2002: organization of a dedicated “Detector Performance Group”

working group within the ECFA-LC workshop

regular presentations to the LC workshop at general meetings

small intermediate working meetings

current conveners:
- Markus Schumacher, Bonn
- Pascal Gay, IN2P3
- Mark Thompson, Cambridge
- Nicolo de Groot, Bristol/ Rutherford

Goal:
Review the overall detector design, identify area of concern
Optimize the overall detector design
Study specific questions (e.g. crossing angle...)
Contribute and steer development of central tools

(see talk by M. Schumacher in Cornell ALCPG meeting)
Activities

Look at the overall detector concept
(Europe: large detector model)

Montpellier: “Devils advocate talk by J.E.Augustin

- tracking: is the gaseous tracker concept the best?
- vertexing: what performance is really needed?
- calorimeter: optimal detector configuration?
  optimal connection to the rest of the detector
- globally: how do we optimize a detector for particle flow?
- Are there machine-technology dependent issues?

This talk: review status, with particular emphasis on tools to do the job
Vertex Optimization

Number of layers?

Inner radius of beampipe?

little effect for b-tagging

some effect for c-tagging.

Impact on physics?

other questions to be asked:
  background sensitivity?
  pat rec stability?
  VTX detector stand-alone performance?

Tools: b-tagging available in SIMDET and BRAHMS, analyses are available
Tracking

current EU default:
- large volume gaseous tracker (TPC), supplemented by 2 layer of SI tracker (SIT)
- possibly additional SI layers outside the TPC

Reasoning:
- prejudice: many point == stable, efficient pattern recognition
- prejudice: tracking very close to the beam is susceptible to background problems
- prejudice: “strong” particle ID is important benefit for many analyzes
- prejudice: dedicated PID detector is more trouble than it's worth

- many 3D points: TPC
- stand-alone tracking in at least 2 devices: TPC and VTX
- particle ID through dE/dx in TPC

Is this reasoning correct?
- stable SI-only pat rec is possible!
- background? Is this an issue?
- is particle ID really needed?

most importantly:
relation to particle flow: what is best?

Tools: complete tracking available in BRAHMS, optimised though for large detector
**Calorimetry**

**most fundamental statement:**
accept particle flow as fundamental concept for event reconstruction

- granular ECAL (transverse and longitudinal)
- granular HCAL (transverse and longitudinal)
- hermetic

this statement is (currently) not being discussed, but accepted!

(this was done extensively in earlier studies, primarily leading to TESLA TDR)

**Ongoing:**
optimisation of calorimeter geometries (prototypes)

**Tools:**
- first versions of P-flow algorithms available (SNARK, REPLIC)
- first implementation into full reco available

but significant further development is needed for P-flow!
Simulation Comparisons I

Relative energy deposited in the calorimeter sensitive volume: compare GEANT3 and GEANT4 simulations

GEANT3

GEANT4

pion 2 GeV

Electron 2 GeV
correlation neutron energy – energy not reconstructed (neutrinos etc.)

**Tools:** we need to really understand our simulators!

**V. Morgunov**
IR issues

Things to be studied:

- Layout of forward region, impact on physics
- Impact of crossing angle on forward region and physics

Have to define physics goals for forward region:

- Hermeticity?
- Luminosity measurement: required accuracy?
- Polarimetry in the IR region? Before or after IR?
- Energy measurement before / after IR
Crossing angle:

- option for TESLA
- required for NLC (avoid parasitic collisions)

Physics impact:
- crossing angle introduces boost into the event

\[ \alpha_c = 2 \times 50 \text{ mrad} \]

example:
- particle density in the jet increased in the direction of the boost
- no visible effects
Crossing angle and hermeticity

Comparison of energy deposited in forward region

no crossing angle

10mrad crossing angle

(only one charge particles are shown here)

Intrinsically slightly less hermetic detector

Tools: available within both BRAHMS and MOKKA
Crossing Angle

standard example:

VETO in FF region against high E photons/ electrons

SUSY searches

Some effect visible,

but overall effect small

Tools: available (needs fast MC)
Overall Detector Concept

Particle Flow:

- need to seriously optimise a detector for particle flow
  
  optimise the detector, not subdetectors
  really study the interplay between modules

- Focus on
  
  particle separation
  neutral / charged particle separation
  merging

This requires powerful simulation and reconstruction tools!

- High efficiency track and calorimeter reconstruction
- excellent V0 detection (K0, Lambdas, photon conversions...)
- excellent vertexing for particle flow objects
Next Steps

- Get the tools:
  - full / fast simulations
  - a means to create and distribute significant volumes of data
  - reconstruction programs

- Get the people
  - do systematic performance studies
  - do systematic detector comparisons
  - do serious algorithm development

The goal in Europe:

have at the end of the current ECFA workshop (2005) the means available to do the studies, and have first results on some questions.

We should make every effort to join forces as much as possible: duplicating efforts is not needed for most technical issues...
Detector performance group established in Europe since 2002

Main focus: re-evaluate the TESLA (large) detector design

Successful work requires solid simulation and reconstruction tools

Requires very close collaboration between the simulation groups and the detector performance group

For more details on tools available, see simulation session

This is an active and expanding area. We expect interesting results over the course of the ECFA workshop. We are looking forward to also expand our collaboration with the American community.
The current situation:

TESLA detector: example of a large, “conventional” detector
- large volume gaseous and solid state tracking
- high resolution calorimetry
- excellent hermeticity
- redundant subsystems

Is this the perfect solution?

What has happened since the TESLA Detector concept was frozen?

- particle flow: generally accepted, implications better understood
- technological advances in SI tracking
- technological advances in gaseous tracking