Controls & LLRF Working Group

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Highlights

- Three scheduled sessions
  - **20-30 attendees (~50% remotely via Webex) from DESY, FNAL, KEK, SLAC, ANL, UIUC, IHEP**

- Presentations and discussions on
  - **Ongoing and planned activities in three regions**
  - **LLRF implementation**
  - **ATCA as instrumentation platform**
  - **High availability**
  - **Remote operations**
  - **EDR Work Packages**

- Met with EDR Task Force (M. Ross, N. Toge)

16.1 List of LLRF functions

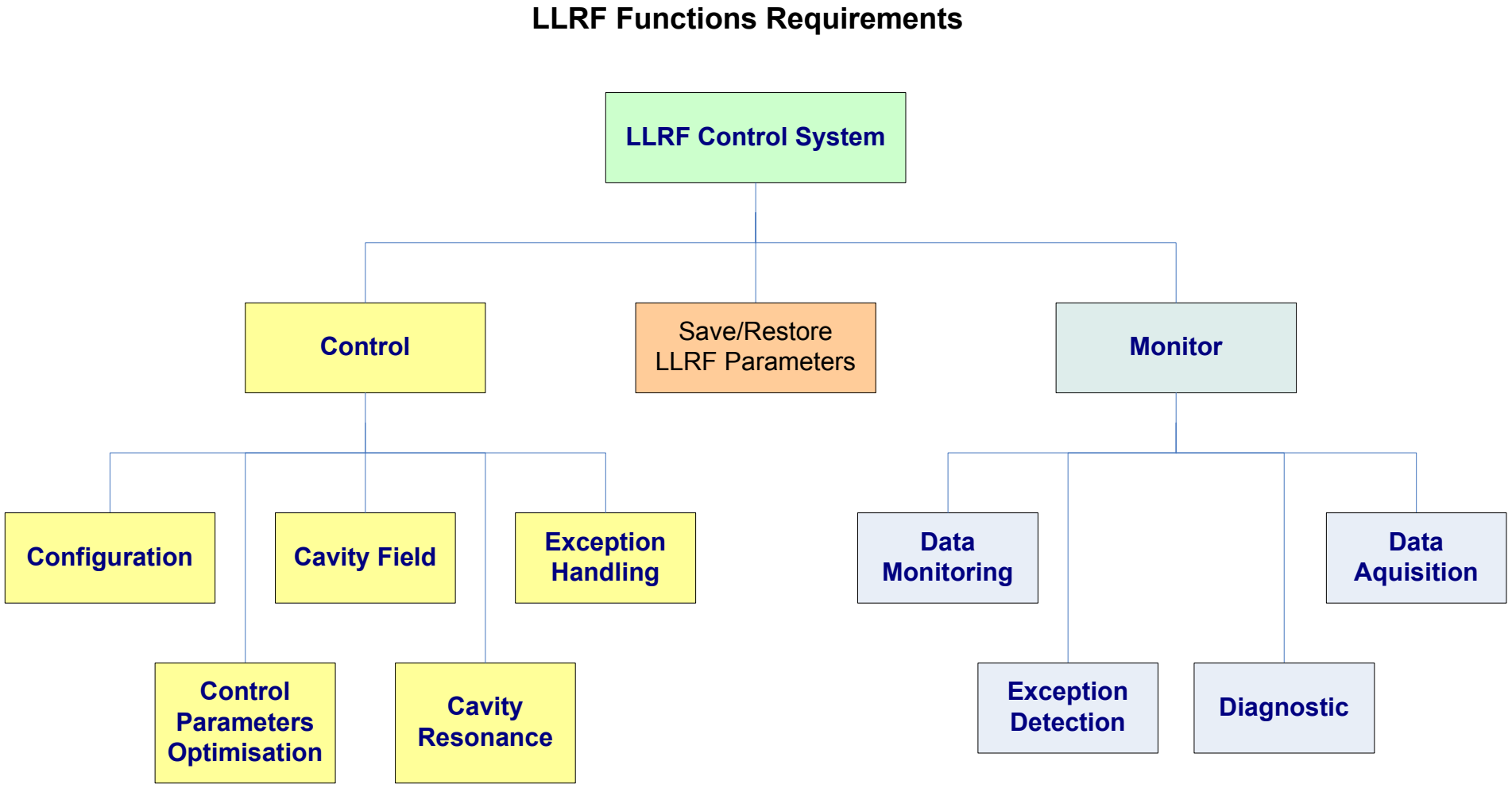


Figure 42 Communication Diagram of the LLRF software

Highlights

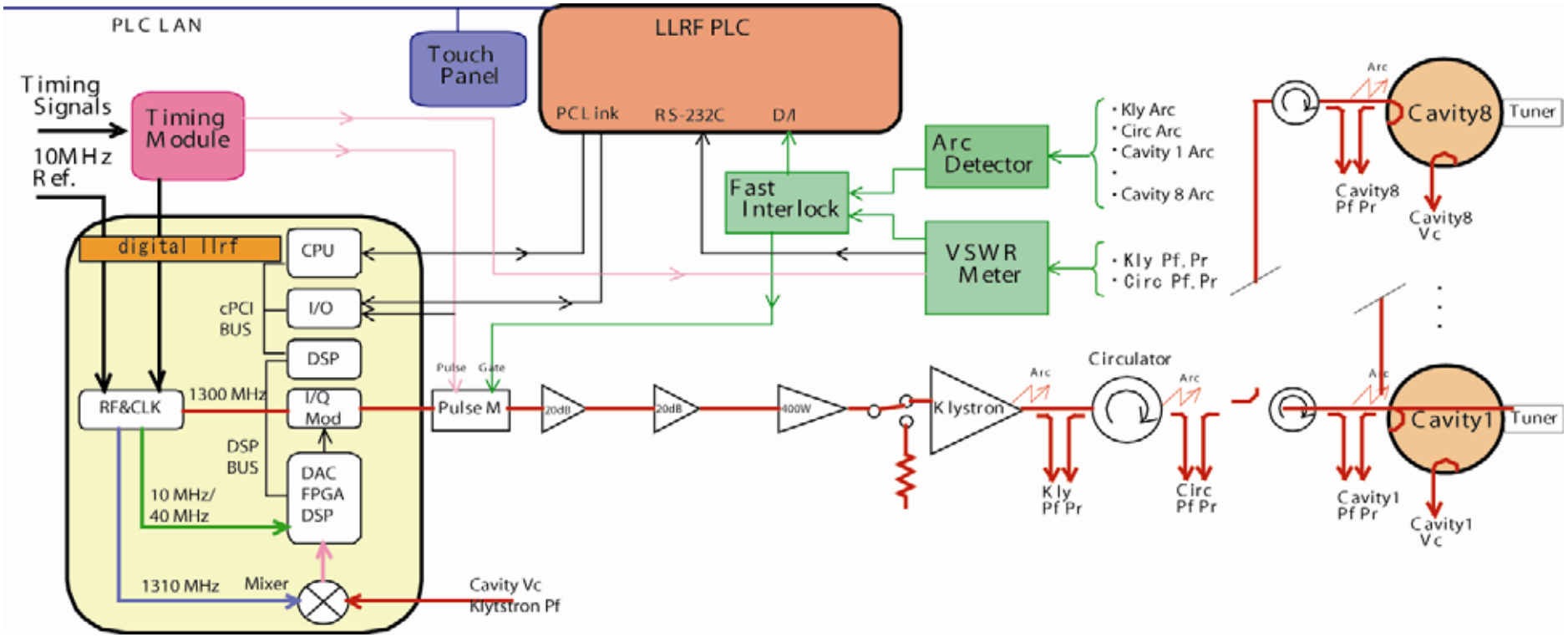
- Third Generation RF Control (WUT-ISE ...)
- Single Bunch Transient Detection (TUL-DMCS ...)
- Multichannel Downconverter (WUT-ISE ...)
- Stable M.O. and Frequency Distribution (WUT-ISE ...)
- RF Gun Control (PSI ...)

- Automation of LLRF Control (TUL-DMCS ...)
- Exception handling (DESY ...)
- Data Management Development (TUL-DMCS ...)
- Control Optimisation (DESY ...)

- Cost and Reliability (DESY ...)
- Radiation Effects on Electronics (ALL)

LLRF system for STF

- LLRF system is based on J-PARC proton linac.
- The main parts are PLC, FastInterlock and digital FB.
- PLC manages all on/off and communicates with control room.
- FastInterlock detects such as Arc discharge and stop rf.



Work package

- Current work package at KEK llrf/control (JFY2007)
  - ***S2:llrf system for STF modulator #1:drive 2 cavities***
  - ***S2:llrf system for STF modulator #2:kly test & can drive 26 cav.***
  - **S2: LLRF network server and EPICS installation**
  - **R&D for ILC**
    - FPGA interlock system
    - Arc detector
    - IF-mixture
- Future work package(JFY2008-)
  - **S2: FPGA board with 32ch ADCs (ATCA or AMC)**
  - **ATCA/uTCA evaluation**
  - **S2: llrf system for STF modulator #3**

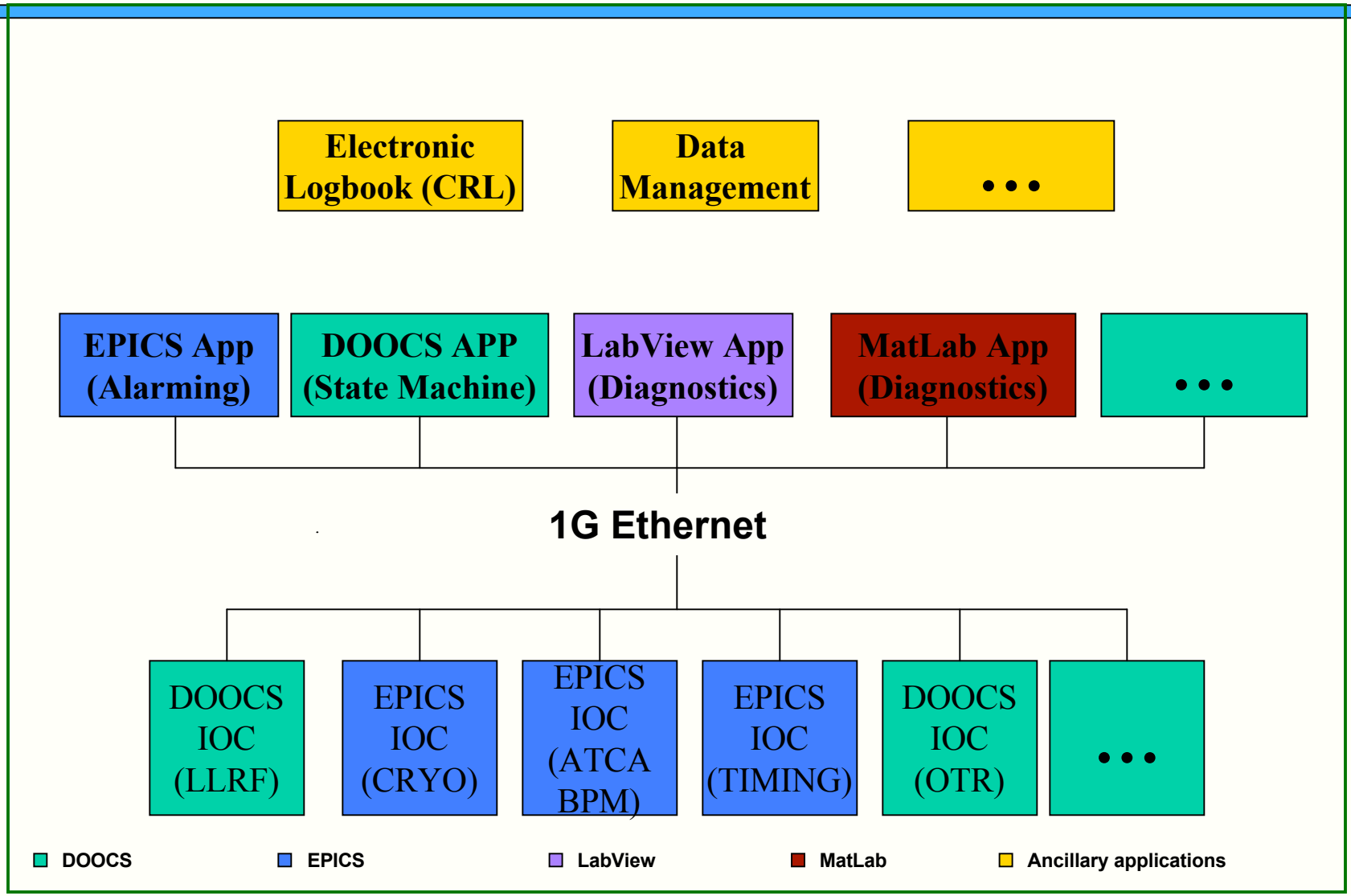
Scope of LLRF Projects

Fermilab

- Vertical Test Stand
  - Cavity testing with automation - analog LLRF (TD/Jlab)
- Horizontal Test Stands
  - Dressed cavity testing - DESY/FNAL LLRF controller(Simcon)
    - Simcon is a 10 channel input VME controller developed for DESY
- High Intensity Neutrino Source HINS
  - 325 MHz, Fast Ferrite Vector Modulator -, LBNL/SNS//FNAL
- Coupler Conditioning Stand
  - 1.3 GHz and 3.9 GHz - rack and stack -> Simcon
- NML - Full RF Unit Test - no beam
  - 3 Cryomodules with 24 cavities - Simcon followed by FNAL design (MFC Module)
- NML - Photo Injector Source - beam to test string
  - Beam based calibration, beam loading, phase reference line - Simcon

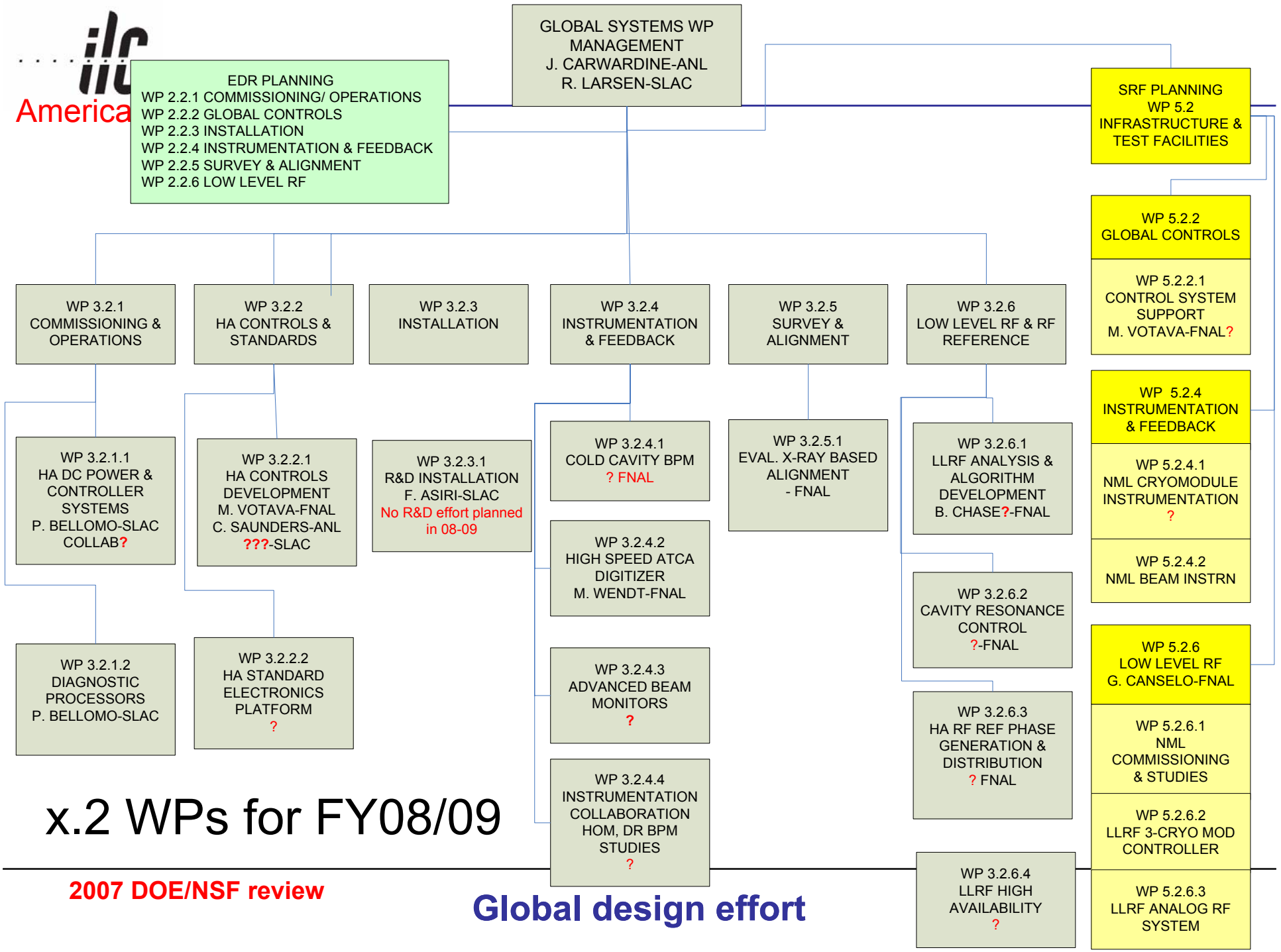
NML Controls Overview

Fermilab



EDR

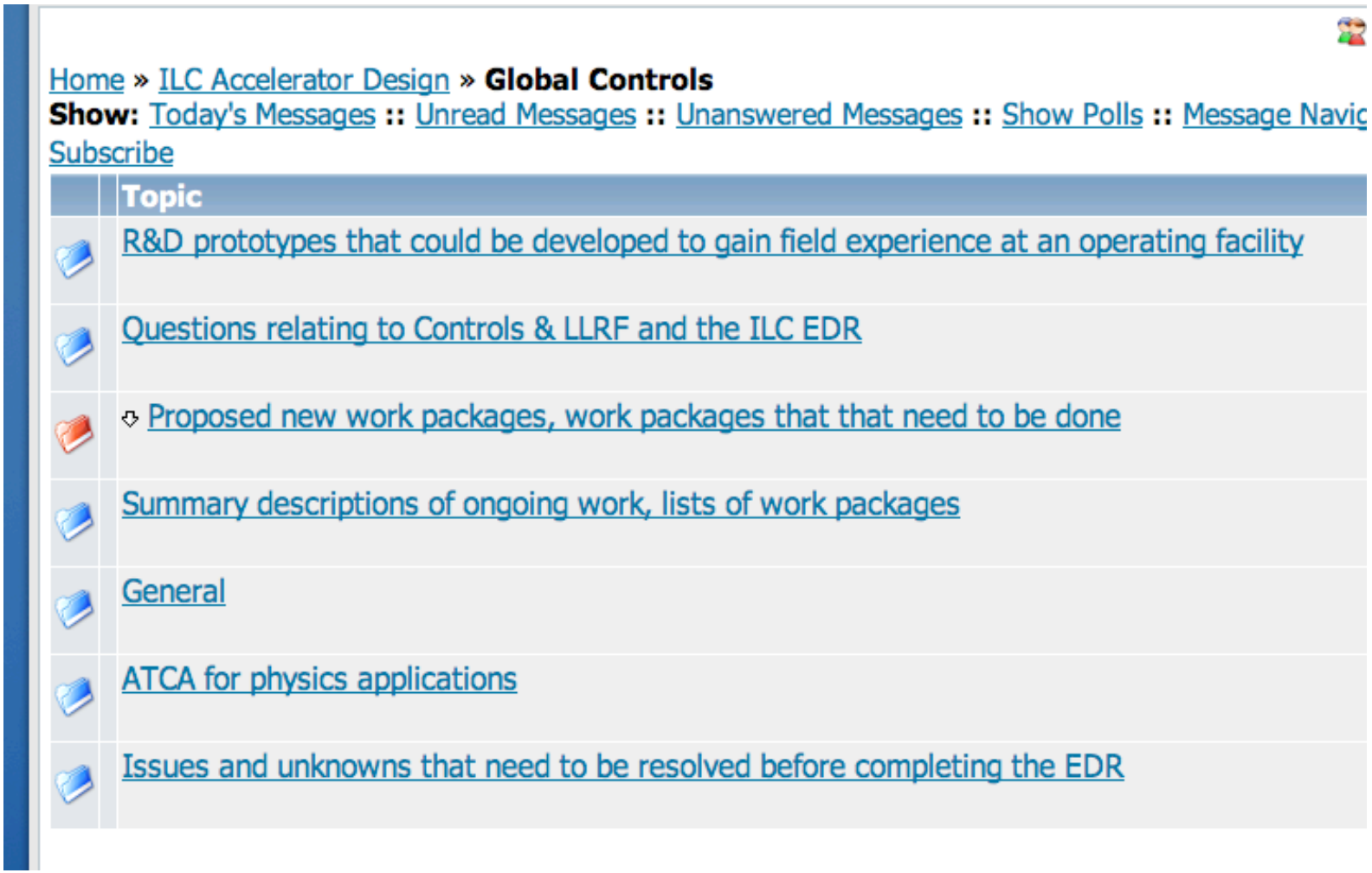
- Goals
  - **Advance the design described in BCD & RDR**
  - **R&D to resolve unknowns and to demonstrate proofs of principle.**
- Already have a good starting point for work packages from the three regions
  - **Americas FY08/09 planning, XFEL work packages. FP7 LLRF proposal, STF work packages, …**
- Develop work packages with multi-region participation
  - **R&D prototype development to gain field experience.**
- Leverage work necessary and ongoing in support of institutional objectives (XFEL, NML, STF,…)


America
EDR PLANNING
WP 2.2.1 COMMISSIONING/ OPERATIONS
WP 2.2.2 GLOBAL CONTROLS
WP 2.2.3 INSTALLATION
WP 2.2.4 INSTRUMENTATION & FEEDBACK
WP 2.2.5 SURVEY & ALIGNMENT
WP 2.2.6 LOW LEVEL RF
GLOBAL SYSTEMS WP MANAGEMENT
J. CARWARDINE-ANL
R. LARSEN-SLAC
SRF PLANNING
WP 5.2
INFRASTRUCTURE & TEST FACILITIES
WP 3.2.1 COMMISSIONING & OPERATIONS
WP 3.2.2 HA CONTROLS & STANDARDS
WP 3.2.3 INSTALLATION
WP 3.2.4 INSTRUMENTATION & FEEDBACK
WP 3.2.5 SURVEY & ALIGNMENT
WP 3.2.6 LOW LEVEL RF & RF REFERENCE
WP 3.2.1.1 HA DC POWER & CONTROLLER SYSTEMS P. BELLOMO-SLAC COLLAB?
WP 3.2.1.2 DIAGNOSTIC PROCESSORS P. BELLOMO-SLAC
WP 3.2.2.1 HA CONTROLS DEVELOPMENT M. VOTAVA-FNAL C. SAUNDERS-ANL ???-SLAC
WP 3.2.2.2 HA STANDARD ELECTRONICS PLATFORM ?
WP 3.2.3.1 R&D INSTALLATION F. ASIRI-SLAC No R&D effort planned in 08-09
WP 3.2.4.1 COLD CAVITY BPM ? FNAL
WP 3.2.4.2 HIGH SPEED ATCA DIGITIZER M. WENDT-FNAL
WP 3.2.4.3 ADVANCED BEAM MONITORS ?
WP 3.2.4.4 INSTRUMENTATION COLLABORATION HOM, DR BPM STUDIES ?
WP 3.2.5.1 EVAL. X-RAY BASED ALIGNMENT - FNAL
WP 3.2.6.1 LLRF ANALYSIS & ALGORITHM DEVELOPMENT B. CHASE?-FNAL
WP 3.2.6.2 CAVITY RESONANCE CONTROL ?-FNAL
WP 3.2.6.3 HA RF REF PHASE GENERATION & DISTRIBUTION ? FNAL
WP 3.2.6.4 LLRF HIGH AVAILABILITY ?
WP 5.2.2 GLOBAL CONTROLS
WP 5.2.2.1 CONTROL SYSTEM SUPPORT M. VOTAVA-FNAL?
WP 5.2.4 INSTRUMENTATION & FEEDBACK
WP 5.2.4.1 NML CRYOMODULE INSTRUMENTATION ?
WP 5.2.4.2 NML BEAM INSTRN
WP 5.2.6 LOW LEVEL RF G. CANSELO-FNAL
WP 5.2.6.1 NML COMMISSIONING & STUDIES
WP 5.2.6.2 LLRF 3-CRYO MOD CONTROLLER
WP 5.2.6.3 LLRF ANALOG RF SYSTEM
x.2 WPs for FY08/09
2007 DOE/NSF review
Global design effort

“List of Lists” for EDR Planning

- **Design and R&D topic areas**
- **R&D Goals**
- **Existing (ongoing and planned) work packages**
- **Issues and unknowns that need to be resolved**
- **New or potential work packages**
- **R&D prototypes to gain field experience**

Global Controls Discussion Forum…



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	Topic
	R&D prototypes that could be developed to gain field experience at an operating facility
	Questions relating to Controls & LLRF and the ILC EDR
	Proposed new work packages, work packages that that need to be done
	Summary descriptions of ongoing work, lists of work packages
	General
	ATCA for physics applications
	Issues and unknowns that need to be resolved before completing the EDR

http://forum.linearcollider.org

Design and R&D Topic Areas

- LLRF algorithms
- RF phase & timing distribution, synchronization
- Machine automation, beam-based feedback
- ATCA evaluation as front-end instrumentation platform
- ATCA evaluation for control system integration
- HA integrated control system
- Integrated Control System as a tool for system-level HA
- Remote access, remote operations (GAN/GDN)
- Failure modes analysis

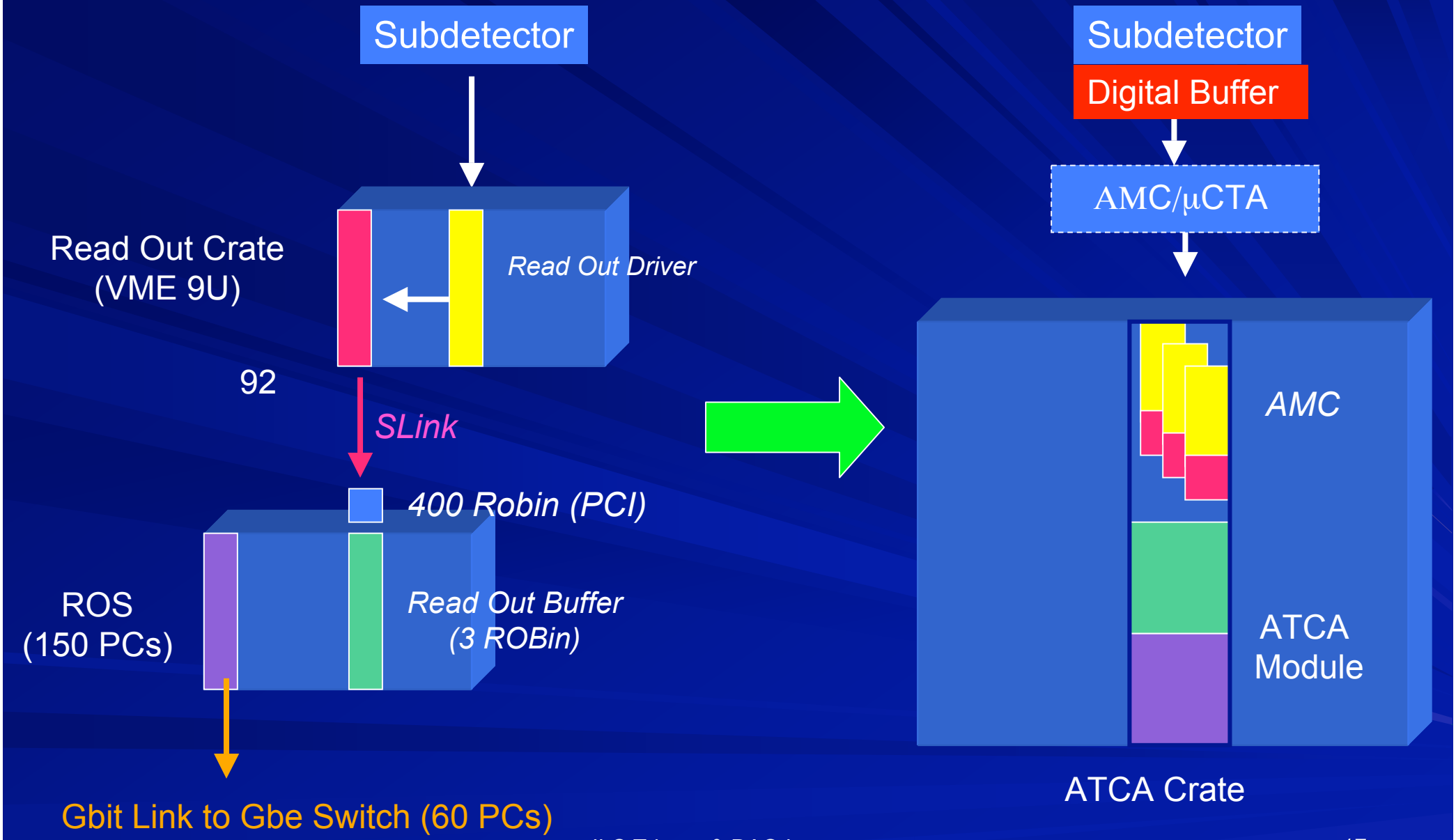
R&D Goals…

- Meet LLRF goals from R&D Board S2 Task Force
- Gain experience using ATCA + uTCA as a platform for ILC front-end electronics applications
  - **Performance as Instrumentation platform.**
  - **Integration with Control system.**
  - **High Availability features.**
- High Availability integrated control system implementation
  - **Integrated hardware and software environments**
  - **Gain experience with tools & techniques.**
  - **Be able to make value based judgments of cost vs benefit of implementation for different applications.**
- Control System as a tool for implementing HA at system level
  - **Integrated Diagnostic tools to detect and pre-empt impending failures in technical equipment**
  - **Managing redundancy at Technical System level.**

Why ATCA?

- State-of-the-art technology
  - **High speed serial communication**
  - **Scalable from small µTCA to large ATCA**
  - **Strong industrial support**
- High Availability – 99.999%
  - **All system components are redundant**
  - **No single element can stop the operation**
  - **Hot-swappable parts**
- Build-in system management
  - **Remote control functions**

Read Out evolution LHC --> ILC

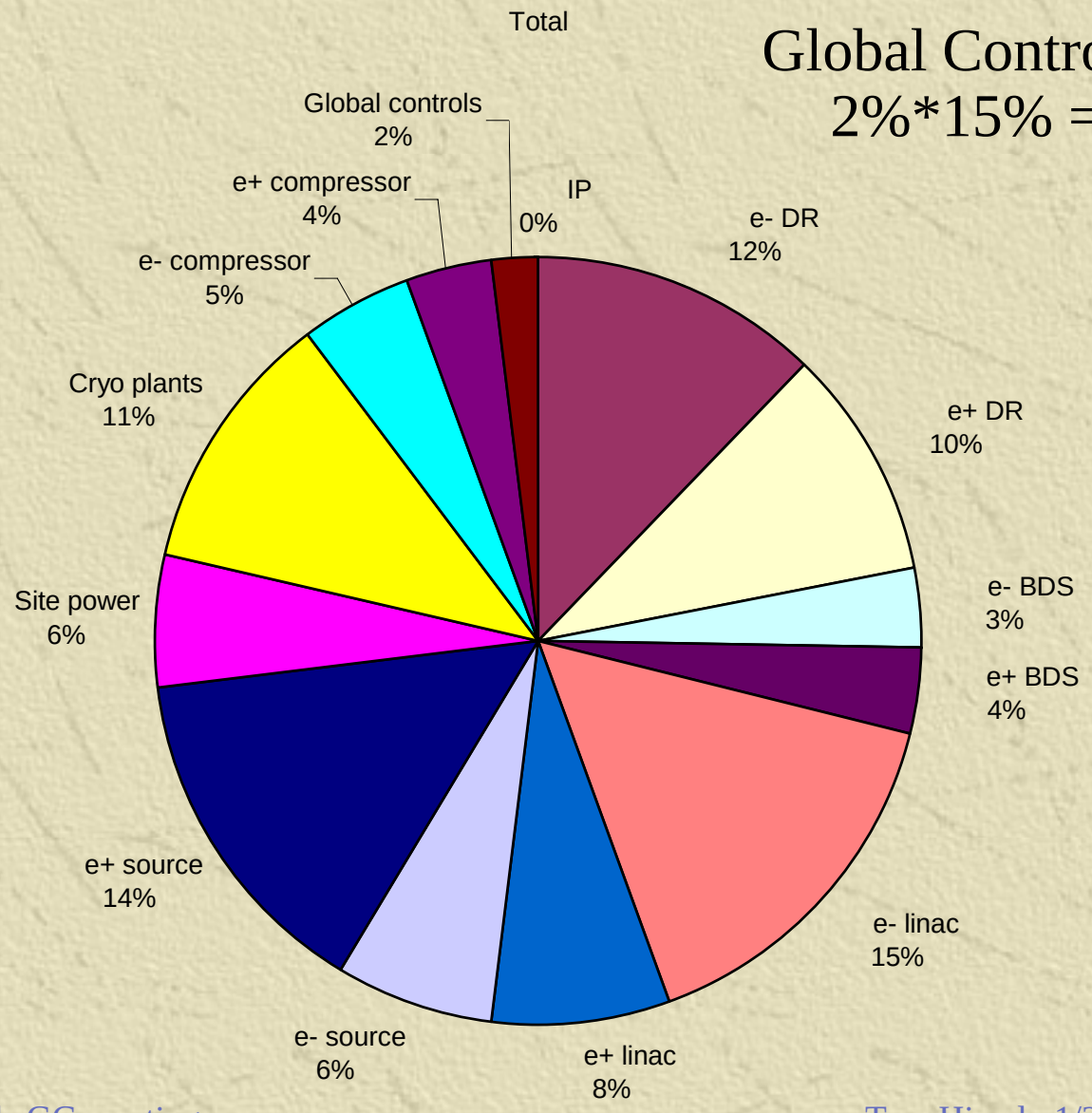


Two aspects to control and availability

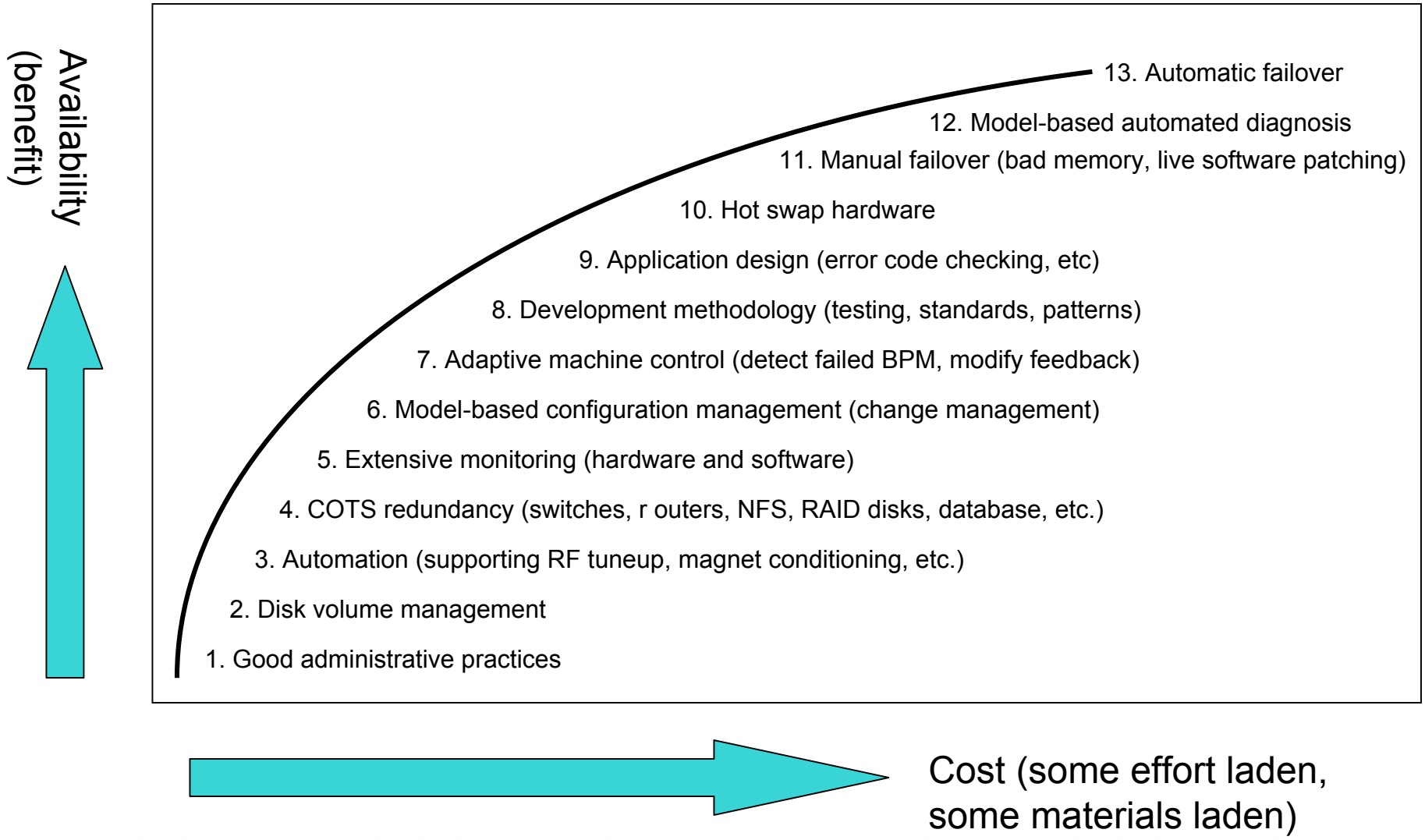
- Controls itself should not go down often. That is what we have been addressing above
- Controls needs to give tools to help discover what is wrong in other systems.

Unavailability budget by region

Global Controls =
2%*15% = 0.3%



Cost/Benefit Analysis of Techniques



Cost/Benefit Analysis

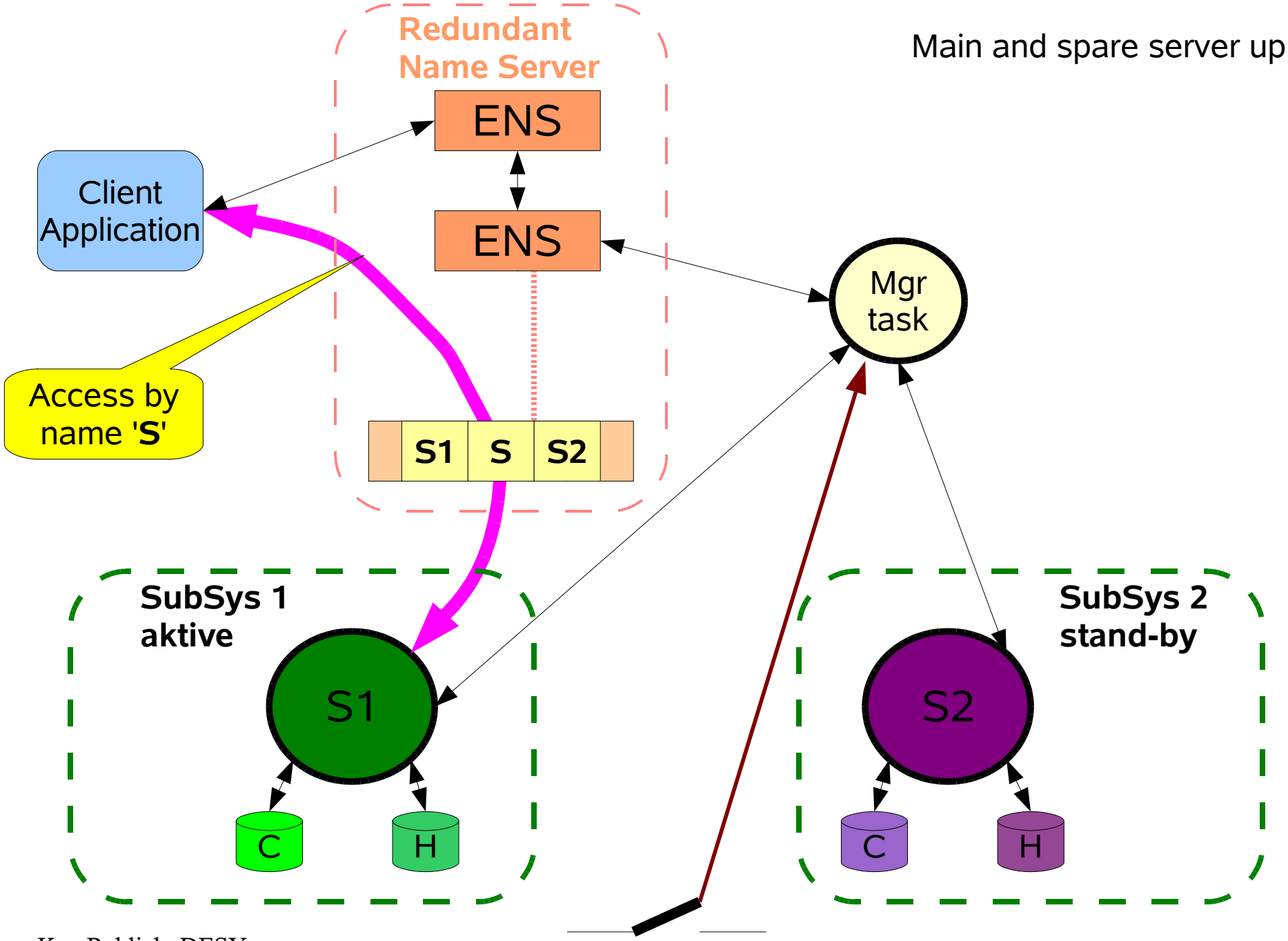
- Order techniques by cost/benefit
  - **To do this, we must:**
    1. Understand controls and system-wide failure modes
    2. Understand which techniques mitigate which failure modes
       - Note: actual list of techniques will be much larger and finer grained than shown on previous slide.
    3. Understand cost of applying a technique (effort and materials)
    4. Re-order and/or add to previous slide
- Cost/benefit ordering not same as R&D priorities.
  - **Some techniques are understood, R&D not necessary.**
- We need cost/benefit ordering and R&D on selected techniques for EDR.

- Following slides touch on some techniques →

Failover @ FLASH

- Used Cases:
  - Two complete subsystems (e.g. Laser, modulator) in a redundant setup
  - A middle layer server with a hot stand-by
  - Two CPUs in a µTCA crate
- Test for the two laser servers are just started

DOOCS Failover Implementation



R&D prototypes to gain field experience

- Vertical slice HA Control System using ATCA front-end instrumentation electronics
- Long-haul and short-haul RF phase & timing distribution
- Fail-over using DOOCS at FLASH
- High Availability EPICS PV gateway on ATCA
- Vertical demonstration of integrated distributed FPGA code management for online front-end systems
- Vertical demonstration of orbit feedback system with transparent recovery from bpm failures
- …

Electronic Systems in general…

- Significant overlap with other ‘electronics’ technical groups (not just Controls and LLRF)
  - **Instrumentation, power supplies, DAQ,…**

- Common lessons to be learnt, opportunities for testing integrated systems (HA, ATCA,…)
  - **High Availability**
  - **ATCA evaluation**

Summary

- A very productive meeting!
- We have a better collective understanding of work being done in the three regions.
- Identified areas of common interest (going even beyond Controls & LLRF)
- ILC EDR specific resources are limited …but there is significant overlap with work being done for the facilities.
- Still lot's of questions on EDR… but we have a excellent starting point for moving forward