Experimental techniques in particle physics, PBL 2.

One possible property of a Quark Gluon Plasma is a copious content of strange quarks. This comes about as an effect of the Pauli principle, blocking formation of u and d quarks, favoring creation of strange quarks, in spite of their larger mass. The expected experimental signature would be enhanced production of particles with non-zero strangeness. An observable, particularly sensititive to the s quark density of the plasma, would be the production ratios between particles with different number of s-quarks in central and peripheral heavy ion collisions, compared with the corresponding production ratios in pp collisions at the same energy per nucleon pair.

Sketch a realistic collider experiment for determining these ratios at mid rapidity.
The experiment is interesting to perform at different collision energies, from RHIC energy to LHC energy.

The focus is on detectors and how they work. Different alternative detector solutions should be described and evaluated against each other. Limiting factors should be identified and discussed.

You have no time to do simulations. But if you identify a simulation need, take a note and keep a list it for later in the course.

Literature list:

Author	Title
Fernow	Introduction to experimental Particle physics
Knoll	Radiation Detection and Measurement
Wigmans	Calorimetry
Ferbel	Experimental techniques in High Energy Nuclear and Particle Physics.
Flyckt	Photomultiplier tubes and applications
Leo	Techniques for Nuclear and Particle Physics experiments
Särtryck	Review of Particle properties, Phys. Lett
Green	The physics of particle detectors
Bock & Vasilescu	The particle Detector Briefbook
Kleinknecht	Detectors for Particle Radiation
Littauer	Pulse Electronics
Grupen	Particle detectors (blå paper cover)

Teachers instructions:

The students must first decide which particles to study in order to study the production ratios between particles with different. This ends up in the cascade baryons (Ω,Ξ,Λ) which all decay by weak interactions, i.e. with observable secondary vertices. They should find out which decays are best to use and motivate the choice.

So the students should design a system, which allows detecting secondary vertices, measure momenta and identify the decay products (reconstruct invariant mass). They should analyse what the aperture of the detection system needs to be and what limitation the proposed system will have. They should motivate the choice of detectors and be able to describe the function.

At the end, they should also, work through what corrections they think they have to apply to the measured spectra and to what extent the study of ratios is simpler than absolute measurements.

Detailed learning goals in key words.

- Magnetic field
  - Solenoid, Dipole
  - Mapping & monitor B-field
  - Stray field
- Vertex tracker
  - Primary Vertex detector
  - Detecting Decay vertex primary & secondary
  - Si strip, Si pixel, Si Pad, Si drift
- Gaseous tracker
  - Drift chamber, TPC
  - Avalanche techniques
  - MWPC, straw tube, GEMs

- Time of flight
  - Plastic scintillators
  - Photomultiplier
  - RPC (resistive plate chambers)
  - Correlate with momentum
- Cherenkov
  - Quartz, Gas, ice, water Cherenkov radiator
  - RICH
  - detecting RICH rings (PM or CsI cathode + gas chamber)
  - Role in particle ID
- Particle identification
  - Calculate mass squared from TOF and momentum

Threshold Cherenkov counters
Ring diameter for velocity
Calculate invariant mass in 2-particle decay
Event mix for background