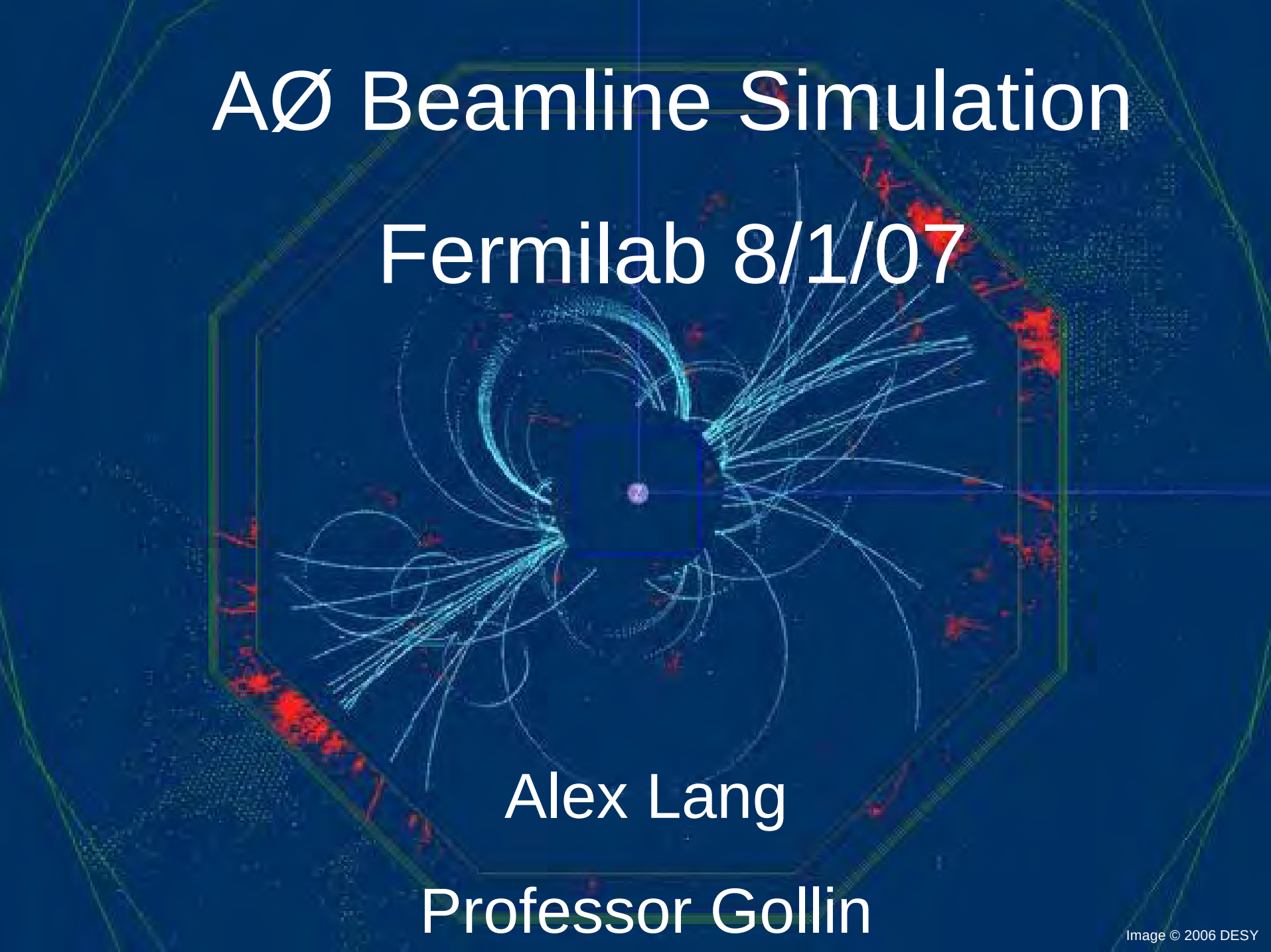
AØ Beamline Simulation

Fermilab 8/1/07



Alex Lang

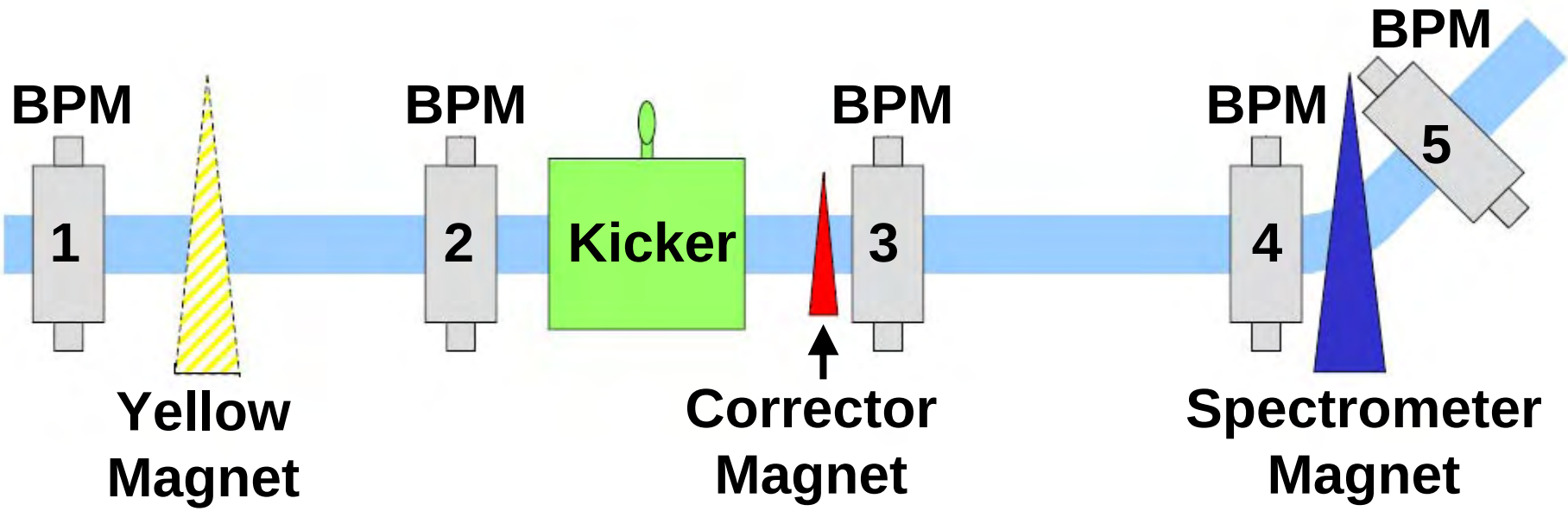
Professor Gollin

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 (μ and σ)
- Beam initial position (μ and σ)
- Beam initial angle (μ and σ)
- 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)

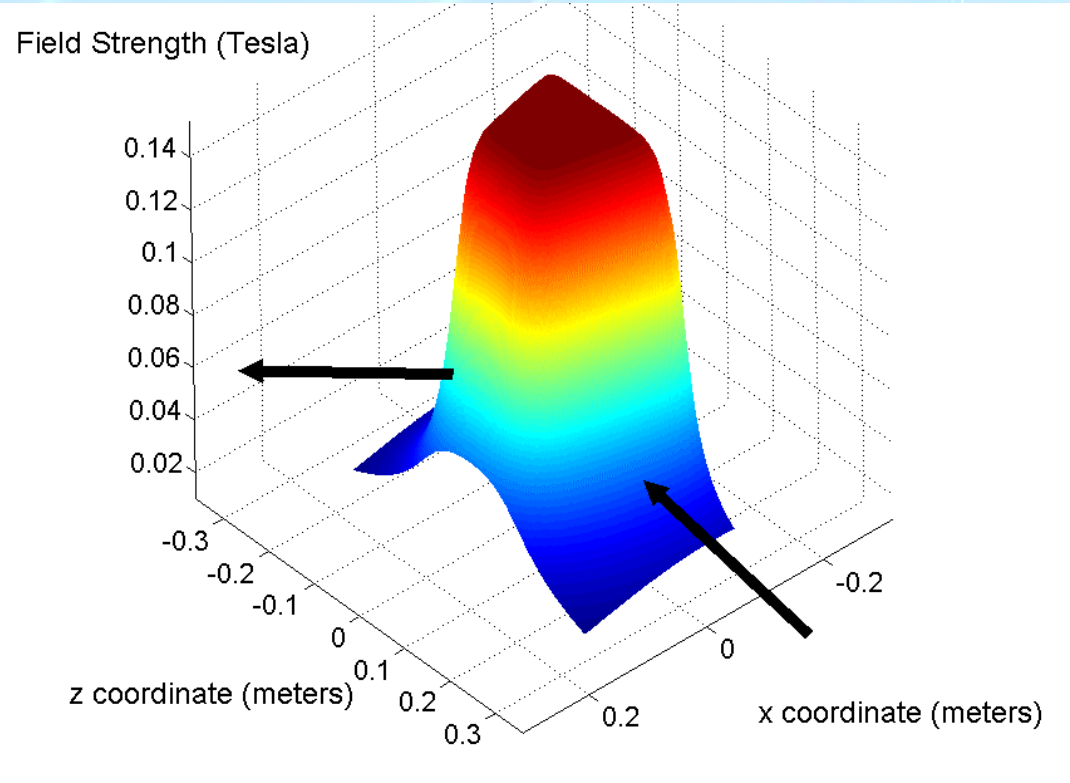
Easy Possibilities

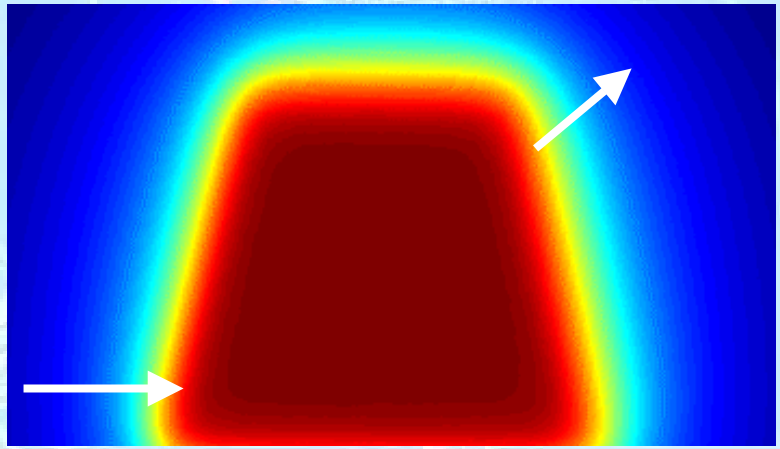
- Timing information (for phase detectors)
- 3D Field Maps
- Intersection point with beamline

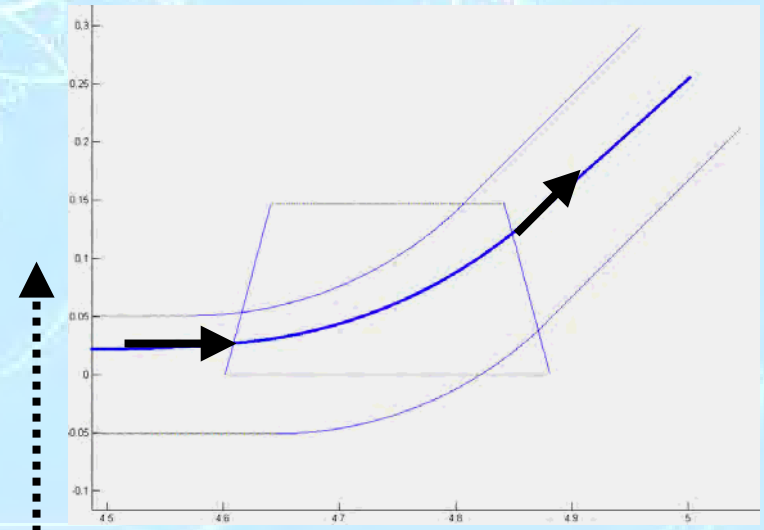
Tougher Possibilities

- 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

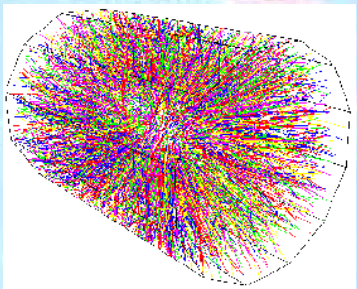
- Momentum (especially angle of entry)
- Initial entry position

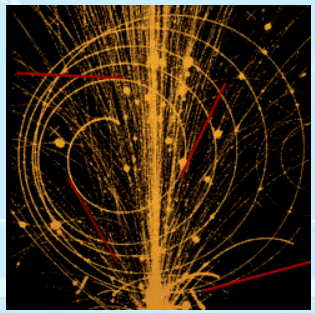
Summary

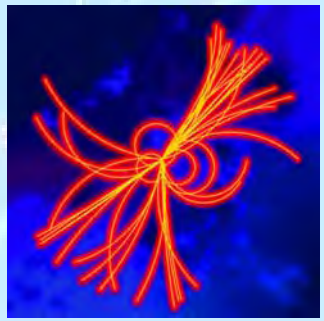
My project was to design a MATLAB© simulation of the AØ kicker tests.

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

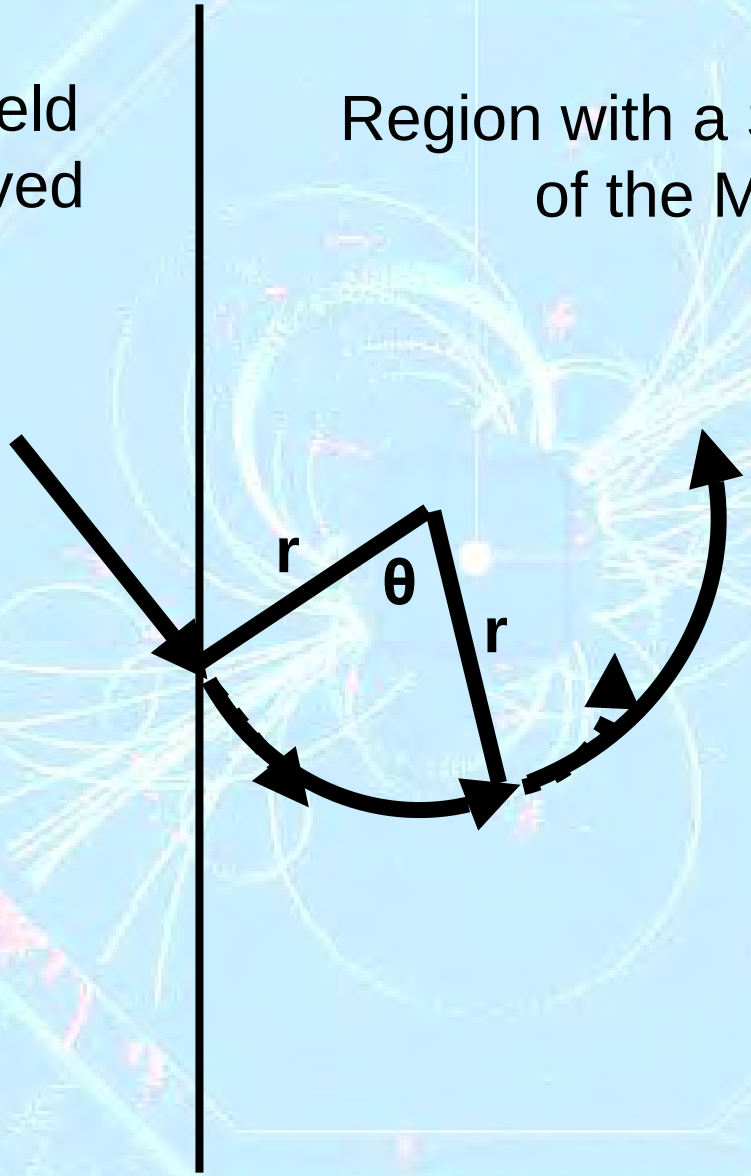
Will Dluger

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++.