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

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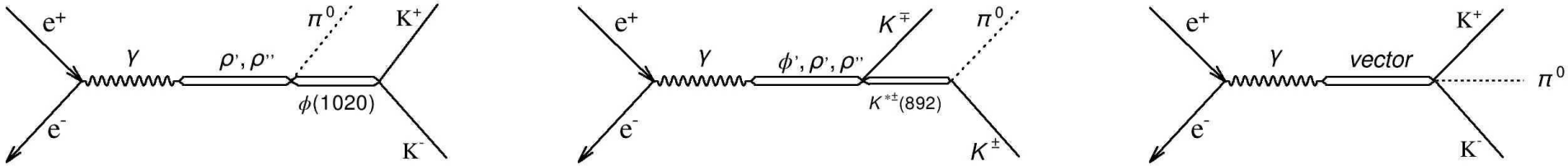
Outline

1. Concept
2. Some results
3. Summary

$e^+e^- \to K^+K^-\pi^0$

There is a new generator for $e^+e^- \to K\bar{K}\pi$ developed by V. Ivanov

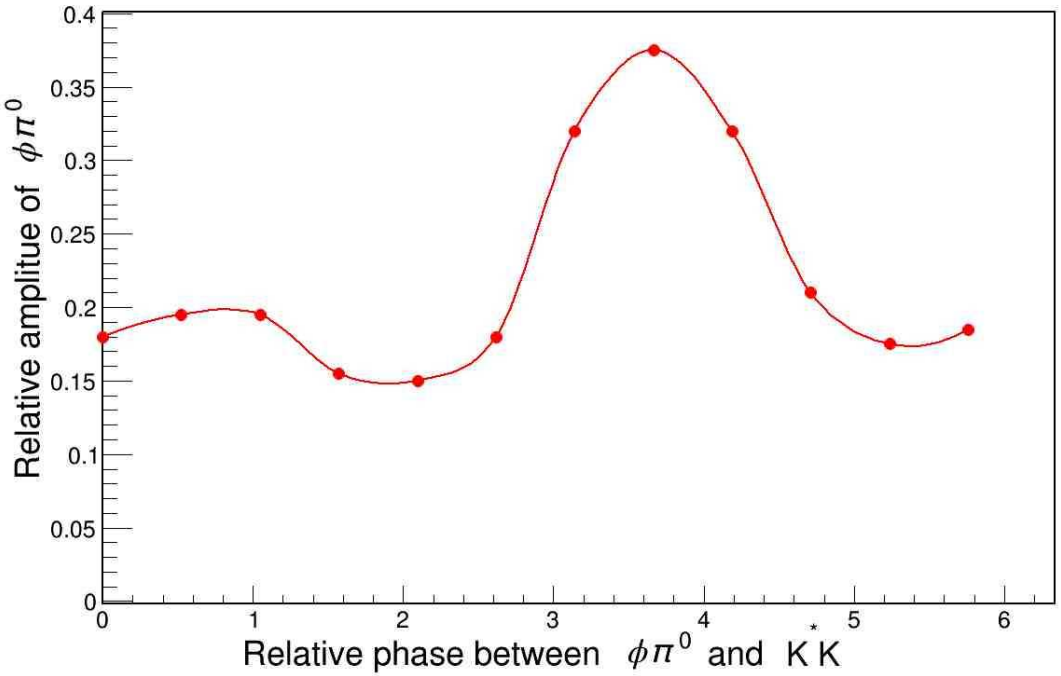


$$\sigma \propto |A_{\phi\pi} + A_{K^*K} + A_{\rm dir}|^2$$

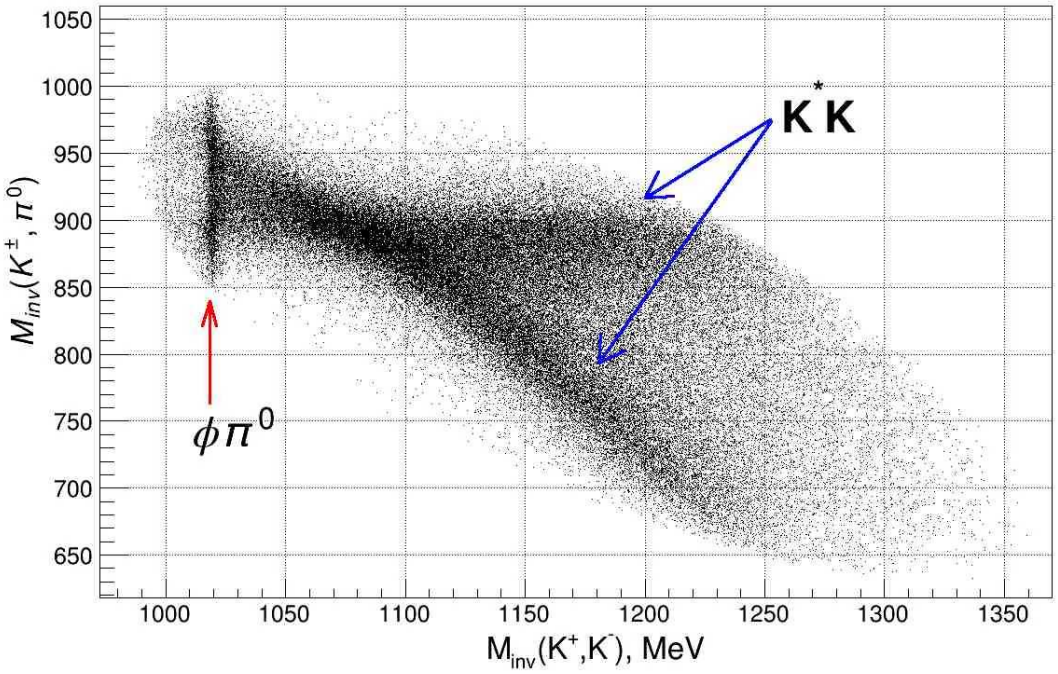
Other $K*$'s with higher mass are also possible.

Interference effects are very important!

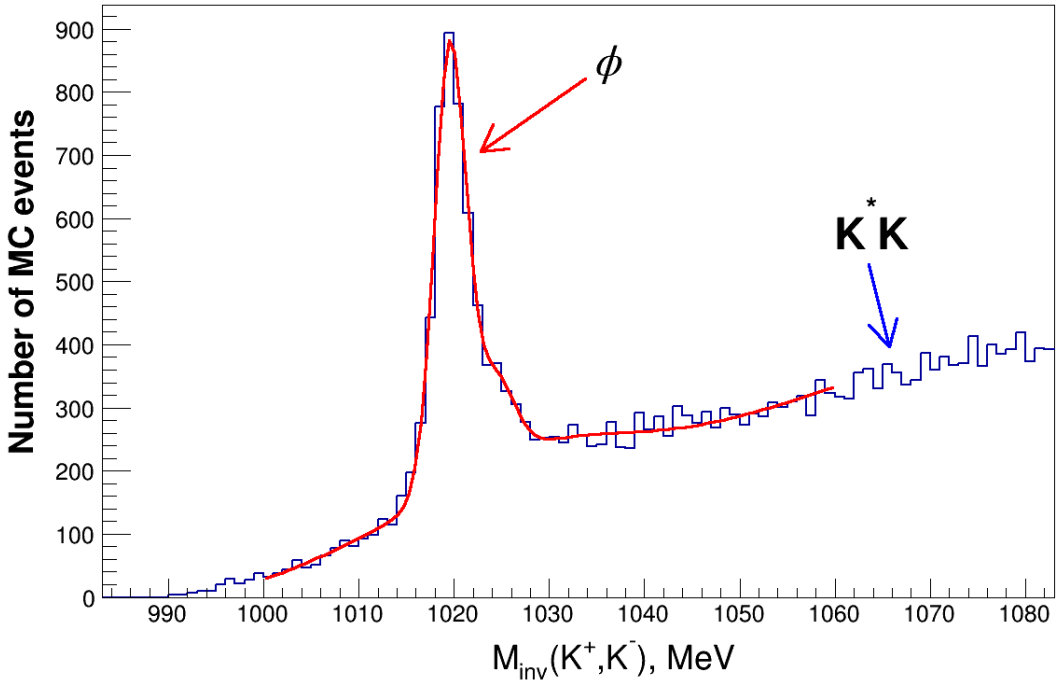
Amplitude vs. Phase



Dalitz Plot


1050
1000
950
900
850
800
750
700
650
$M_{inv}(K^{\pm},\pi^0)$
1000
1050
1100
1150
1200
1250
1300
1350
$M_{inv}(K^+,K^-)$, MeV
K^*K
$\phi\pi^0$

A Fit


Number of MC events
900
800
700
600
500
400
300
200
100
0
990
1000
1010
1020
1030
1040
1050
1060
1070
1080
$M_{inv}(K^+,K^-)$, MeV
ϕ
K^*K

Concept of a Generic MC for Multihadrons Below 2 GeV

Developed by A. Korobov

- 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 – III

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

Also just included are new channels from BaBar with K^0_S mesons

Can We Go to Higher $\sqrt{s}$?

- The range from 2 to 3 GeV is important for $g-2$ and even more for $\alpha(M_Z^2)$
- We are using inclusive method and are very sensitive to the model to calculate the acceptance
- There are a lot of ISR data from BaBar for $2 < \sqrt{s} < 3$ GeV, more will soon start coming from BESIII
- Should we try to move to 3 GeV with the generator I described and compare its exclusive approach to inclusive (H.Hu)?
- We should try new channels like 7-8 pions, 4 kaons plus pions etc.
- Can we move to 3 GeV in the exclusive approach?