[Note: the $D\_K_s\rho$ listed in section B is also present in the Dalitz analysis of $D_o\_K_s\pi^+\pi^-$.]

A golden method for the mixing and CPV in mixing/decay interference is the Dalitz analysis of $D_o$ ,anti-$D_o$ _ $K_s\pi^+\pi^-$ events. If Dalitz model systematics could be kept under control, direct CPV could be invstigated too.
Present data [Babar 2007] show that at $Y_{4S}$ $D^{*\pm}\_D_o\pi^\pm$, $D_o$ _ $K_s\pi^+\pi^-$ can be selected at a rate of $1000/fb^{-1}$ with a purity of 99.x%. and a mistag probability of 0.1%. $K_s$ are reconstructed in $\pi^+\pi^-$ final state, an upper cut on $K_s$ proper time ($< \sim 8\tau_S$) ensure us to push $K_L$ _ $\pi^+\pi^-$ contamination at $10^{-5}$ level [check from theoretical & exp point of view!]. Reconstructing the $D_o$ _ $K_s\pi^+\pi^-$ decay vertex, the D proper time ($t_D$) can be measured with an average error of $\pm0.2$ps in Babar and $\pm0.1$ps at a SuperB, to be compared with 0.4ps, the $D_o$ lifetime. We use the invariant squared mass of $K\pi$ pairs:
$m_+^2 = m^2(K,\pi^+)$ and . $m_-^2 = m^2(K,\pi^-)$, and we define, as in ref [Bondar and Poluetkov 2007], the following Dalitz plot amplitudes and probabilities, which, for us, also depend on t::

$$p_D = p_D\left(m_+^2,\ m_-^2,\ t_D\right)=\left|f_D\left(m_+^2,\ m_-^2,\ t_D\right)\right|^2 \qquad \text{for } \overline{D}_o \text{ tagged events [eq.1]}$$

$$\overline{p}_D = \overline{p}_D\left(m_+^2,\ m_-^2,\ t_D\right)=\left|\overline{f}_D\left(m_+^2,\ m_-^2,\ t_D\right)\right|^2 \quad \text{for } D_o \text{ tagged events. [eq 2]}$$

[Note: experimental uncertainties on the invariant squared mass of $K\pi$ pairs do not seem relevant, up to me]
The signatures for interesting processes are the following ones:
- Mixing (without CPV): $p_D\left(m_+^2,\ m_-^2,\ t_D\right)=\overline{p}_D\left(m_-^2,\ m_+^2,\ t_D\right)$ $\forall$ $t_D$, but
  $p_D\left(m_+^2,\ m_-^2,\ 0\right)\neq \overline{p}_D\left(m_+^2,\ m_-^2,\ t_D\right)$      [eq.3]
- CPV in mixing: $p_D\left(m_+^2,\ m_-^2,\ 0\right)=\overline{p}_D\left(m_-^2,\ m_+^2,\ 0\right)$ and
  $p_D\left(m_+^2,\ m_-^2,\ t_D\right)\neq \overline{p}_D\left(m_-^2,\ m_+^2,\ t_D\right)$      [eq.4]
- Direct CPV: $p_D\left(m_+^2,\ m_-^2,\ 0\right)\neq \overline{p}_D\left(m_-^2,\ m_+^2,\ 0\right)$      [eq.5]

and the physical quantities, to be measured that enter in the previous Dalitz plot distribution functions, are:
- $x \equiv \left(m_1 - m_2\right)/\Gamma$    ! usual mixing parameter      [eq.6]
- $y \equiv \left(\Gamma_1 - \Gamma_2\right)/2\Gamma$    ! usual mixing parameter      [eq.7]
- $\left|q/p\right|$ or $\varepsilon \equiv \dfrac{1-\left|q/p\right|}{1+\left|q/p\right|}$    ! CPV parameter      [eq.8]
- $\phi \equiv \arg\left(\dfrac{q\overline{A}_f}{pA_f}\right)$ as defined in eq (17) of CLEO 05-03 ! CPV parameter. [eq.9]

$x, y, \varepsilon, \phi$ can be extracted in a model dependent with the isobar and/or K-matrix models, making global fits. One example is described in ref [CLEO 05-03] . For the

model dependent approach, we estimate the SuperB sensitivity (at 75ab[-1]), extrapolating in a conservative way the present data.

Statistical errors can be scaled with the square root of luminosity. We get a results which is much better than the desired goal of $10^{-3}$, not reachable by BESIII (and SuperBelle, LHCb?).

The second source is from systematic errors due to the experiment. They are mainly due to background parametrization, efficiency variation through the Dalitz plot, experimental resolution biases on Dalitz plot variables, decay time parametrization, and mistag fraction. Background parametrization is checked with sidebands (according to MC the background does not have any bump in the Do mass signal region), and it scales with statistics. Efficiency variation is studied with Montecarlo and we scale it with MC statistics [at present efficiency plots are comparable with flat distributions, so authors evaluate this systematic making the difference between results from MC distributions and from a flat one] . Biases on Dalitz plot variable mass resolutions are negligible. Decay time parametrization improves with data and the time resolution will be improved at the SuperB (as stated before). Mistag fractions can be checked with other final D states and their contribution is negligible. There is the chance that these errors from experimental source could be reduced scaling to statistics, too, but we prefer to be conservative and evaluate them putting a safety factor of two. They are reported in the table, and we can see that they are less than the statistical ones.

The last, but not least, source of systematic errors, is due to the decay models: the isobar, the K-matrix, partial-waves ones. Uncertainties come from radius parameter, masses and widths of the resonances, the choice of resonances included in the fit.
  Recent results from Cleo and Belle [cite papers] have demonstrated that the mixing and CPV parameters are not very sensitive to Dalitz model variations.
Dalitz  model will be cheked using two model independent approches:

- with very large data sample a partial-wave analysis is capable to determine the amplitude and phase variation over the phase space directly from data.
- Data collected at charm threshold  will make accessible the D-Dbar relative phase [CLEO reference].

Even if it is a hard job to make predictions on the Dalitz model systematics at SuperB it is reasonable to assume that it will be reduced with respect to the present one by a sizeble factor.

| | Belle present errors (0.540 ab-1) | | | |
|---|---|---|---|---|
| | statistical | exper. Syst. | model. syst. | TOTAL |
| x (10-4) | 30,0 | 8,0 | 12,0 | 33,3 |
| y (10-4) | 24,0 | 10,0 | 7,0 | 26,9 |
| eps (10-4) | 15,0 | 2,5 | 4,0 | 15,7 |
| phi (degrees) | 17,0 | 4,0 | 3,0 | 17,7 |

| | SuperB errors (75ab-1) | | | |
|---|---|---|---|---|
| | statistical | exper. Syst. | model. syst. | TOTAL |
| x (10-4) | 2,5 | 1,4 | 12,0 | 12,3 |
| y (10-4) | 2,0 | 1,7 | 7,0 | 7,5 |
| eps (10-4) | 1,3 | 0,4 | 4,0 | 4,2 |
| phi (degrees) | 1,4 | 0,7 | 3,0 | 3,4 |

A model-independent measurement for CPV can be done. By dividing the Dalitz plot in several bins, for D0 and D0bar, the number of events in each bin will depend on the parameters $(x,y,\phi,\varepsilon)$. A similar method has been proposed in literature for the model independent measurement of $\gamma$ [cite Zupan]. In the case of mixing a time dependent analysis could improve the sensitivity with respect to a time-integrated analysis.

The unknowns are four, $(x,y,\phi,\varepsilon)$, assuming we extract the informations about D amplitudes (D0-D0bar relative phase and amplitude magnitudes) from coherent D-Dbar production data. Each bin of the Dalitz plot gives a relation to use for solving the system. We need to divide the Dalitz plot in n>2 bins for D0 and D0bar to solve for the unknowns.

We will have of the order of $75 \times 10^6$ signal events in the whole Dalitz plot.

An optimal binning will have to take into account the region with maximal sensitivity to mixing and CP violation. The statistical error on CP asymmetries scale as $1/\sqrt{N}$, which results in a limit on CPV better than $10^{-3}$ precision for each bin with the available data sample.

- how combine the informations of the measurements in several bins
- comments on the sensitivity to mixing and CPV parameters
- comments on main systematic errors.

0.4%-0.4%-0.2%-1.2$^{\text{o}}$ on $x, y, \varepsilon, \phi$, respectively.