Triggering, Data Acquisition and Computing

SSC Detector Parameters

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Introduction

The purpose of this brief note is to present some assumptions about detectors for the Superconducting Super Collider (SSC) that might be useful in studying the triggering, data acquisition and computing problems associated with the detectors. These assumptions were used as input at the Workshop to provide a common basis for the working groups.

Relevant SSC Parameters

The following parameters were used in the discussions:

- Beam energy: 20 TeV
- Design luminosity: 10^{33} $cm^{-2}sec^{-1}$
- Inelastic cross section at 40 TeV: 100 mb
- 10^{8} inelastic interactions per second at the design luminosity
- Bunch spacing: ~30 ns ie. 3 interactions per crossing at the design luminosity. Very recently (after the Workshop) this has become "no less than ~15 ns". (D. Groom private communication).
- rms bunch length: 7 cm.
- Transverse rms size of collision region: 7μ.

4π Detector Parameters

Some representative parameters for a possible 4π detector at the SSC were given to the Workshop participants. The list below is neither complete nor does it reflect the many possible variations possible for different 4π detector configurations. The values merely represent useful guidelines.

Calorimetry (EM + Hadronic)

- Cover $|y| < 5.5$ hermetically

- $\Delta y = \Delta\Phi = 0.04$ on average. In reality the segmentation in the electromagnetic part of the calorimeter is typically taken to be half that in the hadronic part.
- Three longitudinal segments.
- These parameters believed to be luminosity independent-determined by physics needs.
- Number of elements: 150,000
- Number of electronic channels: 300,000 (2 for each element).

Charged Particle Tracking

- Sign determination in the TeV range for electrons and muons
- Number of elements (e.g.wires) in central tracking is luminosity dependent. Set by survival at the design luminosity.
- Number of elements: 175,000.
- Number of electronic channels: 175,000-350,000.

Muon System

- Also hermetic coverage-ideally also $|y| < 5.5$
- Muon trigger must be P_T sensitive
- Number of elements: 100,000
- Number of electronic channels: 200,000.

Total Number of Electronic Channels: 675,000-850,000.

Questions

As part of this introductory talk a number of questions were asked to be answered at the Workshop. These included

- what are the trigger rates as functions of the
  - number and minimum energies of jets
  - number and minimum energies of electron candidates
  - same as above for isolated candidates
  - number and minimum P_T of muons
  - magnitude of missing E_T
  - combinations of the above eg. muons and jets

- what is the approximate time scale at each level of a trigger system?
- how much of the trigger is analog and how much digital?
- how much data per accepted event must be stored - what is the event size? Crude estimates suggest that the event size $\leq$ Mbyte.
- what is the average data flow rate at various levels in the data acquisition system?
- how much data filtering can be or must be done before permanent data storage? How much should be done "on" the detector?
- are existing bus standards adequate?
- should permanent data storage be done at each experiment or at a central facility?
- what offline computing capacity and capabilities are required?
- what are the technical and organizational requirements for software development?

Workshop Goals

A summary of the major Workshop goals includes:

- quantitative estimates for trigger requirements and the resulting rates for interesting and background physics processes;
- development of models for
  - fast analog triggers
  - higher level triggers
  - special trigger processors
  - data filtering and acquisition systems
  - offline computing requirements including software development