HLRF *EDR Management* Work Packages

Prepared for

HLRF EDR Kickoff Meeting
October 1-3, 2007, SLAC Webex

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EDR Phase Assumptions

- Engineering Design Report to be completed in 2010
  - *Will include detailed technical, cost plans considerably more mature than RDR.*
  - *Will include project schedule, funding profile consistent with plans.*
  - *Will be sufficiently mature to provide a basis for international funding requests, implying*
    - *technology down-selects already in hand or close*
    - *Industry collaboration underway*
    - *New project plans, budget estimates, schedules in hand*

EDR Challenge

- EDR definition implies that interim 08-10 period must be sufficiently staffed, funded to achieve “EDR Readiness” by 2010.
- Requires leadership, strong contributions and collaboration from all Regions
- Requires active involvement of industrial partners
- Building inter-regional and lab-industry collaboration through Work Packages critical to meeting EDR goals.

Definitions: *Management & R&D* WP's

- Two Task Categories for each WP

1. *EDR WP - Management:*
   - Subsystem Engineering leaders perform following tasks:
   1. R&D & Overall Project Plans
   2. Cost Analysis & Schedules
   3. Manufacturing & Installation Models
   4. Develop EDR Report
   5. Develop Bid Packages for all Regions (w/R&D)
   6. Build-to-print for first ACD's
   7. Recommend down-selection (or not)
2. *R&D WP – ACD Prototypes:*
   - Organize collaboration, design, build, test prototypes
   - Documentation for Build-to-Print, Specifications
   - Develop Vendors via prototype procurement
   - Assist Bid Package development. Industry liaison

Management WP Goals

- Develop plans to transition all ACD R&D prototypes to first industry articles
  - *SBK, Marx, Distribution, Charger, I&C*
- Challenges
  - *Involving inter-regional collaborators in R&D phase*
  - *Involving industrial partners in R&D phase*
  - *Developing business models for first industrial procurements of finished articles*
  - *Proprietary technology, licensing issues*
  - *Increasing Regional support*
  - *Transition from small R&D partner companies to large-scale production companies*

Management WP Strategy

- Identify work packages that could:
  - *Use more participants on existing programs who would come with institutional support*
  - *Farm out WP's to other regions to be integrated into higher-level WP effort, Regions providing new manpower, materiel support*
  - *Position ILC to let bids for first commercial prototypes of major HLRF assemblies in 2009-10 timeframe.*
    - Implies ILC ownership of Build-to-Print designs

HLRF Component Work Packages

ACD System	Mgmt WP	R&D WP
Klystron SBK	1	1
Marx Prototype	1	1
Marx DFM	1	1
Power Distribution	1	1
Charger PSS	1	1
Interlocks & Controls	1	1

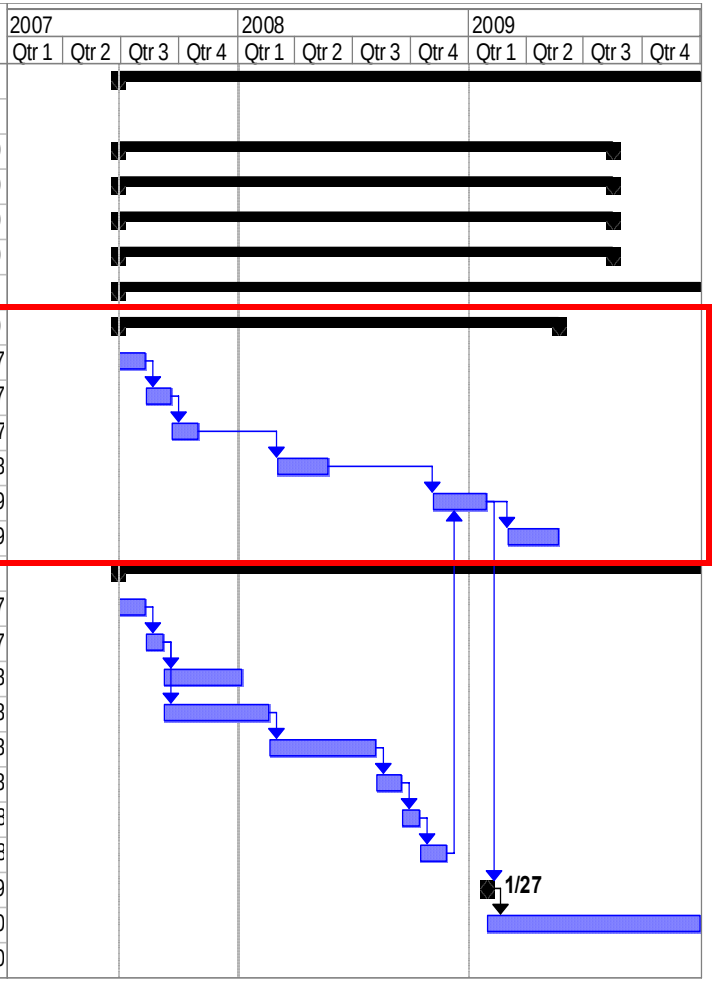
1 Cost Est. 1 Work in Progress

Example *Management* Work Packages - Marx

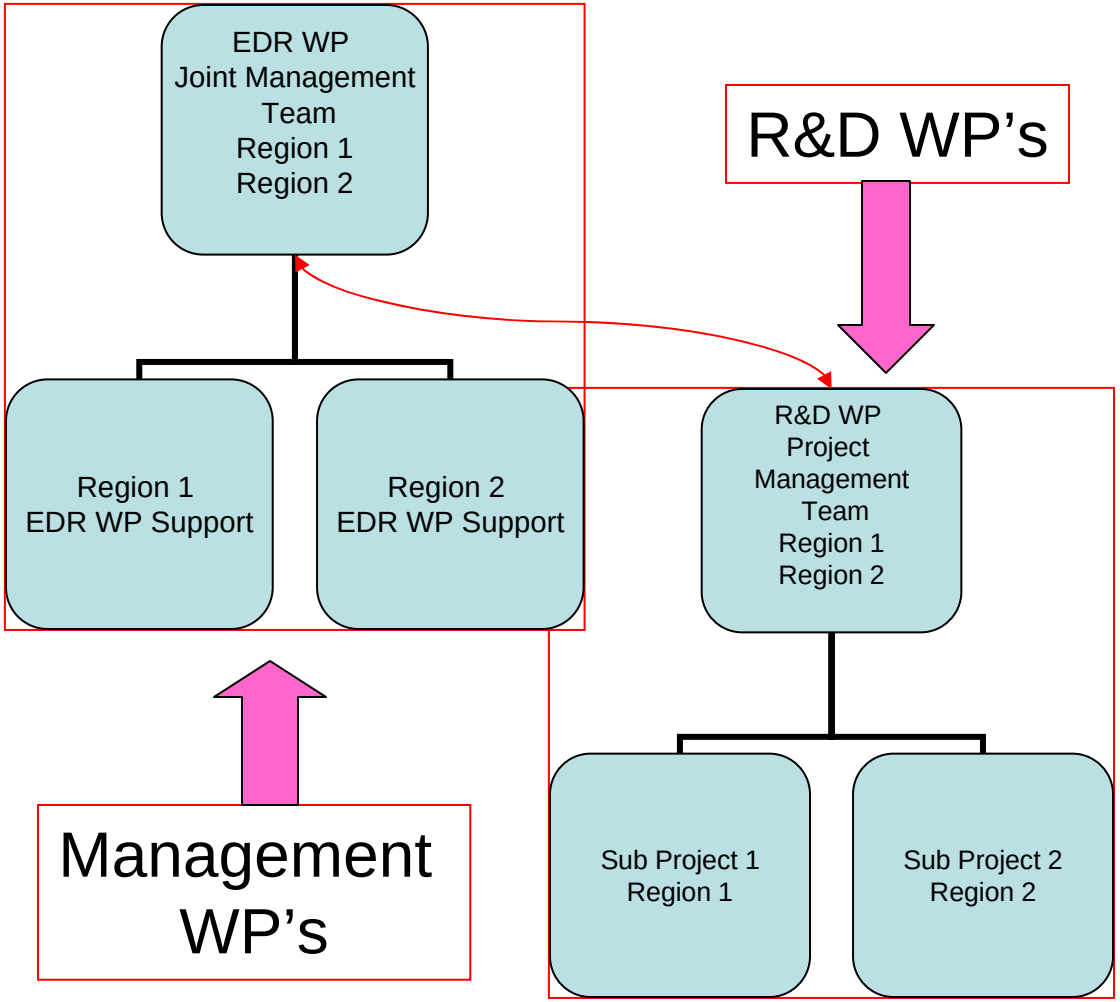
	High Level RF Work Packages	2006	2007	2008	2009	2010	2011	2012	2013	2019
		RDR	EDR			Approval		Construction		Commiss.
1	**EDR Work Packages**									
	Marx Modulator									
	Complete 08-09 Work Packages		♦							
	Down-select technology			♦						
	Prepare bid packages for 3 Regions				♦					
	Place factory orders in 3 Regions				♦					
	Receive units in 3 Regions					♦				
	Implement Test Stands 3 Regions					♦				
	Test Stand operation 3 Regions					------				
2	**R&D Work packages**									
	Marx Modulator									
	Complete prototype power test			♦						
	Complete DFM design			♦						
	Complete DFM Prototype				♦					
	Implement DFM Prototpe on Test Stand				♦-----					

Mgmt WP Schedule Example Marx

ID	Task Name	Duration	Start	Finish
1	**EDR WORK PACKAGES - HA ELECTRONICS**	**705 days**	**Wed 6/27/07**	**Tue 3/9/10**
2				
3	**E1. Magnet Power Supplies & Controller Systems**	**558 days**	**Wed 6/27/07**	**Fri 8/14/09**
4	***E1.1 EDR Management Power Supply Systems***	**558 days**	**Wed 6/27/07**	**Fri 8/14/09**
5	**E1.1.1 Develop R&D & Overall Project Plans**	**558 days**	**Wed 6/27/07**	**Fri 8/14/09**
35	***E1.2 EDR R&D Power Supply Systems***	**558 days**	**Wed 6/27/07**	**Fri 8/14/09**
50	**E2. Marx Modulator ACD (Alternate Conceptual Design)**	**705 days**	**Wed 6/27/07**	**Tue 3/9/10**
51	***E2.1 EDR Management Marx***	**498 days**	**Wed 6/27/07**	**Fri 5/22/09**
52	E2.1.1 Revise Marx R&D Plan, cost, schedule for EDR Phase	30 days	Wed 6/27/07	Tue 8/7/07
53	E2.1.2 Requirements Document for DFM	30 days	Wed 8/8/07	Tue 9/18/07
54	E2.1.3 Specifications Document for DFM	30 days	Wed 9/19/07	Tue 10/30/07
55	E2.1.4 Develop EMIC Plan, Cost & Schedule for Project	60 days	Mon 3/3/08	Fri 5/23/08
56	E2.1.5 Develop Bid Packages for Industrial Prototypes	60 days	Wed 11/5/08	Tue 1/27/09
57	E2.1.6 Develop EDR Report for Modulators	60 days	Mon 3/2/09	Fri 5/22/09
58	***E2.2 EDR R&D Marx Protoype 1 & DFM 1***	**705 days**	**Wed 6/27/07**	**Tue 3/9/10**
59	E2.2.1 Complete, test Vernier pulse flattener Proto 1	30 days	Wed 6/27/07	Tue 8/7/07
60	E2.2.2 Complete assembly in enclosure Proto 1	20 days	Wed 8/8/07	Tue 9/4/07
61	E2.2.3 Complete full power tests Proto 1	90 days	Wed 9/5/07	Tue 1/8/08
62	E2.2.4 Complete design DFM Proto 2	120 days	Wed 9/5/07	Tue 2/19/08
63	E2.2.5 Compete Construction DFM Proto 2	120 days	Wed 2/20/08	Tue 8/5/08
64	E2.2.6 Commission DFM Proto 2	30 days	Wed 8/6/08	Tue 9/16/08
65	E2.2.7 Install in Test Stand ESB DFM Proto 2	20 days	Wed 9/17/08	Tue 10/14/08
66	E2.2.8 Documentation for DFM Bid Packages	30 days	Wed 10/15/08	Tue 11/25/08
67	Bid Packages Ready DFM Industrial Protos	0 days	Tue 1/27/09	Tue 1/27/09
68	E2.2.9 Procure DFM Prototypes 3 Regions	250 days	Wed 1/28/09	Tue 1/12/10
69	E2.2.10 Install in Test Stands, Commission	40 days	Wed 1/13/10	Tue 3/9/10



Example Collaboration Concept



Management Model

- Joint teams may require co-location for some overlap period
- Single lead managers optional also
- Sub-projects in different regions include low level or high-level projects (e.g. Design a controller; Build a klystron or modulator with Regional industry

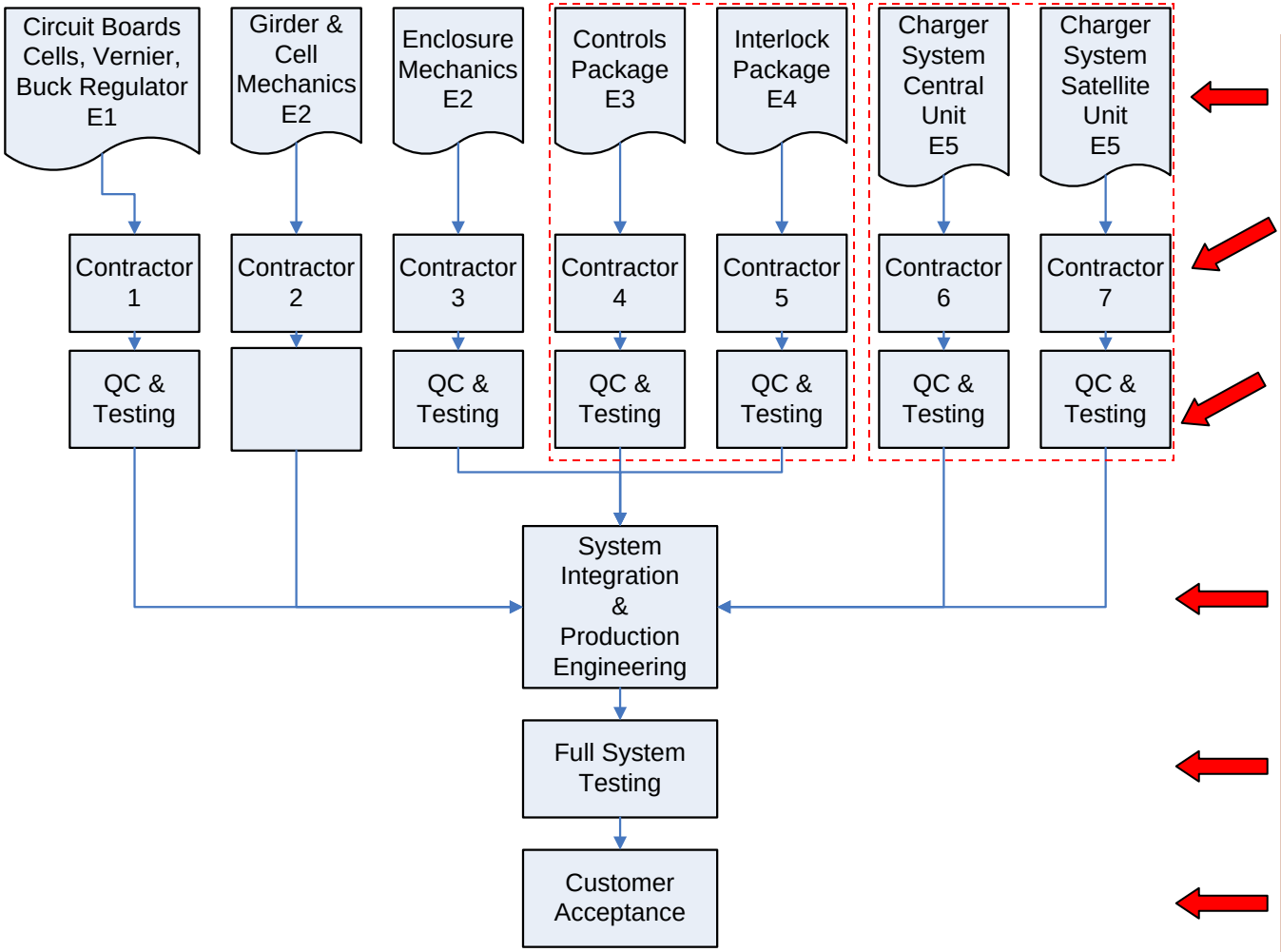
Industrialization

- Assume all major HLRF Units (Modulator, Klystron, distribution, Charger, Controls) will be provided by industry.
- Industrialization has two meanings:
  - *1. Development & deployment of industry process*
    - For new designs of an exotic nature, e.g. SCRF structures, Sheet Beam Klystron
  - *2. Identification & qualification of vendors for new designs of non-exotic nature*
    - Modulator, Charging System, Controls & Interlock Protection System

ACD Industrial Procurement

- ILC is developing and will *own* designs from ACD process
- First article ACD procurements will be “Build-to-Print”
- Vendors may propose design improvements or to build to specification if proposed design meets approval
- Owning designs important for long term future:
  - *Modulators, Distribution have virtually no follow-on business so future procurements could be problematical*
  - *Klystrons have significant follow-on business but much smaller; owning a design is excellent insurance against future vendor ability to deliver (e.g. PEPII experience)*
- HLRF cost models assumed procurement split 50-50 between 2 vendors. (Actual ratios would vary.)

Example WP's for Marx Production



LAB ENGRG. TEAM

- **Generate Bid Packages**
- **Oversee Vendor Production**
- **Oversee Vendor-Based QC, Testing**
- **Oversee Vendor-Based Integration, Production Engineering.**
- **Oversee Vendor based Full System Test**
- **Customer Acceptance**

Mgmt WP Summary Remarks

- Manager Requirements for Coordinating Major WP's:
  - *EDR Leaders who can oversee both Management and R&D planning*
  - *R&D Leaders with basic tools of project management: Technical skills, project experience, estimating and scheduling tools, budget management, personnel management*
  - *Access to creative engineering and support talent*
- WP Managers Required Framework:
  - *Management protocols, methodology*
  - *WP Project Engineering disciplines*
  - *Project standards for reviews, documentation*
  - *Clear lines of responsibility, oversight, reporting*

END OF SLIDES

Appendix

Additional Background Slides
EDR & R&D WP Details

Criteria for Down-Selection

- HLRF ACD's aimed at improved performance (including HA) and significantly improved cost
- Performance Criteria for Marx ACD was selected to be 2000 hr test at full power into test load.
- Assume similar criteria for Sheet Beam Klystron driving test load
- By 2010 very limited test quantities will be available so down select in some cases may be made in 2010 or later.
- In these cases BCD option must be kept alive for insurance, but with minimal new development.

Example WBS/WP's - Marx

- E2. Marx Modulator Alternate Conceptual Design (ACD)
  - *2.1 EDR Management*
  - *2.2 EDR R&D*
    - 2.2.1 First Prototype
    - 2.2.2 DFM Prototype
- E.3 Marx Diagnostics
- E.4 Modulator Charger System
- E.5 M-K Interlocks & Controls

WBS/WP Marx Modulator

- E2. Marx Modulator Alternate Conceptual Design (ACD)
  - *E2.1 EDR Management*
    - Plan the First prototype and DFM prototype program through Fy2009
    - Secure resources of funds & engineering
    - Develop Requirements, Specifications for inclusion in bid packages
    - Oversee completion of full documentation suitable for Build-to-Print option
    - Develop Bid Packages & tailor to 3 regions as needed

WBS/WP Marx Modulator 2

- *E2.2 EDR R&D Marx Modulator*
  - E2.2.1 Marx First Prototype (Work in Progress)
    - 2.2.1.1 Hardware
    - 2.2.1.2 Controls & Software
    - 2.2.1.3 On-Board Diagnostics
    - 2.2.1.4 Vernier Board (for flat top compensation)
    - 2.2.1.5 System Power Testing
    - 2.2.1.6 Packaging for service in ESB
    - 2.2.1.7 Complete all as-built documentation
  - E2.2.2 Marx DFM (Work planned & partly funded but not started)
    - 2.2.2.1 Revise Hardware Design to fit Tunnel
    - 2.2.2.2 Controls & Software upgrade
    - 2.2.2.3 On-Board Diagnostics upgrade
    - 2.2.2.4 Vernier Board Upgrade
    - 2.2.2.5 Documentation for Bid Package

WBS/WP Marx Diagnostics

- E3. Marx Diagnostic Processor
  - *Work in Progress*
    - Prototype units per each Marx Cell installed
    - Features: Gather diagnostics data including
      - Waveform capture & memory
      - Charging waveforms
      - Current & Voltage levels
      - DC trip set points for current, voltage
      - Module on-off status
    - Send data via fibers to Ground Station => IOC => Main Control
    - Use for maintenance planning to replace failed modules before Marx trips off and interrupts operation
  - *Status: First prototype checked out, installed but on-board voltage, current probes not yet instrumented*
  - *Plan to compete on First Prototype in FY08*
  - *Plan advanced design for DFM unit in FY08*
    - Note: Another Diagnostics Processor effort underway for HA power supplies, large bulk power supplies.

WBS/WP Charger System

- E4 Marx Modulator Charger System
  - (New proposal)
  - *Motivation:*
    - Charger systems must be carefully designed to smooth out the high power pulsed loading, harmonics of high voltage AC lines
    - System with N+1 redundancy for high availability (HA) also very desirable
  - *Method Proposed:*
    - “6-Pack” design with central 80% supply and 20% trim supplies at each modulator
    - Central unit oversized 50% and switches added to permit feeding 3 units on either side in case of central unit failure
    - Meets harmonic content goals, HA goals
  - *Status:*
    - Conceptual design, preliminary bottom-up cost estimate complete
    - First phase funding planned in FY08, complete in 2009 (C. Adolphsen)

WBS/WP M-K Interlocks & Controls

- E5 Modulator-Klystron Interlocks & Controls
  - First prototype (Work in progress)
    - Fiber optic links to each Marx cell for controls, triggering, timing
    - Ethernet link from Ground Station inside Marx to nearest control system IOC.
  - DFM (New proposal)
    - Develop interlocks and controls on HA standard platform (ATCA)
    - Perform interlock protection functions in FPGA module
    - Design all input and control channels to be testable
    - Build redundancy into safety systems
  - Status
    - Marx prototype complete but not interfaced to IOC
    - DFM conceptual & packaging design in planning stages
    - Proposed for 2008 Funding

Factory Model Assumptions

- Factory Models were developed for Modulators, Klystrons and Distribution for cost modeling in 2006. Assumptions:
  - *Factories to provide fully tested units essentially ready for final prep and installation to tunnels*
  - *Factories to be provided with necessary test equipment, support personnel*
  - *ILC inspectors at factory sign off on testing before shipment allowed*
  - *Delivery to on-site staging area for nominal inspection that no damage occurred in shipping, plus final prep before releasing to installation*

Factory Models 2

- Further Assumptions:
  - *All components originally assumed built to specifications (electrical power, cooling, mechanical form factor, drive requirements, test procedures)*
    - However for ACD's this seems impractical for early units
  - *Build to specification could come later in process, if designs approved*
  - *Modulator factory provided with fully instrumented test stations, test loads*
  - *Klystron factory provided with klystron test stations, RF driver system, water loads*
  - *Integrated Distribution systems delivered packaged for quick final assembly, mounting on cryo-module in staging area for cold tuning prior to moving to tunnel*

Production Phase Cost Estimate

- *All industrialization models require support personnel and equipment*
- *Estimates of numbers and types of personnel were made for the entire procurement, installation and test models*
- *Resources of engineering, coordination, technical, administrative support were calculated as part of HLRF total cost estimate.*
- *Unit costs were then given to Areas for cost rollups per Area.*
  - *Only exception was cost of installation from staging areas into tunnels, made by Installation Group in separate budget.*

Regional Resources

- Resource Issues
  1. *Personnel:*
     1. Besides defining work packages, need to define new participants from other regions
     2. EDR Management tasks can be more easily shared since do not require co-location
     3. Participation at R&D design level more difficult; requires more face-to-face time, design reviews, hands-on participation in testing etc.
     4. Co-location for planned periods highly desirable
  2. *Funding:*
     1. New participants need to come with funding from home institutions