Accelerator Segmentation

Segmentation is the positive isolation of a length of the accelerator to allow warming to room temperature in order to perform maintenance.

Methods to achieve positive isolation

- U-tubes – truly positive isolation
- Dual valves with warm helium guard
  - Valve leakage and thermal crosstalk are a concern

Segmentation Decision Making

Balance between

- up front capital costs and
- maintenance period time & scope

Possible additional concerns

- component thermal cycling
  - leaks, magnet retraining, gradient degradation

Need for Segmentation

If you will never need to do maintenance or upgrades, you will not need segmentation.

For the rest of us:

Becomes a game of cost versus “expected” failure statistics

Statistics

Superconducting accelerator failure statistics tend to be after-the-fact.

Each new superconducting machine tends to push the limits of technology (quench current or gradient) which reintroduces uncertainty in previous statistics.

Many assembly joints (welds, mechanical seal or solder) adds a level of uncertainty.

Segmentation Cost Factors

Isolation boxes

Parallel cryogenic transfer line (although accelerator components become less complicated)

Added tunnel length (1-3 m per isolation)

Added tunnel diameter or alcoves (to accommodate transfer line and U-tube pulling)

Increased probability for ODH event

Segmentation of Large SC Machines

Machine	Segment		Margin		Cold	Iso.	
	#	m	Comp.	Tech.	Joints		
Tevatron	24	250	No	Low	Seal	U-tube	Driven by warm iron design
HERA	8	800	No	High	Weld	Valve	Significant performance margin
LHC	32	750	No	Low	Weld	Valve	Rest of octant floats in temperature
CEBAF	40	~8	Yes	Med.	Both	U-tube	Individual cryomodules
SNS	23	~5	Yes	Low	Both	U-tube	Individual cryomodules
XFEL	1	1,700	Yes	Low	Both	-	
ILC (RDR)	10	2,472	Yes	Low	Both	-	

Tevatron Statistics