Generic MC Generator for $e^+e^- \to$ Hadrons at $\sqrt{s} < 2$ GeV

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Outline

1. Concept
2. Some results
3. Summary

Concept

- There is a need for a generic MC generator approximately reproducing real picture of $e^+e^- \to$ hadrons below 2 GeV
- Such generators exist for higher energy ranges: LUND, PYTHIA, ... based on a complicated scheme of quark and gluon hadronization and provide events of $e^+e^- \to q\bar{q}$, $q = u, d, s, c, b$
- These generators are used for background estimation
- One can't create a generator based on first principles at low energy $\Rightarrow$ Existing data on cross sections should be used

Algorithm

- A database of all σ measurements created
- Energy dependence of σ for each exclusive final state is approximated by a physically motivated analytic function $f_i(s)$
- Event generation:
  - $\sigma_{\rm tot}(s) = \Sigma f_i(s)$ calculated at needed $\sqrt{s}$ based on $f_i(s)$
  - A random number specifying the final state is sampled
  - An event of the specific process is sampled based on the corresponding dynamics

Processes Considered – I

Process	σ	ME	Process	σ	ME
$\pi^+\pi^-$	+	+[a]	$2\pi^+2\pi^-\pi^0$	+	PS
$\pi^+\pi^-\pi^0$	+	+[b]	$\pi^+\pi^-3\pi^0$	IR	PS
$\pi^+\pi^-\pi^+\pi^-$	+	+[c]	$3\pi^+3\pi^-$	+	PS
$\pi^+\pi^-\pi^0\pi^0$	+	+[d]	$2\pi^+2\pi^-2\pi^0$	+	PS
–	–	–	$\pi^+\pi^-4\pi^0$	IR	PS

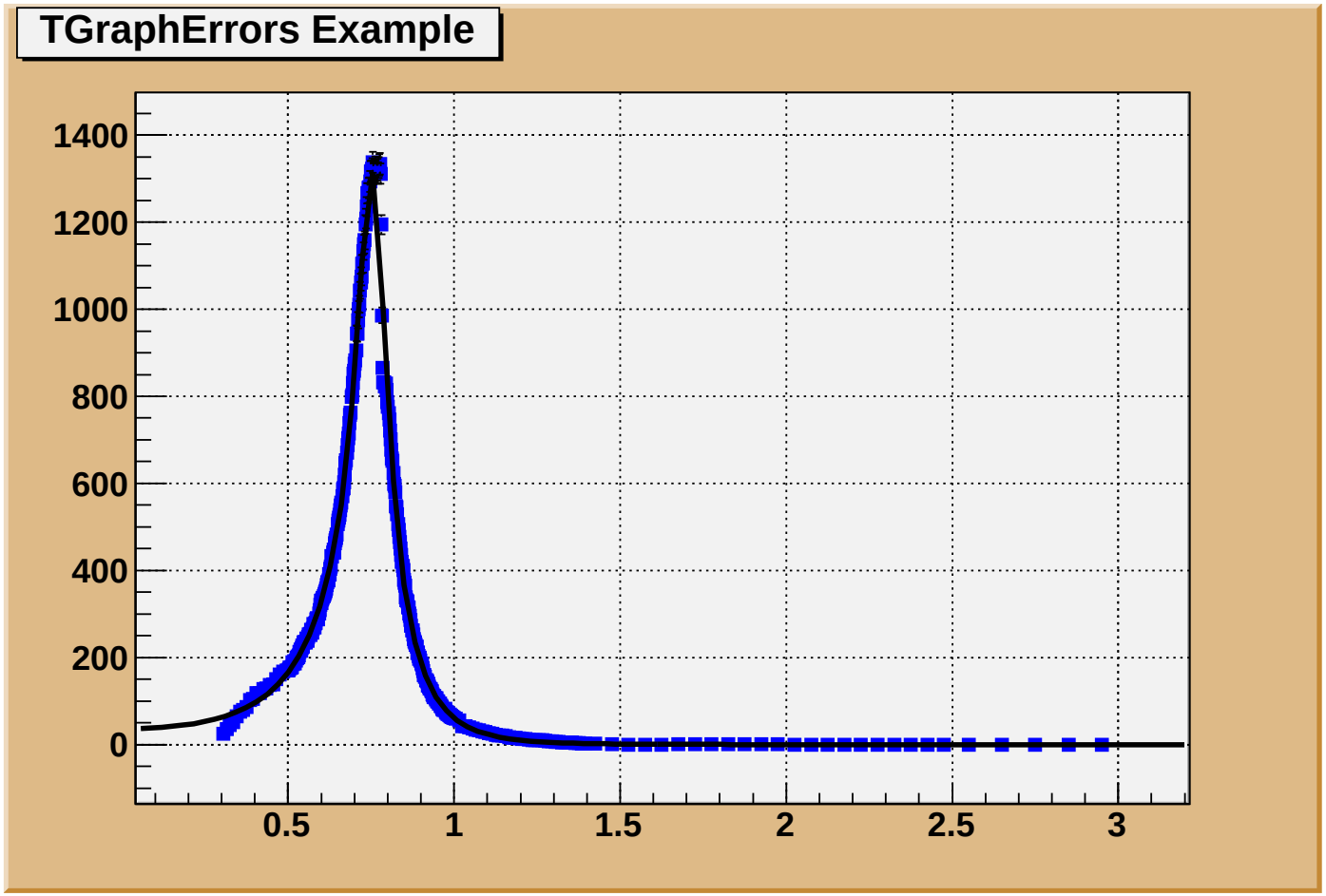
Processes Considered – II

Process	σ	ME	Process	σ	ME
K^+K^-	+	+[a]	$K^+K^-\pi^+\pi^-$	+	PS
$K^0_SK^0_L$	+	+[b]	$K^+K^-\pi^0\pi^0$	+	PS
$K^+K^-\pi^0$	+	PS	$K^\pm K^0_S\pi^\mp\pi^0$	IR	PS
$K^0_SK^0_L\pi^0$	IR	PS	$K^\pm K^0_L\pi^\mp\pi^0$	IR	PS
$K^\pm K^0_S\pi^\mp$	+	PS	$K^0\bar{K}^0\pi^+\pi^-$	IR	PS
$K^\pm K^0_L\pi^\mp$	IR	PS	$K^0\bar{K}^0\pi^0\pi^0$	IR	PS

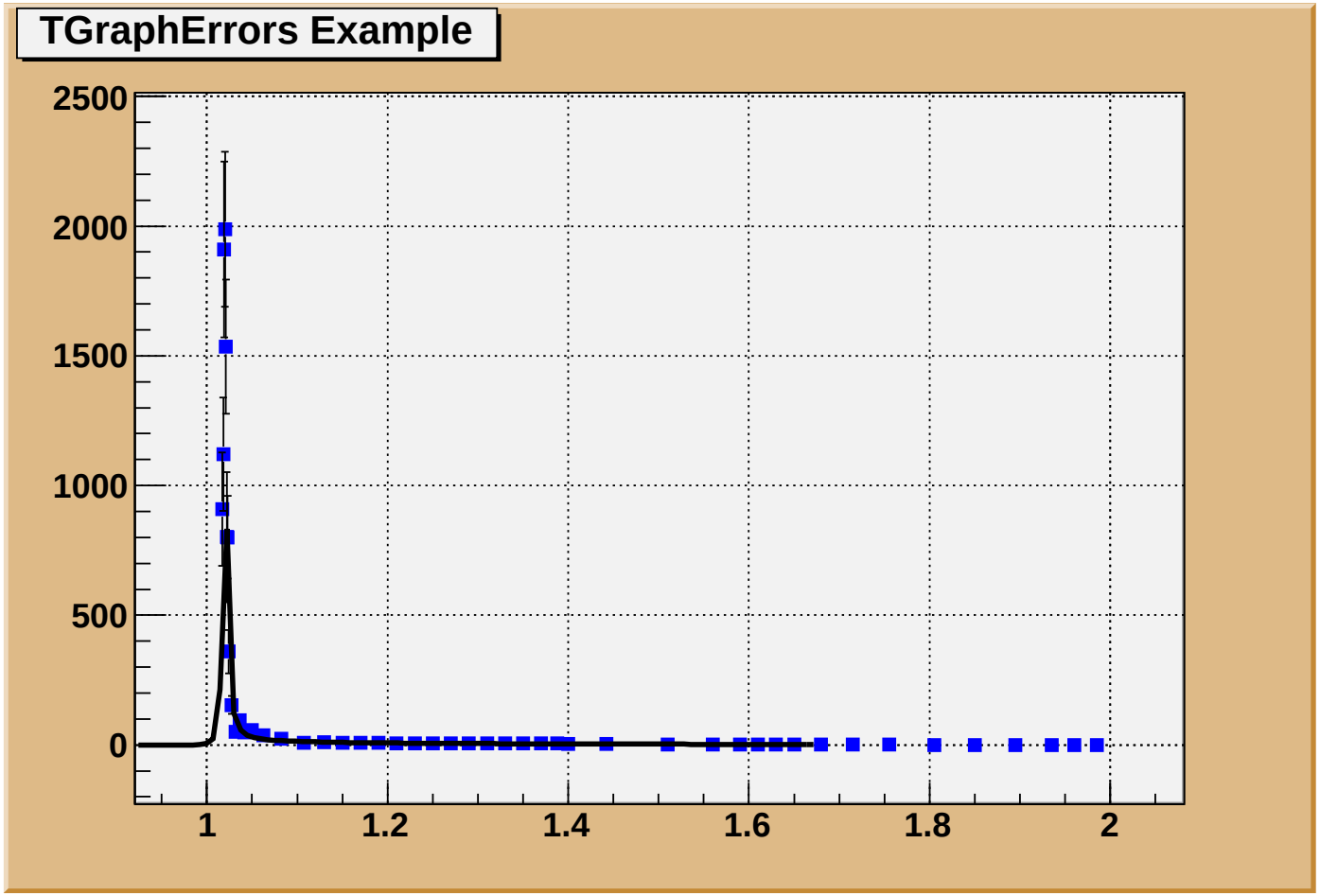
Processes Considered – II

Process	σ	ME	Process	σ	ME
$\pi^0\gamma$	-	-	$p\overline{p}$	-	-
$\eta\gamma$	-	-	$n\overline{n}$	-	-
$\pi^0\pi^0\gamma$	-	-	$\pi^+\pi^-\eta$	-	-
$\eta\pi^0\gamma$	-	-	$K^+K^-\eta$	-	-
–	–	–	$\pi^+\pi^-\pi^0\eta$	-	-

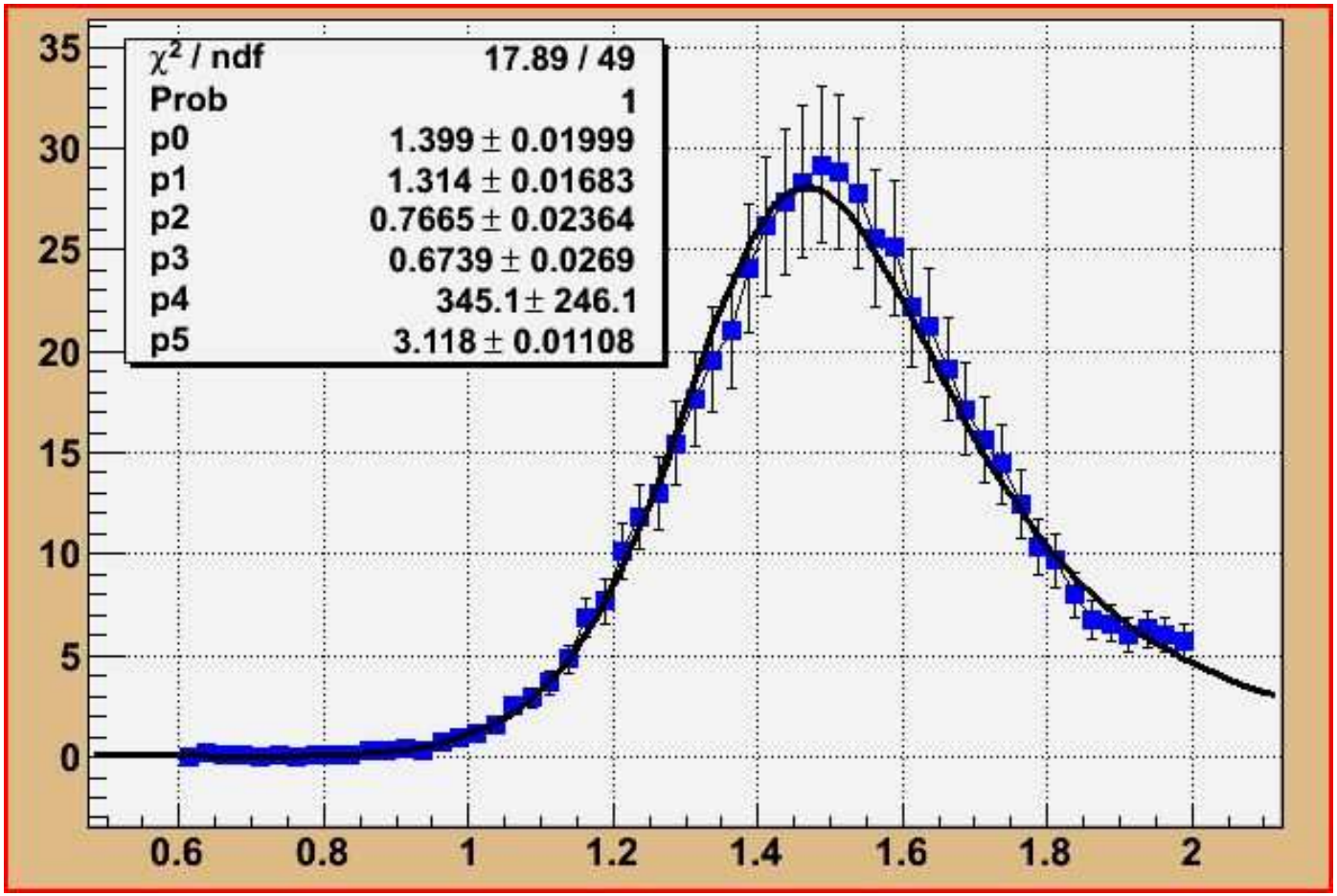
$e^+e^- \to \pi^+\pi^-$


TGraphErrors Example
1400
1200
1000
800
600
400
200
0
0.5
1
1.5
2
2.5
3

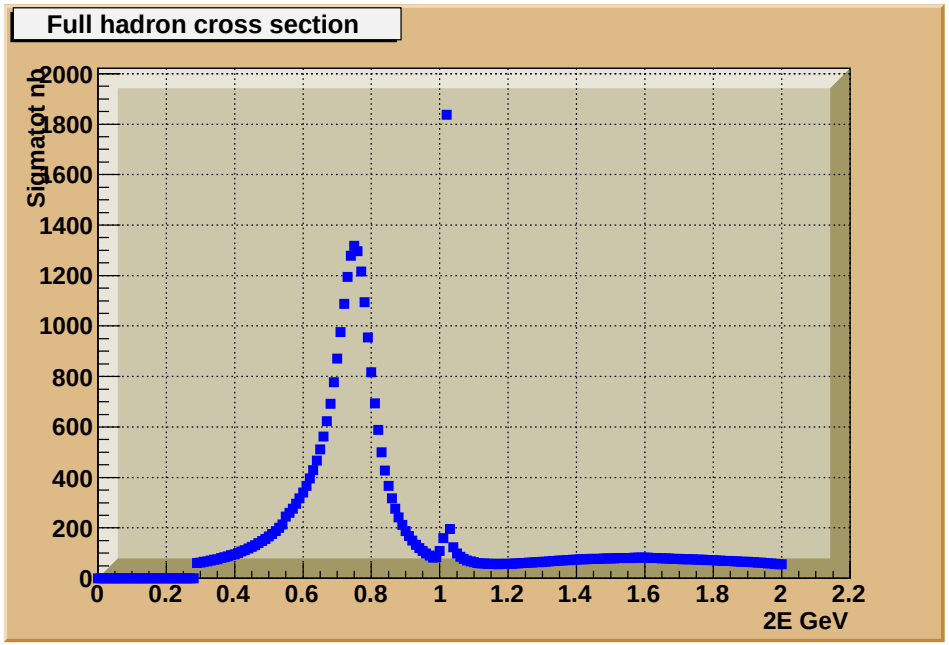
$$e^+e^- \to K^+K^-$$

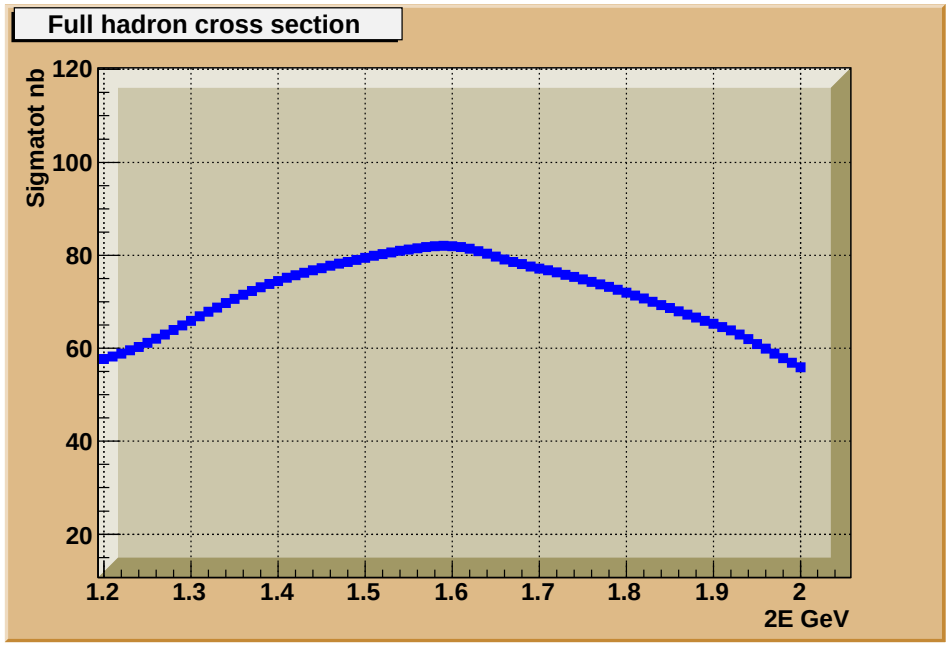


$e^+e^- \to 2\pi^+2\pi^-$


χ² / ndf 17.89 / 49
Prob 1
p0 1.399 ± 0.01999
p1 1.314 ± 0.01683
p2 0.7665 ± 0.02364
p3 0.6739 ± 0.0269
p4 345.1 ± 246.1
p5 3.118 ± 0.01108
35
30
25
20
15
10
5
0
0.6
0.8
1
1.2
1.4
1.6
1.8
2

Total Cross Section





Conclusions

- The first version of the MC generator has been created helping in preselection of main backgrounds
- A list of things to do includes an increase of the number of processes, find more data, improve isospin relations, take into account dynamics (from phase space to real matrix elements)
- Also planned to include approximately an ISR photon
- Important: how to estimate its accuracy?