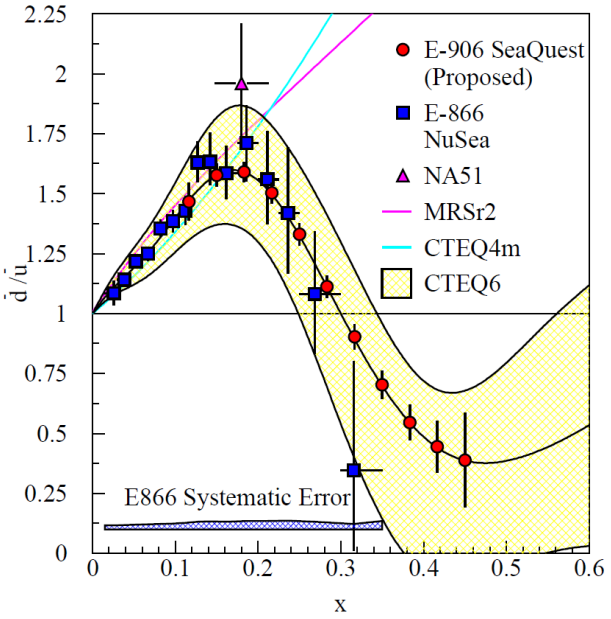
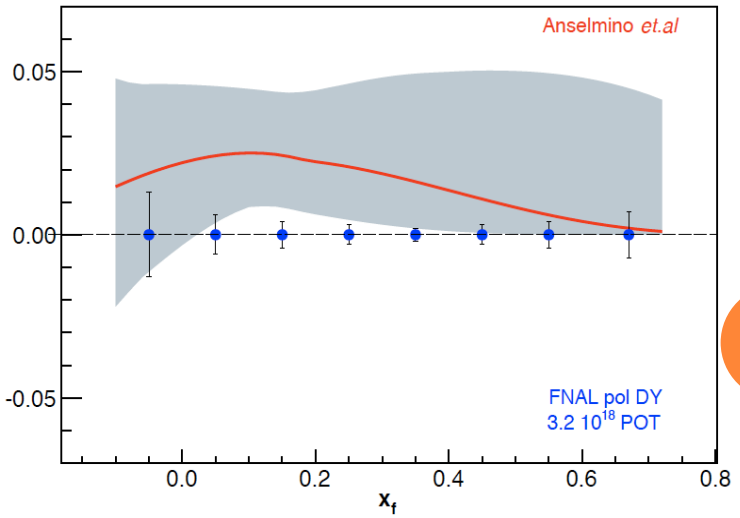
Exploring Light Anti-quark Asymmetry with the SeaQuest Experiment

Zhongming Qu
University of Michigan

Drell-Yan Fixed Target Experiment at Fermilab

- What is the structure of the nucleon?
  - What is $\bar{d}/\bar{u}$?
  - What is the origin of the sea quarks?
- What is the structure of nucleonic matter?
  - What is $\bar{d}/\bar{u}$ in Fe, C, and W?
- SeaQuest: 2012 – 2015
  - Significant increase in physics reach
- Beyond SeaQuest
  - High-luminosity Drell-Yan program: complementary to spin programs at RHIC and JLAB
  - Polarized beam at Fermilab Main Injector (see C. Aidala's talk, JC 00003)
  - Polarized target at Main Injector (see K. Lee's talk, JC 00006)





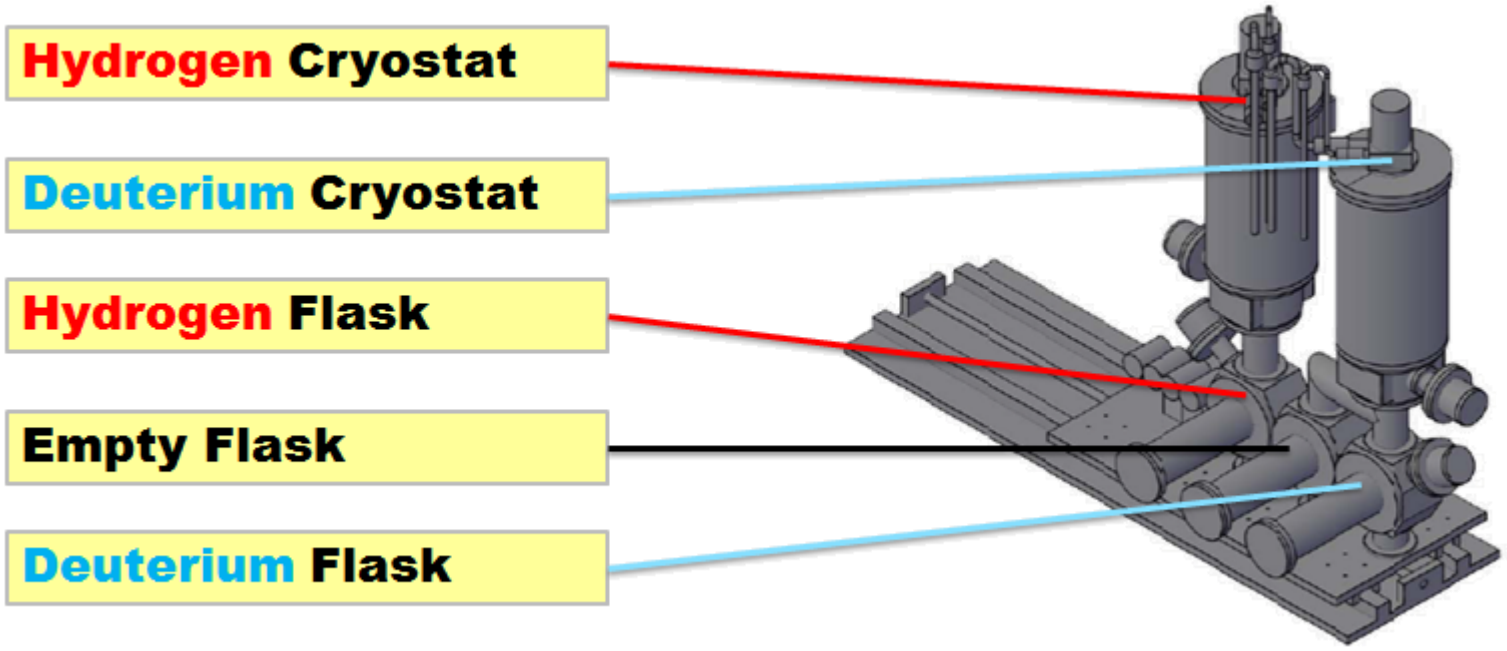
10/25/2012

SeaQuest Status

- Commissioning Run: Late Feb. 2012 – April 30th 2012
- First beam on March 8th 2012
- Main Injector shut down began on May 1st 2012 (for 12 months)
- Extensive beam tuning by the Fermilab accelerator group
  - 1×10^{12} protons/s (5s spill/min)
  - 120GeV
- Cryogenic target systems (LH_2 and LD_2) worked smoothly
- All the detector subsystems worked
  - Improvements underway
- Reconstructed di-muon events seen
- Analysis underway

Successful Run

Target Setup



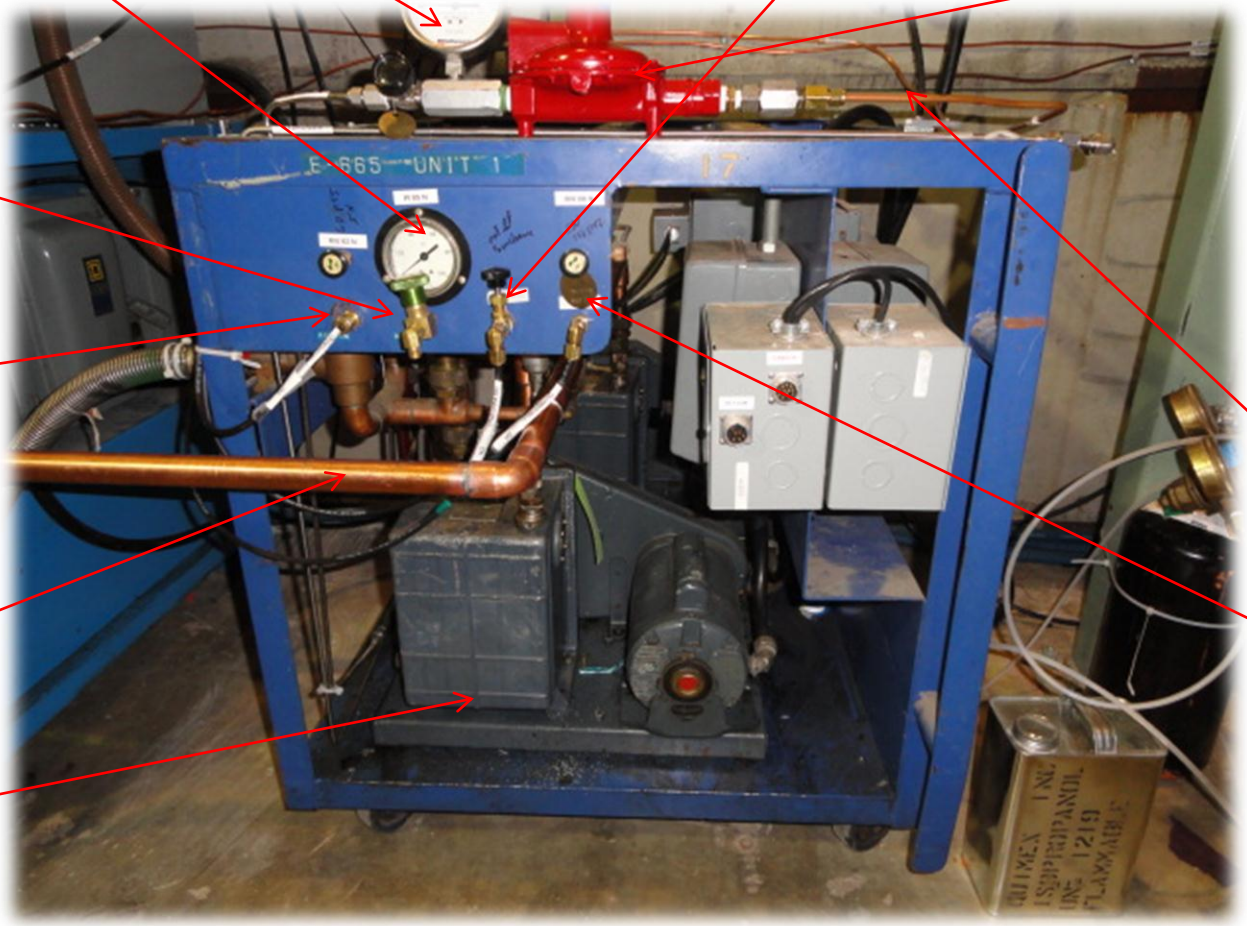
Target in the Enclsore

5 Targets

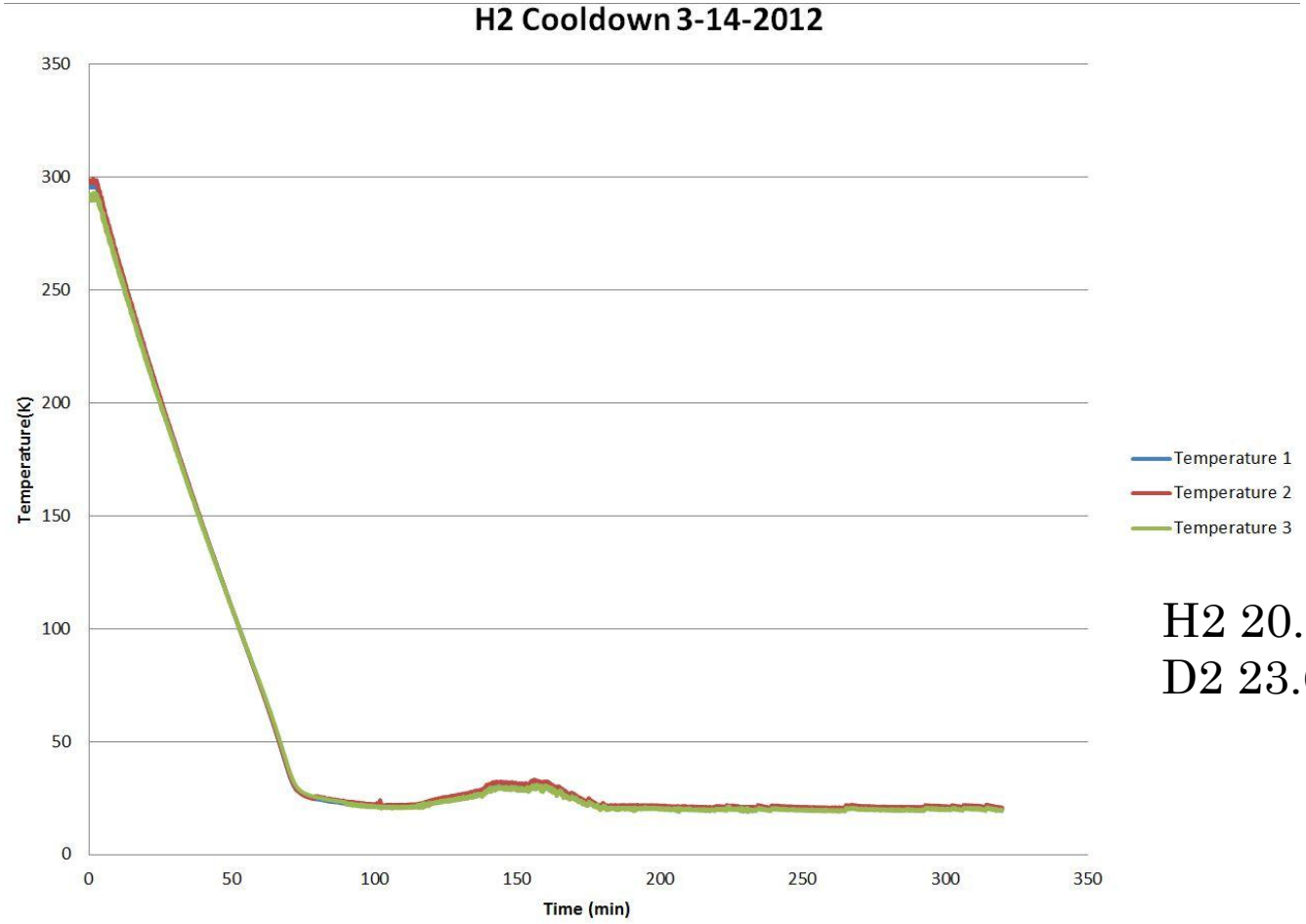
- LH_2
- Empty Flask
- LD_2
- "No Target"
- Fe
- C
- W

Motion Table
PLC controlled

H2 Pumpcart outside the Enclosure



H_2 Cooldown Curve



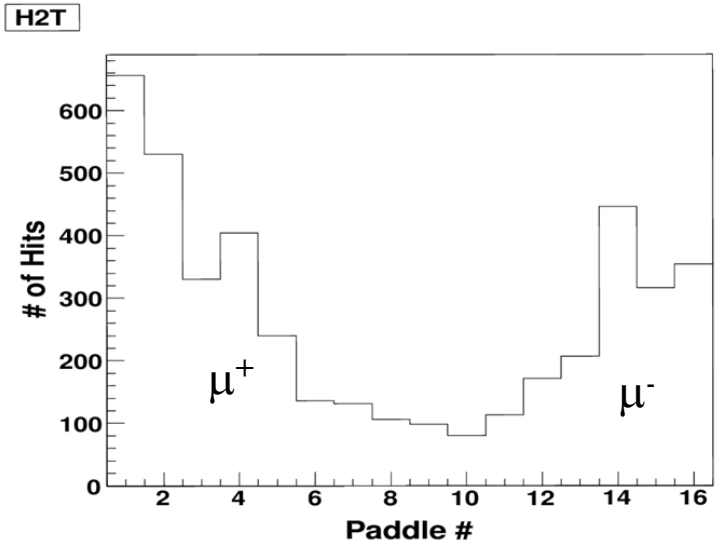
H2 20.28K
D2 23.66K

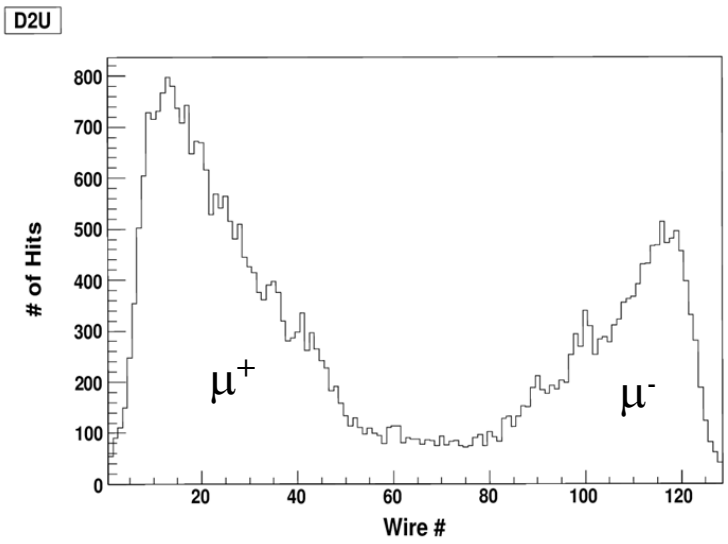
The cooldown takes less than an hour. But the actual fill during the experiment took 16h for H_2 and 12h for D_2.

Detectors' Hits

Hodoscopes – provide triggers

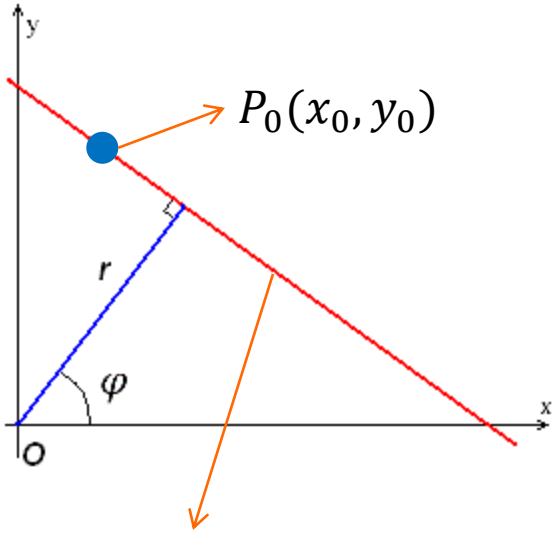
Wire Chambers & Proportional Tubes





- Detectors showed hits consistent with their orientation/ geometry
- Final check of their calibration on-going
- New Station 1 and Station 3 chambers for the next run!

What is the Hough Transformation?



$$x\cos\varphi + y\sin\varphi = r$$

$$r(\varphi) = x_0\cos\varphi + y_0\sin\varphi$$

For a given point $P_0(x_0, y_0)$, any straight line passing it can be written out with two parameters (r, φ):

$$x\cos\varphi + y\sin\varphi = r,$$

where

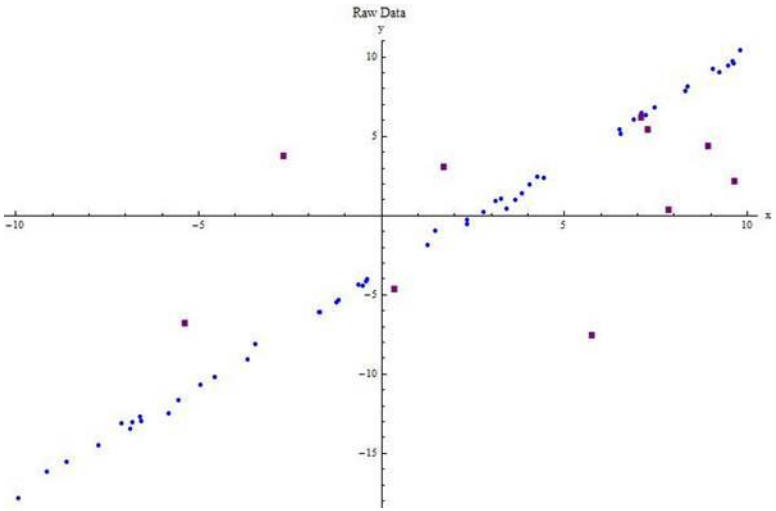
$$r(\varphi) = x_0\cos\varphi + y_0\sin\varphi$$

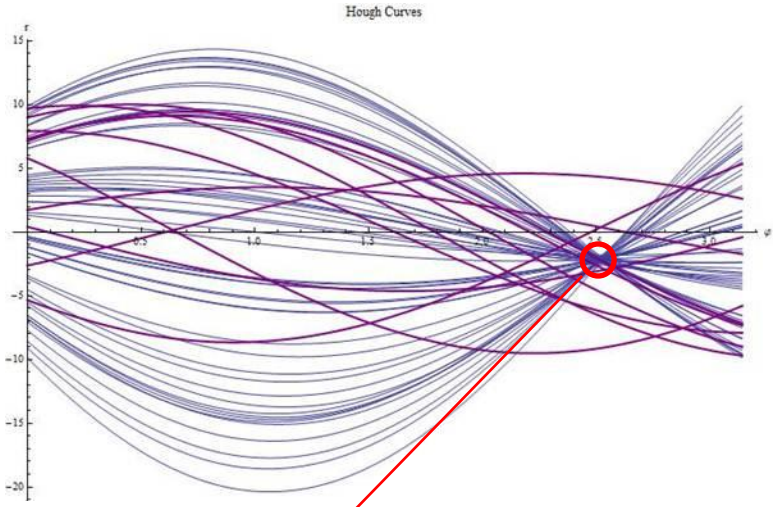
is a sinusoidal curve in the (r, φ) space, or the **Hough Space**.

50 Signal + 10 Background

Euclidean Space

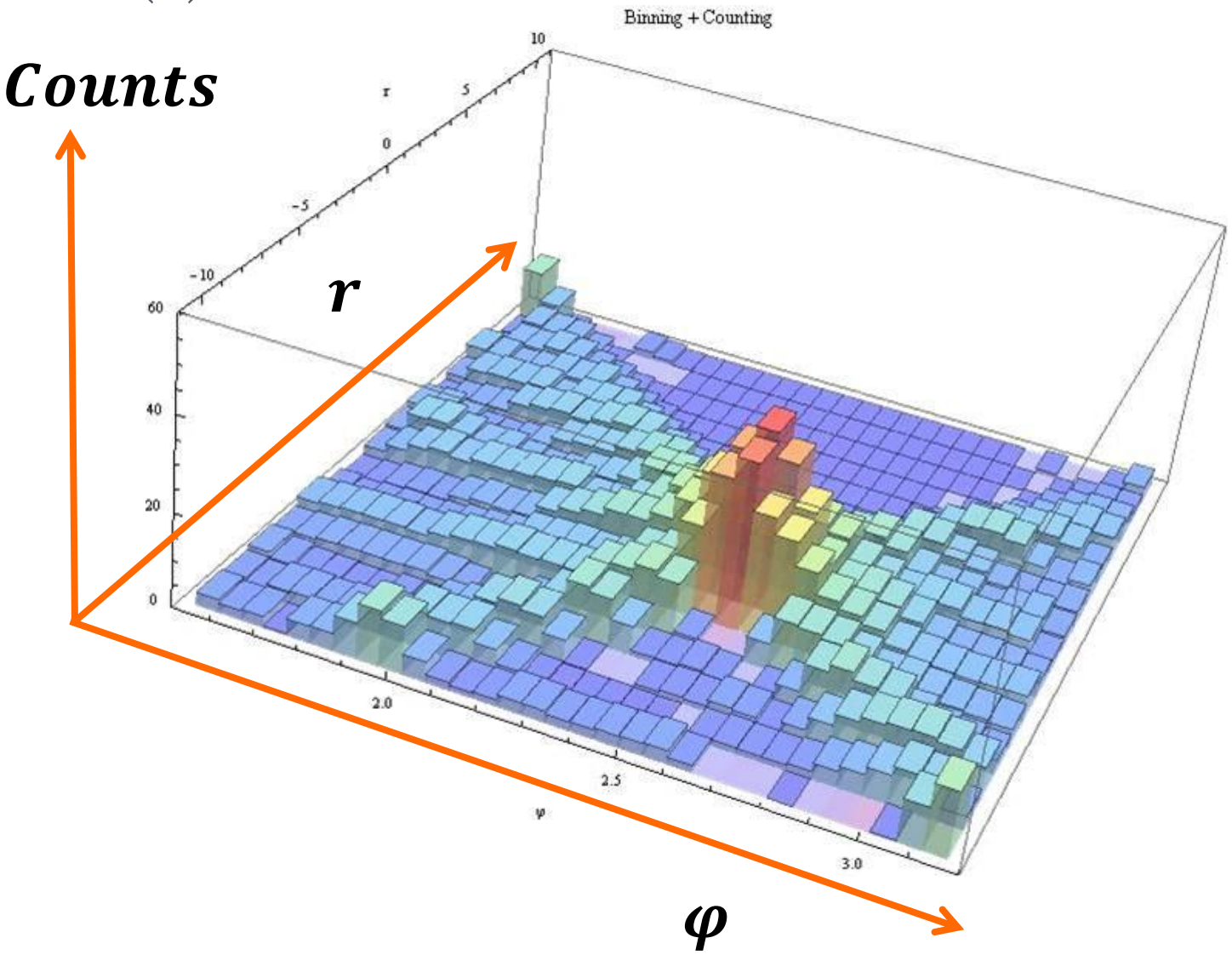
Hough Space



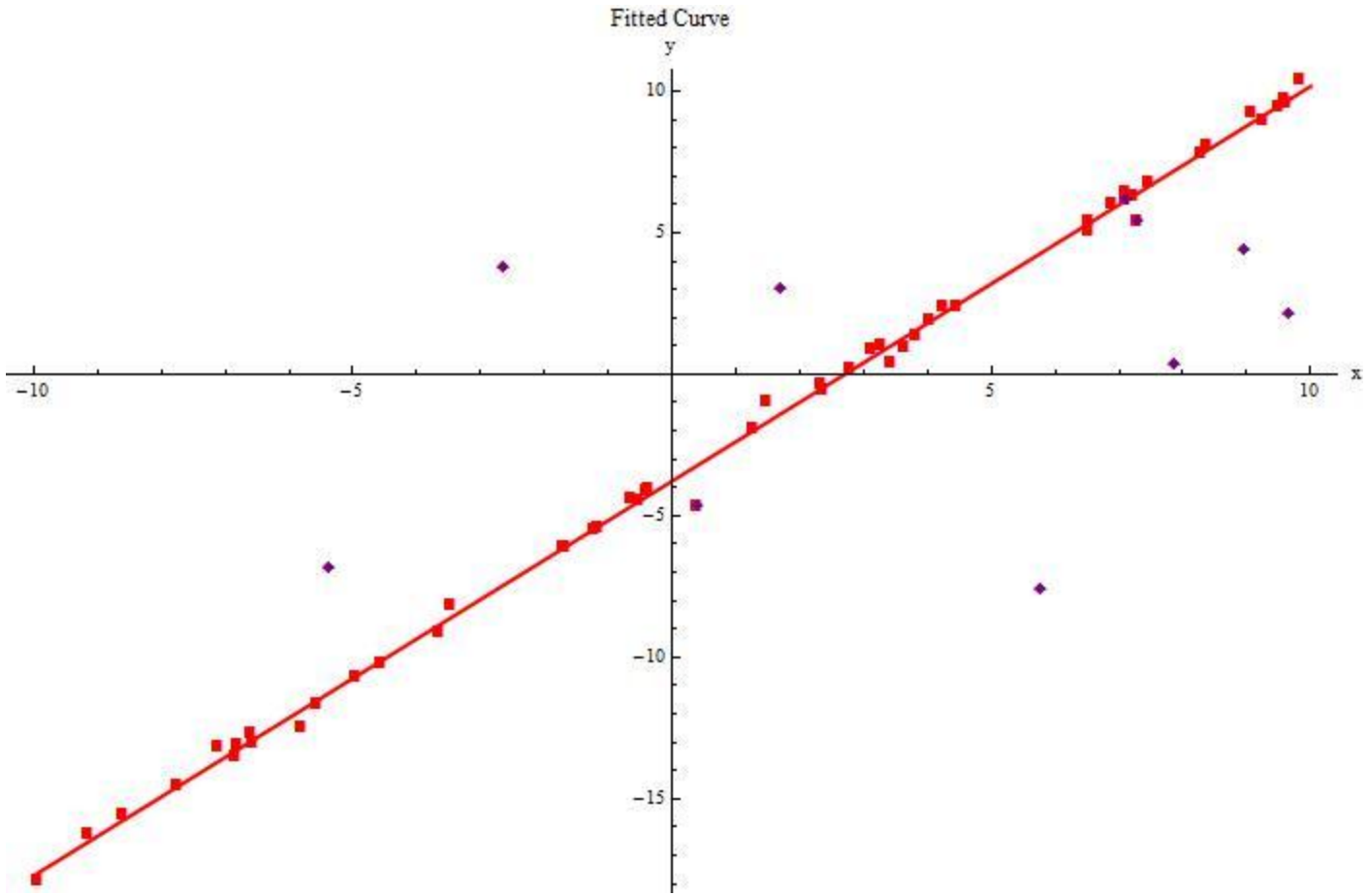


Approximate Intersection Point

Peak(s) in the Hough Space

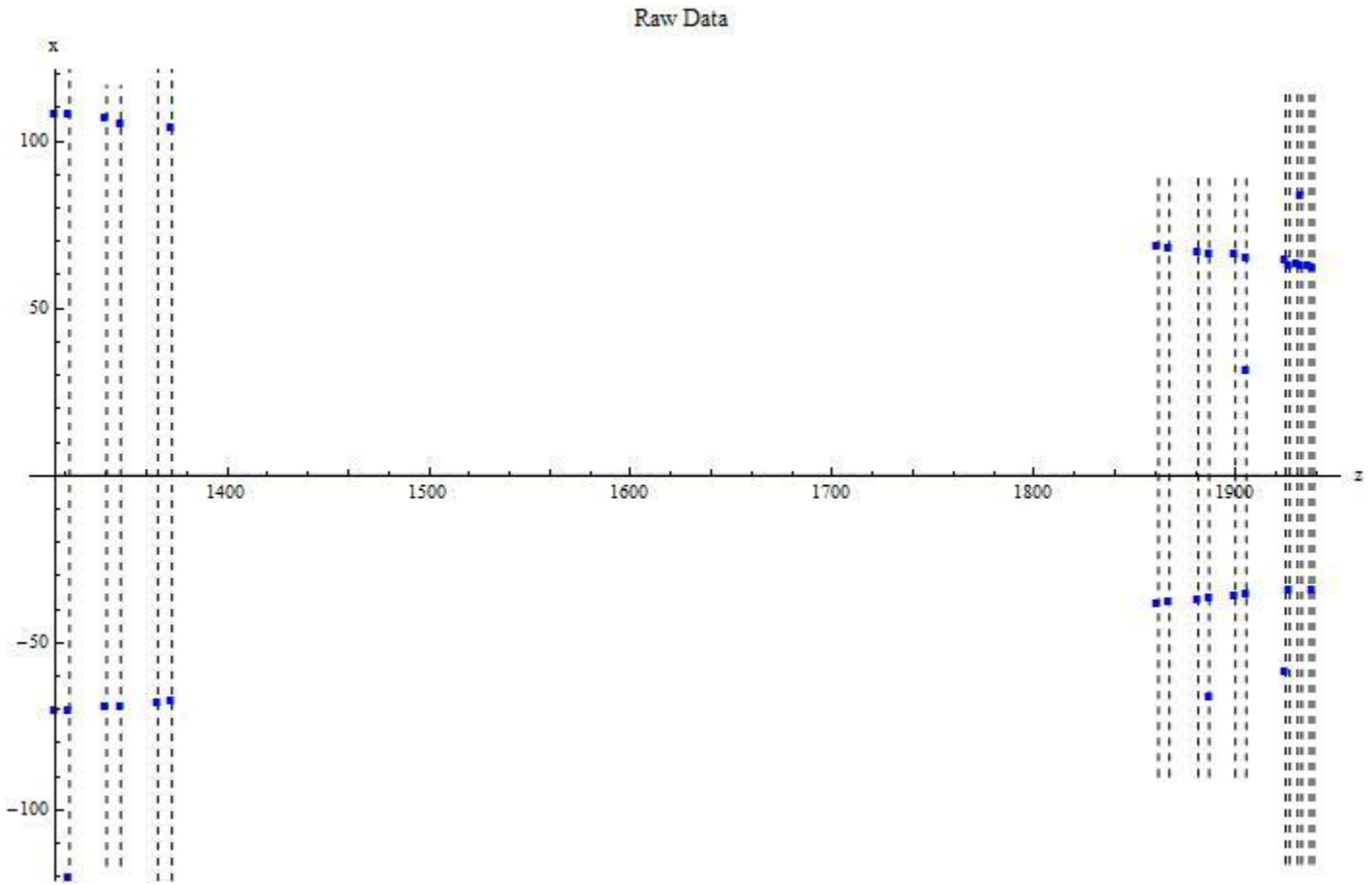


Identified Hits and Fitted Track

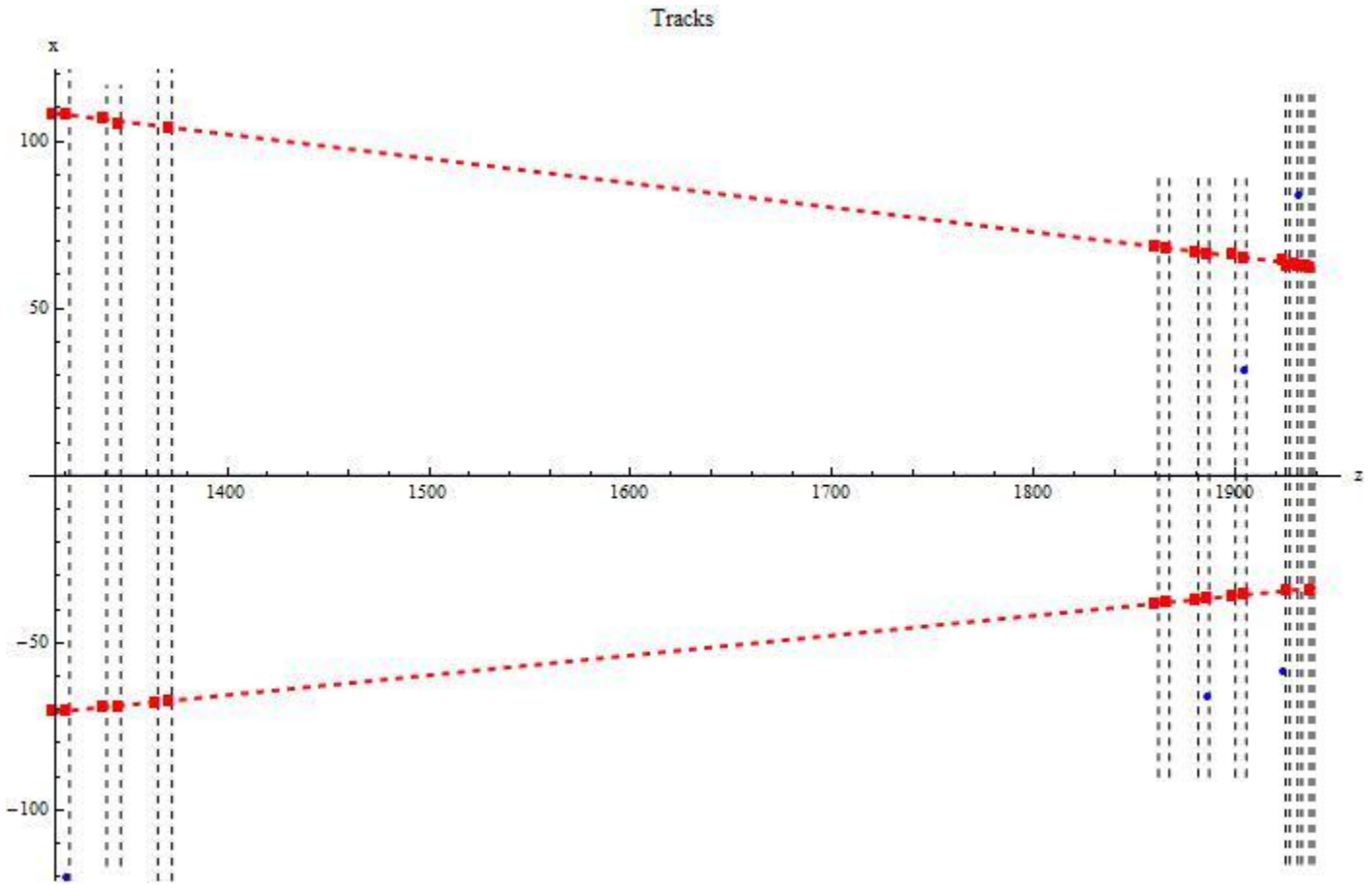


Hough transformation “thinks” the red squares should form a line. The red line is from least square fit.

Two Tracks



Two Tracks



Tracking

- Generalize to 3D
  - Straight lines in 3D space can be projected onto $x-z$ and $y-z$ plane to get two separated, though interrelated 2D straight lines.
  - As long as we do well with 2D tracking, we do well for 3D tracks.
- A new approach for E906
  - More efficient/ robust for many hits with noise
  - Very promising approach to tracking