University of Athens

The IASA/UoA outreach team:
Christine Kourkoumelis
Dimitris Fassouliotis
Stelios Vourakis
George Vasileiadis

HEP in (Greek) classrooms

- European and International efforts/resources
- National Masterclasses
- CERN expositions
- Science fairs in Greece
- The HYPATIA tool for University students

The HEP main challenge:

How can we provoke students' curiosity for HEP? (which in most countries is absent from the national curriculum)

- So far a lot activities for high school students (IPPOG's International Masterclasses, mini-masterclasses, virtual visits to the experiments, Quarknet, etc etc)
- The students get engaged in hands-on experimentation directly connected to **top-level real-time research** and discoveries
- EU outreach projects developed a lot of material which is ready to be used in **the duration of a school lesson**
- **At University level enhance labs with research tools**

European/International efforts

- EU outreach programs
- IPPOG Masterclasses
- Beamline for schools
- Non-accelerator masterclasses

The running EU outreach projects + CREATIONS

➢ Go-Lab (Nov. 2012 - Nov.2016, 20 partners)

❖**Online science laboratories for the large-scale use in schools**

http://www.go-lab-project.eu/

GO-LAB

- ➢ 385 on-line labs
- ➢ 343 Inquiry Learning Spaces
- ➢ 37 Apps

In all STEM curricula subjects in 10 languages

➢ Inspiring Science Education (ISE) (Just ended 31/7, 31 partners)

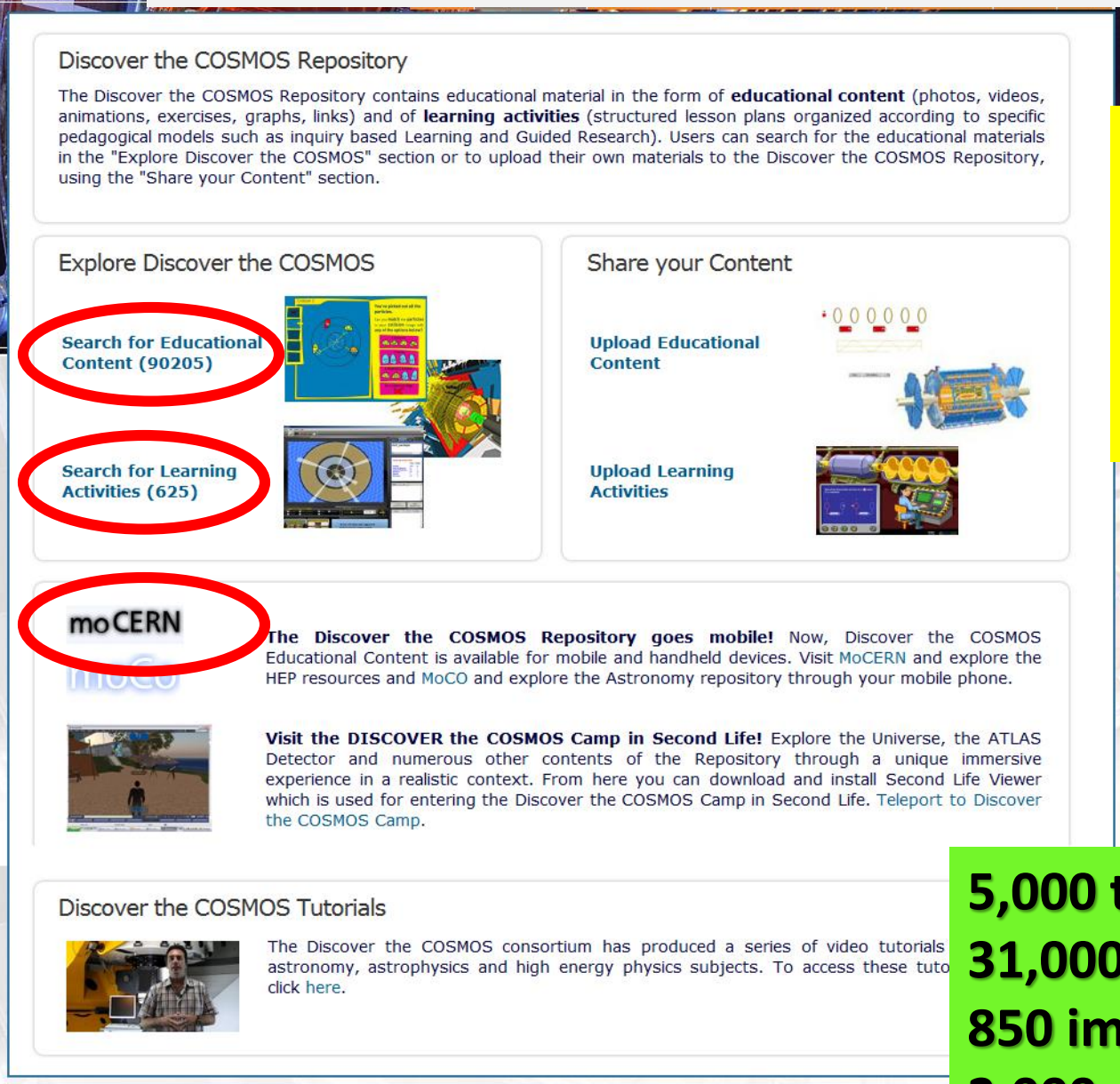
❖**eLearning tools for 5,000 schools in 14 countries**

inspiring SCIENCE education

http://inspiring-science-education.org/

- ➢ 120 Demonstrators (in all STEM curricula subjects)
- ➢ +Harvested existing repositories with 278,000 educational resources (mainly ODS and DtC)
- ➢ **In forty months has reached 5,000 schools**

Past project: Content of Discover the COSMOS



Repository

~ 95,000 items in Educational content
~ 630 educational scenaria (HEP/Astronomy)

HEP tool-box
- **HYPATIA**
- **MINERVA**
- **CAMELIA**
- **CERNland**
- **LHCgame**

5,000 teachers and
31,000 students reached
850 impl.activities in schools
2,000 schools and continuing

CREATIONS

Developing an Engaging Science Classroom

New project
1+2 years

http://creations-project.eu/

Developing an Engaging Science Classroom

- 36 months, 1,8 ME , 7 WPs
- Coordinator: University of Bayreuth
- Summer school for teachers and students

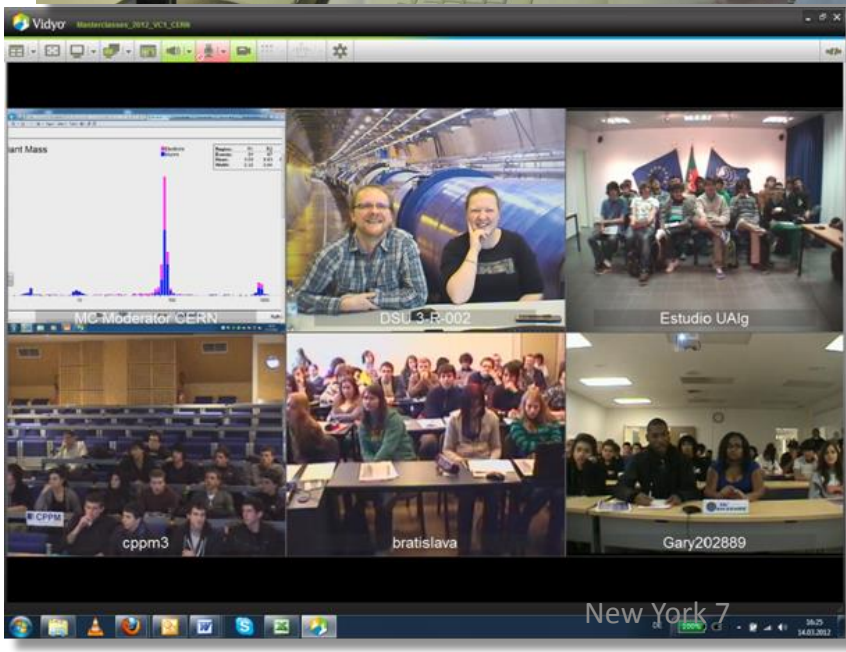
http://creations.ea.gr/

16 Partners

CERN (Art@CMS), UoB, IASA, STFC + Quarknet +Science Opera etc

IPPOG's International Masterclasses

- **High school students (15 – 19) are "scientists for one day"**
- **Get invited to a research institute or university**
- **Introductory talks**
- **2 h measurement with LHC data (ATLAS, CMS, ALICE, LHCb) +New also with Icecube data**
- **International video conference (2 – 5 inst. + CERN/Fermilab)**



International Masterclasses

This year: 11 February – 23 March 2016

46 countries – 213 institutes – 13’000 high-school students – 1’100 teachers

IPPOG masterclasses in Greece (2016)

Athens

- Athens Univ.
- N.R.C. Democritos
- NTUA

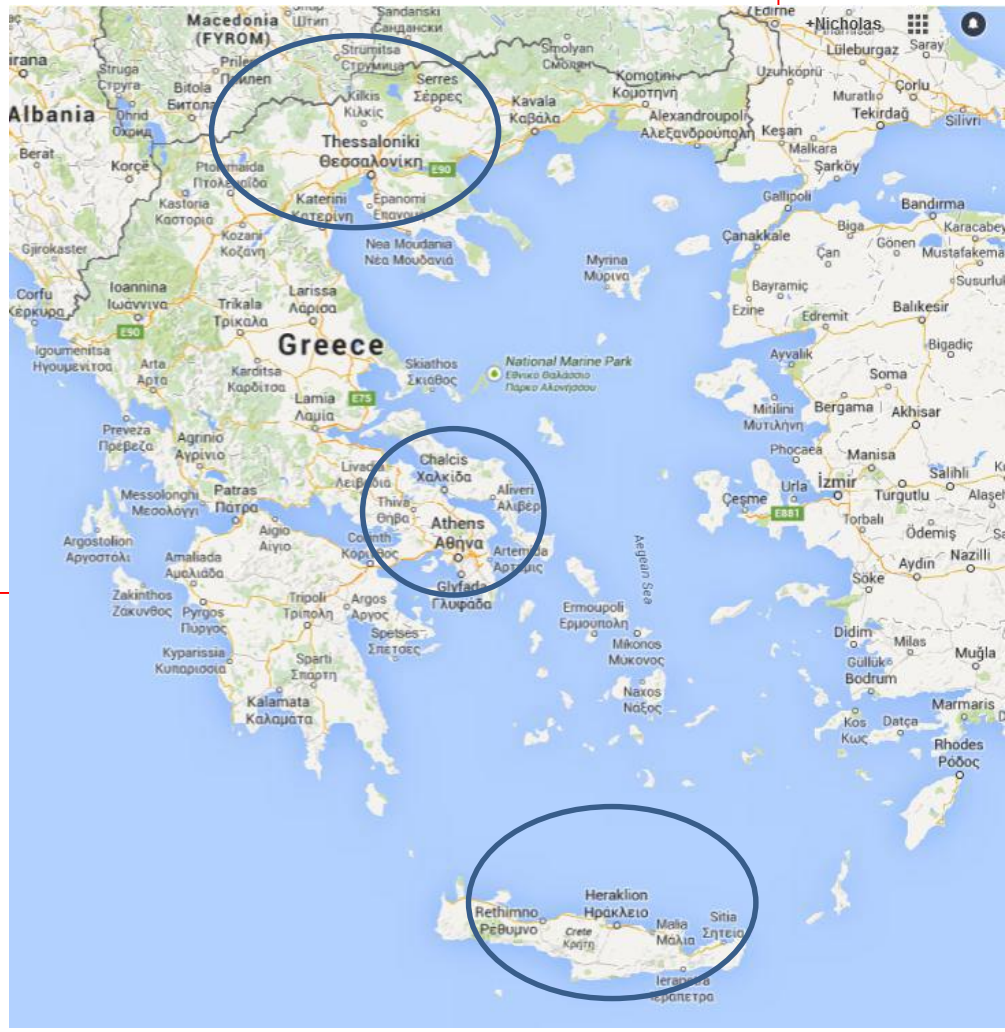
Applications from 74 schools (~370 students) for 220 places (+ 35 teachers)

- **Thessaloniki University (AUTh)**

Applications from 70 schools (~350 students) for 100 places

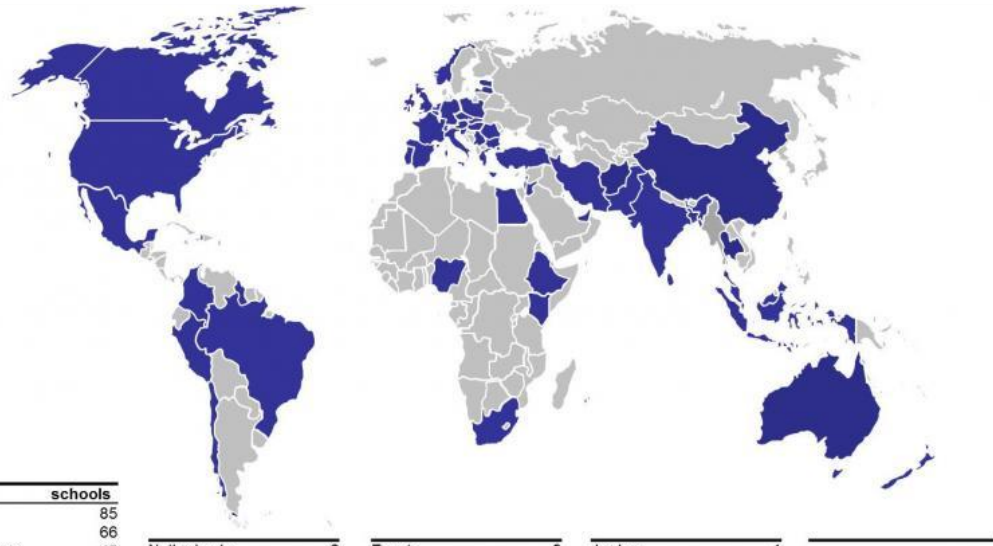
- **Crete University**

100 students from 16 schools (+18 teachers)



Competition: a beam line for schools

IPPOG acts as local contacts
to schools in many countries.
IPPOG members take responsibilities
for multiple countries to ensure that language barriers will not be a insurmountable hurdle.



Enter CERN's Beamline for Schools 2016 competition now

Country	schools
Italy	85
Spain	66
United States	45
United Kingdom	43
India	28
Greece	19
Germany	17
Canada	13
Poland	10
Switzerland	8
France	7
Portugal	7
Romania	6
Turkey	6
Netherlands	6
Singapore	5
South Africa	5
Indonesia	4
Hungary	4
Austria	4
Mexico	4
Ireland	4
Iran	3
Colombia	3
Estonia	3
Thailand	3
Egypt	3
Slovakia	3
New Zealand	2
Czech Republic	2
Brazil	2
Norway	2
Serbia	2
Slovenia	2
Bulgaria	2
Australia	2
Afghanistan	2
Lebanon	1
Jordan	1
Mauritius	1
China	1
Kuwait	1
Nigeria	1
Malaysia	1
Ethiopia	1
Haiti	1
Pakistan	1
Guyana	1
Peru	1
Latvia	1
Belgium	
Sri Lanka	
Cyprus	
Malta	
Qatar	
UAE	
Israel	
Chile	
Bangladesh	
Kenya	
Total	45

GENERATION OF SCIENTISTS AND INNOVATORS

17 Nov 2015 — Alcoa Foundation and the CERN & Society Foundation join forces for the third annual Beamline for Schools Competition

Search this site
Search

First Competition 2014
(to celebrate 60th anniversary)
Winner a Greek team!!

Expanding to Astroparticle physics – discussions and pilot tests ongoing

IceCube Masterclass

http://icecube.wisc.edu/masterclass/home

Auger Masterclass

http://auger.colostate.edu/ED/

- Pilot tests in German Netzwerk Teilchenwelt

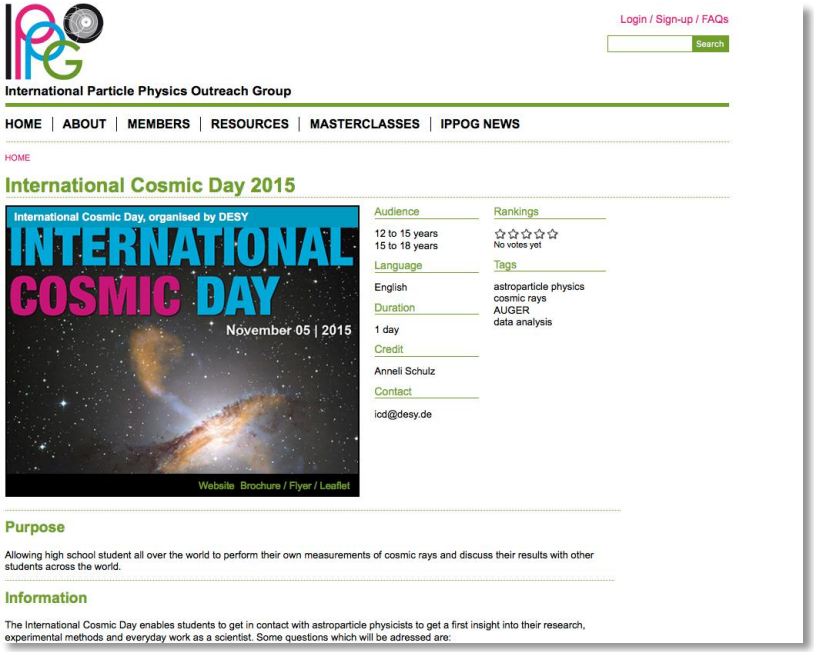
International Muon Week

Quarknet

http://Internationalmuonweek.org

International Cosmic Day

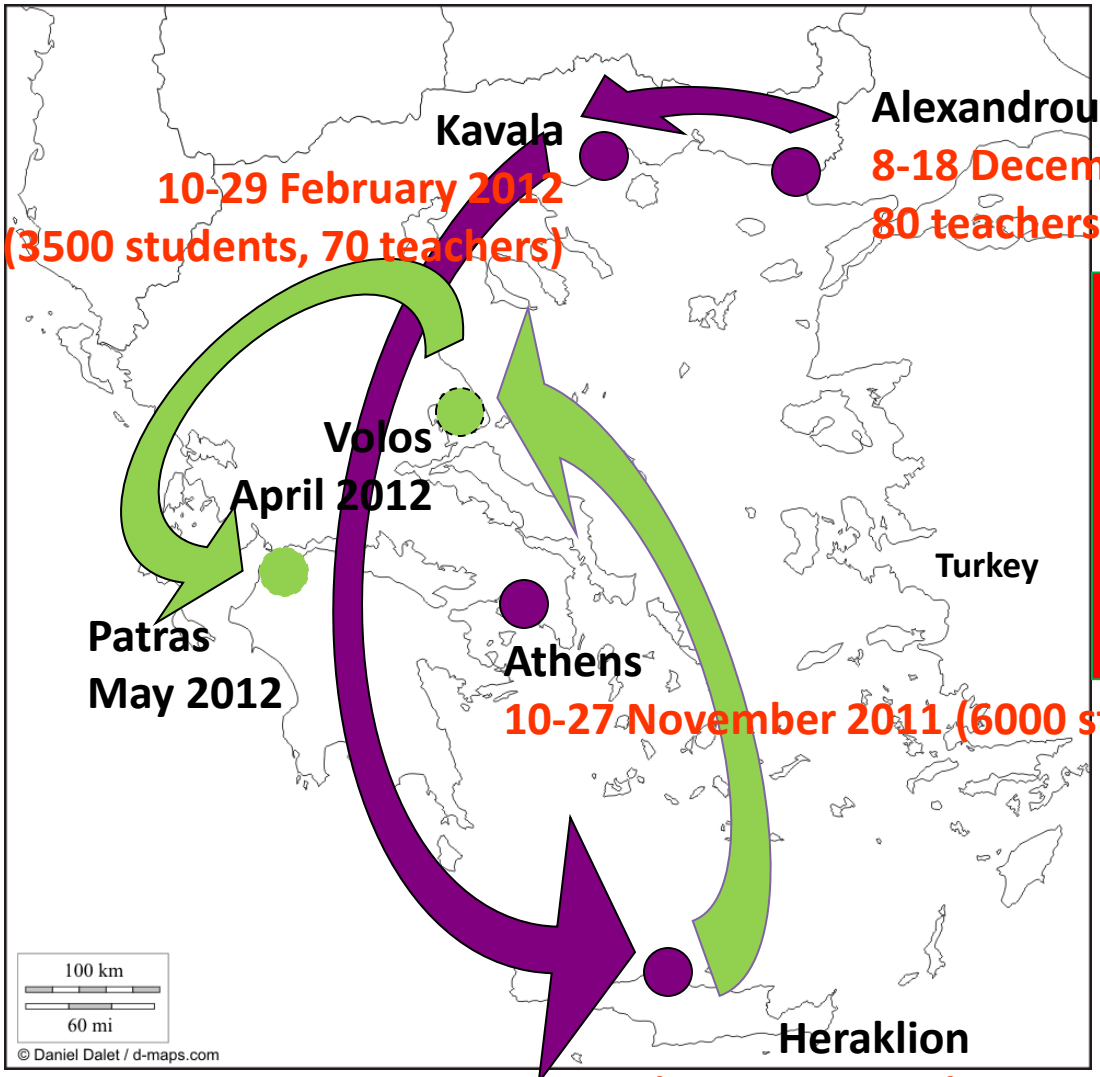
http://icd.desy.de



CERN exhibitions in Greece
Science fairs in Greece

CERN in Greece mini expo (2011-2012)

8 cities in 8 months



~22,000 students visited
~750 teachers trained in concurrent workshops

Accelerating science
CERN exhibition in Athens

April 12 – May 31 2014 at Eugenides Foundation
(science museum housing a planetarium)

Goal: To familiarize the Greek public with CERN, its activities and scientific achievements

Target group

- School students 9-17
- Teachers
- University students
- General public
- Families interested in engaging their children with science

Accelerating science
CERN exhibition in Athens

- 11,238 visitors (!!)
- 4014 students 10-17 years old mostly in organized school visits (a guide always present) from 92 schools (who came from as far as 500km from Athens)
- 115 teachers attended 6 seminars **(4 of them three hour long dedicated on ATLAS and hands-on HYPATIA tool)**
- **HYPATIA "demo" on-line version running during exhibition**

- 4 different press releases
- 474 publications in all types of media
  - Magazines, newspapers 35 articles
  - Internet 422 articles
  - TV 8 appearances
  - Radio 9 appearances

Accelerating science
CERN exhibition in Greece

- Opening
  - Exhibition inaugurated by the (then) General Secretary of Science and Technology Dr. C,Vassilakos (two days after the visit of the **President of the Greek Republic @ CERN and ATLAS** , the first one in 60 years!!)

  - Attended by 200 people
  - Lecture about CERN by Prof. E.Tsesmelis


Accelerating Science


LHC accelerator


standard model?
How small are nuclei?
How small are atoms?

The children chorus of EA sang the “Higgs boson” song

Science Fair in Chania (Crete) for four consecutive years
Every year organized by the ICNFP
Activities

Experiments (by courtecy of M.Bardeen):

- Conservation of momentum
- Rolling with Rutherford
- Probe matter
- Quark workbench
- W signatures

Masterclasses : ATLAS, ALICE

Puzzles, books, card games* etc

Evening public lecture (in Greek) +music performance


Fantastic setting!!!

Space filled with people and activities set-up on several two meter long benches+ smaller tables)

Space filled with people and activities set-up on several two meter long benches+ smaller tables)

Space filled with people and activities set-up on several two meter long benches+ smaller tables)

Science Events organized by this conference

- Veroia 27/8
- Thessaloniki 28/8

Format was similar to the Chania one
Public lecture by E.Tsesmelis


Science Event for the Public
with the participation of researchers from the "large experiments" of
CERN
Veroia
12th International Conference
"Quark Confinement and the Hadron Spectrum"
Organisers:
Yiota Foka, Christina Kourkoumeli
Morning Science Event
Presentation and Projections
of CERN Experiments
Evening Science Event
19:00 First part of musical performance
19:15 Public lecture
"CERN and search for new physics"
20:00 Second part of musical performance
20:15 Questions and discussion with the public
Speaker: Emmanuel Tsesmelis
Soprano: Kalliopi Petrou
Public Library, Time 11:30 - 14:00
Cultural Center, Time 19:00 - 20:30
Free Entrance
Veroia, Saturday 27 August 2016
indico.cern.ch/e/conf12
CERN
CREATIONS


ALICE

Science Event for the Public
with the participation of researchers from the "large experiments" of

CERN

Thessaloniki

12th International Conference
"Quark Confinement and the Hadron Spectrum"

Speaker: Emmanuel Tsesmelis
Soprano: Kalliopi Petrou

Programme

18:00 Introduction to Cern, Exhibiton
18:45 Theatrical play by high school students
19:30 First part of musical performance
19:45 Public lecture
"CERN and search for new physics"
20:30 Second part of musical performance
20:45 Questions and discussion with the public

Free Entrance

Sunday 28 August 2016, Time: 18:00 - 21:00
Thessaloniki, New Town Hall, Auditorium "M. ANAGNOSTAKIS"

Welcome Reception

Welcome the Conference Participants, Monday 29 August 2016
New Town Hall, Open Amphitheater

indico.cern.ch/e/conf12

CERN ΔΗΜΟΣ ΘΕΣΣΑΛΟΝΙΚΗΣ CREATIONS

National masterclasses

Introduction: High school activities

How can we attract students interest in science education (STEM and STEAM)?
(Their interest is decreasing with age)

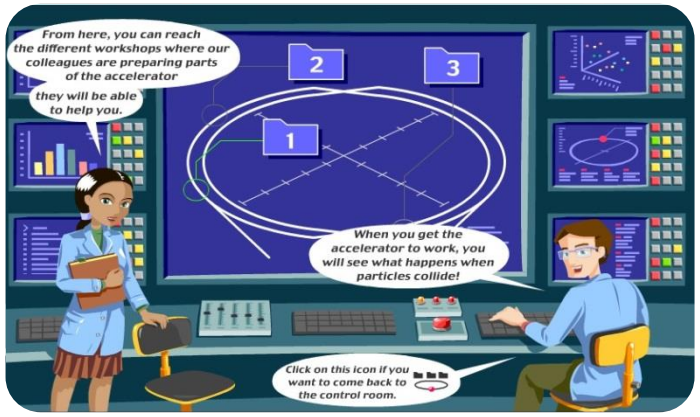
In general:

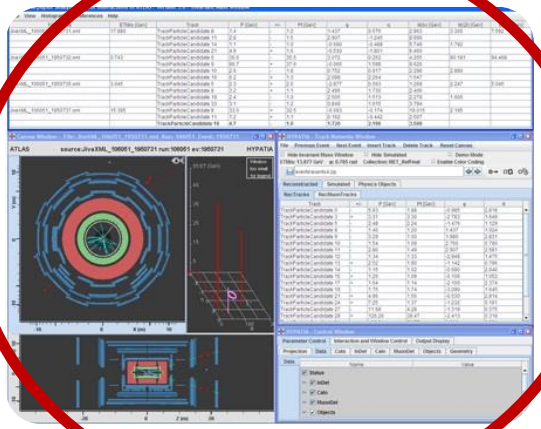
- Train teachers in intergrading IBSE in the classrooms
  -> gradually change their teaching approach
- Promote use of existing ICT, new methodologies and new eLearning tools ready to be used in the classroom
- Resources should be linked to the curricula
- Build teacher communities
- Engage learner in scientifically oriented questions

Scenaria: Big Ideas of Science

the continuity

#1. All material in the Universe is made of very small particles





CERN Land
6-9, 9-12

LHC Game
12-15

Hypatia
15-18

HEP applications
The main tool: HYPATIA
Best practice

- **Offline version** used by IPPOG's **Z-path** http://hypatia.phys.uoa.gr/
- **Online version** http://hypatia.iasa.gr/

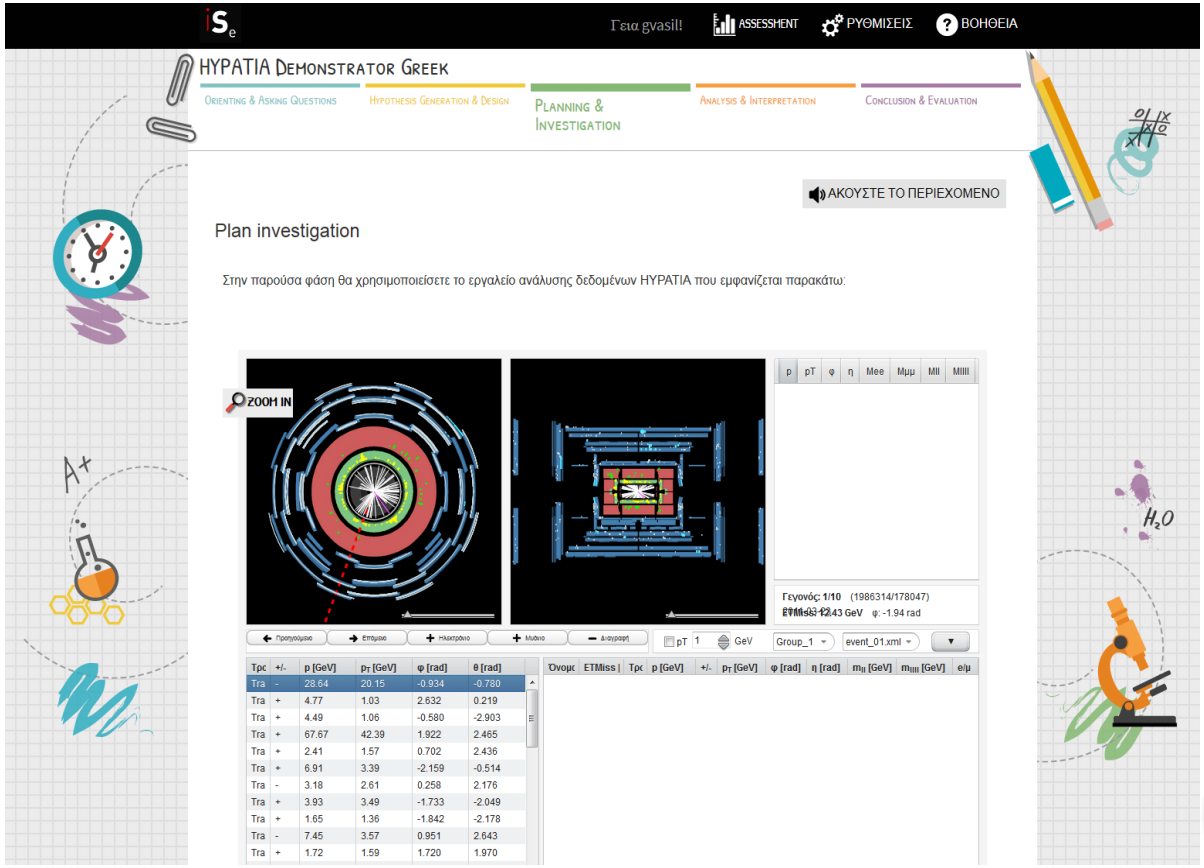
has been used since 2010 in about 150 Greek schools across the country

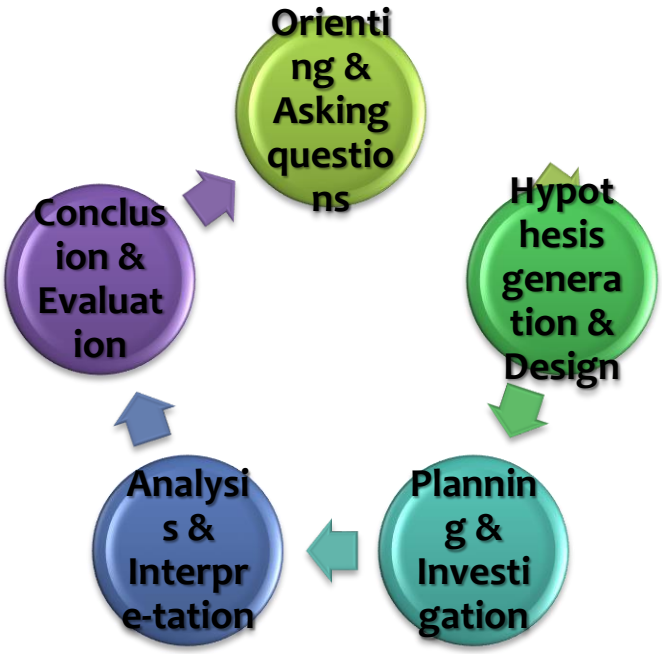
Local Masterclasses, e-Masterclasses & Virtual Visits

Students learn "how science actually works" (half day)

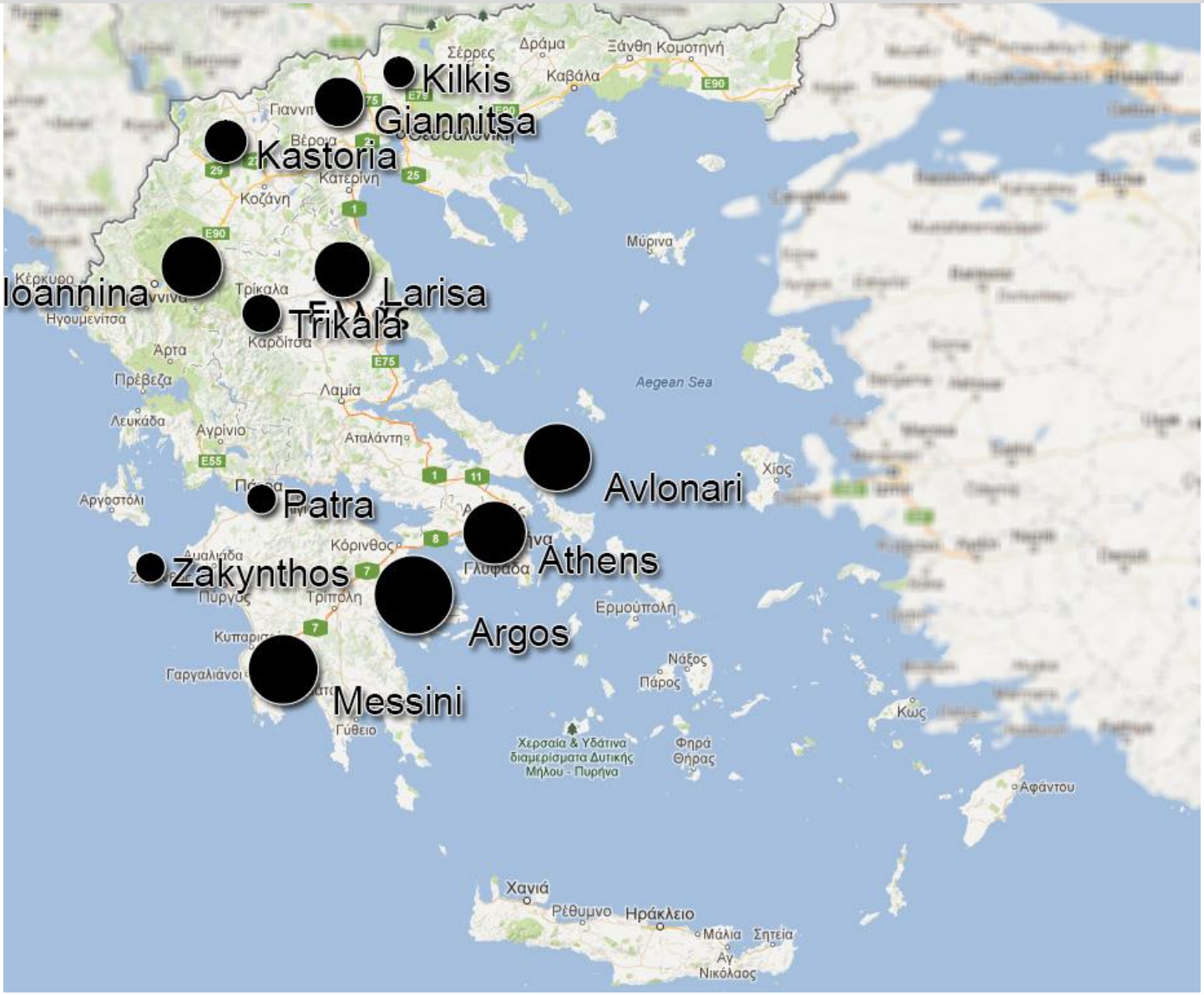
- Listen to lectures
- Follow a virtual visit to the ATLAS control room
- Analyse events with the HYPATIA on-line tool
- Scenarios for different ages are available

ISE HYPATIA demonstrator +PISA assessment questions

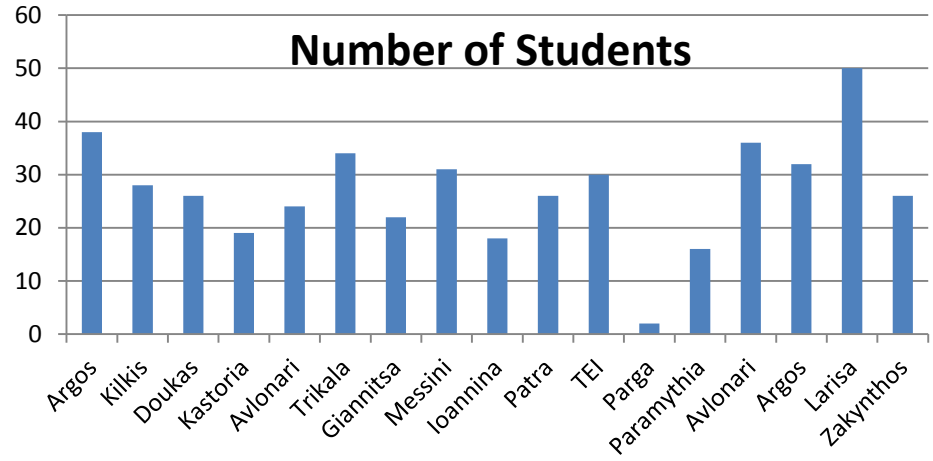




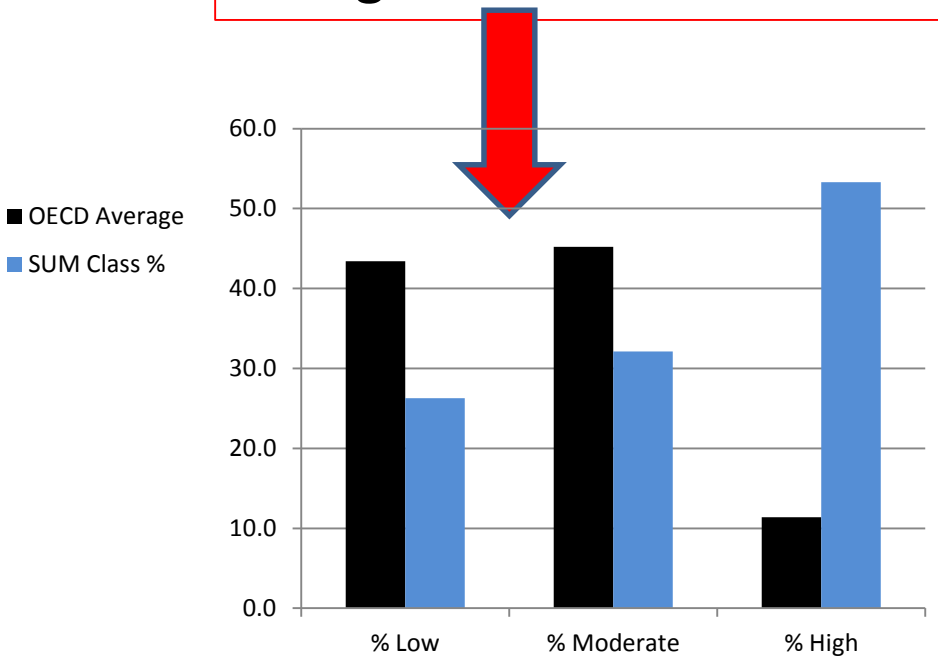
Masterclasses and VV in Greece (last two years)



Tested demonstrator (February 2015-May 2016) in **76 schools** at seventeen different locations (urban, sub-urban and rural schools) **~430 students**



Problem solving competence -> Higher than "PISA"



Scenaria: Big Ideas of Science

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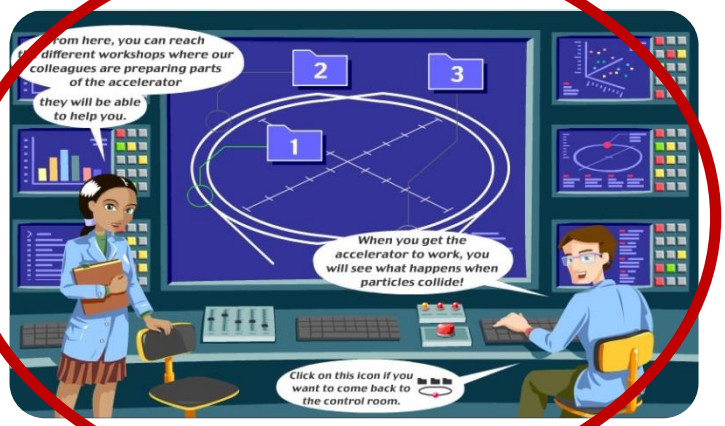
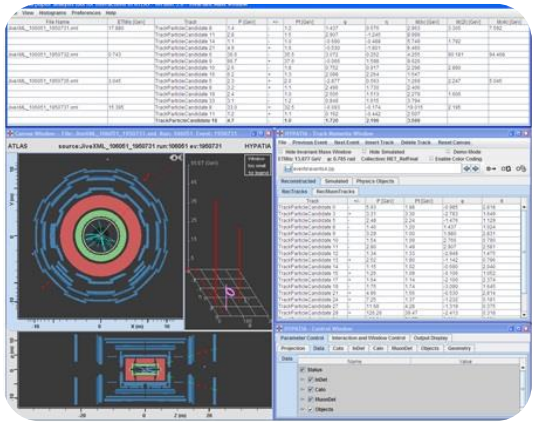
#1. All material in the Universe is made of very small particles





CERN Land
6-9, 9-12

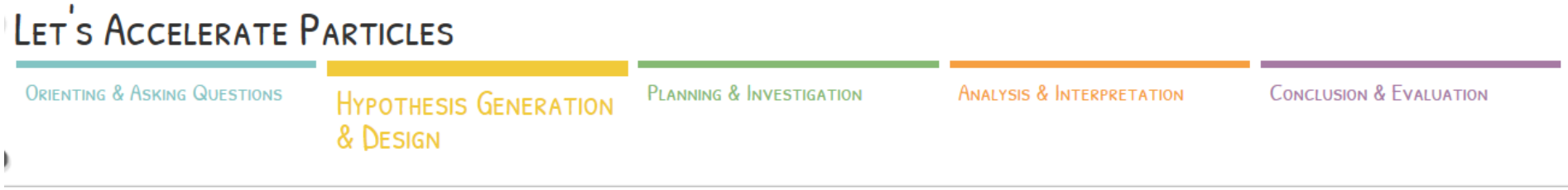
LHC Game
12-15

Hypatia
15-18

ISE demonstrators for younger kids:

1)Let's accelerate partcles (LHC game)

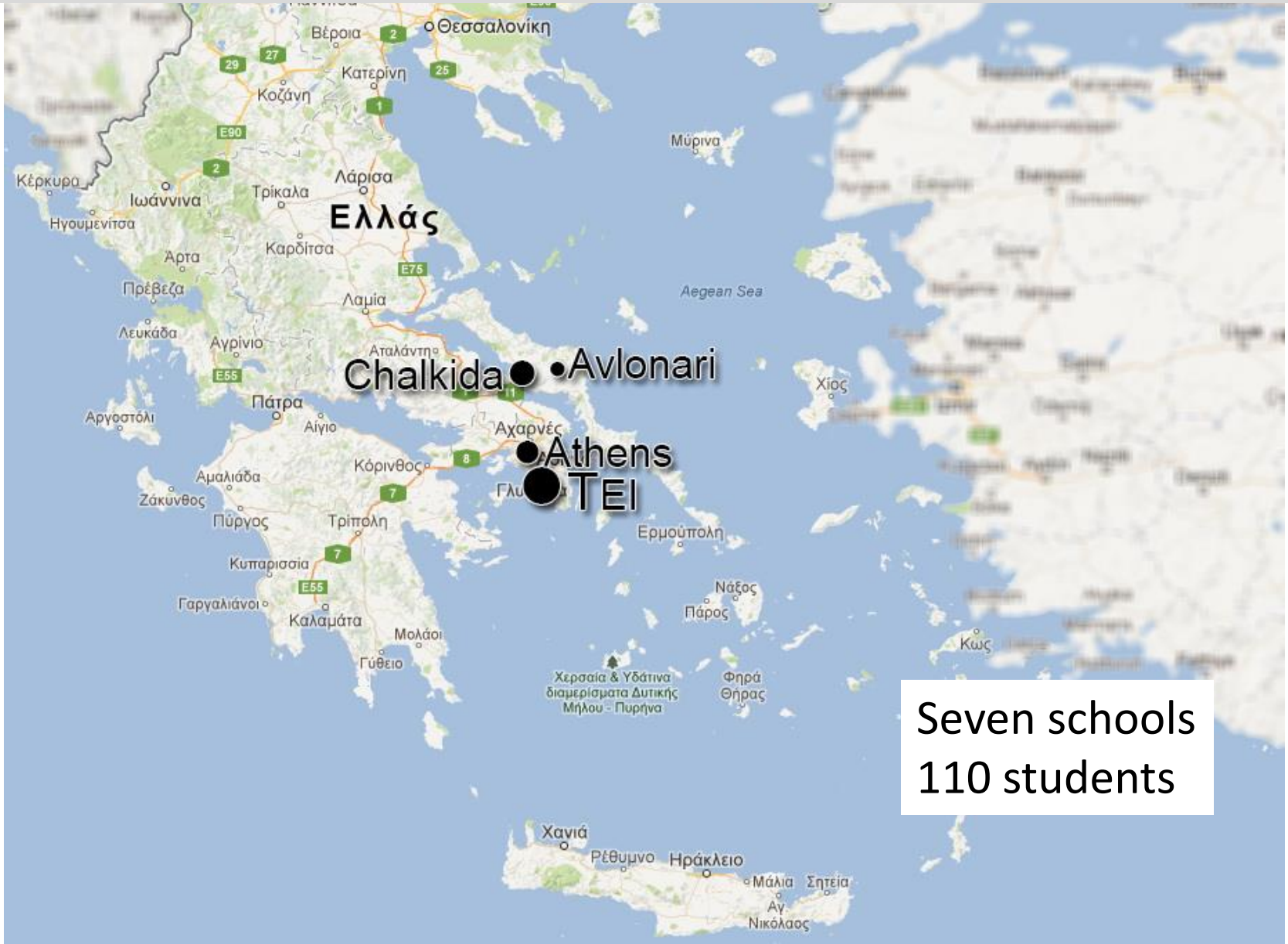
http://tools.inspiringscience.eu/delivery/view/index.html?id=c4e9fd501dce4f6290d35f8dcb9dcf1d&t=p



2) All that MATTERs (make atoms,make nucleons)

http://tools.inspiringscience.eu/delivery/view/index.html?id=02afe7b3264f4848bf59c42a6b07e3cf&t=p

Masterclasses for younger ages in Greece (only in six months)



Seven schools
110 students

In addition developed material for University students since most resources were addressed to high-school

Decided to target University students

- Up to now very few universities had such lab courses addressed to their students
- University of Athens has been one of the few, BUT was using small set of ATLAS data
- Need experimental data (real and MC)
- Multiple groups have shown interest in obtaining larger datasets
- So an effort was launched by the **ATLAS Outreach Data and Tools group** to define the data and is about to get approval for **1fb^{-1}** data (an ATLAS note under preparation).The dta was just released.
- Have developed a batch process event analysis **which optimizes cuts for the Higgs→4l search**

Methods of analyzing large event samples

We investigated (and worked) on several options

- Offline HYPATIA (the IMC version)

→ too slow, data files too large

- Root analysis , more or less ready but we didn't develop it further
- Online HYPATIA analysis →

(which won the **"best visualized experiment award"** by the online labs IEEE consortium). Fully developed


Global Online Laboratory Consortium

GOLC

2016 Online Lab Award

The GOLC Online Laboratory Award 2016 in the category

„Visualized Experiment"

is presented to

HY.P.A.T.I.A. Event Display

Submitted by:

Christina Kourkoumeli and Stylianos Vourakis

Awarded during the 13th International Conference on Remote Engineering and Virtual Instrumentation (REV2016) in Madrid, Spain

Michael E. Auer
GOLC Secretary General

Karsten Henke
GOLC Awards Committee chair

University Student analysis using HYPATIA (1)

Use the large datasets to process events in batch mode for:

- teaching data analysis strategies such as selection optimization, histogramming and statistics
- detector and accelerator physics

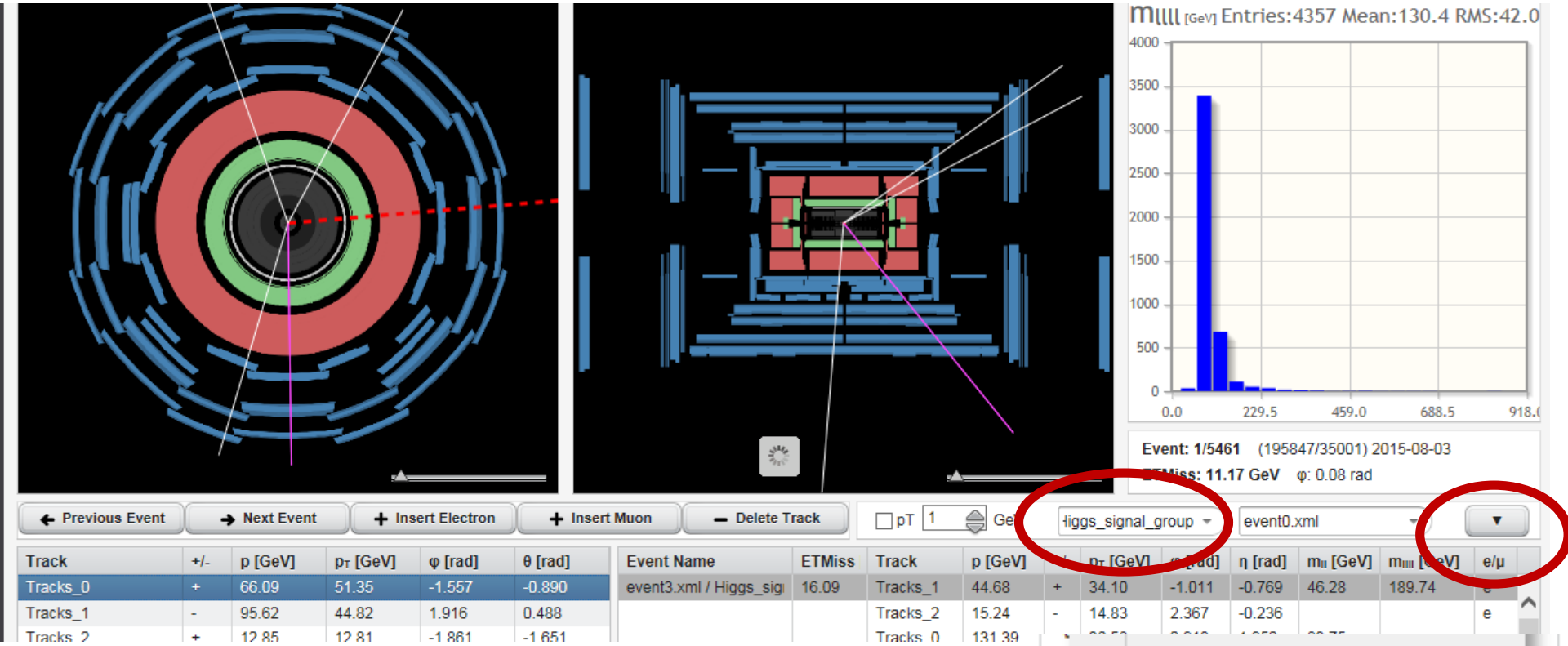
HYPATIA has been running on event-by-event display mode ->modification to run large datasets

University Student analysis using HYPATIA (2)

After **visually** inspecting some events

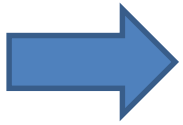
- Process many events in **batch jobs** (which have some minimum defaults cuts)
- A GUI opens to set manually **cuts** like p_T, d_0, $|z_0$-vrtx|, isolation , invariant mass range
- Inspect histos (signal/real data and MC) →rerun, etc
  - Run on 2 leptons (look for Y, Z, Z')
  - **Run on four leptons (Higgs)**

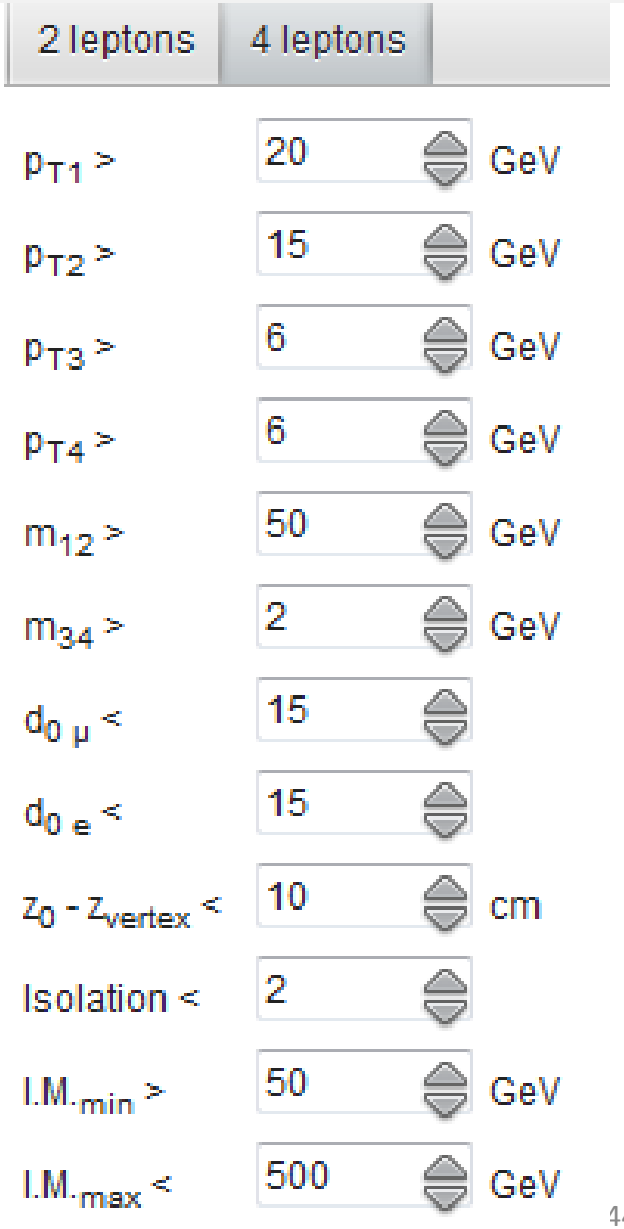
Implemented in the online HYPATIA



Higgs 4l analysis (MC signal and bkg files)

When the “batch processing” mode is chosen a GUI opens up where the student can select and optimize various cuts and check histograms of significance, signal/background etc





EXERCISE VI - Event batch processing

Using large samples (constisting of thousands) of events, study the histograms and select the appropriate parameters which will allow you to separate the signal (Higs boson decays) from the background.

Detailed instructions

http://hypatia.iasa.gr/en/exercise.html#part6

- Comes with a full 10-page instruction manual http://hypatia.iasa.gr/en/Exercise_6_eng.pdf
- Event files are built-in (converted from mini-trees provided by the ATLAS event tool group) For the moment are password protected (till the official release)
- **Runs VERY fast (300k events in < 1 sec)**
- And questions to the students for their write-up

Optimization technique

Optimize cuts by "N-1" method

Use MC samples for both signal and background

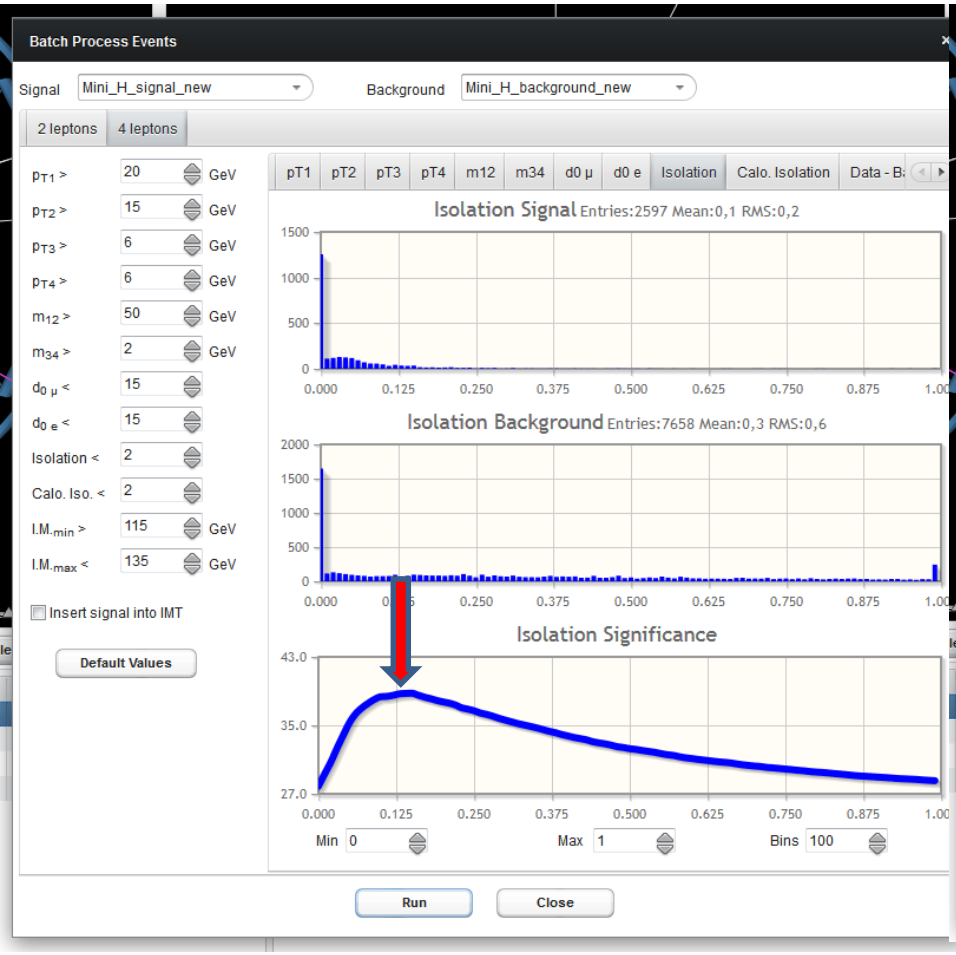
- ❑ Apply all cuts except the one under study and plot its distribution
- ❑ Determine the optimum cut value by looking at the significance plots

$$significance = \sqrt{2 * \left((S+B) * \ln\left(1 + \frac{S}{B}\right) - S \right)}$$

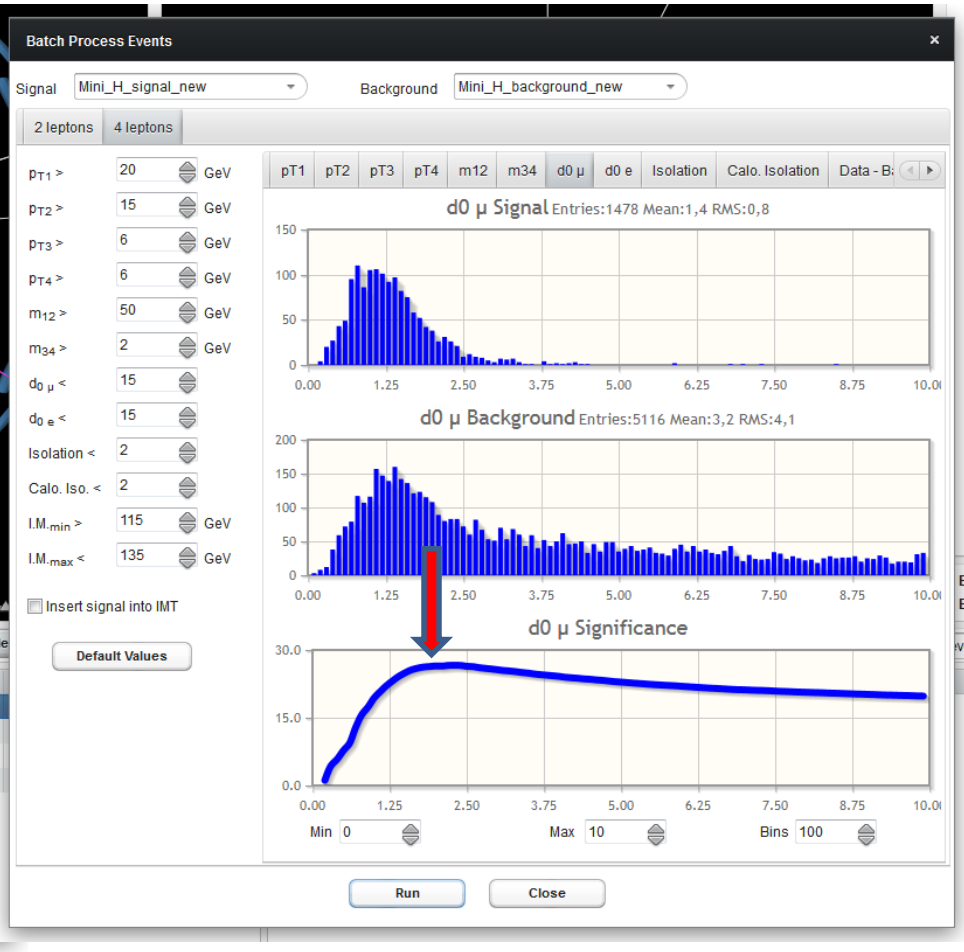
- ❑ Iterate for all cuts
- ❑ Plot invariant mass of 4 leptons and try to maximize signal/bkg

Examples of cut optimization based on the significance for isolation and impact parameter

Track Isolation



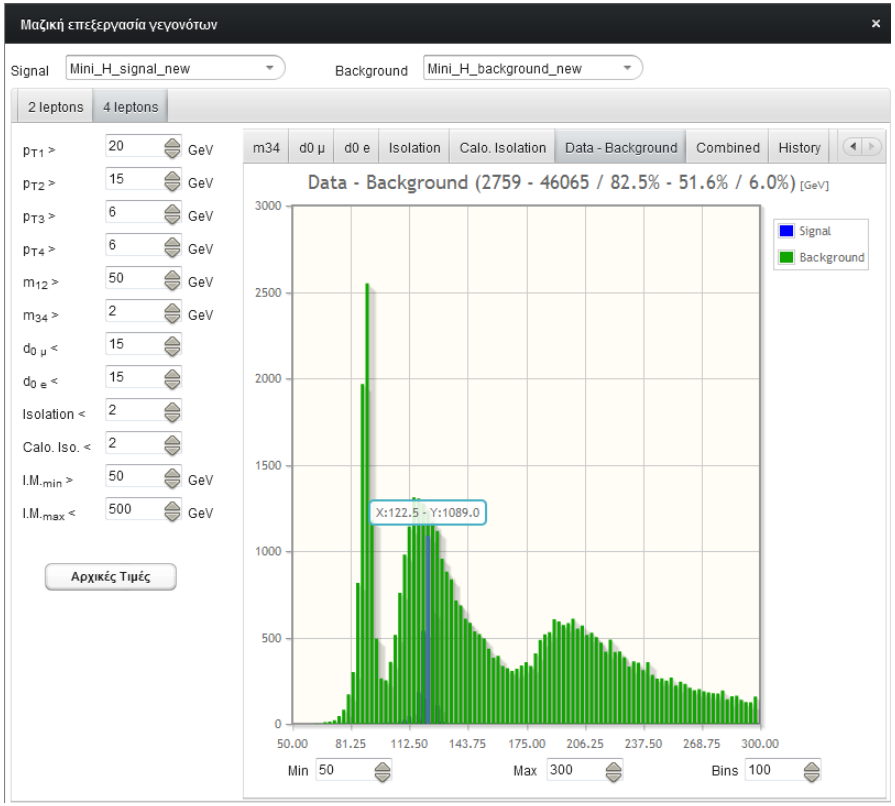
Muon d_0 significance

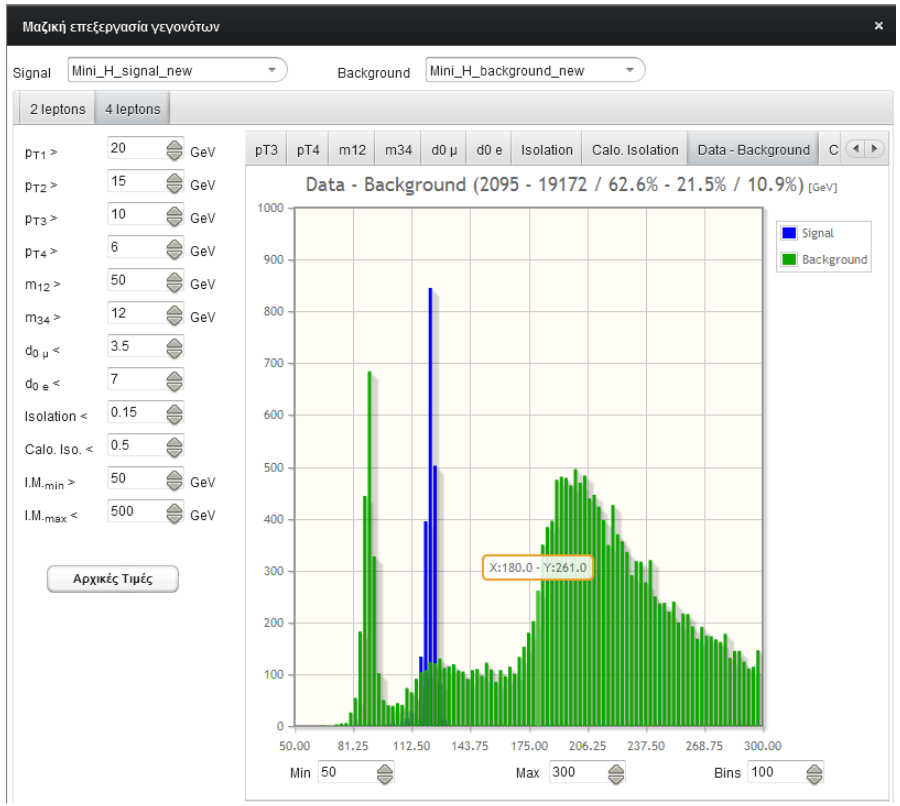


Indicative results:

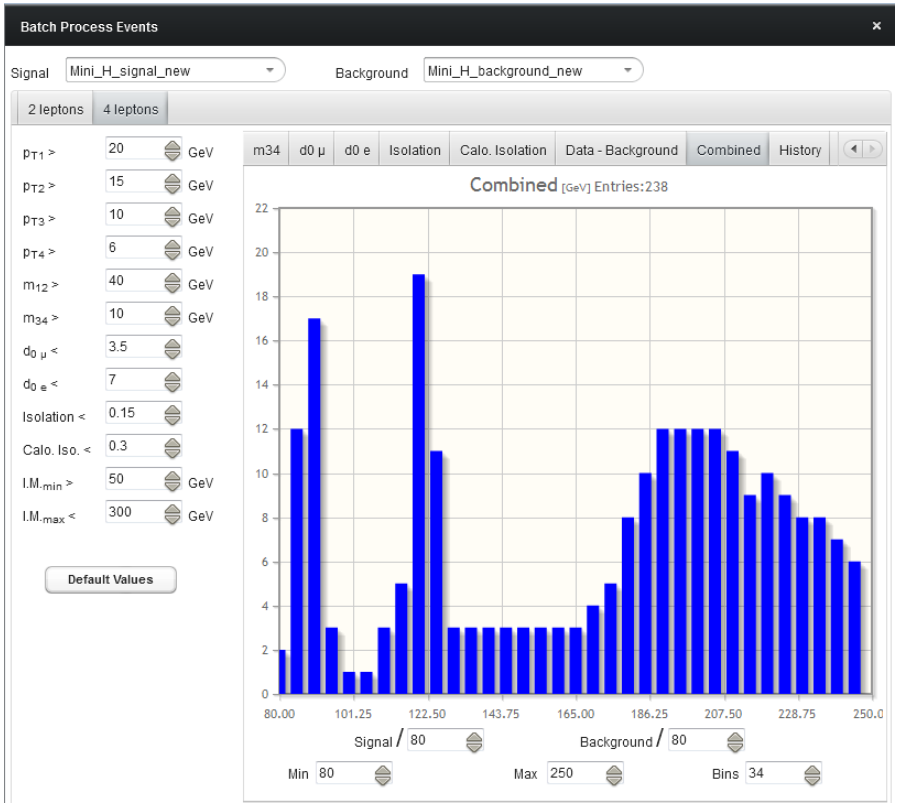
Before cut optimization
between 120-130 GeV
Signal/Background: 1/2

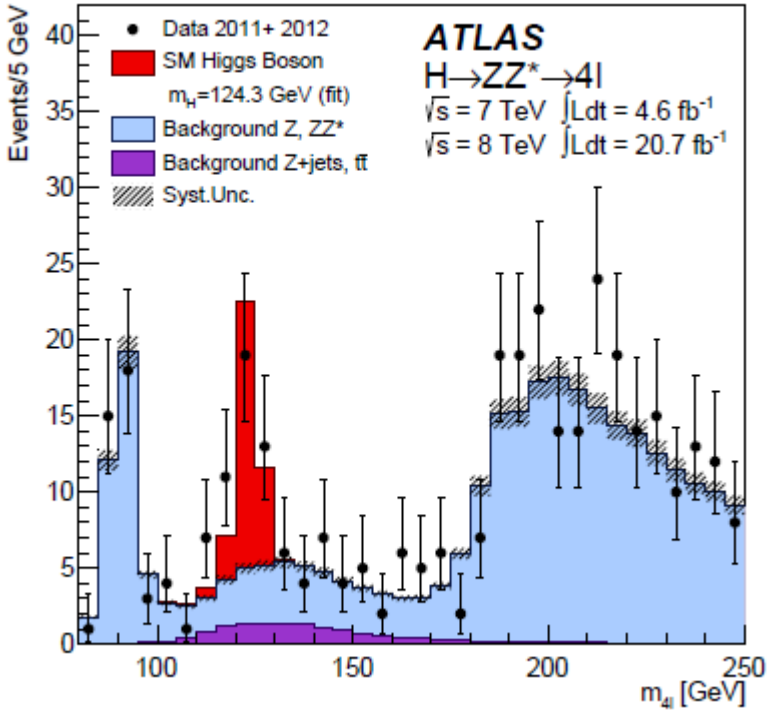
After cut optimization
Reduction of background >10
Loss of signal ~20%





Indicative results:





Conclusions

A plethora of outreach activities in Greece

- On the context of EU programs
- On the context of IPPOG
- On the context of conferences

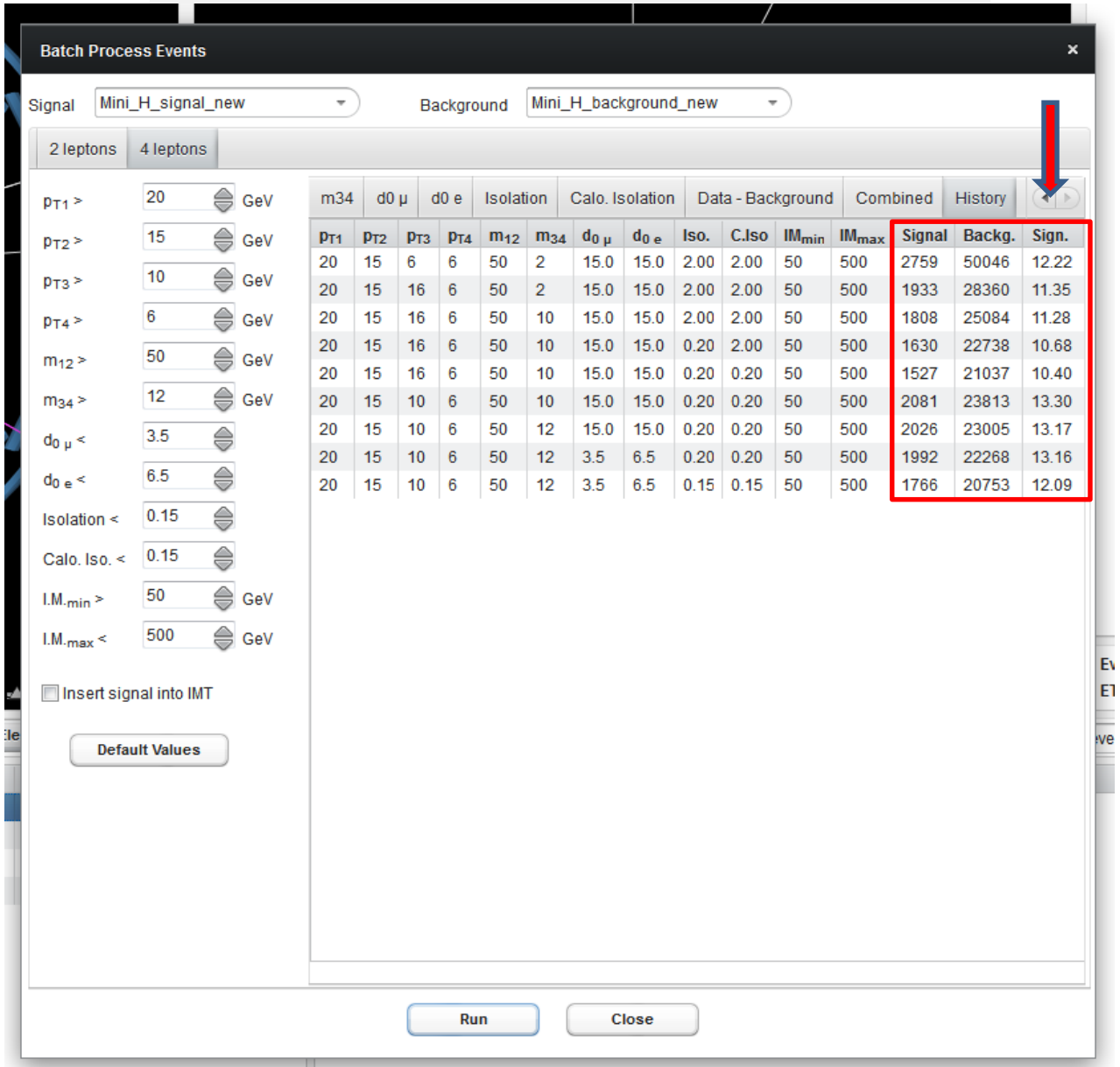
- Students from **in urban, sub-urban and rural areas** of Greece get to know about HEP research .using hands-on interactive tools
- Most advanced HEP analysis techniques are introduced at the University level

BACK-UP

Status

- The first implementation to the 3rd year physics students labs was done on Winter 2015 semester
- About 60 students –interested in particle and nuclear physics-participated in lab
- It involved two 3 hour parts:
  - Visual inspection of 50 events, identification of e's ,μ′s, Z's and ZZ events
  - The batch analysis described here
- The results are VERY encouraging!! All students performed very well and liked the lab!
- Will add the real data set and do comparisons
- Resume next fall

Indicative results:



p_{T1}	p_{T2}	p_{T3}	p_{T4}	m_{12}	m_{34}	$d_{0\,\mu}$	$d_{0\,e}$	Iso.	C.Iso	IM_{min}	IM_{max}	Signal	Backg.	Sign.
20	15	6	6	50	2	15.0	15.0	2.00	2.00	50	500	2759	50046	12.22
20	15	16	6	50	2	15.0	15.0	2.00	2.00	50	500	1933	28360	11.35
20	15	16	6	50	10	15.0	15.0	2.00	2.00	50	500	1808	25084	11.28
20	15	16	6	50	10	15.0	15.0	0.20	2.00	50	500	1630	22738	10.68
20	15	16	6	50	10	15.0	15.0	0.20	0.20	50	500	1527	21037	10.40
20	15	10	6	50	10	15.0	15.0	0.20	0.20	50	500	2081	23813	13.30
20	15	10	6	50	12	15.0	15.0	0.20	0.20	50	500	2026	23005	13.17
20	15	10	6	50	12	3.5	6.5	0.20	0.20	50	500	1992	22268	13.16
20	15	10	6	50	12	3.5	6.5	0.15	0.15	50	500	1766	20753	12.09