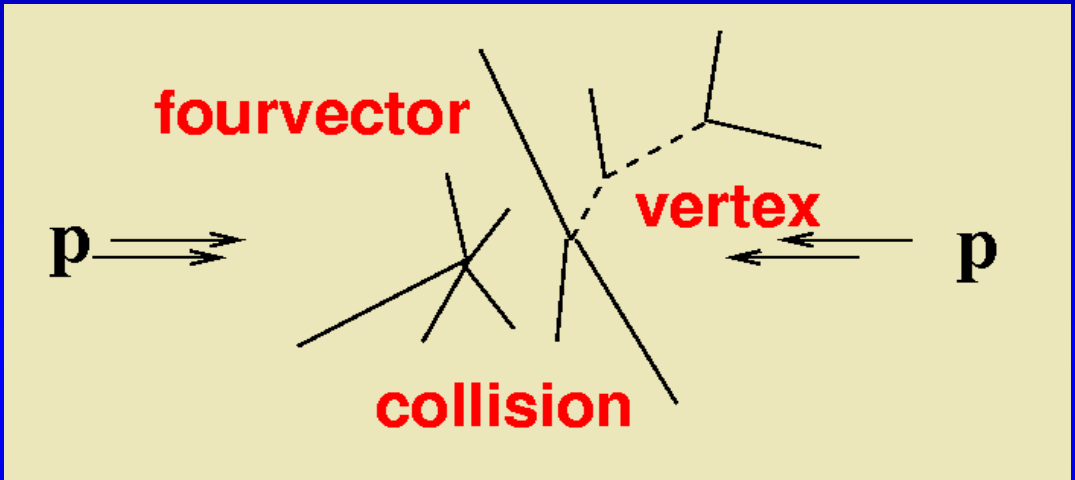
Physics Analysis Expert (PAX)

Experience at CDF & CMS



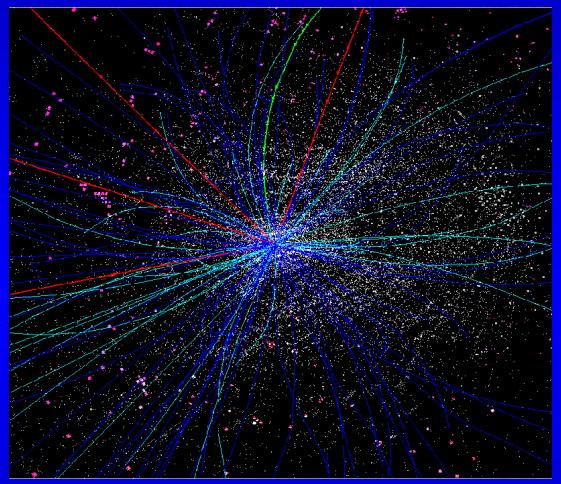
Martin Erdmann,

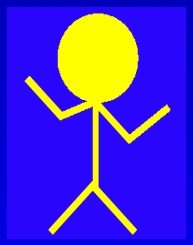
Hirschbuehl, Jung, Kappler, Kirsch, Miksat, Piasecki, Quast, Rabbertz, Schalla, Schemitz, Schmidt, Walter, Weiser

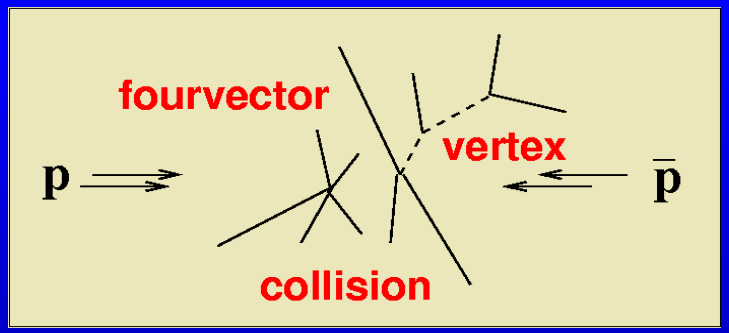
University Karlsruhe

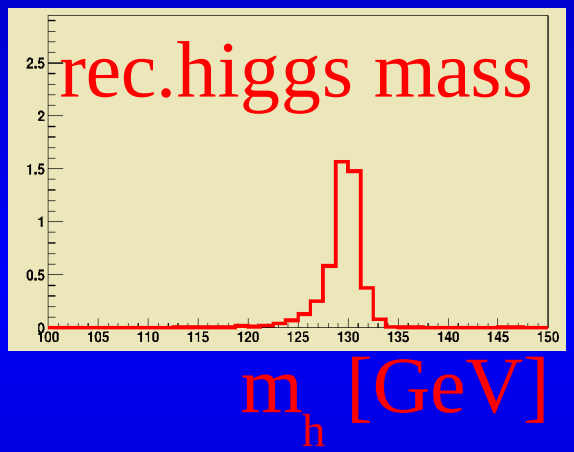
FNAL D0DFWG, 13-May-2004

unified access to detector reconstruction requires new level of abstraction



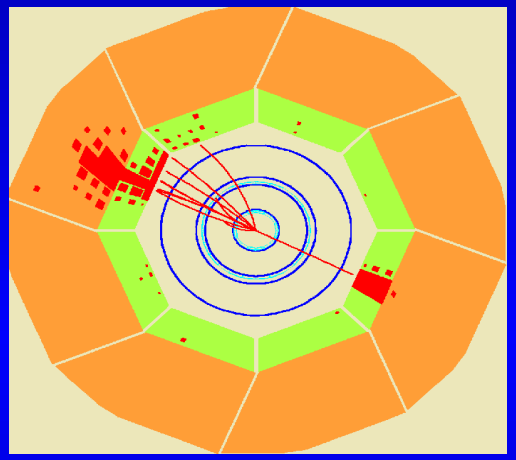


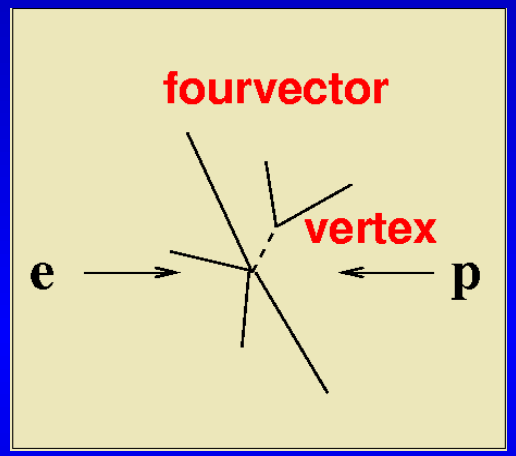


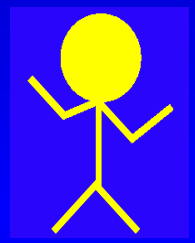


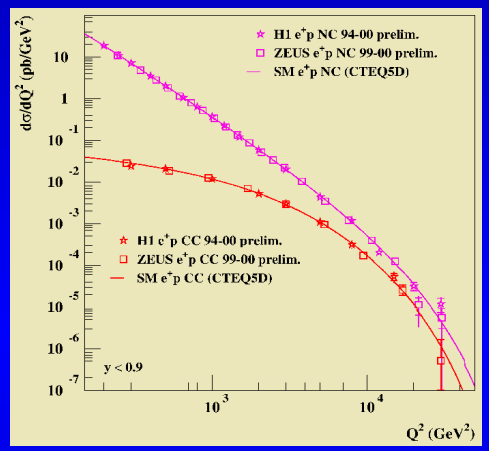
Physics Analysis Expert (PAX)

FORTRAN: H1PHAN, ALPHA
H1-, ALEPH-Experiments



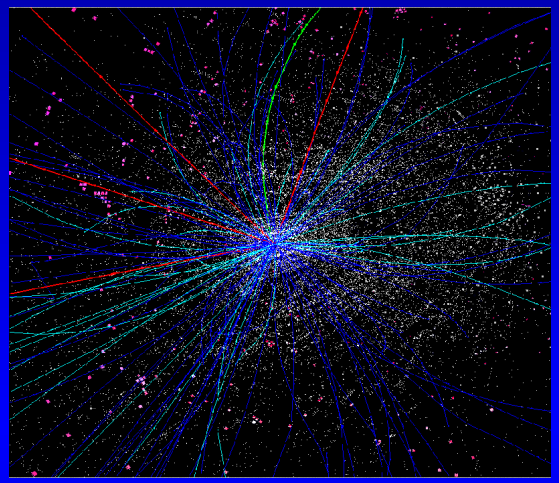


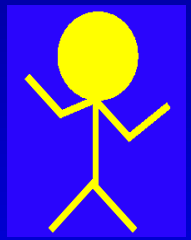


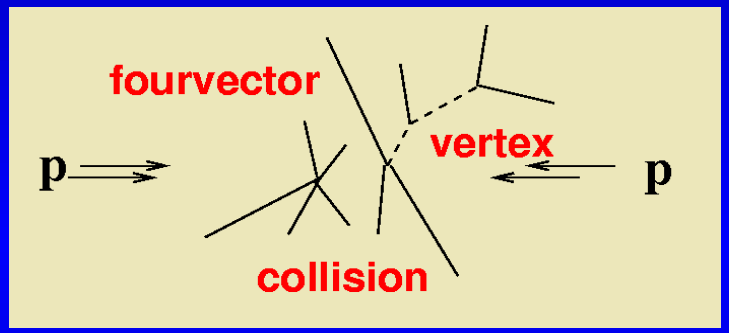


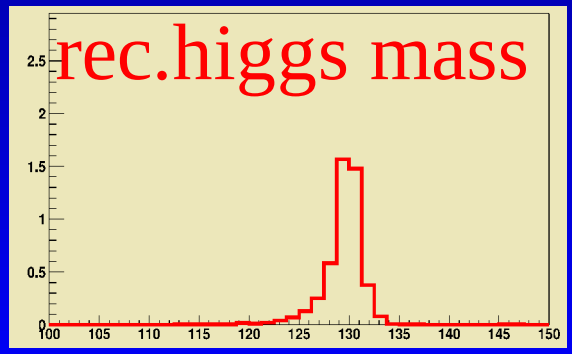
- emphasis on unified access to reconstruction
- complete filling: user 'behind' H1PHAN
- designed for single collision events
- majority of H1-publications via H1PHAN

OO/C++: Physics Analysis Expert (PAX)



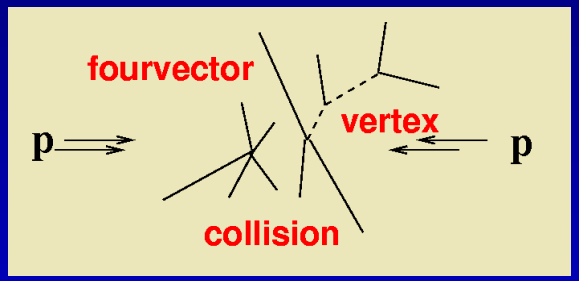






m_h [GeV]

- toolkit: full user control
- multiple collision events
- multiple event versions

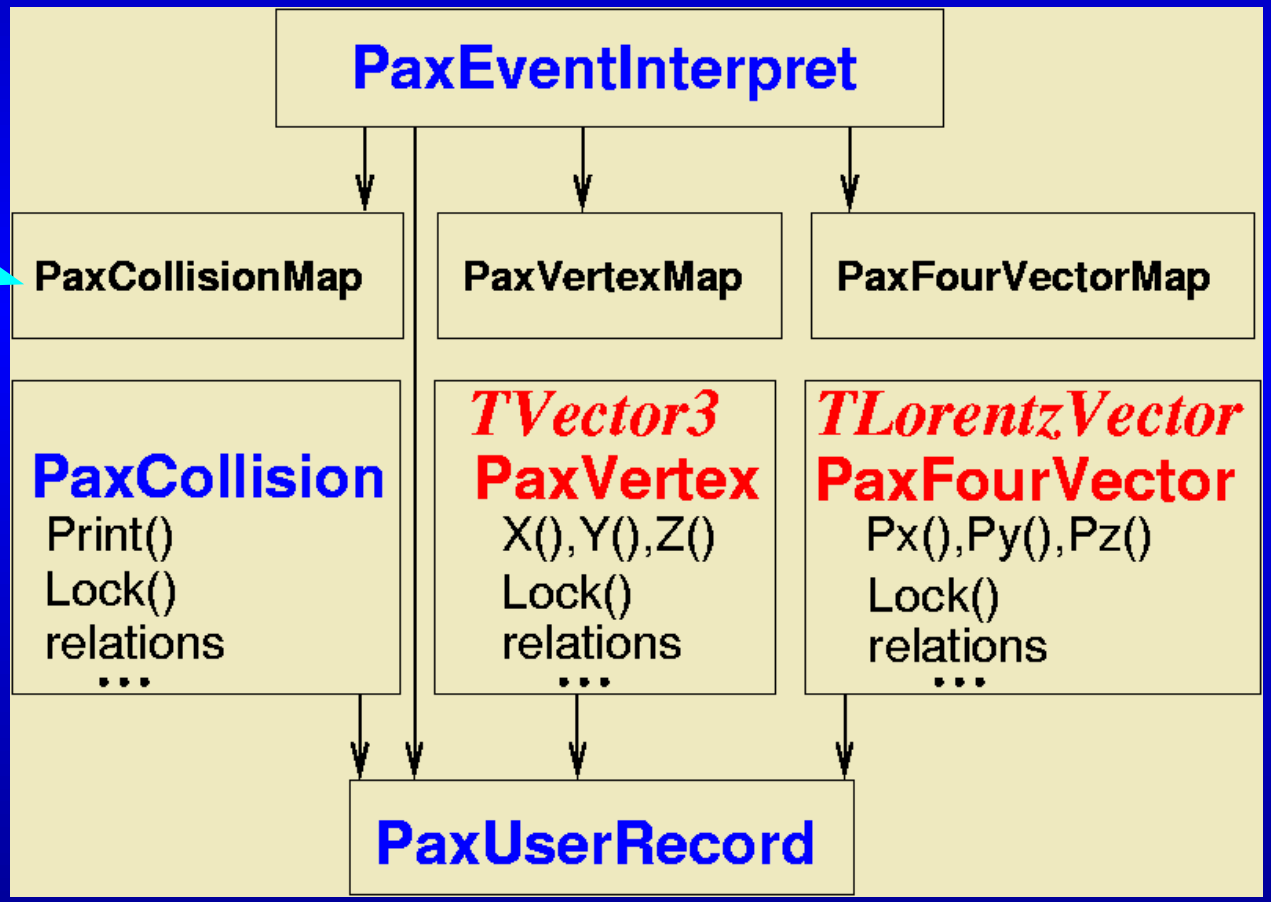


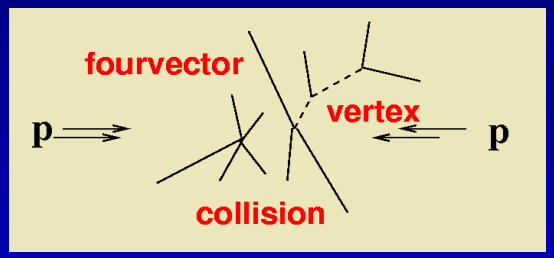
the basic unit in PAX: "event interpretation"

STL

CLHEP or ROOT

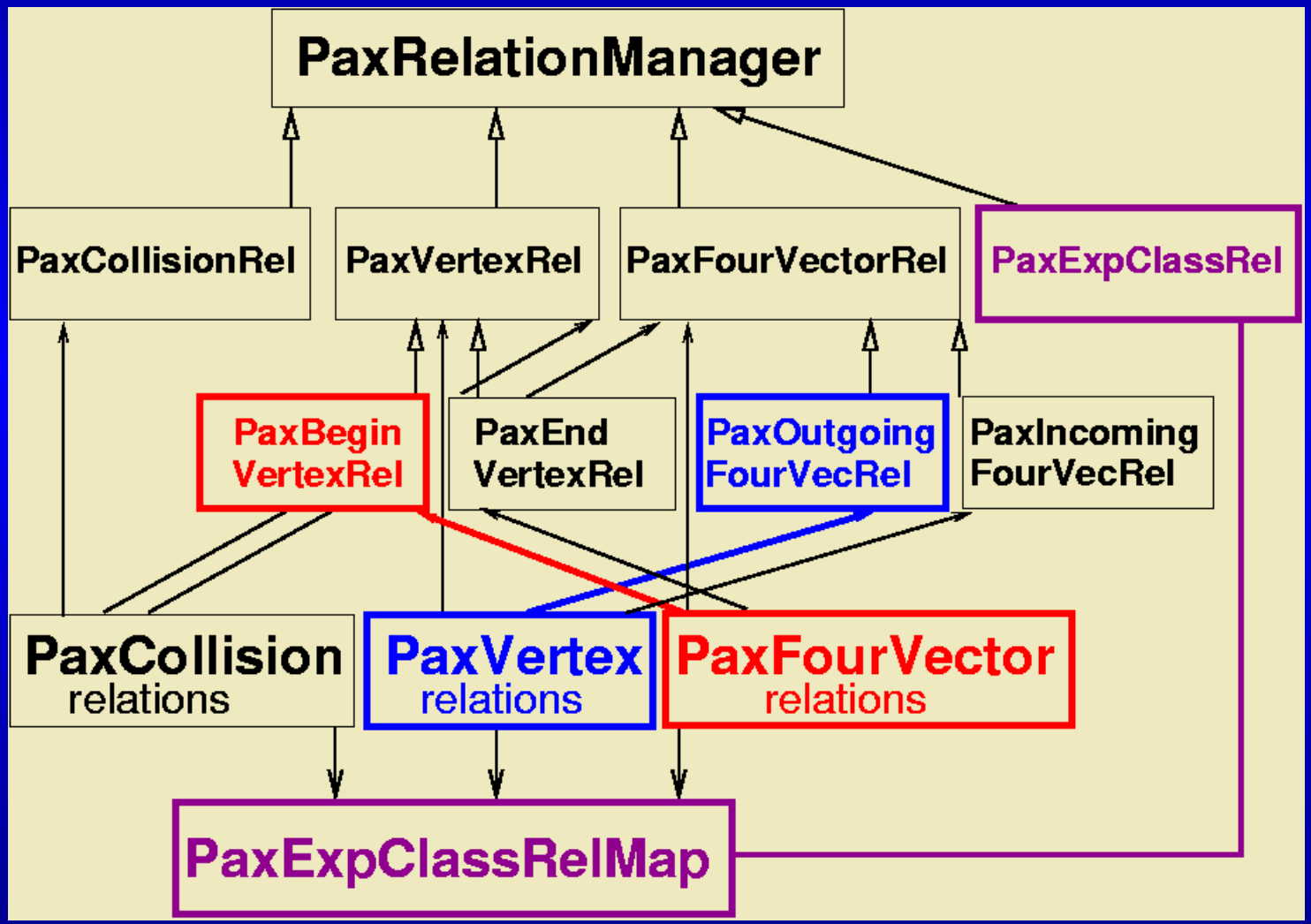
H1PHAN



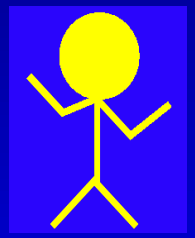


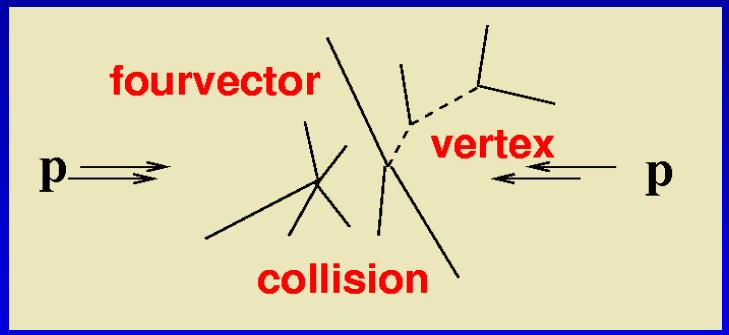
the heart of PAX: relation management

design pattern: mediator

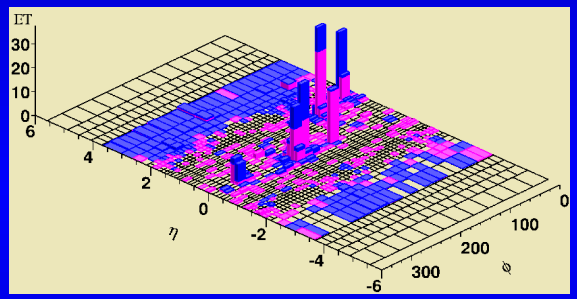


CDF detector reconstruction → PAX



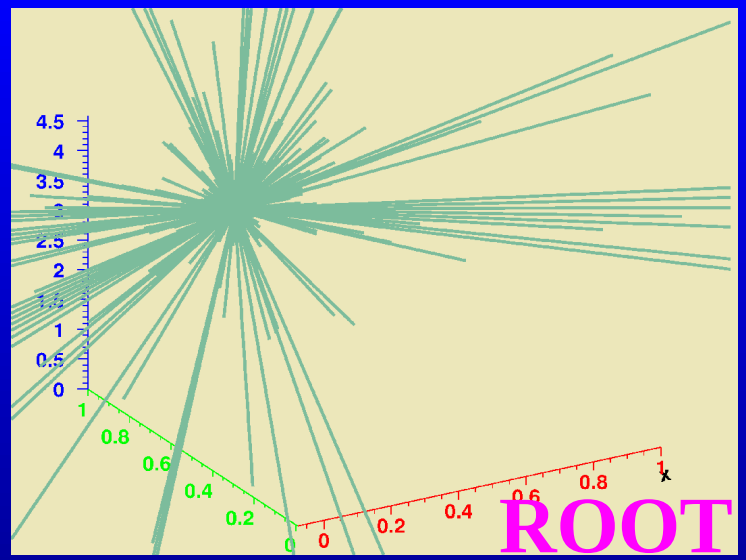


books



fills → **fillCalorimeter()**

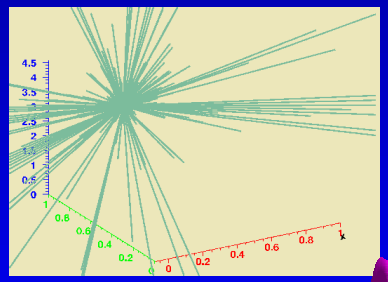
draws



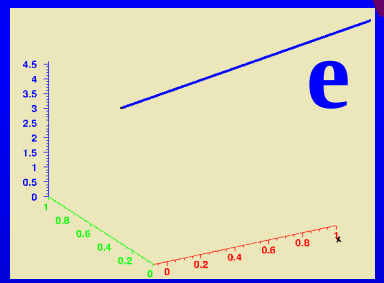
deletes

combine detector reconstruction

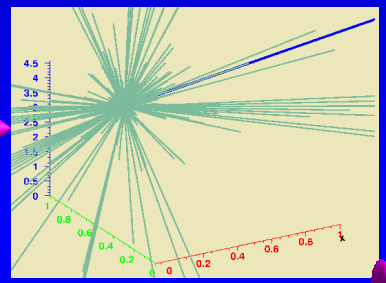
calorimeter



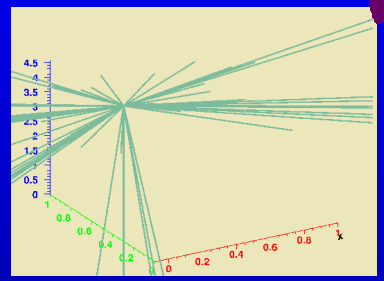
electrons



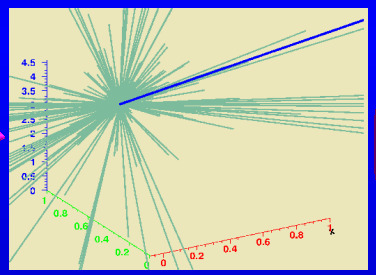
combined 1



tracker



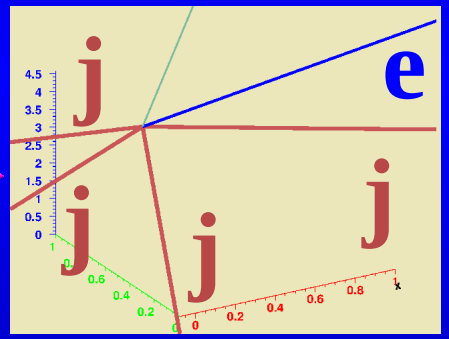
combined 2



electron

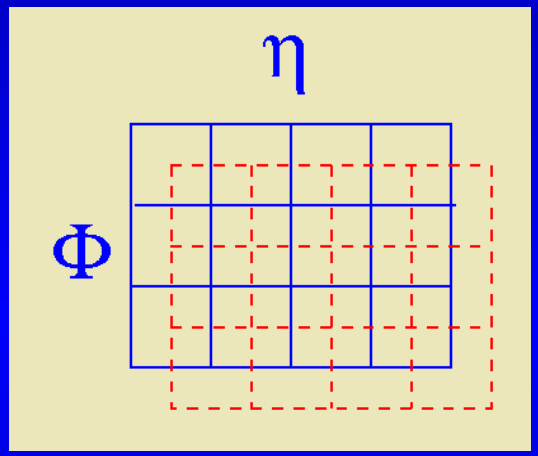
jets

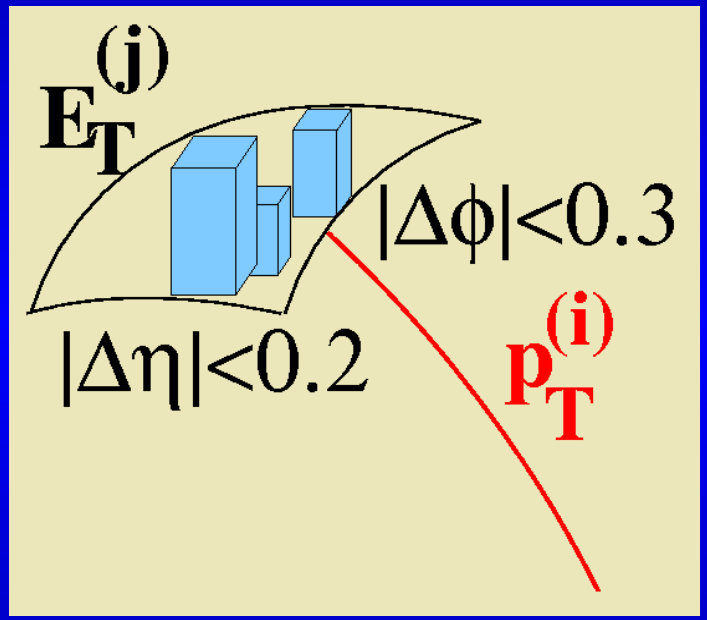
others

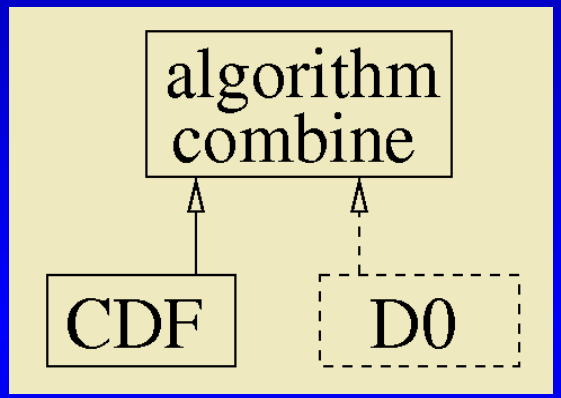


algorithms

combine calorimeter and tracks using PaxFourVectors







Design

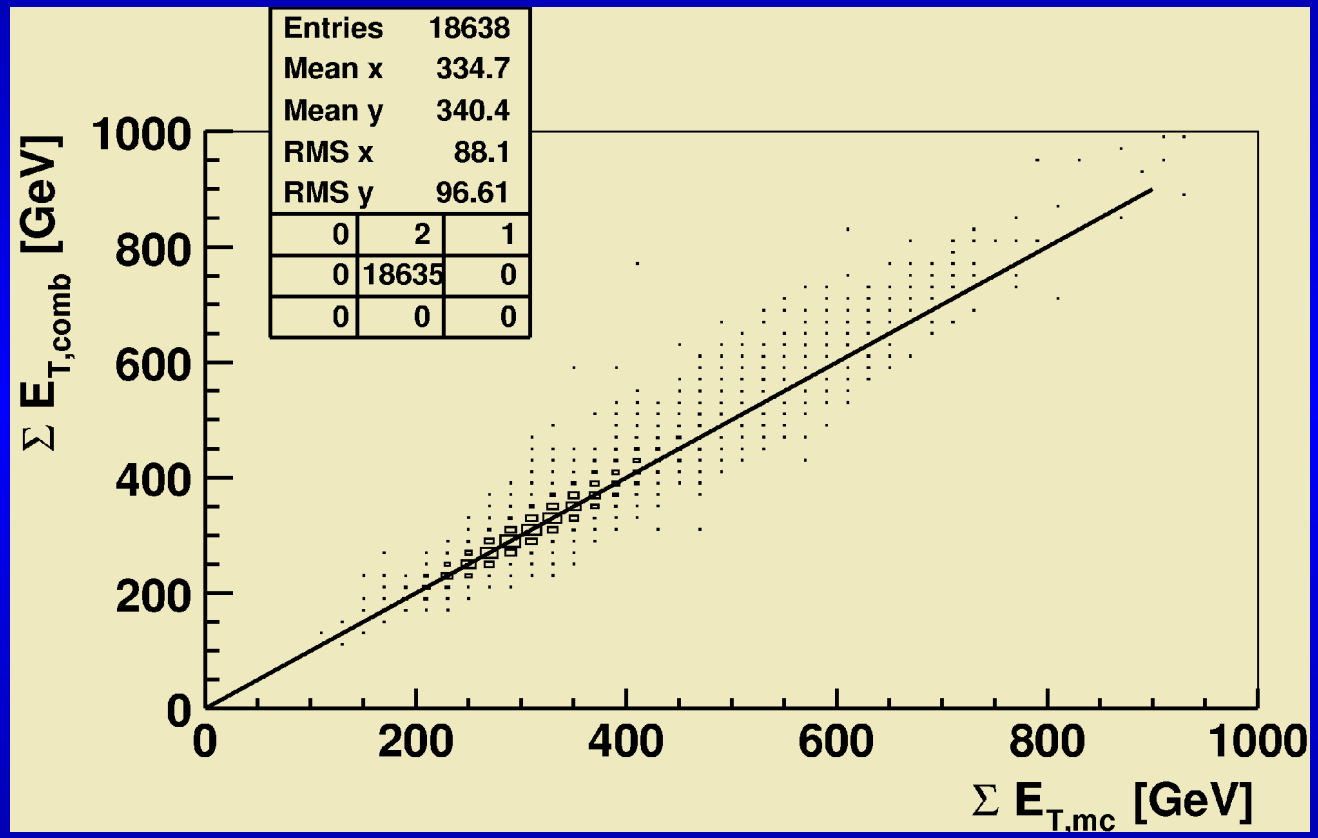
define regions of interest

associate according to best $E_T \leftrightarrow P_T$ match

combined measurement: quality

Herwig $t\bar{t}$

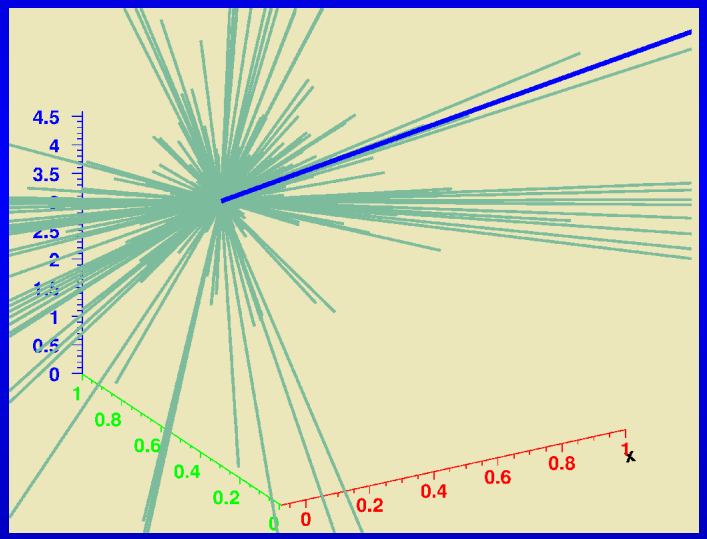
rec. ΣE_T



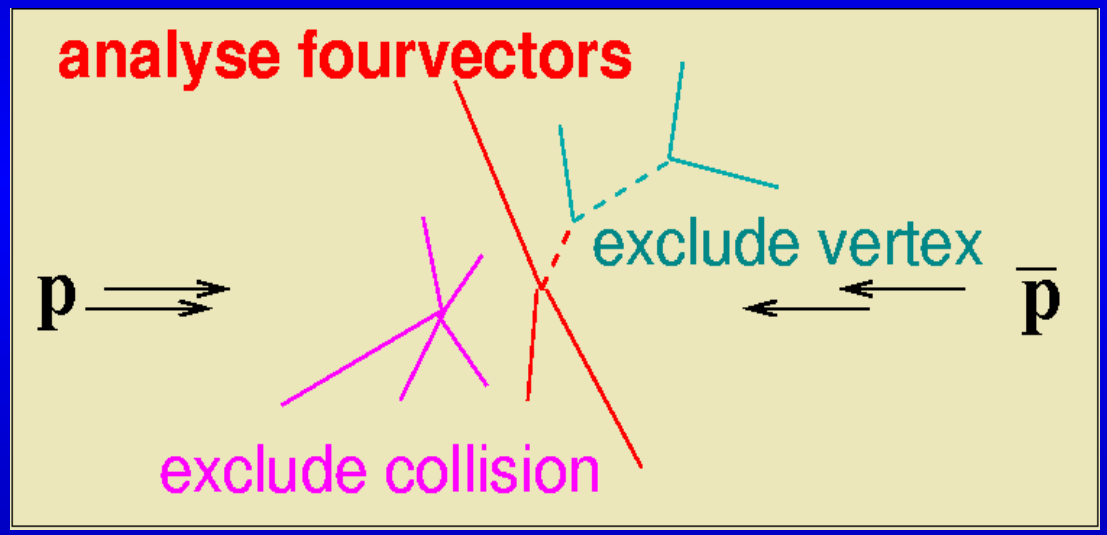
true ΣE_T

exclude part of event from analysis

simple: lock electron during jet finding



sophisticated lock mechanism

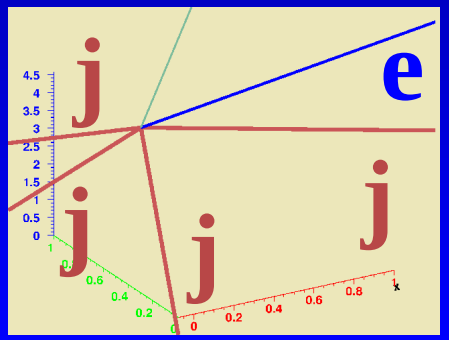


lock collision, vertex, fourvector

→ exclude following decay tree

PAX: access to original instance of experiment specific class

example: b-tagging in jets



PAX class PaxExperiment< > allows, e.g.,

PaxExperiment < TStnTrack > ( )

to be registered with its PaxFourVector

access original member function → NSvxHits()

→ few fourvectors remember complete analysis history

PAX: top quark analysis

algorithm

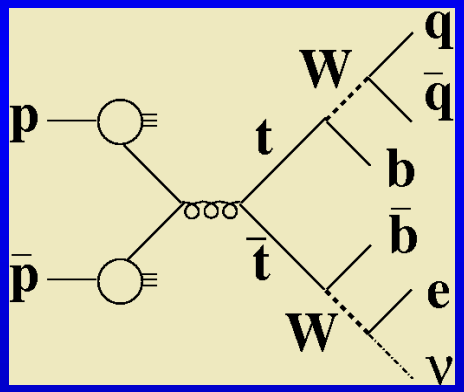
t→ bW→ beν

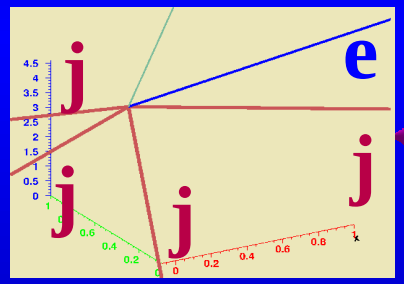
W→ eν

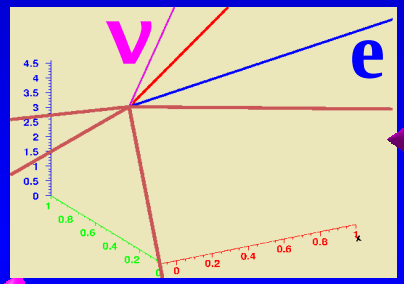
electron

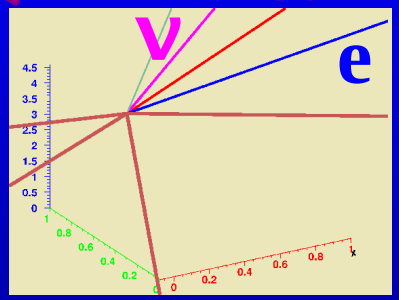
jets

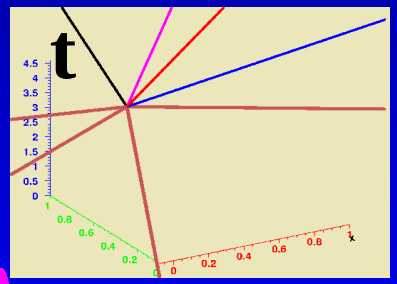
others

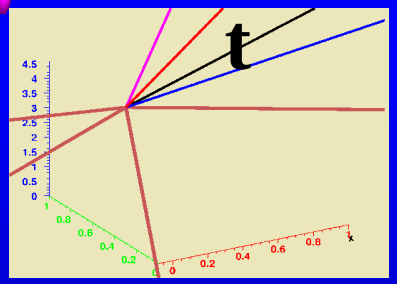












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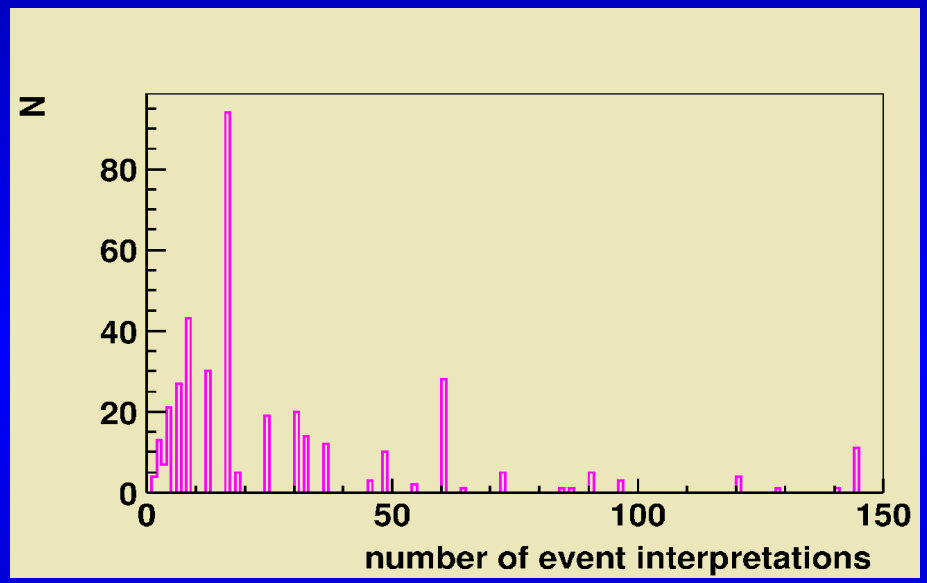
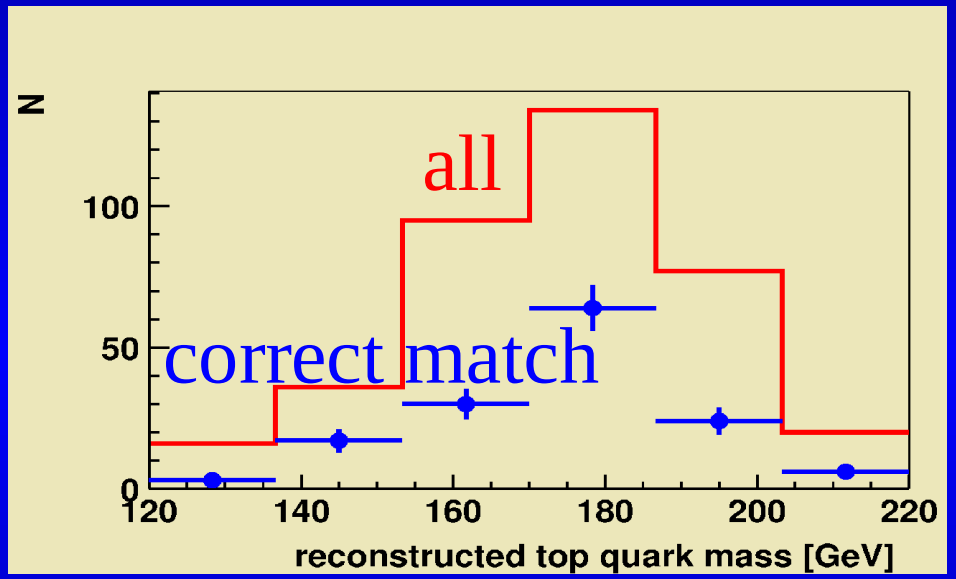
→ **collect relevant information *before* making decisions**

select event interpretation

Herwig $t\bar{t}$



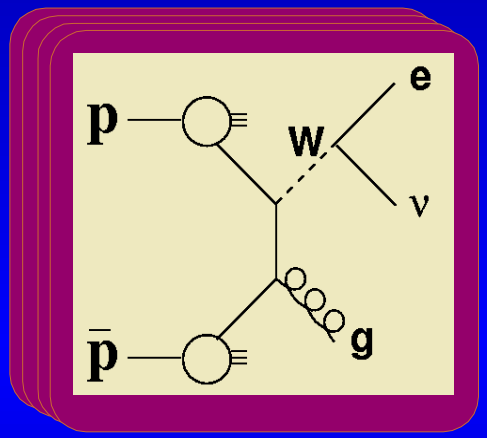


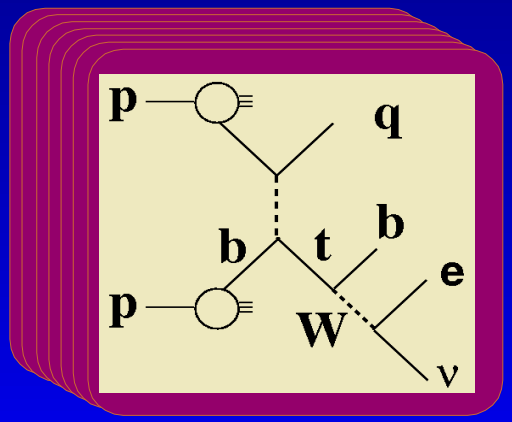
number of $t\bar{t}$ event interpretations

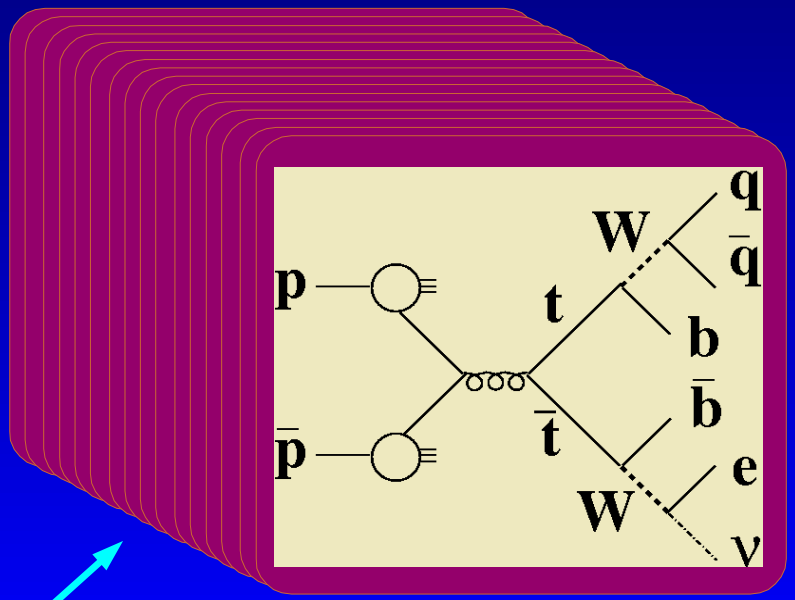
rec.top mass

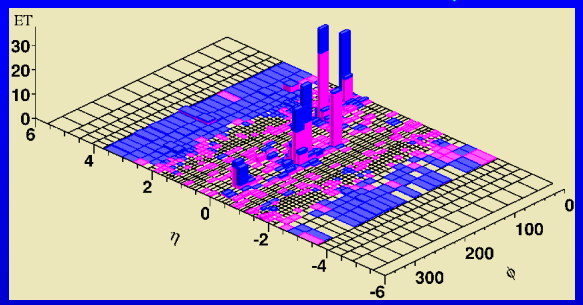
$m_t \rightarrow bW \rightarrow be\nu$

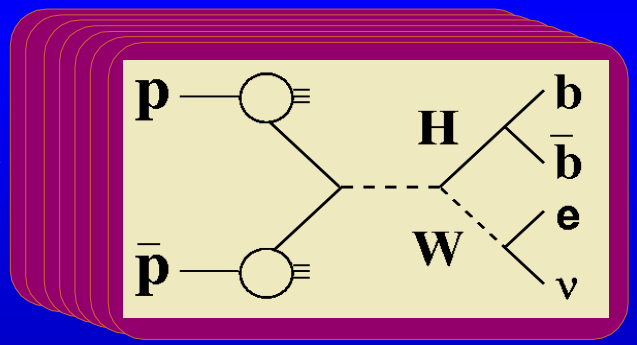
analysis factory

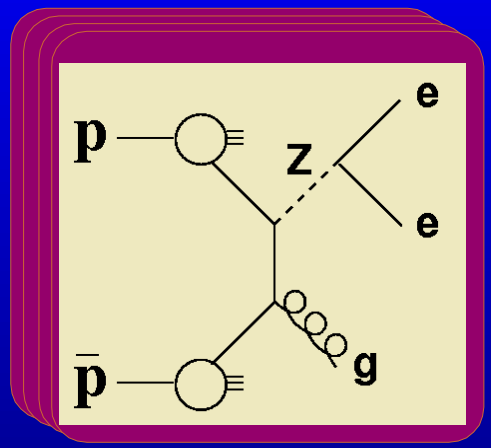












aim: classify events to disentangle rare processes

PAX user guide

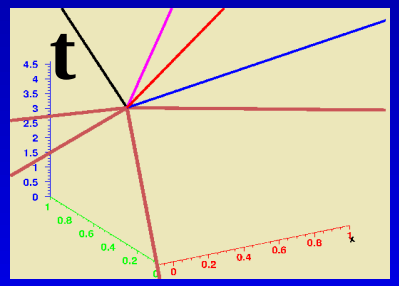
http://cern.ch/pax

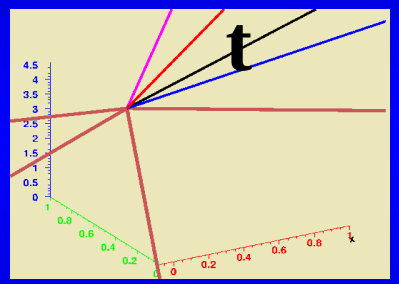
Physics Analysis eXpert CMS Version 1.02.02, November 2003

mission	manual pdf , ps	citation, license	authors:	Martin Erdmann , Christopher Jung , Steffen Kappler , Patrick Schemitz , Alexander Schmidt , Christian Weiser	
installation		fill, print event interpretation		loop over fourvectors, histogram pt	loop over vertices and their related fourvectors
and examples		access CMS Class		reconstruct W	read/write PAX file
PaxEventInterpret	members	fill collisions, vertices, fourvectors	access collisions, vertices, fourvectors	relations to generated particles	user records
PaxCollision	members	fill	access	lock	user records
PaxVertex	members	fill	access	lock	user records
PaxFourVector	members	fill	access	lock	user records
PaxExperiment Class	members	fill	access	.	.
technical details doxygen	container iterator	relations	id	print level	read/write file

persistency

t→ bW→ beν





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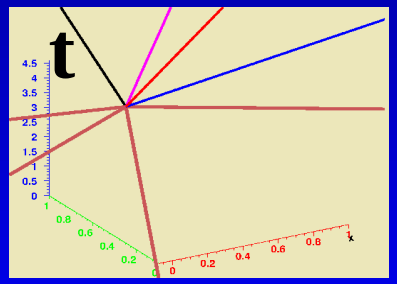
ROOT based

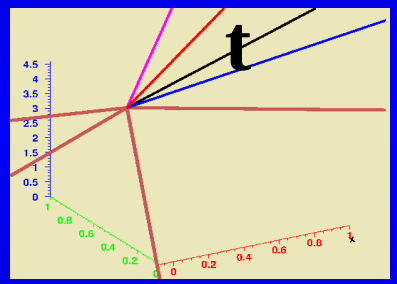
write →

FILE

read →

t→ bW→ beν





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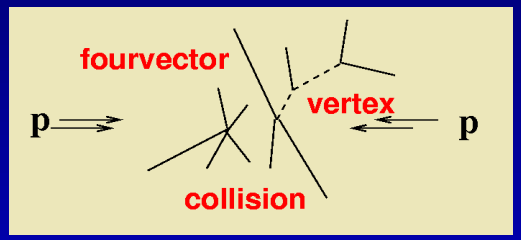
- enable team to work independent of experiment specific software
- 2.5 kB per $t\bar{t}$ event interpretation

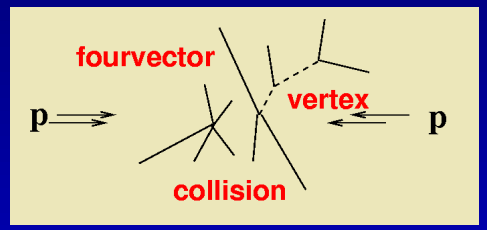
PAX assists physicists:



from detector reconstruction to physics interpretation of event

- **toolkit:** full user control, any C++ framework
- **covered:** typical use cases in physics analysis
- **interface:** event interpretation [*for team work*]
- **experience:** STL, CLHEP, design patterns, *H1PHAN*
- **persistency:** event interpretations, io based on ROOT
- **applications:** demonstrated in two HEP experiments
- **documentation:** arxiv: physics/0306085, web manual
- **user programming:** intuitive standards
- **development status:** advanced beta

Discussion: PAX@D0



- **possible procedure for trying PAX** **we provide**

D0 reconstruction output → **you fill muon, $\not{p}_x$, $\not{p}_y$ (selection)** → **Example User analysis $W \rightarrow \mu\nu$**

- **Gordon: „most algorithms in D0root deal with TLorentzVector“ → work with PAX (?)**