Summary of Simulation / Detector Performance / Reconstruction

Tomohiko Tanabe (ICEPP, U. of Tokyo)

September 30, 2011

LCWS11

Granada, Spain

ilcsoft
(F. Gaede)

lcsim
(N. Graf)

Clupatra
(F. Gaede)

Forward
tracking in ILD
(R. Glattauer)

ILD
Tracking
(S. Aplin)

Non-prompt
tracks in SiD
(B. Schumm)

Samples for
CLIC CDR
(S. Poss)

Samples
for DBD
(A. Miyamoto)

SGV:
fast simulation
(M. Berggren)

SiD-Iowa
PFA
(R. Zaidan)

PandoraPFA
(J. Marshall)

Pixel sensor
simulation
(N. Sinev)

PFA
performance at CLIC
(A. Muennich)

Lepton ID
at CLIC
(J. Marshall)

Electron reco.
in BeamCal
(A. Rosca)

FPCCD
digitization and reco.
(D. Kamai)

Flavor
tagging at CLIC
(J. Strube)

W/Z
separation at 1 TeV
(T. Barklow)

Beam
backgrounds at CLIC
(A. Sailer)

LCFIVertex+
(T. Tanabe)

Jet energy res.
with π^0 fit
(B. van Doren)

Photon with
shower fitting
(G. Wilson)

Muon
background at CLIC
(M. Thomson)

- core software
- event generation / simulation
- backgrounds
- detector models
- tracking
- PFA
- flavor tagging
- particle reconstruction

core software

F. Gaede

N. Graf

iLCSoft release v01-12

CED	v01-03	Overlay	v00-11
CEDViewer	v01-03	PandoraPFANew	v00-07
CLHEP	2.0.4.5	QT	4.2.2
CondDBMySQL	ILC-0-9-5	RAIDA	v01-06-01
Druid	1.8	StandardConfig	v03-00
Eutelescope	v00-06-03	cernlib	2006
KalTest	v01-02	dcap	1.9.5-5
KalDet	v01-02	gear	v01-00
LCFIVertex	v00-06	gsl	1.14
LCFI_MokkaBasedNets	v00-01	lccd	v01-02
Marlin	v01-01	lcio	v02-00
MarlinPandora	v00-06	mysql	5.0.45
MarlinReco	v00-30	root	5.28.00f
MarlinTPC	v00-06	ilcutil	v00-02
MarlinUtil	v01-04	**MarlinTrk**	**v01-00**
Mokka	mokka-07-07	**MarlinKinFit**	**v00-01**
MokkaDBConfig	v03-02	**MarlinFastJet**	**v00-02**

updated
new
this talk

development release targeted at getting the software into shape for the DBD

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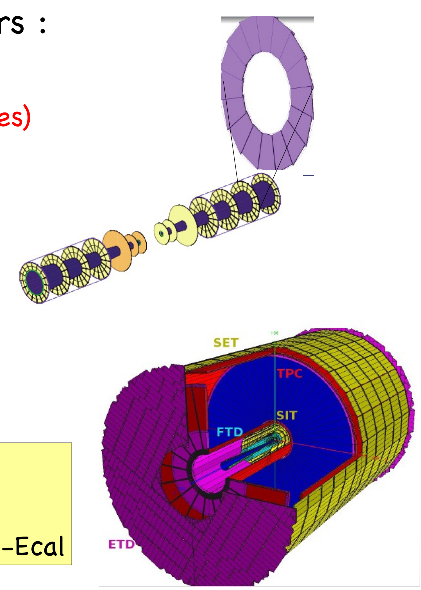
recent developments in Mokka

- major rewrite of some sub detector drivers :
  - SIT, SET, ETD - FTD - Muon
  - increased level of detail and realism (incl. services)
- made existing drivers more realistic:
  - TPC, AHCal, Ecal
- new drivers (technology options):
  - SDHCal, SciEcal
- added overall services and cables
- new models under development:

ILD_01_pre02	- AHCal and	Si-Ecal
ILD_01_SDH_pre00	- SDHCal and	Si-Ecal
ILD_01_SciW_pre00	- AHCal and	Scintillator-Ecal

- next steps:
  - finalize and debug these models
  - adopt new Gear materials



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Simulation & Reconstruction

- **SLIC provides full detector simulation in Geant4**
  - runtime detector description in XML
  - stdhep input
  - standard LCIO output
- **org.lcsim reconstruction/analysis suite**
  - Java-based reconstruction & analysis framework
  - full, *ab initio* signal digitization, track finding & fitting, calorimeter cluster finding and association (PFA)
  - LCIO provides access to global LC code base
    - flavor-tagging via LCFI
    - PFA via Pandora
  - AIDA histogramming and fitting
  - WIRED 3-D event display

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Continued improvement in core software tools used by ILC & CLIC.

More realistic detector models.

event generation

S. Poss

A. Miyamoto

Introduction

Introduction

- 6 benchmark analysis:
  - $e^+e^- \to h\nu_e\overline{\nu}_e$,
  - $e^+e^- \to H^+H^-$, $e^+e^- \to H^0A$,
  - $e^+e^- \to \widetilde{q}_R\overline{\widetilde{q}}_R$,
  - $e^+e^- \to \widetilde{\ell}\overline{\widetilde{\ell}}\,(\ell = e, \mu)$,
  - $e^+e^- \to \widetilde{\chi}^{\pm}{}_i\widetilde{\chi}^{\mp}{}_j$, $e^+e^- \to \widetilde{\chi}^0{}_i\widetilde{\chi}^0{}_j$,
  - $e^+e^- \to t\bar{t}$ (500 GeV).
- Plus all the backgrounds (Standard Model)
- 2 detector models

Number of events processed in the last 9 months: $17 \cdot 10^6 \times 3$ processed.

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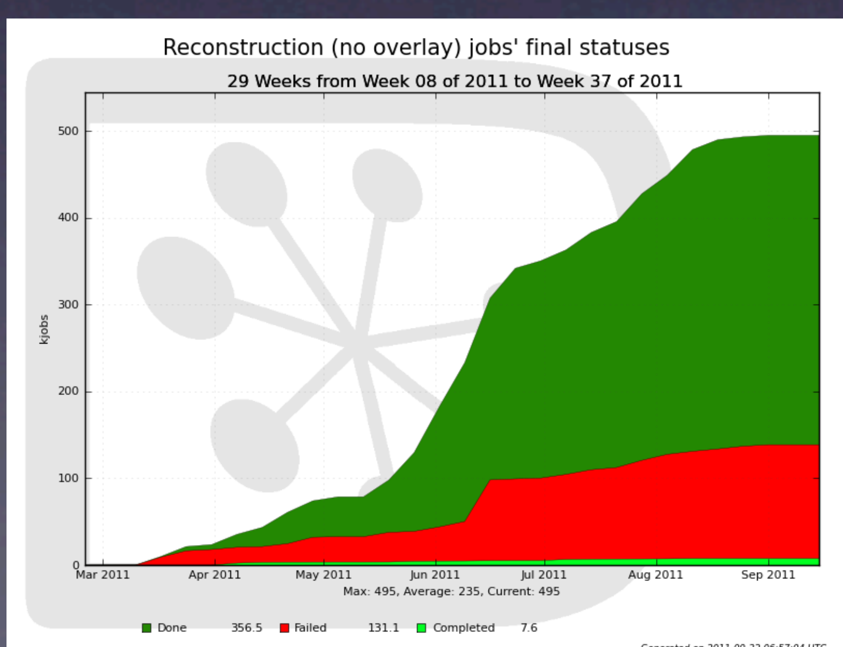
Task for DBD study

- Benchmark processes for the DBD studies
  - Ecm=1TeV
    - $e^+e^- \to \nu\bar{\nu}h^0$
    - $e^+e^- \to W^+W^-$
    - $e^+e^- \to t\bar{t}h^0$
  - One of LOI benchmark processes at Ecm=500 GeV
- Backgrounds
  - Relevant SM processes, up to 8 fermions final states for $t\bar{t}h$
  - Machine backgrounds and same-bunch crossing $\gamma\gamma$ events should be overlaid in some way…

27 September 2011 Akiya Miyamoto, LCWS2011 3



Over 50 million events generated & reconstructed for CLIC CDR.

Test samples for DBD available.

fast event simulation

M. Berggren

The need for fast simulation

The need for fast simulation

- We have very good full simulation now.
- So why bother about fast simulation ?
- Answer:
  - R. Heuer yesterday: *We need to update the physics case continuously*.
  - Light-weight: run anywhere, no need to read tons of manuals and doxygen pages.
  - Anyhow, the LOI exercise showed that for physics, the fastSim studies were good enough.

But most of all:

Fast simulation is Fast !

So...

Why do we need speed ?

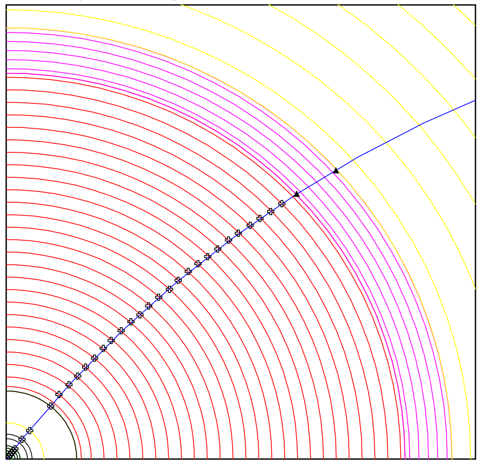
Mikael Berggren (DESY-HH) | SGV 3.0 - a fast detector simulation | LCWS, Granada, 2011 | 3 / 24

Fast simulation

SGV: How it works

SGV is a machine to calculate covariance matrices

Tracking: Follow track-helix through the detector, to find what layers are hit by the particle.



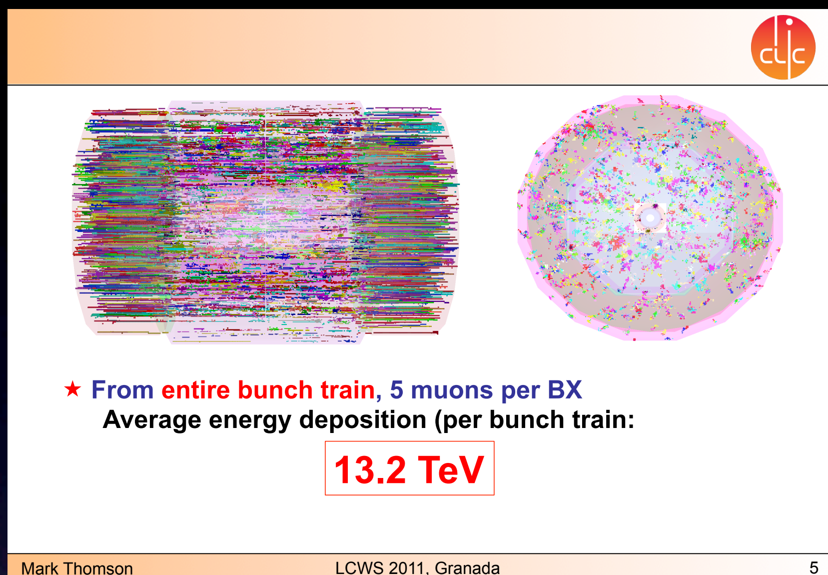
- From this, calculate cov. mat. at perigee, including effects of material, measurement errors and extrapolation. NB: this is exactly what Your track fit does!
- Smear perigee parameters accordingly, with Choleski decomposition (takes all correlations into account)
- Information on hit-pattern accessible to analysis. Co-ordinates of hits accessible.

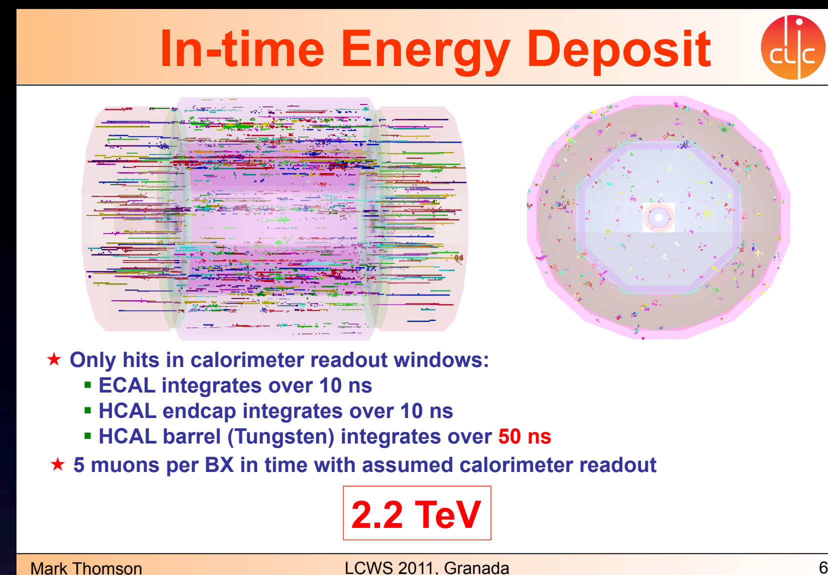
Mikael Berggren (DESY-HH) | SGV 3.0 - a fast detector simulation | LCWS, Granada, 2011 | 7 / 24

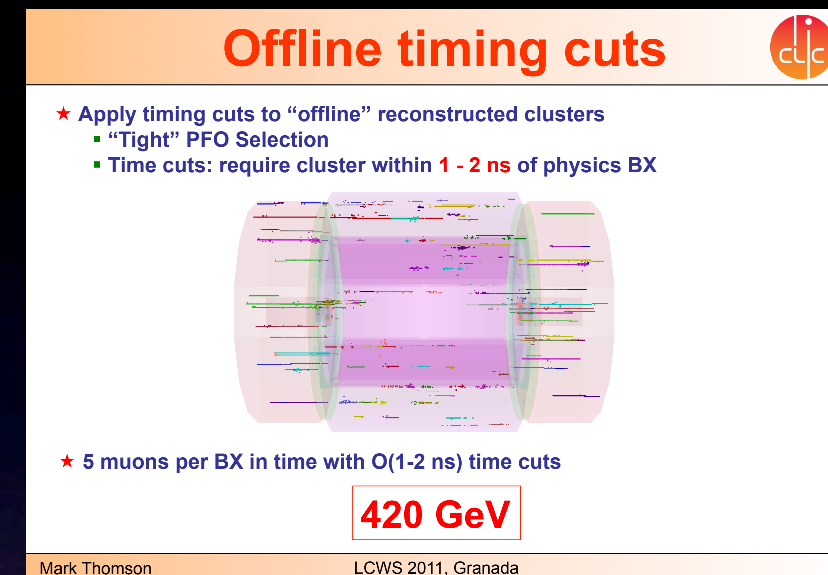
SGV: new fast event simulator based on covariance matrix calculation.

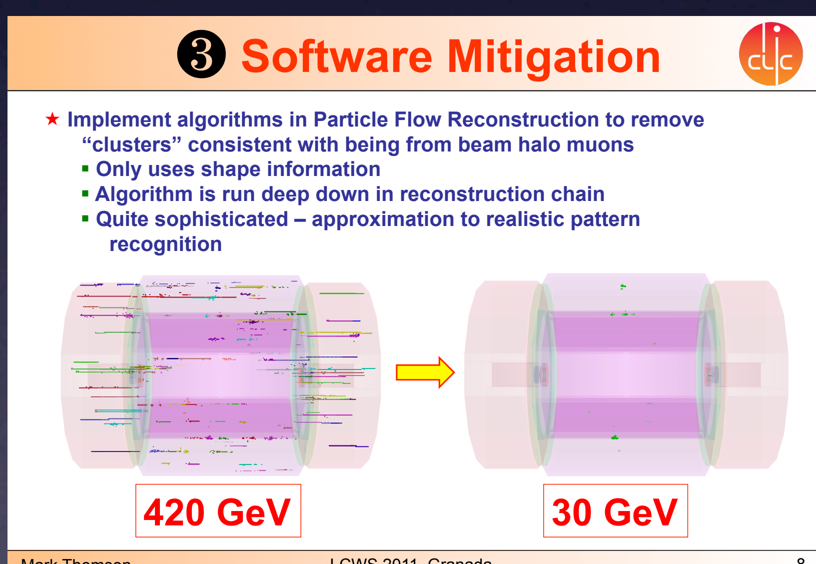
Beam halo muon background at CLIC

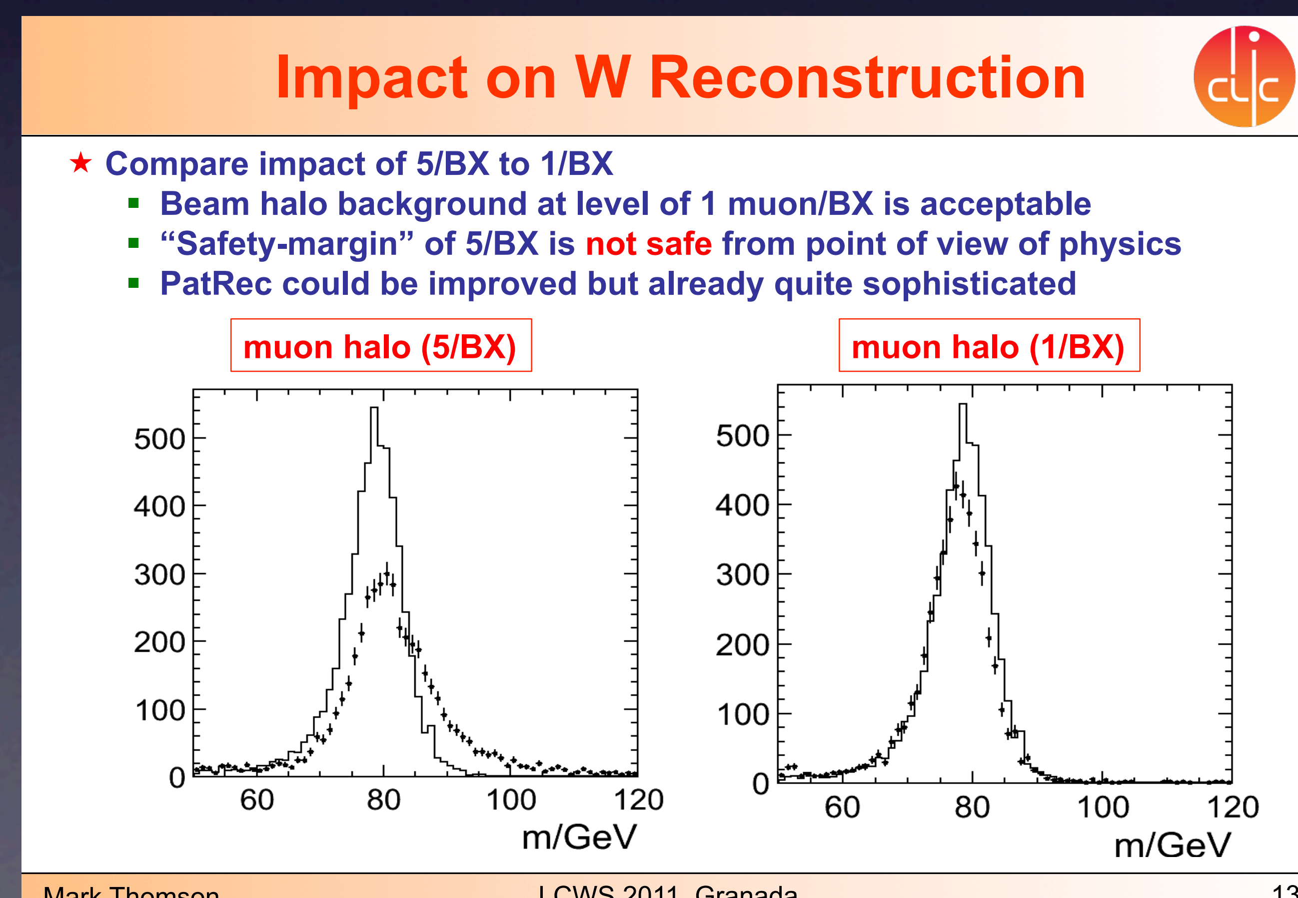
M. Thomson









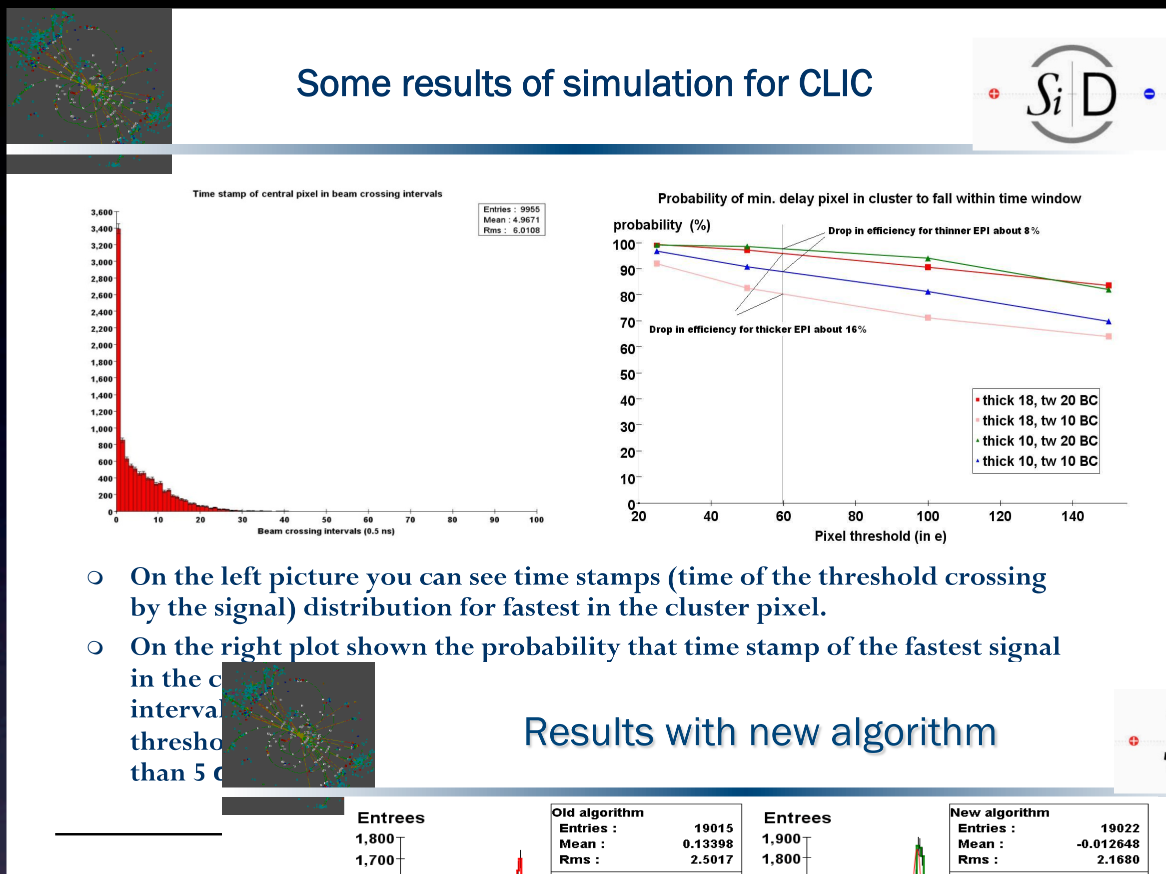


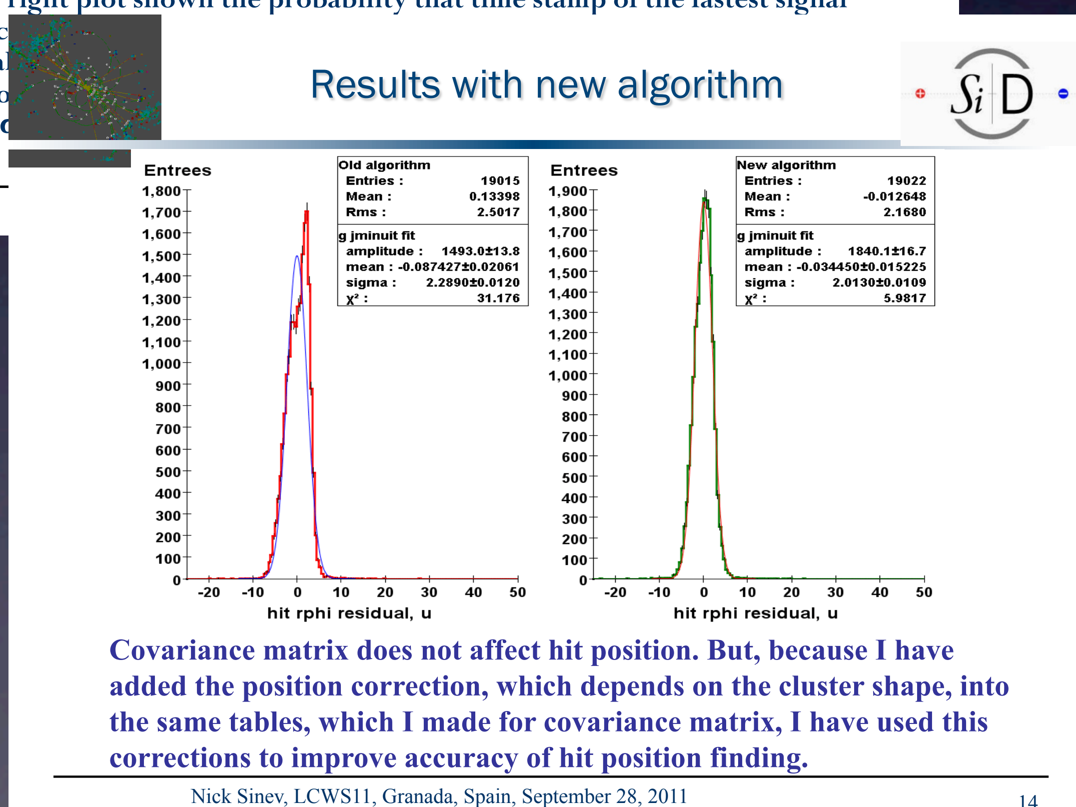
Beam halo background of 1/BX is manageable.
5/BX degrades physics performance.

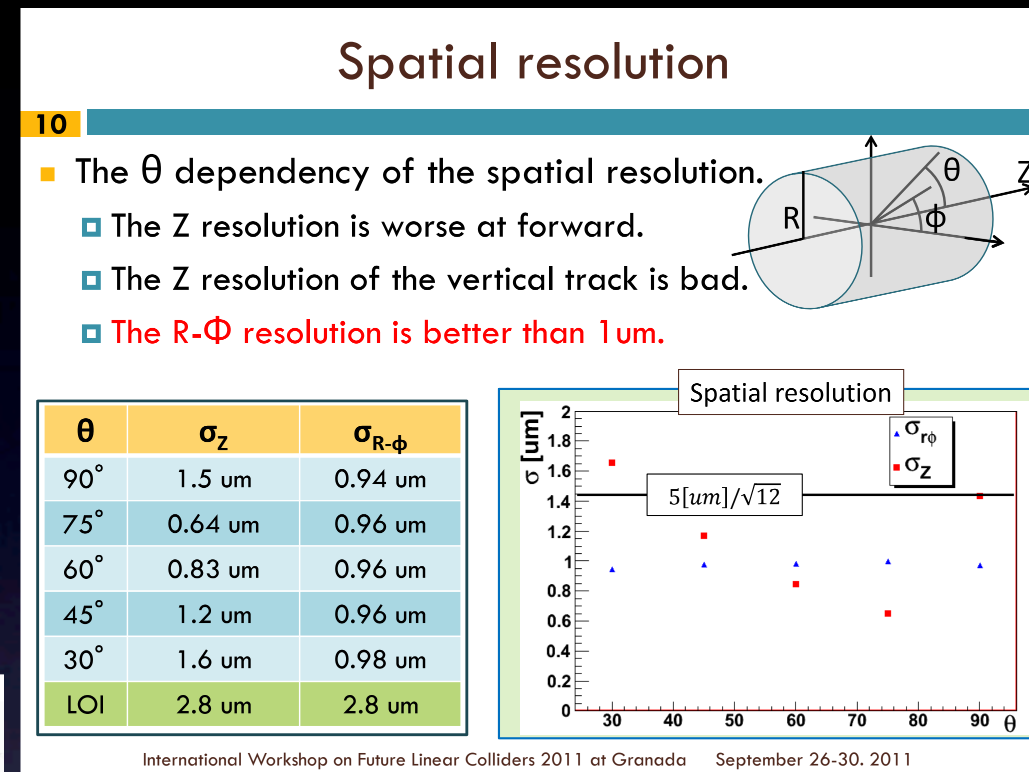
vertex detectors

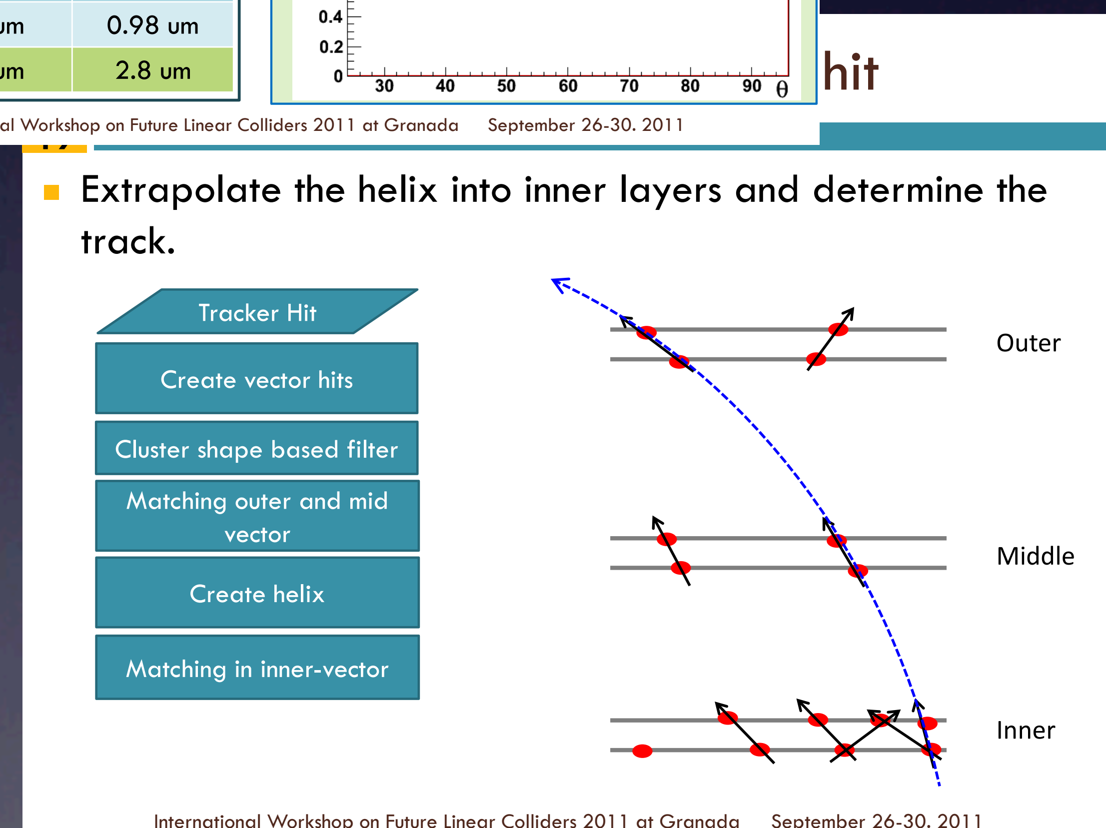
N. Sinev

D. Kamai









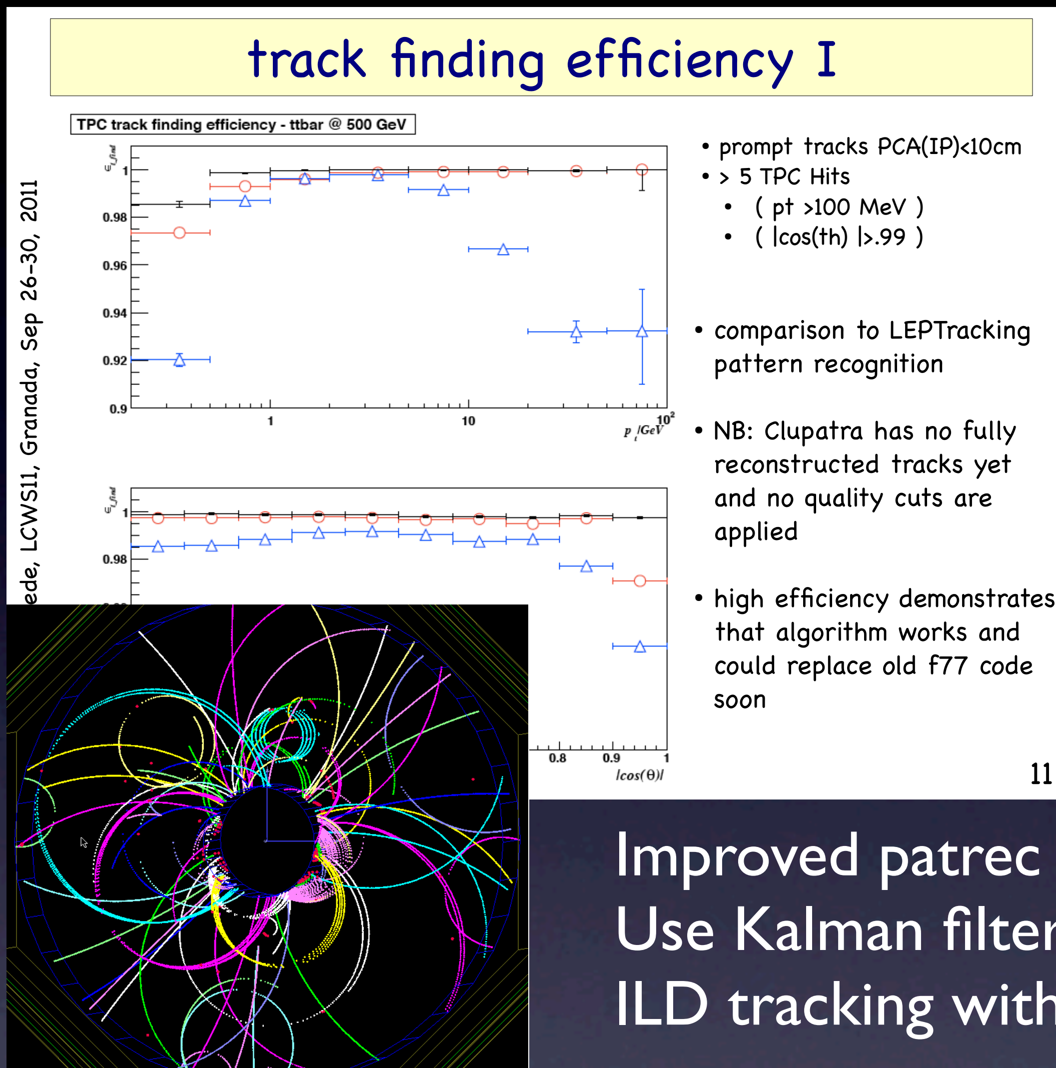
New PixSim drivers for CLIC.
Improvements in reconstruction.

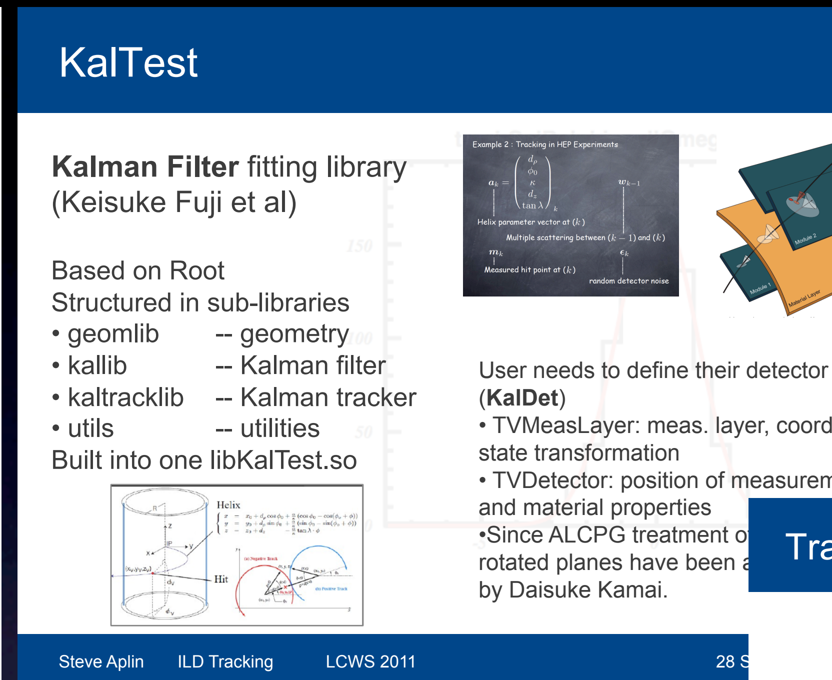
FPCCD: good spatial resolution.
Si tracking based on mini-vectors.

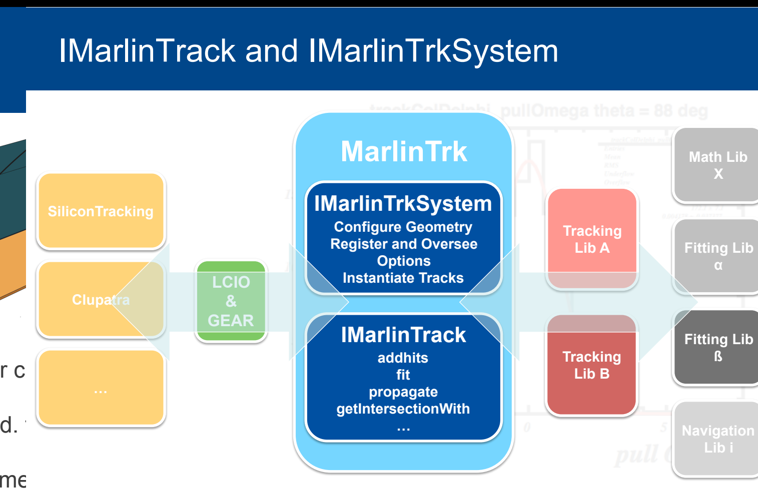
tracking

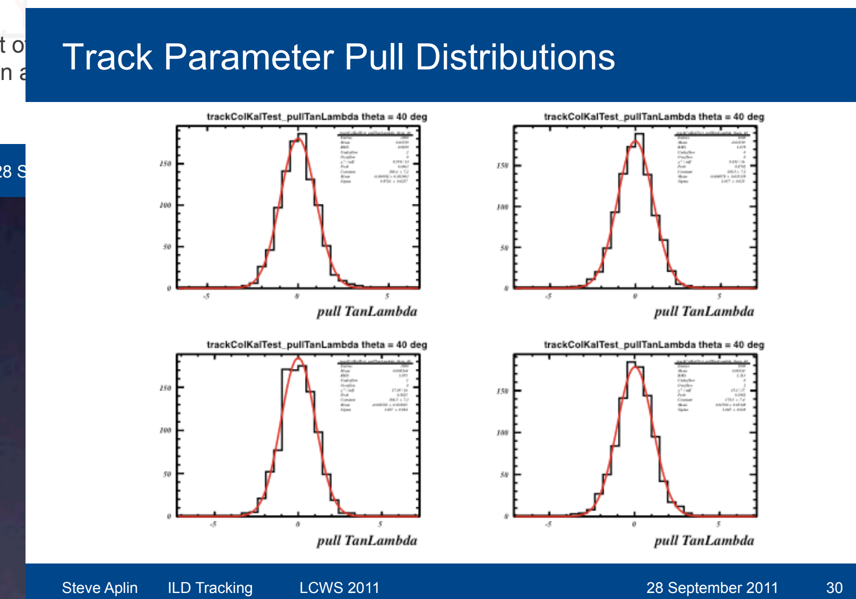
F. Gaede

S. Aplin

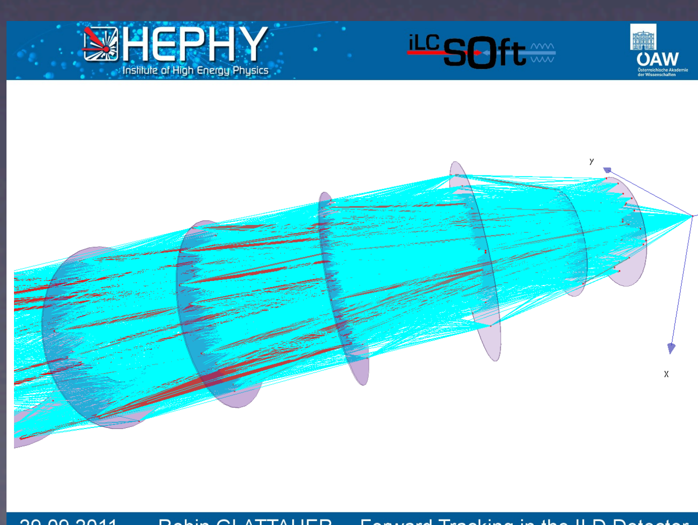


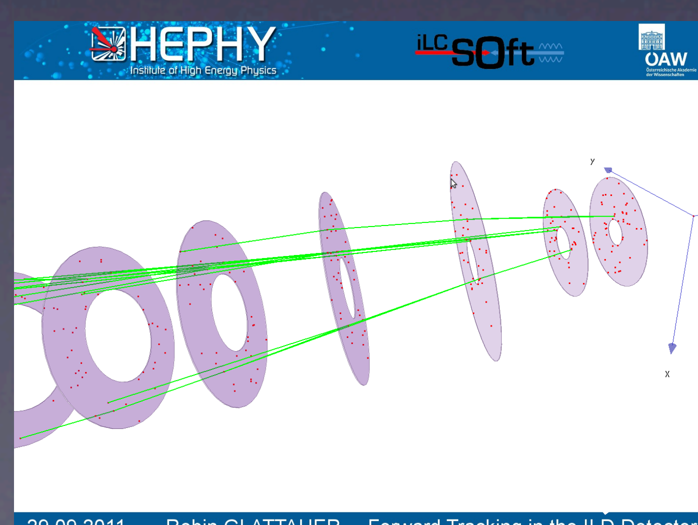






Improved patrec for ILD tracking (clupatra).
Use Kalman filter library (KalTest).
ILD tracking without F77!



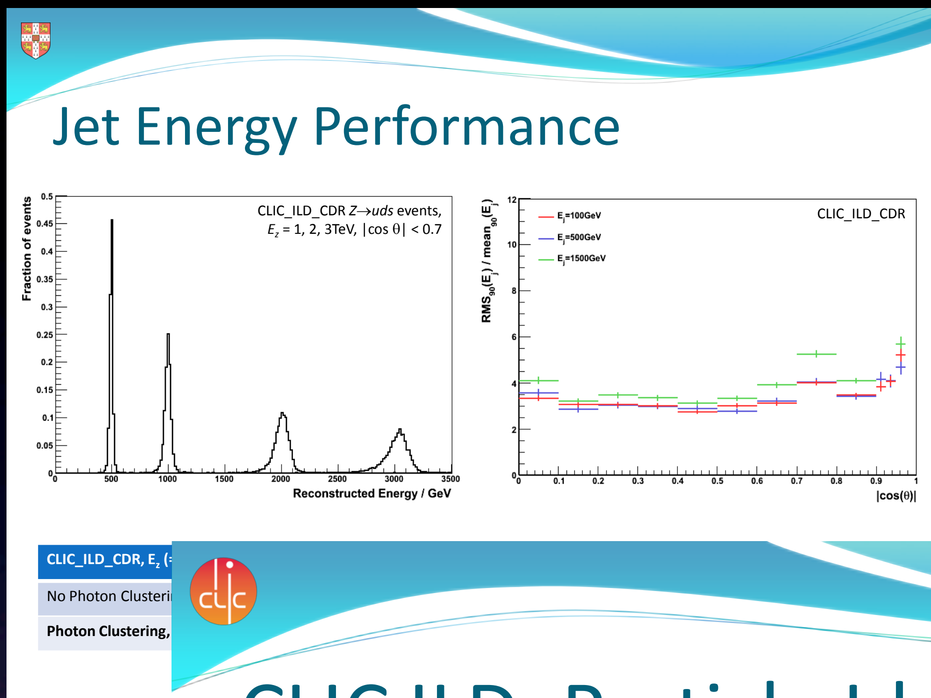


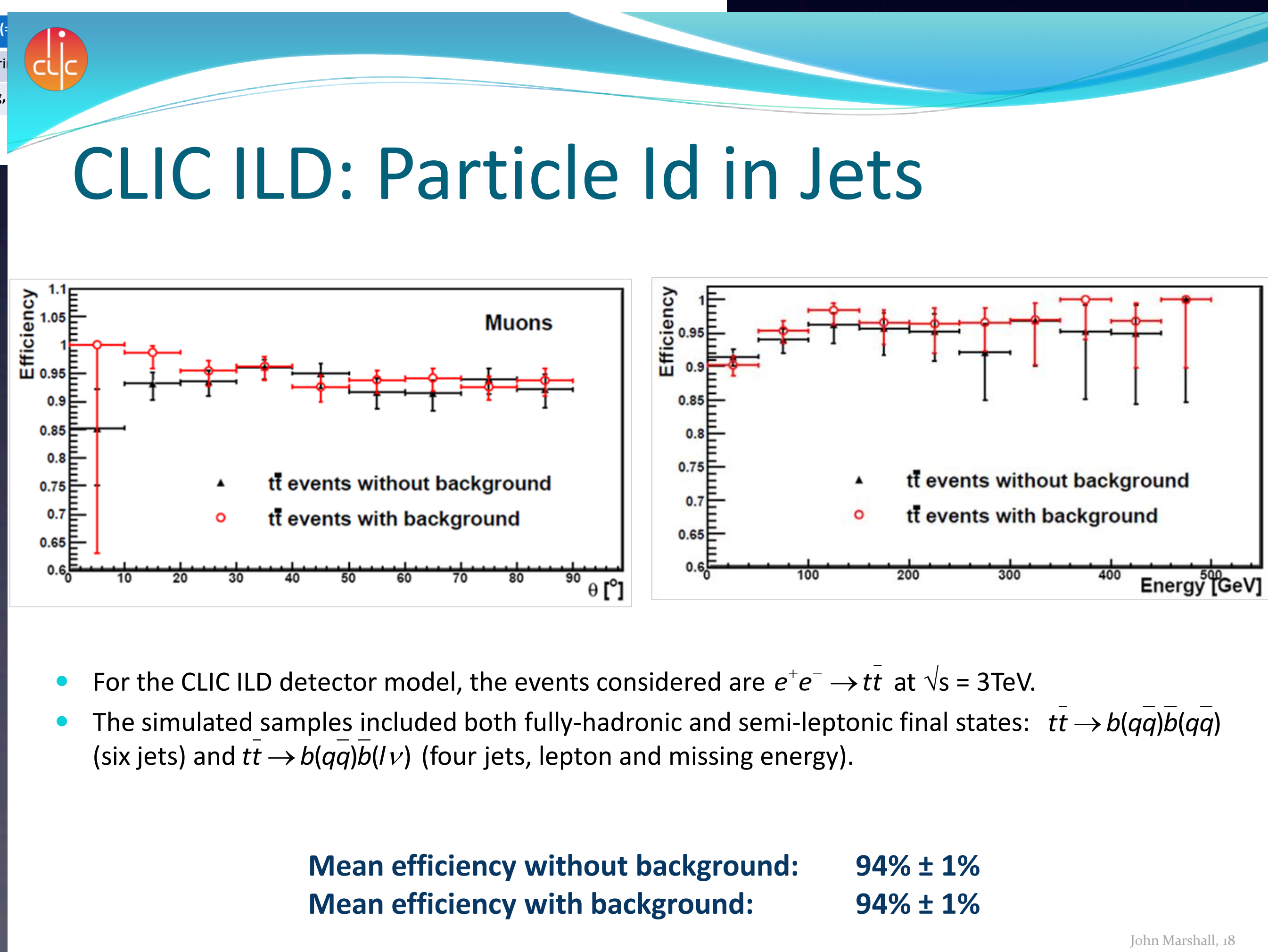
R. Glattauer

Forward tracking based on cellular automaton, Kalman filter, neural network.
Standalone tracking to deal with beam-related background.

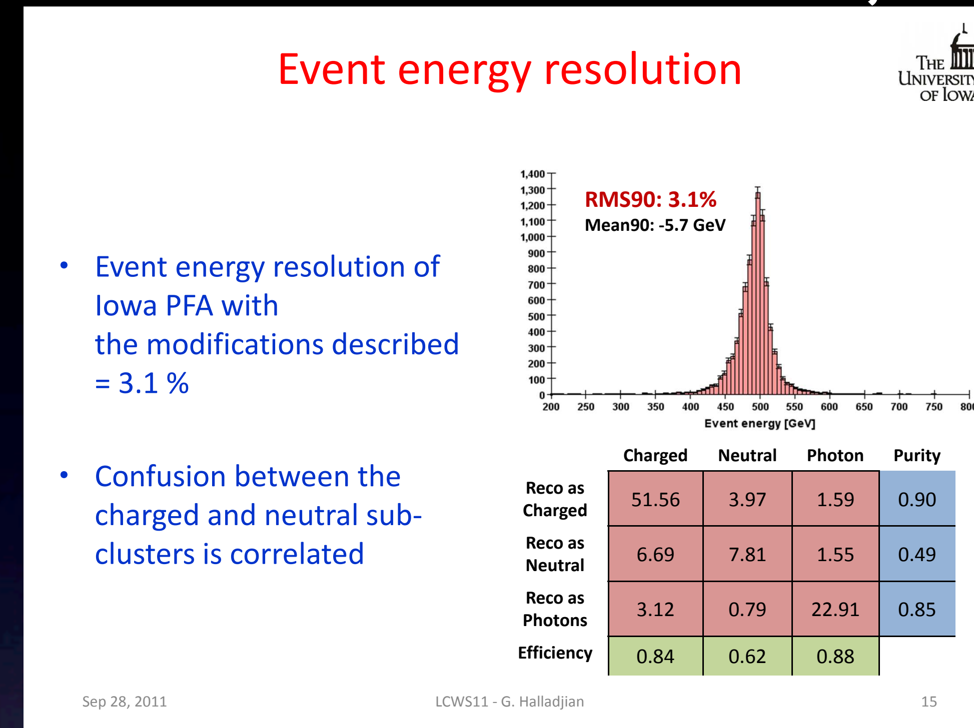
PFA

J. Marshall

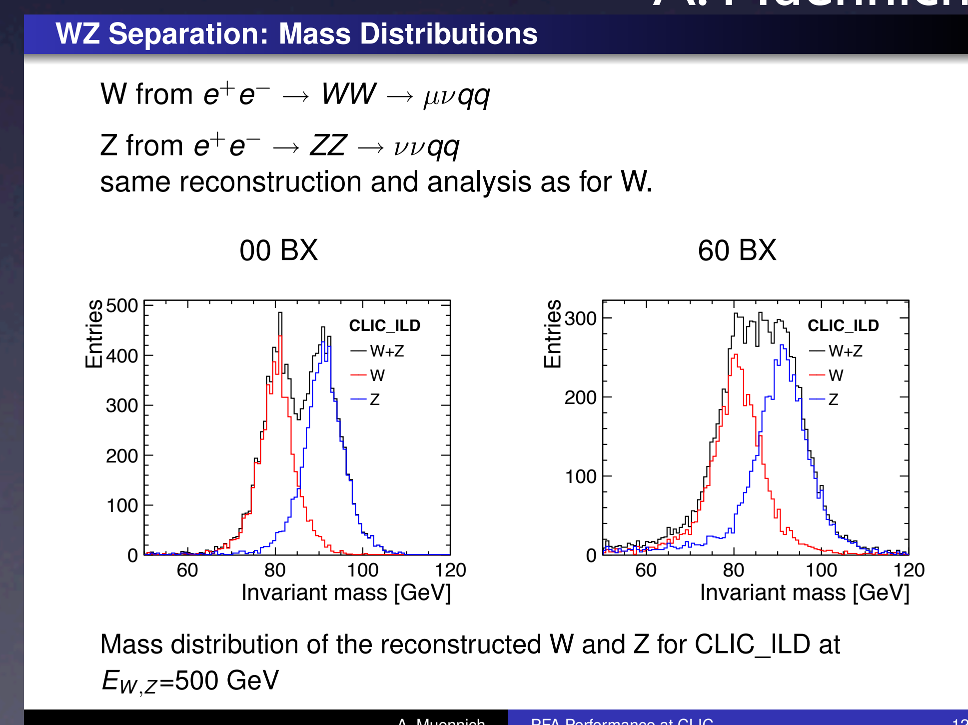




G. Halladjian



A. Muennich



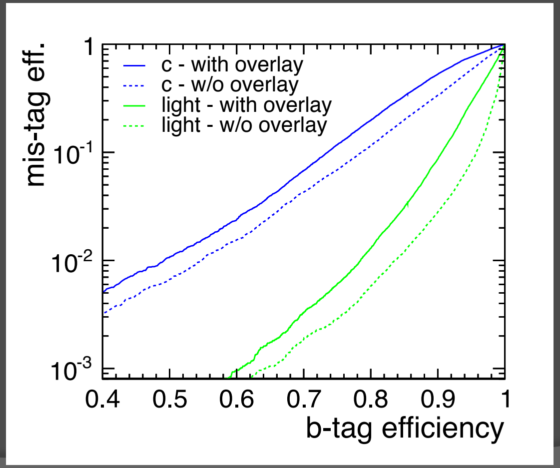
Improvements in PFA algorithms; lepton ID. Performance studies for CLIC.

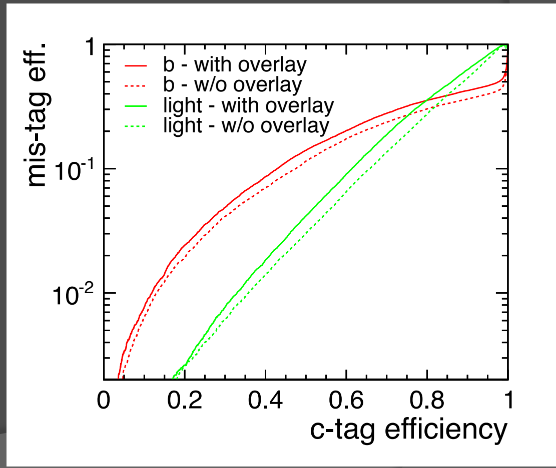
flavor tagging

J. Strube

Light Higgs decays to bottom and charm

- Mean energy of Jets 130 GeV
- Using FastNN for training
- Additional track-based variables used in additional step
- b and c(!) tagging



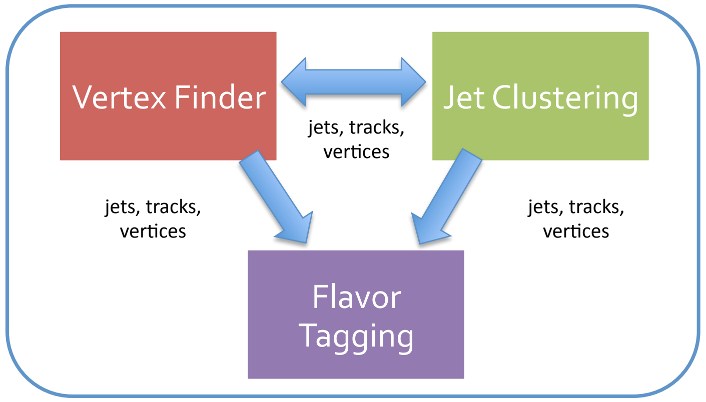


Jan Strube - LCWS2011 13

T. Tanabe

LCFIVertex framework

- improvements in **vertex finding, jet clustering, flavor tagging** in a unified way
  - creation of a new framework suited to this task
    - data types: event, track, neutral, mcparticle, jet, vertex
    - algorithms: vertex finding, jet clustering, flavor tagging

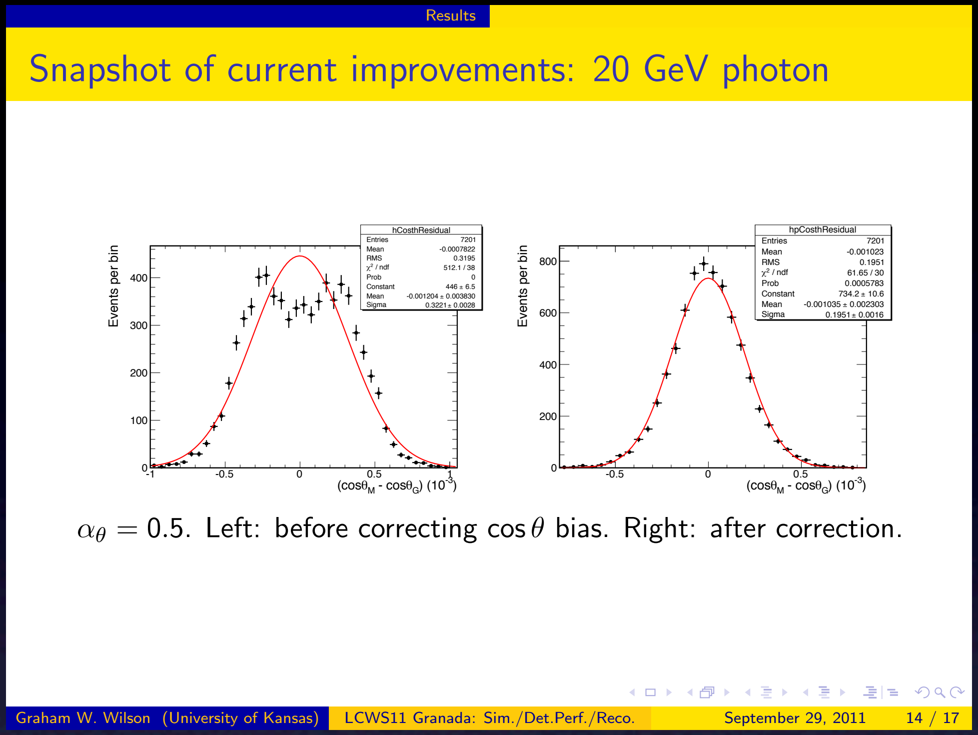


T. Tanabe 10

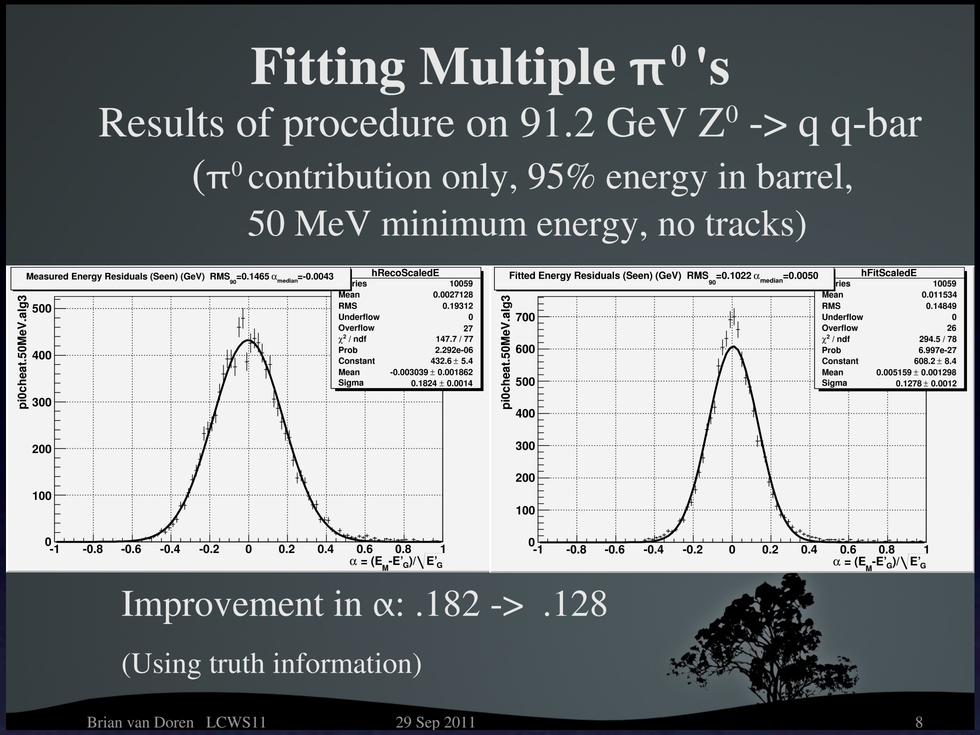
On-going effort to improve flavor tagging.

particle reconstruction

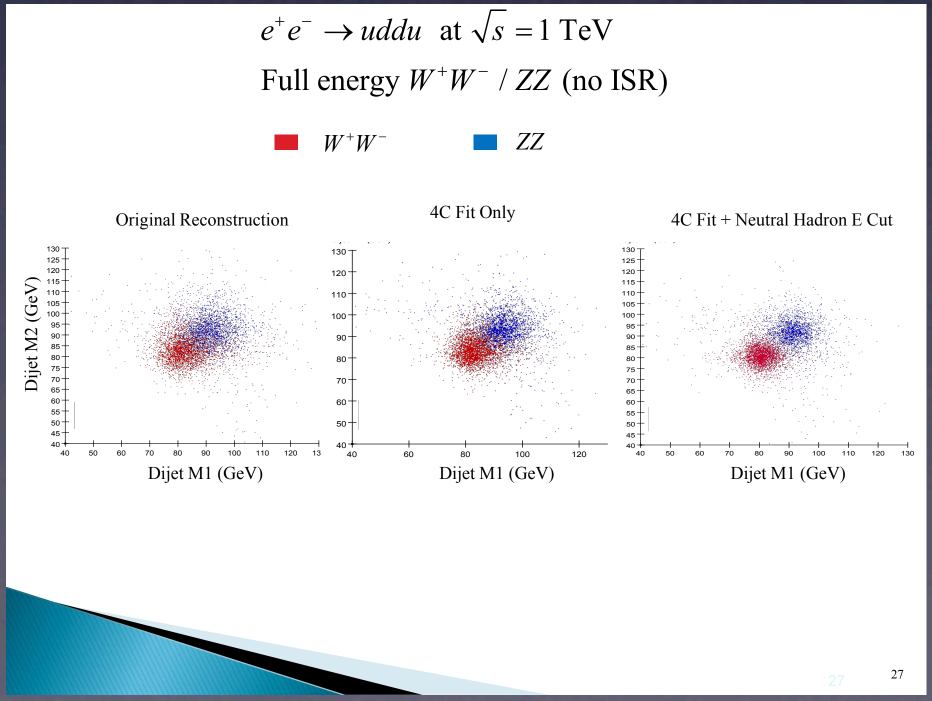
G. Wilson



B. van Doren



T. Barklow



Shower fitting improves calorimeter measurements.
Constrained fits improve pi0, W/Z resolution.

- Tremendous amount of progress made (mostly) driven by
  - CLIC CDR
  - DBD for ILD & SiD
- Keep up the good work!