

# ALICE proposal for MasterClass based on visual identification of strange particles in pp LHC data

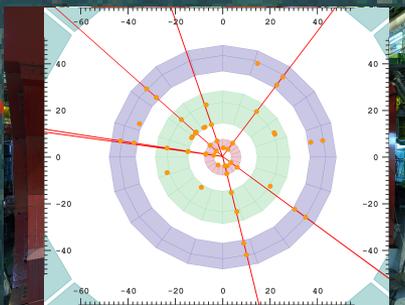
**P. Debski**

P. Foka,

B. Hippolyte, A. Maire, H. Oeschler

M. Tadel

Outreach coordinator  
D. Hatzifotiadou



# MasterClass Roadmap

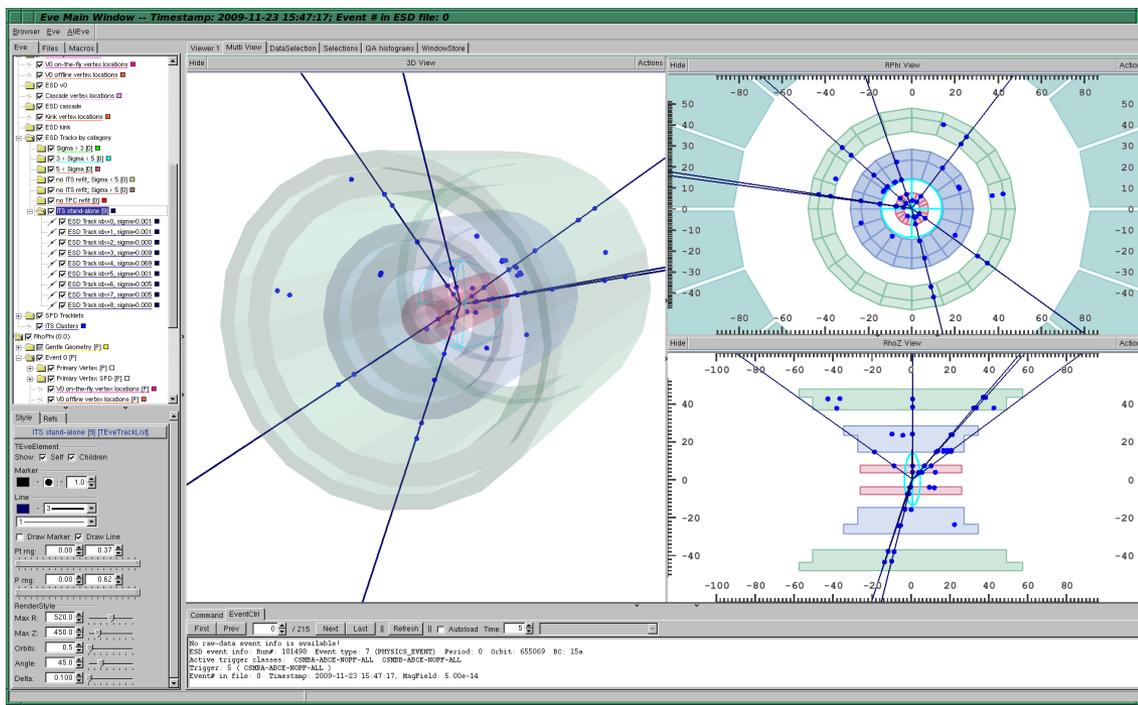
Keep in mind: give ALICE data to school children to analyse like physicists do

discovery potential measurements

keep looks of tools close to the ones used in experiment

use real published data

easy to install and easy to give experimental data



# Basic idea

**Identify strange particles through their decay pattern  
using visualisation tools**

**Measurement:**

**count n. of different species of strange particles**

**Aim: Variant A**

Count strange particles, compare to MC

**Aim: Variant B**

**Count strange particles, make ratios: strange/non-strange particles**

**Check QGP signature (strangeness enhancement)**

To Be Given

n. of non-strange particles in real and MC data

**Works for  
pp and PbPb**

# Cascade topology reconstruction in PbPb

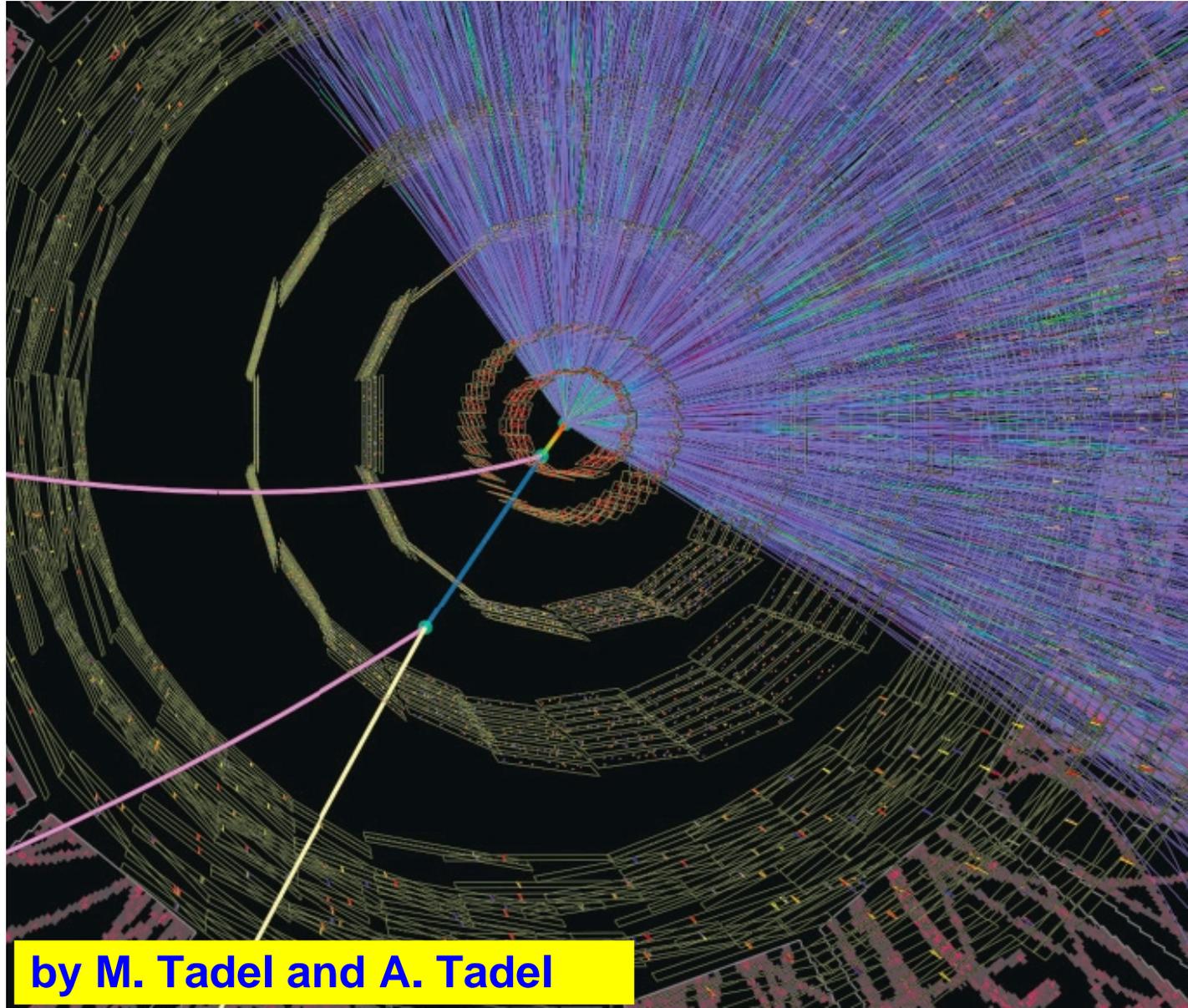
Tracking challenge but it works!!

MC PbPb event

Cascade:  $\Xi, \Omega$

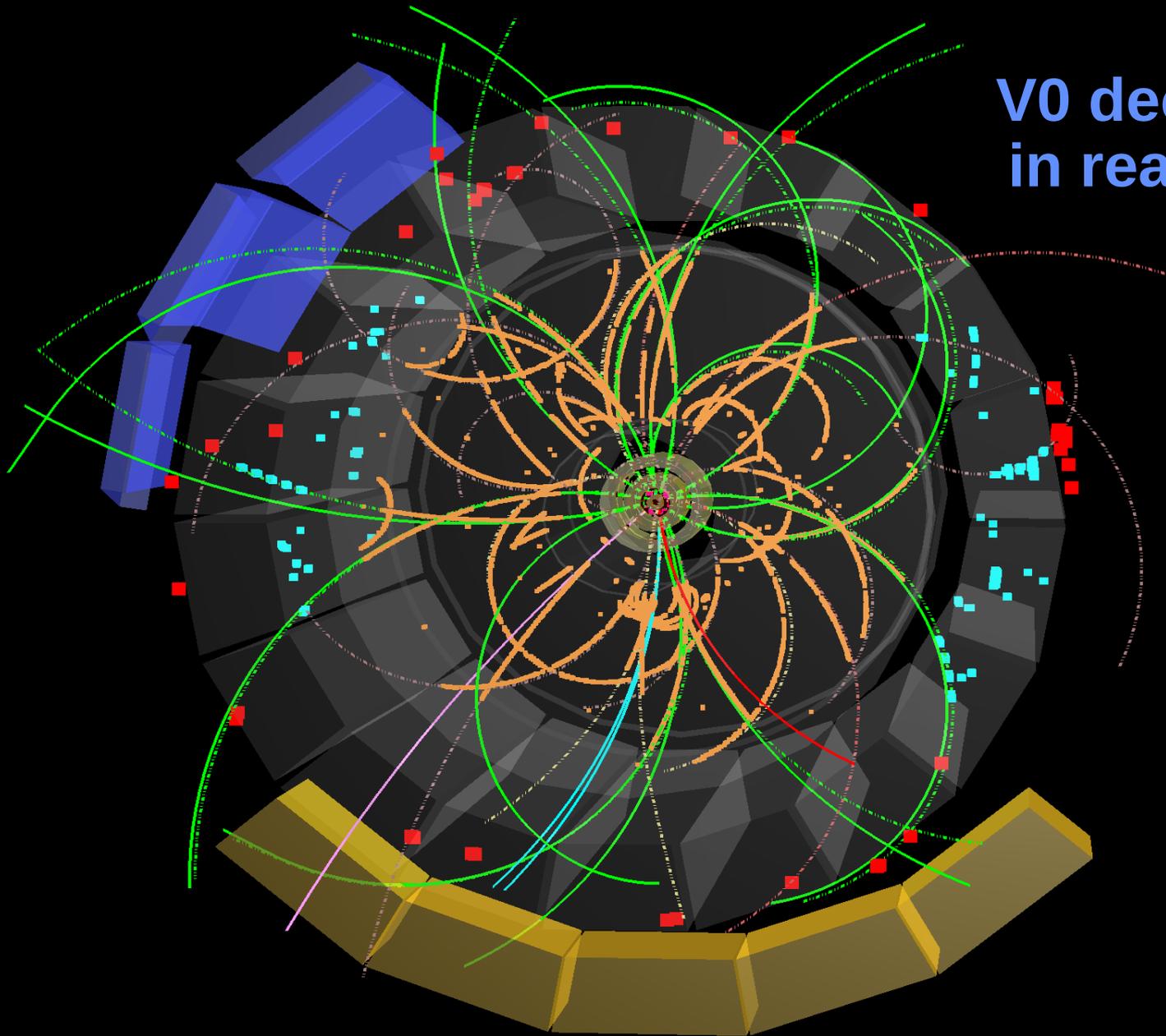
with part of the event removed  
displaced  
vertices can be seen

$\Xi^- \rightarrow \Lambda \pi^-$



by M. Tadel and A. Tadel

V0 decay pattern  
in real pp events



# Basic idea

Identify strange particles through their decay pattern  
using visualisation tools

Measurement: count n. of different species of strange particles

## Aim: Variant A

Count strange particles

Compare measured counts (“yield”) to MC (Pythia)

Correctness of MC  
underlying event

Outcome: strangeness production; confirm or not the MC

## Example of reporting table

For MC give  
pre-calculated values

Particle species	Real	Pythia
$K^0$	measured	given
$\Lambda$ (anti $\Lambda$ )	measured	given
$\Xi$	measured	given
$\pi$	given	given
Nch	given	given

# Basic idea

Identify strange particles through their decay pattern  
using visualisation tools

Measurement: count n. of different species of strange particles

## Aim: Variant B

Count strange particles, get n. of non-strange particles  
make ratios: strange/non-strange particles  
Compare ratios in real pp data and reference (Pythia)

Discovery potential  
QGP-like pattern  
in (high multiplicity) pp

Outcome: confirm or not strangeness enhancement (predicted as QGP signature)

particle species	real	Pythia	Ratio strange/ $\pi$	real	Pythia
$K^0$	measured	given	$K^0 / \pi$	deduced	given
$\Lambda$	measured	given	$\Lambda / \pi$	deduced	given
$\Xi$	measured	given	$\Xi / \pi$	deduced	given
$\pi$	given	given			
Nch	given	given			

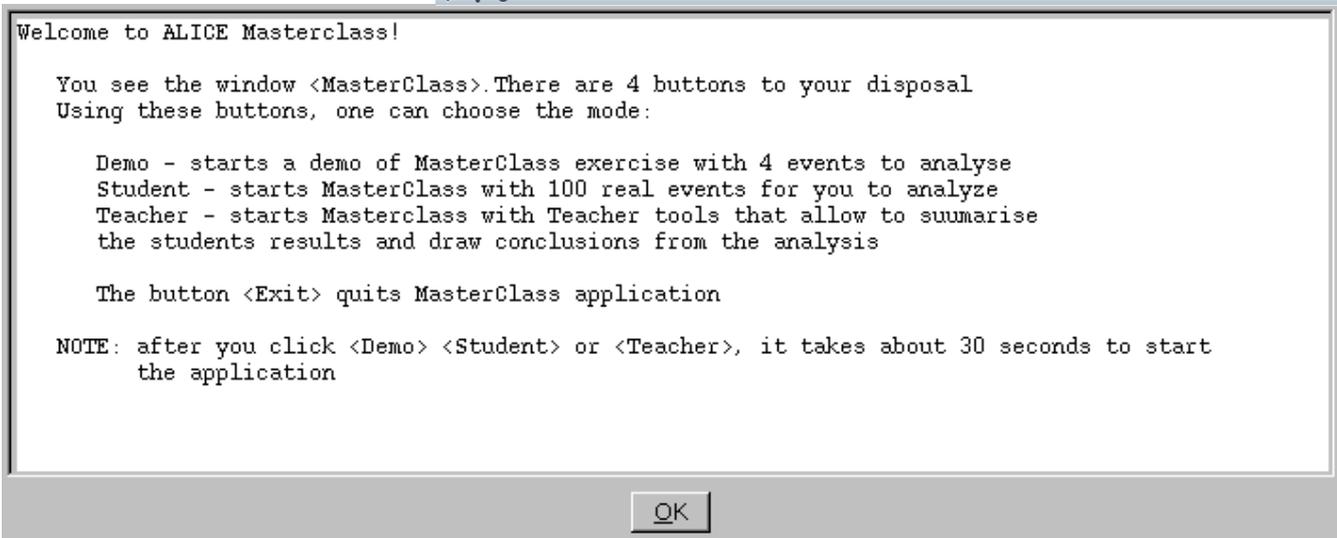
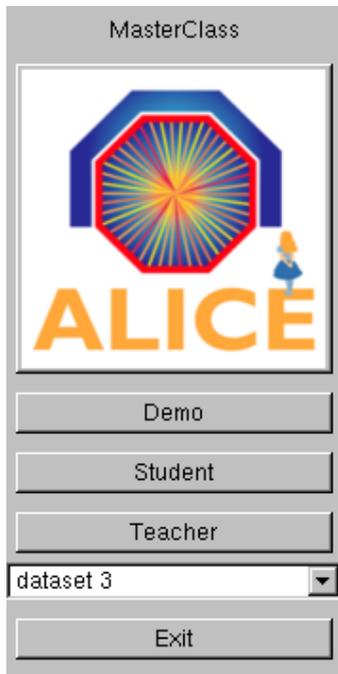
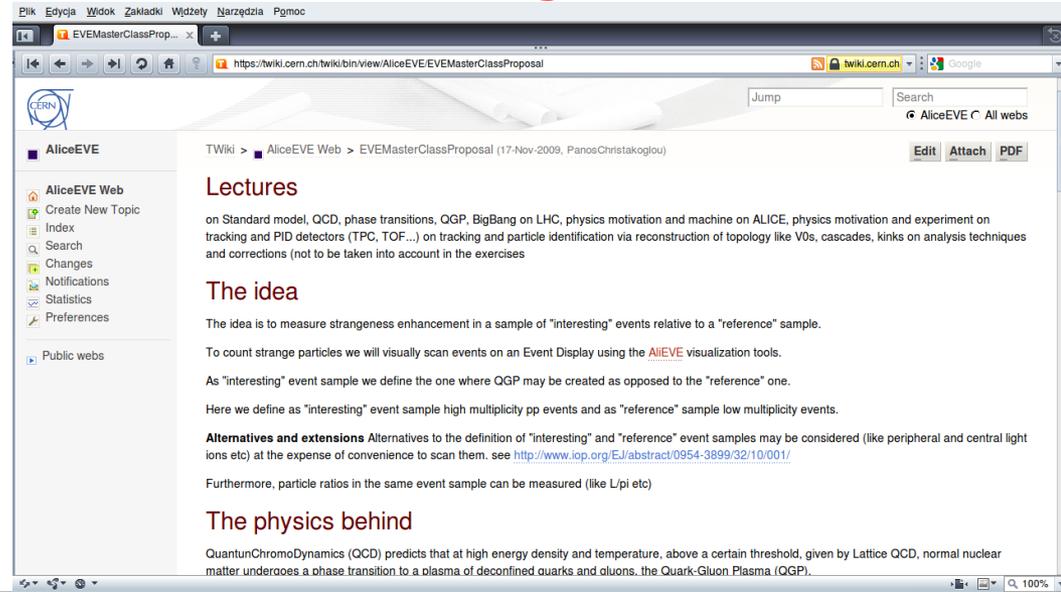
Ratio of total strange to non-strange (proper normalisation)

# From ideas to reality

First proposal CERN NN

First prototype Oslo 15.04.10

Beta version CERN 14.10.10



MasterClass package available in  
[/afs/cern.ch/user/p/pdebski/public/masterclass](https://afs.cern.ch/user/p/pdebski/public/masterclass)

# Real life tests

- ALICE Summer Students demo (CERN; mid-aug)
- Alternative teaching presentation (greece; end aug)
- ALICE students excercise (CERN training centre; 5 oct)



# Questionnaire for feedback



**Questionnaire given during exercise**

- ALICE Summer Students mid-aug
- ALICE Students 5 oct

**Get feedback**

**Implement comments**

**Next Round:**

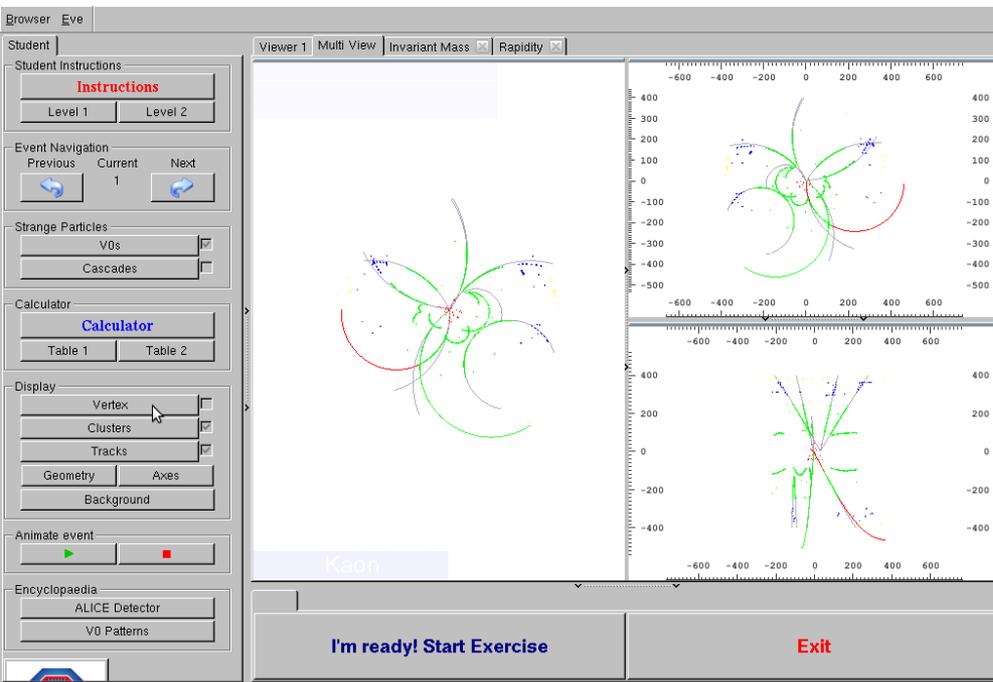
**school children at CERN; 17 nov**

# Questionnaire for feedback

## Main point:

100 events data samples are too big

Now 50 events per sample



## Feedback Questionnaire

### The lecture

Did you find the subject matter interesting?

Yes

No

If no, what didn't you like about it? \_\_\_\_\_

You found the session:

Too long

Just as it should be

Too short

You found the subject matter:

Difficult

About right

Easy

Please comment on the more difficult sections:

## Other comments:

Too easy (for ALICE students)

Complexity can vary with or without  
all tracks and clusters of the event

Better explanation of decay patterns  
through the buttons of MasterClass

# Language versions

Main version in english

Translations in

- french
- greek

```
//=====
MasterClass Instructions fenêtre principale
//=====

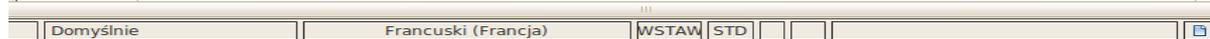
Bienvenue au Masterclass ALICE!

Vous voyez la fenêtre <MasterClass>. Il y a 4 boutons à votre disposition.

En les utilisant vous pouvez choisir entre les modes:

Demo- Lance l'exercice MasterClass avec 4 événements à analyser
Student- Lance l'exercice MasterClass avec 100 événements que vous devez analyser
Teacher's summary- Lance MasterClass avec des outils qui permettent d'avoir les résultats des élèves et
en tirer des conclusions des analyses.

Le bouton Exit - ferme l'application MasterClass
```



```
//=====
Κύριο παράθυρο οδηγιών του MasterClass
//=====
Καλώς ήρθατε στο MasterClass!

Βλέπετε το παράθυρο < MasterClass >. Υπάρχουν τέσσερα κουμπιά στη διάθεσή
σας.
Με αυτά τα κουμπιά μπορείτε να επιλέξετε λειτουργία:

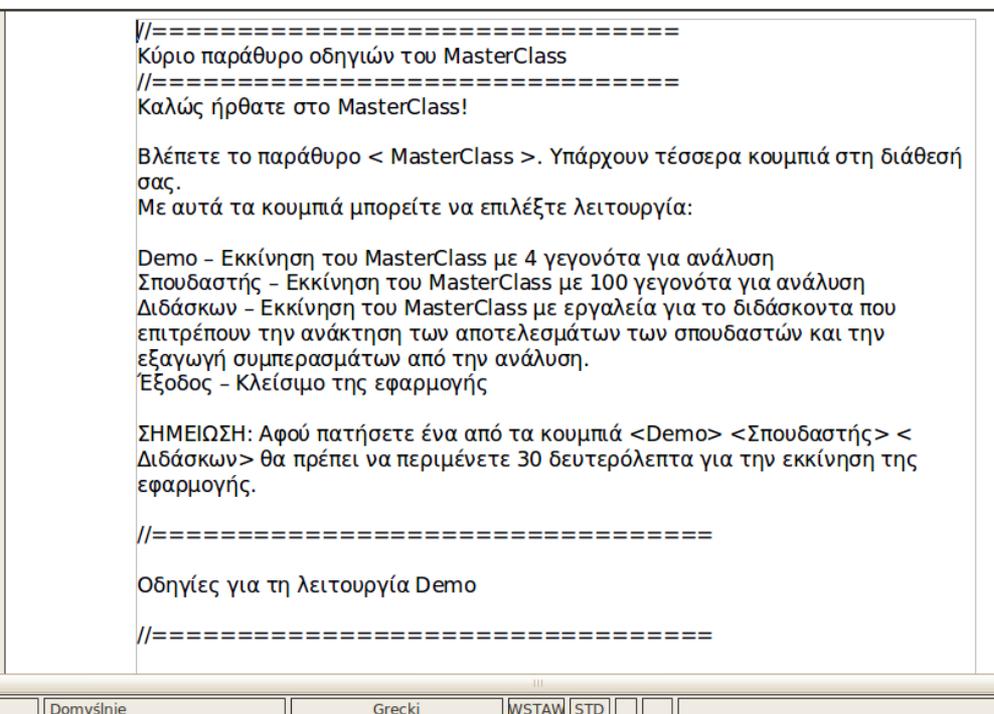
Demo - Εκκίνηση του MasterClass με 4 γεγονότα για ανάλυση
Σπουδαστής - Εκκίνηση του MasterClass με 100 γεγονότα για ανάλυση
Διδάσκων - Εκκίνηση του MasterClass με εργαλεία για το διδάσκοντα που
επιτρέπουν την ανάκτηση των αποτελεσμάτων των σπουδαστών και την
εξαγωγή συμπερασμάτων από την ανάλυση.
Έξοδος - Κλείσιμο της εφαρμογής

ΣΗΜΕΙΩΣΗ: Αφού πατήσετε ένα από τα κουμπιά <Demo> <Σπουδαστής> <
Διδάσκων> θα πρέπει να περιμένετε 30 δευτερόλεπτα για την εκκίνηση της
εφαρμογής.

//=====

Οδηγίες για τη λειτουργία Demo

//=====
```



# Implementation

## ● Introductory lecture

- ⇒ QGP physics, strangeness as signature
- ⇒ Experiment
- ⇒ Detector principle
- ⇒ From signal recording to visualisation
- ⇒ Tracking and PID ( $\pi$ ,  $K$ ,  $p$ )
- ⇒ Strange particles decay patterns ( $K^0$ ,  $\Lambda$ ,  $\Xi$ ,)
- ⇒ Strange particles identification criteria, counting and statistics

## ● Exercise

- ⇒ Demo, “guided tour”
- ⇒ On your-self

**data samples: 100 real pp at 900 GeV per student**

## ● Individual measurements

- ⇒ Students work on their data sample: identify, count and report

## ● Analysis by the class

- ⇒ Teacher collects individual reports: data analysis, conclusions

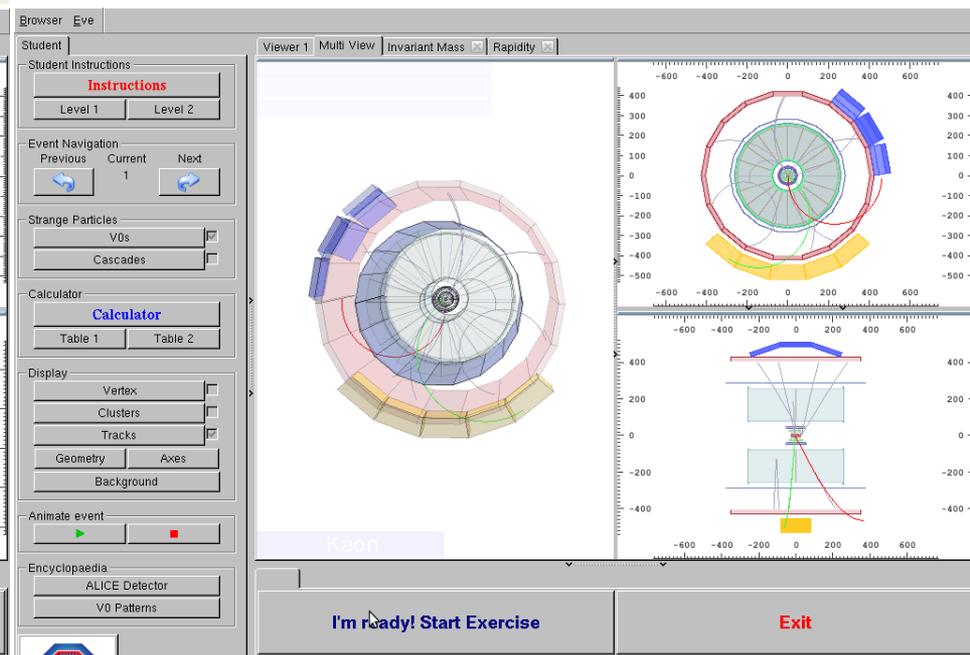
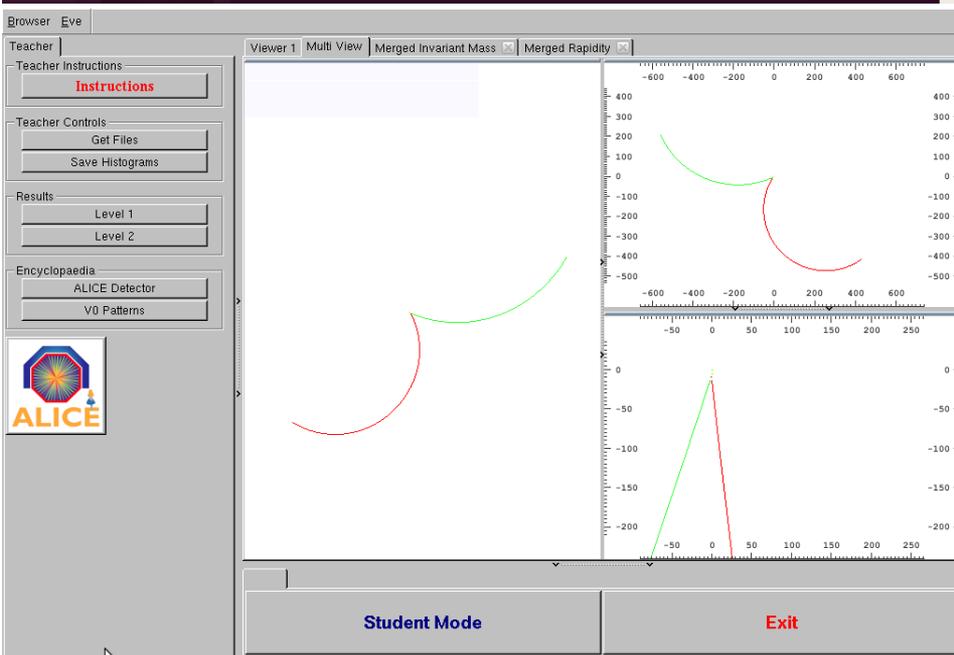
# Implementation

```
Plik Edycja Widok Terminal Pomoc
pdebski@pdebski-laptop:~/MasterClass$ root
*****
*
*   WELCOME to ROOT
*
*   Version 5.26/00b   9 February 2010
*
*   You are welcome to visit our Web site
*   http://root.cern.ch
*
*****
ROOT 5.26/00b (tags/v5-26-00b@32288, Aug 25 2010, 10:52:00 on linux)
CINT/ROOT C/C++ Interpreter version 5.17.00, Dec 21, 2008
Type ? for help. Commands must be C++ statements.
Enclose multiple statements between { }.
root [0] .x masterclass.C
```

Based on ROOT only

Data and geometry are imported  
(as VSD root files)

Can be of any experiment



# Support material

⇒ QGP physics, strangeness as signature

Text and simplified slides

**animation of heavy-ion collision**

⇒ Experiment

**Text, experimental set up and photos**

**animation of the experiment and detectors**

**animation of collision in the centre of experiment**

**and particle propagation in the detectors**

⇒ Detector (emphasis on TPC)

**animation for TPC principle of operation**

⇒ From signal recording to visualisation

**animations of events 900 GeV and 7 TeV pp**

⇒ Tracking strategy and Strange particles decay patterns ( $\pi$ ,  $K$ ,  $p$ ), ( $K^0$ ,  $\Lambda$ ,  $\Xi$ ,)

**views of V0s and Cascades in 900 GeV and 7 TeV pp**

**Some support material via:**

- buttons of the MasterClass
- photoframe
- web pages

**use of visualisation  
in every day life**

Plik Edycja Widok Historia Zakładki Narzędzia Pomoc

file:///home/pdebski/www/webpage-masterclass.html

Często odwiedzane Getting Started Latest Headlines

ALICE

# Existing prototype



## Finding strange particles and checking for strangeness enhancement in ALICE Experiment at LHC



**Introduction:**

**ALICE**

- ALICE Experiment
- ALICE Physics
- The strong interaction
- What happens during a collision of heavy nuclei?
- Confinement
- Generation of mass
- Free quarks and gluons
- Back to the beginning

**Chapter 1:**

**Decay patterns of strange particles**

- Introduction
- V0 pattern
- Cascade pattern
- Kink pattern

**Chapter 2:**

**Decay patterns from MC/REAL data**

- Decay patterns from MC/REAL data

**Chapter 3:**

Zakończono

Plik Edycja Widok Historia Zakładki Narzędzia Pomoc

file:///home/pdebski/www/webpage-masterclass.html

Często odwiedzane Getting Started Latest Headlines

ALICE



## Finding strange particles and checking for strangeness enhancement in ALICE Experiment at LHC



Plik Edycja Widok Historia Zakładki Narzędzia Pomoc

file:///home/pdebski/www/webpage-masterclass.html

Często odwiedzane Getting Started Latest Headlines

ALICE



## Finding strange particles and checking for strangeness enhancement in ALICE Experiment at LHC



**Introduction:**

**ALICE**

- [ALICE Experiment](#)
- [ALICE Physics](#)
- The strong interaction
- What happens during a collision of heavy nuclei?
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**The strong interaction**

Plik Edycja Widok Historia Zakładki Narzędzia Pomoc

file:///home/pdebski/www/webpage-masterclass.html

Często odwiedzane Getting Started Latest Headlines

ALICE



## Finding strange particles and checking for strangeness enhancement in ALICE Experiment at LHC



**The ALICE Experiment**

ALICE is the acronym for A Large Ion Collider Experiment, one of the largest experiments in the world devoted to research in the physics of matter at an infinitely small scale. Hosted at CERN, the European Laboratory for Nuclear Research, this project involves an international collaboration of more than 1000 physicists, engineers and technicians, including around 200 graduate students, from 105 physics institutes in 30 countries across the world.

**The detector**

Weighting 10 000 tones and with a height of 16 m and a length of 26 m, ALICE is a large and complex detector composed of 18 sub-detectors to track and identify the tens of thousands of particles produced in each heavy-ion collision. To record up to 8000 collisions per second, the ALICE detector is based on state-of-the-art technologies:

- high precision systems for detecting and tracking the particles;
- ultra miniaturized systems for processing electronics signals;
- a worldwide distribution of computing resources for data analysis (the Grid).



ALICE Collaboration

file:///home/pdebski/www/alice\_experiment.html

# Still To Do

## Improve presentation and support material

- lecture(s) according to grade level
- web pages

## Organise delivery of exercise package and support material

- CDs
- web based

## Test with outside CERN institutes; interest from

- GSI/HD
- Strasbourg
- Warsaw
- Italy/...

## Automatise the procedure to get best candidates from experiments ESD to MasterClass VSD root data files

- repeat for 7 TeV high multiplicity pp data
- repeat for 2.36 TeV PbPb data

# Still To Do

Formulate clear conclusions; to popup under buttons YES or NO

- for 0.9 TeV minimum bias pp data
- for 7 TeV high multiplicity pp data
- 2.36 TeV PbPb data

Strange Particle Statistics		
Particle	MC Data	Real Data
Kaons	13.4	0
Lambdas	3.9	0
antiLambdas	3.5	0
Xis	5.5	0
DO THEY AGREE?	YES!	NO!
Close		

Particle Ratios		
Particle Ratio	MC Data	Real Data
Kaons/Pions(+)	0.094	0.000
Lambdas/Pions(+)	0.026	0.000
antiLambdas/Pions(+)	0.024	0.000
Xis/Pions(+)	0.037	0.0000
DO THEY AGREE?	YES!	NO!
Close		

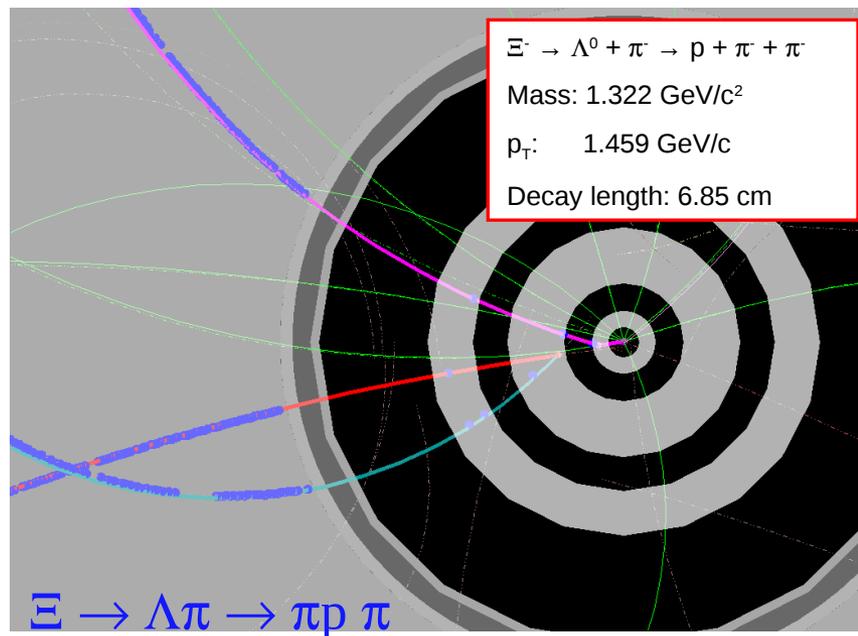
# Demo with real data

```

Plik Edycja Widok Terminal Pomoc
pdebski@pdebski-laptop:~/MasterClass$ root
*****
*                                     *
*      W E L C O M E  t o  R O O T      *
*                                     *
*  Version 5.26/00b  9 February 2010  *
*                                     *
*  You are welcome to visit our Web site *
*      http://root.cern.ch             *
*                                     *
*****

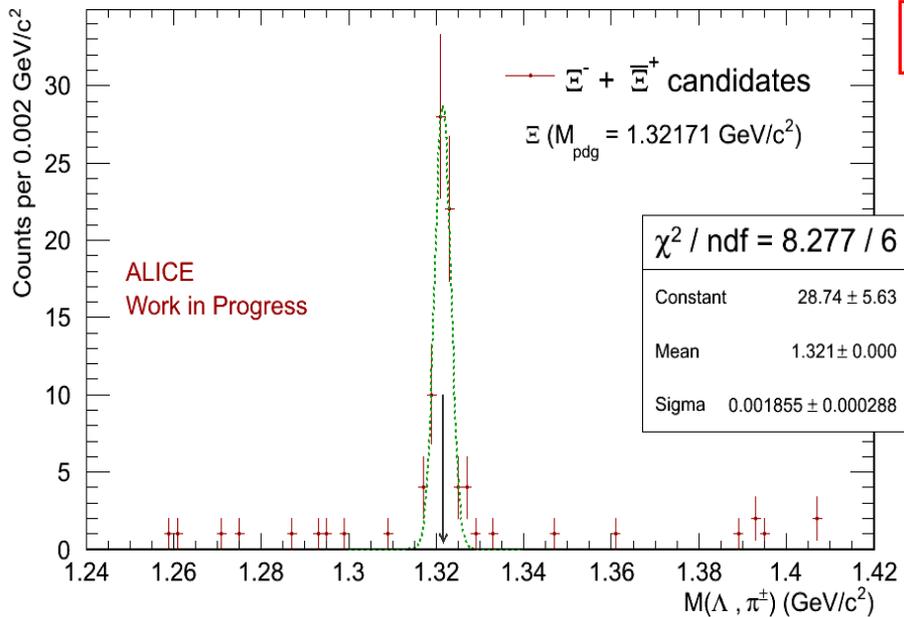
ROOT 5.26/00b (tags/v5-26-00b@32288, Aug 25 2010, 10:52:00 on linux)

CINT/ROOT C/C++ Interpreter version 5.17.00, Dec 21, 2008
Type ? for help. Commands must be C++ statements.
Enclose multiple statements between { }.
root [0] .x masterclass.C
  
```



ALICE data, p-p at 900 GeV

Run 104892, chunk 09000104892020.130, event in chunk 1840



→ Strangeness production paper:

⇒ K<sup>0</sup>, Λ

⇒ Ξ<sup>-</sup>