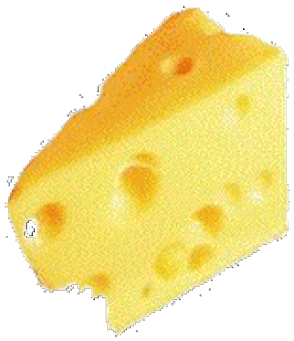

RANDOM HIGHLIGHTS FROM RECENT MICE MEETINGS

Yağmur Torun, IIT

NFMCC Weekly Meeting

June 16, 2006 - Fermilab

ILLINOIS INSTITUTE OF TECHNOLOGY

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Notes on things I won't cover

- New collaborators (Cockcroft/Lancaster, ICST Harbin)
- New upstream Ckov design (downstream Ckov RIP)
- Engineering progress in beamline and target
  - Reviews held after cm15
- Preparations for upcoming beam test at Frascati in July for detectors and DAQ
- Progress in analysis of tracker data from KEK test and QA procedures
- Discussions on hydrogen system engineering
- Other cooling devices in MICE? MANX
- Lots more
- This talk: analysis and software

Analysis Forum: progress since cm14

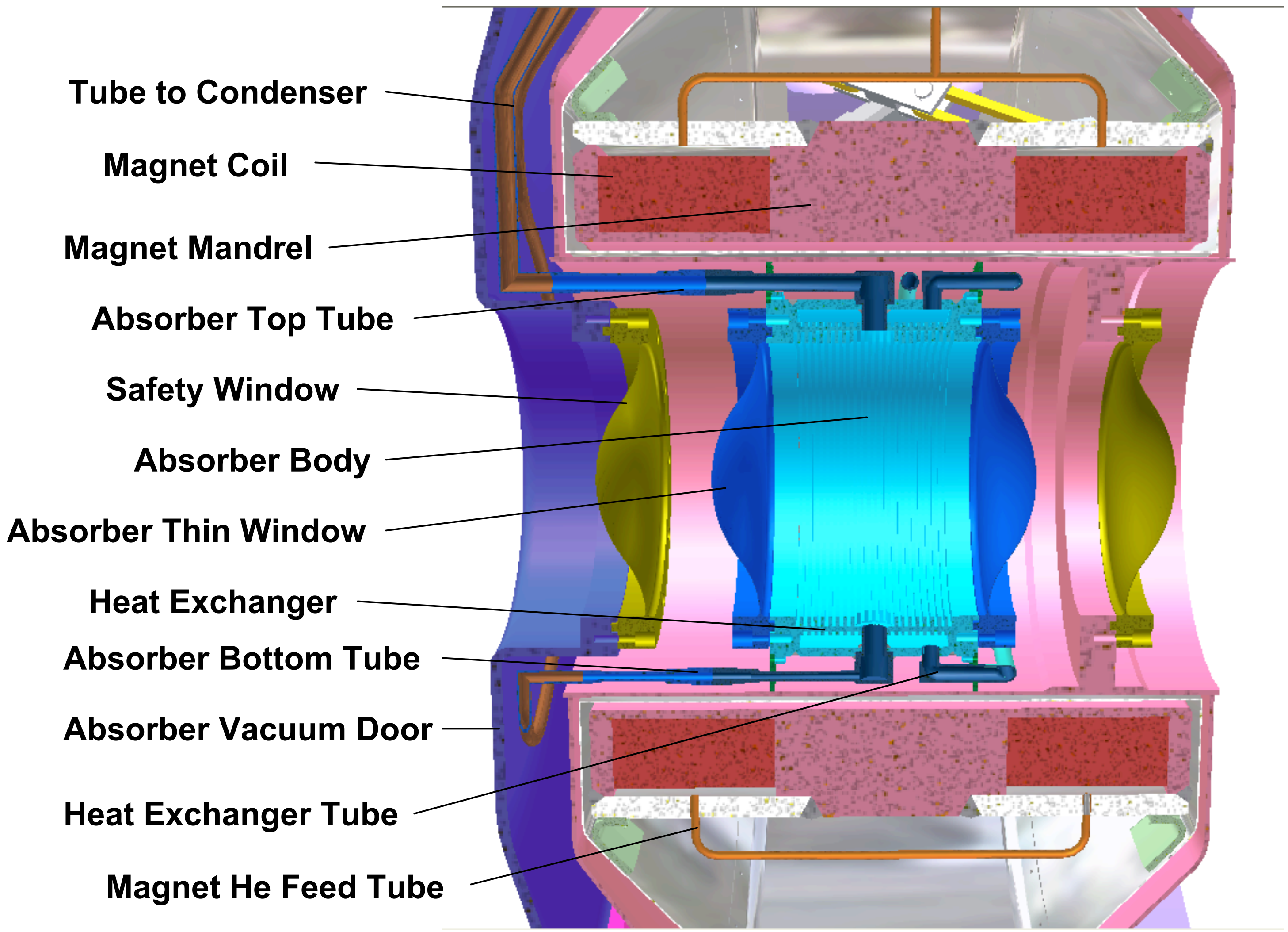
- Maintained bi-weekly phone meetings
  - Jun 1, May 18, May 4, Apr 20, Apr 6, Mar 23
  - Average attendance: 6.5 people
  - Now a working group!
- Discussed
  - TOF resolution requirements (Rogers, Sandström)
    - Draft document prepared for TOF2 performance justification
  - Longitudinal dynamics in SFoFo channel (Rogers)
  - Stage III optics and cooling (Apollonio, Cobb)
  - Detector performance (Sandström)
  - Acceptance of channel and detector sizes (Apollonio, Cobb, Palladino, Rogers, Sandström)
  - Software tools (Ellis)
- Didn't quite get around to
  - Physics parameters (but materials discussed here at cm15)
  - Run plan (postpone to next phone conference)

Analysis parallel session

- Introduction - Yagmur
- Materials in beam path
  - Controlling LH2 - M. Green
  - Discussion
- Offline bunching, cooling and acceptance
  - Slicing phase space - Chris
  - Beam profiles in the channel - Marco
  - Discussion
- Optics issues
  - Longitudinal dynamics - Chris
  - Emittance growth in vacuum - Marco
  - Discussion
- PID issues
  - Summary of efficiency and purity - Rikard
  - Discussion
- Run Plan
  - Plan draft - Yagmur
  - Discussion
- Other (discussion)
  - 6D cooling
  - Software tools

Can MICE Solid and Liquid Absorbers be Characterized to better than 0.3 Percent?

Michael A. Green[1], and Stephanie Q. Yang[2]
1. Lawrence Berkeley Laboratory
2. Oxford University Physics Department



Can MICE Solid and Liquid Absorbers be Characterized to better than 0.3 Percent?

Michael A. Green[1], and Stephanie Q. Yang[2]
1. Lawrence Berkeley Laboratory
2. Oxford University Physics Department

Can we predict cooling to ±0.3 percent with the MICE liquid absorbers?

- The MICE absorber performance can be predicted to ±0.3 percent when it is filled with liquid hydrogen, because we know the hydrogen temperature within ±100 mK.
- It is not clear that the MICE helium absorber performance can be predicted to ±0.3 percent when it is filled with liquid helium, because it is unlikely that the absolute temperature can be easily measured within ±20 mK. More work is required to find the right temperature sensors.

Can MICE Solid and Liquid Absorbers be Characterized to better than 0.3 Percent?

Michael A. Green[1], and Stephanie Q. Yang[2]
1. Lawrence Berkeley Laboratory
2. Oxford University Physics Department

- The candidate solid absorbers (except LiH) can be characterized to ±0.3 percent. The best materials are Be, polystyrene, graphite, Mg, and Al.
- A LH_2 absorber can be characterized to ±0.3 percent because we know the density of LH_2 to better than ±0.3 percent.
- A LHe absorber may not be characterized to ±0.3 percent because we may not know the density of LHe to ±0.3 percent.
- For many absorber materials, absorber performance can be predicted to ±0.3 percent.

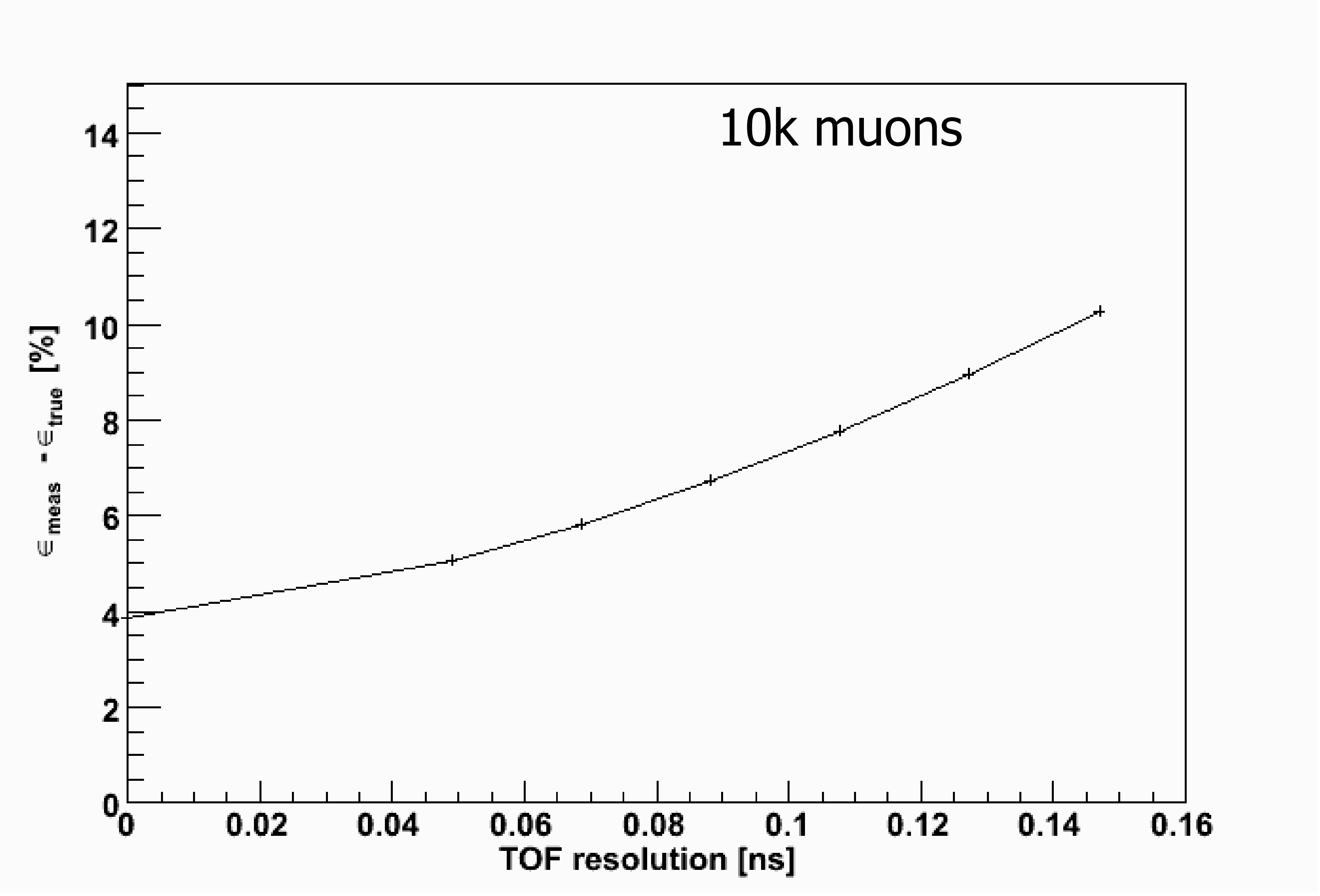
Chris Rogers

TOF Resolution

- Required to measure bunch length
    - ~ 0.5 ns RMS from RF Bucket size
- For 1e-3 emittance measurement resolution of TOF should be <14%*0.5 ns ~ 70 ps
    - Is 1e-3 emittance measurement the right quantity?
- Really the calibration is more important
    - This needs to be < ~ 7 ps absolute
    - Also worry about correlations and biases
- Requirement/consideration also needed for correlations
    - Between *t* and *x,y,px,py,pz*

Chris Rogers

Long emittance error at TRP

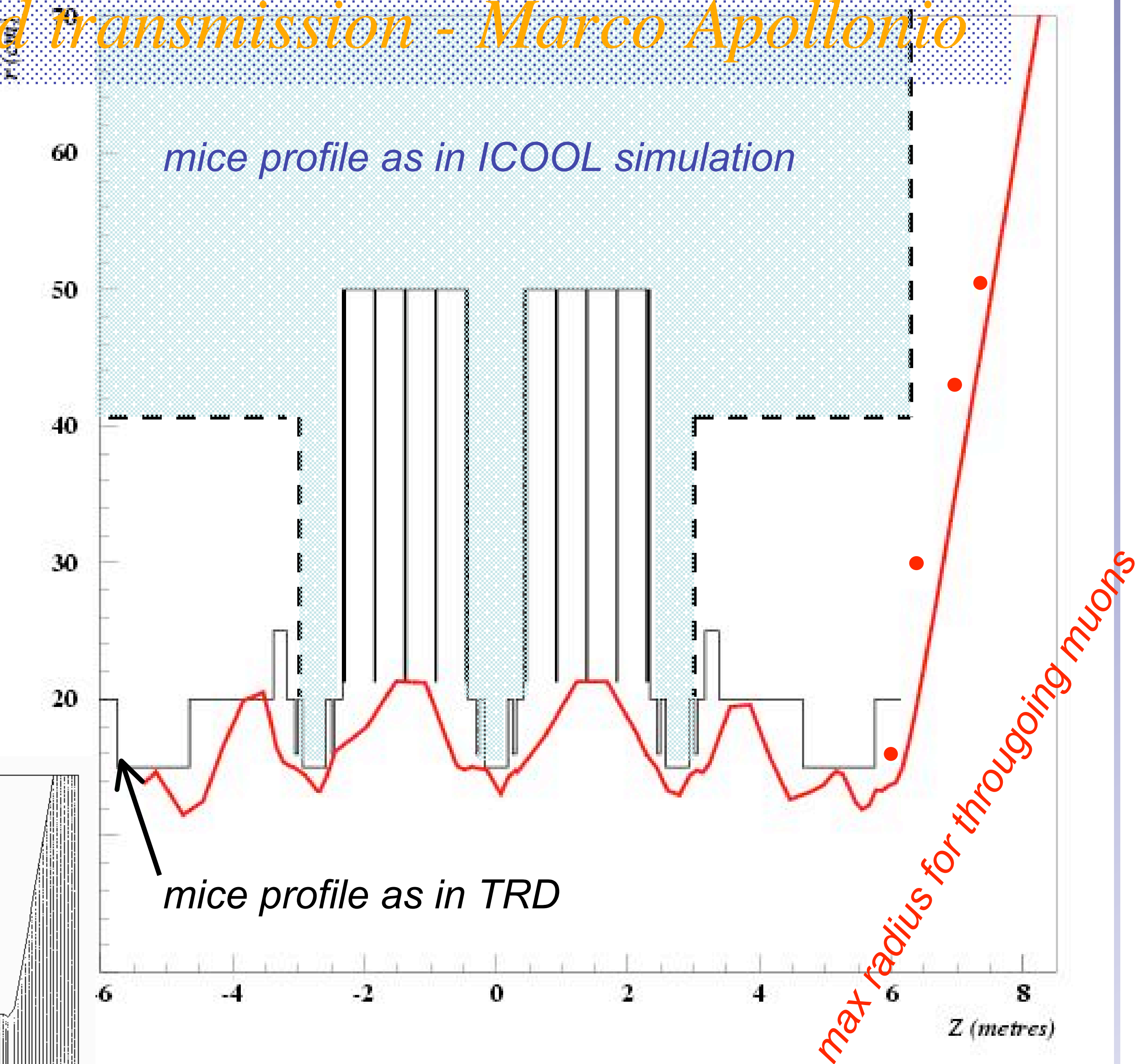


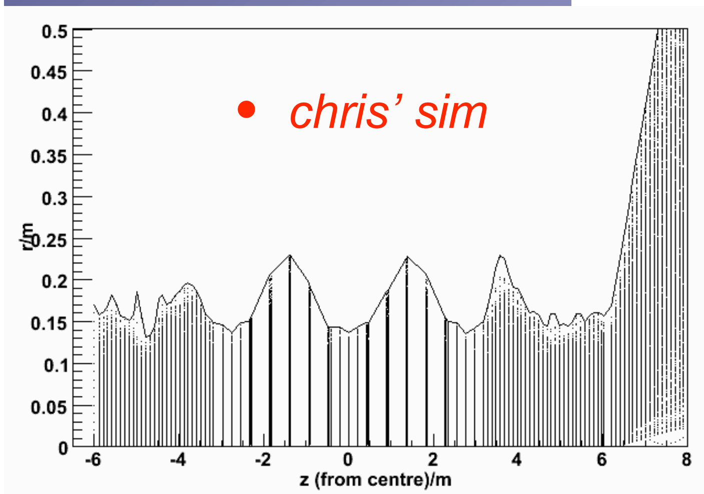
Chris Rogers

Beam weighting

- Pseudo-algorithm
  - "Measure" phase space density f(**u**) of muons in phase space
  - Apply statistical weights s.t. f(**u**) -> g(**u**)
    - I.e. weight each muon according to w(**u**)=g(**u**)/f(**u**)
- There may be an "off-the-shelf" solution…
- Otherwise two algorithms in mind
  - (I) Voronoi diagrams
  - (II) Hack
- What is the job?
  - Do we want to be able to generate **any** beam using **experimental data**
  - Or do we want to be able to generate a few beams; optimise our code; and then use the code for complex beams
  - I.e. do we want to simulate A^2-p correlations and p-dependant β-funcs with experimental data?

beam radius and transmission - Marco Apollonio





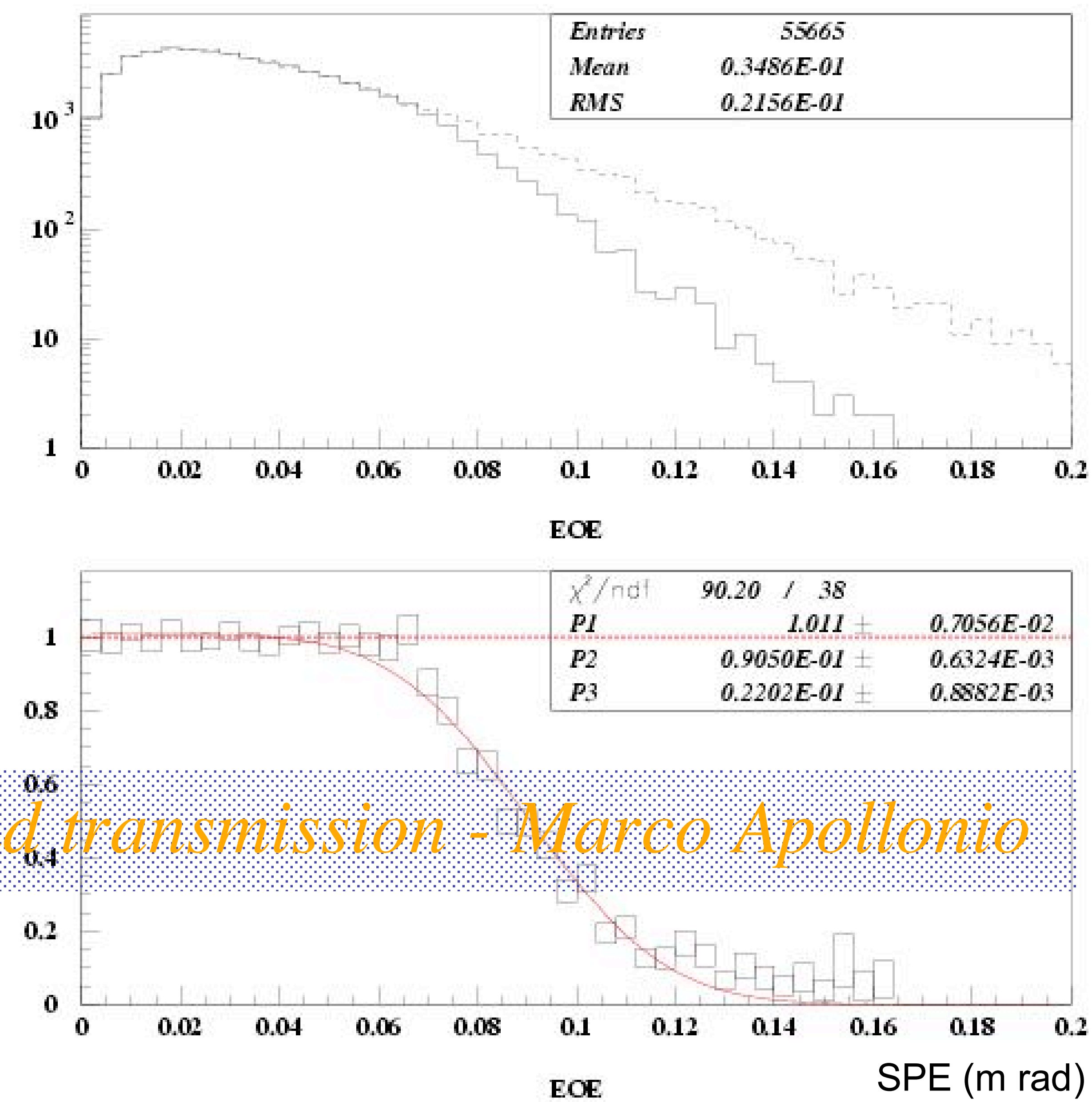
single particle emittance or amplitude (A)

before cooling channel
after " "

effect of geometrical apertures only

this time NO selection on througoing muons
→Transmittance (A)

Study just started …

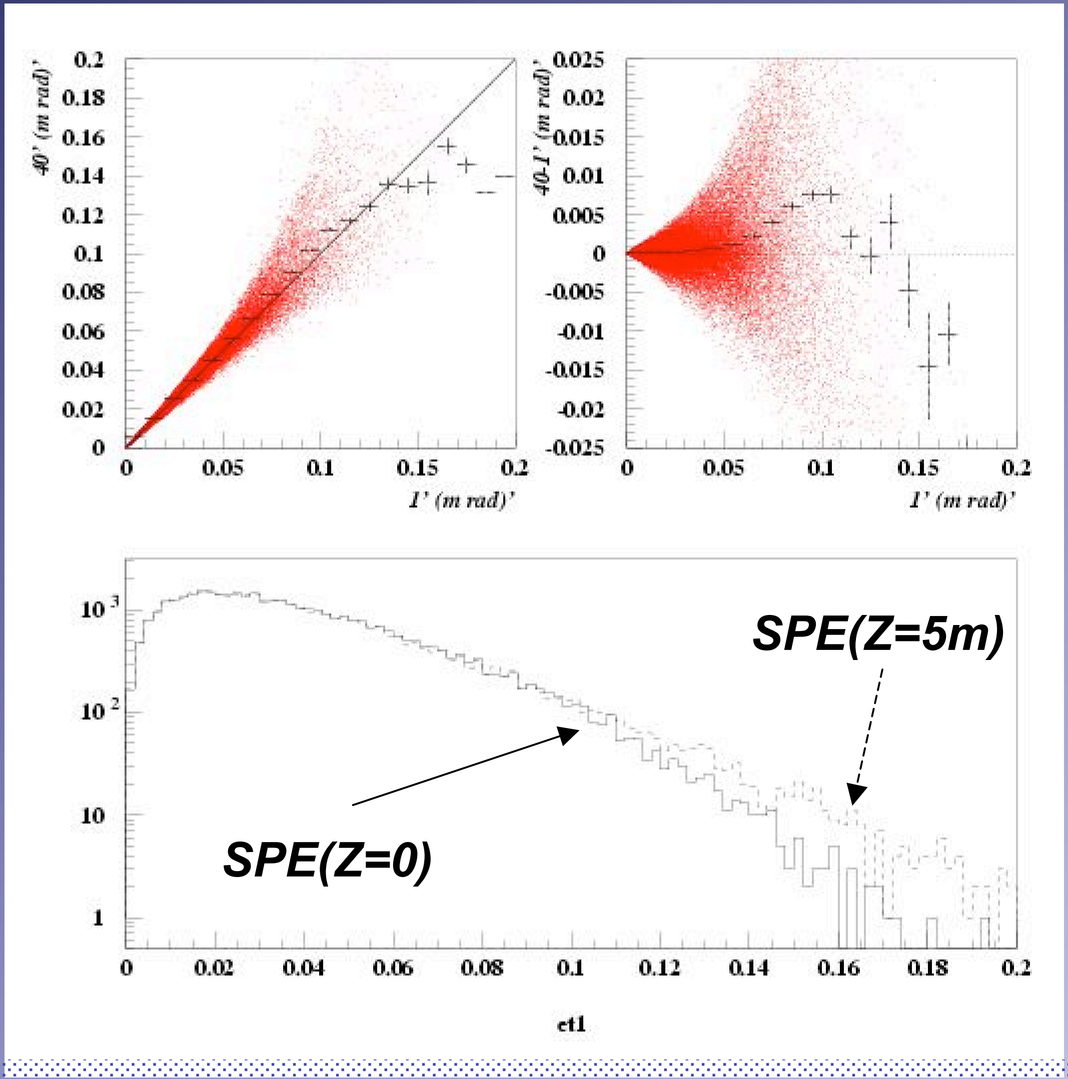


beam radius and transmission - Marco Apollonio

- *G. Penn's note 71: p.10, eq. (15)*
- *Can be derived from the general expression of normalized emittance (4D)*

$$m^2c^2\varepsilon_N\varepsilon'_N = \left\langle \frac{xP_x}{P_z} \right\rangle \left\langle P_x^2 \right\rangle - \left\langle xP_x \right\rangle \left\langle \frac{P_x^2}{P_z} \right\rangle + \left\langle xP_y \right\rangle \left\langle \frac{qB_z}{P_z} xP_x \right\rangle$$
$$- \left\langle \frac{qB_z}{P_z} xP_y \right\rangle \left\langle xP_x \right\rangle - \left\langle x^2 \right\rangle \left\langle qB_y P_x \right\rangle + \left\langle qB_y x \right\rangle \left\langle xP_x \right\rangle$$
$$+ \left\langle yP_x \right\rangle \left\langle qB_x x \right\rangle$$

- *Predicts an emittance growth in vacuum*
- *Ideally if Bz=const+uniform and Pz=const the emittance growth is zero: this is fairly true in the solenoid regions where infact ε~const*
- *When you cross the flip region you have a rapid change in Bz ➔ Bx, By components: emittance blows up*

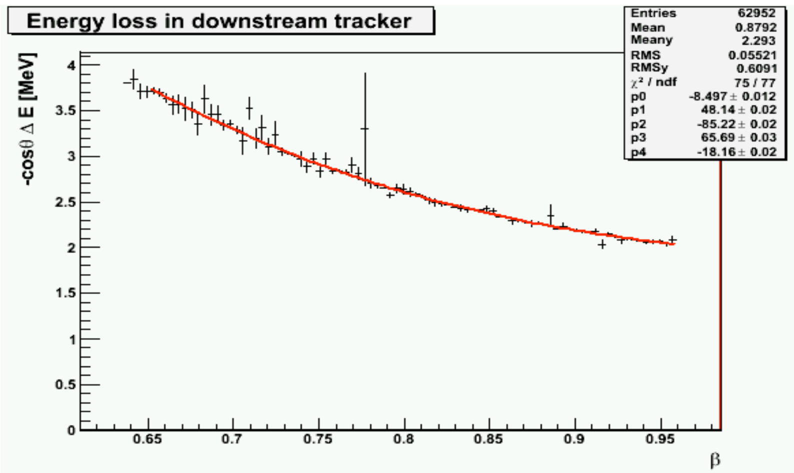


emittance growth in step III - *Marco Apollonio*

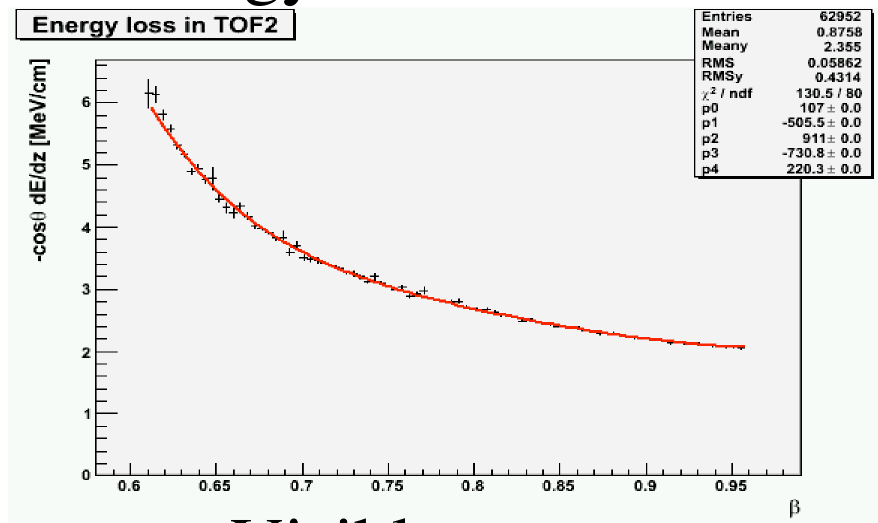
Summary of downstream PID

Rikard Sandström

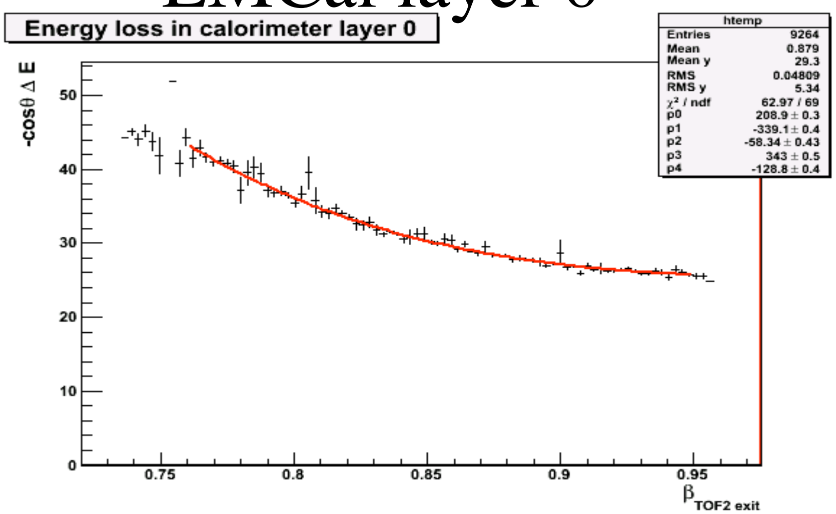
Energy loss in tracker



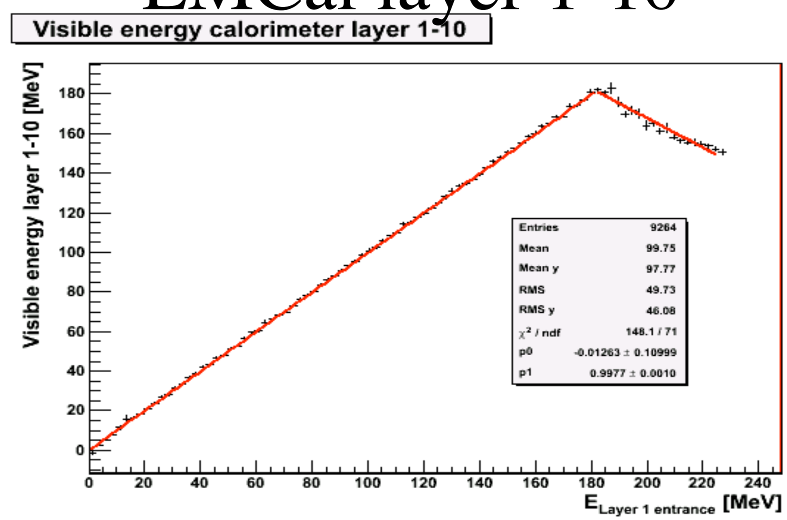
Energy loss in TOF2



Energy loss in EMCal layer 0



Visible energy EMCal layer 1-10



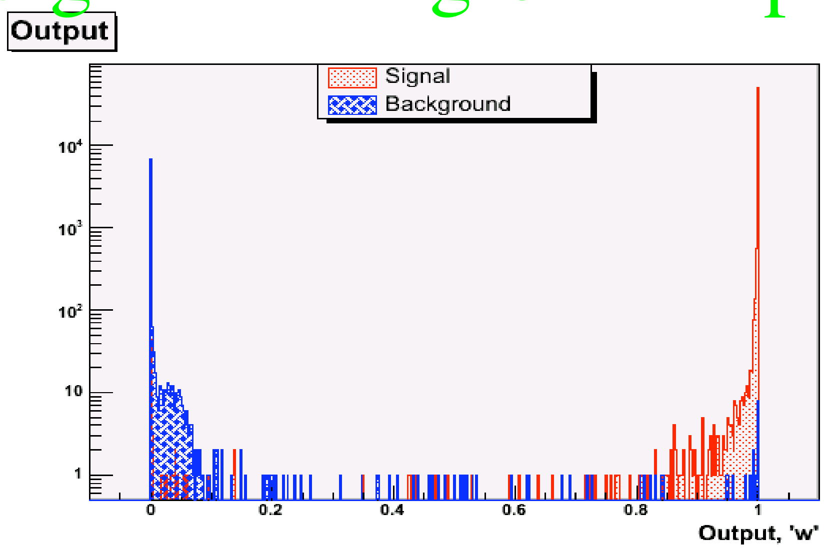
Summary of downstream PID

Rikard Sandström

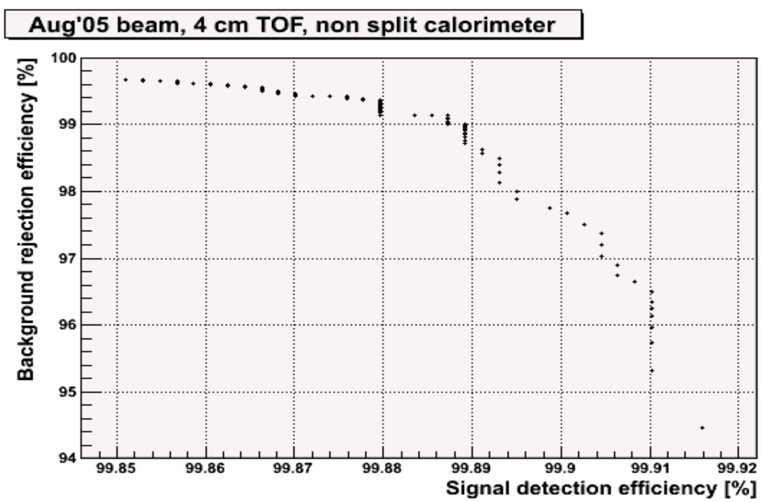
Fits -> Useful PID variables

- Discrepancy variables:
  - D = 1-expected/measured (D = 0 indicates signal = muon)
- Used in Neural Net analysis
  - Barycenter disc, total ADC disc, tof, tof disc, range disc, tdc peaks, holes/range, high threshold adc/ low threshold adc, adc layer0/ total adc, adc layer0/ adc layer1.
  - Some variables are correlated.

Signal - background separation



Efficiency



Summary of downstream PID

Rikard Sandström

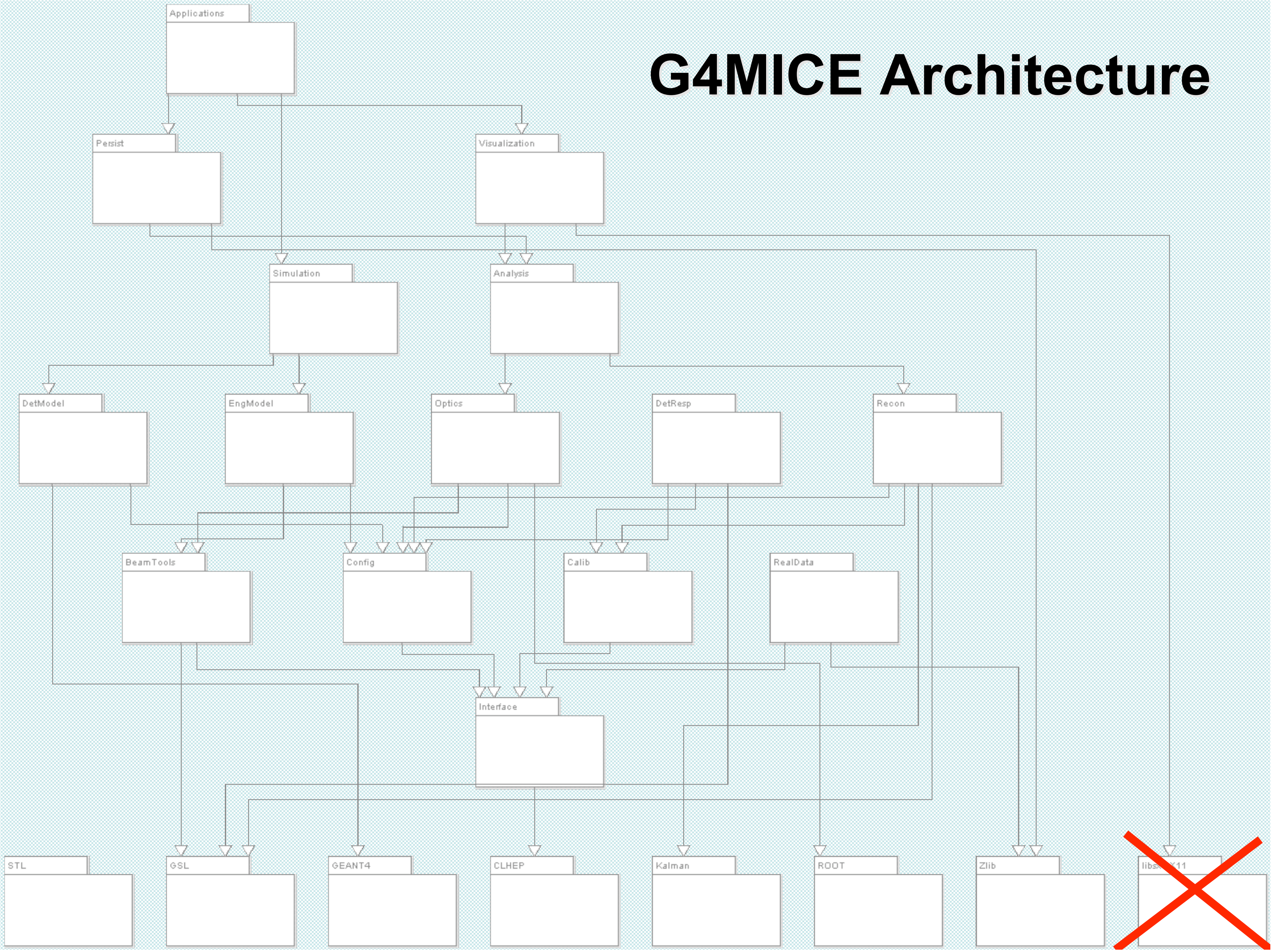
What signal events are miss IDed?

- For w<0.2,
  - 8% of muons are stopped in TOF2.
    - Will be worse a lower momentum.
  - 8% are leaving TOF2 with very large angle and misses calorimeter.
    - Will be worse a lower momentum.
    - Move calorimeter even closer to TOF2.
  - 8% decay between TOF2 and calorimeter.
    - Move calorimeter even closer to TOF2.
  - 60% are muons decaying in ADC gate and too close in time to its own track that only one TDC peak is registered.
    - Tweaking TDC threshold could help.
    - Harmless!

Analysis Forum Outlook

- Need to continue regular working group meetings and increase participation
  - Will encourage more MICE-Notes
- Still urgent issues
  - Offline selection and weighting
  - Cooling performance indicators
  - PID performance
  - Physics parameters
  - Run plan
- Want to start discussing other interesting topics
  - Future options for 6D cooling in MICE
    - Wedges, MANX, etc.
- It's time for a simulation/analysis challenge to focus our effort
  - Put a large number of tracks through end-to-end simulation (Monte Carlo+reconstruction)
  - Following the run plan
  - Perform cooling analysis
  - Preferably by cm16

G4MICE Architecture



Software Report - Malcolm Ellis

MiceModule Motivation

- Refer to Domains diagram (previous slide):
  - Several different domains that have specific tasks/responsibilities (e.g. Reconstruction, Simulation, Visualisation, Analysis).
  - Each of these tasks requires accurate knowledge of some subset of the information that specifies a given configuration (e.g. MICE stage 6)
- We need to be able to know that for any different application that *should* have the same configuration, that it *does* have it.
- We also need the ability to deliberately make differences in order to study systematics (e.g. wrong field in reconstruction, misaligned components, magnetic axis != magnet bore axis, etc...)
- Solution:
  - One model per configuration
  - Many representations of this model, one for each specific use

Model vs. Representation

- A Model describes everything about a stage of MICE that is needed to perform any software task, however not necessarily in a format that is usable by the code.
- A model does not depend on any task specific external (or internal) library (e.g. G4, RecPack, X11).
- For each specific task that requires the use of the model, a representation is built for that task that combines the knowledge of the configuration in the Model with the application specific code for that task.

MiceModule

- Single class provides the modeling of any MICE stage.
- Each instance has a volumeType (Box, Cylinder, Tube) with dimensions, a position with respect to the module that it is placed inside of and an orientation with respect to the axis of the object that it is placed inside.
- Each instance can report its orientation with respect to its mother and any of its mother's mothers up to the global coordinate system (i.e. the MICE Hall).
- In addition, a MiceModule can hold an arbitrary number of properties of type:
  - bool, int, double, string, Hep3Vector, …
  - used to define any aspect of the module needed for one or more representations.
    - PropertyBool
      - Invisible 1 — don't visualise this module
    - PropertyInt
      - Station 4 — the station number
    - PropertyDouble
      - Pitch 0.420 mm — the fibre pitch
      - RedColour 0.5 — how much **red** to use
    - PropertyString
      - Material POLYSTYRENE — what material to simulate
      - SensitiveDetector TOF — make hits in this module
    - PropertyHep3Vector
      - MagneticField 0.0 0.0 1.0 tesla — fixed field

Software Report - Malcolm Ellis

Representations

- Code to create representations has been written for three areas:
  - Simulation: builds all the GEANT4 classes automatically, including making the SciFi and TOF detectors sensitive.
  - Reconstruction: build the complete description required in RecPack automatically, and is used by the Reconstructed classes to determine the position of hits, points, etc.
  - Visualisation: buid a HepRep XML file to visualise the model with a program such as WIRED.

Configurations

- A single text file is used to describe a configuration.
- A configuration will use one or more modules that are defined separately.
- Each module can contain 0 or more sub modules (and so on).
- The syntax of files that describe configurations and modules is the same.

Software Report - Malcolm Ellis SM9

- 9th Software Workshop was held at Fermilab before cm15
- Well attended and very productive:
  - Aron Fish, Ben Freemire, Jean-Sebastien Graulich, Terry Hart, Takashi Matsushita, Chris Rogers, Hideyuki Sakamoto, Rikard Sandstrom, Yagmur Torun, Michael Wojck, Makoto Yoshida
- Most of the MICE models were produced by a few students:
  - IIT: Ben Freemire and Mike Wojck
  - Geneva: Rikard Sandstrom
  - Imperial: Aron Fish
- Lara Howlett was unable to come to Chicago but did a lot of work to test/debug MiceModules code prior to the Workshop.
- Goals of the workshop were:
  - Software for the KEK test beam analysis:
    - Completed reconstruction/analysis code and analysed 400k events
  - Continued development and use of MiceModules
    - Units were added (Chris Rogers) and many new modules and configurations were created.
  - Design work towards upgrade of field map utilities
    - Done (Chris Rogers)
    - Work is now in progress to implement the changes (Chris).

Software Report - Malcolm Ellis

Future Workshops

Start Date	End Date	Proposed Location	Associated Meeting
5th June	7th June	Fermilab √	MICE CM
19th July	21st July	RAL	
Early September	Early September	Fermilab	After NuFact06?
4th October	6th October	RAL	MICE CM

- Internal review (with external consultation) planned for the end of this year (probably around the October CM).
- Always very happy to train new users/developers (two summer students started from scratch and produced 6 MICE stages in under a week!)