth of applied physics without impacting other groups

MEDICAL

3-Radioactive Liquids in X-Ray room

MEDICAL



Improvements:
-Adapt X-ray room and radioactive use facility to manipulate non-encapsulated sources

Impact:
-Capacity to manipulate phantoms and run standard medical imaging protocols
-Among others, capacity to evaluate capacity of VIP-PET scanner, not yet done (since 2017!)

QCT

-**Manual wire bonder (35k€)**: Existing automatic wire bonder is overkill for the QCT group, where the operation is with prototypes, one at a time (no standardization). Also, availability of the existing tool at IFAE is limited to 1 workshop engineer. A manual tool is highly needed to obtain: 1) flexibility in the timing (both wait time and duration) to perform wire bonding, and 2) in the designing of devices where a manual wire bonder allows designs with no constrains.

-**Vector Network Analyzer (VNA, 60k€-120k€):** These type of analyzers perform frequency characterization of devices in the frequency range kHz~20GHz. The QCT group is currently using an IFAE-owned VNA which is over 20 years old, giving signs of proximal death, with no available spare parts. Also, this instrument is limited to 8.5GHz which limits characterization of devices to this frequency. A functional VNA is crucial for the characterization of devices and cavities both at room temperature and at low temperature. Desirable frequency range: up to 20GHz.

ATLAS

Infrastructure

Problem: poor state of IFAE micro-electronics lab (problem also for medical physics and other IFAE users as “clients”)

- **FC 150 (flip-chip machine)**
  - Barely working, last intervention May 2025: “After many restart the machine was enough stable to be used but we can’t guarantee how many times you will be able to use it , this equipment is obsolete and even for us ; provide software assistance is a real challenge.”
- **X-ray inspection**
  - Tube vacuum error makes difficult to turn on
- **Pull-tester**
  - Does not work for more than ~2 months (cartridge being repaired… still unclear)
- **Wire-bonder**
  - Machine damaged after repeated water leaks years ago, last intervention March 2025
  - Problems with alignment of pads and visual display
  - Bond force degradation
- **Tight space in lab**
- Other (logistics, bureaucracy...)

Need more details

Pre-Compliance EMC test facility

★ Space needs:

- Upgrade existing shielded room into a semi-anechoic chamber for in-house EMC testing

★ Investment:

- Chamber conversion (absorbers): **40-80k€**
- Instrumentation: **100-130k€**, including:
  - GTEM cell and broadband antennas
  - LISNs + CDN (conducted tests)
  - EMI receiver + spectrum analyzer
  - RF signal generator + amplifier
  - ESD, EFT, and surge generators
  - Field probes + control software

★ Operations and maintenance

- Annual calibration (~**5k€/year**)
- Run by trained electronics engineer (0.1-0.2 FTE)

★ Enable tests:

- Radiated & conducted emissions
- Immunity (RF, surge, burst, ESD)
- Space electronics pre-qualification

★ Strategic value:

- Project de-risking
- Enables faster, cheaper R&D and qualification of prototypes
- Enhance competitiveness & leadership in international consortia
- Builds critical, highly-valued skills and provides training assets for IFAE scientific and technical personnel
- Service to spin-offs and local industry

GAMMA RAYS

Shaker

★ Space needs:

- ~40-50 m^2 dedicated room with a high ceiling (>4m for crane access) and reinforced floor to prevent building vibrations

★ Investment:

- Complete shaker system (~**400k€**), including:
  - shaker,
  - amplifier,
  - slip table,
  - controller,
  - sensor suite

★ Operations and maintenance

- Initial training (~**10k€**) by vendor.
- maintenance/calibration contract with vendor + consumables (~**20k€/year**)

★ Enable tests:

- Random vibrations
- Sine vibrations
- Shock response spectrum
- Constant acceleration
- Rapid iterative testing

★ Strategic value:

- Project de-risking
- Enables faster, cheaper R&D and qualification of prototypes
- Enhance competitiveness & leadership in international consortia
- Builds critical, highly-valued skills and provides training assets for IFAE scientific and technical personnel
- Service to spin-offs and local industry

Cosmo

- R&D: we have also been discussing ways for our group to join the next-generation spectroscopic surveys, in particular DESI-II (start 2029) and its continuation Spec-S5 (start 2035). Following our contribution to DESI (the guiding and focusing cameras), we have considered similar in-kind contributions, but the field is moving quite rapidly and the Technical Division of IFAE risks falling behind. We thought it could be useful for IFAE as a whole to invest in R&D for future detectors that would substitute (or complement) the now ubiquitous CCDs, like CMOS detectors or “skipper CCDs”, currently being developed at FermiLab and Berkeley Lab. We would also like to increase the infrastructure for testing IR and VLWIR detectors for future missions in Space. We have a great opportunity given our responsibilities in ARRAKIHS and the EU ATHENA project to continue in this field of research.

—> Here we need more details

Building a matrix of synergies

	GW	Medical	QCT	ATLAS	Gamma-Rays	Cosmo	1/2 cost
Flip-chip machine							450k€
Radioactive Liquids — infrastructure							30k€
Manual wire bonder							20k€
VNA							60k€
EMC tests/Magnetometers							130k€
Optical / IR Lab							50k€
UHV + RGA							100k€
FP Cavity							100k€
IR scatterometer							130k€
Maintenance existing machines in clean room							100k€ (full)
Enlargement of clean rooms							???
							1.1M€

In principle via co-funding we could honor all the requests provided the space exist
I did not include the cost of building new space in the Lab for Clean and Grey Rooms
SO should not pay for the maintenance of the existing hardware… should come from IFAE budget.. overheads …

Last call for Infrastructures and Technicians were in Fall 2024 — we need to prepare for this fall applications

Let’s discuss