Prospects of $\gamma$-$\gamma$ physics at Da$\Phi$ne-2

Dario Moricciani on behalf of KLOE-2 collaboration
Summary of the talk

- Physics motivation
- DaΦne-2 constraint
- Tagger requirement

Conclusion
The $\sigma$ meson case 1/2

cleanest channel to assess existence & nature

$(2q \text{ vs } 4q)$ of the $\sigma$ is $\gamma\gamma \rightarrow \pi^0\pi^0$ at low energy

ChPT data affected by large uncertainties

Nguyen, Piccinini, Polosa, EPJC 47, 65 (2006)
Mass and Width of the Lowest Resonance in QCD

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(Received 29 December 2005; published 5 April 2006)

We demonstrate that near the threshold, the $\pi\pi$ scattering amplitude contains a pole with the quantum numbers of the vacuum—commonly referred to as the $\sigma$—and determine its mass and width within small uncertainties. Our derivation does not involve models or parametrizations but relies on a straightforward calculation based on the Roy equation for the isoscalar $S$ wave.

\[ M_\sigma = 441^{+16}_{-8} \text{ MeV}, \quad \Gamma_\sigma = 544^{+18}_{-25} \text{ MeV}. \]  

(9)
Why we need tagging ... at 510 MeV

Estimated yields

<table>
<thead>
<tr>
<th>channel</th>
<th>Total Production ($\mathcal{L} = 10$ fb$^{-1}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$e^+e^- \rightarrow e^+e^-\pi^0$</td>
<td>$4 \times 10^6$</td>
</tr>
<tr>
<td>$e^+e^- \rightarrow e^+e^-\eta$</td>
<td>$10^6$</td>
</tr>
<tr>
<td>$e^+e^- \rightarrow e^+e^-\pi^+\pi^-$</td>
<td>$2 \times 10^6$</td>
</tr>
<tr>
<td>$e^+e^- \rightarrow e^+e^-\pi^0\pi^0$</td>
<td>$2 \times 10^4$</td>
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</table>

Background from $\phi$ decays

<table>
<thead>
<tr>
<th>decay mode</th>
<th>esc.particle</th>
<th>events</th>
<th>bckg to:</th>
</tr>
</thead>
<tbody>
<tr>
<td>$K_S(\pi^0\pi^0)K_L$</td>
<td>$K_L$</td>
<td>$\sim 10^9$</td>
<td>$\pi^0\pi^0$</td>
</tr>
<tr>
<td>$K_S(\pi^+\pi^-)K_L$</td>
<td>$K_L$</td>
<td>$\sim 2 \times 10^9$</td>
<td>$\pi^+\pi^-$</td>
</tr>
<tr>
<td>$\pi^+\pi^-\pi^0$</td>
<td>$\pi^0$</td>
<td>$\sim 10^9$</td>
<td>$\pi^0$</td>
</tr>
<tr>
<td>$\eta(\gamma\gamma)\gamma$</td>
<td>$\gamma$</td>
<td>$\sim 10^8$</td>
<td>$\eta$</td>
</tr>
<tr>
<td>$\pi^0(\gamma\gamma)\gamma$</td>
<td>$\gamma$</td>
<td>$\sim 5 \times 10^8$</td>
<td>$\pi^0$</td>
</tr>
</tbody>
</table>

- additional (sizable) bckgs from non $\phi$ decays (ISR and continuum processes)
- kinematics cut (mainly from $P_T$ of $\pi\pi$) → rejection factor $< 100$

hopeless w/o tagging of the scattered $e^\pm$
ДаΦне-2 for Siddharta run
DaΦne --> DaΦne-2

Half IR1 Magnetic Layout

Old layout

Splitter magnet

~10 m

New layout

Crab waist sextupoles

Compensator solenoids not installed for the SIDDHARTA run

$\alpha = 0.071 \text{ rd}$

$\theta_{IP} = 0.025 \text{ rd}$
Interaction point for Siddharta run

Tagger position
Schematic view for next test

Plastic veto

$E_e = (190, 210) \text{ MeV}$
3D View
Tagging - by Graal experiment

2+5 plastic scintillators

BC418 + BC800 + Hamamatsu 1635

Spatial resolution: 300 µm

128 µstrip silicon detector
Tagging characteristics

Spatial resolution: 300 mm
128 mstrip silicon detector

Final time resolution ≈ 600 ps
10 plastic scintillators
Montecarlo study about tagging possible location (by BDSIM)

Magnetic lattice

200 MeV e^+
Tagging possible location

KLOE

QCAL

Compensating Magnet

Not in scale
$W_{\gamma\gamma}$ in various region

<table>
<thead>
<tr>
<th></th>
<th>LET</th>
<th>LET$_1$</th>
<th>LET$_2$</th>
<th>MET</th>
<th>HET</th>
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<tbody>
<tr>
<td>LET</td>
<td>600 - 640</td>
<td>-</td>
<td>-</td>
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<tr>
<td>LET$_1$</td>
<td>440 - 530</td>
<td>280 - 420</td>
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<tr>
<td>LET$_2$</td>
<td>400 - 440</td>
<td>240 - 330</td>
<td>200 - 240</td>
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<tr>
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<td>375 - 405</td>
<td>215 - 295</td>
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<tr>
<td>MET</td>
<td>340 - 380</td>
<td>180 - 270</td>
<td>140 - 180</td>
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<td>140 - 240</td>
<td>100 - 150</td>
<td>40 - 90</td>
<td>0 - 60</td>
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</tbody>
</table>
LET and $\text{LET}_1$ could be enough?
Conclusion

- Prototype construction almost completed
  - Installation expected for next month
- Integration with QCAL under study
  - Different detector for tagging
- Particle tracking in progress
  - Interaction point
  - Emission angle
- Data analysis of data taken at $\sqrt{s} = 1$ GeV during KLOE run is in progress