# Counters around the Target

## Purpose of the Counters

- beam definition
- decay tagging of hypernuclei
  - background from in-flight $K^-$ decay
    - $\mu^-$ and $\pi^-$ from $K_{\mu 2}$ and $K_{\pi 2}$ decays
  - most of decay particles are detected due to wide acceptance of 48D48 spectrometer
    - S/N ~ 1/100
  - tagging of non-mesonic decay ($\Lambda p \rightarrow np$) of hypernuclei with scintillation counters
    - S/N ~ 10/1
- additional K-beam and scattered-$\pi$ ID's
  - Cherenkov detectors in front of and just after the target
  - minimize decay region of $K^-$
    - normal decay region is from IC1 to FC (about 100 cm in geometry)
    - reduce down to 15 cm
- NaI array for $\gamma$-ray detection
- charge veto for NaI array

# Counter Design

- beam defining counter (BS)

  19mm(H) × 72mm(W) × 10mm plastic scintillator

  viewed by two 3/4” PMT’s
- live target (LC)

  four 17mm(H) × 62mm(W) × 32mm glass cells (1.1mm thickness)

  viewed by two 3/4” PMT’s

  liquid scintillator $^{13}C$ enriched benzene base

  about 10 g/cm$^2$
- decay particle counter (DEC)

  four or six plastic scinttilator, 15 mm

  viewed with single 2” PMT

  above and below the live target

  also absorbers of low energy charged particles
- beam Lucite counter (BLC)

  28mm(H)×150mm(W)×10mm Lucite (n=1.49)

  - also prepare quartz (n=1.458)

  differential type Cherenkov detector

  viewed with two 9/8” PMT’s
- forward aerogel Cherenkov counter (FAC)

  60mm aerogel (n=1.035), 100mm × 100mm

  viewed with single 5” PMT

- NaI array (NaI)
  2.5” $\times$ 2.5” $\times$ 12” NaI(Tl) crystals
  viewed with single 2” PMT
  16 new crystals $\Delta E/E$(FWHM)=8% (@668keV)
    - already have 8 and buy 8 more

  56 old crystals $\Delta E/E$=13%
  two 6$\times$6 (=32) arrays (top and bottom)
- charge veto counter (VETO)
  eight 10mm plastic scintillator
  viewed with two 2” PMT’s
  four modules cover one 6$\times$6 array of NaI

# Layout

- see figures

# Trigger System (proposal)

## Trigger Types

- normal triggers
  - reaction triggers
    - (K, $\pi$), (K, K), ($\pi$, $\pi$)
  - beam triggers
    - K-beam, $\pi$-beam
  - pulser trigger
- new triggers
  - absolute energy calibration of NaI
    - before beam time
    - 9 MeV and 8.5 MeV $\gamma$-ray from $^{58}$Ni(n,$\gamma$)
    - other conventional $\gamma$-ray sources
    - need self trigger (OR of 72 modules)
      - 72 short cables from PMT to NIM bin
      - 72 channels of amplifier (TFA)
      - discriminator + OR module or linear fan-in + discriminator
      - one trigger cable to counting house
  - relative energy calibration of NaI with LED
    - with beam
    - LED array + diffuser + optical fiber
    - need trigger similar with pulser trigger
    - in burst and/or out of burst

energy calibration of reference NaI with source

- $^{22}$Na in plastic scintillator ($\beta$-$\gamma$ coincidence, 100-1000 Bq)
- need coincidence between $\beta$-counter and one reference NaI
- in burst and/or out of burst

# Trigger Rates

| Trigger Type | Rate (trigger/burst) | Down Scale |
|---|---|---|
| (K, p) | 60 | |
| (K, K) | 5 | yes |
| (p, p) | 5 | yes |
| K-beam | 5 | yes |
| p-beam | 5 | yes |
| LED | 10 | |
| reference NaI | 10 | yes |
| Total | 100 | |
| | | |
| NaI self | 800 trigger/sec | yes |