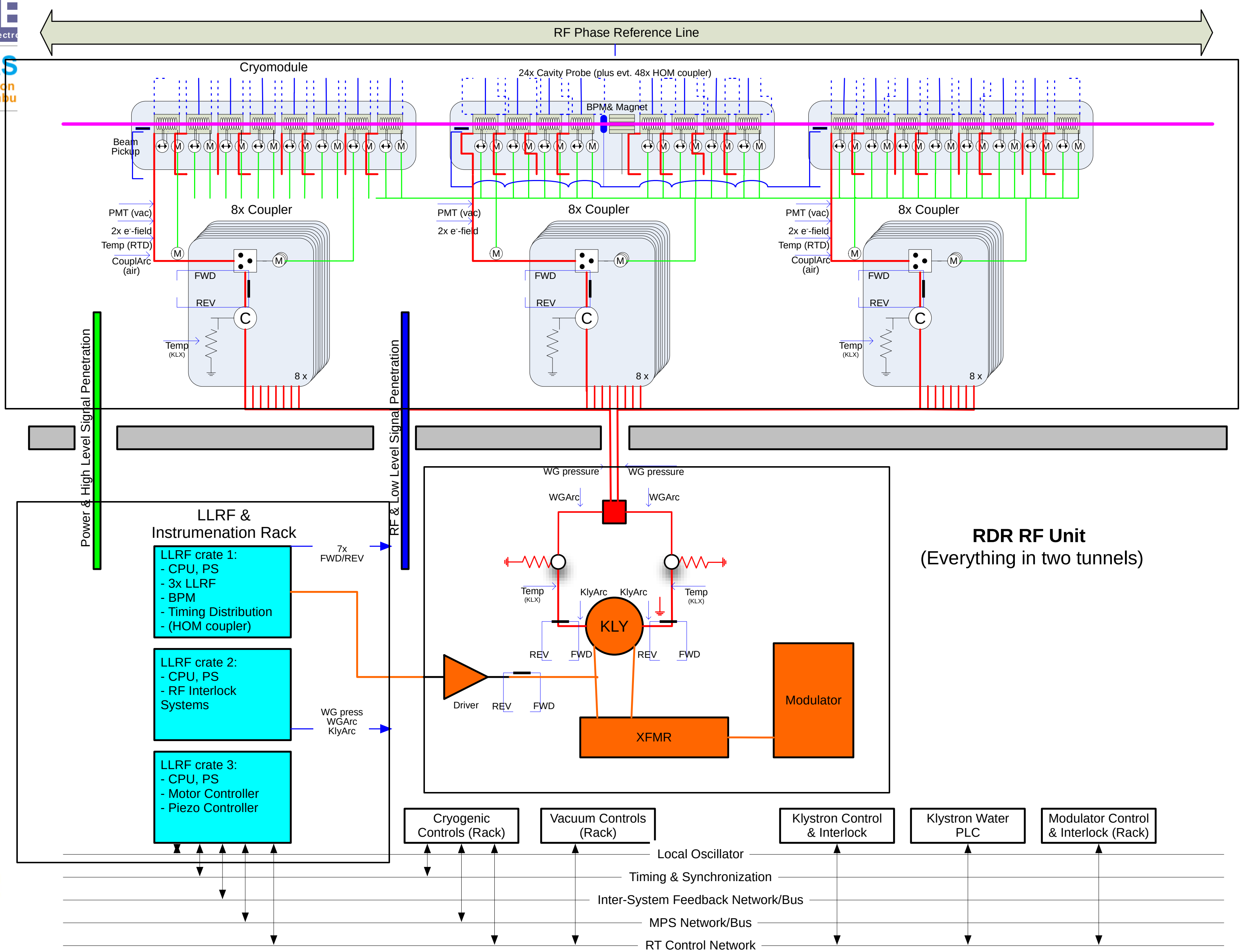
Proposed TDR baseline LLRF design

J. Carwardine, 22 May 2012

LLRF system layout per the RDR



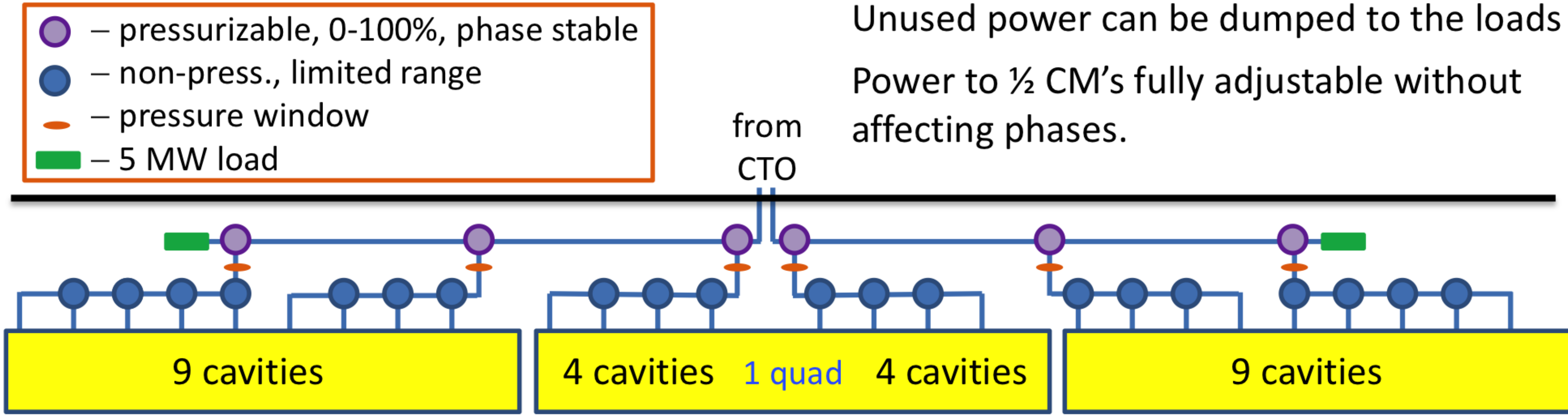
LLRF for TDR: KCS vs DKS

- **DKS**
  - Essentially the RDR layout revised for Low Power config
  - RDR: RF Unit had one klystron feeding 3 CMs (26 cavities)
  - TDR: still uses groups of 3 CMs, but for Low Power config, each klystron feeds 1½ groups of 3 CMs (39 cavities)
  - Vector Sum control of 39 cavities, remote adjustment of Pk, QL, and phase for each cavity, mechanical tuners, piezo tuners,
- **KCS**
  - Each group of 3 CMs is fed from a coaxial tap-off from a single 300MW rf feed
  - Low Power config removes klystrons from each cluster but doesn't change the Local PDS
  - Length of KCS section in ML: 26 groups of 3 CMs = 1.25km
  - Vector Sum control of 26 groups of 3 CMs (676 cavities)
  - Long loop delays due to transit times

Streamlined PDS

Unused power can be dumped to the loads

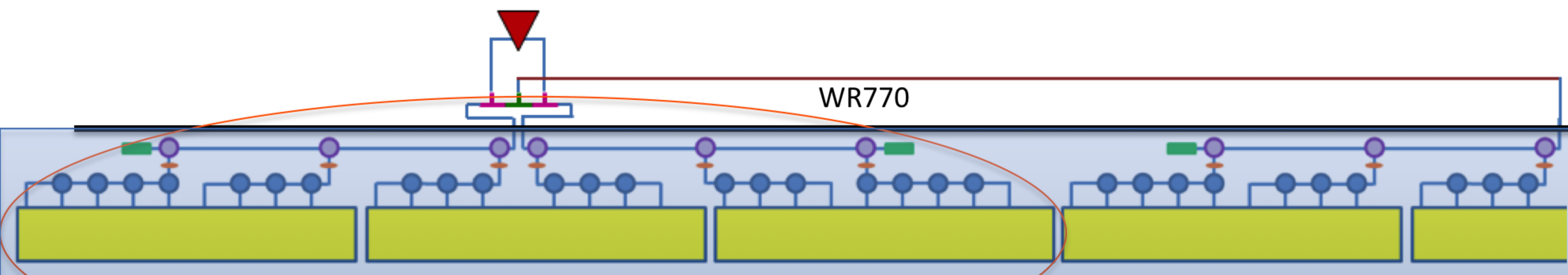
Power to ½ CM's fully adjustable without affecting phases.



phase shifter on each feed, as well as isolator, bi-directional coupler, and flex guide.

RF UNIT: 3 cryomodules (26 cavities)

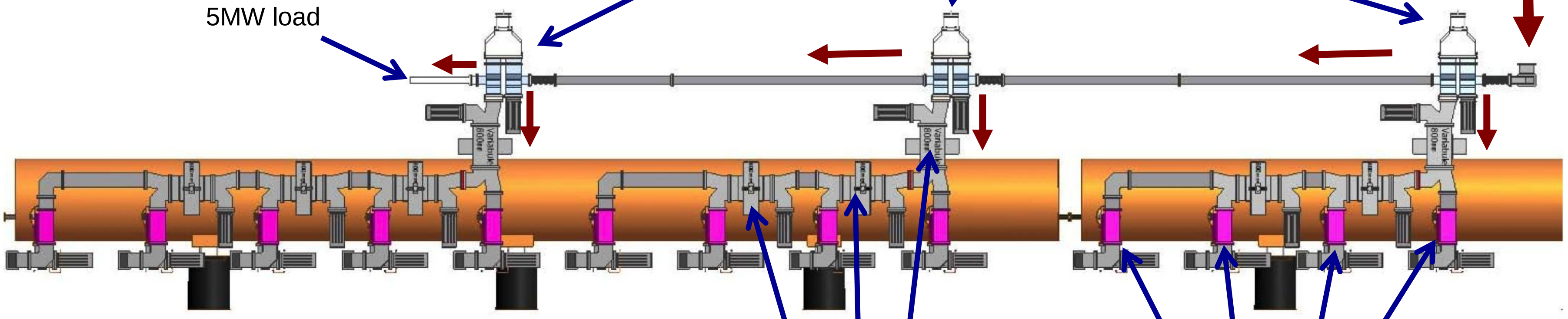
Common Local power distribution



For low power **Kamaboko** (DKS) option, one klystron powers 1 ½ rf units or 4 ½ cryomodules (39 cavities).

A. Yamomoto

TDR Local Power Distribution System for 'Low Power' configuration (Showing half of an RF-Unit for KCS)



KCS (RF source: one CTO per 3 cryomodules)
(Still uses 3 CM group as in RDR)

½ RF-unit for KCS (shown above) comprises:

- Cryomodules: 1 + ½ = 1 ½
- Cavities: 5+4 + 4 = 13

- Motorized double U-bends (2 per CM): 3
- Motorized variable hybrids: 4+3 + 3 = 10
- Motorized phase shifters: 5+4 + 4 = 13
- Motorized input couplers: 5+4 + 4 = 13

Total knobs for each ½ RF Unit for KCS = 39

DKS (RF source: 2 klystrons per 3 groups of 3 cryomodules)
(RDR configuration but with every third klystrons removed)

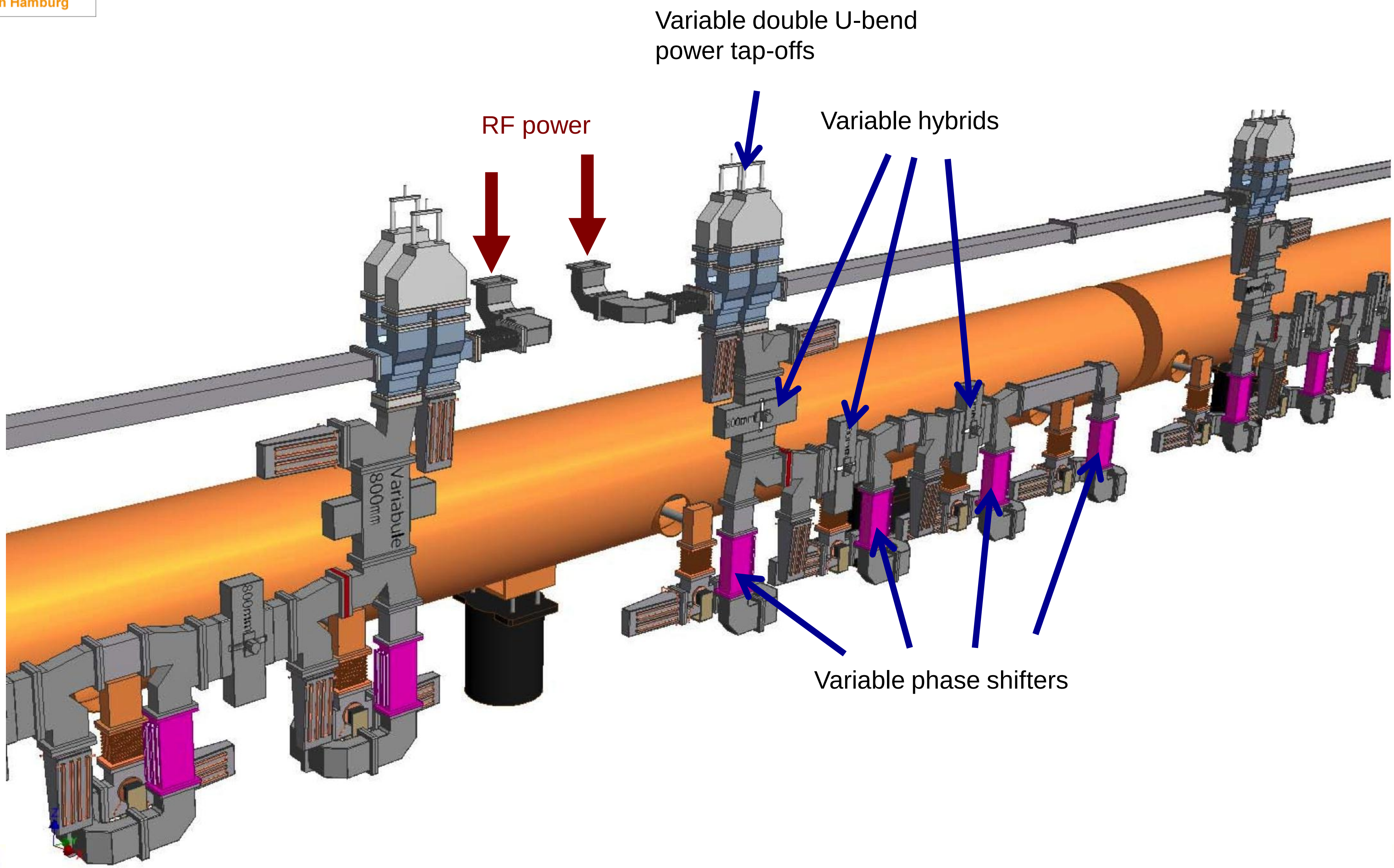
½ RF-unit for DKS comprises:

- Cryomodules: 1+ ½ + ½ + 1 + 1 + ½ = 4 ½
- Cavities: 5+4 + 4 + 4 + 4+5 + 5+4 + 4 = 39

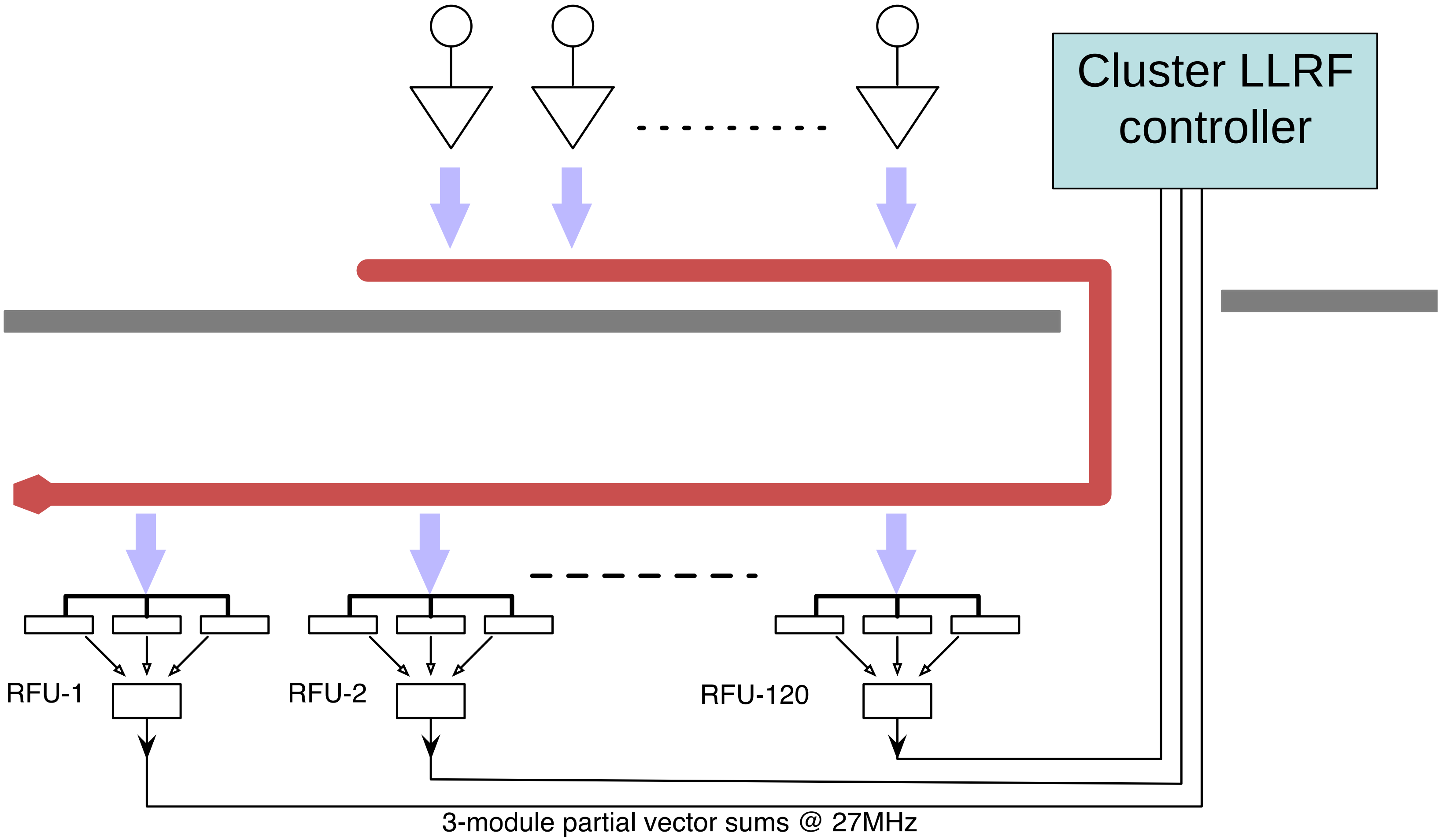
- Motorized double U-bends (2 per CM): 9
- Motorized variable hybrids: 4+3 + 3+3 + 3+4 + 4+3 + 3 = 30
- Motorized phase shifters: 5+4 + 4+4 + 4+5 + 5+4 + 4 = 39
- Motorized input couplers: 5+4 + 4+4 + 4+5 + 5+4 + 4 = 39

Total knobs for each ½ RF Unit for DKS = 117

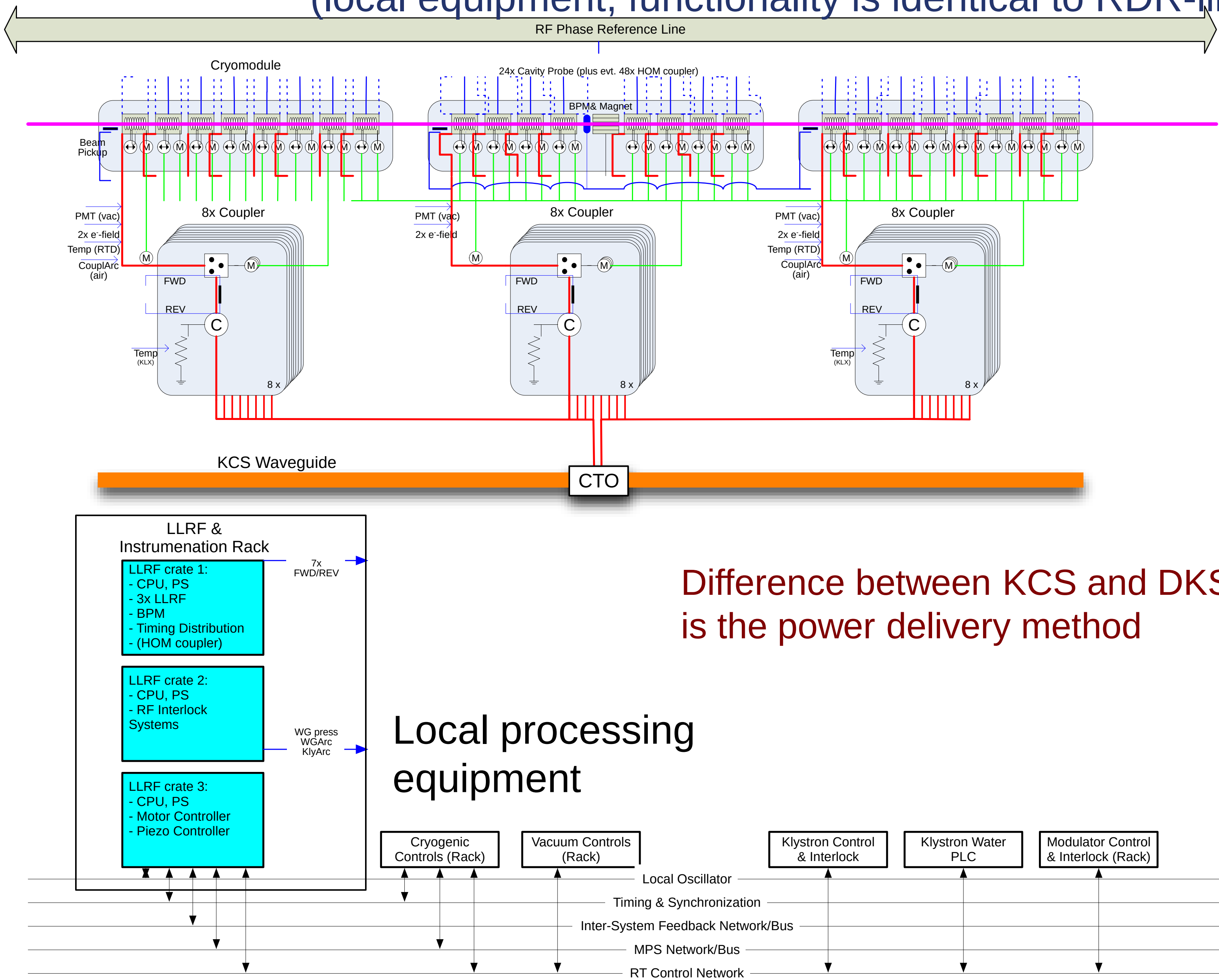
New TDR Baseline Local Power Distribution System



KCS – global view



KCS LLRF concept – local at RF unit (local equipment, functionality is identical to RDR-like



Difference between KCS and DKS is the power delivery method

Local processing equipment

Technical Design Report outline

	Part II: The ILC Baseline Reference	Page counts	Author
1	**Introduction and overview**	**5**	
2	**General parameters and layout**	**15**	
3	**SCRF Linac Technology**	**39**	
	Main linac top-level parameters and general layout	2	Adolphsen
	Cavity performance and production specifications	10	Yamamoto
	Cavity integration (couplers, tuners etc.)	10	Hayano
	Cryomodule design including quadrupole and cryogenic systems	10	Perini
	RF power source	3	Fukuda
	Low-level RF control concept	2	Carwardine/Michizono
	Cavity and cryomodule testing	2	Hayano
4	**Main linac layout for a flat topography**	7	
	Layout	2	Adolphsen
	Klystron cluster scheme RF power distribution system	4	Nantista?
	LLRF control for Klystron Cluster Scheme	1	Carwardine/Michizono
5	**Main linac layout for a mountain topography**	7	
	Layout	2	Adolphsen?
	Distributed Klystron scheme power distribution system	4	Fukuda
	LLRF control for Distributed Klystron Scheme (‘RDR-like’)	1	Carwardine/Michizono

Scope of LLRF sections

- **In Main Linac Technology (2 pages)**
  - LLRF system hardware functional description (1 page + diagram)
  - LLRF system applications / functionality (1 page + diagram)

- **In ML for flat topography (1 page)**
  - LLRF system layout diagram
  - Achieved LLRF performance
- **In ML for mountain topography (1 page)**
  - LLRF system layout diagram
  - LLRF performance limitations due to large VS and long transport delays
  - Global control at cluster level vs fast local processing at the CM

- **Only 4 pages allocated in total, so will need to be able to cite other papers, documents, etc for details**
  - What do we have that can be referenced?

List of functions / applications (from Julien Branlard)

- **Global (klystron-level applications)**
  - MIMO: second order dynamical regulator
  - LFF: modifies FF to minimize repetitive controller error
  - BLC: modifies FF to compensate beam loading
  - BBF: modifies setpoints to minimize beam energy error

- **Local (cryomodule-level applications)**
  - Gradient limiter: truncate RF/acts on SP to lower cav. Grad.
  - Quench detect: RF off at next pulse
  - Auto Loaded-Q: set and monitor cav. QL
  - Auto Pk/Ql control to flatten gradients
  - Auto piezo setup: Lorentz force detuning compensation
  - Energy optimizer: distribute energy losses to other stations

- **Operations: startup, shutdown, exception management,…**