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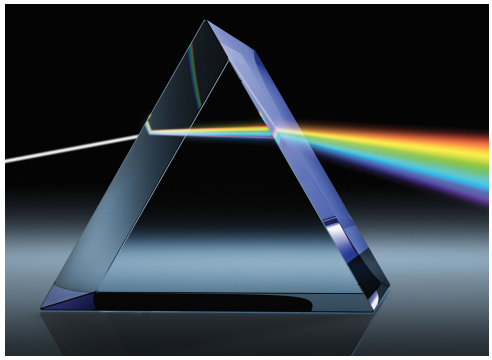
LHCb Global Particle ID



General information

Particle identification in LHCb is provided by four different detectors: the calorimeter system, the two RICH detectors and the muon stations. These pages are for the LHCb Global Particle ID, the combination of the individual sub-detector PID performance measures into a single source of information to be used by the physics applications.

A good introduction (at PhD student level) to the Particle Identification in LHCb can be found in this lecture. A concise and updated description of the Particle Identification in LHCb can be found in Section 4 of the LHCb Performance paper. In particular, Section 4.4 of the same document synthetically describes the methods used to combine the information for charged particles in a single set of variables that provide optimal particle identification performance.

An event display can be an useful tool to understand the detector. This talk presents a new 3D online and offline event display; it uses platform independent technology and established standards.The offline version for tests can be found here.

Mailing lists

Questions or comments concerning Particle Identification may be sent to the following mailling list: `lhcb-phys-PID-topics@cern.ch`. Please use this mailing list for ***general PID topics***.

Questions or comments concerning the PIDCalib packages may be sent to the following mailling list: `lhcb-phys-pid-calibration@cern.ch`. Please use ***this*** mailing list for any question that ***involves PIDCalib***.

If you wish to ask a question regarding the ***reconstruction of particle ID information***, you may post a message to the LHCb Da Vinci working group mail list.

Regular meetings

PID meetings: Particle Identification Indico category under LHCb Meetings Indico category

Muon ID meetings: Muon Indico category under LHCb Meetings Indico category

PPTS meetings: PPTS Indico category under LHCb Meetings Indico category

Workshops

PID workshop

Charge Asymmetry workshop

Here a link to very old (2005/2006) information.

PID liaisons

The Physics Analysis Working Groups provide liaisons to the Physics Performance Working Groups, like PID, and other key areas. The WG contacts are listed here. Below a list of responsibilities for the PID liaisons (have a look also to this presentation, from 24 September 2014 PID meeting):

- Attend the PID meetings (for now only "on demand" meetings, usually Wednesday 11am).
- Regularly inform WG on status of PID, in particular announce the release of new version of PIDCalib package, and inform about the existence of new PID samples.
- Collect from ongoing WG analyses, information and requirements related to PID, in particular for what concerns the evaluation of systematic effects.
- Notify the PID conveners about the lack of PID calibration samples that could be useful in some WG analyses, in particular for what concerns statistics of the control samples and/or kinematic coverage.
- Even if the matter is discussed also at the PPG, notify the PID conveners about the request of MC samples related to the PID.
- Notify in advance the PID conveners when there are important presentations/analyses concerning PID, to let the conveners decide whether to join the physics WG meeting and follow the relevant presentations.

Good examples of information/reports from liaisons: BnoC, SL, Flavor tagging, QEE.

Also this talk (prepared by the BnoC WG foe the A&S week in Oct 2013) is a very good example of "propagation of information".

PIDcalib

All is here: https://twiki.cern.ch/twiki/bin/view/LHCb/PIDCalibPackage, with very clear instructions: have a look!

A dated but very good tutorial can be found here. A comprehensive presentation (Jan 2014) can be found here.

Description of some technical improvements in PIDCalib can be found here. From this work the proposal for a TrigCalib tool, equivalent to PIDCalib but for trigger efficiency/performance evaluation.

PIDCalib: issue with systematics (P. Hunt and J. Otalora, PPTS of 8 Jul 2013 devoted to PID); here some technical detail.

PIDCalib in-depth talk (P. Hunt, PPTS 11 Nov 2013)

Discussion about efficiency obtained from sPlot and its possible bias by M. Schmelling and O. Schneider
See also sFit: concept, implementation and possible pitfalls from Y. Xie at the 50th A&S week (Jan 2013).

A detailed discussion about PID calibration uncertainties can be found in Sect. 8.1 of this ANA note.

Calibration data

Particle identification performance can be measured from data using the tag-and-probe method on suitable control samples: Jpsi -> ee from b decays are used for electrons (from Jpsi2eeForElectronIDBu2JpsiKLine stripping line), Jpsi -> mumu from b decays are used for muons (from JpsiFromBNoPIDNoMip stripping line), and D0 -> K pi from the Dstar -> D0 pi decays are used for pions and kaons (NoPIDDstarWithD02RSKPi stripping line). For protons two samples are used: Lambda -> p pi decays (from Lam0LLLine1V0ForPID stripping line) which has poor kinematic overlap with heavy physics decays, while the small sample of protons from _c decays (from ... stripping line) covers the higher kinematic region.

Detailed information about each stripping line can be found in the Stripping Project page (Useful link to svn repository). Stripping 21, released autumn 2014, is the legacy stripping for Run1 data, collected in 2012 and 2011 years.

PID topics

This section collects information relative to specific PID topics; for some a **specific task** has been assigned (see table below).

The tasks may be considered as part of the effort required during 2013-14 (and beyond) to maximize the physics potential of the existing data, and to prepare for higher energy collisions. The concept was outlined in a talk at the LHCb week, 7 September 2012, and further details were given in this talk.

Review of PID lines for Run2 (for both Stripping and HLT)

Ongoing work for the PID lines in HLT.

The status of the Stripping lines that are part of the Calibration stream are kept under control by the Calibration-Stripping liaison in this Twiki page.

The list of the Turbo lines can be found here.

The list of HLT PID lines can be found here.

A file with a summary of PID for RUn2 is attached at the end.

Online monitors from physics.

Resurrect a study done by Patrick Koppenburg about the idea of monitor the Luminosity using B, D and J/psi production. Here and here some material presented at the PPTS (March 2012).

Common MuonID for HLT and offline reconstruction.

The current Hlt muonID algorithm and the offline muonID are different. This is one of the last places (if not the last) where this still happens. The goal is to maximize the sharing between both parts. 100% would be optimal but maybe not feasible due to heavy timing constrains at the trigger level.

A task force with people from Offline and Trigger MuonID has been formed. Regular meeting held on Monday afternoon, 14.30-15.30. Use the following mailling list: `lhcb-muonID-HLT-offline@cern.ch` for discussion and information exchange.

Combined variables: DLL and ProbNN

The PID information obtained separately from the muon, RICH, and calorimeter systems is combined to provide a single set of more powerful variables. Two different approaches are used. In the first method (**`DLL`** variables) the likelihood information produced by each sub-system is simply added linearly, to form a set of combined likelihoods. These variables give a measure of how likely the mass hypothesis under consideration is, for any given track, relative to the pion hypothesis. A second approach (**`ProbNN`** variables) has been subsequently developed to improve upon the simple log likelihood variables both by taking into account correlations between the detector systems and also by including additional information. This is carried out using multivariate techniques, combining PID information from each sub-system into a single probability

value for each particle hypothesis.

Detailed information about the **ProbNN** approach can be found in this presentation; some comparative study of **DLL** versus **ProbNN** variable performance can be found here (A. Pearce, PPTS of 8 Jul 2013) and here (A. Hicheur, PID workshop, Jan 2014)

ProbNN variables use information from the tracking and the 3 PID systems, CALO RICH and MUON. The variables used as input for the **ProbNN** can be found here, actually sued at runtime to list what variables are used (looking at a specific file: the first 5 lines are other settings, the inputs start on the 6th; lines with a # at the start are commented out, so not used). The names in these files can then be match to actually know how data are extracted by looking at this file, which shows the mapping between the name and a helper class, and then to this which shows exactly what each helper does.

The training of **ProbNN** variables is done using MC inclusive B events. Actual performance depends on the tuning (blending of MC samples) used. A large collection of information on the various tunes can be found digging in this folder. For general purposes MCTuneV2 and MCTuneV3 tunings are available, that have different performance (ID and/or misID) and can be used simultaneously, the choice depending on the specific analysis. The main difference between MC12TuneV3 and MC12TuneV2 is that ghosts have been removed from the training samples (explicitly the ghost have been removed from the backgrounds of all the networks excluding the ghost one). This leads to an improvement in the performance for electrons (have a look to slides 18-23 here for a summary of electron ID performance with the two tunings) while for the other particles it is not that simple to say whether MCTuneV2 or MCTuneV3 is best.

To see which tune performs better in a specific analysis it is useful that the MCTuneV2 and MCTuneV3 might coexist. Users can directly compare themselves the two tunings by means of the new TupleTool TupleToolANNPID. This tool can be configured with a list of tunes, and will add each (with the tune in the variable name) to each stable particle you ask it to. The values are computed on the fly, rather than relying on the values saved in the ProtoParticles, and thus is able to save more than one tuning at the same time, which previously was not possible.

Charge asymmetry

A synthetic introduction to detector asymmetries can be found here (LHCb week, February 2013) and here (PID workshop, January 2014) for aspects more related to PID.

Charge asymmetry has been studied in detail using D+ -> K- + + events (see this talk, December 2012).

An internal note on measurement of the kaon detection asymmetry using double-tagged partially reconstructed D0 decays.

Detector asymmetry effects studied as systematic effects for a^D_SL measurement, presented here.

An internal note about the measurement of the K detection asymmetry.

Tracking asymmetry (P. Koppenburg, PPTS 11 March 2013)

Charge asymmetry versus (P. Koppenburg, PPTS 17 June 2013)

Asymmetries in NoBias data (P. Koppenburg, PPTS 26 August 2013)

#protonID

Proton ID

The state of the art in January 2014: a comprehensive summary and one with details on source of detection asymmetry.

Contribution to the p- separation from the Aerogel here, slides 13-19.

Photons and neutral objects

Link at the Calo Objects Twiki Page

Here the state of the art in January 2014

Presentation of useful tools: photonID and photon-pi0 separation. The latter is described also in INT-NOTE.

PIDCalib Internal Note

Produce a short document to describe the PIDCalib package beyond the regularly updated Twiki page.

MC resampling tool

A first study of a MC calibration for the PID variables can be found in this talk, slides from 3 to 7.

Need of corrected PID distributions in Monte Carlo e.g. to include them in a multi variate tool (BDTs..). First tool developed by BKstmumu working group for internal use only; here some documentation.

Add a new version of the tool (independent of BKstmumu framework) in PIDCalib package. Latest information can be found here and here.

Electron samples in PIDCalib

Add in PIDCalib electron samples from J/ -> ee decays; add to the other samples the variables to be tested against the electron hypothesis.

A summary of the electron PID before the work described in this task can be found here. First results were presented at the PPTS, 26 May 2014.

New proton samples in PIDCalib

Add in PIDCalib proton samples from _c decays (Existing coverage of -> p pi samples has poor kinematic overlap with heavy physics decays).

See also this presentation to know about the real increase of available proton statistics in the new samples.

Repository of PIDCalib data set

Find a stable destination of the PIDCalib data sets; present version uses /castor area of the user who produced the sample It seems that the best solution is to stored the files on EOS, at CERN. Philippe is currently creating the storage element in DIRAC, and Joel will create a dirac group for PID calibration.

Updated fits in PIDCalib

The determination of the hadron PID misidentification probabilities is a key ingredient of the Bsmm analysis. For this the Bsmm group performed a detailed study of the muon ID and misID, including a careful check of PIDCalib results. Details can be found in these presentations given in September 2013 and June 2014. A concise description of the work can be found in Section 4 of this internal note.

PID related tasks

The status of a task is identified by a color. A completed task is green. A task taken and in progress is blue; contribution is always welcome, but it's better to focus on the ones still free. A task available or that requires more effort is red.

Task name	Lead (tools, or other) group	Task description	People/groups involved	Effort/status	Past studies and/or expertise from
Fit in PIDCalib	Bsmm	Check PIDCalib code against fits implemented in Bsmm analysis	M. Palutan, M. Rama, B. Sciascia, R. Vazquez Gomez	Closed	
PIDCalib INT-NOTE	PID	Writing the note	A. Pearce	No/On going	
New Proton samples in PIDCalib	PID	Add in PIDCalib proton samples from _c decays (Existing coverage of -> p pi samples has poor kinematic overlap with heavy physics decays)	S. Ogilvy, S. Malde,	No/On going	M. Vesterinen, L. Carlson, Y. Zhang
MC resampling tool	PID	Write python scripts	M. Tresch,V. Rives Molina, A. Contu	No/On going	
Electron in PIDCalib	PID	Add in PIDCalib electron samples from J/psi -> ee decays; add to the other samples the variables to be tested against the electron hypothesis	T. Bird, S. Malde	Closed	M-H Shune, A. Shire
Disk space	PID/Computing	Find a stable destination of the PIDCalib data sets; present version uses /castor area of the user who produced the sample	S. Malde	Closed	B. Couturier
Unify Hlt-Offline MuonID	PID/Hlt	Unification and optimization of MuonID in Hlt and Offline	Task force leads by R. Vazquez Gomez	No/On going	

Miscellanea

The following is an organized collection of links to presentations (typically at PPTS meetings) more o less related to PID.

L0muon

L0muon efficiency (J. Cogan, PPTS 23 Jan 2012)

L0muon induced charge asymmetry (J. Cogan, PPTS 12 Mar 2012)

Neutral objects

Calo Objects tool: status report (E. Tournefier, 48th A&S week, 23 Apr 2012)

Charged PID 2012. Status report (C. Jones, 48th A&S week, 24 Apr 2012)

MC calibration of / 0 separation (M. Hoballah, PPTS session during 49th A&S week)

New Tools for Conversions and Bremsstrahlung (E. Tournefier, PPTS of 3 Dec 2012)

The photon ID revisited (M. Hoballah, PPTS of 15 Jul 2013)

Charged PID

PPTS of 14 May 2012 Charged PID session with contributions from all physics WG

PID session in the Subdetector reports, 4 Sept 2012, LHCb week Davos (contributions from Calo, RICH, and Muon)

RICH ID

RICH PID performance in 2012 by A. Powell (PPTS session during 49th A&S week, three PID contributions)

Muon ID

Overview of MuonID by B. Sciascia (PPTS session during 49th A&S week)

Muon-PIDCalib and MuonID performance in 2011 and 2012 data (J. Otalora, PPTS of 11 Mar 2013)

Sources of muon Mis-ID (Decay-in-flight on MC) (M. Schut and X. CId Vidal, PPTS of 2 Dec 2013)

Improvements in Muon ID (L. Anderlini and G. Graziani, PPTS of 2 Dec 2013)

Muon ID performance estimate in upgrade conditions (M. Palutan, B. Sciascia, R. Vazquez Gomez, PPTS of 2 Dec 2013)

Charge Asymmetry

Effect of PID on charge asymmetry in D+ ->K-pi+pi+ (The canary in the RICH) (H. Gordon and A. Powell, PPTS of 10 Dec 2012)

Stripping line for proton detection asymmetries (A. Pearce, P. Spradlin, S. Easo, PPTS 26 Aug 2013)

Charge Asymmetries in unbiased long tracks (P. Koppenburg, PPTS 26 Aug 2013)

Detection Asymmetries (M. Vesterinen, PPTS 7 Oct 2013)

Muon efficiencies, fake rates and asymmetries in 2012 data (C. Hadjivasiliou and M. Artuso, PPTS 7 Oct 2013)

Proton

Proton ID calibration (M. Coombes, PPTS of 14 Jan 2013)

Proton PID calibration with μ -tagged c pK (M. Vesterinen, PPTS of 18 Mar 2013)

Areogel discussion (RICH operation meeting of 12 Feb 2014)

Stripping line for proton detection asymmetries

A Stripping line devoted to the proton detection asymmetry has been presented at the PPTS 26 August 2013 and again at the Workshop on Beauty baryons at LHCb, 22 January 2014. An update has been discussed at WG SL meeting, 16 July 2014.

Combined PID and PIDCalib

PID Calibration and Mass Position & Resolution (C. Elsasser, PPTS of 8 Apr 2013)

PID calibration on R14S20 (P. Hunt and J. Otalora, PPTS session during 51th A&S week)

PID on 2015 (C. Jones, joint OPG/PPTS Meeting 25/11/2013 on 2015 restart)

Auto(magically) draw decay trees

"Auto(magically) draw decay trees" is a tool developed by Paul Seyfert. This Twiki page describes the background MC tree plotter presented for the first time at this PPTS meeting.

About alignment

This the link to the Twiki page for 2015 data.

Sub-detectors

The following section provide links to the latest information of the individual sub-systems (Twiki pages and to some general information).

RICH

Details on the RICH software and performance can be found here.

RICH Twiki page

PID performance plots, for the various reconstruction versions and datasets, can be found on the RICH-Online twiki page.

A good summary talk on PID performance in 2012 by Andrew Powell.

PPTS presentation describing RICH alignment for Run2 can be found here.

Calorimeters

Calo Twiki page and link to the Calo Objects Twiki page.

Online calibration for Run2 have presented here.

Muon system

The Muon System Software web pages can be found here.

Muon link to the Muon page.

HLT

General information about LHCb High Level Trigger can be found here.

The HLT incorporates RICH particle identification calculations that are designed to be faster than those used for the offline reconstruction, which is necessary due to the timing constraints imposed on the HLT. Detailed information can be found in the LHCb-PUB-2014-038 note.

Software

Full details on how particle ID is implemented in the LHCb, in the reconstruction application Brunel and the DaVinci Analysis framework, can be found here.

For tests on the StrippingLines see here: link

BarbaraSciascia - 2015-02-16

This topic: LHCb > GlobalParticleID
Topic revision: r44 - 2015-07-17 - BarbaraSciascia