SANE

Spin

Asymmetries

of the

Nucleon

Experiment

SEEN THROUGH THE EYES OF JOHN GERMAN
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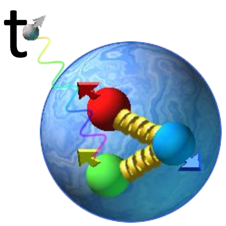
A&T STATE UNIVERSITY.   JUNE 2010

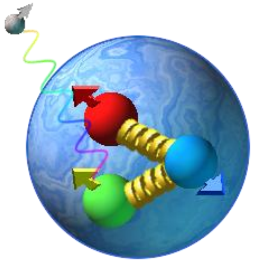
OVERVIEW

- Measure the moments of the deep inelastic scattering polarized structure functions $g_1(x,Q^2)$ and $g_2(x,Q^2)$ for $x=0.3<x$ Bjorken<0.8 and $2.5<Q2<6.5$ GeV^2 for protons.
- In addition to the spin structure functions g_1 and g_2, we also want to measure the physics asymmetries A_1 and A_2.
- We would also like to use our measured g_2 to study quark-gluon correlations/interactions.
- Goal is to learn all we can about proton SSf's from an inclusive double polarization measurement



METHOD

- Measure inclusive spin asymmetries for two orientations of target spin relative to beam helicity (anti-parallel and near-perpendicular)
- The technique is double polarization inclusive scattering (mentioned previously). The target polarization is relative to the beam direction. More specifically the perpendicular orientation is horizontal, meaning that it is still in plane with the beam.

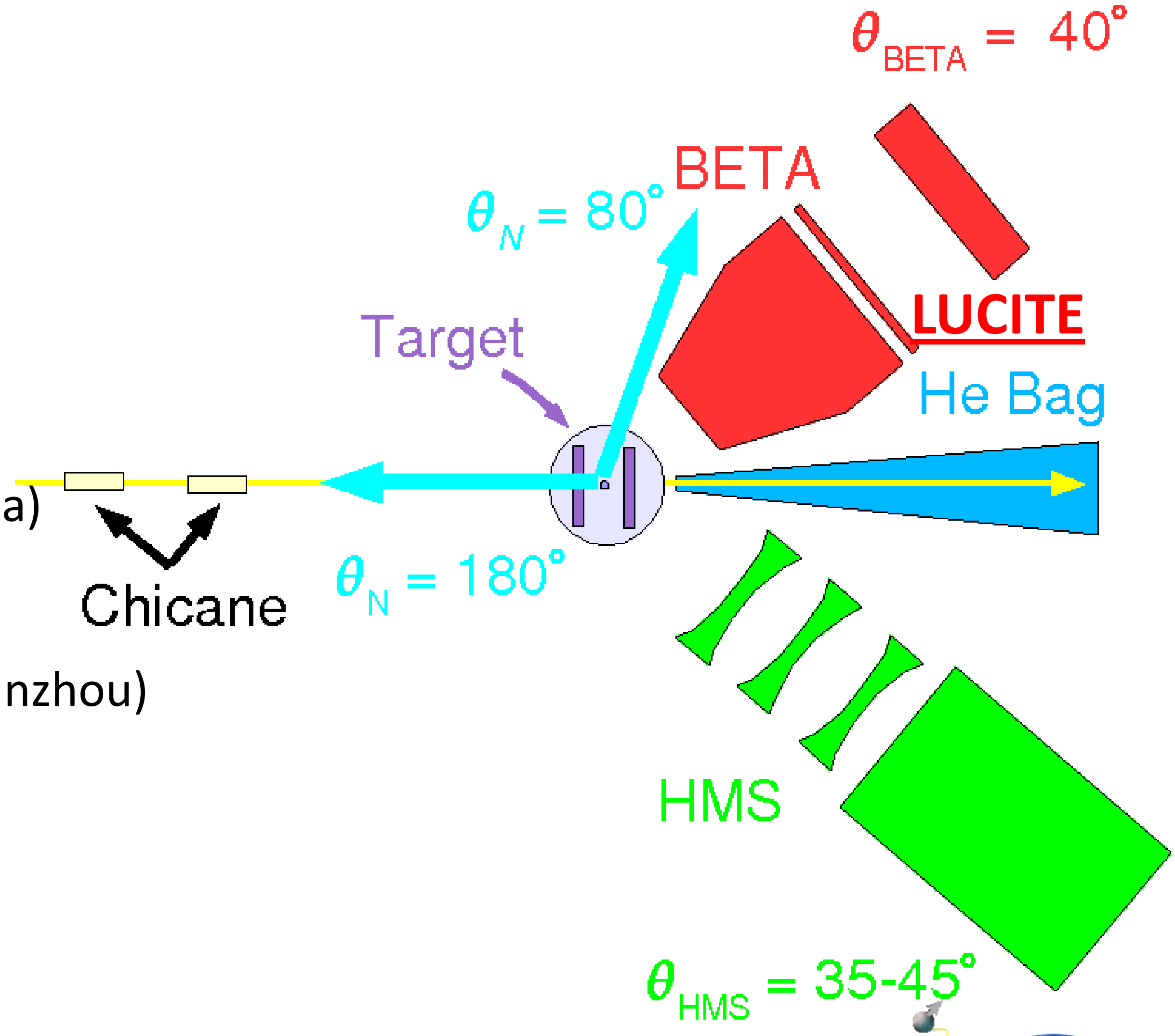


Target:
- Polarized NH3 target (UVa)
- 5T field

Beamline:
- Chicane
- Helium Bag (Mississippi State)

Electron Arm:
- Tracker (Nofolk State U., Regina)
- Cerenkov (Temple)
- Lucite (North Carolina A&T)
- BigCal (IHEP Protvino,W&M,Lanzhou)

Other Physics:
- HMS detector



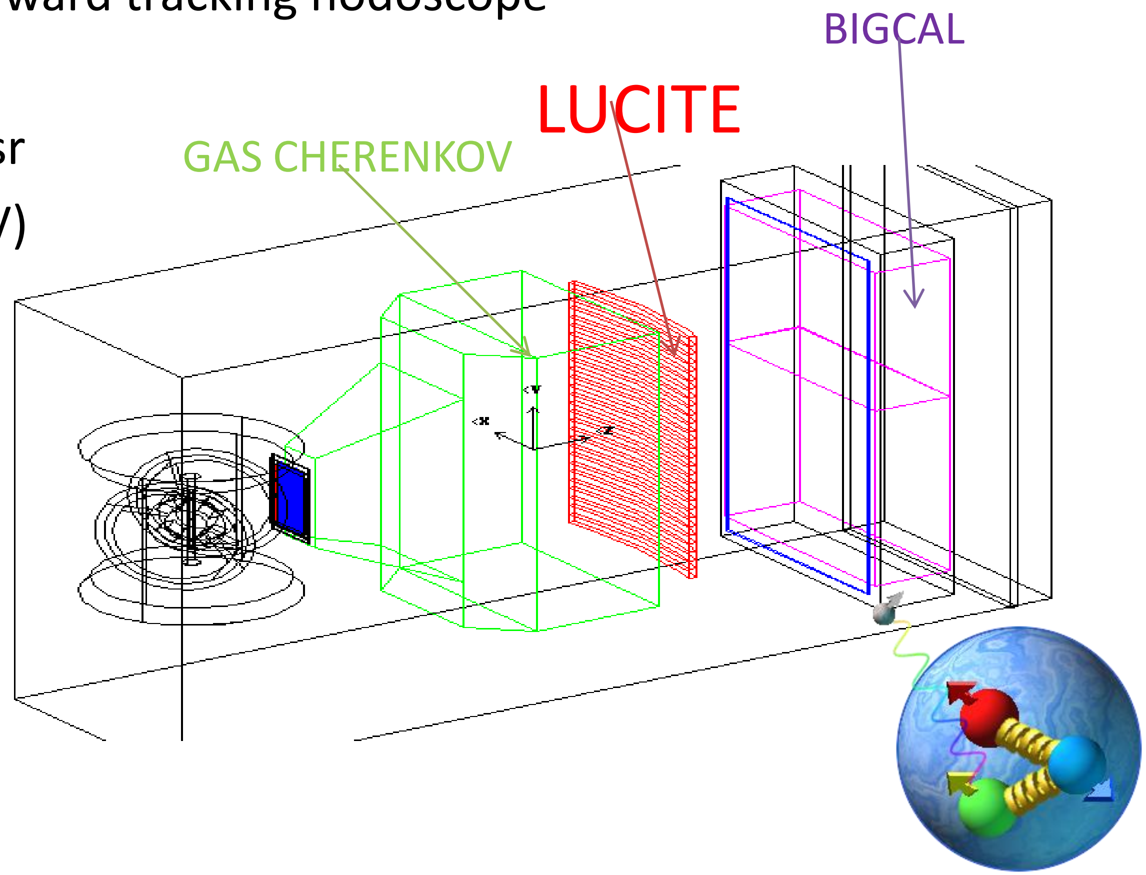
SANE LAYOUT

COMPUTER SIMULATED VIEW OF BETA

Big Electron Telescope Array

- BigCal lead glass calorimeter: main detector, being built for Gep-III
- Gas Cherenkov: main pion rejection
- Tracking Lucite Hodoscope
- Tracking fiber-on-scintillator forward tracking hodoscope
- BETA's characteristics

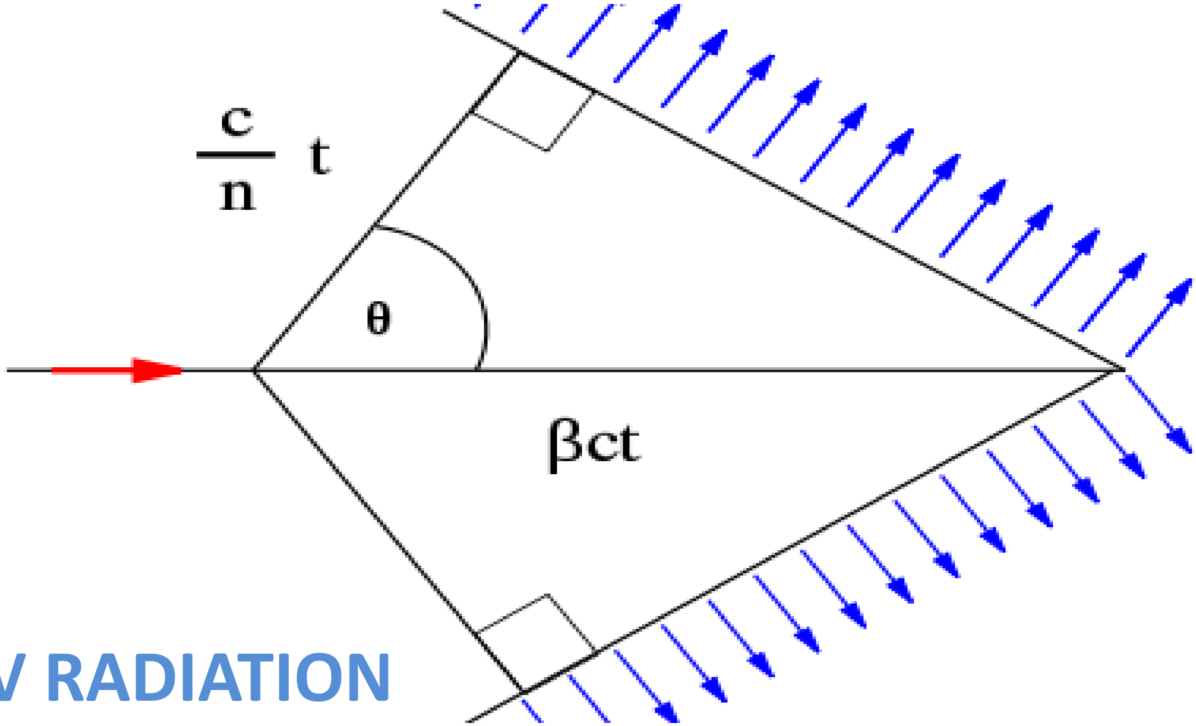
1. Effective solid angle = 0.194 sr
2. Energy resolution 5%/√E(GeV)
3. Angular resolution < 0.8°
4. 1000:1 pion rejection
5. Vertex resolution ~ 5 mm
6. Angular resolution ~ 1 mr



A LITTLE PHYSICS

- Cherenkov Radiation

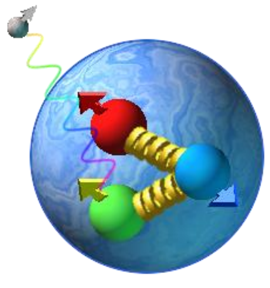
- Total Internal Reflection



CHERENKOV RADIATION

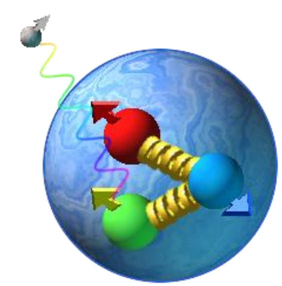
Electromagnetic radiation emitted when a charged particle gives off energy as it moves through a transparent medium faster than the speed of light in that medium.

The radiation is emitted in a cone whose half angle is greater for faster particles and media with higher refractive indices. Radiation occurs mainly in the visible and near UV (especially blue) region of the spectrum.



TOTAL INTERNAL REFLECTION

Total internal reflection occurs when a ray of light strikes a medium boundary at an angle larger than the critical angle with respect to the normal to the surface. If the refractive index is lower on the other side of the boundary no light can pass through, hence light is totally reflected. When light crosses a boundary between materials with different refractive indices, the light will be partially refracted at the boundary surface, and partially reflected. However, if the angle of incidence is greater than the critical angle, the light will stop crossing the boundary altogether and be totally reflected back internally.

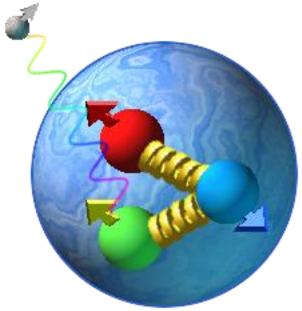


A LITTLE EXTRA INFORMATION

- Photomultiplier tubes (PMTs)
- Lucite Hodoscope
- Discriminators
- Time to Digital Converters (TDCs)
- Analog to Digital Converters (ADCs)

Photomultiplier Tubes

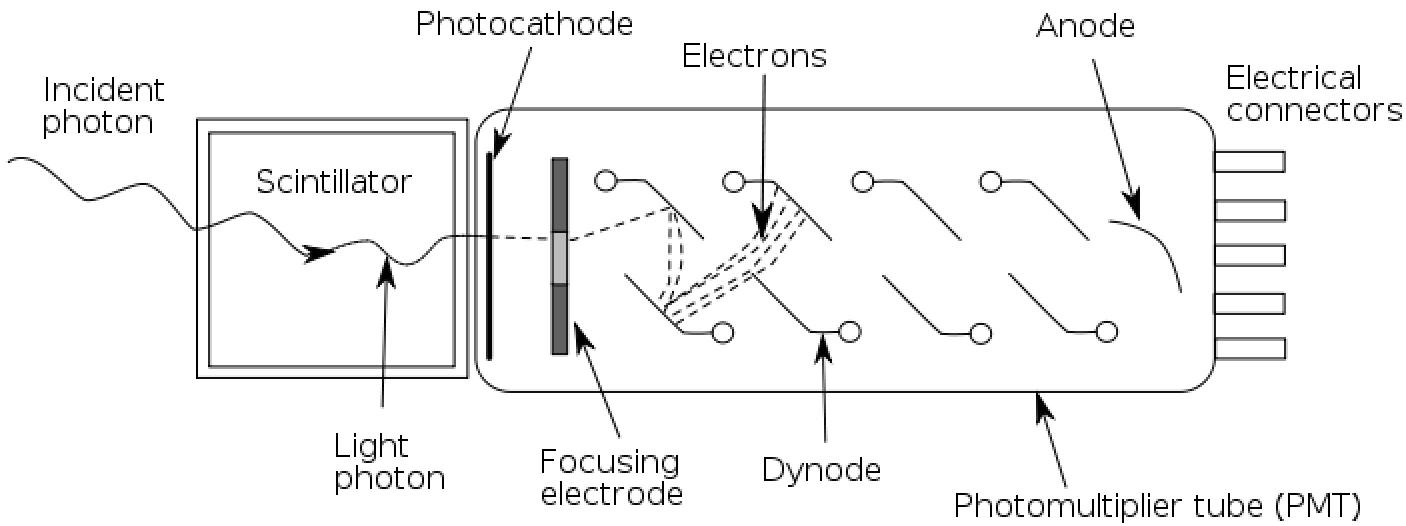
Photomultiplier Tubes are extremely sensitive detectors of light in the ultraviolet, visible, and near-infrared ranges of the electromagnetic spectrum. PMTs have high bandwidth and noise free gain on the order of a million, with ultra-fast response. They are ideal for the detection of extremely low light or short pulses light. Photomultipliers can be used to detect photons from 115nm to 1700nm. A typical Photomultiplier consists of a photo emissive cathode (photocathode) followed by an electron multiplier and an electron collector (anode). The detectors can multiply the signal produced by incident light by as much as 100 million times. Photomultipliers are constructed from a glass envelope with a high vacuum inside. Light which enters a Photomultiplier Tube is detected and produces an output signal through the following processes.

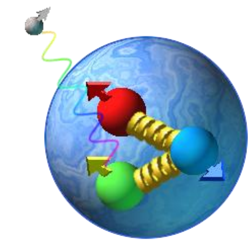


PHOTOMULTIPLIER TUBES

1. Light passes through the input window.
2. Light excites the electrons in the photocathode so that the photoelectrons are emitted into the vacuum (external photoelectric effect).
3. Photoelectrons are accelerated and focused by the focusing electrode onto the first dynode where they are multiplied by means of secondary electron emission. This secondary emission is repeated at each of the successive dynodes.
4. The multiplied secondary electrons emitted from the last dynode are finally collected by the anode.

PMT AND SCINTILLATOR





LUCITE HODOSCOPE

When a charged particle enters the Lucite material and moves at a faster rate that the speed of light, Cherenkov radiation can be observed. With the use of photomultiplier tubes, we are able to convert the small flash of emitted light into measurable electrical pulses that can be counted and analyzed. One of the goals is to provide useful position resolution at a reasonable cost. Also, we will like to detect the charged particles with good efficiency.

LUCITE HODOSCOPE

Lucite is an inexpensive material used in making the hodoscopes. Hodoscopes, from the Greek for “path viewer”, detects charged elementary particles. 28 Lucite bars with dimensions 3.5 x 6.0 x 96.7 – 91.5 cm^3. The bars are curved to 240 cm, normal incidence from target. Edges of bars cut at 45 degree angles to avoid reflections.

LUCITE HODOSCOPE

- **How this works**
- To begin with we take an electron and fire it at a target. The resultant particle travels trough devices until it hits the Lucite detector. There because of Cherenkov radiation and total internal reflection, a signal is sent to the PMTs attached to the end of the lucite bars.
- Upon hitting the PMTs, the flash of light is multiplied and sent through a scintillator device. This device can convert the flash into electrical pulses. The discriminator lets us select only those pulses of interest to the experiment. Along with the TDCs and ADCs, we will know the time the event started and will be able to convert these analog signals into digital information for the computer program.

DISCRIMINATORS

We use a 16 channel discriminator to convert a property of an input signal into an amplitude variation.

TIME TO DIGITAL CONVERTERS

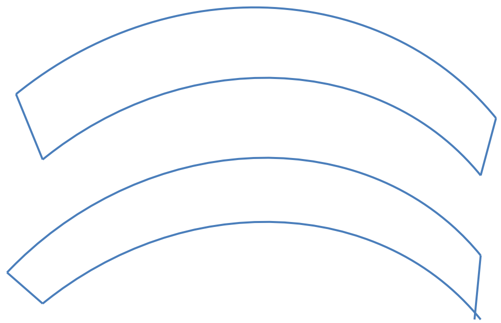
In signal processing a time to digital converter is used to convert a signal of sporadic pulses into a digital representation of their time indices. Basically, it will output the arrival time for each incoming pulse. These devices are used for measurements where the events occur infrequently. In most cases the time to digital converters follow a discriminator.

ANALOG TO DIGITAL CONVERTERS

To convert continuous signals to discrete digital numbers in signal processing, an analog to digital converter can be used. An ADC can have several sources of errors; quantization, non-linearity, and aperture error

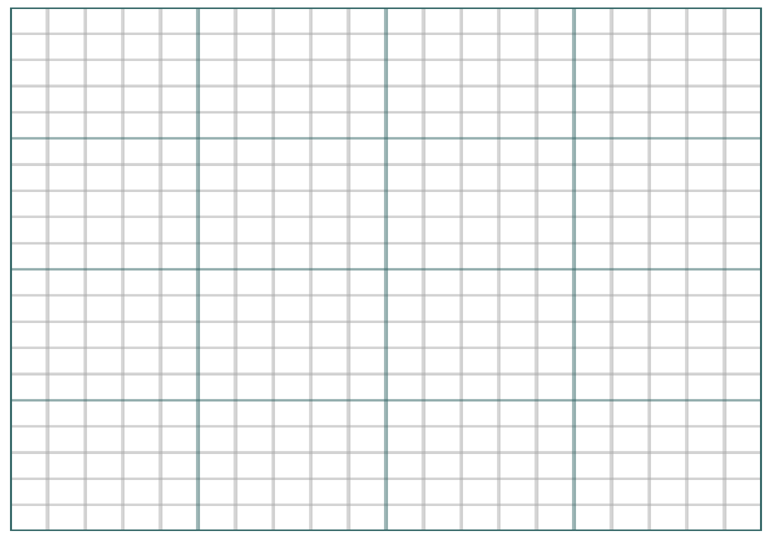
LUCITE DETECTOR AND ME

- POSITION RESOLUTION



Lucite Bars

Big Cal



- EFFICIENCY

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Thank You

AGGIE PRIDE