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# **LArIAT FY15 and FY16 Computing Needs**

Hans Wenzel\* (taking over from Michael Kirby)

Scientific Computing Portfolio Management Team (SC-PMT) Review

4<sup>th</sup> March 2015

\*With Input from: Michael Kirby, Bill Badgett, Andrzej Szelc, Kurt Biery, Jennifer Raaf, Flavio Cavanna, Jason St. John, Elena Gramellini, Irene Nutini, Randy Johnson, ...

# Outline

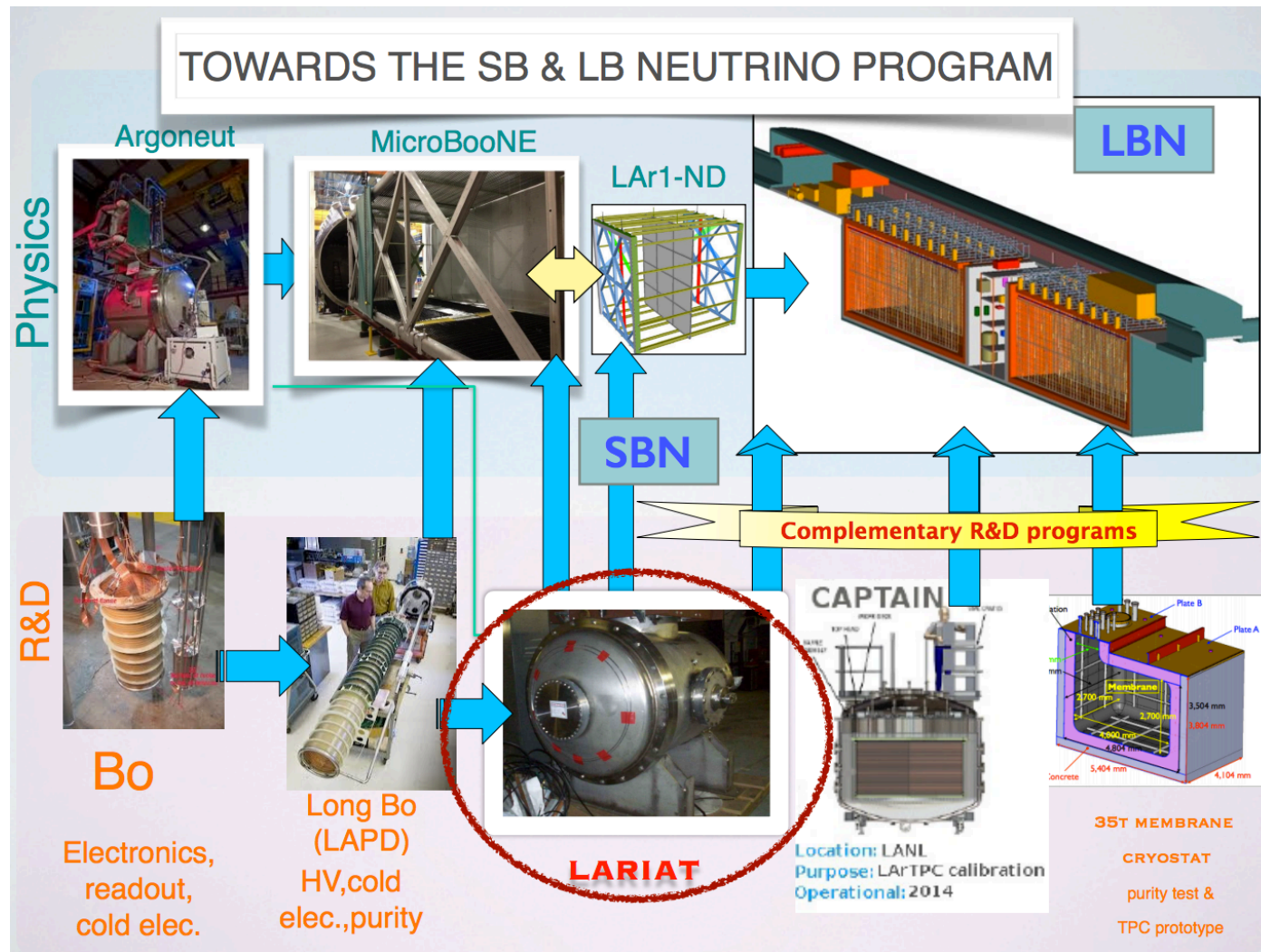
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- Introduction
  - The experiment: science outlook, status and schedule
- Storage and processing estimates
- Scientific Service Requests for LArIAT
- TSW/EOP Status and Plans
- Future Directions (Challenges and R&D)

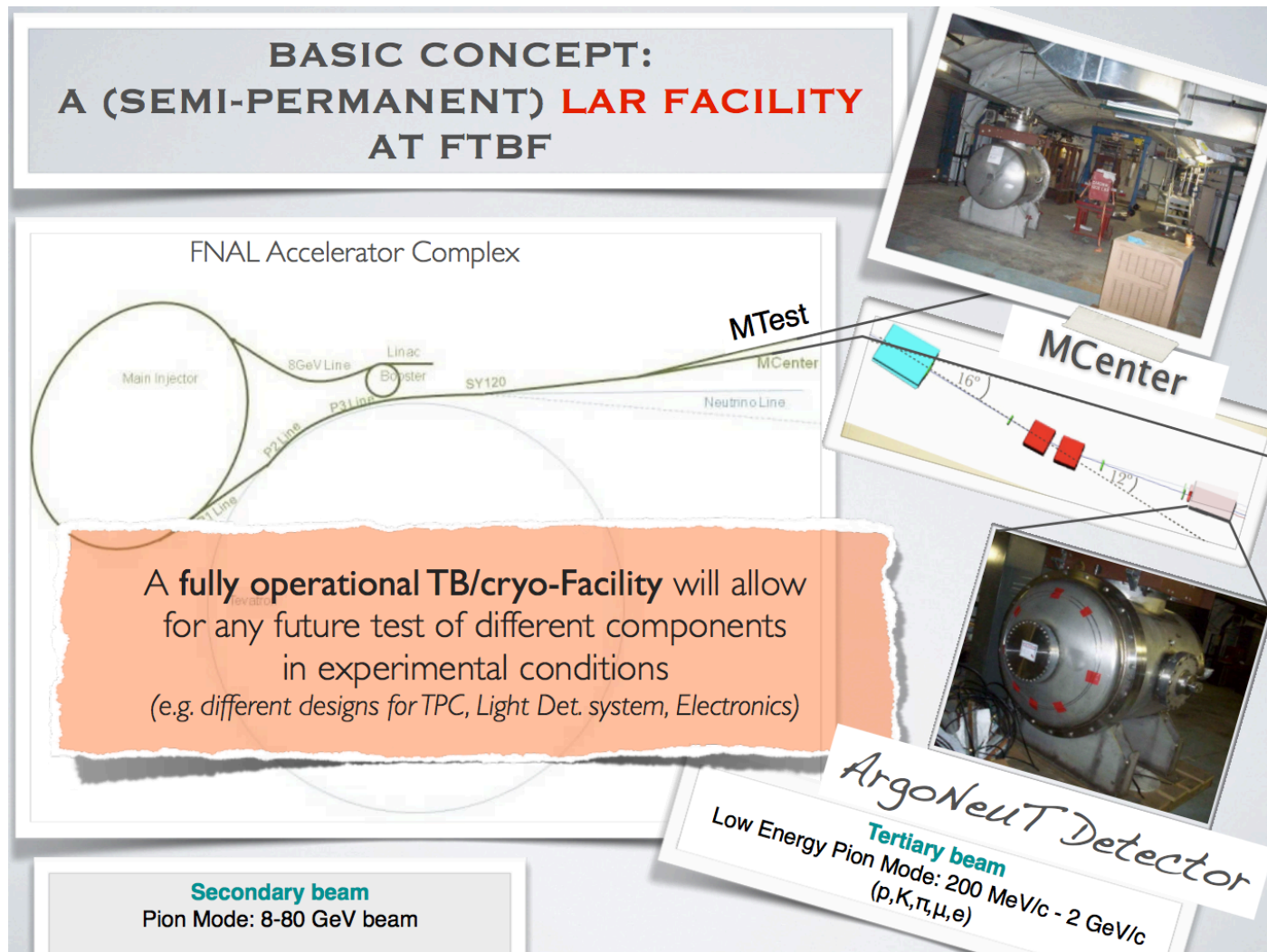


<http://lariat.fnal.gov>

# Slides taken from Flavio Cavanna's Northwestern Seminar



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## SCIENCE OUTLOOK:

### **ELECTRON VS PHOTON SHOWER DISCRIMINATION**

Experimental confirmation for the separation efficiencies (MC determined) - key feature of LArTPC technology

### **MUON SIGN DETERMINATION (W/OUT MAGNETIC FIELD)**

Explore a LArTPC feature never systematically considered (decay vs capture in LAr)

### **STUDY OF NUCLEAR EFFECTS**

Pion Absorption,  $\pi^0$  from  $\pi^\pm$  Charge Exchange, Elastic Cross-Section

Kaon interaction channels

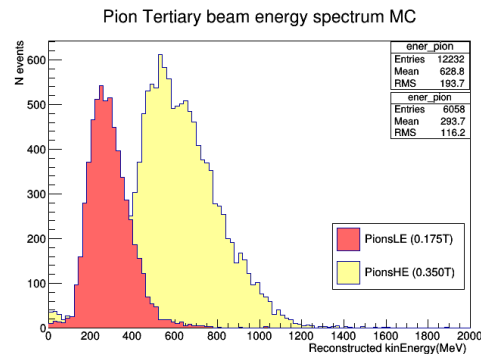
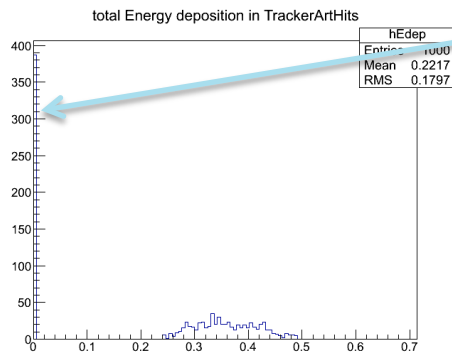
Antiproton annihilation (relevant for n-nbar oscillations)

### **DEVELOPMENT OF A NEW CONCEPT FOR LAR SCINTILLATION LIGHT COLLECTION**

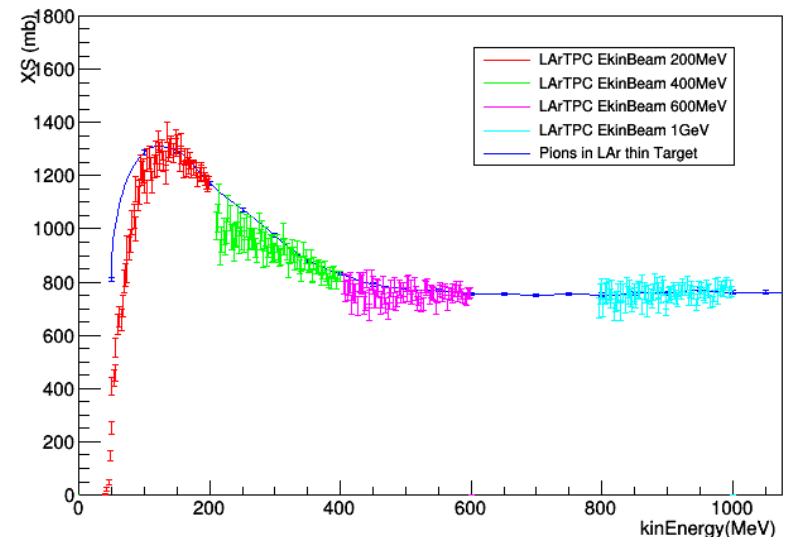
Relate energy deposited to **charge** and **light** for an improved calorimetric energy resolution

## Science outlook (cont.)

- Calorimeter R&D: study nuclear interactions and the role of protons produced for hadronic calorimetry → improved calorimetric resolution, what we learn here can be applied to future calorimeter concepts.
- LAr TPC provides very detailed snapshot of the event and will provide data to validate Geant4/Genie -> good synergy (already found “*features*” in Geant 4.9....)



Total cross section per nucleon for pions in LAr





# Slides taken from Flavio Cavanna's Northwestern Seminar

## **First Run** (engineering run - completed, Sept. '14):

- Secondary Pion Beam Commissioned - June '14
- DAQ & Trigger Commissioned - July/Aug '14
- Tertiary Beam Commissioned - Aug./Sept. '14
- *Beam DATA (rate, momentum, mom. resolution, PID in excellent agreement w/ MC expectations)*

## **Beam shutdown** (Sept.-Nov. '14)

- Cryo-System Delivery & Assembly
- LArTPC/Cold Electronics & Scintillation Light System Test
- *Installation in test-beam enclosure (ongoing now...)*

## **Second Run** (starting asap): \*

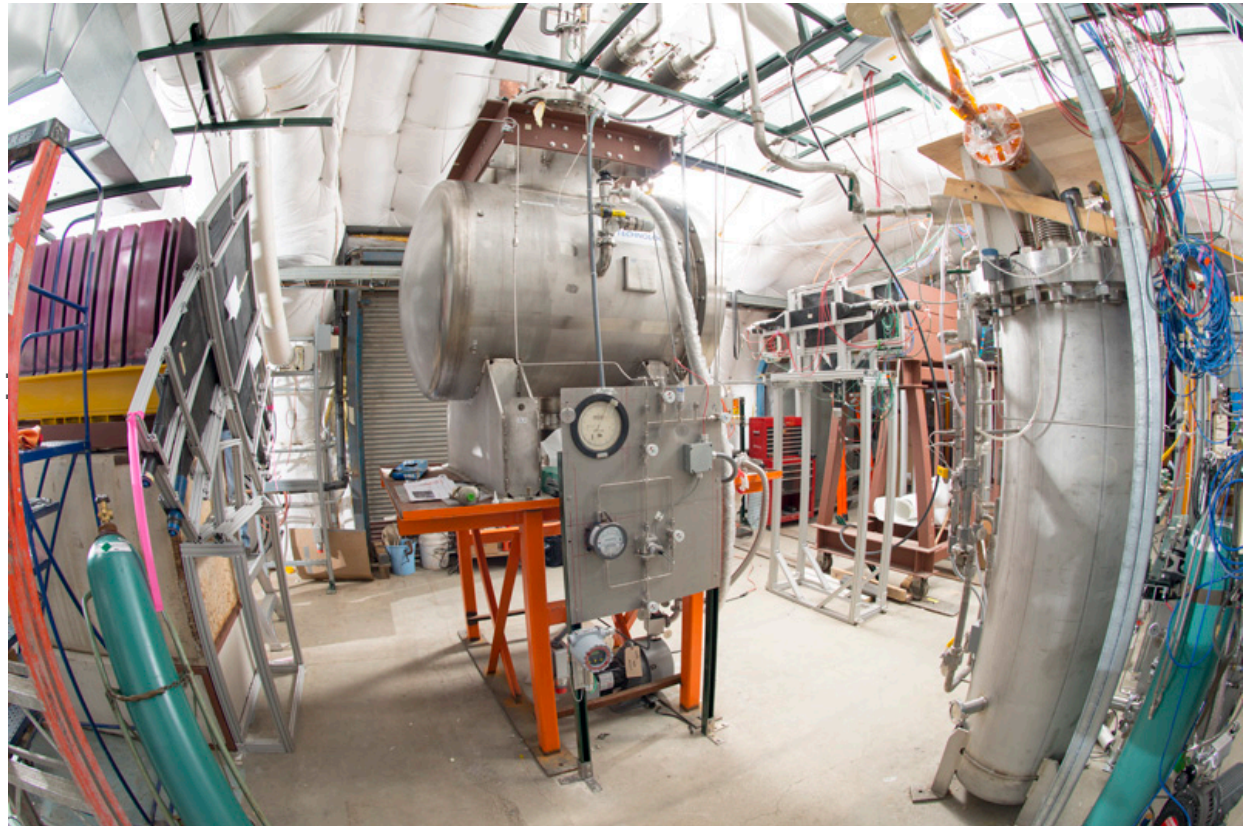
- Cryo-System Commissioning (LAr filling)
- LAr detectors (TPC, PMT & SiPM) Commissioning
- *Physics Run*

## Starting asap – What does this mean?

- Today 11am (March 4), Operational Readiness Clearance (ORC) to get beam in MC7 for commissioning aerogel Cherenkov counters, and to finalize DAQ commissioning.
- Filter regeneration and filling: last two weeks of March.
- LArTPC data-taking: April 😊

→ Exciting!!

- See more pictures at <http://goo.gl/k0wY6m>





# FY 15 Data Storage and Processing estimates

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- Tertiary Beam delivers 4.2 sec spill every minute
- Raw Data is non-zero suppressed from the LAr TPC -> ~150 MB per spill and ~1.9 MB per TPC readout
- anticipate 100 TPC readouts for every spill
- FY15 initial run 3 months, 24x7 with 3 shifts -> 126000 spills
- $126000 \text{ spill} \times 150 \text{ MB/spill} = 20 \text{ TB}$
- expect that simple gzip delivers 6X compression
- Raw Data total for FY15 is 3.3 TB on permanent storage
- Estimate that reconstruction combined with zero removal leads to reconstructed data 4 TB on permanent storage

**FY15 Detector Data Volume = 7.3 TB**

## FY 15 Data Storage and Processing estimates

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- Cosmic Trigger (being set up now) planned to be active for 30 sec between spills.
- Estimated Trigger Rate:  $< 1$  Hz (may be only 4-5 evts/minute).
- 43.2 k cosmic triggers per day.
- 3.9 million triggers  $\times$  1.9 MB per TPC readout = 7.4 TB  $\rightarrow$   $7.4/6 = 1.2$  TB of compressed data in 3 month.
- Estimate that reconstruction combined with zero removal leads to 2.7 TB on permanent storage

**FY15 Cosmic Data Volume = 2.7 TB**

## FY 15: Data Storage and Processing estimates

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- 126000 spills X 100 TPC readout -> 12 M Data evts
- Estimate that we need 10X the simulated events
- 120 M Simulated events of varying configurations
- 4 MB / evt X 120 M evt -> 480 TB
- again zero removal and compression -> 80 TB

FY15 Simulation Data Volume = 80 TB

FY15 Detector Data Volume = 10 TB

Request  
FY15 Total Data Volume = 90 TB

# FY15 Data Storage and Processing estimates

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- Reconstruction of 12 M data events
- estimate ~ 20 sec / evt ( $\mu$ BooNE (30 sec/evt))
- 12 M evts X 20 sec / event -> 67K CPU hrs
- anticipate processing data 3 times during FY15

**FY15 Data Processing = 201K CPU hrs**

- Simulation and Reconstruction of 120 M simulated events
- Estimate 6 sec / event for simulation and digitization.  
120 M evts X 6 sec / event -> 0.2 M CPU hrs
- Processing(reconstruction) 3 times (20 sec) -> 2M CPU hrs
- analysis of data similar scale to all reprocessing -> 2M CPU hrs

**FY15 Sim Processing = 4.2 M CPU hrs**

## FY 16: Data Storage and Processing estimates

- FY 16 plan on running for 6 months after the shutdown
- no change in readout or processing anticipated
- double the data and simulation volume
- double the processing

FY16 Simulation Data Volume = 160 TB

FY16 Detector Data Volume = 20 TB

Request

FY16 Total Data Volume = 180 TB

FY16 Data Processing = 400K CPU hrs

FY16 Sim Processing = 8.4M CPU hrs

Note: might reap huge benefit in CPU time from optimizing the code!!!

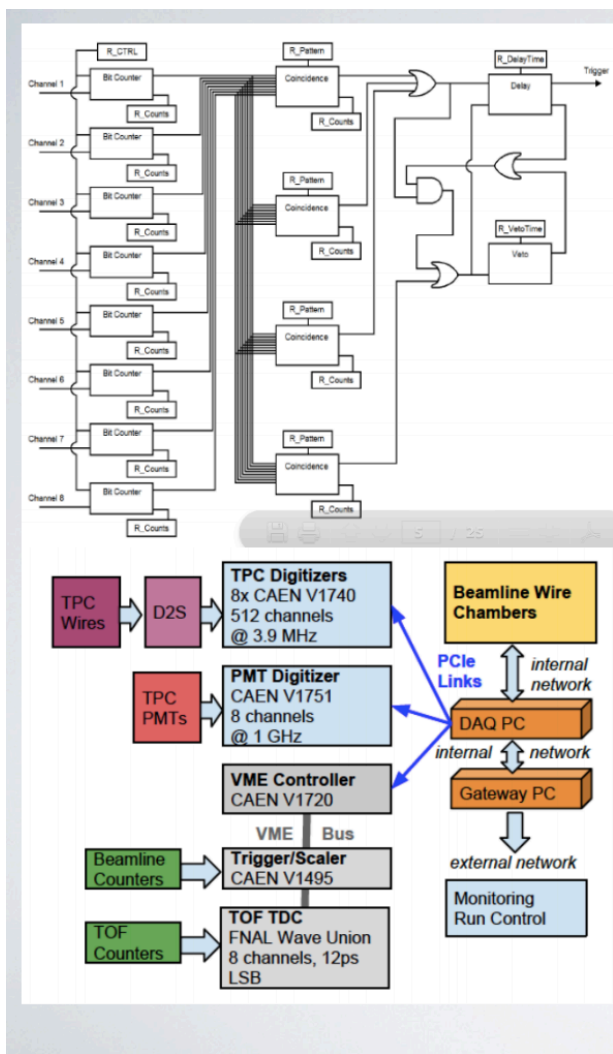


# Scientific Service Requests for LArIAT

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- DAQ – active development using artdaq – request continued support from RSE (Real-Time Systems Engineering) group (Kurt Biery)
- FermiGrid – In Production (currently 25 slots ☹)
- FermiCloud – no current need but know how to utilize
- Gratia – In Production
- JobSub – In Production
- FIFEMon – In Production
- OSG Enabled – effectively ready with infrastructure, waiting for analyzers to adapt scripts and workflows
- Amazon – no plans
- dCache/enstore – currently finalizing, scratch in production – requested tape storage, no large request for more BlueArc

# Slides taken from Flavio Cavanna's Northwestern Seminar



## Trigger System and DAQ



Mike Kordosky  
William Badgett  
Flor Blaszczyk  
Pawel Kryczynski  
Jason St. John  
Ryan Linehan

W&M,  
FNAL,  
LSU,  
Cincinnati,  
BU

# Scientific Service Requests for LArIAT

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We use the standard SCD tools:

- IFDH/Gridftp – in production
- SAM Web – in Production
- FTS – is installed, and we're working to get it running.
- Software Framework (LArSoft) – in Production → request help for profiling and optimizing the code (started), being able to quickly update Geant 4 versions.
- Continuous Integration – planning
- GENIE/Geant4 – Scientific Computing Simulation Group (Daniel Elvira) Assistance on: selecting Physics lists, specialized physics list, selecting Genie/Geant 4 version, Validation → continued effort

# Scientific Service Requests for LArIAT

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- custom databases:
  - configuration db:
    - LArIAT will want to retrieve data & MC files based on individual DAQ config parameter values <http://goo.gl/rgmgWR>.
    - SCD to host, serve, back up, and maintain this database. (24x7 uptime & support)
    - CD is helping us access these database tables through SAM and we are beginning to organize the access of these tables by the analysis programs.
    - Expect ~100 entries / week during 2015.
    - The \_dev configuration table in the database has been up and running for two weeks now. The table in the \_prd database has been created and data can be inserted when start saving data.
  - SAM db: The SAM db instance has been set up. We expect one entry each minute.

# Scientific Service Requests for LArIAT

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- production operations – no plans now, but would like them
- CVMFS – have an active ticket to deploy repository at Fermilab → moving along
- Interactive Computing: GPCF (*General Physics Computing Facility*) VMS lariatgpvm01-03 with 2/4/4 CPU's, 6/12/12GB of memory.
- experiment control room – at Meson Center, fully operational
- Redmine – in production  
<https://cdcvcs.fnal.gov/redmine/projects/lardbt>
- CVS/Git – in production
- ECL (Electronic Logbook) – in production:  
<http://dbweb4.fnal.gov:8080/ECL/lariat/E/index>



# Scientific Service Requests for LArIAT

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- ups/upd – in production
- docDb – in production:  
<http://lartpc-docdb.fnal.gov:8080/>
- video conferencing – in production, Readytalk
- federated data management/high throughput analysis facilities – no plans

## Did you meet your FY14 Scientific Goals?

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Based on last year's Portfolio review and actions taken by SCD  
– did you accomplish what you said you would?

There wasn't a portfolio review...

# TSW/EOP Status and Plans

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- Are your TSWs signed and up to date?
  - The TSW for FTBF is signed and up to date. The current agreement with Roser was only for 5 TB of storage.
- If not, do they need revision?
  - Yes! Art Kreymer provided TSW template → reviewing right now.

## Future Directions (Challenges and R&D)

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- Will your SOPs (*Standard Operating Procedure*) change significantly in the future (new phase of the experiment, new running conditions, etc.)?
  - FY17 will involve LArIAT Phase-II if funded
- Are future R&D projects in the pipeline? Yes
- Are additional resources going to be required to meet them?
  - Yes

# Smooth ride from here on!

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# Backup

# LArIAT Spreadsheet

1/15/15 Experiment:		LArIAT										
Service	Service Offering	Offering details	Definition of row or column	See notes below	Threshold for reporting (if below threshold, then enter "Yes" if small request)	Prior usage (e.g. previous 3 months, to be supplied)	Current usage (allocation and/or utilization of resources, to be supplied)	Projected needs: "Immediate" Needs at this moment. If different from current level then requires immediate reallocation of resources.	"This year" thru end FY15 Expectation of needs thru remainder of FY15. If different from current level then requires gradual reallocation of resources.	"Next year" thru end FY16 Expectation of needs thru end of FY16. If different from FY15 level then requires purchases or reallocation in FY15.	"Out year" thru end FY17 Expectation of needs thru end of FY17. If different from FY16 level then requires purchases or reallocation in FY16.	Comments: Use footnotes if necessary.
SCIENTIFIC COMPUTING SYSTEMS	Batch Worker Nodes (assume all CPUs equivalent)	FermiGrid yearly integral	# CPU-hours	1	100,000	366669			1000000	2000000		
		FermiGrid peak integral	# CPU-hours	2	any	87000	2000		100000	200000		
		FermiGrid peak duration	# of hours	2	any	100	20		150	150		
		FermiGrid peak count	# of peak periods	2	any	2	0		3	3		
		OSG opportunistic yearly integral	# CPU-hours	1	100,000	0	0					
		OSG opportunistic peak integral	# CPU-hours	2	any	0	0					
		OSG opportunistic peak duration	# of hours	2	any	0	0					
		OSG opportunistic peak count	# of peak periods	2	any	0	0					
	Server & Storage Support	External dedicated yearly integral	# CPU-hours	3	100,000	0	0					
		Large Memory or Multi-CPU	Describe needs in Comments		any	0	0		0	0		
		Static Interactive Service	# of Static Services (e.g. VMs)	4	any	3	3		3	4		
		Other Static Services	# of Static Services	4	any	1	1		1	1		
		Dynamic Services, average	# of Dynamic Services	5	2	0	0		0	0		
		Dynamic Services, peak	# of Dynamic Services	2	10	0	0		0	0		
		cmfs Service	Repository (Yes or No)		Yes	Yes	Yes		Yes	Yes		
		Build & Release Service	Use facility (Yes or No)	6	Yes	Yes	Yes		Yes	Yes		
SCIENTIFIC DATA STORAGE & ACCESS	dCache	Database Service	Specify type(s), numbers	7	any	2	2		2	2		
		Other Disk Service (specify)	Servers with attached disk	8	any	0	0		0	0		
		Shared RW	Cache disk storage (TB)	1	20	Yes	Yes		4	4		
		Shared RW lifetime	Cache disk desired lifetime (days)	1	10		30		30	30		
	enstore	Shared Scratch	Cache disk storage (TB)	1	20	Yes	Yes		20	20		
Shared Scratch lifetime		Cache disk desired lifetime (days)	1	10		30		30	30			
NETWORKED STORAGE	NAS/BlueArc	Dedicated Write	Cache disk storage (TB)	1	any	0	5		5	5		
		New/additional capacity	Tape media (TB)	1	25	0	5		60	120		
NETWORK SERVICES	Physical Infrastructure	*-app	Dedicated NAS (TB)	1	any	2	2		3	3		
		*-data	Dedicated NAS (TB)	1	any	8	8		8	10		
		*-prod	Dedicated NAS (TB)	1	any	0	0		0	0		
		*-ana	Dedicated NAS (TB)	1	any	0	0		0	0		
WAN Infrastructure	DAQ LAN bandwidth	Dedicated for DAQ		any 10GE	?							
	LAN bandwidth	Specific to experiment		any 10GE	?							
	DAQ WAN bandwidth	Dedicated for DAQ		any	?							
	WAN bandwidth	Specific to experiment		average > 2 Gb/s	?							
	Dedicated WAN circuits	Dedicated for experiment		any	?							

Service	Service Offering	Offering details	Definition of row or column	Past (e.g. previous 3 months, to be supplied)	Current/Recent (allocation and/or utilization of resources, to be supplied)
SCIENTIFIC COMPUTING SYSTEMS					
Batch Worker Nodes (assume all CPUs equivalent)	Server & Storage Support	FermiGrid yearly integral	# CPU-hours	366669	
		FermiGrid peak integral	# CPU-hours	87000	2000
		FermiGrid peak duration	# of hours	100	20
		FermiGrid peak count	# of peak periods	2	0
		OSG opportunistic yearly integral	# CPU-hours	0	0
		OSG opportunistic peak integral	# CPU-hours	0	0
		OSG opportunistic peak duration	# of hours	0	0
		OSG opportunistic peak count	# of peak periods	0	0
		External dedicated yearly integral	# CPU-hours	0	0
		Large Memory or Multi-CPU	Describe needs in Comments	0	0
		Static Interactive Service	# of Static Services (e.g. VMs)	3	3
		Other Static Services	# of Static Services	1	1
		Dynamic Services, average	# of Dynamic Services	0	0
		Dynamic Services, peak	# of Dynamic Services	0	0
		cvmfs Service	Repository (Yes or No)	Yes	Yes
		Build & Release Service	Use facility (Yes or No)	Yes	Yes
		Database Service	Specify type(s), numbers	2	2
		Other Disk Service (specify)	Servers with attached disk	0	0
SCIENTIFIC DATA STORAGE & ACCESS					
dCache	enstore	Shared RW	Cache disk storage (TB)	Yes	Yes
		Shared RW lifetime	Cache disk desired lifetime (days)	30	30
		Shared Scratch	Cache disk storage (TB)	Yes	Yes
		Shared Scratch lifetime	Cache disk desired lifetime (days)	30	30
		Dedicated Write	Cache disk storage (TB)	0	5
		New/additional capacity	Tape media (TB)	0	5
NETWORKED STORAGE					
NAS/BlueArc		*-app	Dedicated NAS (TB)	2	2
		*-data	Dedicated NAS (TB)	8	8
		*-prod	Dedicated NAS (TB)	0	0
		*-ana	Dedicated NAS (TB)	0	0
NETWORK SERVICES					
Physical Infrastructure	WAN Infrastructure	DAQ LAN bandwidth	Dedicated for DAQ	?	
		LAN bandwidth	Specific to experiment	?	
		DAQ WAN bandwidth	Dedicated for DAQ	?	
		WAN bandwidth	Specific to experiment	?	
		Dedicated WAN circuits	Dedicated for experiment	?	