

# Multivariate Analysis :

optimisation → tagging, PID, BKG suppression

1<sup>st</sup> “large” report

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**On behalf of the MVA chapter editors and contributors**

## Summary of decisions taken during 1<sup>st</sup> workshop at SLAC

Reorganisation of the former “MVA/Analysis Optimisation” chapters

## Status of various subchapters

General Introduction / Analysis Optimisation

Tagging algorithms

PID algorithms

Continuum-suppression algorithms

## Manpower, timing issues

## Outcome from 1<sup>st</sup> worksop : reorganisation

Tools and methods	43
3 Flavor tagging	43
4 Vertexing	65
5 Resol $B$ meson reconstruction	74
6 Multivariate discriminants	94
7 Maximum likelihood fitting	112
8 Dalitz analysis	127
9 Analysis optimization	142
10 Blind analysis	149

### From the 1st “strawman draft” :

a few disconnected chapters  
flavour tagging  
multivariate discriminants  
analysis optimisation

all refer to tools/methods based on similar methods

about 50 pages in total in 1<sup>st</sup> count

yet PID missing from list  
not suitable for detector part

## Outcome from 1<sup>st</sup> workshp : reorganisation

<b>Tools and methods</b>	<b>1</b>
4 Vertexing . . . . .	1
5 Multivariate discriminants . . . . .	1
5.1 Particle identification . . . . .	1
5.2 Flavor tagging . . . . .	1
5.3 Background discrimination . . . . .	1
5.4 Analysis optimization . . . . .	1
6 <i>B</i> -meson reconstruction . . . . .	1
7 Time-dependent analyses . . . . .	1
8 Maximum likelihood fitting . . . . .	1
9 Dalitz analysis . . . . .	1
10 Angular analysis . . . . .	1
11 Blind analysis . . . . .	1

– Part B on “Tools and methods” contains a large chapter on “Multivariate discriminants” into which three previously independent chapters — on “Flavor tagging”, “Background discrimination”, and “Analysis optimization” — have been absorbed as sections; a new section on “Particle identification” has also been added.

### **(retained) reorganisation proposal :**

**a single chapter, with 4 sections**

**a general introduction :**

**structures the overall landscape  
useful for students**

**3 specific applications :**

**tagging, PID, bkg suppression**

**easier to manage (and decrease page length)**

# Analysis optimization

## Section

**Analysis optimization**

### Subsection

**Introduction**

**Notations**

**Figures of merit**

**Methods**

### Subsubsection

**Rectangular cuts**

**Linear discriminants**

**Neural nets**

**Binary decision trees**

**Boosting**

**Bagging**

**Random Forest**

### Subsection

**Available tools**

### Main features :

Pedagogical introduction

Fix notations

framework reference for the  
specific applications following

**± 6-8 pages**

### Main section editor

Frank Porter

### Identified contributors

Ilya Narski, José Ocariz

Belle ?

# Flavor tagging

## Section

### Flavor tagging

#### Subsection

##### Introduction

Definitions

Physics sources of tagging information

Multivariate methods used

Things we tried, what worked, what didn't ?

#### Subsection

##### Flavor tagging algorithms

BaBar and Belle algorithms

Categories

#### Subsection

##### Measuring flavor tagging performance

History of tagging performance in Belle and BaBar

#### Subsection

##### Systematic effects

Tag-side interference

#### Main features :

Example of MVA application

Specific to B-factories

To be broadly referenced

± 8 pages

#### Main section editor(s)

Juerg Beringer

Belle ?

# Particle Identification

Outline could look like :

## Section

**Particle Identification**

## Subsection

**Introduction**

**Definitions**

**Detector and physics sources of PID**

**Multivariate methods used**

## Subsection

**PID algorithms**

**BaBar and Belle algorithms**

## Subsection

**Measuring PID performance**

**History of PID performance in Belle and BaBar**

## Subsection

**Systematic effects**

Main features :

Example of MVA application

Large references to detector part

Does not fit into detector part

To be broadly referenced

± 6-8 pages ?

Main section editor(s) : TBD!

Potential contributors

ongoing contacts (BaBar), Belle ?

## Background suppression

### Section

#### Background suppression

##### Subsection

##### Introduction

##### Sources of backgrounds: continuum, B-related

##### Subsection

##### Kinematical discrimination

$m_{ES}/M_{bc}$ ,  $\Delta E$ , intermediate resonant masses, angular distributions

##### Subsection

##### Topological discrimination

Information from complete event and/or ROE

Thrust, B momentum, energy flow, Legendre, *SFW*, etc...

##### Subsection

##### Optimisation criteria

S/B, significance, minimize systematics, CPU-related.

linear vs. non-linear, treatment of correlations, etc...

##### Subsection

##### History

##### Subsection

##### Validations, systematics

### Main features :

Various examples of MVA apps

To be broadly referenced

Feedback/interplay with physics chapters

### Main section editors

Hidekazu Kakuno, José Ocariz

### Identified contributors

several volunteers (BaBar)

± 8 pages

### Discussion of some interesting MVA-related topics

(e.g. time-evolution of performances, of optimisation criteria)  
would add value to the pedagogical purpose of the book  
implementation foreseen in the tagging and PID sections  
for bkg suppression, would be better illustrated with physics examples

### Example from BaBar : optimisation criteria in $B \rightarrow \pi\pi, K\pi$

suppress continuum vs. minimize systematics  
different requirements for CP analyses vs. BR analyses  
could be discussed in the charmless chapters or here

### Example from BaBar : background suppression in charmless Dalitz $B \rightarrow hhh$

treatment of non-linear correlations wrt Dalitz variables  
“external” technical considerations (i.e. CPU)  
could be discussed in the charmless, Dalitz chapters or here

### Decisions on whether/where to include such topics :

requires discussion with global and physics editors  
may bring forward-referencings and (mild )revisiting of section structure  
needs to check relevance on the Belle side

### Overall chapter/section structure

designed to ensure global coherence and minimize redundancies  
suits the pedagogical purpose of the book

### Manpower

tagging, background-suppression  $\pm$ OK ...  
... less true for PID...

a few important contacts yet to be established  
need both BaBar/Belle contributors on all sections  
→ homework for us chapter editors!

### Timing

most chapter writing could start now  
interplay/feedback with physics chapters  
check for specific needs and redundancies  
channel-oriented illustrations of specific MVA features