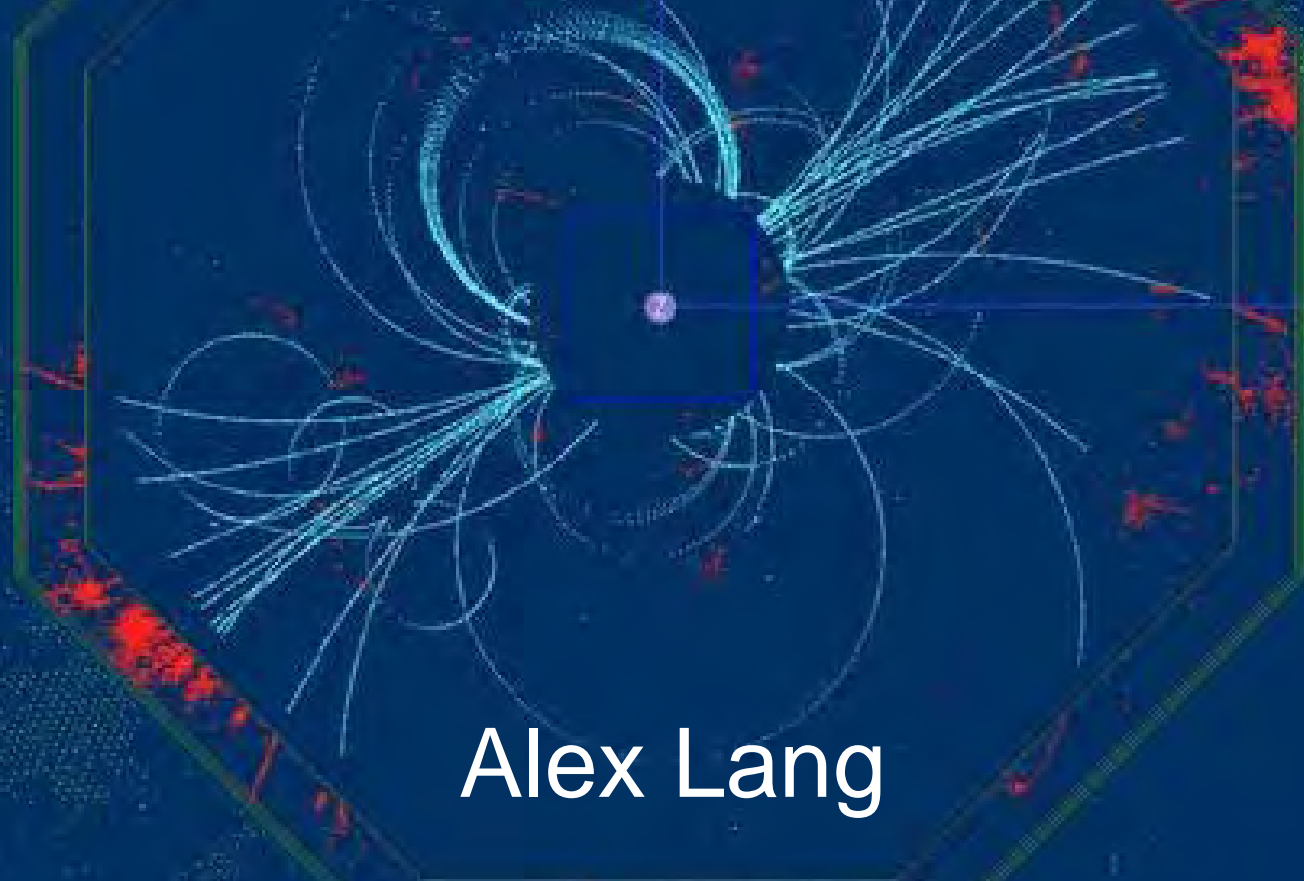


# AØ Beamline Simulation

Fermilab 8/1/07



Alex Lang

Professor Gollin

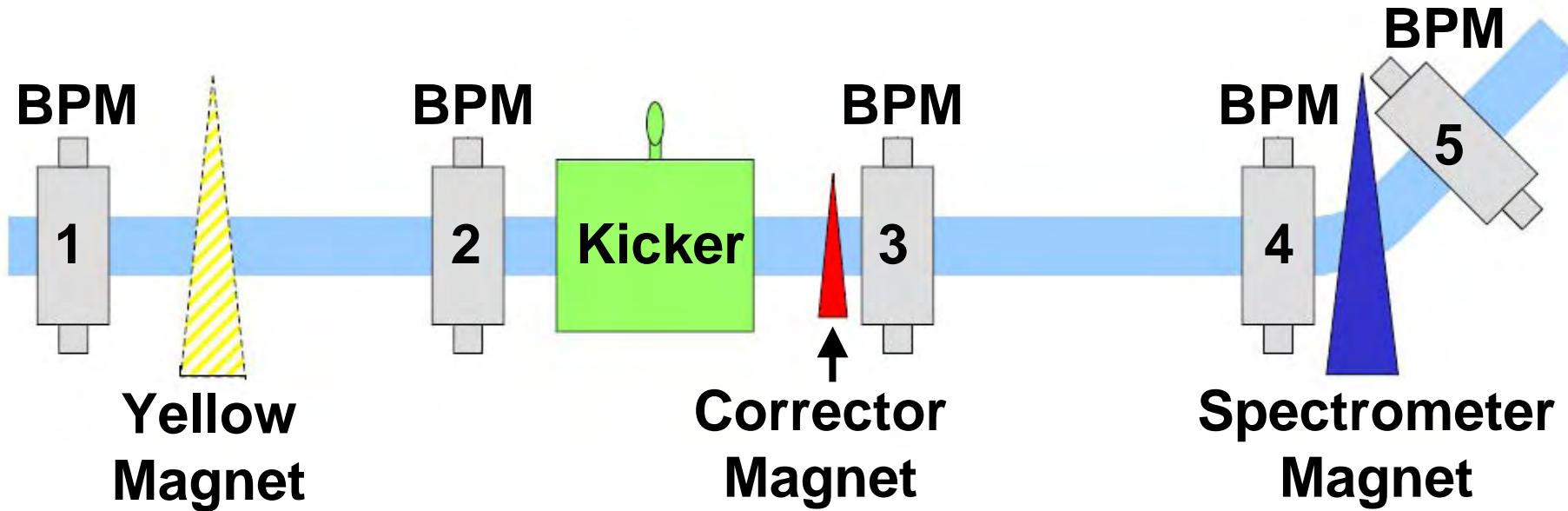
# AØ Project Outline



Kicker tests were run at Fermilab in 2005/2006

My research involved doing a MATLAB© simulation of the beam line so that the run data can be analyzed and the next tests can be more precise

# A Zero Schematic



**BPM:** Beam Position Monitor

**Yellow Magnet:** Not part of experiment, suppose to be off

**Corrector Magnet:** Undoes “kick”

**Spectrometer Magnet:** Bends beam to analyze its momentum

# Parameters

- Beam energy ( $\mu$  and  $\sigma$ )
- Beam initial position ( $\mu$  and  $\sigma$ )
- Beam initial angle ( $\mu$  and  $\sigma$ )
- Background magnetic fields
- BPM resolution
- Time step
- Yellow Magnet field strength
- Kicker field strength
- Corrector Magnet current
- Spectrometer Magnet field strength
- A Zero Layout (needs to be same general geometry)

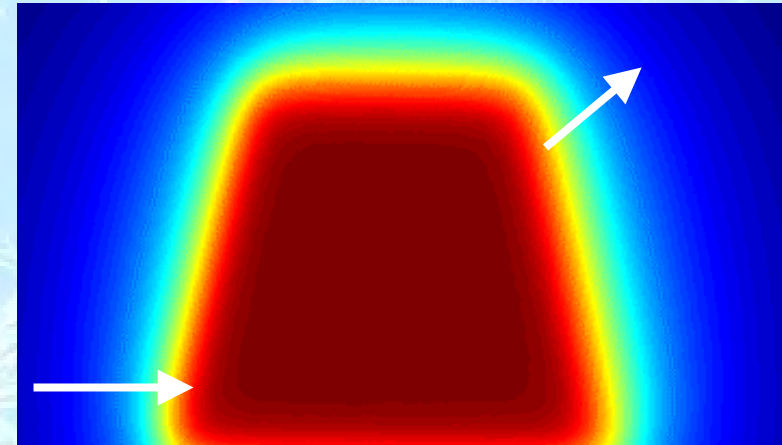
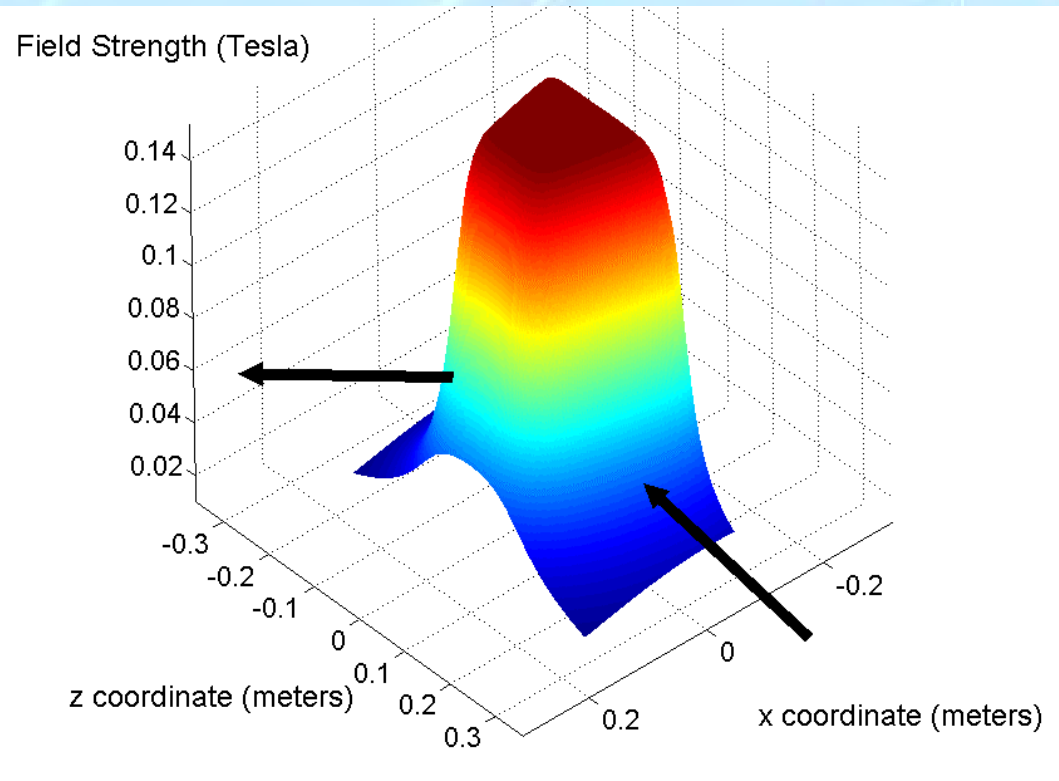
# Easy Possibilities

- Timing information (for phase detectors)
- 3D Field Maps
- Intersection point with beamline

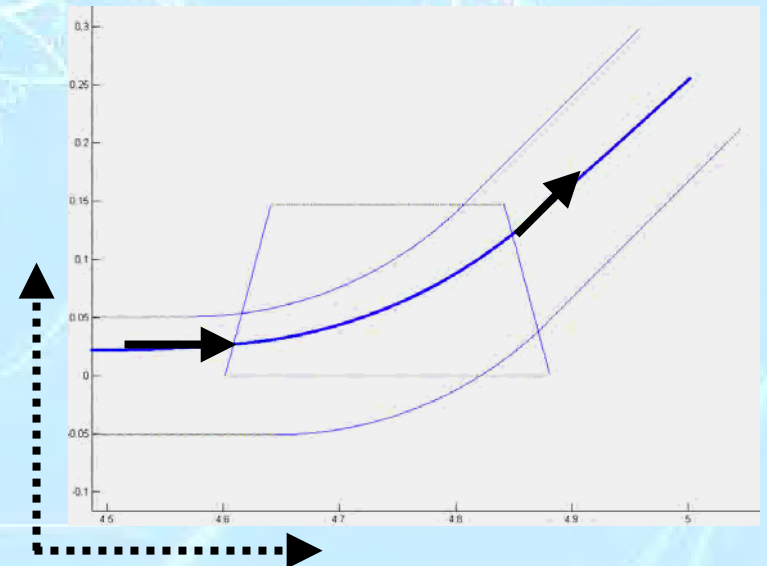
# Tougher Possibilities

- Arbitrary Layout
- Time dependent fields

# Spectrometer Magnet



X Axis



Z Axis

# Spectrometer Magnet

Difficult to exactly determine correct strength.

The field map was produced with the magnet at 4.5 amps. During actual runs, the magnet was turned up to 6.65 amps. A linear relationship was assumed.

However, in order for the beam to hit the final BPM, I had to introduce a scaling factor of 75%.

Possible Causes:

- Exact beamline geometry not known
- Effect of steel plates on field strength
- Nonlinear field vs current (magnet at saturation)

# Simulation Improvements



## Kicker

- Space and time dependence of E and B fields

## BPMs

- Electrical vs mechanical center
- Laser alignment

## 3D Field Maps

- Map of everything!

## Beam Characteristics

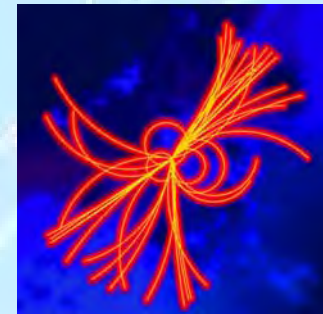
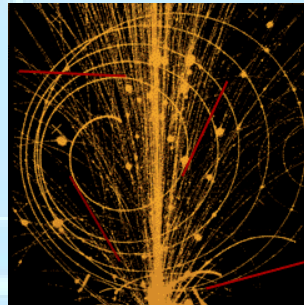
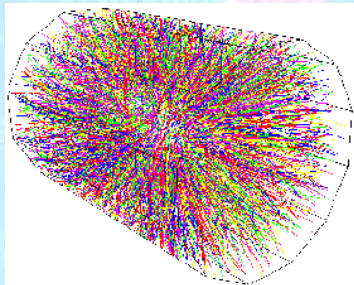
- Momentum (especially angle of entry)
- Initial entry position

# Summary

My project was to design a MATLAB© simulation of the AØ kicker tests.

The spectrometer magnet is a very complicated system that loses significant details with approximation.

My simulation can be used for further studies of kicker data.



# Research Group

Professor George Gollin



## Other Group Members

Mike Haney

Jason Chang

Perry Chodash

Michael Davidsaver

Mike Kasten

Will Dluger

Yehan Liu

# What does each time step look like?

Magnetic Field  
Already Moved  
Through

Region with a Spatial Dependence  
of the Magnetic Field



$$r = \frac{p}{qB}$$

$$\theta = \frac{v dt}{2\pi r}$$



# What is MATLAB?

MATLAB® is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation.

-- MATLAB Help Manual

MATLAB is a numerical calculator. Originally it was designed to be simplified FORTRAN but now it incorporates properties of C and C++.