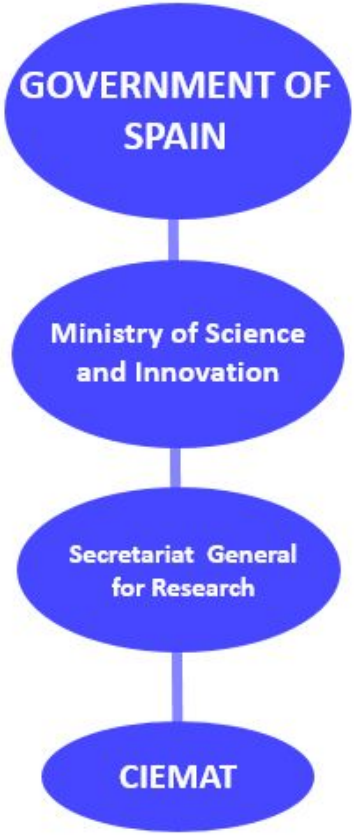
CIEMAT

National laboratory under the Spanish Ministry of Science, and Innovation through the Secretariat General for Research

Personnel: 1200 (30% PhD)
Running cost: 100 M€/year

Headquarters in Madrid



Resources

CIEMAT team at Virgo

Name	Teaching	Virgo%	Author	Student/ Postdoc	Topical Fractions
Carlos Delgado	No	50%	Yes	No	DA & INST
Pablo García Abia	No	50%	Yes	No	DA & COMPUTING
Carlos Diaz	No	50%	Yes	No	INST
Miguel Polo[1]	No	40%	Yes	No	INST
Gustavo Martinez	No	10%	No	No	INST
Miguel Cardenas	No	40%	Yes	No	DA & COMPUTING
Gonzalo Merino	No	40%	Yes	No	COMPUTING

+ Daniel Beltrán (student) in data analysis
+ Salvatore Mangano(senior) maybe for data analysis

PEOPLE

Carlos Delgado Méndez
Staff researcher – Contact
CTA, AMS, Virgo, ET

Pablo García Abia
Staff researcher – Contact
DarkSide, Virgo, ET

Carlos Diaz Ginzo
Mechanical engineer – Contact
CTA, AMS, DES, PAU, Virgo

Gonzalo Merino Arévalo
Staff Researcher – Contact
PIC, Virgo, ET

Miguel Polo Rodríguez
Mechanical Engineer – Contact
CTA, DES, PAU, Virgo

Miguel Cárdenas Montes
Staff Researcher – Contact
Computing, Virgo

Gustavo Martínez Botella
Electronics Engineer – Contact
CTA, AMS, Virgo

Salvatore Mangano
Staff Researcher – Contact
CTA, Virgo

Computing resources available for CIEMAT

WLCG Tier-2 Centre at CIEMAT: main user is CMS, possibility of opportunistic use of a fraction of these resources

CIEMAT Tier-2 resources

- 2 Petabytes of Disk storage
- 2500 CPU cores of compute capacity
- 2 x 10 Gbps WAN connectivity
- Swtiched Ethernet LAN connectivity with 10Gbps links (aggregated bandwidth ~1Tbps)

Puerto de Información Científica (PIC): require a dedicated investment to be used for Virgo

- 35 Racks with a total capacity of 1500U
- 550 kVA UPS and 2MWA diesel electric generator
- 9 Petabytes of Disk storage
- 53 Petabytes of Tape storage capacity (used 24 TB).
  24 drives, 3.5 GB/s aggregate read throughput.
- 8000 CPU cores of compute capacity
- Switched Ethernet LAN with 10Gbps links (aggregated bandwidth ~1Tbps)
- 2x20 Gbps WAN

Computing resources available for CIEMAT - II

A collaborator is a person working on a CIEMAT project. Another form of collaborator is someone who has come to do a stay, or an exchange.

High Performance Cluster - XULA: CIEMAT users (collaborators?)

- XULA computing nodes:
  a. 44 x PowerEdge C6420 nodes with 2 x Xeon Gold 6148 2.4Ghz 20 cores, ram 192 GB
  b. 1760 cores and 135 TFlops peak
- XULA2 computing nodes:
  a. 56 x Lenovo Thinksystem SD530 with 2 x Intel(R) Xeon(R) Gold 6254 CPU @ 3.10GHz, ram: 192 GB
  b. 2016 cores and 200 peak TFLOPS.
- Login nodes:
  a. 2 x PowerEdge R640, processor: 2 x Xeon Gold 6130 2.1Ghz 16 cores, ram: 128 GB
- Storage:
  a. 2 x PowerVault ME4084 enclosure each with 28 x 12TB 7.2k NLSAS 12GB 3.5" disks
  b. 56 disks each of 12TB (339T net)
- Interconnection networks
  a. 10GbE ethernet network for management
  b. 100Gb/s infiniband EDR 100Gb/s network for the computing nodes.

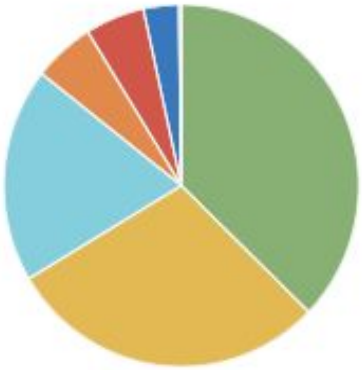
The implemented system is based on the OpenHPC 1.3.7 architecture, based on CentOS 7.6.

VIRGO/LIGO opportunistic access to PIC

In place since Jul 2019

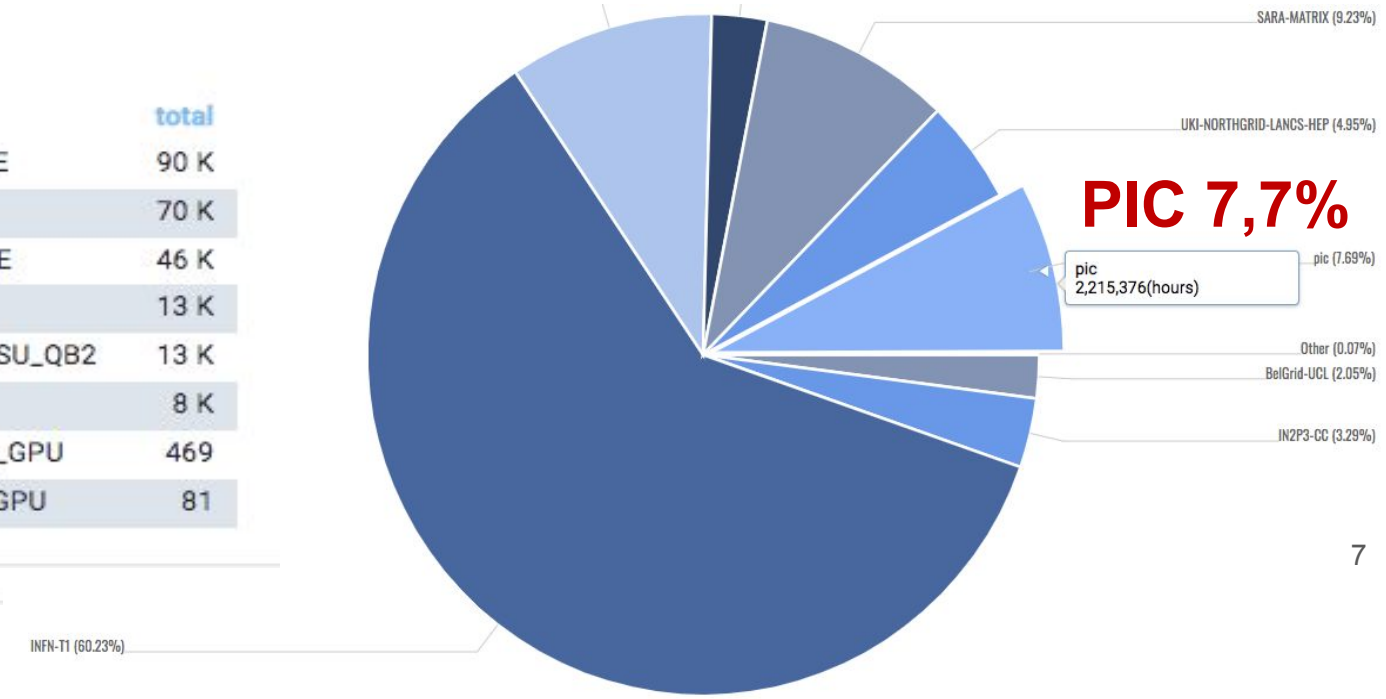
- **VIRGO CPU 2020: 2.2 Mhrs at PIC, 3rd top EU country after IT and NL (~8% contribution)**
- **VIRGO GPU 2020: 8 khr at PIC, top (only) EU contributor (~4% contribution)**

GPU hours (from OSG portal)



	total
LIGO-CIT-CE	90 K
Crane	70 K
LIGO-WA-CE	46 K
SDSC-PRP	13 K
LIGO_US_LSU_QB2	13 K
pic	8 K
ND - CAML_GPU	469
ND - CMS_GPU	81

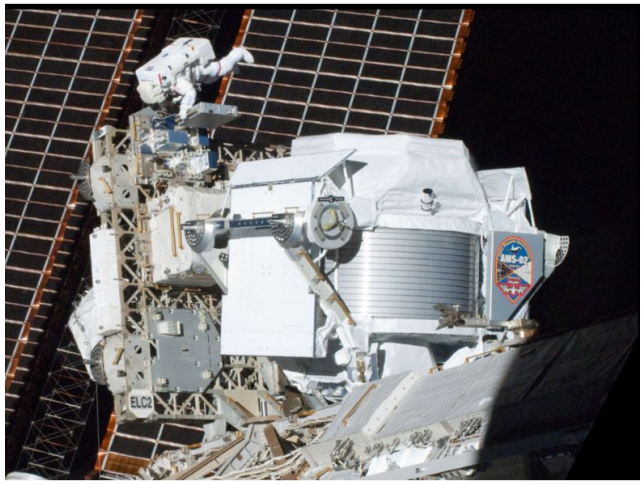
CPU hours (from EGI portal)



Hardware experience

CMS muon DT (30%)
Production & AIV

Design, AIV and operation of the RICH detector of AMS



Design, AIV of the camera of the CTA-LST

Full responsibility, together with IFAE, of ProtoDune light detection system

Design, AIV of passive neutron shielding of DarkSide

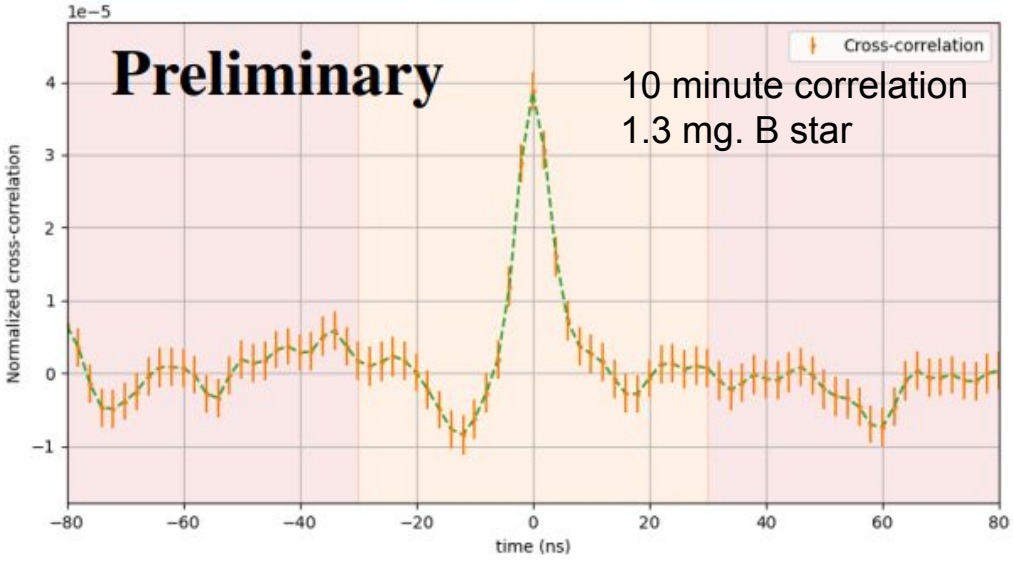
PAUCam CCD & filters validation, Mechanics & cooling design of crates

Some (close to Virgo) analysis contributions

Low level realtime analysis of intensity interferometry data in Cherenkov telescopes:

- Compute the cross-correlation of two data streams sampled at 500MS/s for hours with no deadtime
- Make uses of long streams (0.5 seconds, 2^18 samples per channel) realtime FFT computations in GPUs (together with some processing)
- Hardware, DAQ, low level analysis and high level analysis produced at CIEMAT.
- Seed for an ERC grant project

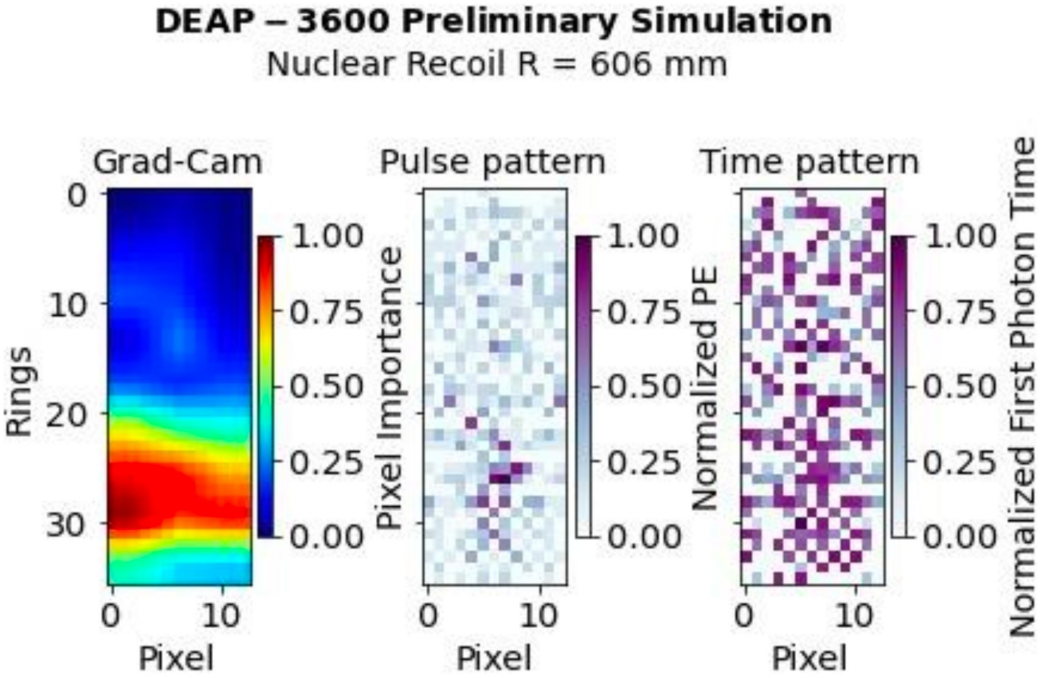
For more information:
https://inspirehep.net/files/df2ff63989c7c011beecd7a50c327f4a

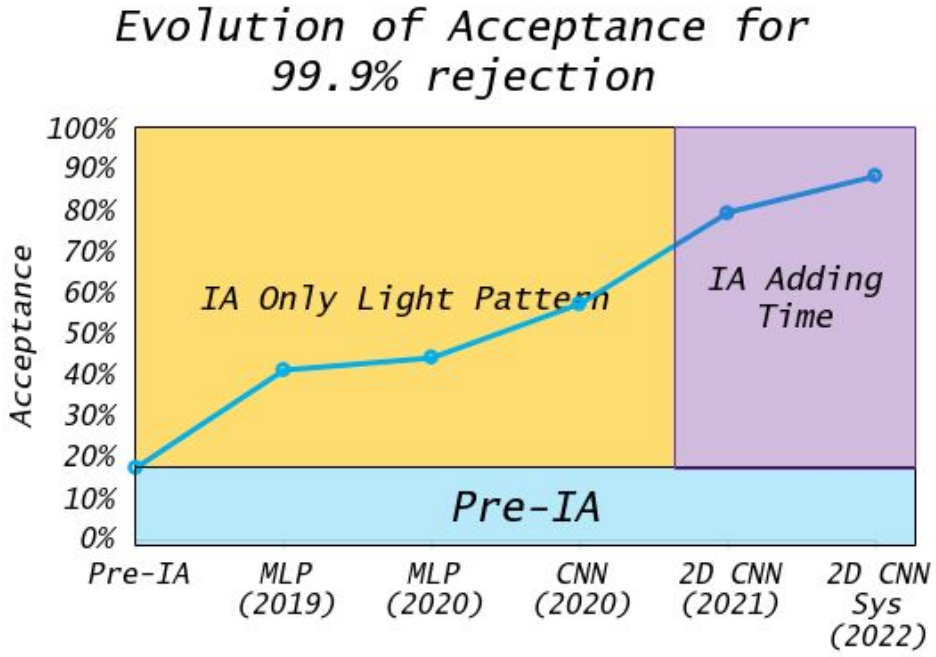


Some (close to Virgo) analysis contributions - II

ML analysis of Dark Matter experiments, Air Quality (indoor-outdoor) and Health.

- Use of CNNs and XAI to identify neck and dust events of DEAP-3600. Continued effort!
- More information in Miguel's presentation today.
- Articles:
  - "*Uncertainty Propagation and Salient Features Maps in Deep Learning Architectures for Supporting Covid-19 Diagnosis*", in AI and ML Methods in COVID-19 and Related Health Diseases (Springer) 2022
  - "*PBIL for optimizing inception module in convolutional neural networks*", in Logic Journal of the IGPL (Oxford UP) 2022
  - "*Estimation of Machine Learning model uncertainty in particle physics event classifiers*", in Comp. Phys. Comms. (Elsevier) 2021.



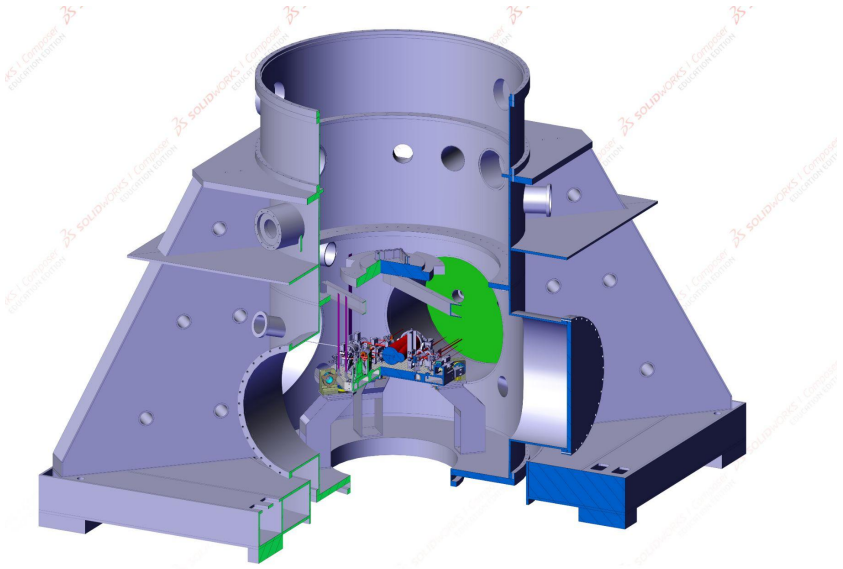


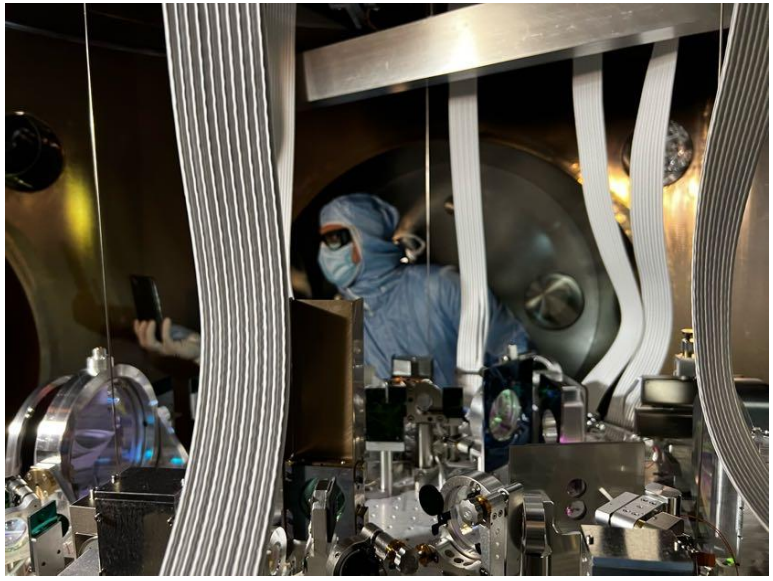
Contributions to Virgo

Hardware contribution I: Scattered light mitigation at output port

Reduction of the (stray) light intensity detected in the output port, to reduce its impact in the sensibility.

Main challenges (so far) is the lacking of room to install it.



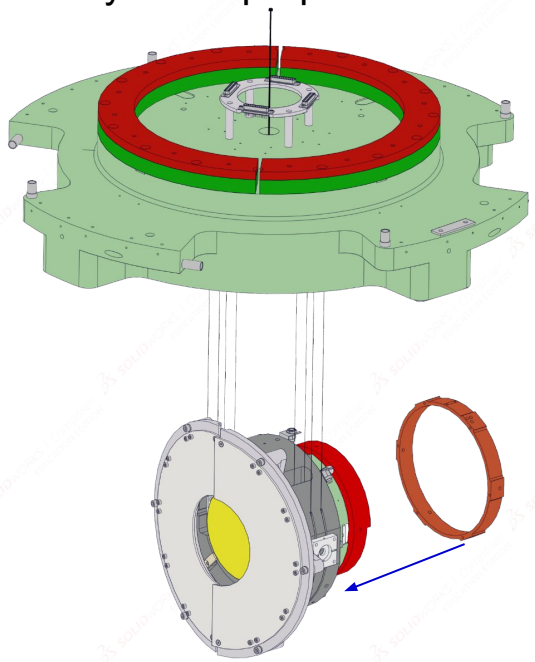


Hardware contribution II: Adding ROC tuning in IMC payload for O5

Design and production of the support structure of the payload to hold a ring heater to tune the mirror ROC of the IMC payload.

Aiming to improve the stability of the input Mode Cleaner cavity.

Main challenge (so far) is to keep the dynamic properties of the payload after modifying it.



Computing contribution I: offsite low-latency pipelines for O5

Two phases:

- First instance of the computing cluster for low-latency pipelines at CIEMAT in a rather short term. That would allow us to get acquainted with the software and hardware requirements.

- With that experience in hand, for O5 we would set up a production cluster at PIC with up-to-date hardware and a higher service level.

Requirements:

- Having the the possibility to make some customizations like:
  - at system management level, opening some ports for allowing low latency data transfer
  - installation of software packages on shared disk areas visible on the whole cluster (via CVMFS of NFS)
- Approximate sizing in term of CPUs/HS06
  - two stand alone virtual machines (dedicated to online data transfer/data distribution): 24 CPU / 290.4 HS06
  - HTCondor farm: 240 CPU / 2904 HS06
  - For a total of 264 CPU / 3194.4 HS06
- Approximate sizing in term of storage
  - Limited requirements: in the order of few TB made visible to all nodes of the cluster via NFS

Analysis software

- (X) machine learning to improve/accelerate searches (See Miguel talk)

- Usage of acceleration technique in pipelines (?)
  - A la intensity interferometry at CIEMAT

Physics Analysis

Long standing interest, due to our background, on:

- Dark matter searches (primordial black holes, clumps in the environment of massive objects)
- Cosmology (measurement of parameters)
- Multimessenger follow up studies of sources with EM and neutrino counterparts
- Others…