HIBEAM Testbench at Stockholm

Stockholm University

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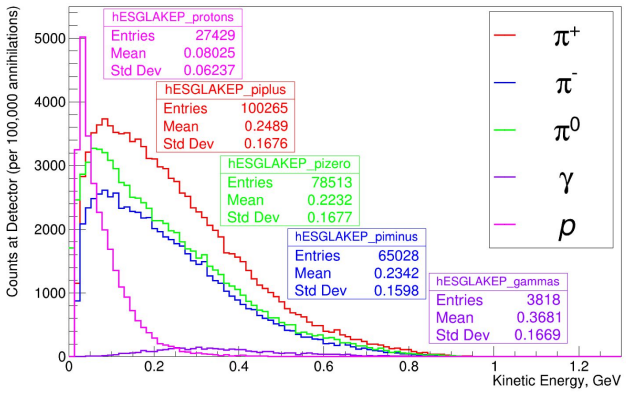
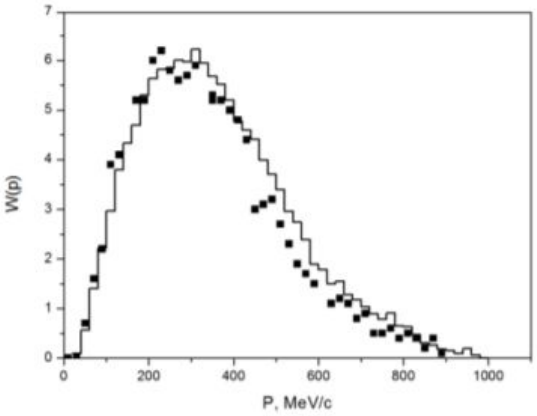
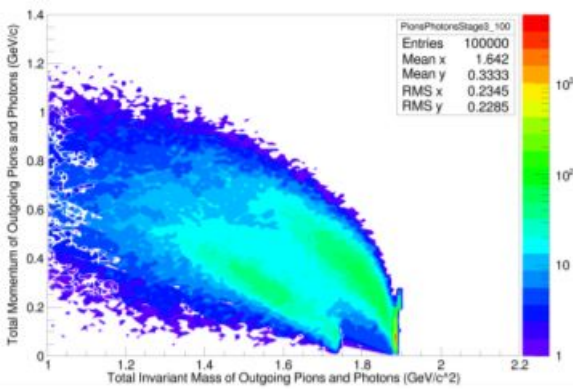
NNbar at ESS Workshop

Dec 2019

Signal







E. Golubeva, J. Barrow, C. Ladd,
Arxiv: 1804.10270

- Signal ~ charged pions and photons (up to ~4) with kinetic energies ~50-400 MeV
- Invariant mass of final state ~1400-1900 MeV

Backgrounds

- >10^10 low energy photons/s from activation of target
  - Pile-up ?
- Cosmic ray bg (charged and neutral)
  - ~3Hz (post veto+timing)
  - Charged and neutral
  - Dominant
- High energy spallation products
- Beta-delayed spallation products
- Nuclear fragments

Activation of ILL carbon target.

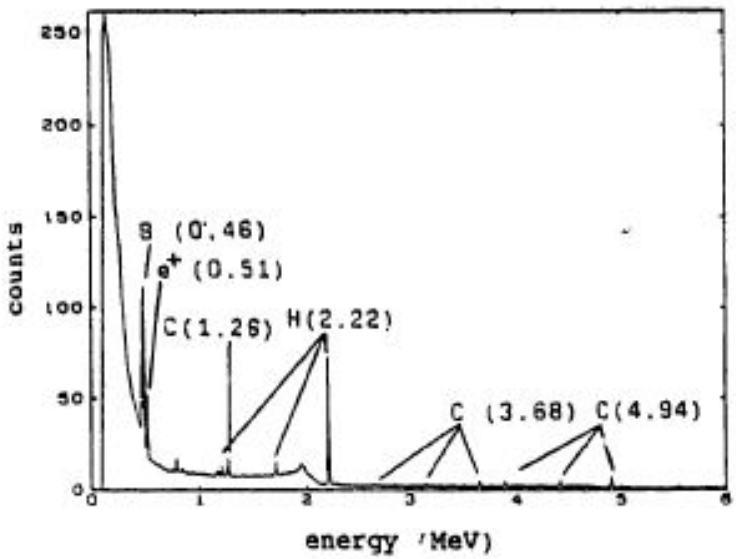


Fig. 3. Prompt neutron capture gamma spectrum of the $n\bar{n}$ target measured with a Ge (HP) detector. The primary gamma ray energies are given in parentheses (in MeV). The boron peak comes from the B_4C neutron shield, see fig. 1. No target impurities other than hydrogen contribute visibly to the spectrum.

What's happening now?

- Stockholm group: D. Milstead, S. Silverstein, K. Dunne, + another PhD student (search ongoing)
- Bidding for faculty money for test bench
- Right now we're trying to work out what the most useful test set-up would be (hence this talk!)

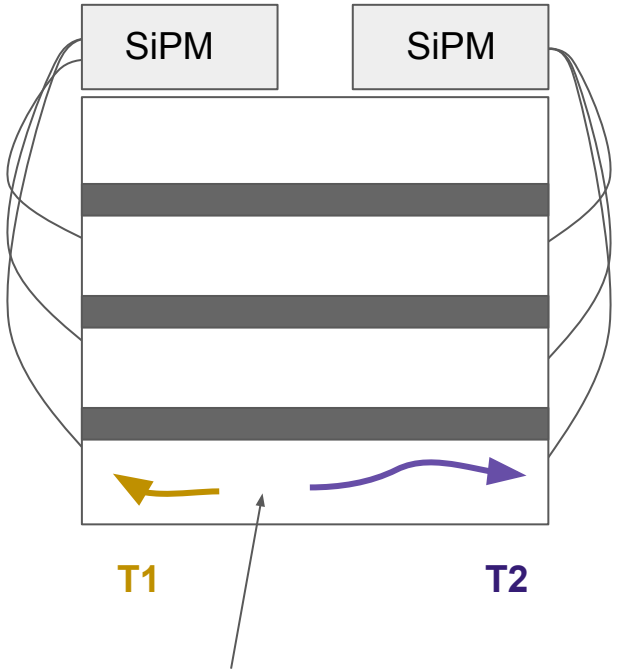
    -> construction could begin April 2020

Calorimeter Practicalities

- Sampling calorimeter
  - Materials Simulations to be done before deciding on geometry
  - Al-scintillator ?
  - What segmentation needed to reduce to ~1 event per cell?
  - Lead-glass ?
    - Blind to low energies and suited for us ?

What can usefully be measured?

- Characterise prototype section of a calorimeter specific to the our signature with different sources and test-beam
- Determine response to backgrounds
  - Various sources, eg gamma, in house
    - Lund neutron source
    - Controlled, large flux, reference detectors for n's.
- TIming studies
  - Ability to discriminate cosmic rays vs signal
  - Sensitivity to pile-up
- Measure energy resolution
- Measure Position resolution
- Validate detector Geant simulations
- Test proposed readout scheme (more next slide)
- Ideas very welcome!



Self-Triggered Readout

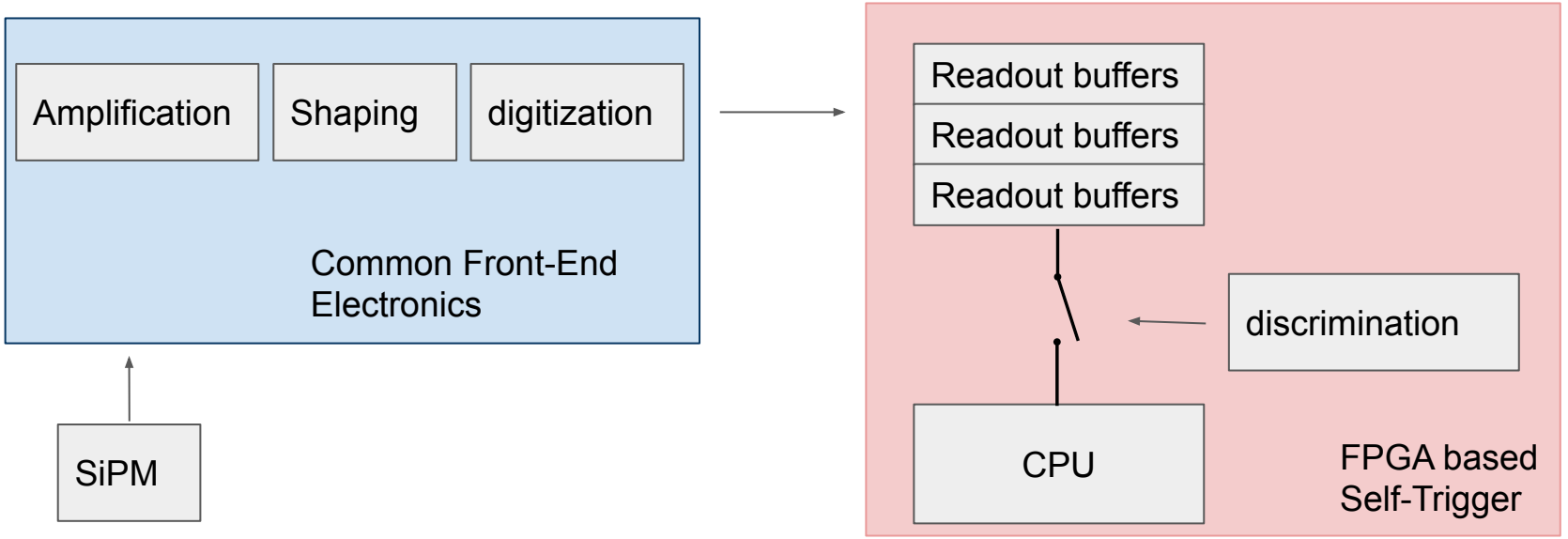
Assuming simple **trigger on energy threshold** in calorimeter

Challenge

- continuous beam with events (and backgrounds) at arbitrary times
- not typical collider environment with events e.g. every 25 ns

Solution

- Readout individual time stamped hits
- FPGA based back-end interfaced to front end electronics common to all sub-detectors
- Allows development of front-end electronics separate from trigger scheme



Simulation

- Using NNbarX developed by A. Reid, R. Pattie, M.Beckhard, A. Young
- Simulation of detector segmentation / pile up / fake rates crucial before determining geometry
- First steps:
  - Cosmic rays - using CRY generator
  - Use annihilation generator as input
  - Replicate results using experiment at ILL geometry