Version 1
March 11, 2013

Intro to the art-workbook

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Introduction

- The *art* workbook uses a toy experiment to illustrate the features of *art*.
- Plan A: Phase I by May 1, 2013
  - Then ds50 came along …
- Current status: a prototype
  - Some glitches
  - Some missing features
  - Written material exists only as stream-of-consciousness bullet points.

Workbook

- What it will look like when it's done:
  - A series of exercises that people can work through on their own and at their own pace.
  - Backed by layered written documentation, a discussion forum …
  - Main audience: the end-user scientist-analyzer
  - Additional material for the scientist-developer
- This week:
  - Due to early state of the written material, we will work through the exercises together.
  - Please ask lots of questions.

Products

- AKA External Products
- Examples:
  - ROOT, Geant4, CLHEP, boost
  - The g++ compiler!
- Experiments use art as just another product
  - Experiment specific code is built as plug-ins (.so) that are loaded and used by art.
  - Your “main program” is in an external product!

UPS/UPD

- Products are managed by ups/upd
  - FNAL home brew; battled-tested and modernized.
- Product path: echo $PRODUCTS
  - /grid/fermiapp/products/common/db/:/ds50/app/products
- /grid/fermiapp/products/common/db
  - Some general tools, mostly FNAL specific.
- /ds50/app/products
  - The main body of products used by ds50
  - You can download a tar file of this area, untar it on your laptop and go (if your laptop runs a supported OS).

UPS Environment Variables

- When you “setup” a UPS product
  - Defines environment variables
  - May add to your path
  - May add to LD_LIBRARY_PATH
- Example environment variables:
  - ART_DIR – the root of the version of the product
  - ART_INC – the root of include files for this version
  - ART_LIB – location of libraries
  - … usually more …

The Toy Experiment

- Deployed as a product:
  - Name: art-workbook-base
  - You will use this an external product.
    - You will uses its header files and its libraries
  - Experts should feel free to look at the insides to learn things not covered by the workbook.
    - The mature workbook will eventually have exercises targeted at scientist-developers that tell you to check out art-workbook-base and modify it.
- art-workbook-base and art-workbook are not the same!

Big Picture

art-workbook

PRODUCTS:
art-workbook-base
Art
ROOT
CLHEP
boost

- Source for art-workbook is stored in a source code management system: git
  - Think svn++ or cvs++++
- What you will do:
  - Check out the art-workbook
  - Build it
  - Run exercise 1
  - Modify some code, rebuild and rerun.
  - Repeat for exercise 2, 3, 4 ….
  - You won't check in any code.

Establishing Working Environment

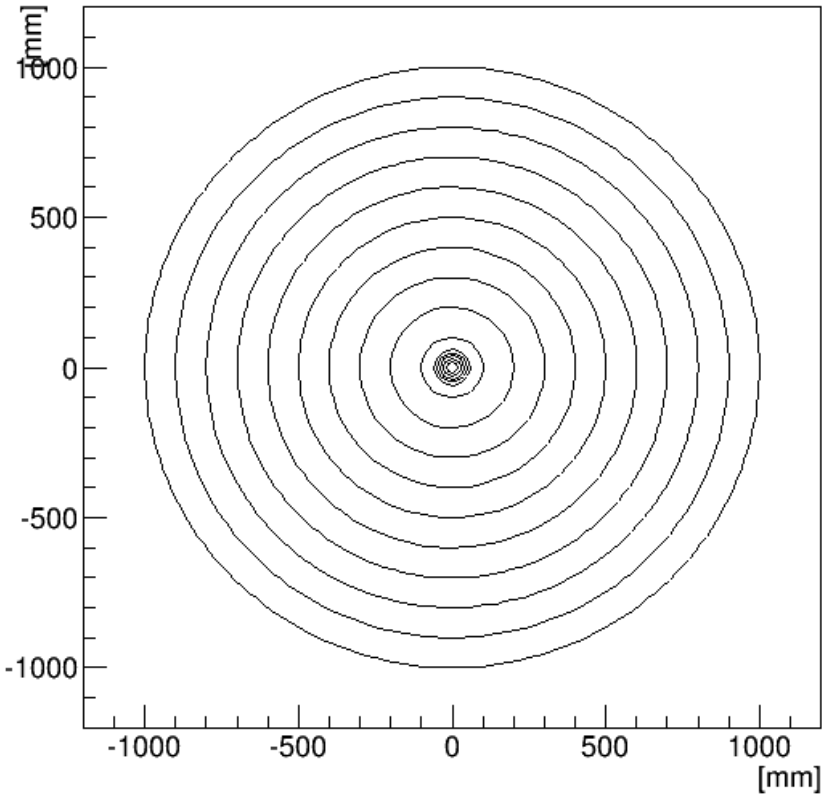
- A four step process:
- source /ds50/app/ds50/ds50.sh
  - Tells ups to where to find the ds50 products
- source /ds50/app/ds50/setup_workbook_tutorial.sh
  - Makes working space for the workbook project
  - Checks out the art-workbook project from git
- cd $buildDir
- source ../art-workbook/ups/setup_for_development –d
  - “sets up” all ups products needed for the art-workbook project.
  - After this step the ups environment variables are defined; PATH and LD_LIBRARY_PATH are extended.

The Toy Experiment

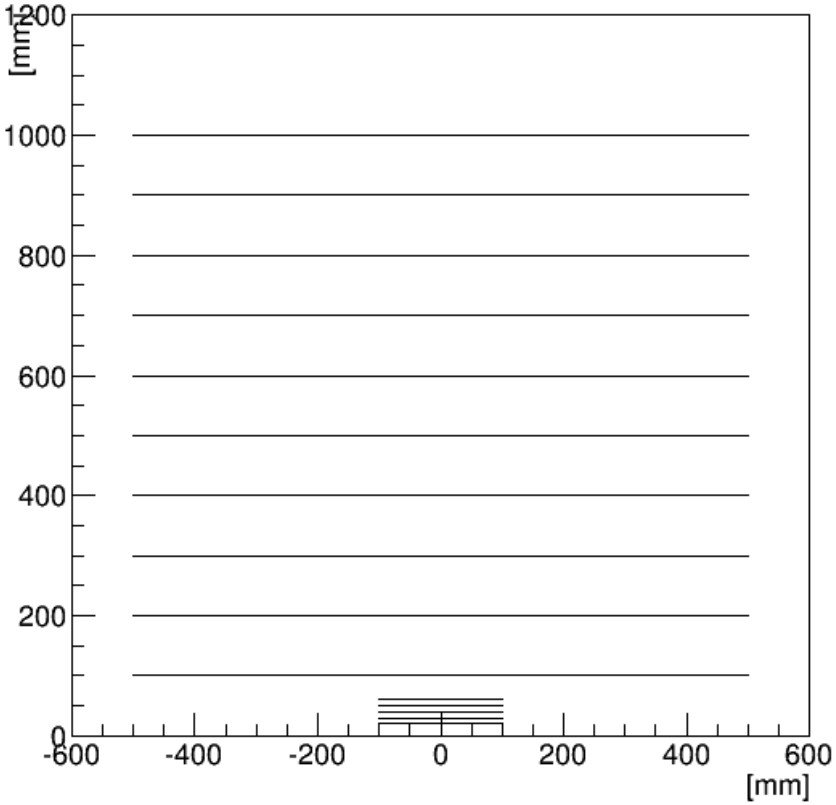
- Simulation code produces
  - Truth information
  - Data-like raw data
  - Helpers to navigate among raw data and truth.
- Reconstruction and analysis code produces
  - Information derived from the raw data
  - Helpers to navigate the derived information
- Given both sets of helpers one can navigate from the final answer back to the simulated interaction and ask, "Did I get it right? If not what sort of error did I make?"
- Code is structured as "modules"
  - Each "module" does one step of the simulation process or one step of the reconstruction/analysis process.
  - Here "module" has no precise technical meaning – it's just a bunch of code that works together and can be turned on or off.

The Toy Detector

Y vs X view



R vs Z view



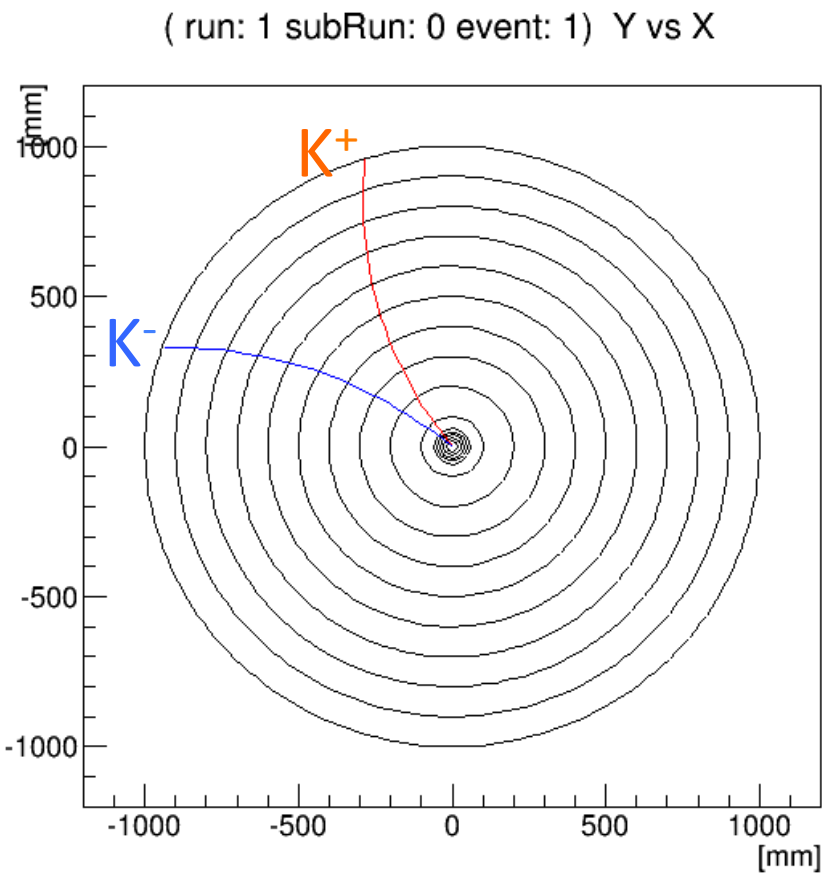
15 concentric sensitive shells

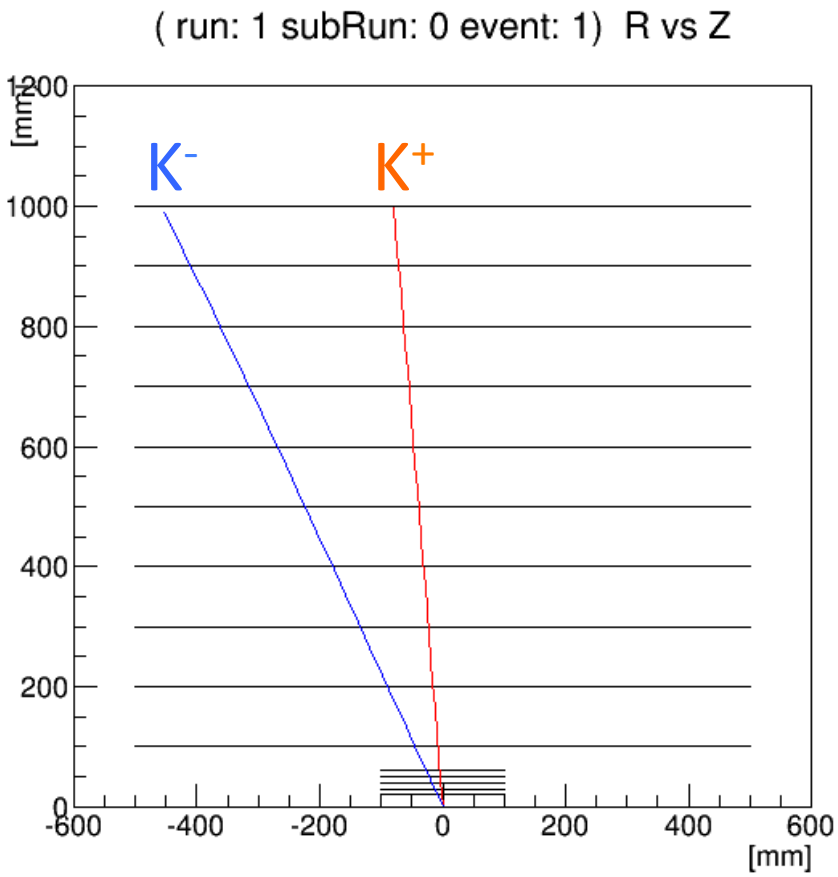
Uniform B Field: (0., 0., 1.5) T

Comments on Previous Slide

- 15 Shells
  - Inner 5: Closely spaced radially; short in z
  - Outer 10: Widely spaced radially; long in z
- All shells:
  - Make 2D measurements: (ϕ,z)
  - Perfectly gaussian
  - Perfect separation of nearby tracks
  - Efficiency and resolution: run-time configurable per shell.

Generated Particles: Event 1





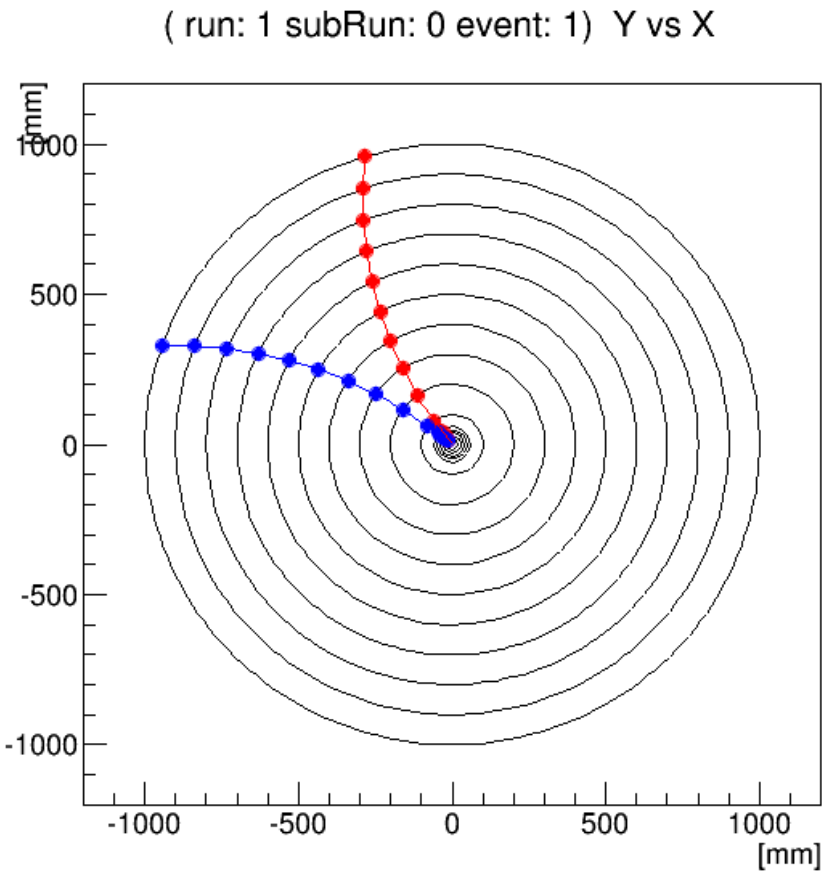
One neutral particle: m = m(ϕ) = 1020. MeV

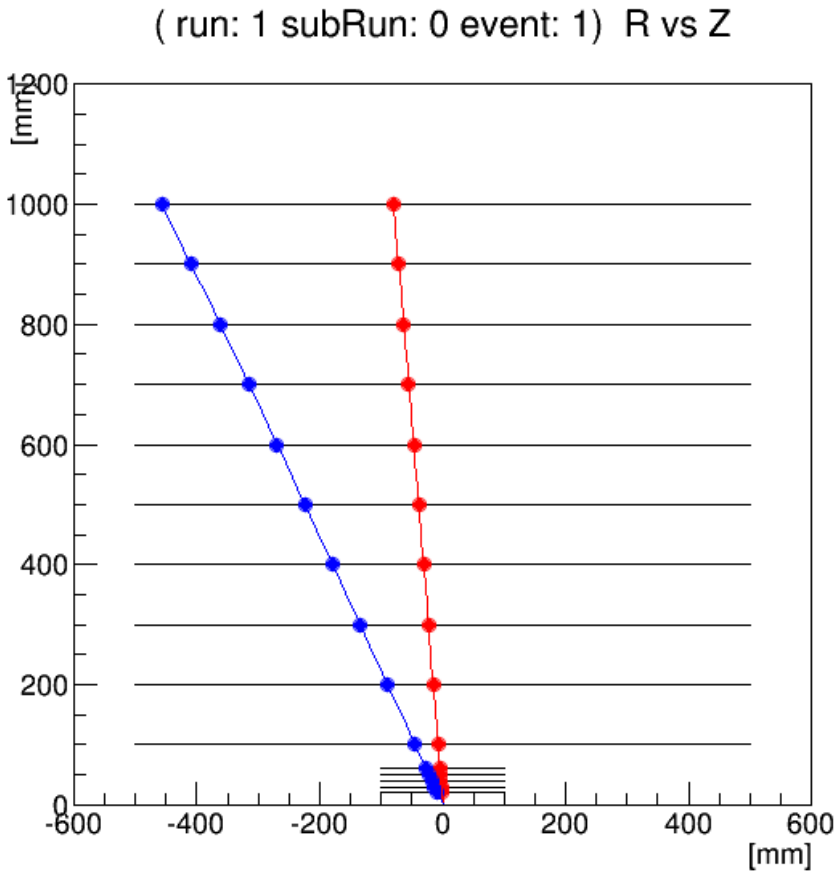
Decays immediately to K^+K^-

Comments on Previous Slide

- Phi meson generated uniform on 4pi, with momentum uniform from 0 to 2000 MeV/c.
- Decay is isotropic in rest frame.
- K^+K^- are tracked through the detector
  - Never interact in the materials
  - Never decay
  - Travel in perfect helices
  - Only follow particle for the outgoing arc of the helix or until it leaves the detector, whichever comes first.
- Compute intersections of each trajectory with each shell:

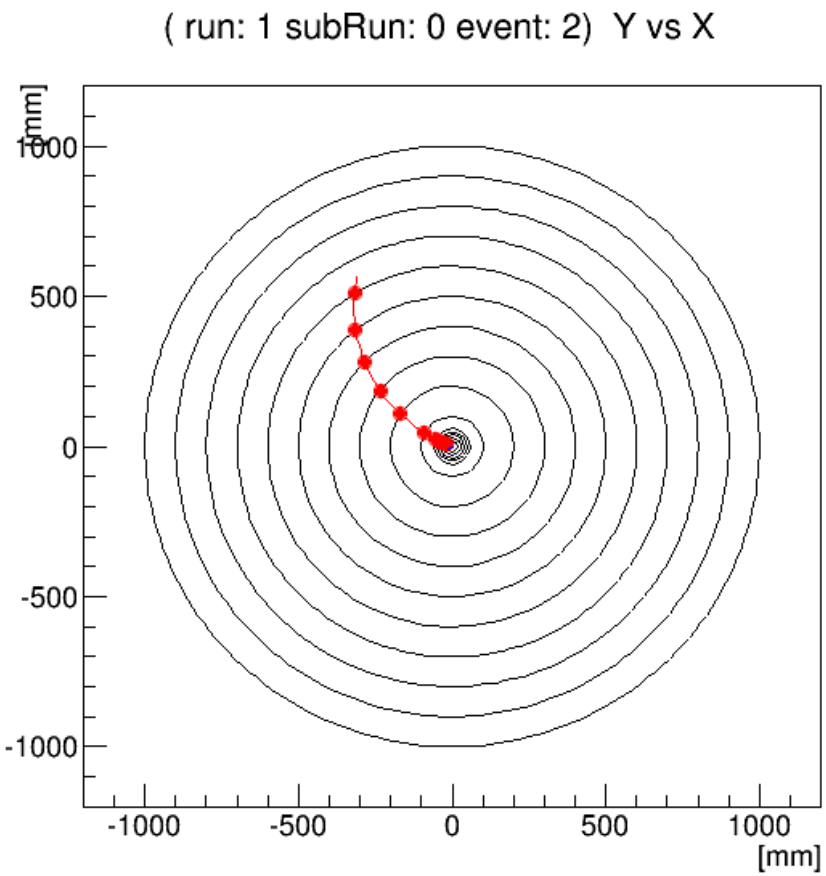
Intersections

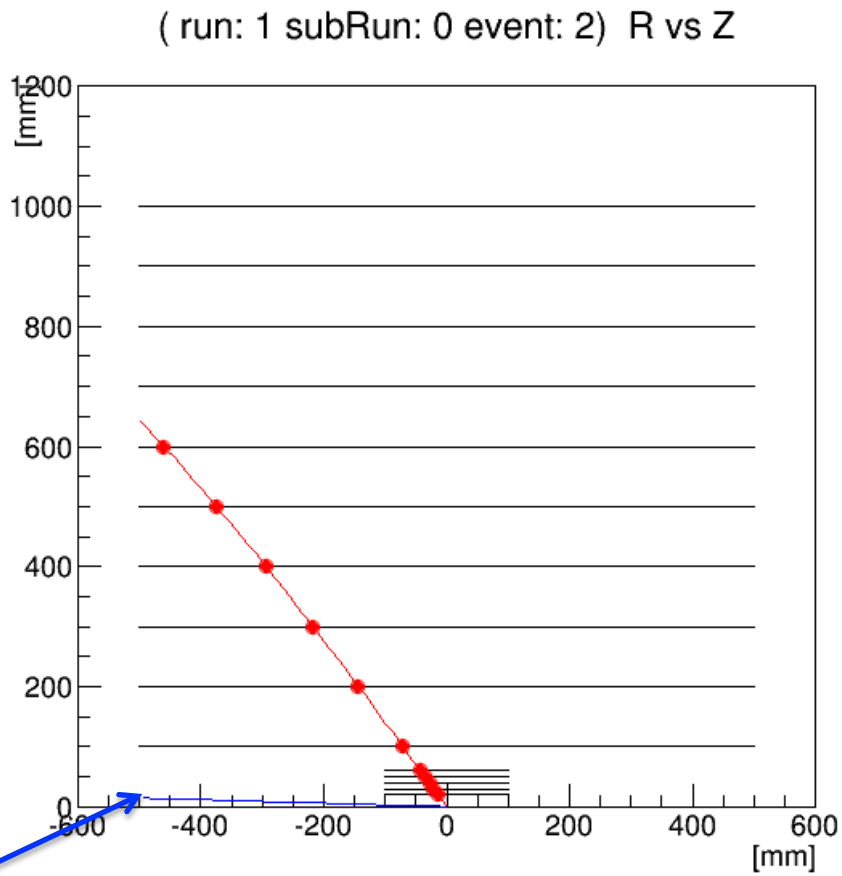




Intersections shown as filled circles.

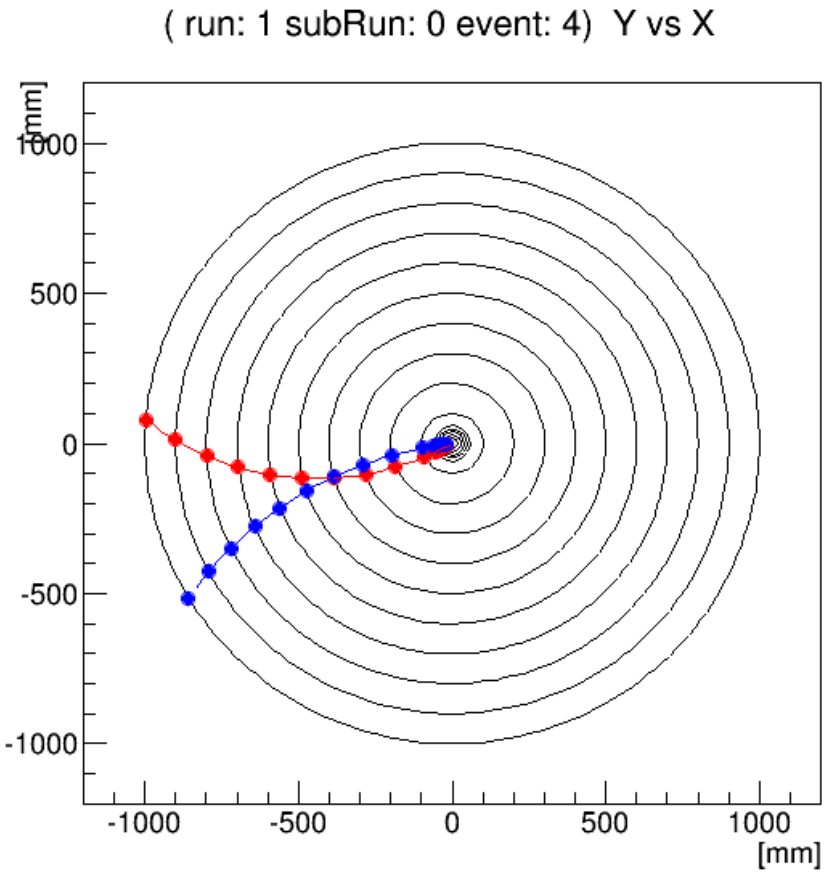
Event 2

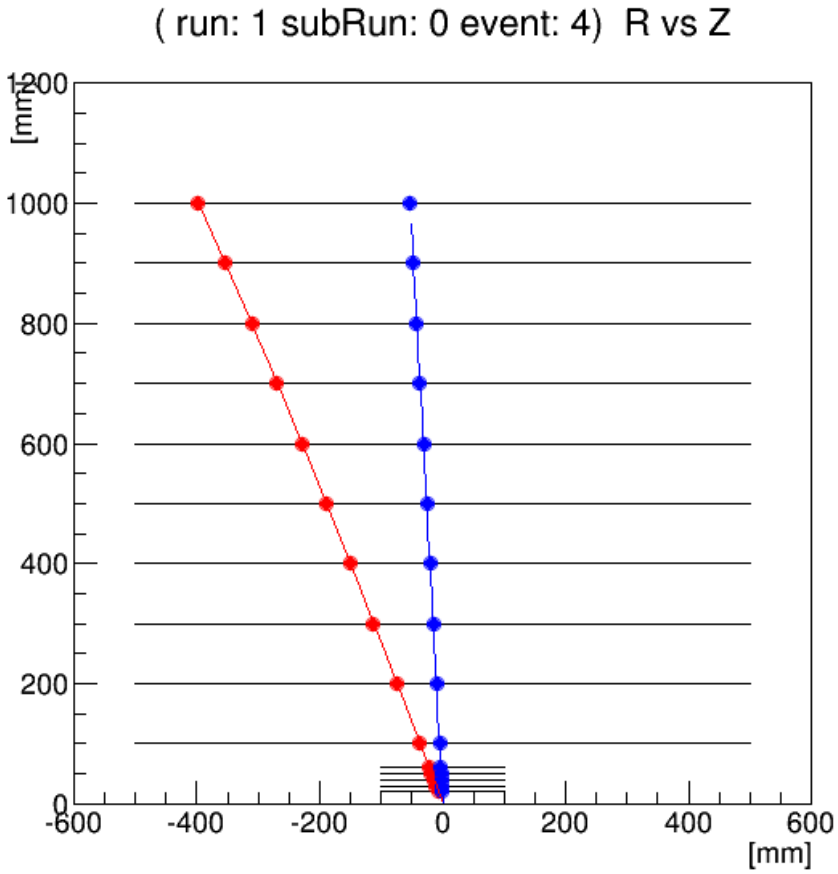




K^- is outside of the fiducial volume.

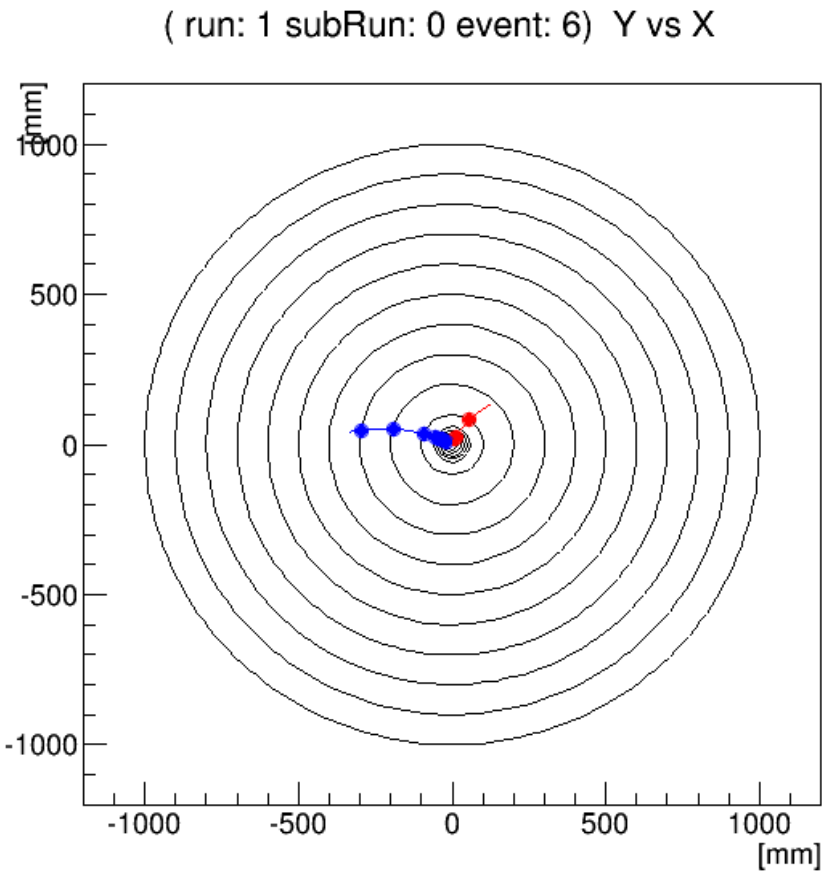
Event 4

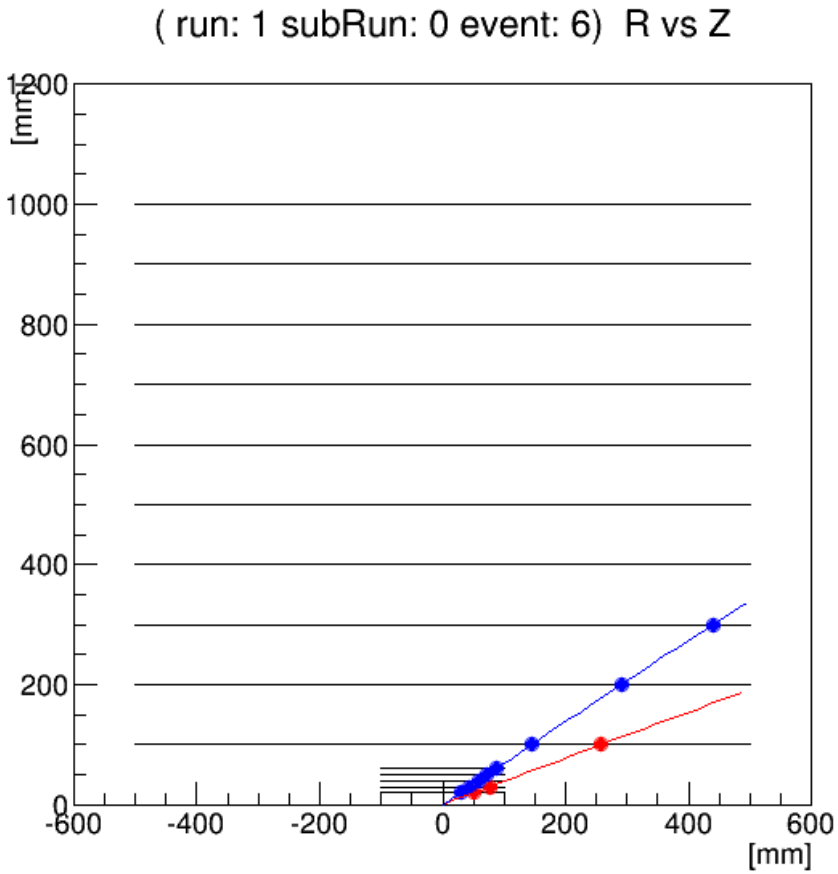




Another typical event.

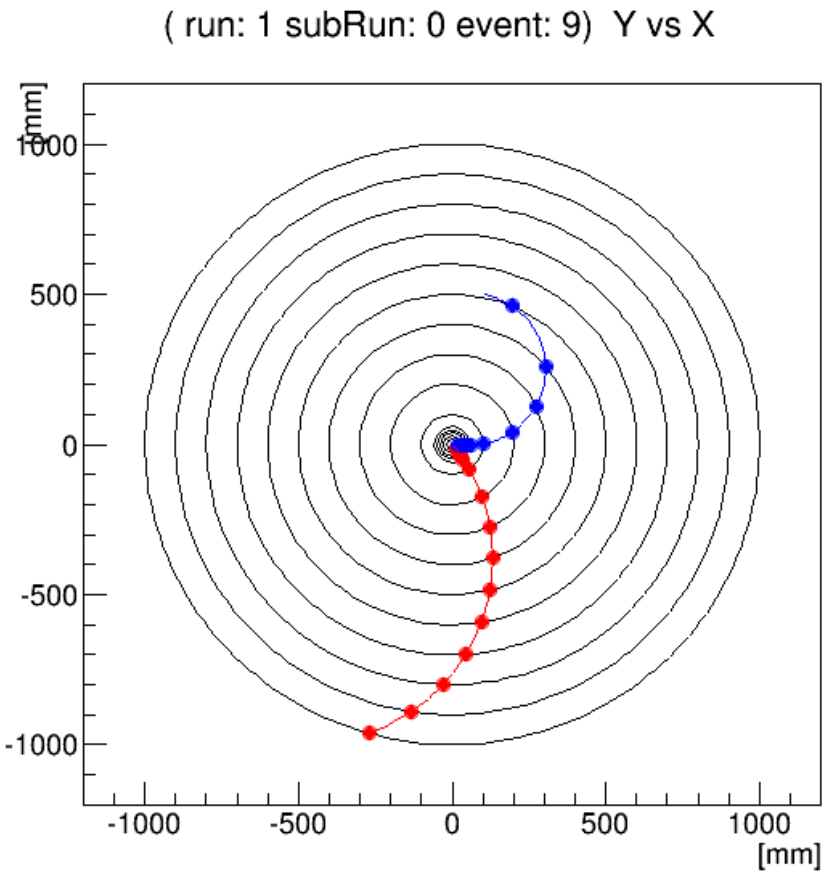
Event 6

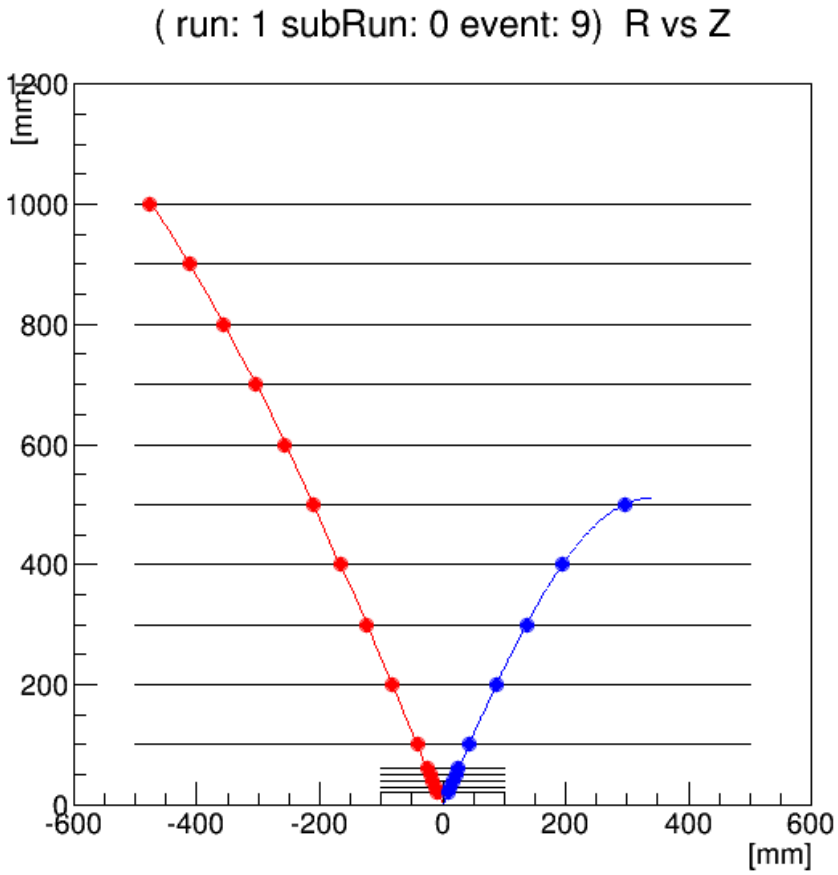




Both tracks go out the end.

Event 9



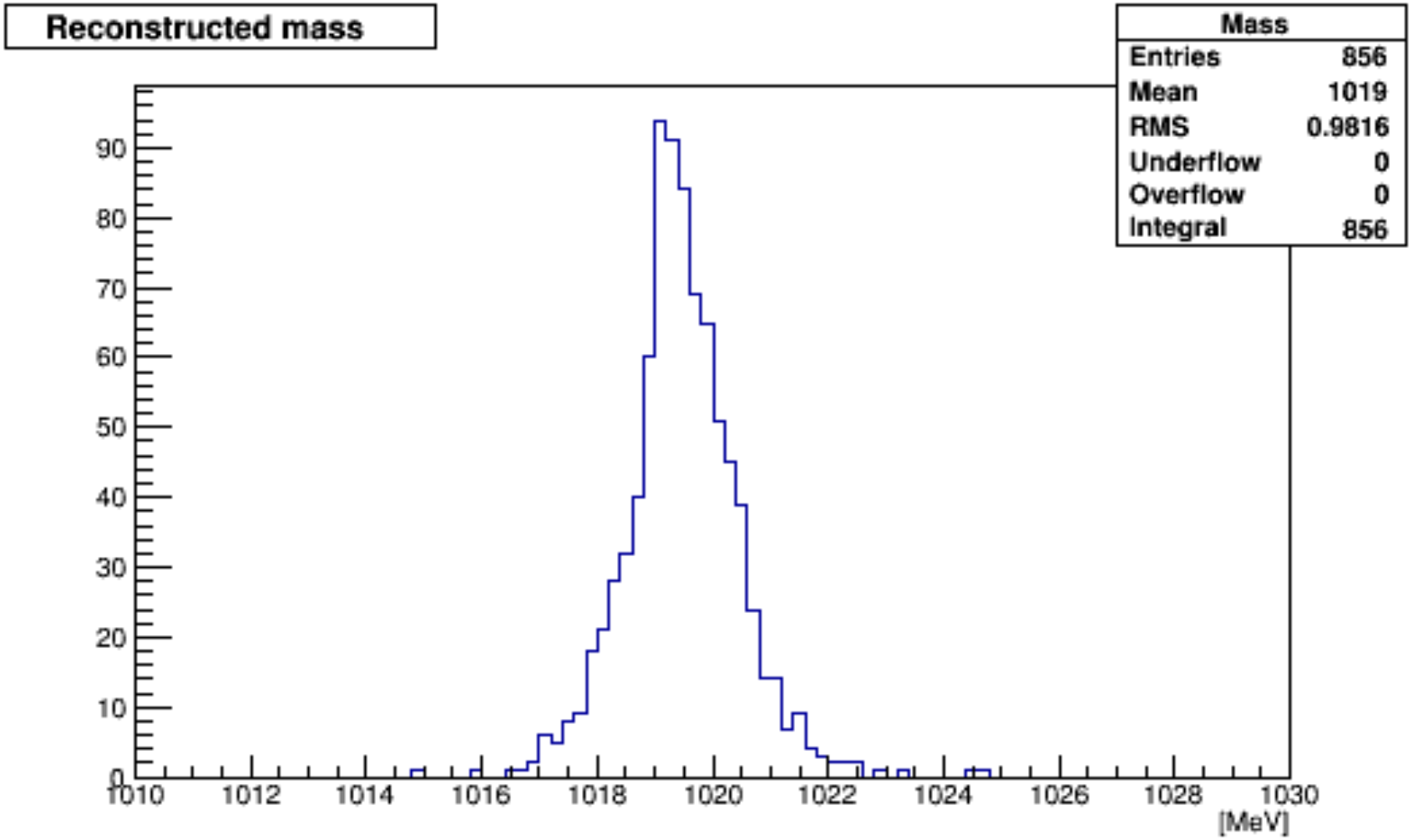


The simulation code stopped tracking the blue track (K^-) when it completed a full outgoing arc. Why? To reduce complexity for this toy example.

The Rest of the Story

- Simulation:
  - Use the intersections to compute data-like hits.
  - Make a helper to navigate back and forth between hits and intersections.
- Reconstruction:
  - Use the data-like hits to compute fitted tracks
    - Require minimum number of hits.
    - Prototype code uses MC truth. A later version will not.
  - If both K^+ and K^- are reconstructed, compute the invariant mass of the reconstructed K^+K^- system.

The Final Plot



From 1000 generated events, 856 reconstructed.

Example Files

- The exercises in the workbook use 4 input files that contain simulated event-data.
  - They are distributed in art-workbook-base
- There are example log files, root files and pdf files in:
  - /ds50/data/user/kutschke/workbook-blessed-outputs/

Get Started!

- Logging in, etc
  - https://cdcvs.fnal.gov/redmine/projects/darkside-public/wiki/Get_Started
- Starting the workbook
  - https://cdcvs.fnal.gov/redmine/projects/darkside-public/wiki/Working_the_Workbook
- Ask questions.