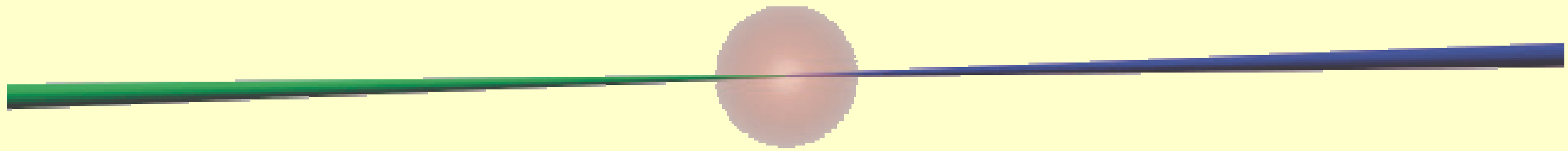


Keystone '98: Tracking Session Summary

I.O.'s: Keith Riles, Dean Karlen,
Chris Hearty

Keystone CO, Sept. 29, 1998

Summary of Tracking Session

- **review of European LC tracking R&D**
- **experience with "prototypes"**
  - ALEPH TPC, SLD DC
- **designs of new systems**
  - CDF, DØ, ATLAS, CMS, CLEO III robots
- **R&D reviews**
  - gas microdetectors, Si readout, diamond, Si drift chamber, TPC, flat panels, CsI
- **Working group planing**

European LC tracking R&D

Ron Settles

- **Studies concentrate on a TPC**
  - recoil mass resolution for Higgs drives need for good momentum resolution
  - high granularity reduces effects of beam backgrounds
  - minimize material to reduce background photon conversions
  - number of R&D projects related to TPC and its readout are in progress

Experiences with “prototypes”

- **SLD drift chamber** Tracy Usher
  - tracks from VTX masks pose difficulties for track trigger
  - SR background is large, 10% occupancy, background bursts trip HV frequently
  - wire breakage can mean long down time
- **ALEPH TPC** Ron Settles
  - no major problems
  - alignment can be challenging

New system designs

- **CDF II** David Gerdes
  - SVX II has 5 layers 2.5 cm < r < 10 cm
  - intermediate silicon layer
  - drift chamber 44 cm < 132 cm
    - **field panels - limit effects from broken wires**
- **DØ** Norman Graf
  - new coil limits volume to r < 50 cm
  - 4 layer Si, r < 12 cm
  - 8×4 layers of scintillating fibers r > 20 cm

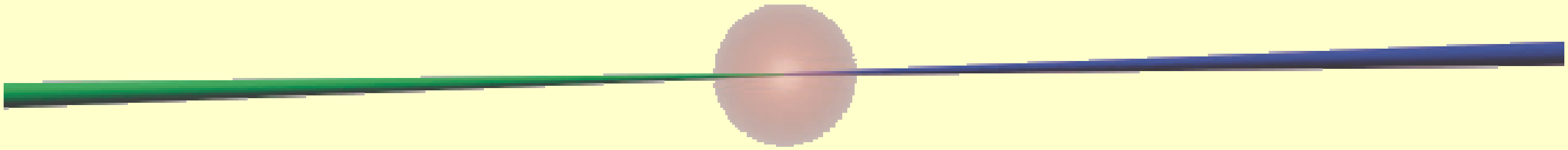
New system designs (continued)

- **ATLAS** Hartmut Sadrozinski
  - Si pixels, Si strips, straw tubes, 0.3 -1 X_0
  - high occupancy in straw tubes (up to 40%)
  - recommendations:
    - **keep FEE and services out of tracking vol.**
    - **use disks in endcap, add Si layer before ECAL**
- **CMS** Muzaffer Atac
  - Si pixels, Si strips, and MSGCs
  - MSGC design not yet proven, possibly combine with GEM

New system designs (continued)

- **CLEO III - robotic chamber stringing**
  - chamber geometry (wedding cake) made human stringing impossible
  - robotic procedure worked well
  - can consider more radical DC designs
    - **very small wire diameters**
    - **very small cell sizes**

Steve Csorna



Detector R&D talks

Gas microdetectors R&D

Madhu Dixit

- **MSGCs born 11 years ago**
  - very active research area
  - many variants of the design
  - HERA-B and CMS tracking
- **problem:**
  - discharges and shorts in test beams
    - not seen in lab tests
    - now understood - non quenched streamer mode induced from cathode
    - CMS coats edge of cathodes

Gas microdetectors R&D (cont.)

- **GEM:**
  - 50 μm thick kapton metalized with 5 μm gold and perforated with micro holes
  - can be used alone or as a multiplying stage for a MSGC
- **microdot**
  - pixilated form of MSGC, good performance
- **micromegas**
  - micro mesh just above strips

Gas microdetectors R&D (cont.)

- **Remaining problems**
  – heavily ionizing particles will limit gains in such detectors (except μ-dot) to 1500-2000
    - **not much room for error**
  – aspect ratio gives poor performance for tracks incident > 10° from perpendicular
    - **possible solution using CsI coatings…**
    - **not a problem for use in TPC readout**

CsI for tracking

John Kadyk

- **replace 3mm gas gap in MSGC with a 400 μm thick columnar CsI layer**
  - high efficiency secondary electron emission, actual gain in CsI itself
  - hit efficiency no longer depends on incident angle
- **enough electrons from CsI itself… MSGC is not required!**
  - 1-2 % X_0 per layer, not small

Flat panel displays

John Kadyk

- **Active Matrix Arrays**
  - commercially available (displays, imagers)
    - **100×100 μm^2 pixels over 50×50 cm^2 area**
  - 50×50 μm^2 pixels possible
  - readout speed needs to be improved… expect that 10 ns/pixel easy to achieve
  - fast reset possible: 10 ns
  - costs are dropping rapidly

Silicon readout R&D

Bruce Schumm

- **many issues needing study**
  - turning off electronics between NLC trains
  - maximize S/N - allowing thinner detectors
  - optimize timing resolution - remove background hits from other bunch crossings
  - improve spatial resolution - charge spreading from Lorentz angle
- **estimated cost for study: $60 - 100K**

Diamond detectors

Hans Ziock

- **why diamond?**
  - large bandgap : 5.5 V
    - **dark current minimal**
  - fast signals, radiation hard
- **disadvantages**
  - 13 eV / e-h pair (3.6 for Si)
  - 3600 e-h / 100 μm (9200 for Si)
  - 4500 e-h / 0.1 % X_0 (8900 for Si)
- **not an obvious match to LC needs**

Silicon drift detectors

Sanjeev Pandey

- **operates like a very thin TPC**
  - drift time gives z coordinate, segmented anode gives transverse coordinate
  - pixel-like detector with low number of readout channels
  - 20 μm resolution easily achieved
- **part of STAR / RHIC**
  - 216 SDD wafers, 104 K channels
  - now in production

Silicon drift detectors

- **prototyped in E896 (Au+Au at AGS)**
  - good performance in high B field (6.4 T)
  - work well at room temperature
- **R&D issues for NLC**
  - improve position resolution to 5 μm
  - reduce thickness from 300 μm to 150 μm
  - larger wafers for longer drift distance, smaller number of channels
- **expertise available after STAR complete (summer 2000)**

TPC R&D

Mike Ronan

- STAR / RHIC tracking by TPC
  - <n ch> = 2500 !
  - front end electronics on endplate, signals transmitted by fiber
    - allows high granularity readout
- LC R&D issues:
  - detector simulations
  - software development
  - chamber design
    - gas, field cage, readout device and geometry

Detector R&D summary

- **very interesting session**
- **many detector techniques are viable candidates for LC tracking**
  - makes specifying options for “L” and “S” detectors that much more difficult
  - simulation used to reduce choices?
  - difficult to begin intensive R&D on a technology until odds of it being used look good

Tracking group plans

Keith Riles

- **Short term goals (few months)**
  - prepare to submit R&D proposals
    - **try to coordinate submissions, joint submission would be ideal**
  - set up tracker simulation infrastructure

- **Medium term goals (year)**
  - carry out simulation studies
  - initial winnowing of tracker options

Tracking group plans

- **R&D proposals**
  - for 1st year, concentrate on simulation
  - detector R&D needs to be specific to LC
  - ask for proposal abstracts from interested groups (about 1 month from now)
  - use abstracts to decide
    - **joint submission or individual**
    - **latter case requires some general recommendations document**
    - **try to minimize overlap of R&D proposals**

Tracking group plans

- **Simulation infrastructure**
  - request technology advocates to provide realistic hit simulation over next 2 months
    - **incorporate into LCD framework**
  - fallback is track parameterization
  - have some volunteers already
- **pattern recognition and fitting**
  - TRF++ (DØ) looks promising
  - may have volunteer for this

Tracking group plans

- **some homework to do:**
  - M. Peskin's list
  - forward tracking for lumi(E_{cm})?
  - intermediate system needed for "L" detector?
  - 2 track separation (θ and ϕ)
  - vertex-mass reconstruction (b/c disc.)
  - requirements of dE/dx
  - "L" option: special tracking layer at tracker/ ECAL boundary.

Conclusion

- **tracking working group sessions had very full and interesting programme**
  - and was well attended
- **large number of questions to be answered**
  - little manpower available to answer them
- **please consider joining the effort and signing up for one of the homework problems!**