Physics Aspects of Software

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Connections between physics and software in development phase

- Requirements
- Testing and Evaluation
- Usage

Support of physics

Current U.S. Activities

Evolution into operations phase

Connections in development phase

The software and hardware are not ends in themselves, they are a service that enables physics to get done

Physicist involvement is essential during requirements and design phase

Ongoing physics simulation provides testing and requirements

Functioning simulation code is always needed in case of detector changes

- Recently the crack between the central and forward calorimeters widened

Large scale tests are provided by Mock Data Challenges

Expected to begin in 2003

Essential for testing complete system

Will provide valuable experience for Regional Center in data access and usage patterns

Interaction of Tier 1/Tier2/CERN can also be tested in detail

Physicist Support

Some support of specifically Physics related activities are needed In particular Monte-Carlo event generators (written by persons outside the collaboration) must be integrated into and maintained within the ATLAS system.

This support must be continuous and backed by a real commitment

Must be part of the project

Based on other experiments experience we expect 1 FTE to be the US share.

I am Coordinator of the group that is responsible for this in ATLAS

Current U.S Activities

Several U.S.ATLAS members are active in leadership of the various physics groups

J. Parsons – Top and other Heavy quarks and Leptons

F. Paige – Supersymmetry

I. Hinchliffe – Monte-Carlos

I. Hinchliffe – Exotics (ended May 1999)

Atlas Detector and Physics Performance TDR provided a thorough work out and testing of "old" system

Forced physicists to work with the software and software developers to deliver a product

Process was painful but very useful

Hinchliffe was co-editor

Detailed contributions from many U.S members

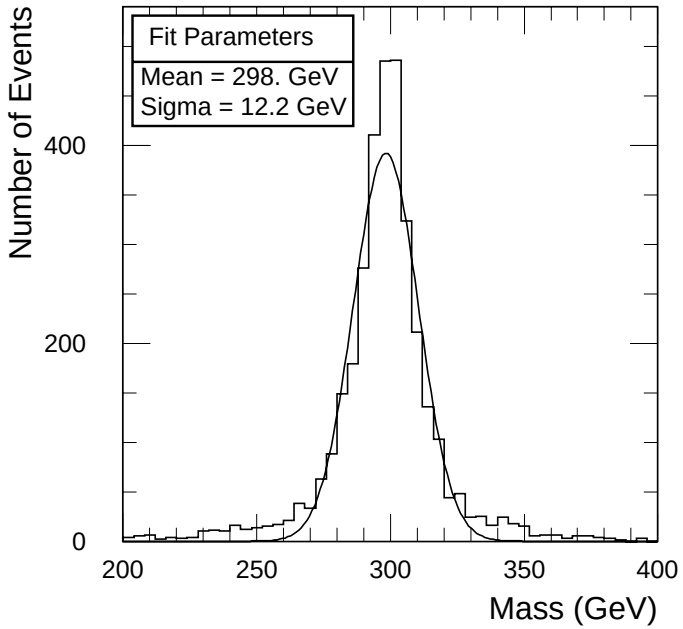
Some examples:-

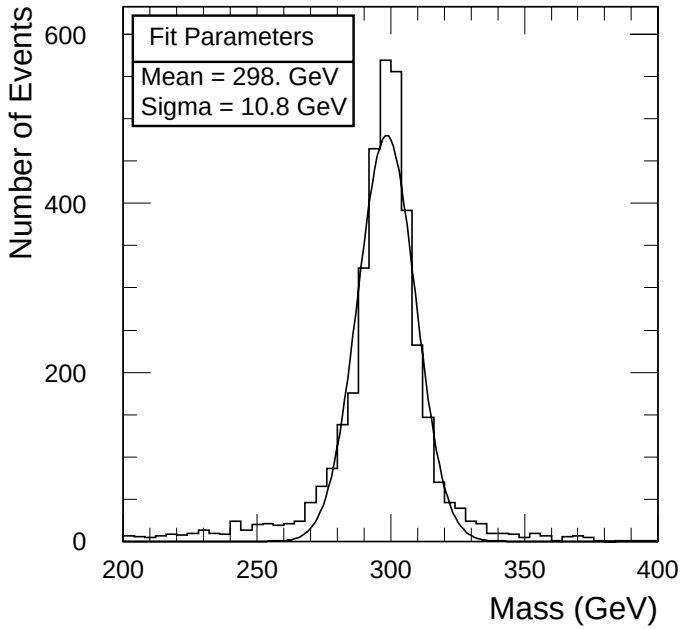
Muon resolution using Inner detector and Muon system

Demonstrated as part of Physics TDR

Required integration of Inner detector and Muon system software

Plots show reconstructed $A \rightarrow \mu^+\mu^-$





Muon system only

Combined system

J. Shank *et.al*

Angular Resolution of LAr Calorimeter for off-beam photons

EM calorimeter designed for excellent angular resolution for photons coming from the interaction vertex

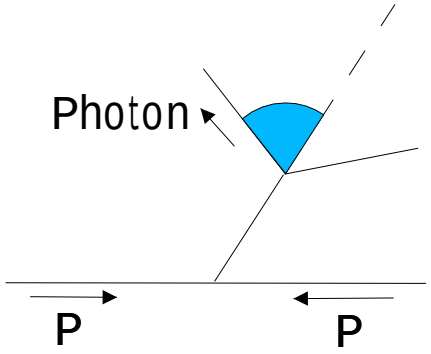
In events with two photons this is used to determine z position of the primary vertex (*e.g.* $H \to \gamma\gamma$)

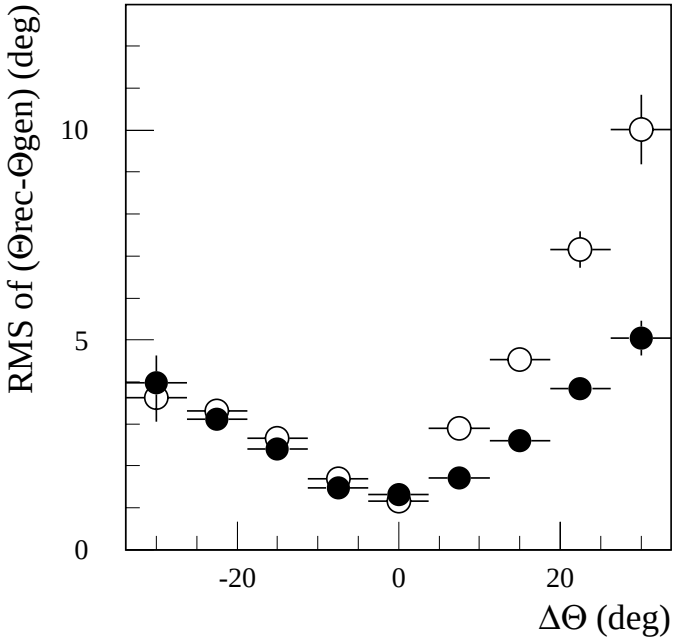
Finite lifetime particles ($c\tau \sim 1km$) decaying to photons produce photons that do not point to primary vertex

These can occur in certain new physics signals

(*e.g.* supersymmetry $\widetilde{\chi}_1^0 \to \tilde{G}\gamma$)

Some degradation of resolution





. Resolution as a function of non-pointing

Resolution good enough to obtain information on lifetime.

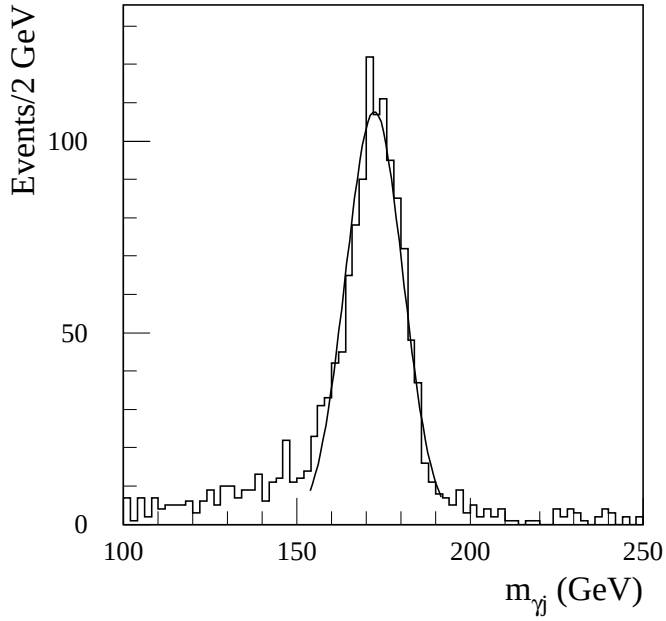
Study tests LAr simulation/reconstruction in addition to its physics interest

Borissov *et.al*

Exotic Top signals

Study of decay $t \to \gamma c$

Ability to set limit on exotic decay depends critically on mass resolution in $jet + photon$ system



Dodd *et.al*

Tau identification/measurement

Taus can be an important signal for new physics *e.g. Supersymmetry*

Measurement and identification is difficult

Leptonic tau decays are of limited use – where did lepton come from?

Use Hadronic tau decays, using jet shape and multiplicity for ID and jet rejection.

Sample of $Z \rightarrow \tau\tau$ was used

Combination of tracking and EM calorimeter used to measure multiplicity and invariant mass of tau decay products

Can give sufficient rejection against hadronic jets with high enough efficiency

Invariant mass of $\tau\tau$ system can be inferred from measured quantities

Coadou *et.al*

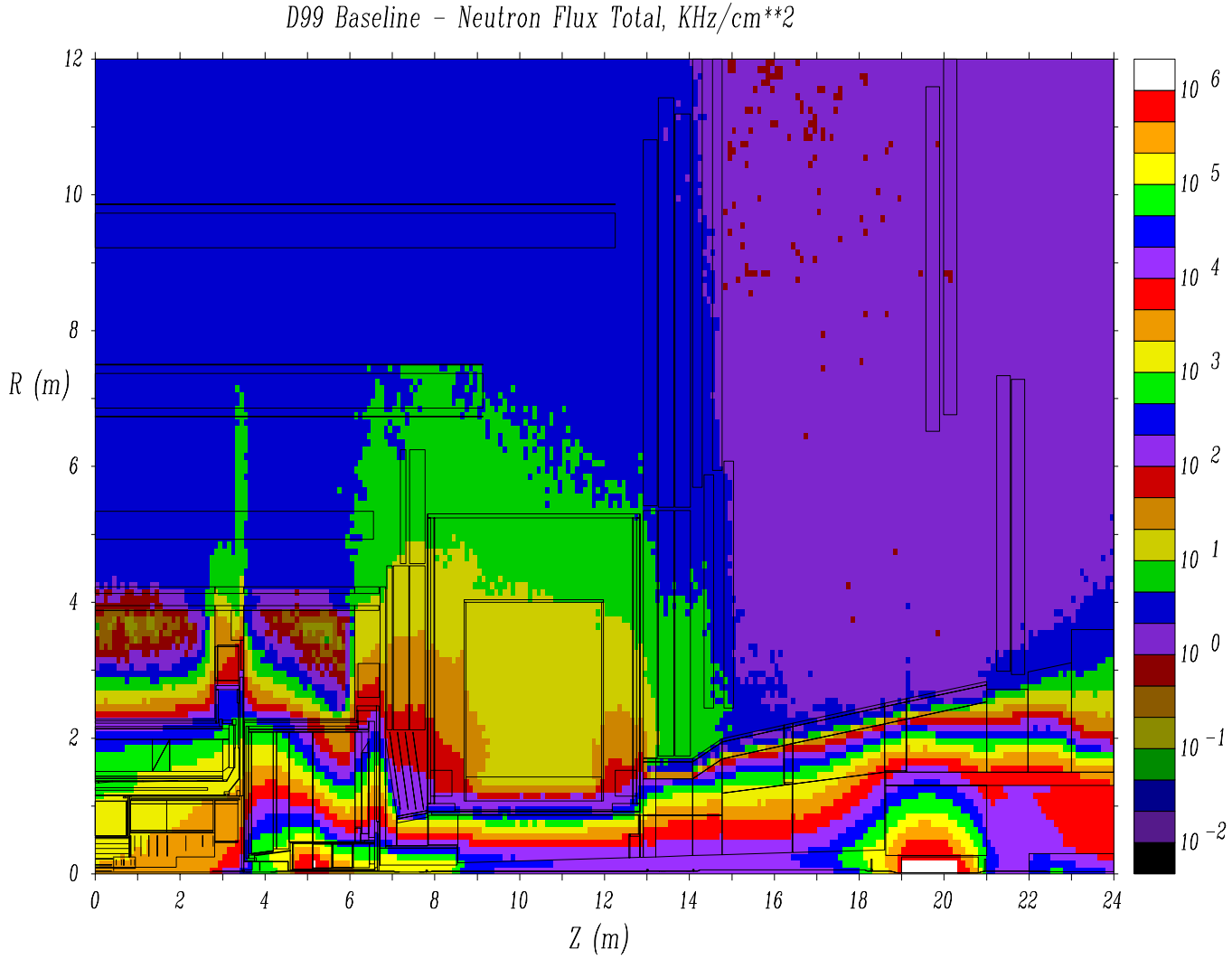
Background simulations

Backgrounds in the Muon system are a very important problem

Simulated using GEANT3/GCALOR

Very CPU intensive

Recent results from studies carried out on the BNL Linux system (Shupe)


D99 Baseline – Neutron Flux Total, KHz/cm**2
R (m)
Z (m)
0
2
4
6
8
10
12
14
16
18
20
22
24
10^{6}
10^{5}
10^{4}
10^{3}
10^{2}
10^{1}
10^{0}
10^{-1}
10^{-2}

Evolution into Data Phase

As ATLAS enters the data phase, relations between project components will change

Data analysis/physics becomes dominant activity

Project will need to evolve to reflect this