

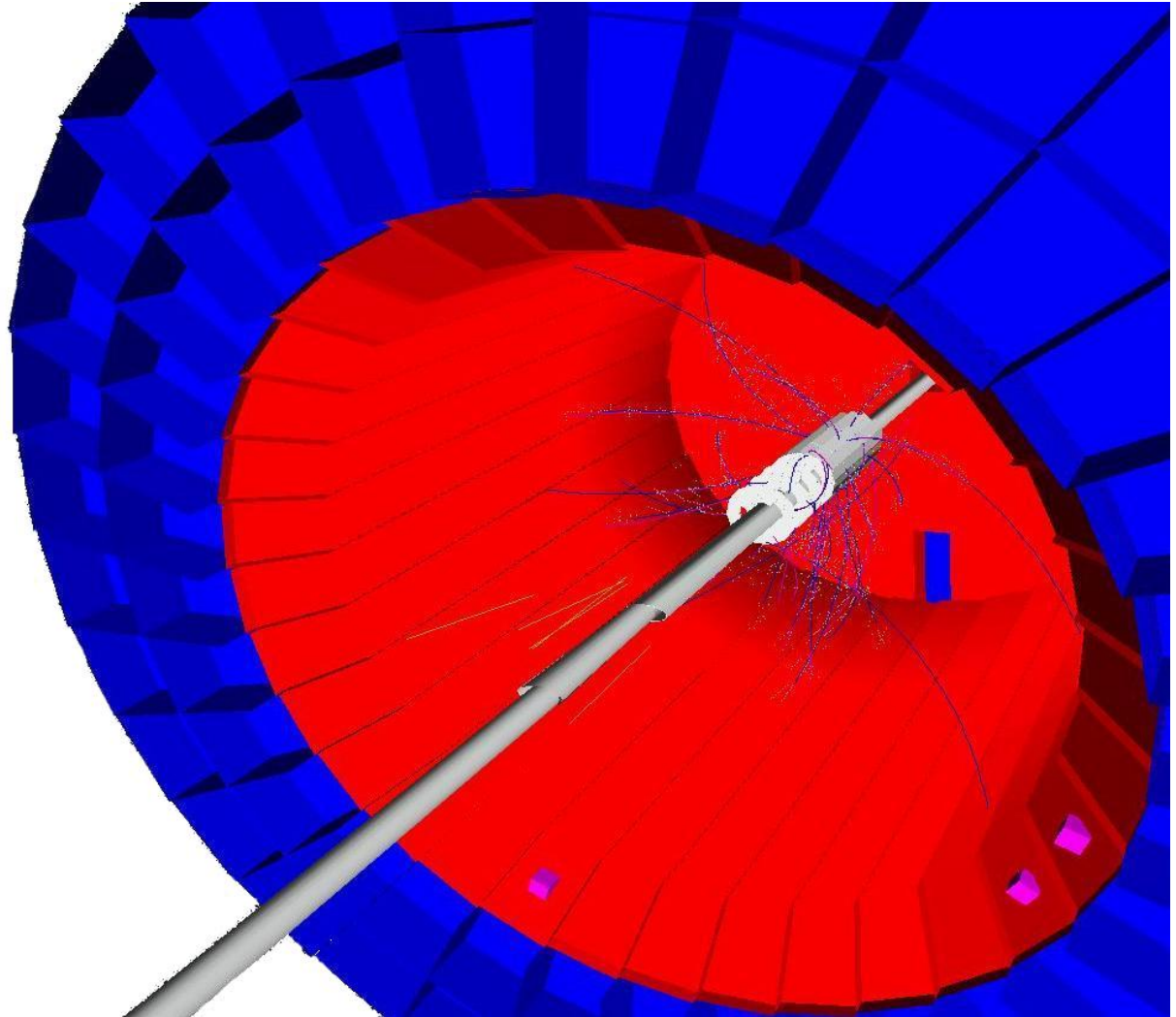
# ZeVis

A Client/Server Event  
Display for the ZEUS  
Experiment

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DESY Computing Seminar



# Outline

- motivation & project history
- general design and data organisation
- client/server concept
- client functionality

# Motivation

## **Hera II challenges: major changes in the Zeus detector**

- new Microvertex Detector
- new Straw Tube Tracker in the forward region
- new beampipe



# ZeVis Project History

- March 2001: start of prestudies (prototypes with Root and Wired)
- September 2001: decision for Root and starting serious coding
- March 2002: 1<sup>st</sup> “slim” release, already in use (commissioning of MVD background studies etc.)
- May 2002: submitted to Zeus software repository
- Spring 2003: 1<sup>st</sup> full release planned

# Aim of the Project

- do it in a modern way (object oriented)
- system independence (support Linux/Unix, possibly Windows)
- internet-accessible → server/client
  - light-weight client
  - server with access to the event store
- fast access
- smooth integration of 2D and 3D graphics
  - 2D layered projections
  - 3D graphics with hidden surface removal
- interactivity
- export, printing etc.
- build on a powerful basis package – no re-invention of the wheel

# Selected Framework: Root

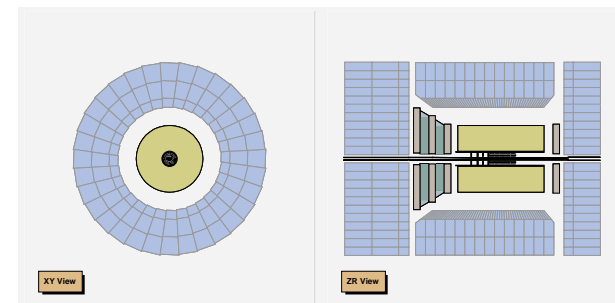
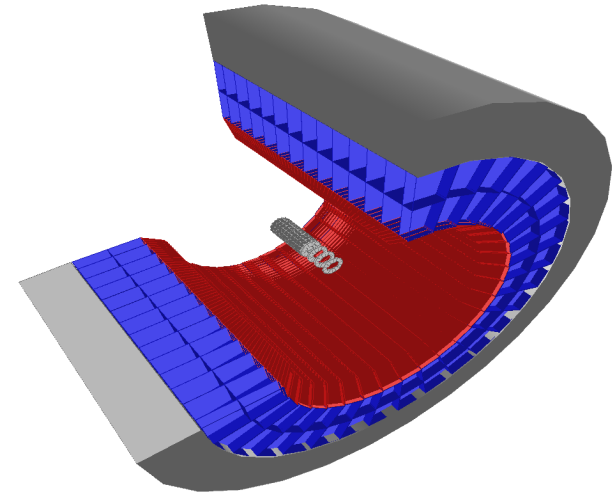
- C++ as basic language,  
interfacing to other Zeus code possible
- 2D and 3D graphics capabilities  
(also OpenGL/OpenInventor viewer)
- detector geometry class library
- object serialisation (streaming)
- plain file and web access
- GUI toolkit
- histogramming and statistics functionality
- schema evolution

# ZeVis Data Organisation

- two-fold data structure:
  - **detector geometry**  
persistent data (loaded only once)
  - **event data**  
transient data
- regarding the class design follow the Root concept and use polymorphism intensely

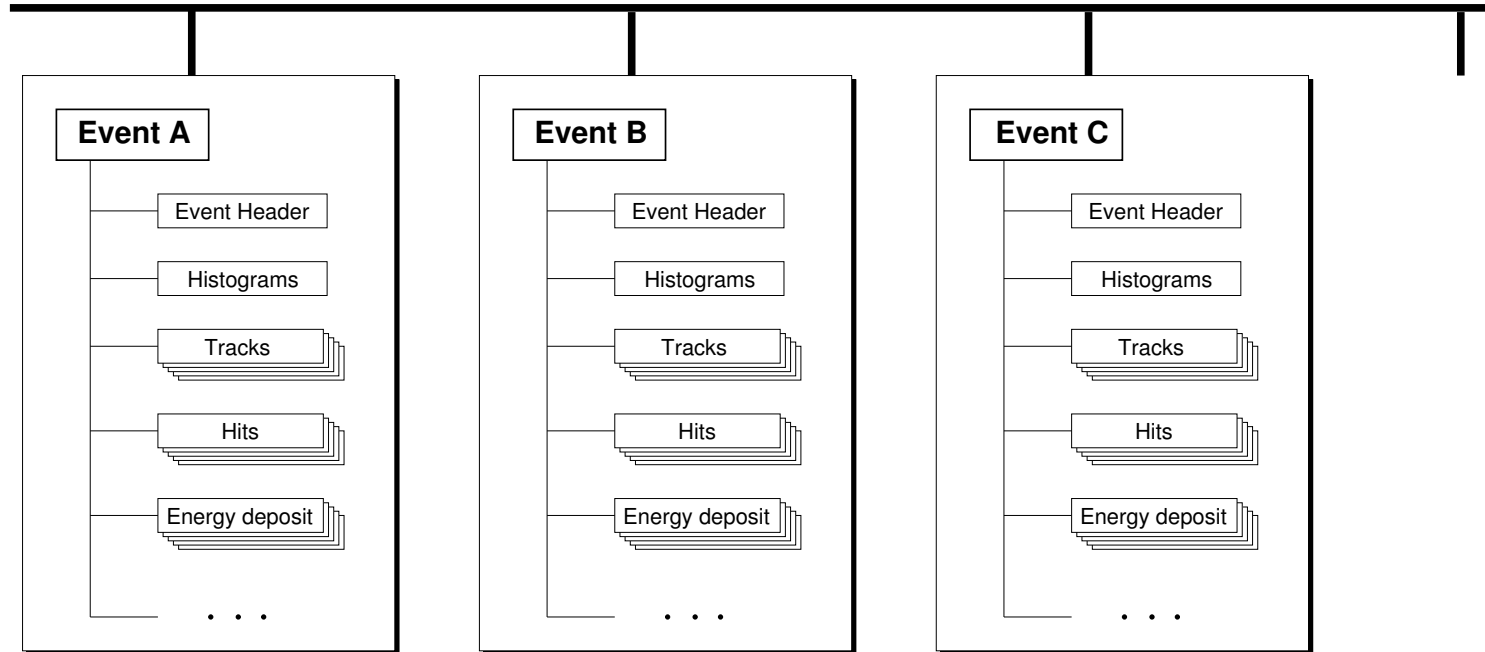
# Detector Geometry Data

- tree-like structure (similar to Geant) containing nodes and shapes (3D representation)
- hold also branches for 2D layered projective representation (mostly used)
- provide one data set for each run period



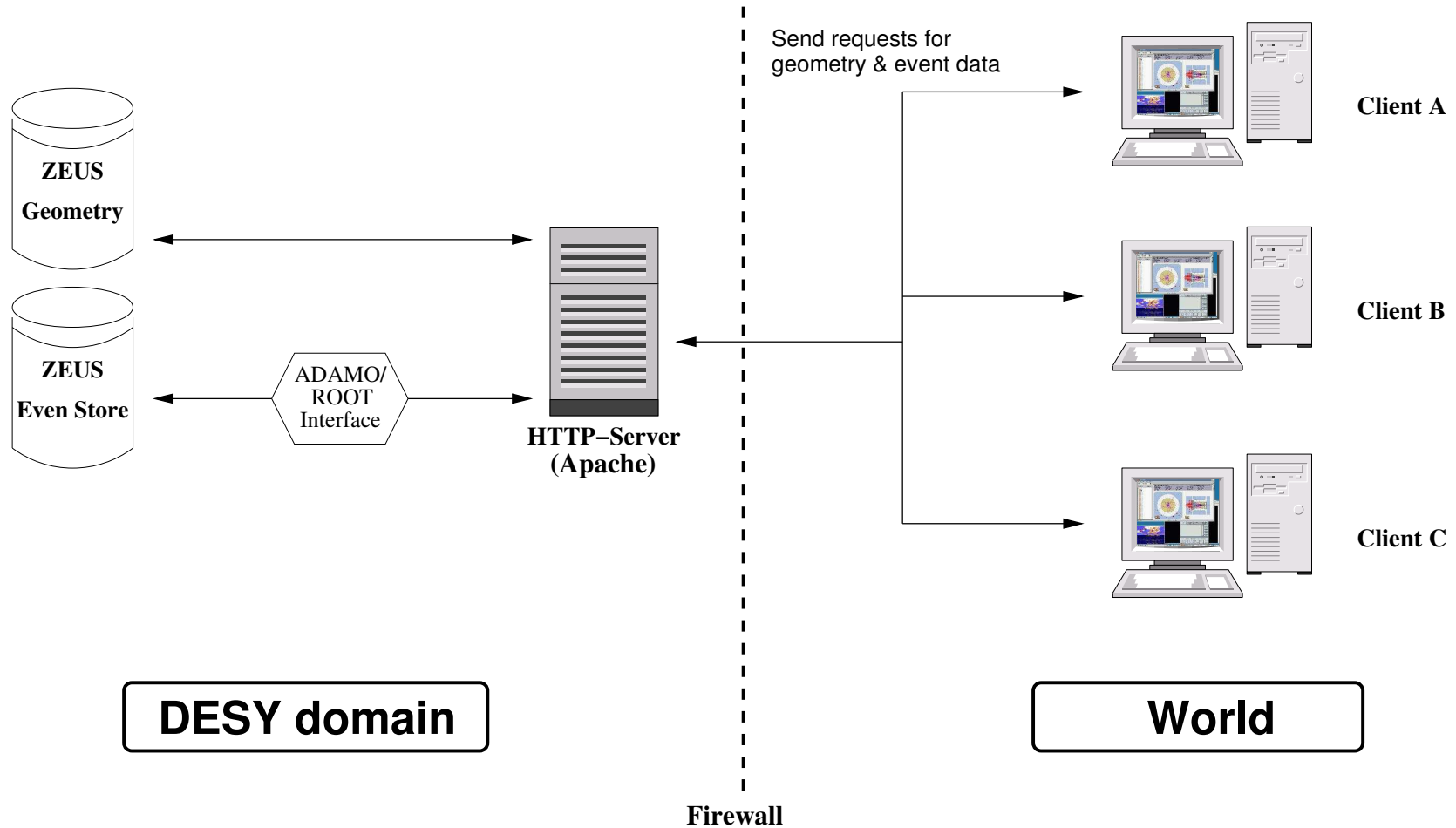
# Event Data

## Root Event Tree



- each object knows how to draw itself
- no detector geometry information inside
- compact format
- compressed

# Client/Server Concept



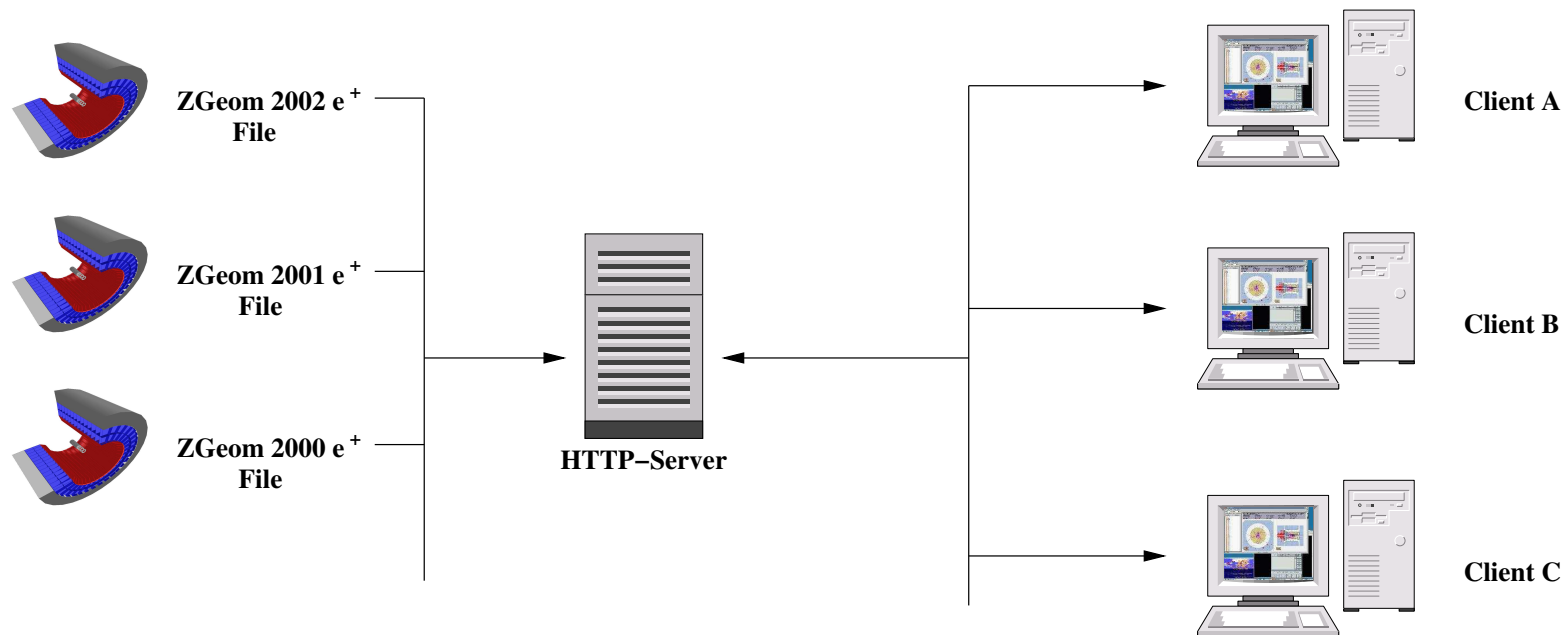
# Server Types

- detector geometry server
- online event server
- multi-event server (offline events)
- single-event server (offline events)
- propaganda server for visitors

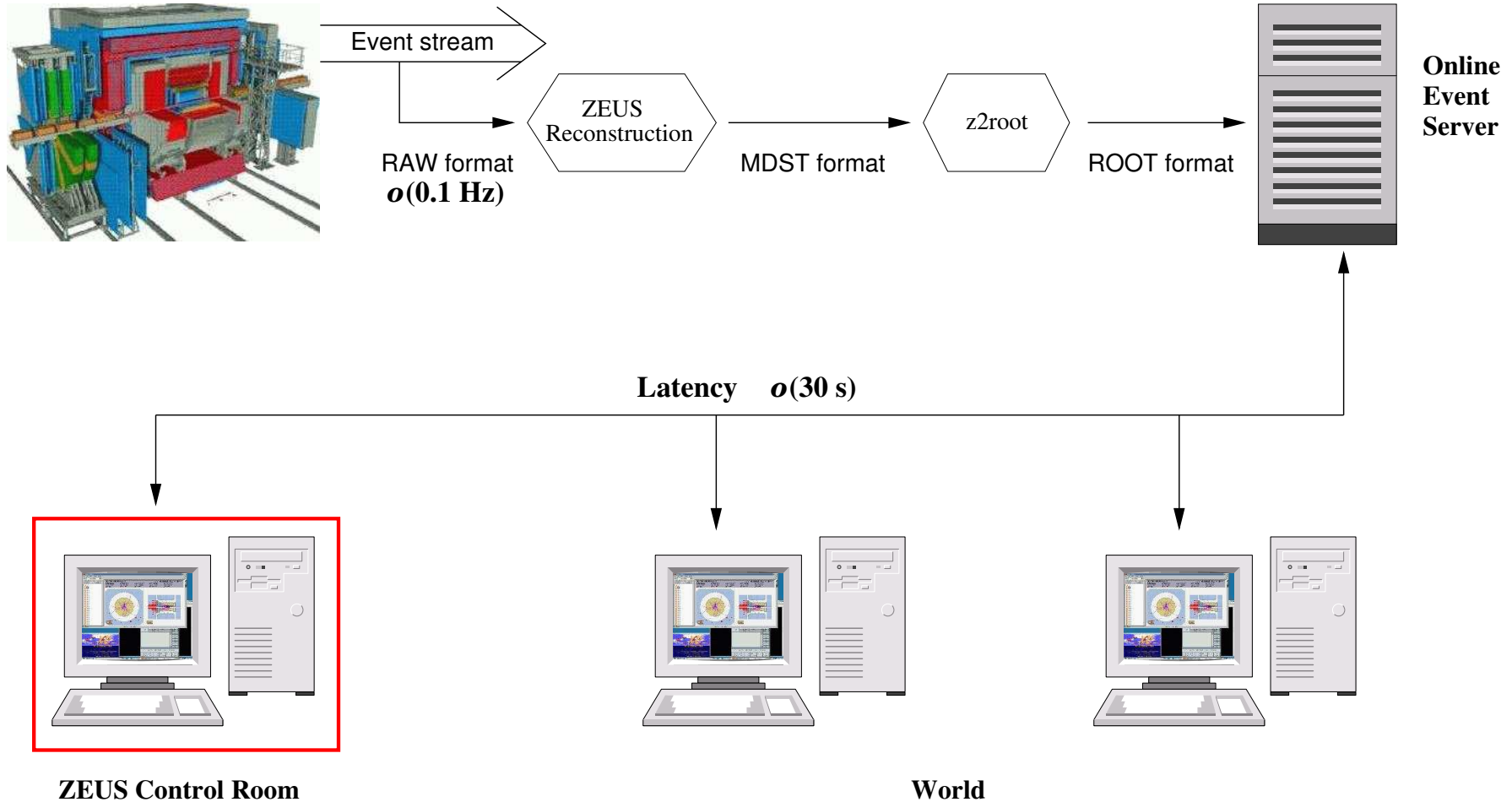
# Geometry Server

- detector geometry Root file for each run period
- requested at client initialization

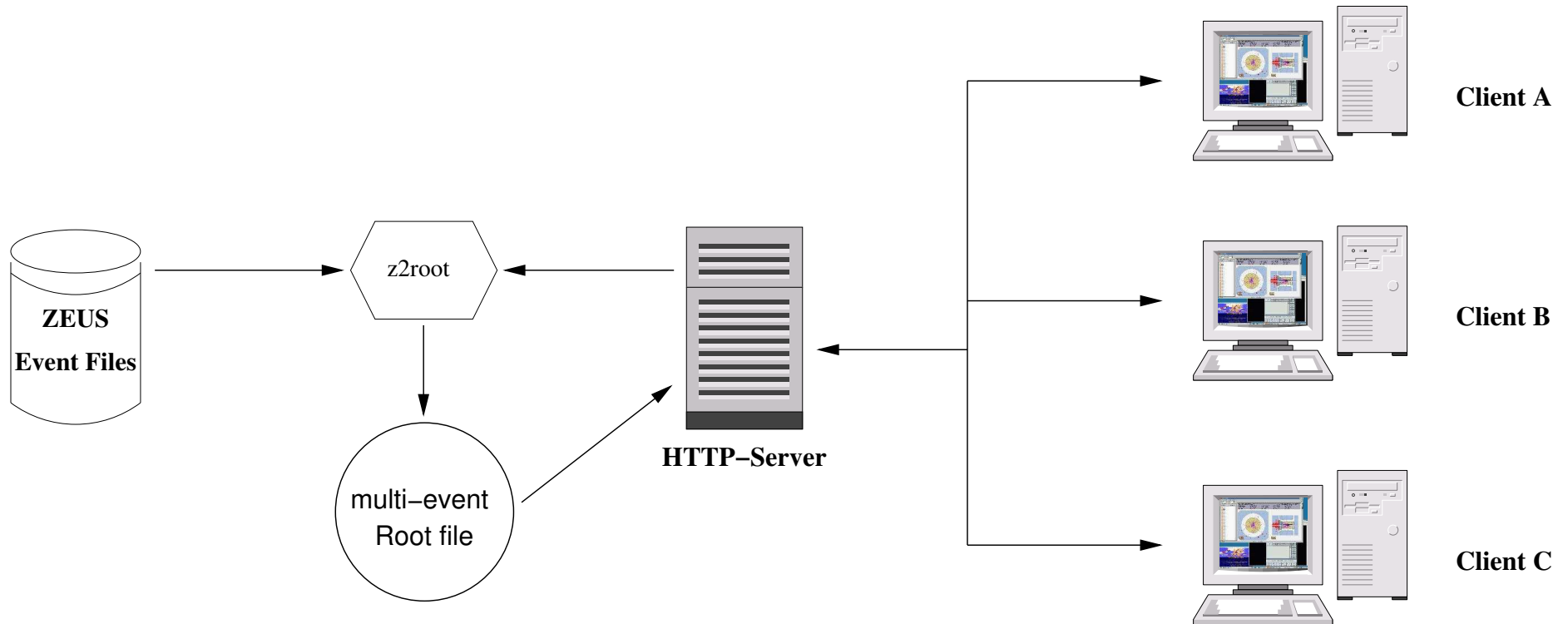
- time consumption  $\ll 1$  s
- geometry can be loaded of-line too



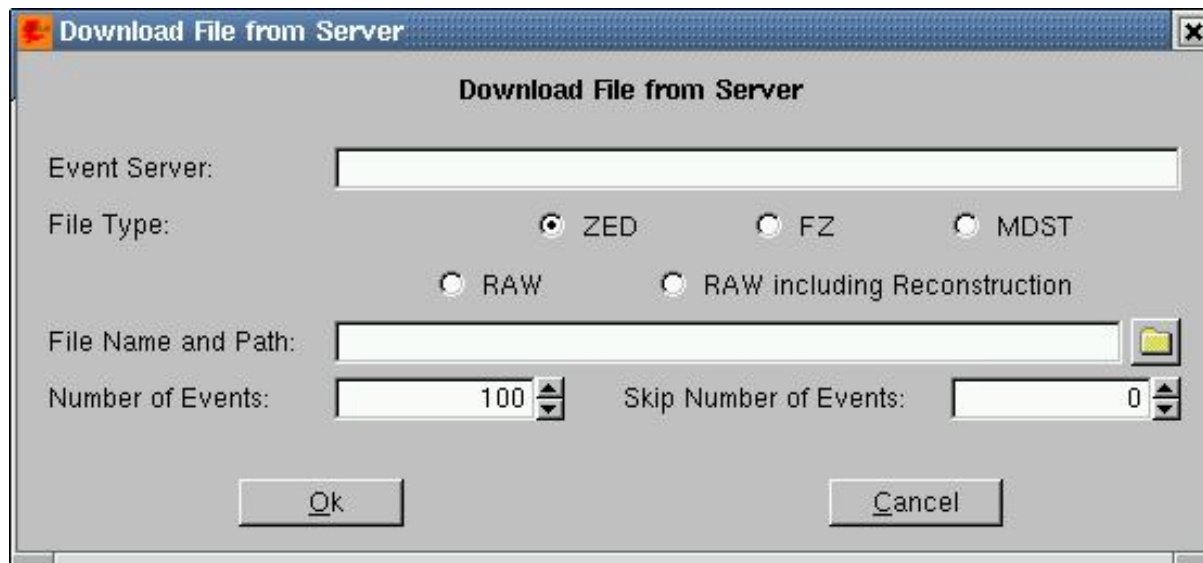
# Online Event Server



# Multi-Event Server

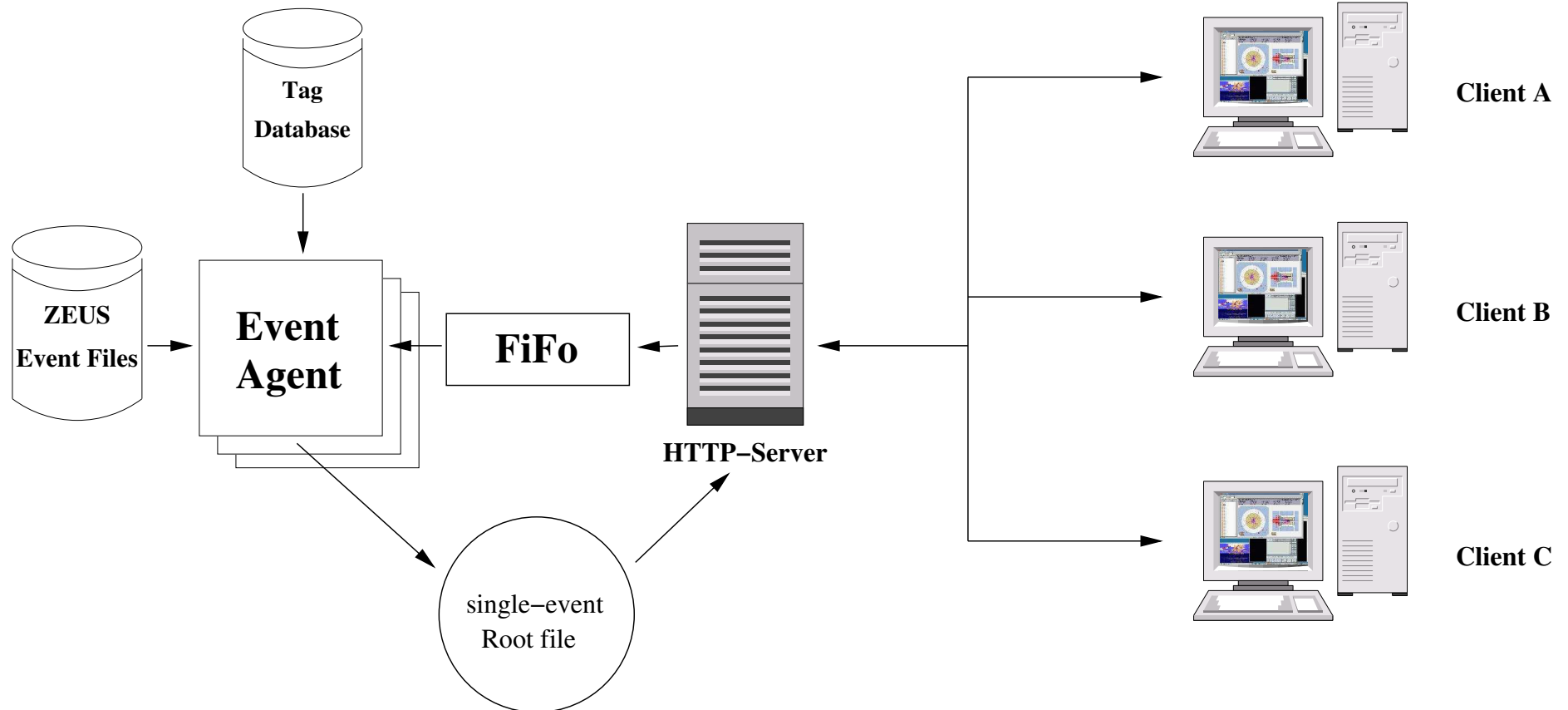


# Multi-Event Server (cont'd)



- can download multi-event file, which can be analysed offline
- $\lesssim 100$  events
- latency  $\mathcal{O}(10 - 30 \text{ s})$
- php driven

# Single-Event Server



# Single-Event Server (cont'd)

Single Event Request

Single Event Request:

Event Server:

Run Nr.:  Event Nr.:

Previous Event  This Event  Next Event

ZES variable query:

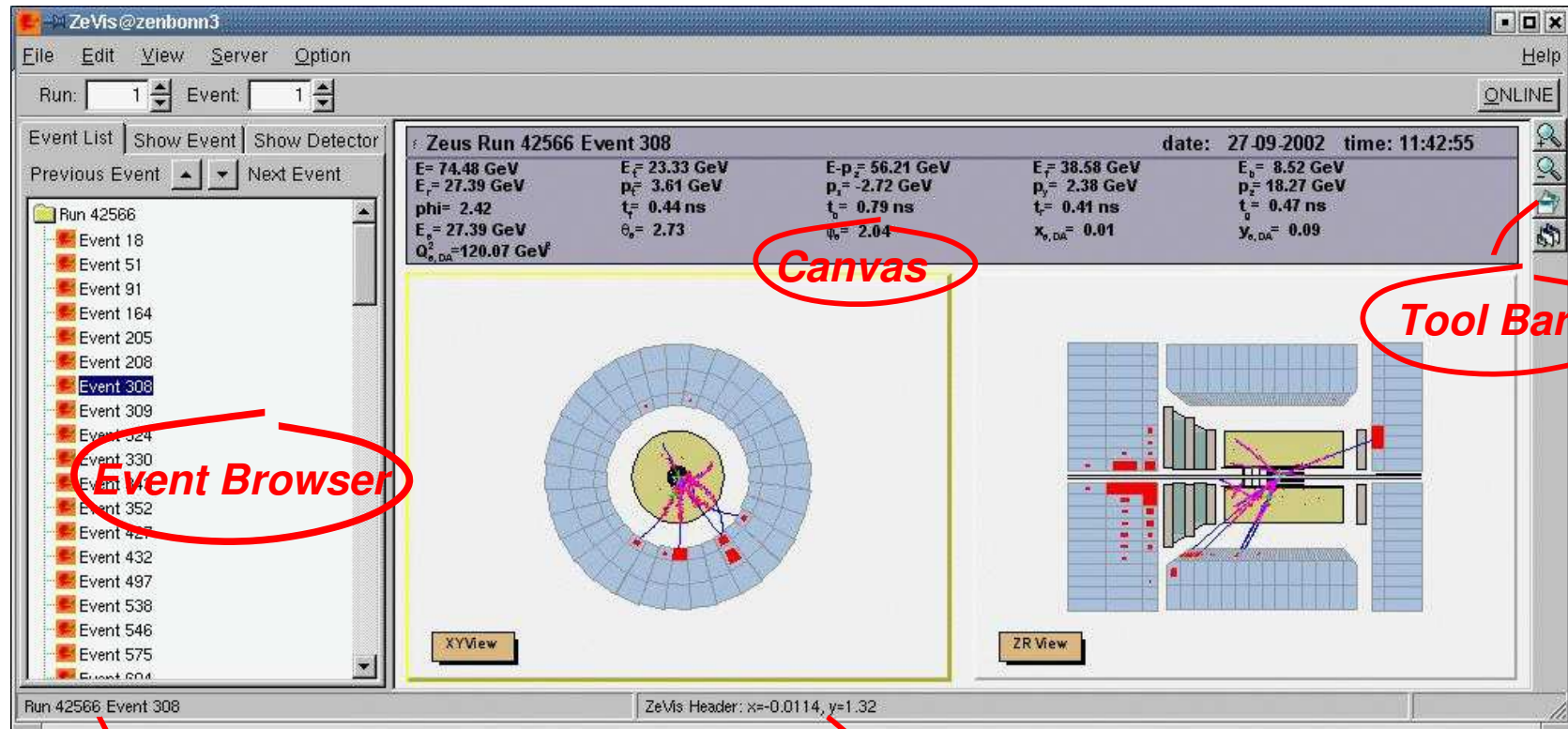
ZES bit query:

ZES sample query:

- fast access
  - low latency
- demon-like implementation

- use Zeus tag database (ZES) for event selection/filtering
- php driven
- not yet in production

# The Client



**Event Browser**

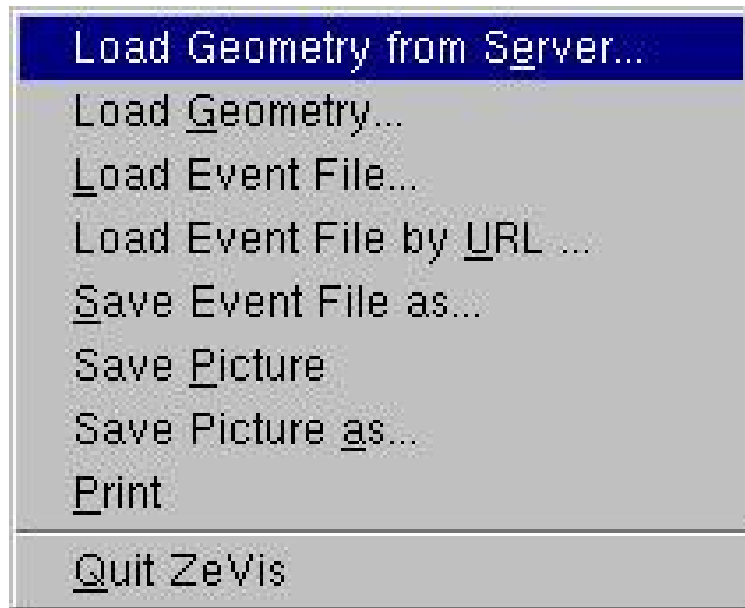
**Canvas**

**Tool Bar**

**Status Bar**

**Info Bar**

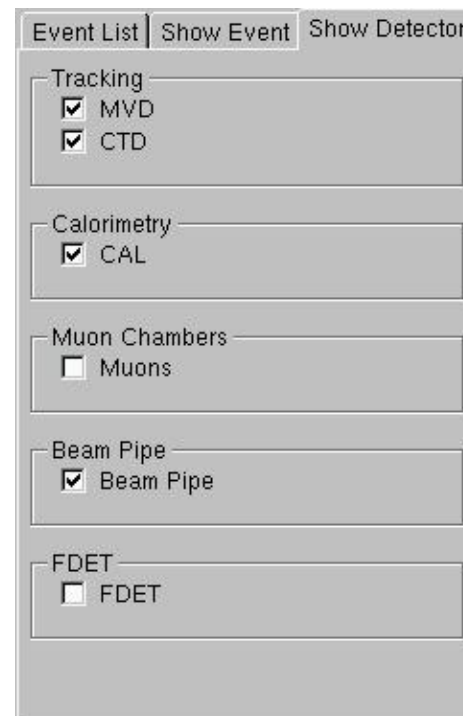
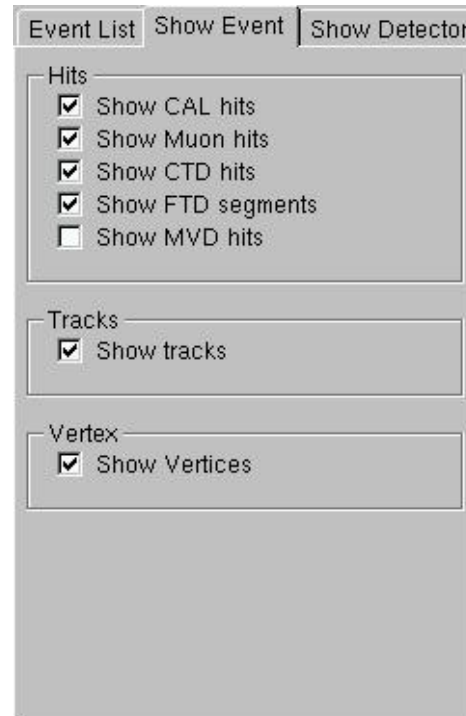
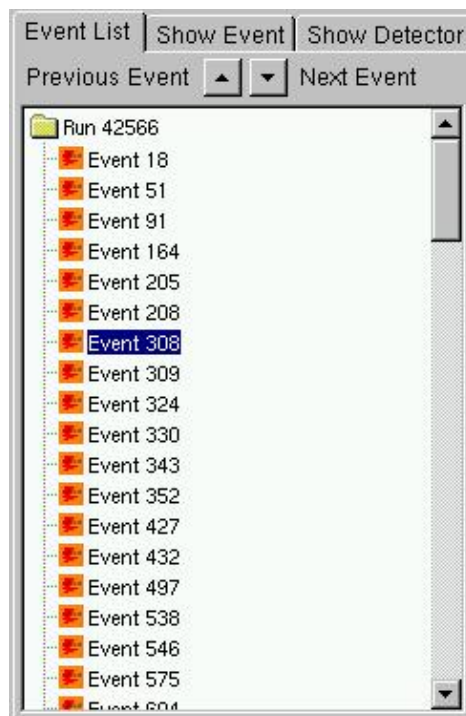
# Client – File Operations



- server connexions
- importing of local geometry files
- loading local event files
- saving events
- graphics export (ps, eps, gif, svg)
- printing

# Client – Display Options

- individual settings of subdetectors and event data possible



# Client – Object Picking

- select objects with mouse to get object information

The screenshot displays the ZeVis software interface for event analysis. The main window shows a detector layout with tracks. A red circle highlights a track, with a red arrow pointing to an 'Object Info' box. Another red circle highlights a track, with a red arrow pointing to an 'Info Textbox'.

**Zeus Run 42566 Event 308**      date: 27-09-2002 time: 11:42:55

$E = 74.48 \text{ GeV}$	$E_{\bar{e}} = 23.33 \text{ GeV}$	$E-p_z = 56.21 \text{ GeV}$	$E_{\bar{e}} = 38.58 \text{ GeV}$	$E_e = 8.52 \text{ GeV}$
$E_{\bar{e}} = 27.39 \text{ GeV}$	$p_{\bar{e}} = 3.61 \text{ GeV}$	$p_{z\bar{e}} = -2.72 \text{ GeV}$	$p_{y\bar{e}} = 2.38 \text{ GeV}$	$p_{z\bar{e}} = 18.27 \text{ GeV}$
$\phi = 2.42$	$t_{\bar{e}} = 0.44 \text{ ns}$	$t_{\bar{e}} = 0.79 \text{ ns}$	$t_{\bar{e}} = 0.41 \text{ ns}$	$t_{\bar{e}} = 0.47 \text{ ns}$
$E_e = 27.39 \text{ GeV}$	$\theta_e = 2.73$	$\phi_e = 2.04$	$x_{e,DA} = 0.01$	$y_{e,DA} = 0.09$
$Q_{e,DA}^2 = 120.07 \text{ GeV}^2$				

**Info Textbox**

REMC RHACD Tower15  
Theta=153.3, R=80.0, Sum(E)=17.550

**Object Info**

ZeVis CTD Track for VCTRHL table 13  
P = 3.436 GeV/c    P = 2.193 GeV/c  
dEdx = 40.150 Mip     $\chi^2/D.o.F. = 0.36$   
 $N_{\text{Add}} = 18$      $N_{\text{ZigZag}} = 7$      $N_{\text{Shed}} = 12$

XYView      ZR View

Run 42566 Event 308      BEMC Module25: Phi=271.8, R=133.6, Sum(E)=4.166

# Client – Object Attributes

- just click the right mouse button for object interaction

The screenshot displays the ZeVis software interface for Zeus Run 42566. The main window shows a list of events on the left, with Event 91 selected. The central area displays a circular detector layout with particle tracks. A context menu is open over the detector, showing options like 'ZVctrl', 'SetInfoBox', 'Dump', 'Inspect', and 'SetLineAttributes'. A detailed data panel at the top right lists event parameters, and a 'ZVctrl' control panel is visible on the right side.

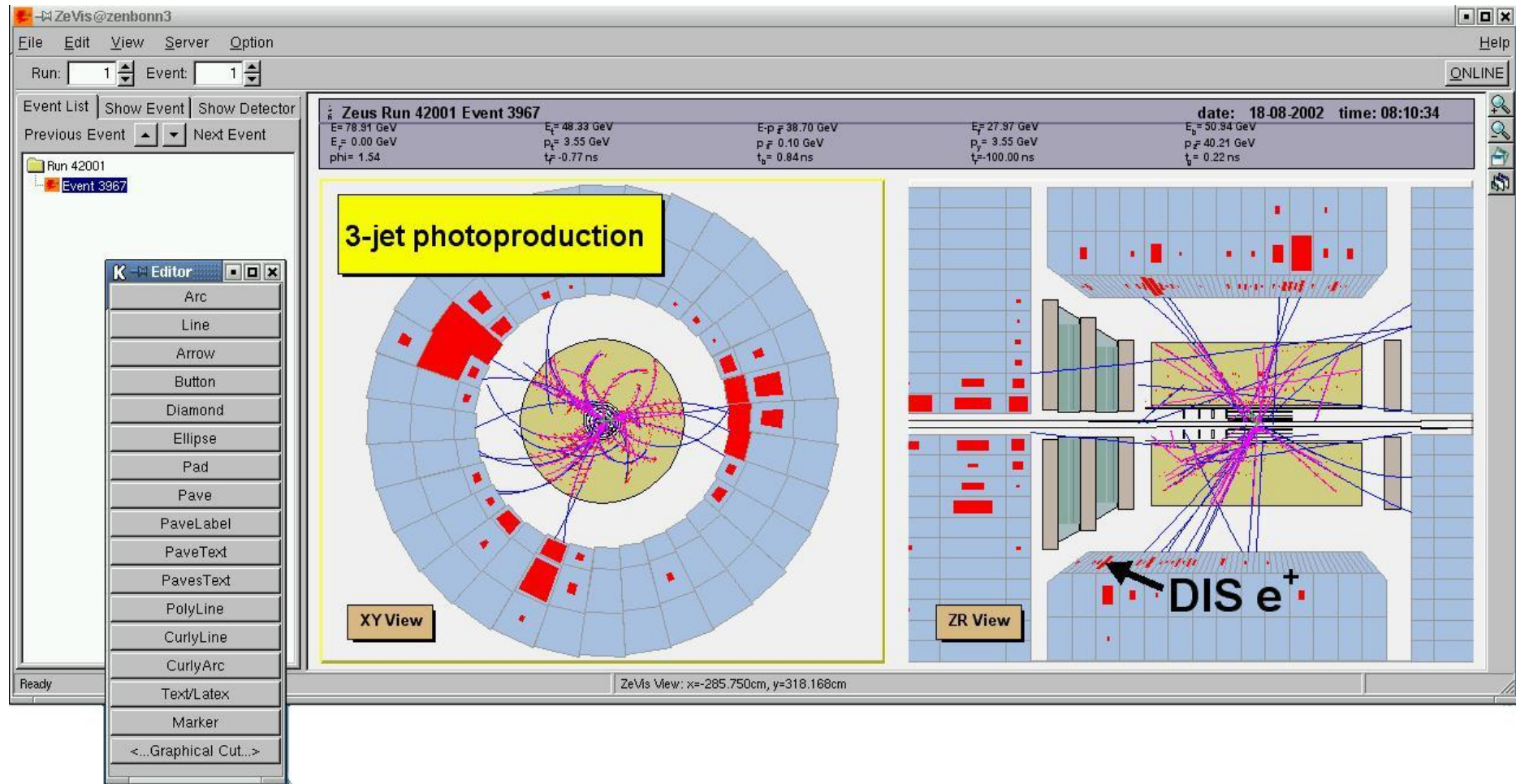
**Zeus Run 42566 Event 91**      date: 27-09-2002 time: 11:42:12

$E=103.70$ GeV	$E_e=19.21$ GeV	$E-p_z=50.22$ GeV	$E_e=77.81$ GeV	$E_b=4.56$ GeV
$E_r=21.33$ GeV	$p_r=1.75$ GeV	$p_x=-0.18$ GeV	$p_y=1.74$ GeV	$p_z=53.48$ GeV
$\phi=1.67$	$t_r=0.39$ ns	$t_b=0.70$ ns	$t_e=1.96$ ns	$t_g=0.66$ ns
$E_g=20.75$ GeV	$\theta_e=3.03$	$\phi_e=0.50$	$x_{e,DA}=0.00$	$y_{e,DA}=0.73$
$Q_{e,DA}^2=2.65$ GeV <sup>2</sup>				

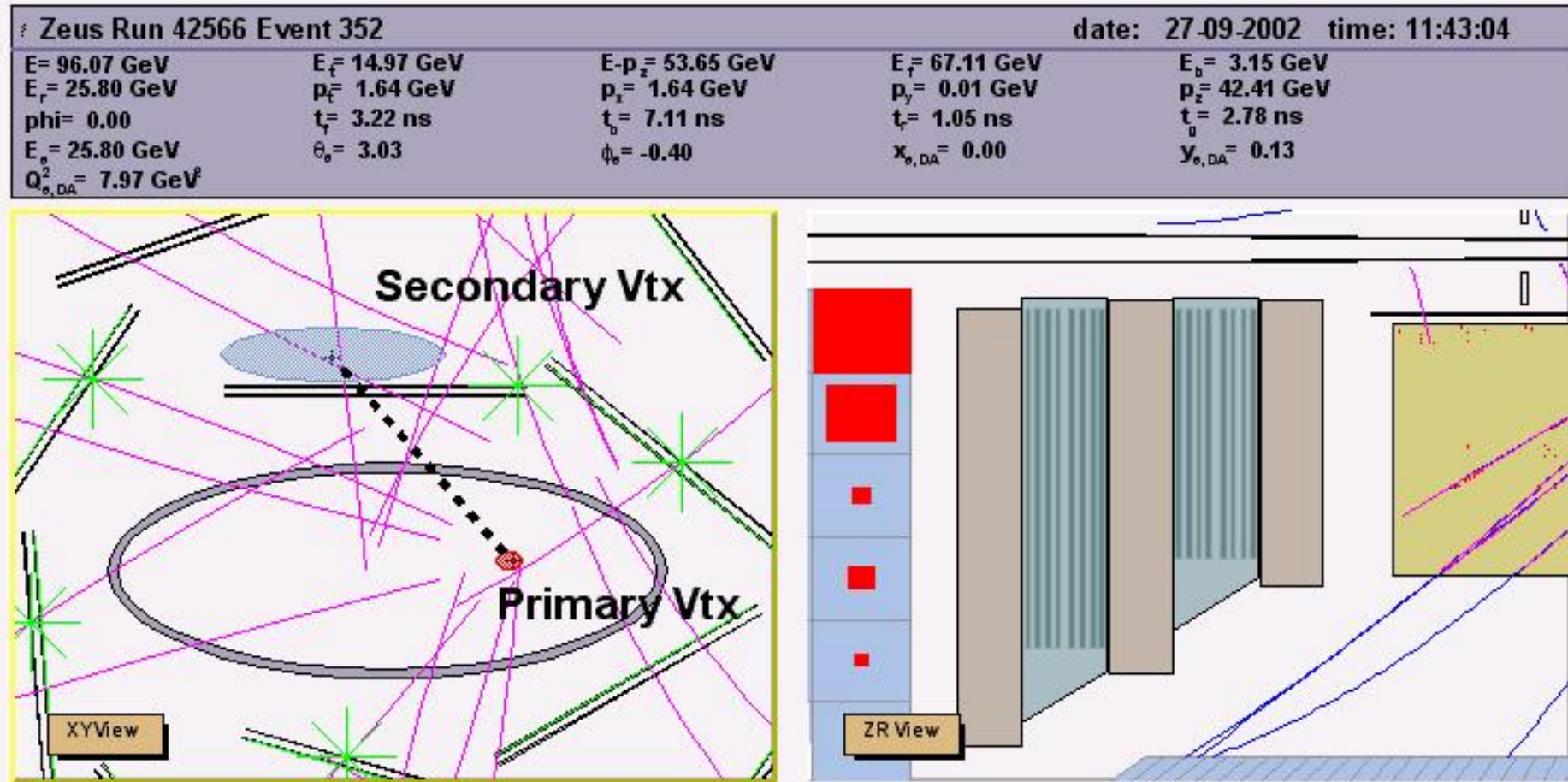
Run 42566 Event 91

Zeus CTD track for ZVctrl table: Id=4, P=0.634, P

# Client – Graphics Editor

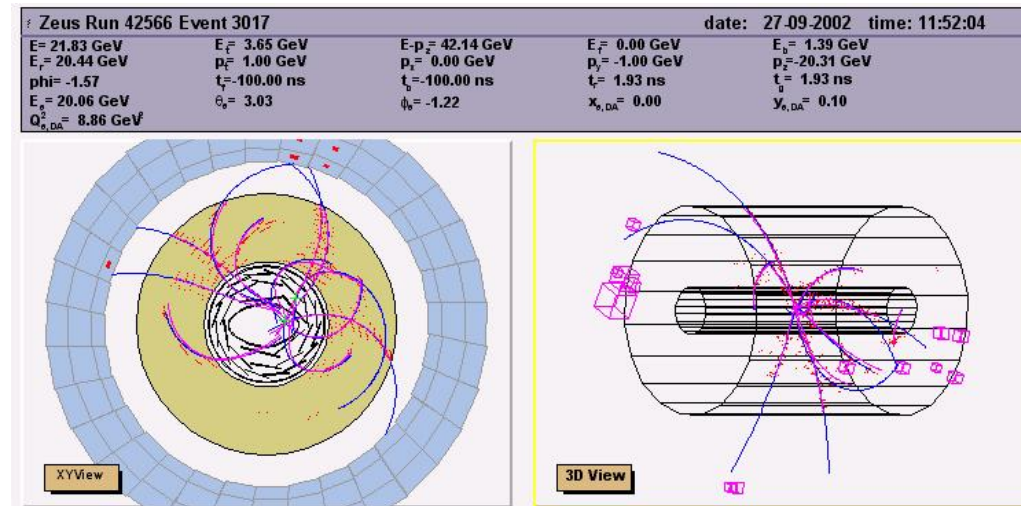


# Client – Zoom/Move



# Client – Views & Projections

- 2D projections (XY and ZR)
- fish-eye
- front, side and top view
- 3D view
  - in canvas
  - OpenGL viewer
  - x3d viewer



# Client – 3D Graphics

The screenshot displays the ZeVis software interface, which is used for visualizing particle detector data. The main window, titled "ZeVis@zenbonn3", features a menu bar (File, Edit, View, Server, Option) and a toolbar with buttons for "Run", "Event", "Show Event", "Show Detector", and "ONLINE".

The central panel shows event data for "Zeus Run 42566 Event 308" with a date of "27-09-2002" and time of "11:42:55". The data is organized into columns:

$E_+ = 74.48 \text{ GeV}$	$E_- = 23.33 \text{ GeV}$	$E_{p_z} = 56.21 \text{ GeV}$	$E_+ = 38.58 \text{ GeV}$	$E_- = 8.52 \text{ GeV}$
$E_+ = 27.39 \text{ GeV}$	$p_+ = 3.61 \text{ GeV}$	$p_+ = -2$		
$\phi_+ = 2.42$	$t_+ = 0.44 \text{ ns}$	$t_+ = 0$		
$E_+ = 27.39 \text{ GeV}$	$\theta_+ = 2.73$	$\phi_+ = 2$		
$Q_{s,0A}^2 = 120.07 \text{ GeV}^2$				

On the left side, there are several control panels with checkboxes:

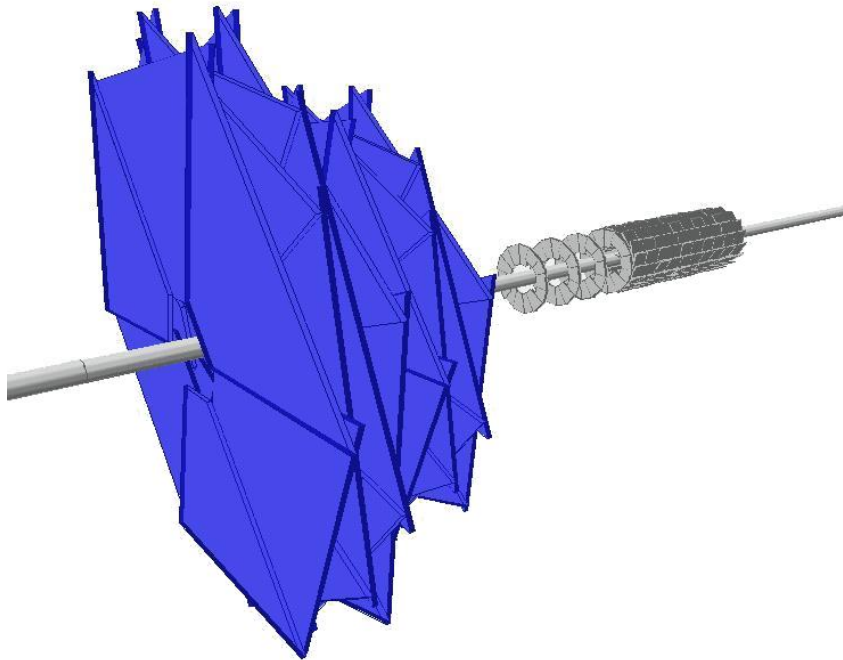
- Tracking:  MVD,  CTD
- Calorimetry:  CAL
- Muon Chambers:  Muons
- Beam Pipe:  Beam Pipe
- FDET:  FDET

The main visualization area shows a 2D "ZR View" of the detector components, with a central collision point and tracks. A secondary window titled "ZeVis\_2" displays a 3D perspective view of the detector, showing a central beam pipe and various detector components (calorimeters, muon chambers) with tracks and energy deposits (purple cubes) extending from the collision point.

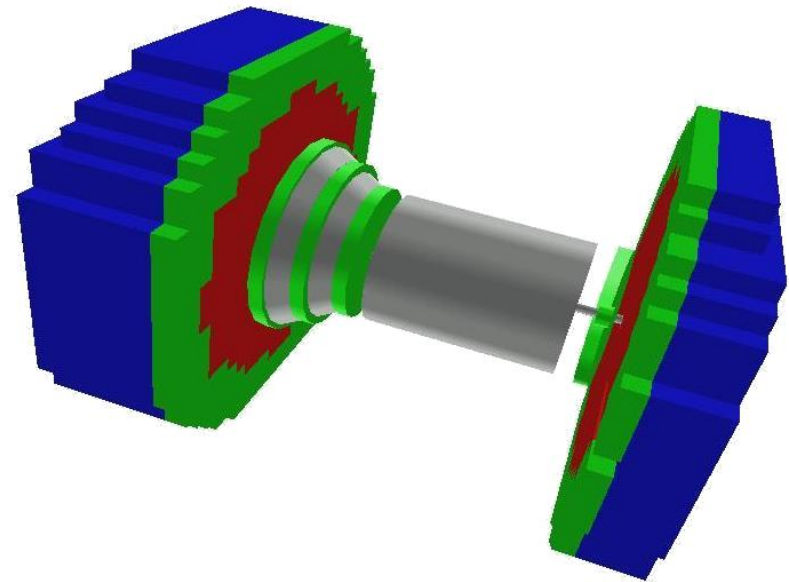
At the bottom of the main window, the status bar indicates "Run 42566 Event 308" and "ZeVis Header: x=-0.792, y=1.16".

# Zeus Inner Detectors

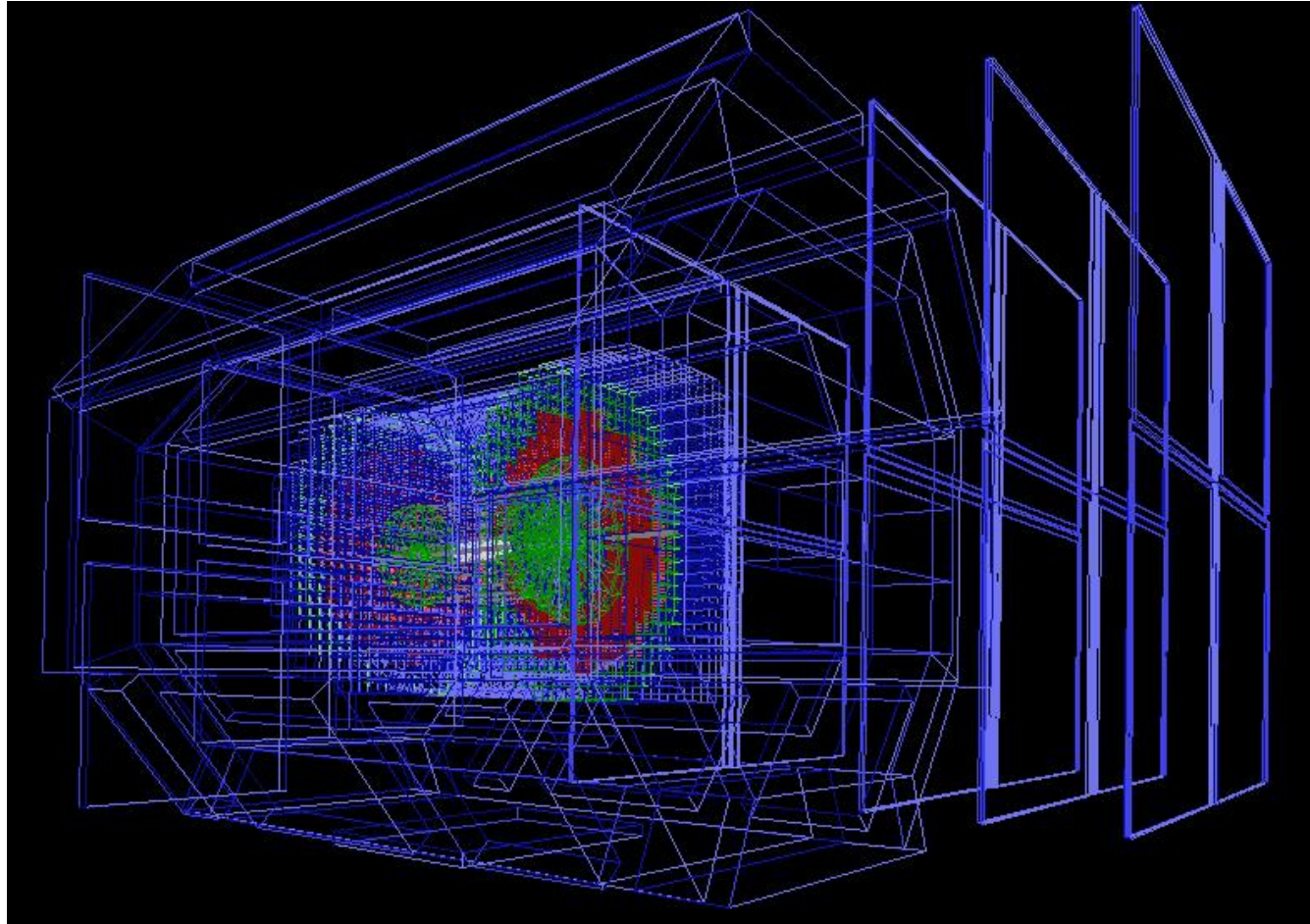
Microvertex Detector & Straw Tube Tracker



Tracking Chambers & Forward-/Rear CAL



# Zeus Outer Detectors



# Summary

- developed new, object-oriented Zeus event display for Hera II
- “slim” release already in use
- implementation of client/server concept
  - fast start-up and response
  - light-weight client
  - access via the internet
- 2D and 3D graphics capabilities
- Root based
- implementation of further detector components ongoing
- full release planned for next spring

# Acknowledgements

## **Thanks to the ZeVis Team:**

Rainer Mankel,  
Chiara Genta, Oliver Gutsche, Eileen Heaphy, Radek Kaczorowski,  
Oliver Maria Kind, Julian Rautenberg, Valentin Sipica

## **Former Members:**

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Ildar Tamendarov

**With the help of some friends:** Ulli Fricke & Ulf Behrens