FastSim Tools for charm threshold running

Gianluca Inguglia
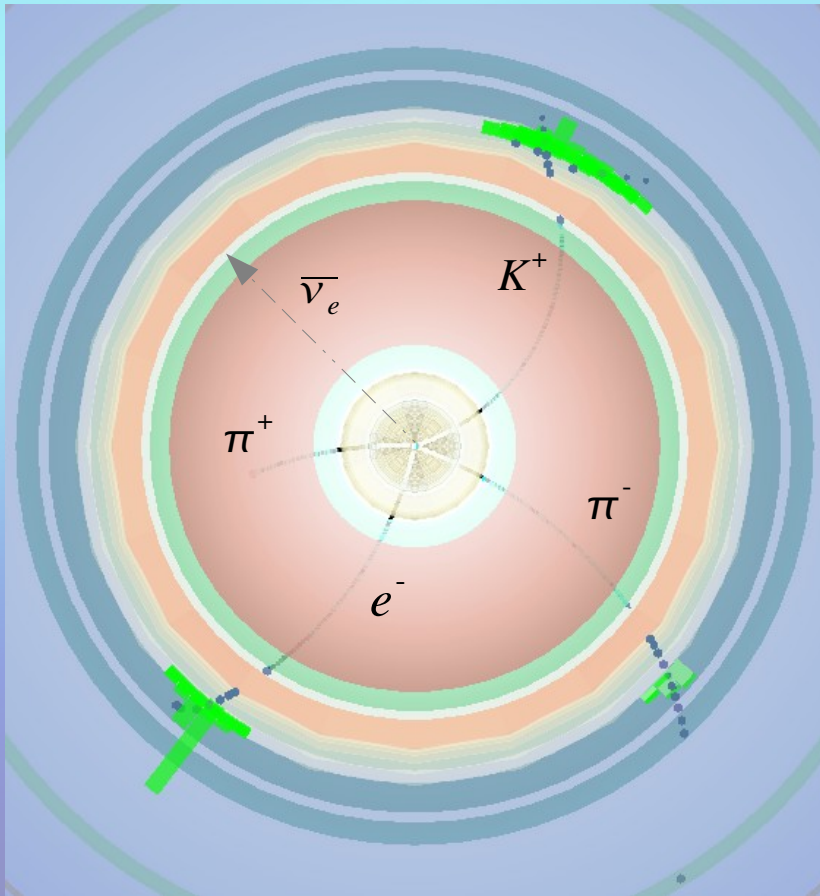Queen Mary University of London
g.inguglia@qmul.ac.uk

FastSim Tools for charm threshold running

→Charm at threshold with FastSim

→Tagging: state-of the art of the physics tools

→Future plans

FastSim at charm threshold
$\overline{D0} \rightarrow$ semi-leptonic, D0 $\rightarrow$ π+π-
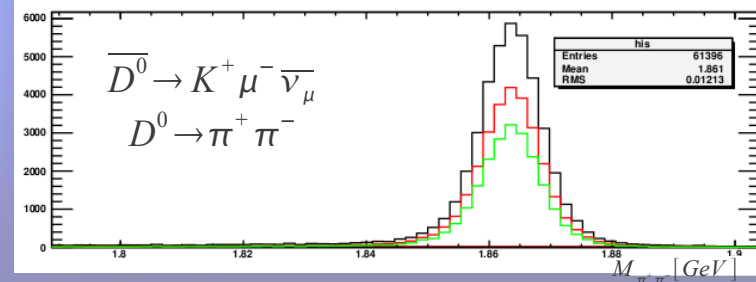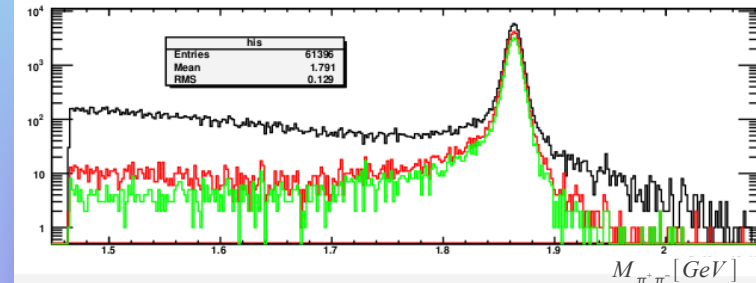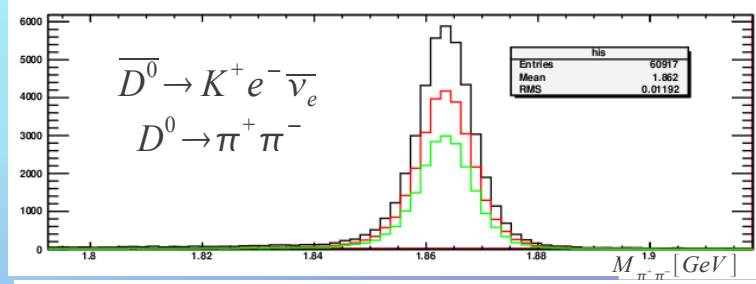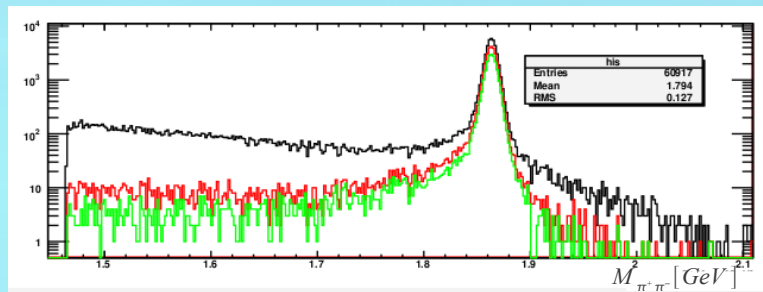

Tasks:

- Identify the D^0 decay channels to study (CP).
- Select the channel to flavor tag the D^0 mesons.
- Find the vertex position.
- Perform the analysis in terms of Δz (Δt) as shown in the next slide.

FastSim at charm threshold
$\overline{D^0} \rightarrow$ semi-leptonic, $D^0 \rightarrow \pi^+\pi^-$

- **No constraints** (black)
- **4 charged particles** (red)
- **4 charged particles and 2 pions** (green)

Still working on selection of SL tagged events!

NOT enough to perform the time-dependent analysis...

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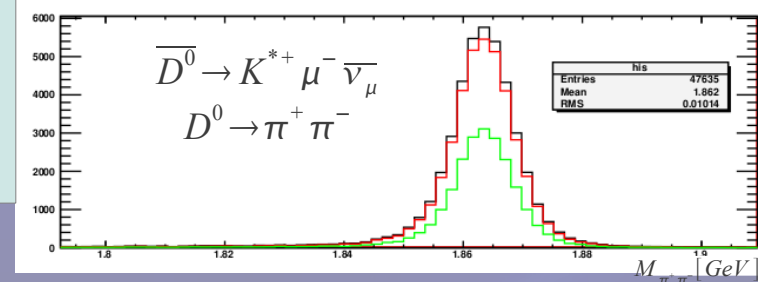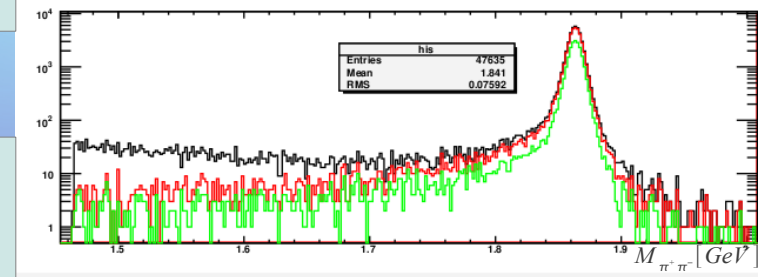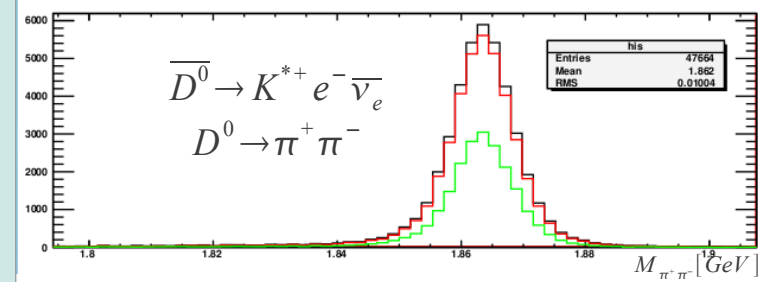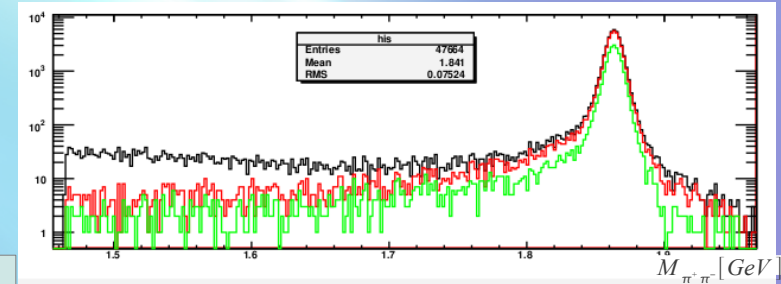
We need something more to flavor tag D mesons...

Correlated mesons and flavor tagging
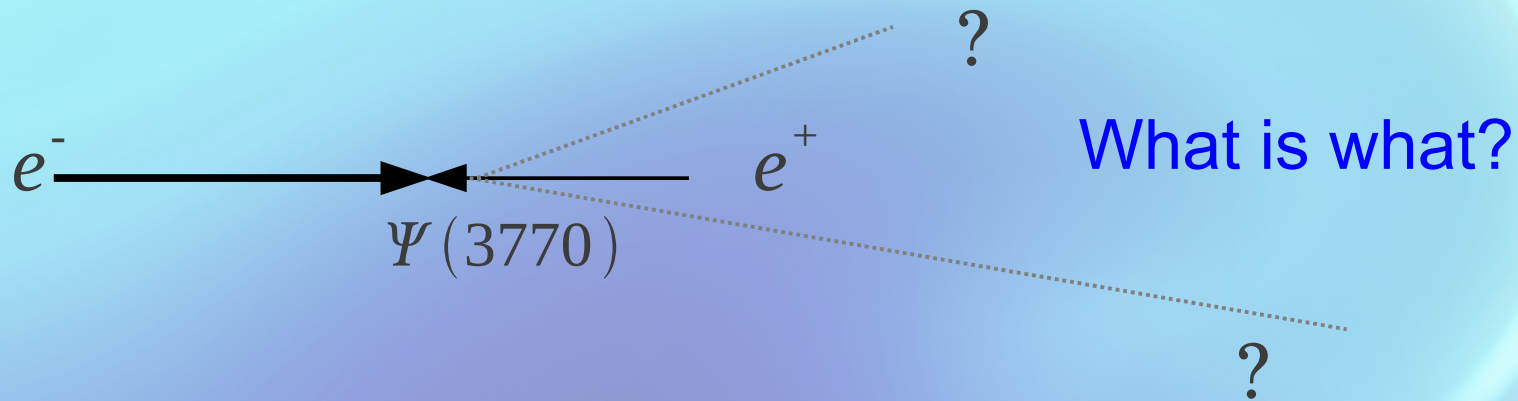
Correlated mesons and flavor tagging
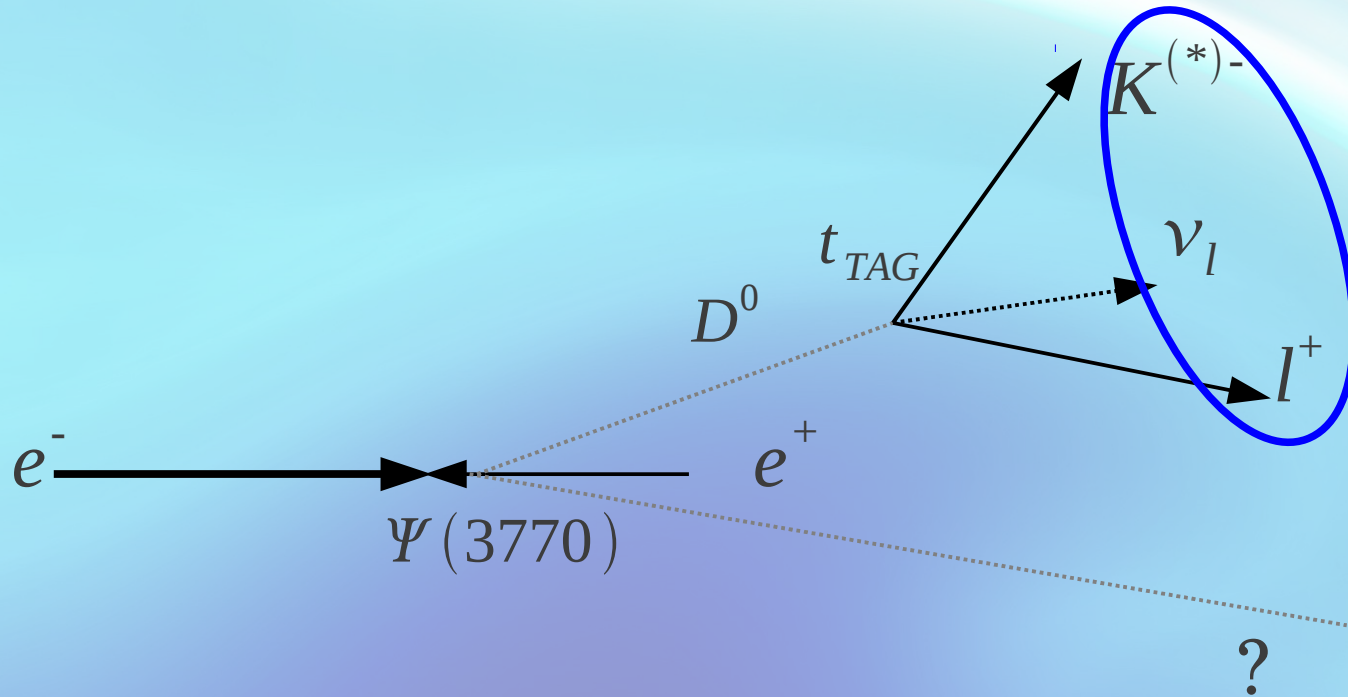
Finding one or more channels that may used to unambiguously identify the flavor of a D meson

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Correlated mesons and flavor tagging
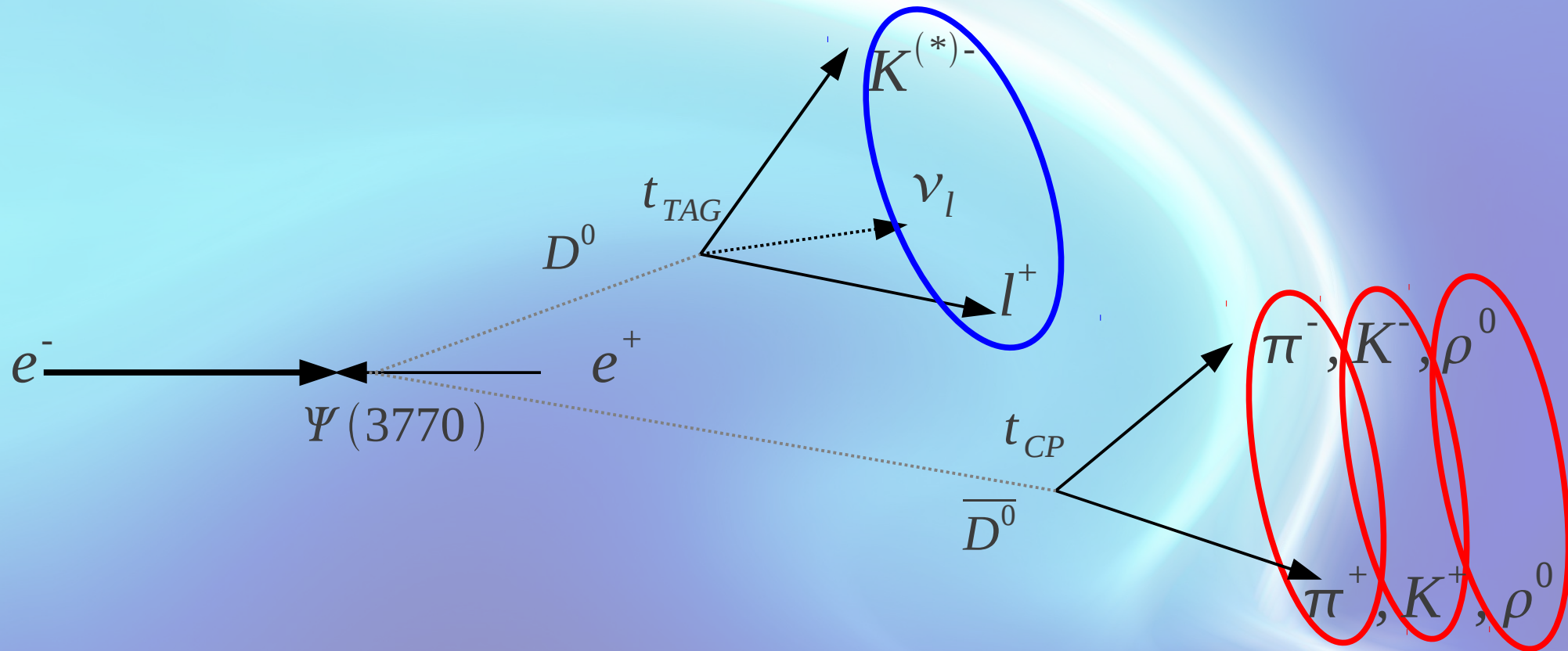
Finding one or more channels that may used to unambiguously identify the flavor of a D meson will enable to automatically identify the flavor of the other meson.

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Correlated mesons and flavor tagging

Identifying the two vertices one is able to perform time-dependent studies (i.e. time-dependent CP violation in charm: Bevan-Inguglia-Meadows, ArXiv:1106.5075)

Correlated mesons and flavor tagging

A run at ψ(3772) can be made where the mistag probability is effectively zero

D mesons are produced in a correlated antisymmetric wave function. The Einstein-Podolsky-Rosen paradox implies that if at a time t_{tag} one decays then we identify the other as well.

$K^{(*)-}$

ν_l

t_{TAG}

D^0

l^+

e^-

e^+

$\Psi(3770)$

π^-, K^-, ρ^0

t_{CP}

$\overline{D^0}$

π^+, K^+, ρ^0

$\Delta z \approx \Delta t \beta \gamma c$
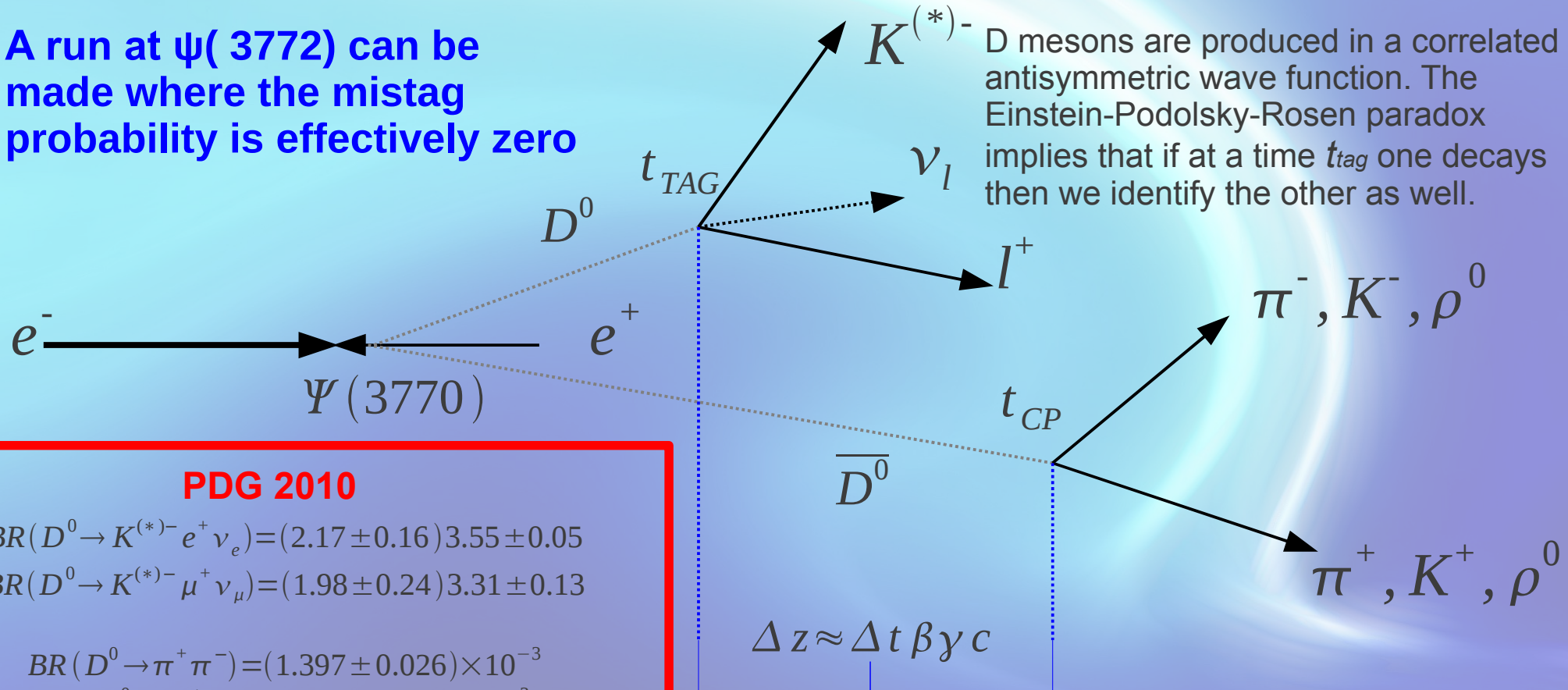
PDG 2010

$$BR(D^0 \rightarrow K^{(*)-} e^+ \nu_e) = (2.17 \pm 0.16)\, 3.55 \pm 0.05$$
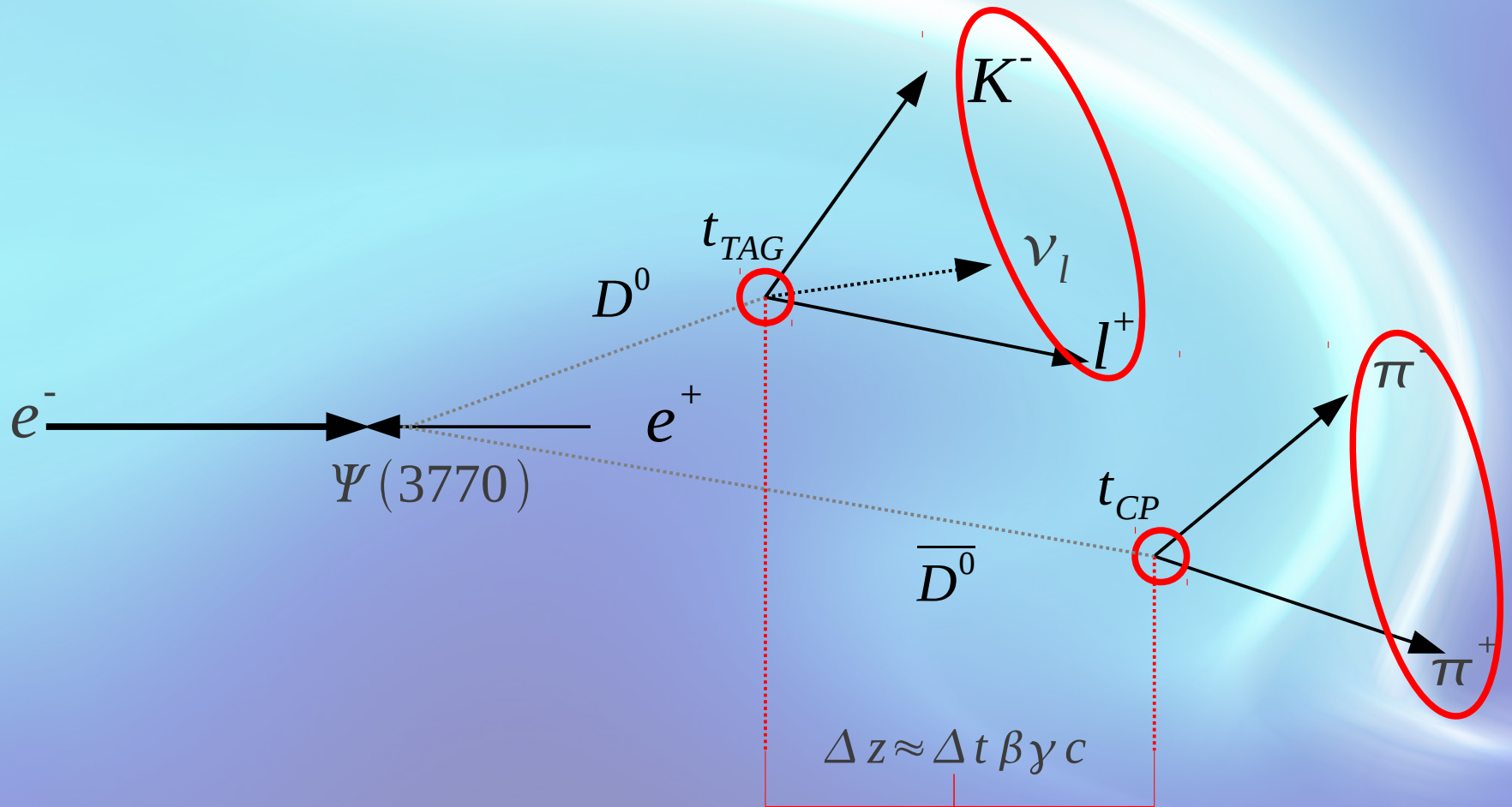$$BR(D^0 \rightarrow K^{(*)-} \mu^+ \nu_\mu) = (1.98 \pm 0.24)\, 3.31 \pm 0.13$$

$$BR(D^0 \rightarrow \pi^+ \pi^-) = (1.397 \pm 0.026) \times 10^{-3}$$
$$BR(D^0 \rightarrow K^+ K^-) = (3.94 \pm 0.07) \times 10^{-3}$$

At time t_{TAG} the decays $D \rightarrow K^{-(+)} l^{+(-)} \nu_l$ account for 11% of all D decays and unambiguously assigns the flavour : D^0 is associated to a l^+, $\overline{D^0}$ is associated to a l^-

One may consider $D^0 \rightarrow K^-X$ (X=anything) to flavor-tag a D^0 meson with a mistag probability ~3% and a total BR~54%

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We need something more to flavor tag
D mesons...

...We need a *Charm Tagging Package!*

Charm tagging package

- AbsDTagging

- DtaggingSequence

- DtaggingTools

- DtaggingUser

- DtaggingUtils

- Psi3770Tools

Charm tagging package

- →AbsDTagging   abstract interface for D flavor tagging

- DtaggingSequence

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Charm tagging package

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Package containing all the needed sequences, starting from a list of BtaCandidates

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Charm tagging package

- → AbsDTagging   Abstract interface for D flavor tagging

- Fundamental concept in *Object Oriented Programming* (OOP)
- Abstract classes and interfaces only define methods and properties to be implemented from their *derived classes.*
- Could be considered as a "template" class/interface.

```
public abstract class Mammal{          public class Man: Mammal {

//abstract method                      //abstract method

public abstract GetWalkingWay();       public override string GetWalkingWay();

//abstract property                    //abtract property

public abstract string Name { get; set; }   public override string Name { get; set; }

...                                    ...

}                                      }
```
Do NOT implement "WalkingWay"   DO implement "WalkingWay"

AbsDTagger.hh   AbsTagInfoMaker.hh   AbsTaggingFactory.hh
#link_AbsDTagging.mk#
AbsDTag.hh   AbsVtxInfoMaker.hh   link_AbsDTagging.mk

Charm tagging package

- → DtaggingSequence Package containing all the needed sequence, starting from a list of BtaCandidates

Create AbsEventTags which contains information on the D-recoil and on the fully reconstructed D

• DtsConfigureDispatch.tcl	Set the tagger. For B mesons BtgBTaggerTag04, BtgBTaggerTag08. DtgDTaggerTag12 for D mesons.
• DtsTaggingSequence.tcl	Script which configures a standard sequence to write all the Dtag information into the event.
• DtsVtxTagSequence.tcl	Standard composition tools. Good tracks for vertex tag reconstruction. Channel selector ($K^0_s \rightarrow \pi^+ \pi^-$)

Charm tagging package

- → DtaggingTools

Repository package for miscellaneous physics analysis tools and utilities

- DtaggingTools/include

Different channels to flavor tag the D mesons are defined here, as well PID, truth and discriminator

- DtaggingTools/training/Tag12

This is the Dtagger: it requires input parameters and use snns file to perform the tag.

Charm tagging package

- →DtaggingUser

Repository for analysis tools and utilities used for studies

- TwobodyTaganal.tcl

creates a Dtagging ntuple

*
*
*
*

*
*
*
*

- DtaggingMicroSequence.tcl

Writing Dtagging information into the Dtagging ntuple

*
*
*
*

*
*
*

Etc.

Charm tagging package

• →DtaggingUtils	Package containing "low" level utilities
• InfoDumper	Tool to extract and write out information into different formats like e.g. ntuples, histograms, or ASCII files, with the goal to separate the accumulation of information from its output into different formats.
• InfoDiscriminator	A base class for implementing discrimination algorithms (e.g. building blocks for tagging algorithms) which take n input variables and produce an output variable. InfoDiscriminator uses InfoDumper for its basic I/O functionality

Charm tagging package

- →Psi3770Tools

```
DtsConvertAttributes.hh                              DtsVtxTIMaker.hh
DtsPlainTIMaker.hh          DtsVertexerFactory.hh    DtsWriteASCII.hh
DtsTaggingDispatch.hh       DtsVertexInfoMaker.hh    DtsWriteDecayModeFactory.hh
DtsTaggingInfoMaker.hh      DtsVertexWrapper.hh      DtsWriteDecayMode.hh
DtsTaggingNtpDump.hh        DtsVtxTagConfig.hh       link_Psi3770Tools.mk
DtsTaggingWrapper.hh        DtsVtxTagMaker.hh
```

Charm tagging package

- All these tools and components have been created, but they are NOT (yet!) available.

- Neural networks still need to be understood.

- We are now studying the tag side using semi-leptonic D^0 decays and we will generalise the work for K-tagged D^0 .

- We are writing a guide/introduction to the TaggingTools.

- Some good news hopefully will come soon.

- <u>FEEL FREE</u> to contact me and get involved..

Many thanks