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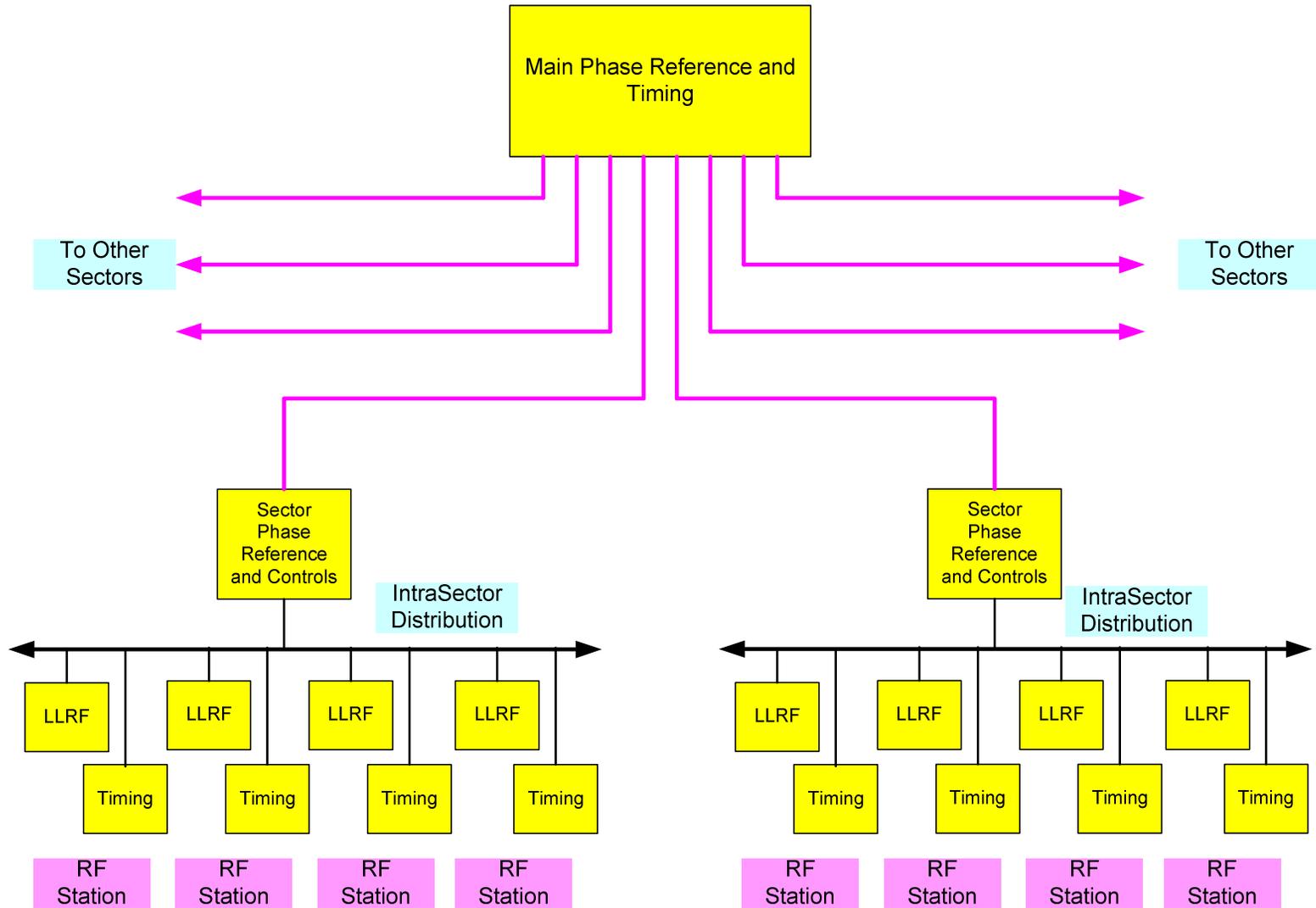
A U.S. Department of Energy laboratory
managed by UChicago Argonne, LLC

Phase Reference System for the ILC

Frank Lenkszus

Advanced Photon Source

Overview



Long Haul Distribution

- Long Haul Distribution
 - Point-to-Point (star) single-mode fiber distribution
 - *1550 nm*
 - Up to 15 km
 - Active Phase Stabilization
 - *Fiber TC ~ 7-10 ppm/°C*
 - *Fiber Dispersion ~10ps/nm/km*
 - Encoded 5Hz fiducial
 - Dual Redundant with auto failover
 - Total of 65 redundant links

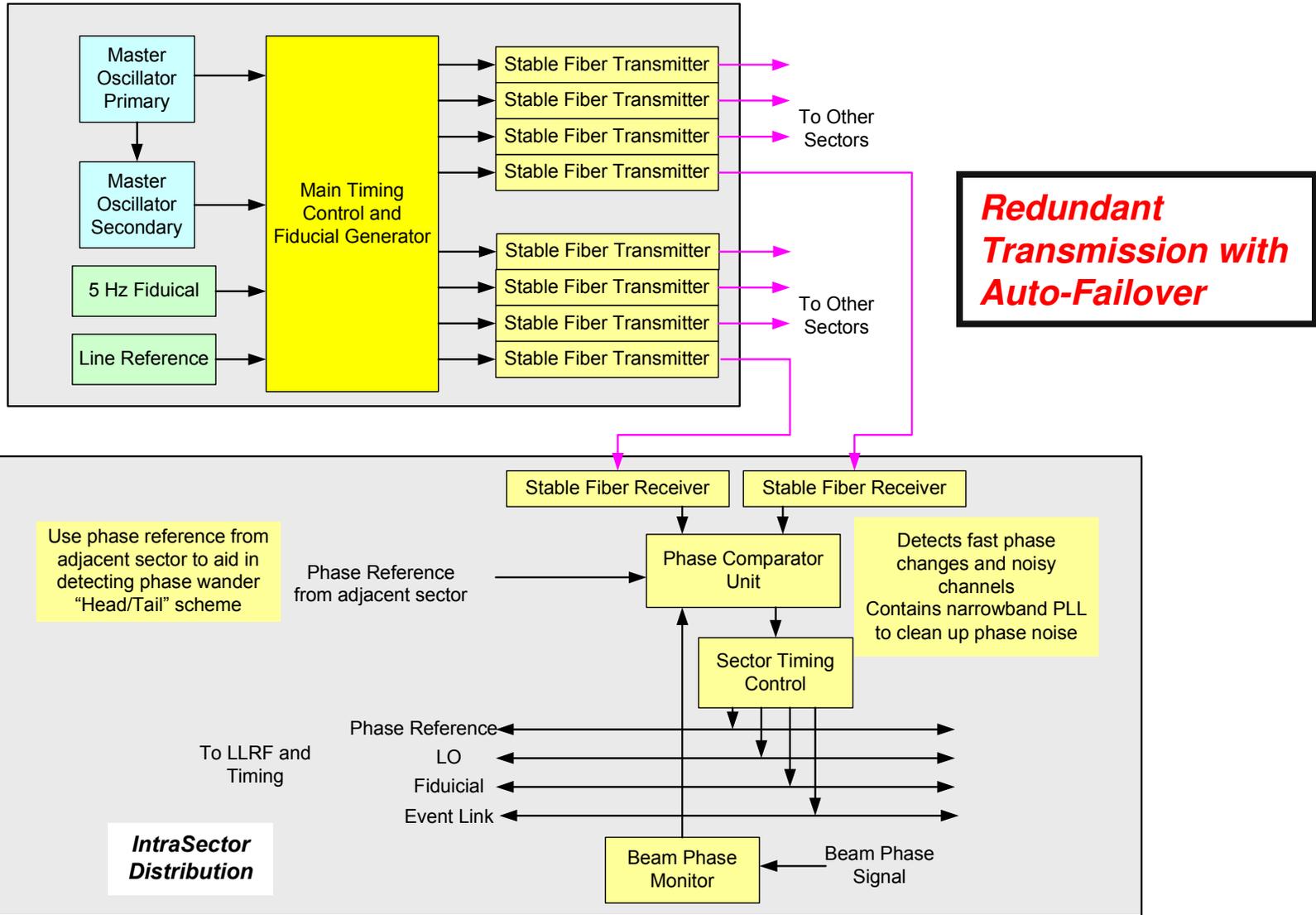
Local (Intra Sector) Distribution

- Local (intra-sector) distribution
 - ~550 m length
 - Cost model based on temperature/pressure stabilized 3 1/8” hard-line
 - *SNS design used as a reference*
 - Alternatives
 - *Active phase stabilization*
 - *Phase Averaging Scheme*
 - Four signals distributed
 - *Phase Reference*
 - *Local Oscillator*
 - *5 Hz Fiducial*
 - *Event System*

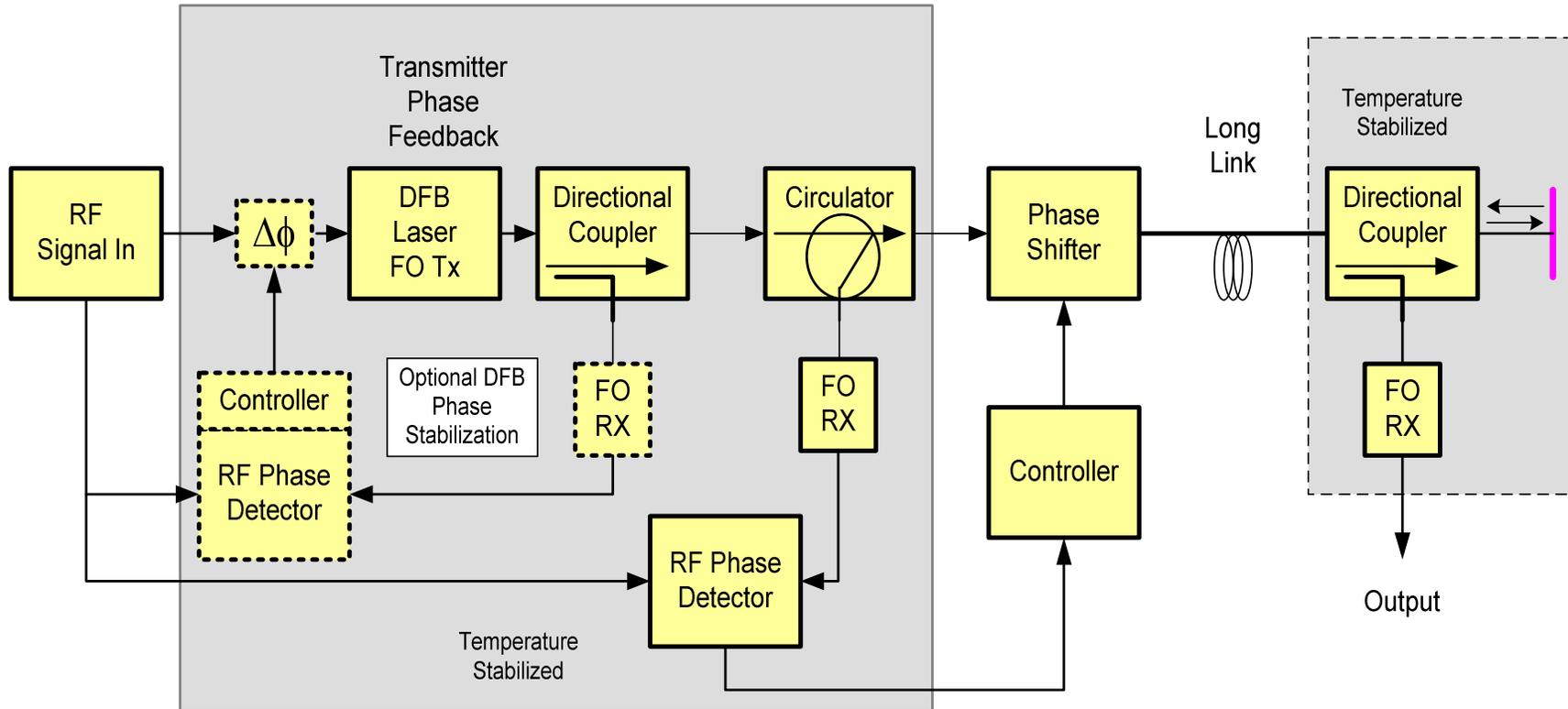
Tolerances

	Correlated	Uncorrelated	RDR Section
Main Linac (Relative to MO)	0.35 degrees RMS	5.6 degrees RMS	LLRF Table 3.9.1
Bunch Compressors (Relative to MO)	0.24 degrees RMS	0.48 degrees RMS	RTML 2.5.4
Crab Cavities (e+ to e-)		61 femtoseconds	BDS 2.7.4.1

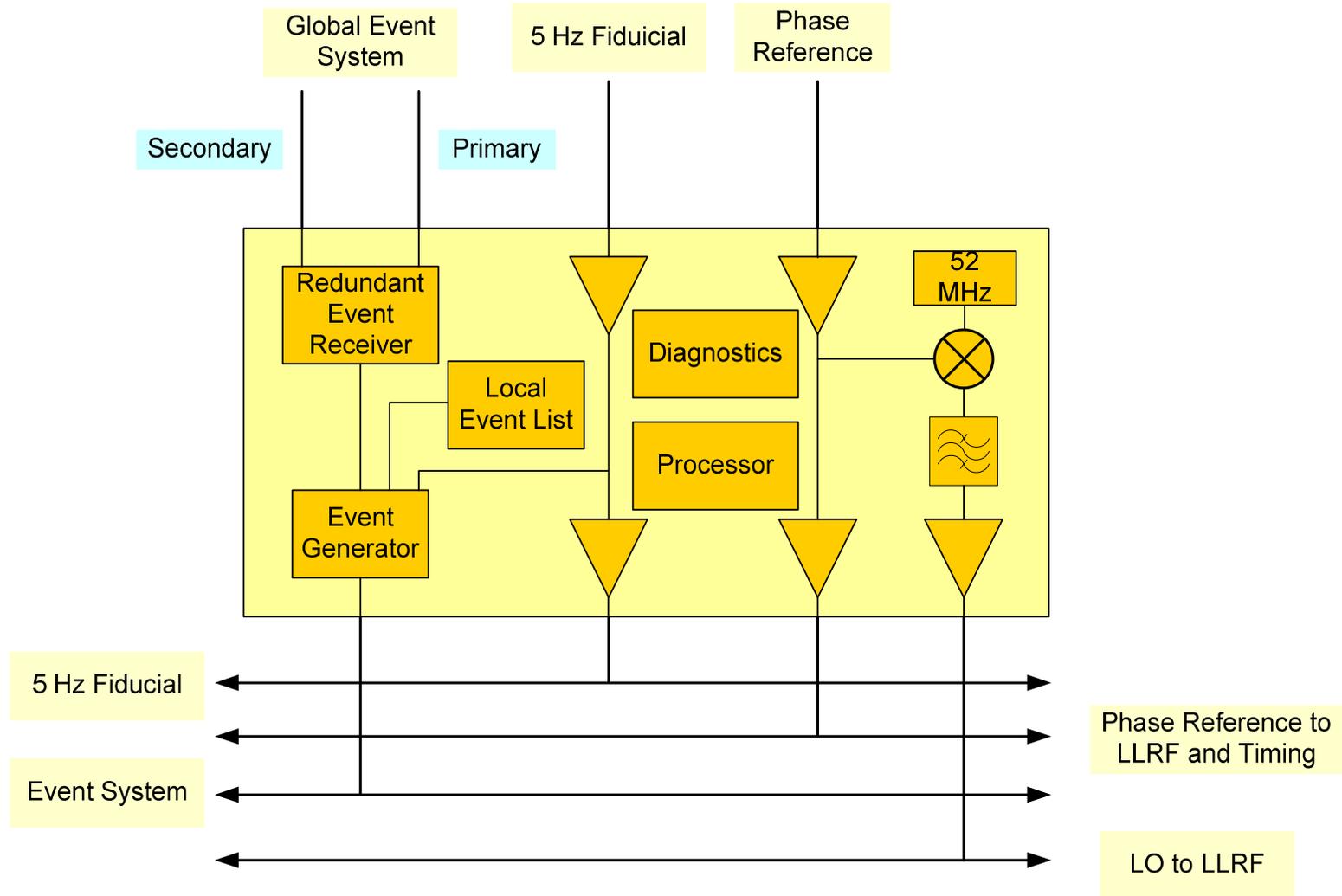
Phase Reference Distribution



Phase Stabilized Link



Sector Timing Control Unit



Other Phase Stabilization Techniques

- Frequency-offset Optical Interferometry (LBNL)
 - Heterodyne from optical to rf
 - Stabilizes phase delay at a single frequency
 - *Correction for phase delay vs group delay needed for ultimate precision*
- Pulsed Laser (Mode Locked) (MIT)
 - RF encoded in pulse repetition rate
 - *Every harmonic can be extracted at receiving end*
 - Group Delay is directly stabilized – not phase delay
 - Coarse RF Lock and fine Optical Cross Correlation can be used for link stabilization

Planned R&D

- High Stability RF Phase Distribution System Development
 - Long haul redundant distribution prototype and test bed (ILCTA)
 - Local (intra-sector) distribution (ILCTA)
 - Investigate other long haul phase stabilization techniques
 - *Bunch compressors and crab cavities*
 - Prototype two channel phase reference receiver with auto fail-over
- Investigate feasibility of using a beam derived reference for locking a local phase reference
 - Investigate HOM phase detector scheme

References

- Frisch, J., Bernstein, D., Brown, D., Cisneros, E., “A High Stability, Low Noise RF Distribution System,” Proceedings of PAC2001, pp. 816-818.
- Czuba K., Eints F., Felber M., Dobrowolski J., Simrock S., First Generation of Optical Fiber Phase Reference Distribution System for TESLA, TESLA Report 2005-08 Hamburg 28.02.2005