WELCOMING REMARKS

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It is a pleasure to welcome you to this Workshop on beam cooling and, I must say, that I am particularly pleased that LBL is co-hosting this conference on such a significant advance in the science of beam-handling devices. I like to believe that this Workshop is consonant with the more than 45 year history of this Laboratory, which stretches back to E. O. Lawrence's invention of the cyclotron and includes such notable advances as Luis Alvarez's linear accelerator and Ed McMillan's concept of phase focusing with his subsequent development of the FM cyclotron and the electron synchrotron. In recent years we have tried to maintain this tradition through the activities of our Advanced Accelerator Research and Development Group and it is that very group which is sponsoring -- with Fermilab -- this meeting.

In my opinion, and I will learn more as the week goes on, beam cooling is one of the two most important advances in beam-handling techniques to have reached the point of practical, engineered availability within the last 5 years. The other is, of course, hard superconducting bending and focusing magnets which are being incorporated most notably, in the Fermilab Energy Doubler/Saver and in Brookhaven's Isabelle.

Beam cooling should make possible tremendous gains in $\bar{p}p$ colliding-beam devices, and this week's Workshop will be devoted to this topic. It is interesting to compare Kjell Johnsen's estimate, in 1962, of the luminosity which might be achieved in the ISR as a $\bar{p}p$ device; namely $L \approx 10^{24}cm^{-2}sec$ or the optimistic estimates of Paul Csonka and myself in 1967; namely $L = 5\times10^{26}cm^{-2}sec^{-1}$, with the Fermilab goal of L up to $10^{32}cm^{-2}sec^{-1}$ or the current CERN estimate of the luminosity in the SPS for $\bar{p}p$ collisions, namely $L = 10^{30}cm^{-2}sec^{-1}$. (Of course I am comparing different devices, but the major import of beam cooling is, nevertheless, evident.)

Now it is interesting to go beyond this Workshop to explore how widely beam cooling can be used with advantage. For example, is it of value in pp colliding beam devices? I can recall studying just this question for the ISR in 1966, immediately after learning of Budker's invention of electron cooling. Hugh Hereward did a rather complete study of the subject, which he reported on at the Orsay Conference on Storage Rings (1966), and he concluded that electron cooling wouldn't improve the ISR very much. Now that result was very sensitive to the boundary conditions; namely the given ISR, and it was prior to the invention by Simon van der Meer of stochastic cooling. It is important to my mind, to explore both in $\bar{p}p$ rings, and beyond $\bar{p}p$ rings, what can be achieved with beam cooling both in existing machines and in machines designed to exploit beam cooling.

Perhaps I could make some comments addressed to why beam cooling isn't obviously a good thing in all devices. Consider, for a moment, electron storage rings. Here we have strong cooling and certainly we take advantage of it in injection: The filling time decreases rapidly as the injection energy is increased and the radiation damping, or beam cooling, is increased.

On the other hand, we know that at high energies the naturally occurring strong beam cooling imposes a severe limit on ring luminosity. Consequently, a number of measures have been developed to heat beams so as to increase the incoherent stochasticity limit due to a highly-cooled, compact intense beam. In this example an incoherent single particle phenomenon limits performance rather than phase space density.

Generally, then, particle handling devices have their performance limited by (1) single particle external field effect by (2) incoherent collective phenomena, by (3) coherent collective phenomena, or (4) by phase space density. Cooling only helps to remove the last-mentioned limit. Thus in many devices, cooling won't help and in those in which it does help, it is necessary to ascertain how much improvement is actually possible before one hits one of the other limits to performance.

Well, enough for these sobering remarks. I felt they were necessary because so often at a meeting on some particular subject one gets carried away and forgets about other relevant subjects. Despite the limits on what can be achieved with cooling, it is clear that cooling is a very significant new technique which has become available to the designer and builder of particle handling devices.

Now, let us turn to hearing what can be achieved with cooling and, also, the important aspects of how, in fact, one designs, builds, and operates $\bar{p}p$ cooling devices. I wish you, on behalf of the sponsors, an interesting and productive Workshop.