International Calorimeter Simulation Effort

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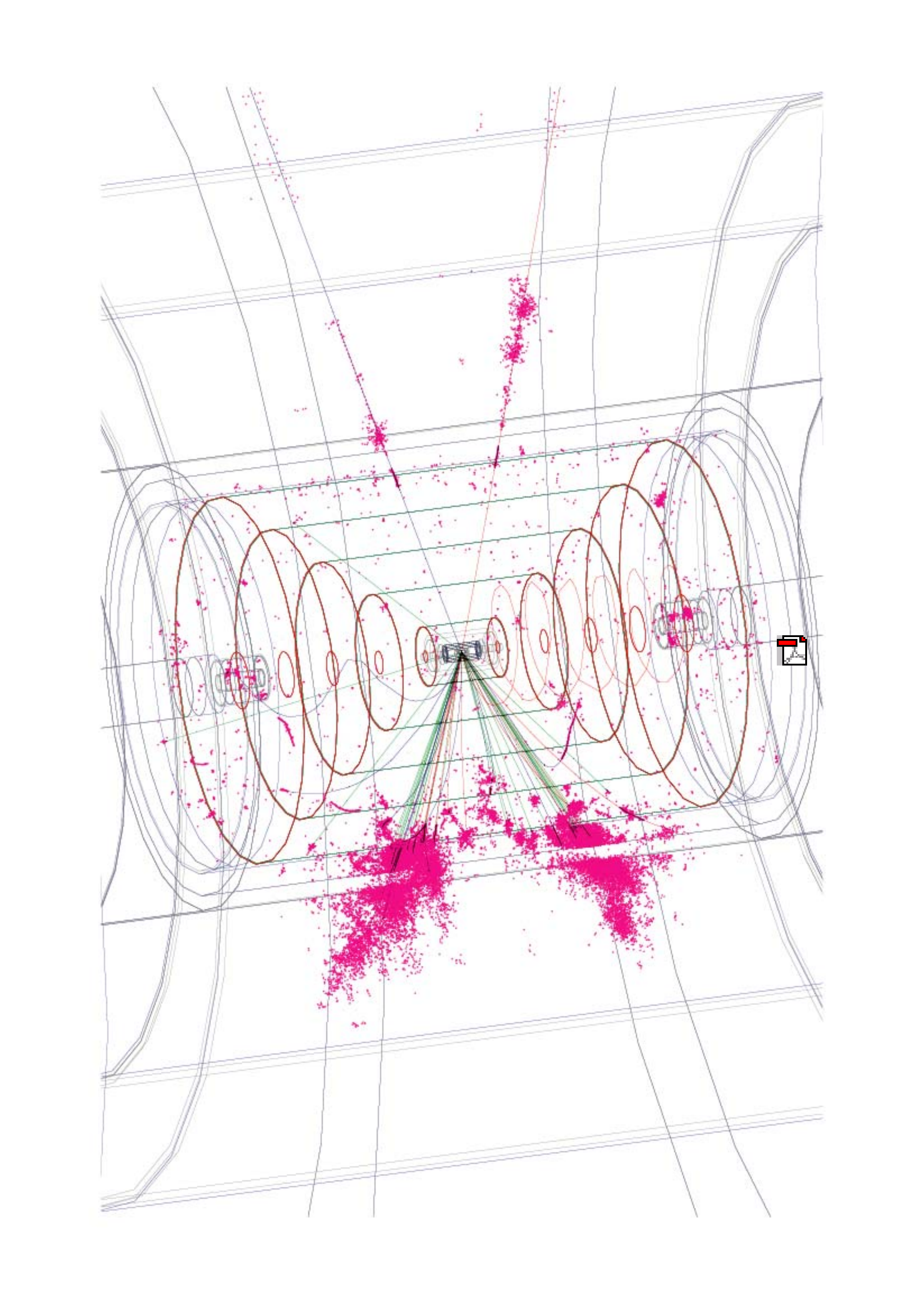
Problem Statement

- Good News
  - Many calorimeter R&D efforts ongoing or being planned worldwide.
  - Active interplay between simulations and detector designs.
- Bad News
  - Little real connection between various groups, even within regions.
  - Simulations not always systematic.

Towards Internationalization

- Suggest that European, Asian and American full simulation groups could run a single GEANT4 executable.
- Geometry determined at run-time.
- Write out common “ideal” hits.
- Digitize as appropriate with plug-ins.
- Enormous savings in effort.
- Makes comparisons easy.
- “You don’t have to build it to use it.”



One executable, multiple geometries

ee→ZH ; Z→μμ (with SD)

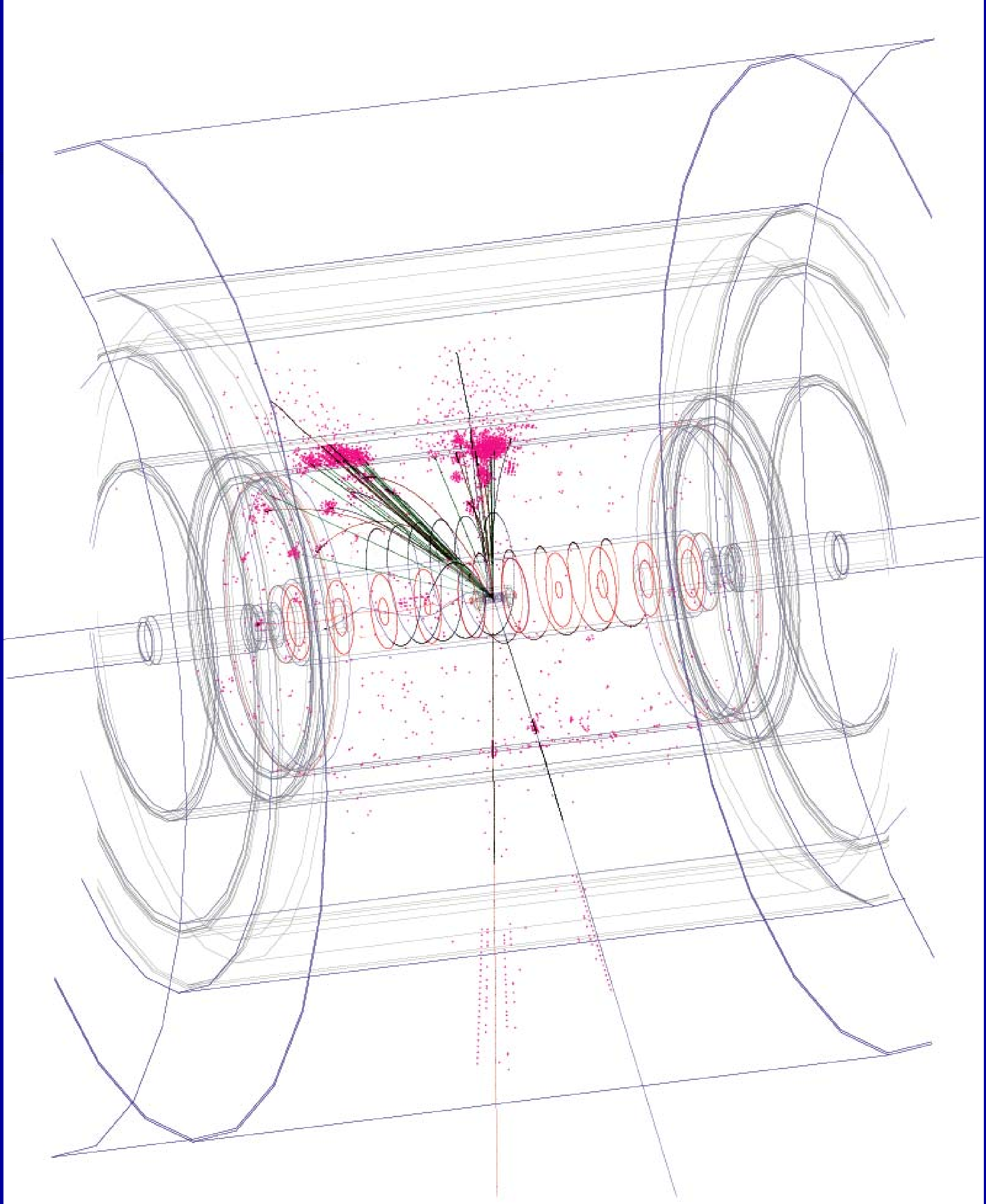
VXD:CCD

Tracker: Silicon strip (5layers)

Magnet: 5Tesla

EM Calorimeter:
Si+W
$5x5mm^2$
R=127cm

HAD Calorimeter:
Stainless Steel + Scintillator
$1x1cm^2$
R=143cm



One executable, multiple geometries

ee→ZH ; Z→μμ (with LD)

- VXD:CCD
- Tracker: TPC
- Magnet: 3Tesla
- EM Calorimeter:
  - Pb+Scintillator
  - $5x5cm^2$
  - R=200cm
- HAD Calorimeter:
  - Pb+Scintillator
  - $20x20cm^2$
  - R=250cm

Calorimeter Hit Basic Definition

- Encoded detector ID (encoding is detector dependent)
- MC ID, energy deposited and time of deposition for each contributing particle
- Convenience attributes:
- Hit Number
- Cell position
  - (Radius, Phi, Z) or (X, Y, Z) of cell
- Total energy deposited in cell

Full Simulations

LCD Full Sim	BRAHMS	JIM
GISMO	GEANT3	GEANT3
C++	FORTRAN	FORTRAN

LCDG4	MOKKA	JUPITER

Common GEANT4 executable

Runtime defined geometry

Generic Hit output

Reconstruction

- Claim is often made that algorithm and detector cannot be decoupled.

Detector →

Algorithm ↓

	A	B	C
x	+		
y		+	
z			+

Off-diagonal terms are essential!

- Argue that Interface and Implementation can and should be separable.
- Essential to be able to answer question "How well does Algorithm x work in Detector C?"

"Crossing the Recon…"

Input:

Calorimeter Cells

Tracker Hits

Implementation is important for efficiency. Essential that we can swap out various concrete examples.

Output:

Particles

e,μ,τ,W,Z,b,c,…

Cooperation/Collaboration

- Results-Based
  - Presentations containing end analysis.
  - Describes end effect of what was done.
- Algorithms-Based
  - Explicit descriptions of techniques used.
  - Describes how it was done.
- Code-Based
  - Allows explicit recreation of analysis.
  - Very tight coupling.

Results-Based Collaboration

- Need to understand exact definitions.
  - e.g. What is meant by photon?
- Need full explication of not only efficiencies, but also fakes and rejections.
- Need to know in what environment results were obtained.
  - Benchmarks or "canonical samples"
- Limited to author's analysis.
  - Not easily applied to different conditions.

Energy Resolution Issues (e.g.)

- Digitization
  - E (sampled) → ADC → Energy (deposited)
- Energy threshold
  - During simulation or ADC zero suppression
- Sampling Fractions
  - μ MIP or minimization (resolution or linearity)
  - Separate e/γ and π EM sampling fractions?
- For single particles, clustered or Etot?

Algorithm-Based Collaboration

- Need definitions of implementation
  - e.g. Clustering
    - Nearest Neighbor or extended neighborhood?
    - Edge or corner neighbors (rectangular cells)?
    - 2D or 3D clustering?
    - Analog or digital connection?
    - Was a seed cell used?
    - Energy cuts applied to list of cells?
- Metrics for ID
  - Simple cuts, fit χ^2, Neural Net, PDF?

Code-Based Collaboration

- Language, OS/Platform, external dependencies.
- Class API
  - What are expected input arguments?
    - e.g. list of calorimeter cells
  - What does the analysis return?
    - e.g. list of clusters
- Easier to share code than to document!
- Who maintains and upgrades?
  - Risk of code forking.

Interface is Key!

- In all cases, the interface between various stages of the reconstruction is the crux of the matter.
- Don't realistically expect us to be sharing reconstruction code any time soon.
- But, if we clearly define what input and output are at successive stages, we can go a long way towards this goal.

Canonical Samples

- $WW\nu\bar{\nu}$ and $ZZ\nu\bar{\nu}$ at 800GeV cms
  - Stresses jet mass resolution.
  - $VV\nu\bar{\nu}$ removes temptation to include beam constraint.
  - 800GeV tests energy extensibility without excluding any one technology.
- $t\bar{t}$ at threshold, $t\bar{t}h$ at 800GeV
  - Stresses pattern recognition and flavor tagging in busy environment.