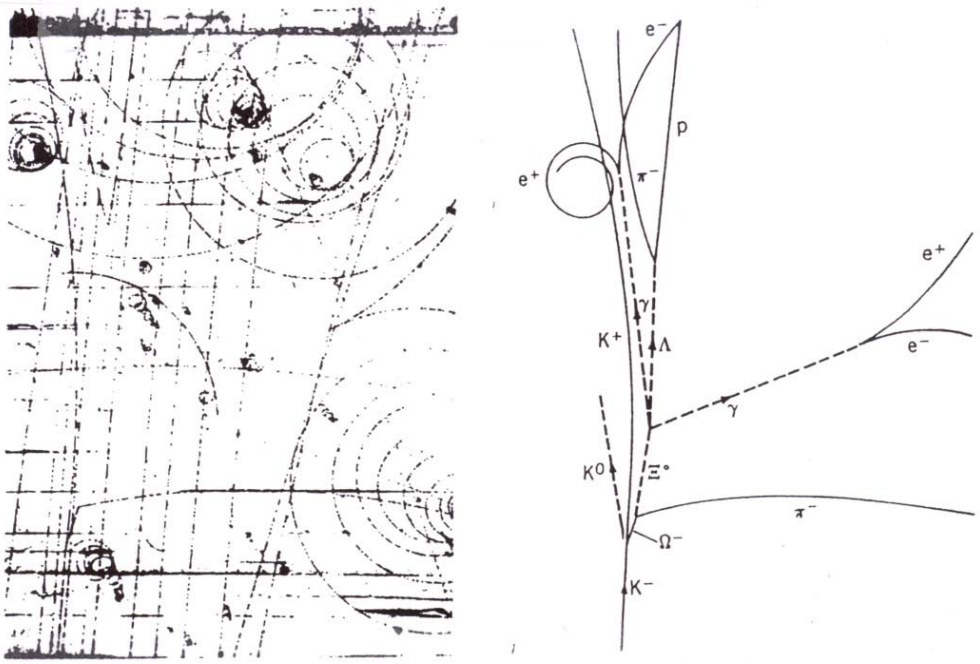
Experimental techniques in particle physics. PBL4



Visual track detectors were very important in the early years of particle physics. Many of the decays listed in the PD-booklet were mapped out from bubble chamber pictures like the famous one above where the Ω^- baryon, produced in a K^- beam, was observed for the first time. Evidently such photographs were very informative. Hundreds of scanners worked hard, year in and year out, at CERN and at Universities to sort out interesting events and then do quantitative measurements on the tracks. The measurement on a track was tedious could take several minutes. It involved determining the curvature of the track and bubble counting.

The last big bubble chamber at CERN, BEBC, was dismounted in the beginning of the 80's after having produced 6.3 million photos. By then, this manual acquisition of experimental data could no longer match the requirements of the physics phenomena to be produced.

In fact, in the LHC experiments, the outstanding performance of the technical replacement of the scanning personnel, is necessary for reaching the physics goals in sensitivity and resolution.

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 partcile Detector Briefbook
Kleinknecht	Detectors for Particle Radiation
Littauer	Pulse Electronics
Grupen	Particle detectors (blå paper cover)

Teachers instructions:

This cycle deals with the electronic processing of detector information, both on the level of an individual charge signal from the detector and on the event level when events of interest are selected on microsecond timescale for assembling full events stored to the disc.

The PBL problem contrasts dramatically with the sensitivity of present days electronic experiments as the total amount of analysed BEBC photos over many years of datataking was of the same order as the number of collisions which ATLAS rejects per second in order to find the events of interest.

The key issue is that the student should understand how the use of electronic information processing, allows to produce rare physics phenomena and to find the needle in the haystack by filtering out those interesting physics events, by the online trigger.

For the events of interest, the chain of analog and digital processing of detector signal is followed from detector to harddisc. By the power of present days electronic readout, a collision can be fully characterized in milliseconds in contrast to minutes in the visual track experiments.

Detailed learning goals in key words.

Charge to voltage preamp.
Noise sources

- Shaping amplifier
  - Shaping time
  - Ballistic deficit
- Analog storage
  - Long cable
  - Switched capacitor
- Digitization
  - Flash ADC
  - Successive approximation ADC
  - TAC, TDC
- Customized readout Front End electronics
  - Analog ASICs
  - Digital ASICs
- Programmable Logics
  - FPGA
  - PAL
- Slow controls
  - Download firmware
  - Configure ASICs (e.g. discriminator thresholds)
  - Protect equipment
  - sensors
  - microprocessors
- Trigger filtering
  - 1^{st} level
  - 2^{nd} level
  - 3^{rd} level
- Data reduction
  - Multiplexing
  - Zero suppression
  - Formatting of data
- Data collection architecture
  - Sub event builders
  - Event builder