



University of Athens

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Involving students in HEP research with the help of the “Inspiring Science Education” and “Go-lab” European outreach projects

The main challenge:

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

- Engage students in hands-on experimentation directly connected to **top-level research** and discoveries
- Attract their attention to **real-time** research
- Create material which is ready to be used in **the internal of a school lesson**
- Directly connect material to **Big ideas of science**
- Material has to be adapted to the **age of students**
- Identify **best practices**

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/>



➤ 143 on-line labs

➤ 132 Inquiry Learning Spaces

➤ 34 Apps

In all STEM curricula subjects in 10 languages

➤ Inspiring Science Education (ISE) (April 2013 + 40mo, 31 partners)

❖ eLearning tools for 5,000 schools in 14 countries



<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 two years has reached 2750 schools

Example of **four HYPATIA lesson plans (ILSs)** developed for **Go-lab** using the full Inquiry Based path :
Orientation, Conceptualization, Investigation, Conclusion, Discussion

1) Conservation of momentum

<http://www.golabz.eu/spaces/conservation-momentum-particle-colisions>

2) Measurement of the magnetic field using the giant ATLAS detector


<http://www.golabz.eu/spaces/measurement-magnetic-field>

3) Hunt for the Higgs boson

<http://www.golabz.eu/spaces/discover-higgs-boson>

4) Discover the Z boson

<http://www.golabz.eu/spaces/discover-z-boson>



Direct
relation
with
school
curricula



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 100 Greek schools across the country

Local Masterclasses, e-Masterclasses & Virtual Visits

Students learn “how actually science works” (half day)

- Listen to lectures
- Follow a virtual visit to ATLAS control room
- Analyse events with the HYPATIA on-line tool

Remark:

Both versions of HYPATIA now “enriched” to **handle large event files** for University students' analysis

Back-up

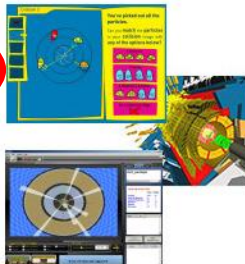
Content of Discover the COSMOS repository/Activities

Discover the COSMOS Repository

The Discover the COSMOS Repository contains educational material in the form of **educational content** (photos, videos, animations, exercises, graphs, links) and of **learning activities** (structured lesson plans organized according to specific pedagogical models such as inquiry based Learning and Guided Research). Users can search for the educational materials in the "Explore Discover the COSMOS" section or to upload their own materials to the Discover the COSMOS Repository, using the "Share your Content" section.

Explore Discover the COSMOS

Search for Educational Content (90205)



Search for Learning Activities (625)

moCERN

The Discover the COSMOS Repository goes mobile! Now, Discover the COSMOS Educational Content is available for mobile and handheld devices. Visit [MoCERN](#) and explore the HEP resources and [MoCO](#) and explore the Astronomy repository through your mobile phone.



Visit the **DISCOVER the COSMOS Camp in Second Life!** Explore the Universe, the ATLAS Detector and numerous other contents of the Repository through a unique immersive experience in a realistic context. From here you can download and install Second Life Viewer which is used for entering the Discover the COSMOS Camp in Second Life. [Teleport to Discover the COSMOS Camp.](#)

Discover the COSMOS Tutorials



The Discover the COSMOS consortium has produced a series of video tutorials astronomy, astrophysics and high energy physics subjects. To access these tutorials click [here](#).

Share your Content

Upload Educational Content



Upload Learning Activities



~ 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 continuing

<http://graasp.eu/ils/547311f2e9934012b7c65f8c/?lang=en>

Measurement of Magnetic Field

xxx ➞

Students will study the motion of a charged particle in a magnetic field, in order to determine the strength of the field of one of the ATLAS magnets, used to measure the momentum of the particles produced by particle collisions at the CERN LHC accelerator. The momentum of the tracks, as measured by the detector, is provided (since the magnetic field is known-but not given for this purpose of this exercise).

Orientation

Conceptualisation

Investigation

Conclusion

Discussion

Introduction

Let's have a look at the Sun's wild surface!

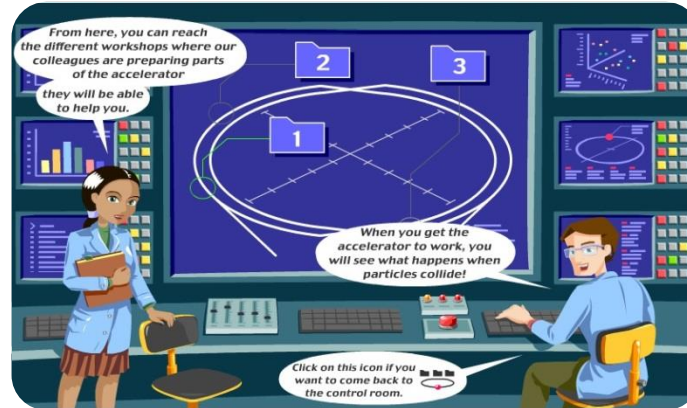
Analysis: Big Ideas of Science

the continuity

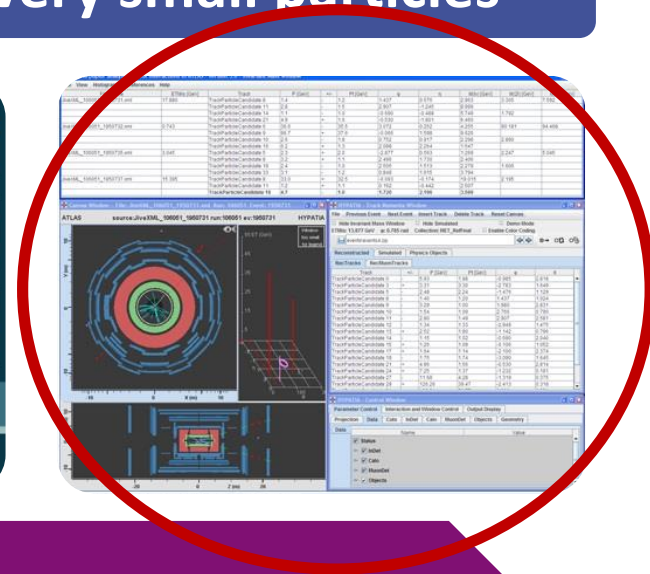
#1. All material in the Universe is made of very small particles



CERN Land
6-9, 9-12







LHC Game
12-15




Hypatia
15-18

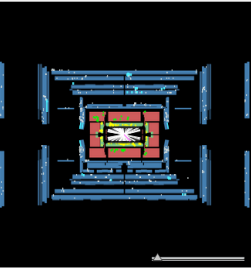
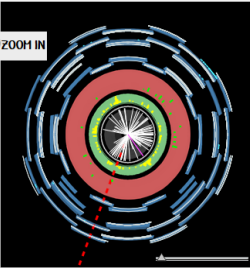

ISE HYPATIA demonstrator +PISA assessment questions

 Γεω. Γραβιλάκης!  ASSESSMENT  ΠΥΘΜΙΣΕΙΣ  ΒΟΗΘΕΙΑ

HYPATIA DEMONSTRATOR GREEK
ORIENTING & ASKING QUESTIONS | **HYPOTHESIS GENERATION & DESIGN** | PLANNING & INVESTIGATION | ANALYSIS & INTERPRETATION | CONCLUSION & EVALUATION

 ΑΚΟΥΣΤΕ ΤΟ ΠΕΡΙΕΧΟΜΕΝΟ

Plan investigation
Στην παρούσα φάση θα χρησιμοποιήσετε το εργαλείο ανάλυσης δεδομένων HYPATIA που εμφανίζεται παρακάτω.



Γεγονός: 1/10 (1986314/178047)
ΕΤΜies: 42.43 GeV ϕ : -1.94 rad

Trpc	+/-	p [GeV]	pT [GeV]	ϕ [rad]	θ [rad]
Tra	-	28.64	20.15	-0.934	-0.780
Tra	+	4.77	1.03	2.632	0.219
Tra	+	4.49	1.06	-0.580	-2.903
Tra	+	67.67	42.39	1.922	2.465
Tra	+	2.41	1.57	0.702	2.436
Tra	+	6.91	3.39	-2.159	-0.514
Tra	-	3.18	2.61	0.258	2.176
Tra	+	3.93	3.49	-1.733	-2.049
Tra	+	1.65	1.36	-1.842	-2.178
Tra	-	7.45	3.57	0.951	2.643
Tra	+	1.72	1.59	1.720	1.970



Horizon 2020

Call: H2020-SEAC-2014-1

Topic: SEAC-1-2014



Proposal acronym: CREATIONS

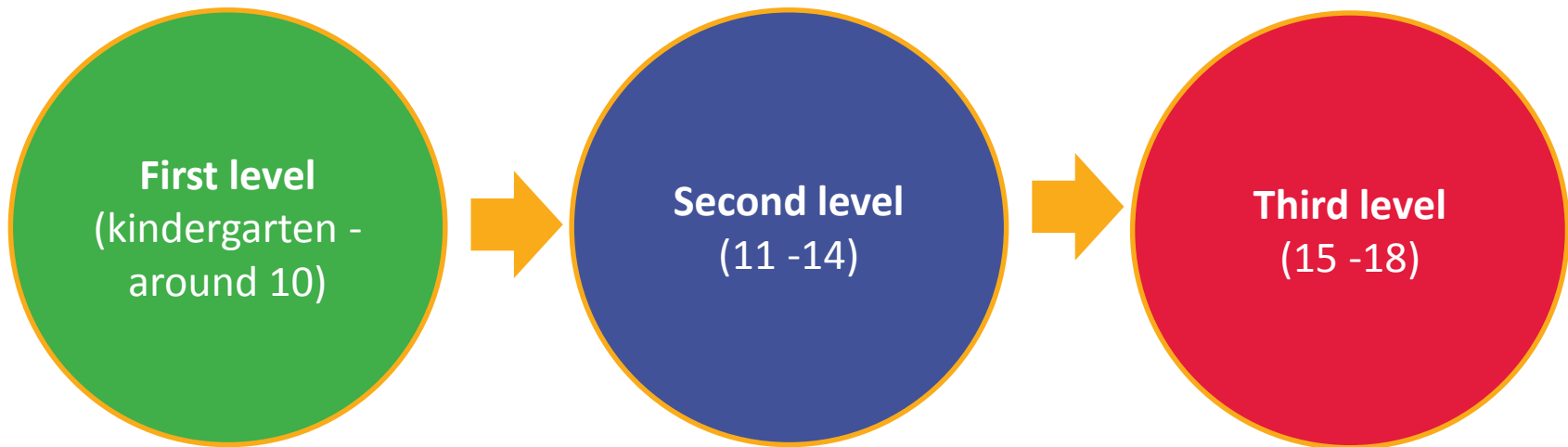
Developing an Engaging Science Classroom

- 36 months
- 1,8ME
- 7 WPs
- Coordinator: University of Bayreuth

16 Partners
(CERN, UoB, IASA,
STFC etc) +
Quarknet

Big Ideas of Science

scheme is to build in depth knowledge around basic concepts and scaffold to big and more complex concepts



from small to big ideas in science, from simple experiences to complex and abstract phenomena in the natural World

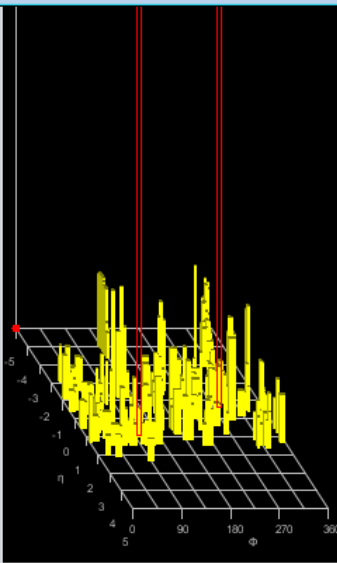
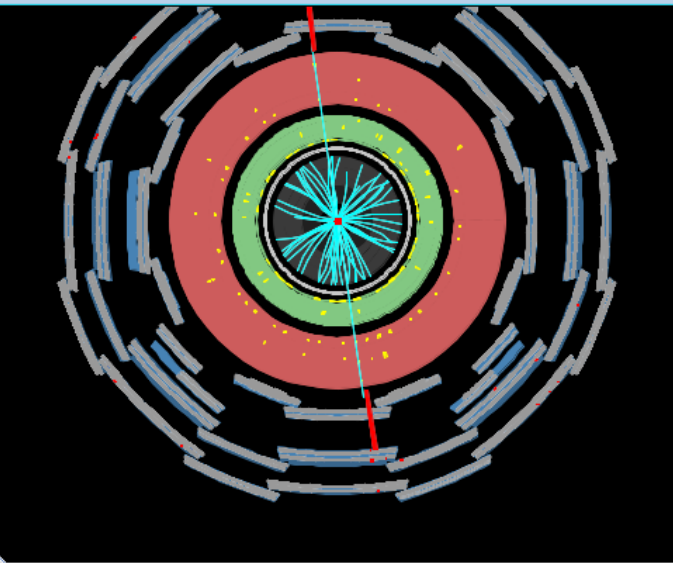
1) "Standard" version of offline HYPATIA

NEW

HYbrid Pupils' Analysis Tool for Interactions in ATLAS - version 7.5 - Invariant Mass Window

File View Histograms Preferences Help

File Name	ETMis [GeV]	Track	P [GeV]	+/-	Pt [GeV]	ψ	η	M(lv) [GeV]	M(2l) [GeV]	4l) [GeV]
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HYPATIA - Track Momenta Window

Previous Event Next Event Insert Track Delete Track Reset Canvas Batch Process Events

☐ Hide Invariant Mass W ☐ Hide Simulated ☐ Demo Mode Find Value

ETMis: 5,395 GeV ϕ : 1,680 rad Collection: MET_RefFinal ☐ Enable Color C...

stina\Documents\HYPATIA\Hypatia 7.5\events\test events\0event001.xml

Reconstructed Simulated Physics Objects

RecTracks RecMuonTracks

Track	+/-	P [GeV]	Pt [GeV]	ψ	θ
Tracks 1	-	5,32	1,56	0,962	0,298
Tracks 4	+	42,01	35,34	-1,404	2,142
Tracks 6	+	5,77	1,22	-1,319	2,928
Tracks 10	+	8,21	1,62	-3,095	0,199
Tracks 11	-	47,12	31,23	1,704	0,724
Tracks 12	-	2,38	1,05	-1,908	0,458
Tracks 14	+	5,39	1,03	1,188	0,193
Tracks 16	+	2,94	1,52	-1,063	2,599
Tracks 19	+	6,03	1,21	-0,341	2,940
Tracks 21	+	9,78	1,78	-1,765	0,183
Tracks 22	-	5,20	1,23	1,175	0,239
Tracks 23	+	3,87	1,08	1,115	0,282
Tracks 25	-	1,57	1,40	2,286	2,045

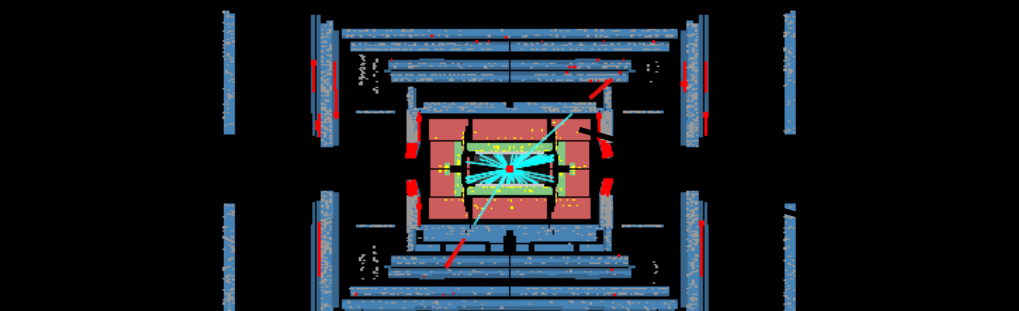
HYPATIA - Control Window

Parameter Control Interaction and Window Control Output Display

Projection Data Cuts InDet Calo MuonDet Objects Geometry

Data

Name	Value
<input checked="" type="checkbox"/> Status	
<input checked="" type="checkbox"/> InDet	
<input checked="" type="checkbox"/> Calo	



2 leptons (J/ψ , Υ , Z , Z')

HYPATIA - University of Athens - Event Batch P...

2 leptons 4 leptons

Pt1	10	GeV
Pt2	10	GeV
d0	1	cm
z0 - vertex	50	cm
Isolation	1	
I.M. Min	10	GeV
I.M. Max	1500	GeV

Run Cancel

4 leptons (Higgs)

HYPATIA - University of Athens - Event Batch P...

2 leptons 4 leptons

Pt1	10	GeV
Pt2	10	GeV
Pt3	10	GeV
Pt4	10	GeV
d0 μ	1	cm
d0 e	1	cm
z0 - vertex	50	cm
Isolation	1	
I.M. Min	10	GeV
I.M. Max	1500	GeV

Run Cancel

- Needs xml files (big)
- Can process any .xml file
- ATLANTIS is slow in loading events
- Takes about 15min for 4000 events

2) Implemented in the online HYPATIA

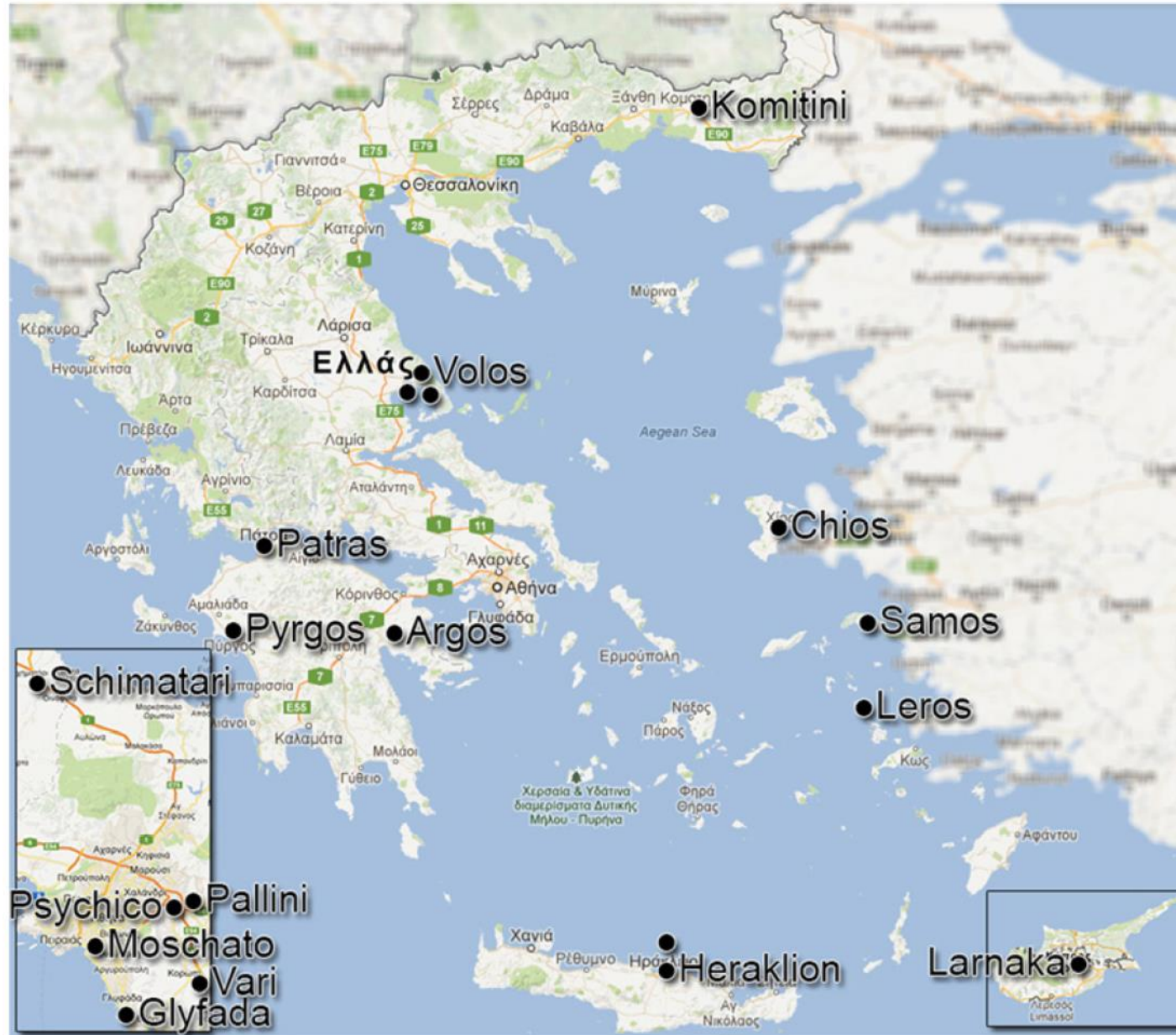
The screenshot displays the HYPATIA online interface. On the left, a circular detector cross-section shows tracks in blue and red. Below it is a table of tracks. On the right, a 3D visualization of tracks is shown. A 'Batch Process Events' dialog box is open in the center, with an arrow pointing to it from a text box. The dialog has tabs for '2 leptons' and '4 leptons'. The '2 leptons' tab is active, showing input fields for Pt1, Pt2, d0, z0 - vertex, Isolation, I.M. Min, and I.M. Max. The 'Run' and 'Cancel' buttons are at the bottom. The background interface includes a top menu bar with variables like p, pT, ϕ , η , Mee, M $\mu\mu$, Mll, Mlll. Below this is a status bar showing 'Event: 1/500 (1155538/208497) 2012-07-06' and 'ETMiss: 5.39 GeV ϕ : 1.68 rad'. At the bottom, there are controls for event selection, including a '1' button, a '500_events' dropdown, and a file name '0event001.xml'.

Track	+/-	p [GeV]	p _t [GeV]	ϕ [rad]	θ [rad]
Tracks_1	-	5.32	1.56	0.982	0.298
Tracks_4	+	42.06	35.39	-1.404	-2.142
Tracks_6	+	5.77	1.22	-1.319	-2.928
Tracks_10	+	8.21	1.62	-3.095	-0.199
Tracks_11	-	47.05	31.18	1.704	0.724
Tracks_12	-	2.38	1.05	-1.908	-0.458
Tracks_14	+	5.39	1.03	1.188	0.193
Tracks_16	+	2.94	1.52	-1.063	-2.599
Tracks_19	+	6.03	1.21	-0.341	-2.940

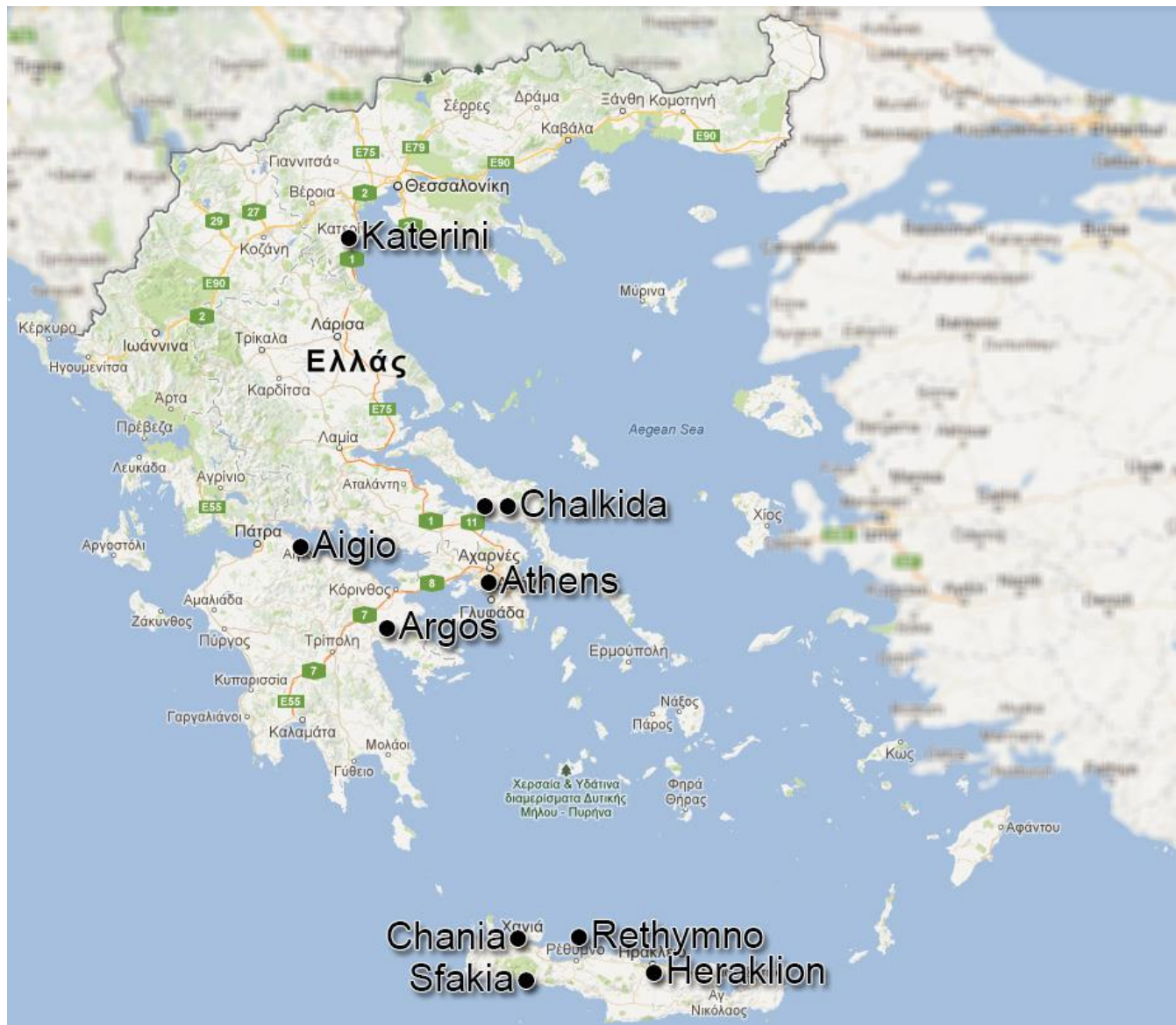
Same GUI for 2 and 4 leptons

- Event files are built-in (converted from xml) but much smaller
- Only works with the built-in event files
- Runs VERY fast

Implementation in Greek schools 2012-2013



Implementation in Greek schools 2013-2014



Implementation in Greek schools 2014-2015

