Λ_c + Tagging at a Tau - Charm Factory

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The cross section for charmed quark production in $e + e -$ annihilation is given by:

$$\sigma = \frac{86.8\ nb\ (2/3)\ 2}{E_{cm}\ 2(GeV)}$$

At 4.6 GeV, just above the $\Lambda_c\overline{\Lambda}_c$ production threshold, the cross section is 1.8 nb. At a luminosity of 10 33 cm -2 sec -1, the production rate is 1.8 Hz, or 36 million pairs per $2 \times 10\ 7$ second year.

According to the traditional quark-diquark fragmentation picture, roughly 10% of these will turn into $\Lambda_c\overline{\Lambda}_c$ pairs. The Mark II at SPEAR measured a higher percentage, 20%,[1] but I will use the lower rate. With it, 4 million $\Lambda_c\overline{\Lambda}_c$ pairs will be produced each year.

The tagging efficiency will depend on the number of modes tagged, and the reconstruction efficiency. The following table lists some possibile modes:

Mode	Branching Ratio(%)	Efficiency (%)	B.R. × Efficiency (%)
$pK\ -\pi +$	4	40	1.6
$\Lambda\pi\ +\pi\ -\pi +$	3	10	0.3
$\Lambda\pi +$	1	20	0.2
$pK\ 0$	3	25	0.7
$pK\ 0\pi\ +\pi -$	3	10	0.3
Total	11	-	3.1
$pK\ -\pi\ +\pi\ 0$	4	20	0.8
$\Lambda\pi\ +\pi\ 0$	4	10	0.4
Total	19	-	4.3

The first total includes the better known all charged final states. The branching ratios come from my estimate for $pK^-\pi^+$ of 4%,[2] with scaling for the other modes. Likewise, the efficiencies are estimates. The latter two π^0 containing modes are more speculative, but the branching ratios should be reasonable guesses, and a tau-charm detector should have good ability for neutral particles. The overall tagging efficiency should be 3-4%, giving a total of roughly 300,000 singly tagged Λ_c^+ per year, and 6400 doubly tagged $\Lambda_c\overline{\Lambda}_c$ per year. This should be sufficient to measure the absolute Λ_c^+ branching ratios with a precision limited by the systematic errors, probably a few percent. Even at substantially lower luminosities, the branching ratios can be measured with good precision. Even at a lumosity of 10 31, the Λ_c^+ absolute branching ratio normalization could be measured to an accuracy of 12%, or 5-10 times better than it is known now. While BEPC should reach this luminosity, it does not have the necessary energy reach.

Of course, with this same data, dozens of different Λ_c^+ decays could be studied, and their branching ratios could be measured.

REFERENCES

1. G.S. Abrams *et al.*, Phys. Rev. Lett. **44**, 10 (1980).
2. S. R. Klein, preprint BU-HEP-89-16, August, 1989.