The New Object Oriented Analysis Framework For H1

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- Motivation and constraints
- Storage model
- Data access
- Analyses
- Event display
- Summary

Introduction

- H1 one of 4 experiments at the ep collider HERA (Desy, Hamburg)

- Data taking since 1992: Analysis done using fortran based environment with hbook, fpack, BOS and PAW
- 2000-2002 Upgrade of accelerator and detector

  $\hookrightarrow$ Good opportunity for software upgrade

Motivation and constraints

Create unique and extendable analysis environment

- One common tool for data storage, user analysis and physics algorithm
- Unification of code
  - Establish a common particle concept
  - Centralize expert knowledge
  - Use of H1 expert knowledge for physics algorithm
- Easy navigation over increasing amount of data & fast event selection
  $\hookrightarrow$ especially partial event reading

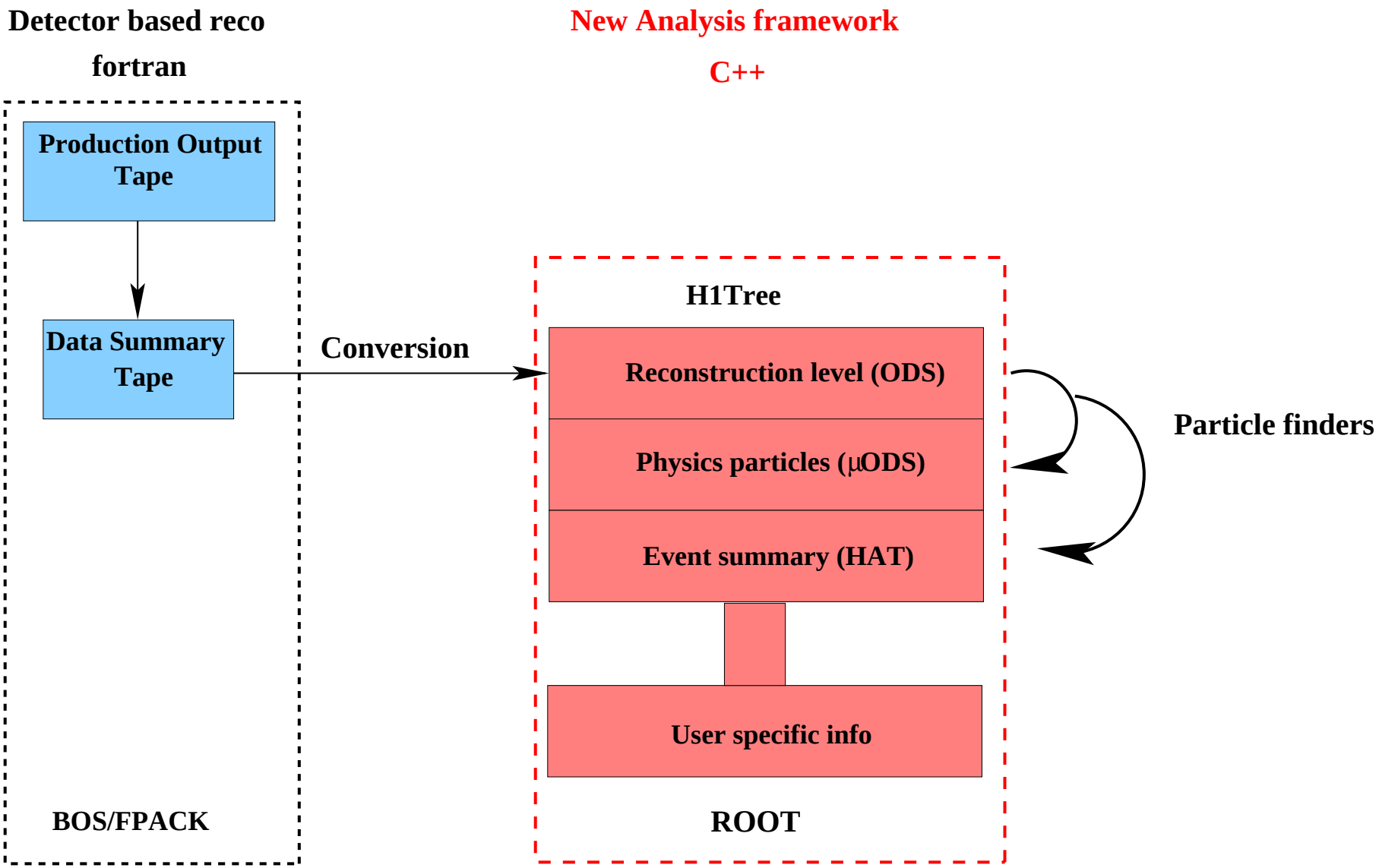
Constraints:

- Time constraint: H1 is running experiment
- Be able to read previous data format
- Keep possibility of using established fortran code

H1 OO: The Project

- 45 packages (managed with CVS)
- $\approx$ 500 classes
- 13 librarians
- 5 physics working groups involved

Relation between fortran and OO environment



Storage Model: (3 + 1) layer structure

ODS ($Object\ Data\ Store$): 13 kb/evt

- Tracks, calorimeter clusters, detector information
- 1-1 correspondence with former DST
- ODS objects created in memory “on demand” (ODS on the fly)

μODS ($\mu Object\ Data\ Store$): 3 kb/evt

- 4Π coverage of detector (no double counted energy)
- 4-vectors of identified particles + associated detector information

  $\hookrightarrow$ ready to use for physics analysis

HAT ($H1\ Analysis\ Tag$): 0.4 kb/evt

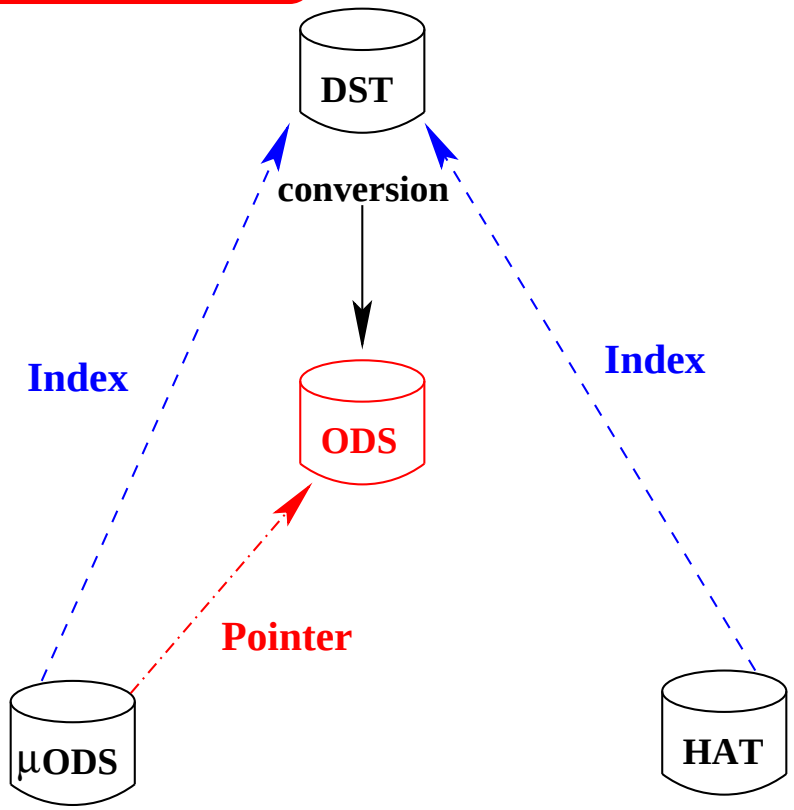
- Detector status, kinematics ...

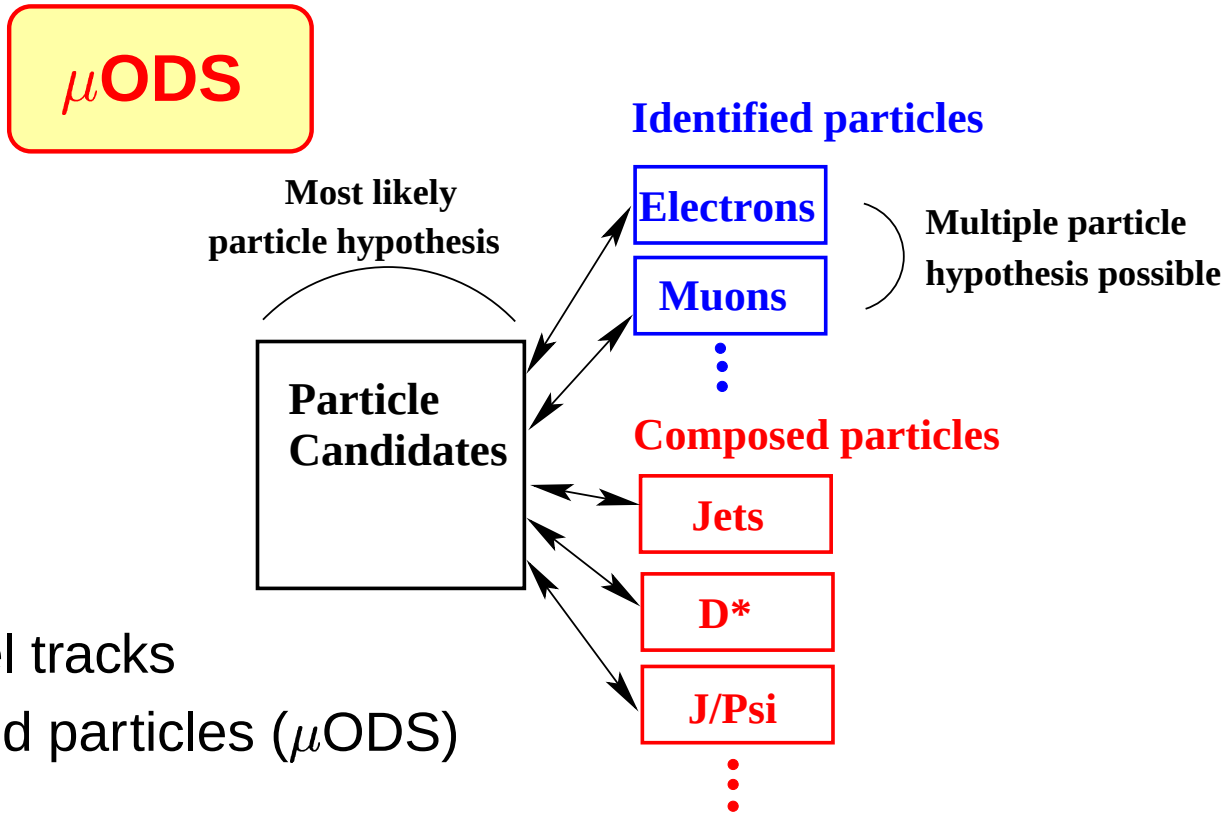
UserTree: user specific info

$\Rightarrow$ Provides a common environment and high flexibility for both H1 and user data

DST to ODS conversion on the fly

- No storage of duplicated information: only DST
  ↪ Allow still fortran compatibility
- Only requested types of objects
  are converted (transparent for the user)
- Dynamic loading of FPACK + BOS libraries
- Fast transient data access:
  only small performance loss in comparison
  to access persistent ods





Particle candidates:

- Particle 4-vector
- Pointers to reconstructed-level tracks and clusters (ODS) & identified particles (μODS)

Identified/Composed Particle Lists:

- Particle kinematics & Detector information (for each particle type)
- Pointers to specific, selected particle candidates

$\Rightarrow$ Provides a quick and easy navigation over particles

$\Rightarrow$ New particle lists could easely be integrated

H1Skeleton:
fully encapsulated data access

H1Skeleton provides user with 2 main classes: $H1Tree$ and $H1Pointer$

$H1Tree$ regroups parallel ROOT trees into conceptually one (user transparent):

- Takes care of file handling (3 layers + user tree)
- Only one event loop over all layers needed
- Equal access for all layers
- Selection of events through $H1EventList$

$H1Pointer$ as extension of ROOT reference lists for all layers:

- Access to partial event information across different layers possible

$\Rightarrow$ Allows easy navigation over data and event delivery according to individual user selection

H1EventList: user selection of events

Contents:

- Selection string (if any)
- Runrange of events
- Name of files associated to
- Type of tree associated to (e.g. μODS)

Characteristics:

- Cumulative selections possible (e.g. preselection + final selection)
- Event (pre-)selection on each layer possible
- No need to know location of data
- Allow subsamples of events without duplication of ROOT files on disk

Physics finders

Input: ODS information (no fortran code involved)

Since 2000:

- Development and validation of finders (electron, muon, jet finder etc...)
- Integration of calibration and alignment

$\Rightarrow$ Same performance level as previous fortran code

$\Rightarrow$ Fully tested in:

- Event by event comparison
- Validation in present analyses

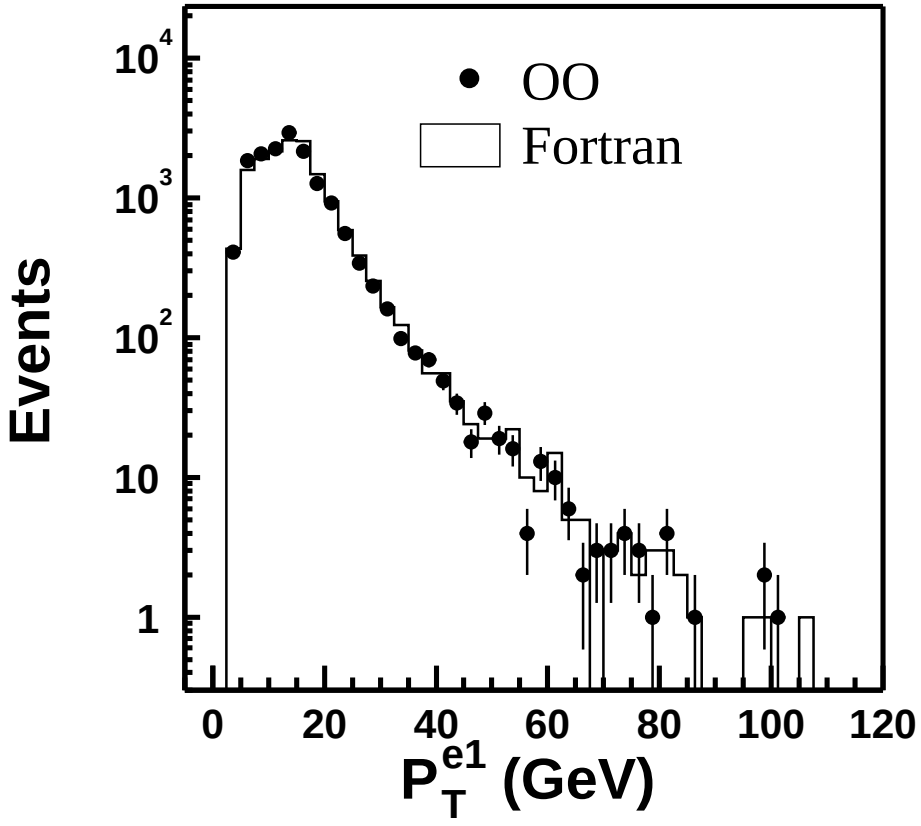
Analyses

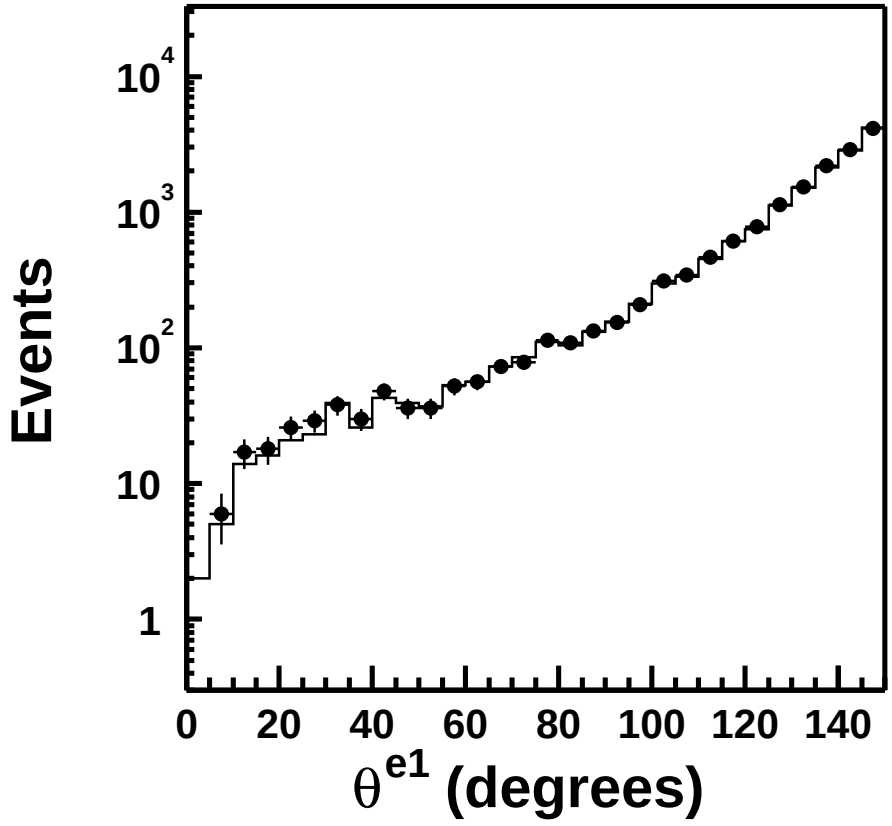
- Ongoing analyses with HERA I data
- All physics working groups involved
- Lower learning threshold for newcomers
- Reduced turn-around for physics analysis job
- Great profit from analyses:
  - Validation of physics algorithm in different phase space regions
  - New usefull variables/algorithms integrated

HERA II data:

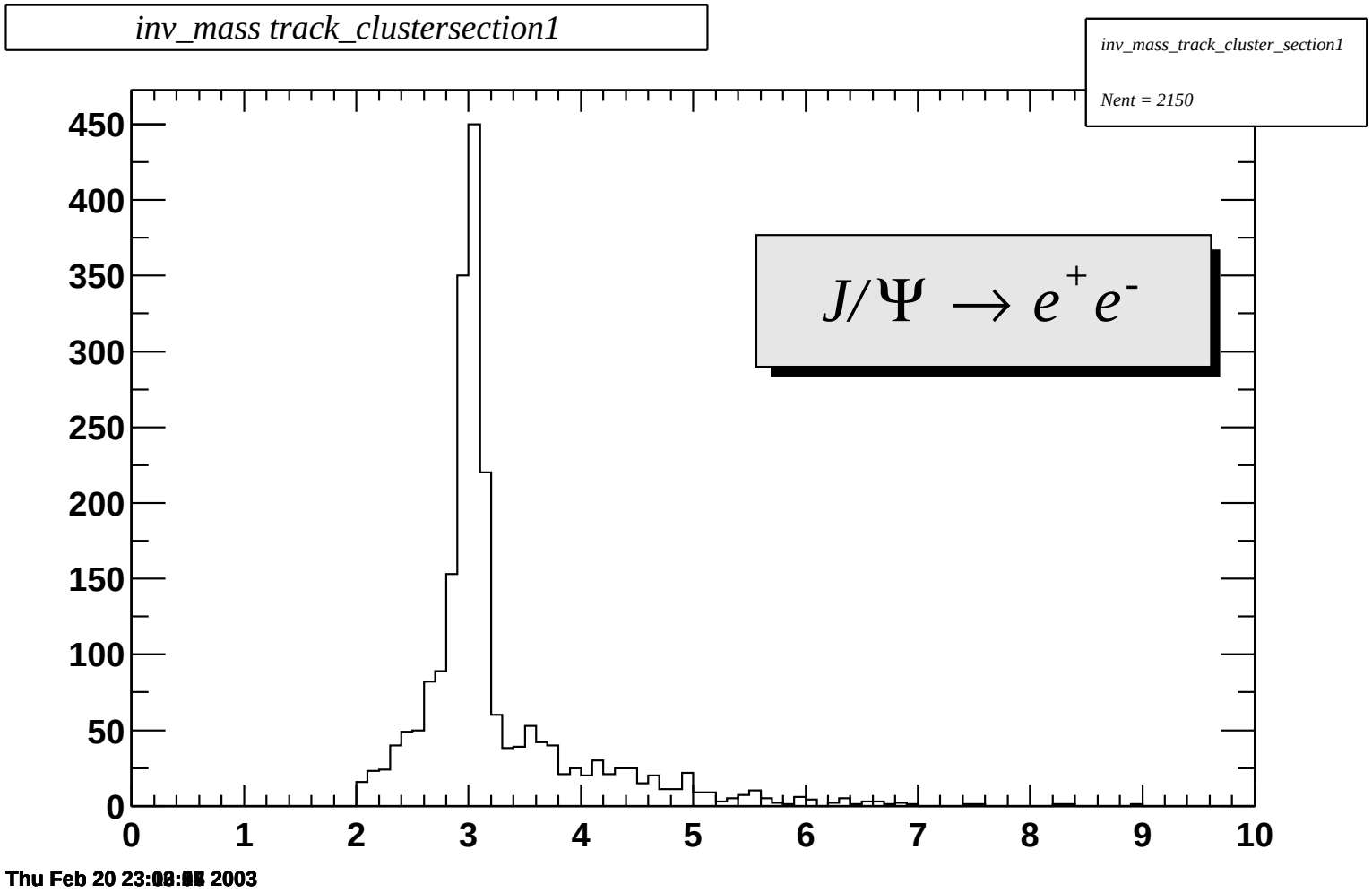
- Used for online production
- Used for data quality checks

Comparison OO - Fortran for NC selection





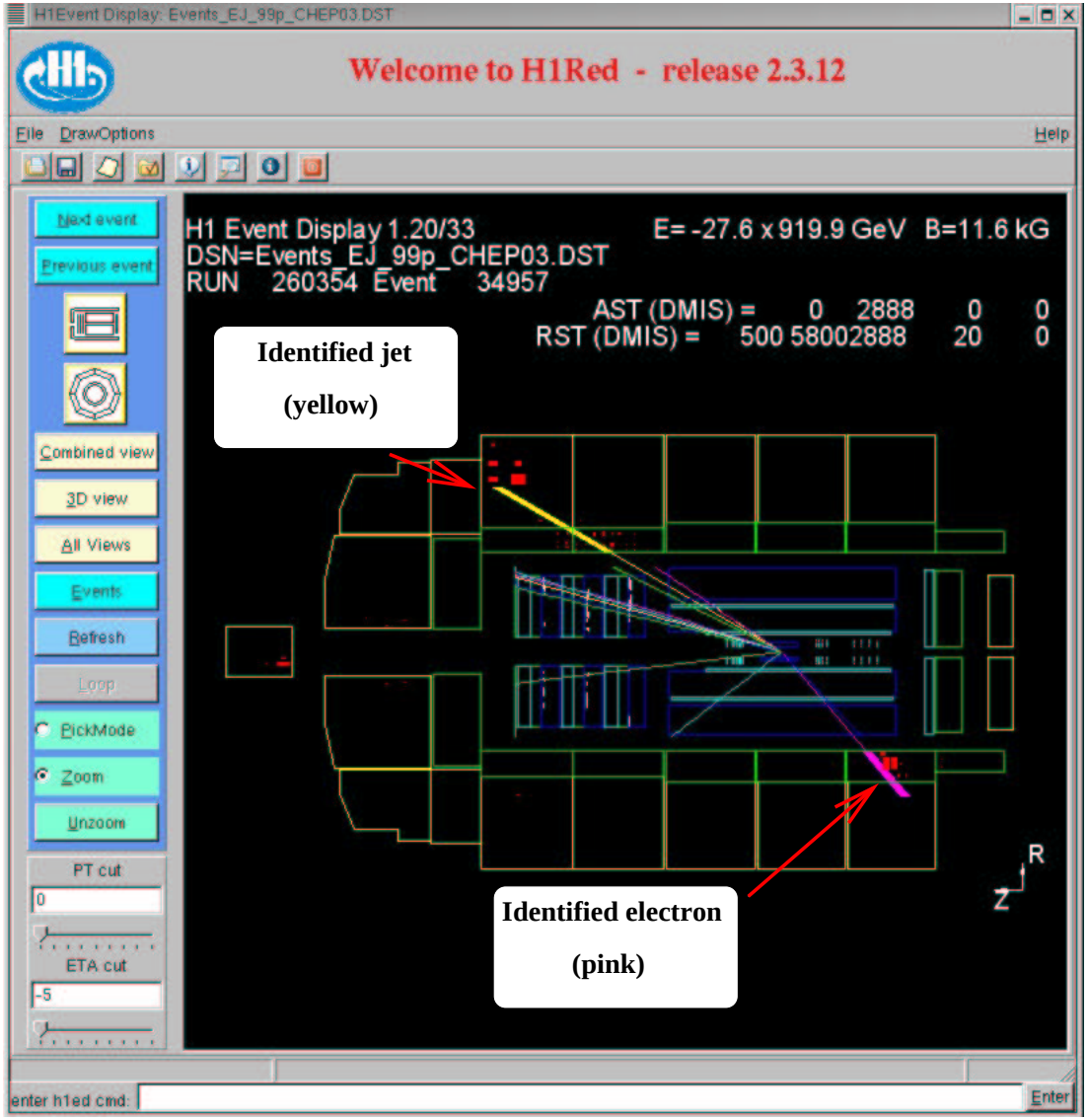
Example of composed particle: J/Psi



Event display

- Completely integrated in analysis framework
- Modern GUI (graphics)
- Software fully compatible with previous H1 display
  $\hookrightarrow$ accepts commands of previous command-line based event display
- Can display:
  - Data in ROOT and BOS format
  - Reconstructed particles and event information
  - Detector hit information

Event display for a typical H1 event

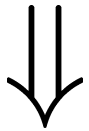


Summary

FORTRAN $\rightarrow$ C++ SUCCESSFUL MIGRATION

Key points are:

- Technical performance and enhanced capabilities of new framework
- Quality of physics algorithms (improvements still ongoing)



The goals for an improved analysis framework have been achieved

It has become a standard tool for H1 physics analysis