Hadron Calorimeter (HCAL) for SBS

- *Viability of the proton detection system depends on the trigger configuration.*
- *Coincidence between BigCal and HCAL for ep elastic scattering.*
- *Calorimeter's cell dimensions are determined by coincidence requirement.*
- *Energy deposited in HCAL above a trigger threshold ($\sim$4 GeV) determined by the proton energy and calorimeter resolution.*

Calorimetry Considerations

- *Calorimeter of the general type - (absorber+scintillator) layers.*
- *Very large fluctuations in hadronic and electromagnetic showers $\Rightarrow$ large fluctuation in fraction of the initial energy deposited as detectable energy.*
- *Slowing down the initial shower and detecting its charged component by (Fe or Pb) and plastic scintillator layers.*
- *Fraction of the total energy of the initial particle measured from light in the scintillator.*
- *Typical calorimeters for protons should have a thickness of $\sim$ 4-6 λ_{int} for the hadronic component and $\sim$12-25 X_0 for the electromagnetic component.*
- *Ideal calorimeter:*
  - *Same response for e and p.*
  - *Response increasing linearly with incident energy.*
  - *Should be 100 % efficient.*
  - *Spatial resolution of $\sim$1-2 cm.*

COMPASS Calorimeter HCAL1 as SBS HCAL

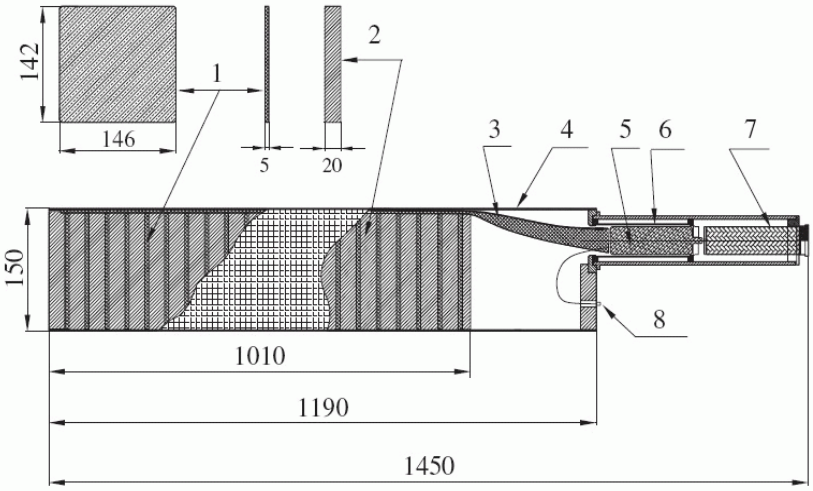

Fig. 48. Structure of the HCAL1 module: 1, scintillators; 2, iron plates; 3, light guide; 4, container; 5, PMT; 6, PMT magnetic shielding; 7, Cockcroft–Walton divider; 8, optical connector for LED control. Dimensions are in mm.

- *Calorimeter consists of 480 modules.*
- *Single module has 40 layers of (Fe+Scintillator) plates.*
- t_{Fe} = 20 mm and t_{Scint} = 5 mm.
- *Cross sectional area of the plates* = 142×146 mm^2.
- *Active usable area* = 10.8 m^2.
- *Light collected by 1.2 m long WLS fibers.*
- *Active length of a single module* = 1.0 m (4.8 λ_{int}).

HCAL1 Performance and Resolutions

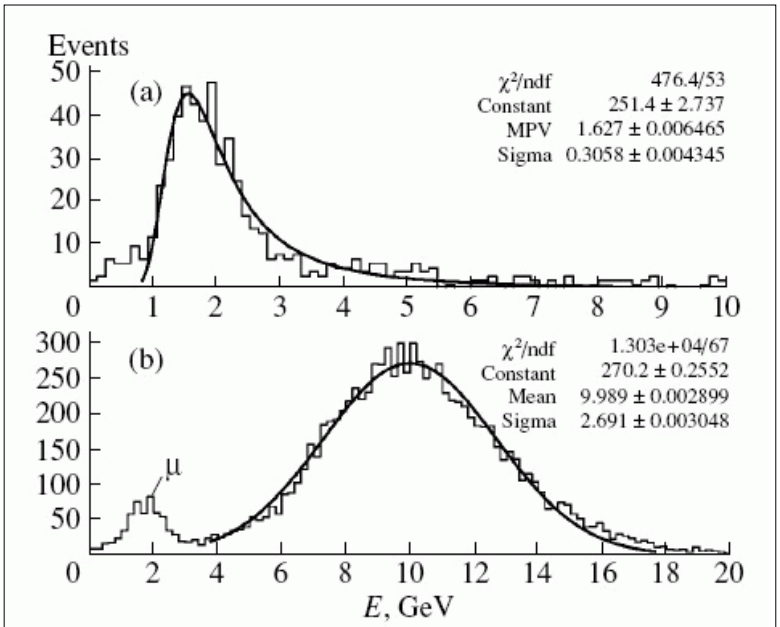

Fig. 6. Spectra of the energy deposited in a matrix of modules by (a) muons and (b) pions and muons at a beam energy of 10 GeV.

- *Linear response as a function of particle energy.*
- *Good energy and position resolutions.*

$$\frac{\sigma_\pi(E)}{E[GeV]} = \frac{59.3 \pm 2.9}{\sqrt{E}} + (7.6 \pm 0.4)\%$$

$$\frac{\sigma_e(E)}{E[GeV]} = \frac{24.6 \pm 0.7}{\sqrt{E}} + (0.7 \pm 0.4)\%$$

$$\sigma_{x,y} \sim 15 \text{ mm}$$

$$\left\langle \frac{e}{h} \right\rangle \sim 1.2 \pm 0.1$$

HERA-B Calorimeters as SBS HCAL

- *Electromagnetic calorimeters (ECAL) for HERA-B experiment.*
- *Inner, middle and outer ECAL sections.*
- *Construct HCAL from middle and outer ECAL modules.*
- *Single module has 37 layers of (Pb+Scintillator) stack.*
- t_{Pb} = 3 mm and t_{Scint} = 6 mm.
- *Cross sectional area of a module* = 112×112 mm^2.
- *Need to increase the thickness of Pb plates such that the* $\left\langle \frac{e}{h} \right\rangle$ *ratio is close to 1 for larger proton energies.*
- *Light collected by WLS fibers.*