Name	Last commit
RooRarFit	Added RooRarFit modified package to the repo.
normal	Added Framework.
rho_separate	Added Framework.
rho_simultanious	Added Framework.
tables	Added Framework.
README.md	Initial commit

RICH STUDIES

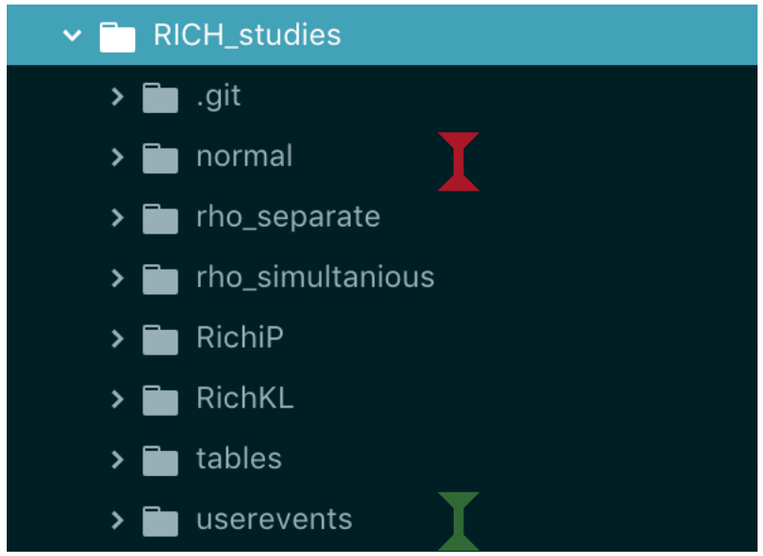
README.md

NICOLAS PIERRE - WORKSHOP

JULY 18, 2019

RICH_Matrices

RICH matrices computation framework.



- Two separate codes :
  - The PHAST user events for data selection
  - The RICH matrices computation code

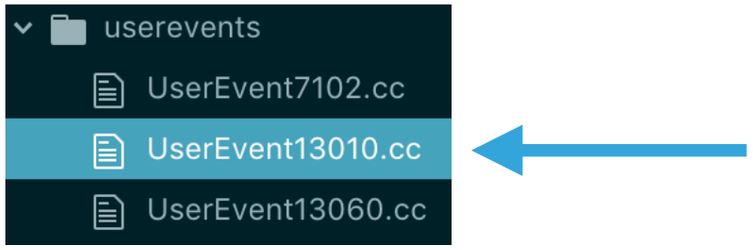
- Evaluation of the (mis)identification probabilities of pion/kaon/proton in bins of momenta and angle.
- Three samples of two body decay used.
- Cuts applied to data :
  - BPV with incoming and scattered muons
  - Primary vertex inside target (PaAlgo::InTarget)
  - Extrap. Track of incoming muon cross all target (PaAlgo::CrossCells)
  - $0.1 \leq y \leq 0.9$

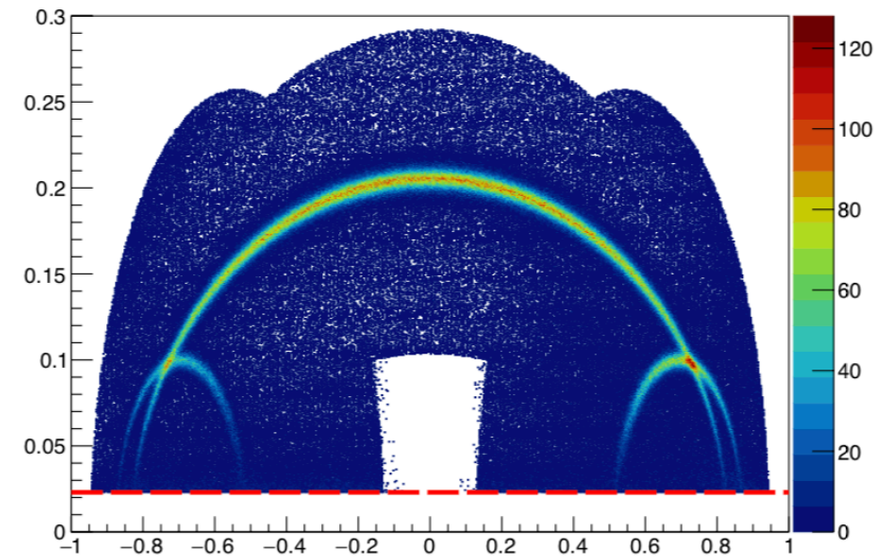
Samples used

$$K^0 \rightarrow \pi^+\pi^-$$

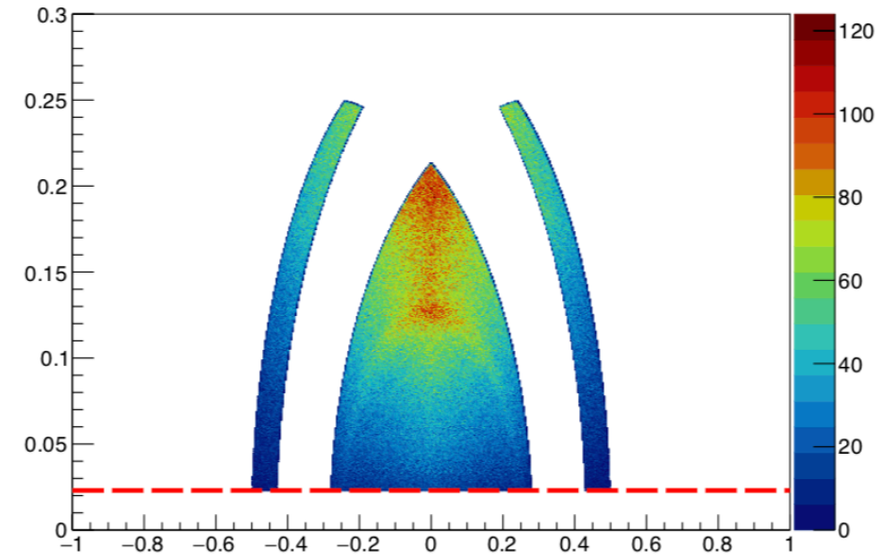
$$\Phi \rightarrow K^+K^-$$

$$\Lambda \rightarrow p\pi^-$$





1. Selection of good secondary vertices
   - Loop over all vertices
   - Vertex is not primary one
   - Exactly two opposite charged outgoing particles
   - The tracks should not be connected to any other primary vertex to ensure that they belong to a secondary vertex
   - Primary and secondary vertex separated by more than two times the reconstruction accuracy
2. Select good hadron tracks
   - Both particles should not have crossed more than 10 radiation length in order to supress the muons from the sample.
   - Last measured position (Z_{last}) behind SM1 to ensure a measured momentum
   - Transverse momentum with respect to the mother particle larger than 23 MeV to suppress electrons from photon conversion
   - Check that the decaying particle is connected to the primary vertex ($\theta_p \leqslant 0.01$)
3. Additional cuts
   - $p_h \geqslant 1$ GeV/c
   - Mass difference smaller than 150 MeV/c^2 between the K^0/Λ mass and the invariant mass of the two decay hadrons assuming the correct masses



1. Selection of possible good events with Φ mesons
   - At least three outgoing particles including scattered muon
   - Loop over all outgoing particles
   - Oppositely charged pairs of hadrons (none is a muon)
2. Select good hadron tracks
   - Last measured position (Z_{last}) behind SM1 to ensure a measured momentum
   - Transverse momentum with respect to the mother particle larger than 23 MeV to suppress electrons from photon conversion
3. Additional cuts
   - $9\ \mathrm{GeV/c} \leqslant p_h \leqslant 55\ \mathrm{GeV/c}$
   - Mass difference smaller than 120 $\mathrm{MeV/c^2}$ between the Φ mass and the invariant mass of the two decay hadrons assuming the kaon mass.

- Momentum p_h (GeV/c): $\{3, 5, 7, 10, 12, 13, 15, 17, 19, 22, 25, 27, 30, 35, 40, 50\}$
- Angle θ_h (rad): $\{0, 0.01, 0.04, 0.12, 0.3\}$

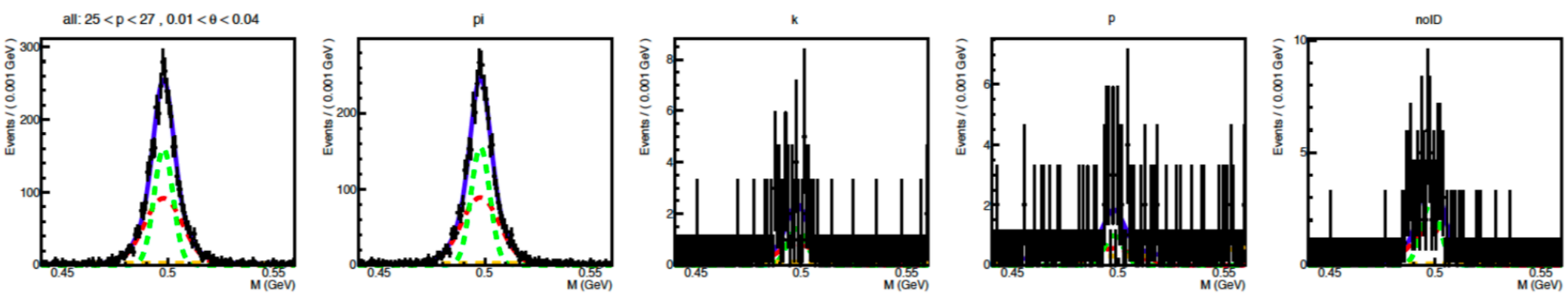
❖ Events put in five different groups (e.g. for π^+):

- All events (RICH not used for second particle)
- Events where π^+ is identified as π^+
- Events where π^+ is identified as K^+
- Events where π^+ is identified as p
- Events where π^+ is not identified

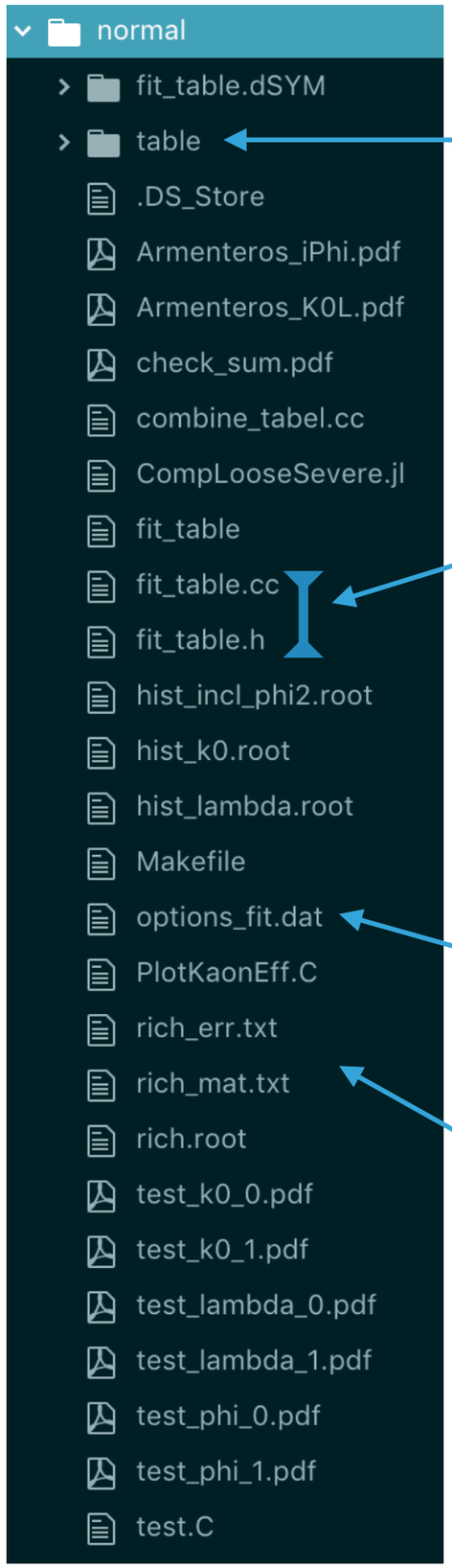
❖ Number of events determined by simultaneous fit of all five spectra.

SAMPLE	SIGNAL	BACKGROUND
K^0	$\delta G(\mu, \sigma_1) + (1-\delta) G(\mu, \sigma_2)$	$1 + ax + b(2x^2 - 1) + c(4x^3 - 3x)$
Φ	$BW(\mu, \sigma_1) \otimes G(\mu, \sigma_2)$	$(x-t)^n \cdot \exp(-a(x-t))$ with $t = 2 \cdot m_K$
Λ	$\delta G(\mu, \sigma_1) + (1-\delta) G(\mu, \sigma_2)$	$(x-t)^n \cdot \exp(-a(x-t))$ with $t = m_p + m_\pi$

K^0



COMPONENTS OF THE FRAMEWORK



- Plots of the probabilities
- Fit program: fits distribution and compute probabilities
- Works in two steps:
  - First plot the distributions for K^0, Λ and Φ.
  - Then fits the distributions
- Option file for the fit program (detailed afterward)
- Matrices in output

FRAMEWORK OPTION FILE

```
# type of analysis (K0L or iPhi)
analysis: K0L

# data file containing the reconstructed informations
data_file: ../RichKL

# data file template name
data_template: RichKL

# first and last data file
data_firstfile_nb: 274508
data_lastfile_nb: 276408

# Fit type
fit_type: all

# data file containing the histograms
hist_file_phi: ./hist_incl_phi2.root
hist_file_k0: ./hist_k0.root
hist_file_lam: ./hist_lambda.root

# data file containing the final results
out_file: rich.root

# remove the rich pipe from the sample
remove_richpipe: true

# difference allowed between proton threshold and real value
thr_diff: 5
```

For plotting the distribution, either K^0/Λ or Φ.

Where the files are located

The files should follow a template like XXX_#run.root

If fit_type == all, then combined fit.

Files containing the distributions.

Likelihood cuts

```
# Options for LH cuts for identifying pions
LH_pi_K: 1.0
LH_pi_p: 1.0
# LH_pi_e:
# LH_pi_mu:
LH_pi_bg: 2.0


# Options for LH cuts for identifying kaons
LH_K_pi: 1.06
LH_K_p: 1.06
# LH_K_e:
# LH_K_mu:
LH_K_bg: 2.0


# Options for LH cuts for identifying protons below threshold ( comparing with bg )
LH_bthr_p_pi: 1.
LH_bthr_p_K: 1.
# LH_bthr_p_p:
# LH_bthr_p_e:
# LH_bthr_p_mu:

# Options for LH cuts for identifying protons above threshold
LH_bthr_p_pi_bg: 2.3
LH_bthr_p_K_bg: 3.0
LH_bthr_m_pi_bg: 2.2
LH_bthr_m_K_bg: 2.9
```

RICH Matrices computation framework available on COMPASS GitLab

https://gitlab.cern.ch/compass/dvcs_sidis/rich/rich_matrices

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README.md

RICH_Matrices

RICH matrices computation framework.

How To Install the RICH Matrices framework ?

- PHAST User Event: the usual way
- The actual framework: a bit tricky
  - Build a special version of ROOT including RelativeBreitWigner.cc from RooRarFit (included in repo in modified/up-to-date state)
  - Then build the RICH Matrices framework (make)

How To Use the RICH Matrices framework ?

- Generate ROOT files with PHAST
- First ./fit_table plots for both cases and then ./fit_table fit to obtain matrices.

What takes the longest ?

- Generate ROOT files with PHAST
- .. and recompiling ROOT with the RooRarFit piece

Setup & Build

To setup the framework, you will need to reinstall your ROOT at some point. Thus have the source of your ROOT prepared.

First, you must compile RooRarFit that you can find on this repo. Look at the README of RooRarFit for further explanation, but short story is:

Verify your ROOT: `echo $ROOTSYS`

Then compile: `cd RooRarFit; make -f GNUmakefile bin`

Then in the ./tmp file, you take the three files:

- RooRelBreitWigner.cc,
- RooRelBreitWigner.hh,
- rarVersion.hh,

and copy them in your ROOT source in the according directories (include for .hh, src for .cc), renaming where necessary the .hh in .h and .cc in .cxx.

Modify the LinkDef.h to add the RooRelBreitWigner to the list, then compile your ROOT.

Eventually, you can compile the framework by doing in the `normal` directory : `make`