# Decision 23:  RF Source Options

## *What are the options?*

1. 10 MW Multi-Beam Klystron (MKB).
2. Alternate designs emphasizing lower cost and higher efficiency for the combined modulator/klystron system.

## *Pros and cons of Option 1 vs. 2*

During the past five years, DESY has funded the development of a high power (10 MW), high efficiency (60-65%), multi-beam klystron at the level of 1 M$/year. Three companies (Thales, CPI and Toshiba) have each designed a version that runs at 115 kV, 135 A, 1.5 ms, 10 Hz (only 5 Hz is required for the ILC). Thales has built four such klystrons, two of which have run at full spec. CPI and Toshiba have each built a single tube that has met the peak power requirement, but has not run at full pulse width due to modulator limitations. None of the tubes have been run at full power for more than a few hundreds hours.

The basic tube design appears to be robust, and in particular, the CPI and Toshiba versions have low cathode heating, which should produce a long gun lifetime (~ 100 khours). However, the tubes are expensive (about 800 k$ for one) and are not particularly easy to build. As alternatives, three designs were discussed that have comparable power levels: although much lower power sources (few hundred kW) have been suggested, no one has yet presented a feasible cost-competitive design. Also, higher power tubes have been not pursued, in part because the power losses in the long rf distribution system that would be required would become significant.

The three options that were discussed are depicted in Fig. 1. The 10 MW sheet beam klystron proposed by SLAC would have similar efficiency as the MBK and could run using the same modulator as the MBK. The planer geometry of the sheet beam klystron should allow it to be more easily manufactured. The 5 MW Inductive Output Tube (IOT) proposed by CPI is an off-shoot of the work they are doing develop lower frequency, lower power versions for the military. The advantage of this 12 beam tube would be a somewhat higher efficiency and a linear drive response near maximum power, which would effectively increase its efficiency to around 75%. However, the gain of the tube is low so a more expensive driver would be required, and its output power is only half of that of the MBK's. Finally, KEK is looking at an MBK with more beams to further reduce the modulator voltage. At about half of the nominal MBK voltage, a simpler type of modulator could be used, for example, a direct switch type that does require a transformer.

None of these alternative sources have been fully designed nor their operation fully simulated. Also, none of them are funded to be developed in FY06, and no detailed cost comparisons to the 10 MW MBK have been made.

**Cost: Favors 2**.  While there have yet to be convincing cost analyses to justify a different tube design, a less expensive tube could probably be developed. However, the development would likely take more than five years.

**Availability Risk: Favors 1**. Currently the 10 MW MBKs are the only source that has been developed, and its design appears to be robust. At worst, if the MBK's did not meet availability requirements, there is a commercial, single-beam, 5 MW tube that could be used (it is currently the 'work-horse' for L-band testing at DESY and FNAL). Although it is less efficient (42%), this tube has been in service for over 30 years with good availability.

## *Recommendation for the BCD*

10 MW MBK of the type being developed by Thales, CPI and Toshiba – the particular version will depend on availability and cost considerations.

## *Recommendation for the ACD*

If funding becomes available, reevaluate the various options and pursue a design that would be less expensive without significant loss in availability.

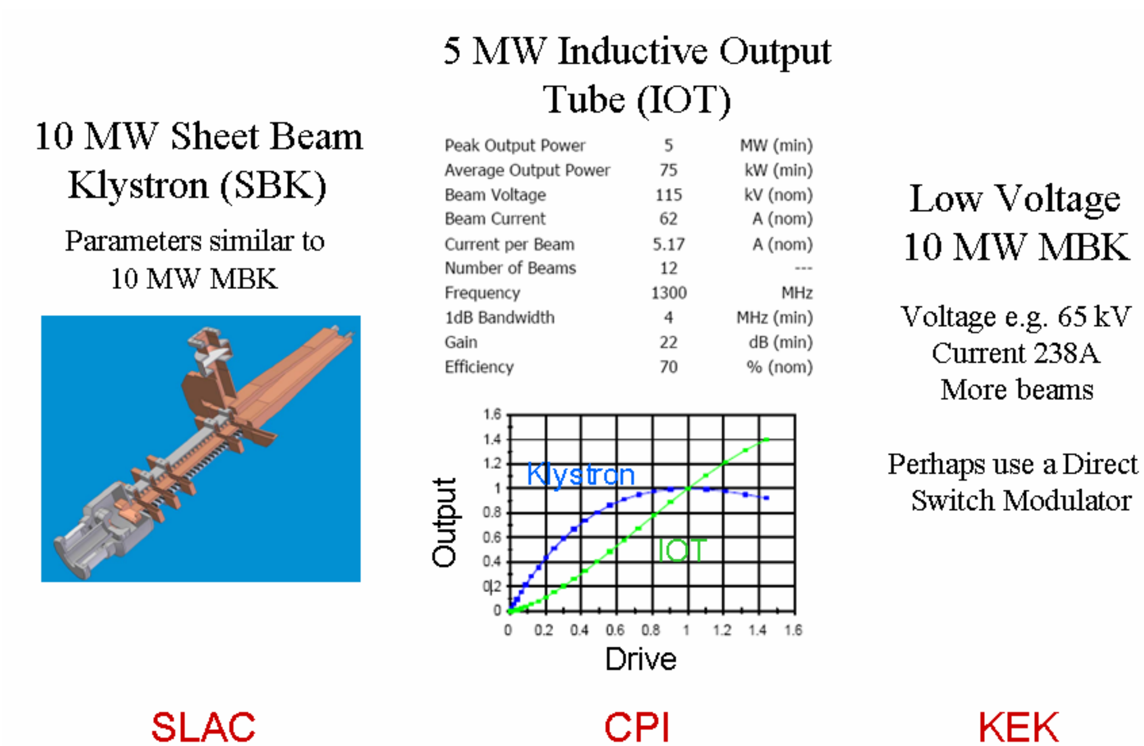


*Fig. 1. Three Power Source Alternatives*