



LabKey Software™
PARTNERS IN SCIENCE

Mark Igra

LabKey Software

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Data Management for Global Health

- Came to biomedical research from the software industry
 - Moved to Fred Hutchinson Cancer Research Center
- Spun Off into LabKey Software
 - Professional *open source* software for scientists
 - 23 Employees
 - Mostly funded by research networks (ITN, HVTN, CHAVI, nPOD).
 - Some funding from University of Wisconsin (O'Connor Lab, Primate Center)
- Focus: Data Management for Research Networks

- Many global health research projects are distributed in nature
- Integrate & Share data amongst
 - Many clinical sites
 - Many research laboratories
- Specimens are a valuable resource
 - Must be tracked & allocated for maximum scientific value
- Integrated data can be leveraged for new uses

- 7 year “Big Science” project
 - PI: Bart Haynes, Duke University
- 12 Clinical Sites
- 45 Universities/Research Institutions
- Goal: Observational studies to identify correlates of control in Acute HIV Infection
- Data management by Statistical Center for HIV/AIDS Research and Prevention (SCHARP)

- Problems faced
 - Combine many data types for HIV Vaccine studies
 - Clinical Response Forms (CRF), Specimens, Many Assays
 - Enable secure collaboration for scientists worldwide
 - Allocate & distribute valuable specimens
- Solution
 - Secure web portal for HIV Vaccine Enterprise Data
 - Core software was written by LabKey
 - SCHARP runs Atlas
 - Defines available data and relationships
 - Manages security and permissions
 - Manages data loading
 - Builds custom modules
- Nelson et al, BMC Bioinformatics, March 2011
- Piehler et al, BMC Immunology, May 2011

Map of CHAVI



Atlas Data Flows

Data Providers

LIMS

Sample Info

Label	Source	Barcode	Accession	Shipment	Shipment	Shipment
2621	45023	S. 1004-001	45023	3	23	2005
300	13472	S. 1004-001	13472	3	23	2005
2622	45023	S. 1004-001	45023	4	14	2005
2623	45023	S. 1004-001	45023	5	9	2005
2624	45023	S. 1004-001	45023	6	11	2005
300	13480	S. 1004-001	13479	5	11	2005
2625	45023	S. 1004-001	45023	6	12	2005
300	13480	S. 1004-001	13480	4	13	2005
2626	45023	S. 1004-001	45023	7	13	2005
2627	45023	S. 1004-001	45023	8	21	2005
300	13500	S. 1004-001	13500	7	21	2005
2628	45023	S. 1004-001	45023	9	28	2005
300	13578	S. 1004-001	13577	8	28	2005
2629	45023	S. 1004-001	45023	9	1	2005
2630	45023	S. 1004-001	45023	10	17	2005
2631	45023	S. 1004-001	45023	11	17	2005
2632	45023	S. 1004-001	45023	12	30	2005
300	13550	S. 1004-001	13550	9	30	2005
2633	45023	S. 1004-001	45023	13	1	2005
300	13561	S. 1004-001	13561	10	1	2005
2634	45023	S. 1004-001	45023	14	14	2005
300	13550	S. 1004-001	13550	11	14	2005
2635	45023	S. 1004-001	45023	15	14	2005
300	13561	S. 1004-001	13561	12	14	2005
2636	45023	S. 1004-001	45023	16	28	2005
300	13561	S. 1004-001	13561	13	28	2005
2637	45023	S. 1004-001	45023	17	24	2005
300	13570	S. 1004-001	13569	14	24	2005
2638	45023	S. 1004-001	45023	18	24	2005
300	13570	S. 1004-001	13570	15	24	2005
2639	45023	S. 1004-001	45023	19	24	2005
300	13570	S. 1004-001	13570	16	24	2005
2640	45023	S. 1004-001	45023	20	24	2005
300	13570	S. 1004-001	13570	17	24	2005

Assays

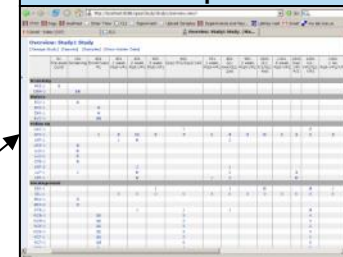
CRF

DOB
BP svs
BP dia
Notes

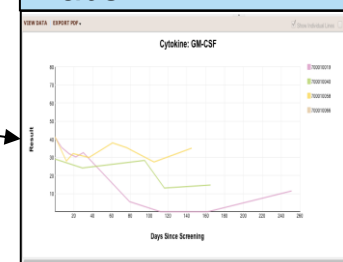
Atlas Web + Database Servers

Data Viewers

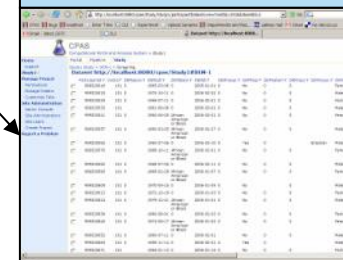
Leadership



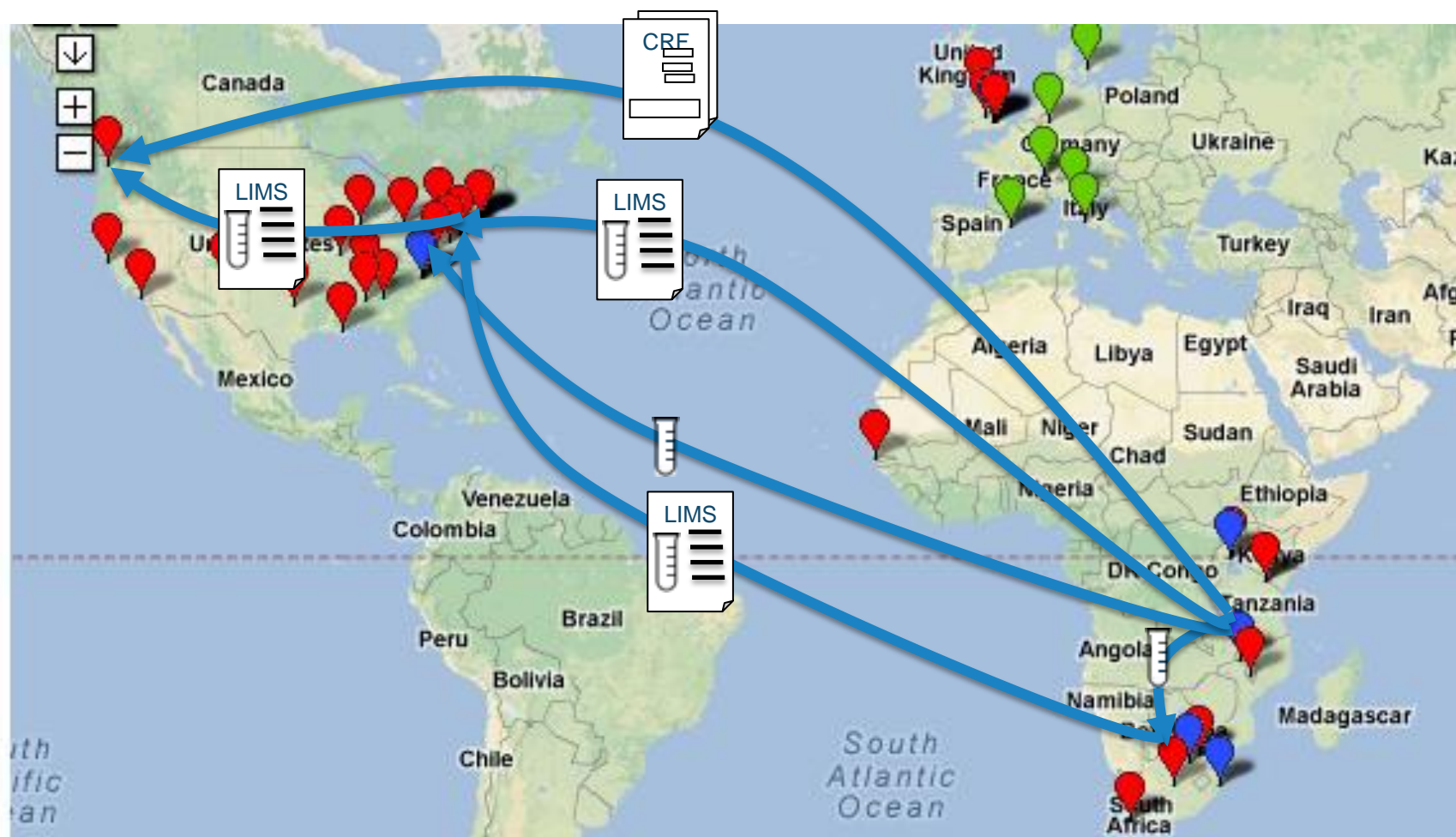
Labs



Collaborators

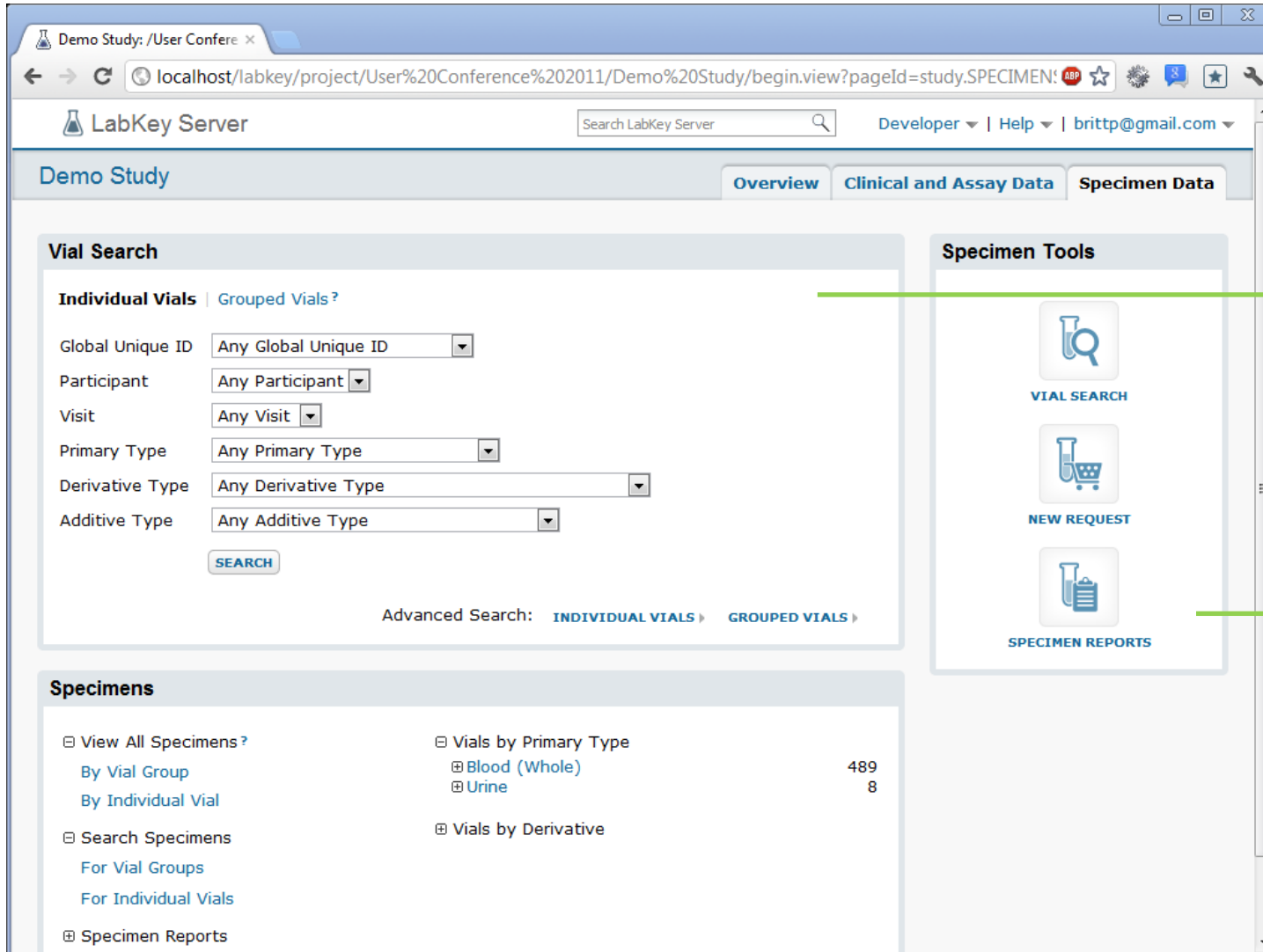


Initial Data/Sample Flows



- Clinical and Sample Data in a Single Repository
- Can ask interesting questions
 - How many samples do I have of each type
 - Where are they?
 - How many from acutely infected patients?

Specimen views: home page



The screenshot shows the LabKey Server interface for a 'Demo Study'. The browser address bar displays the URL: `localhost/labkey/project/User%20Conference%202011/Demo%20Study/begin.view?pageId=study.SPECIMEN`. The page features a navigation bar with tabs for 'Overview', 'Clinical and Assay Data', and 'Specimen Data'. The 'Specimen Data' tab is active, showing a 'Vial Search' section with filters for Global Unique ID, Participant, Visit, Primary Type, Derivative Type, and Additive Type. A 'SEARCH' button is present. Below the search filters is an 'Advanced Search' section with links for 'INDIVIDUAL VIALS' and 'GROUPED VIALS'. On the right, a 'Specimen Tools' sidebar contains icons for 'VIAL SEARCH', 'NEW REQUEST', and 'SPECIMEN REPORTS'. At the bottom, a 'Specimens' section displays a list of vials with columns for 'View All Specimens?', 'By Vial Group', 'By Individual Vial', 'Search Specimens', 'For Vial Groups', 'For Individual Vials', 'Specimen Reports', 'Vials by Primary Type', 'Blood (Whole)', 'Urine', and 'Vials by Derivative'. The counts for 'Blood (Whole)' and 'Urine' are 489 and 8, respectively.

Simple
search and
browse
options

Quick access
to reports
and tools

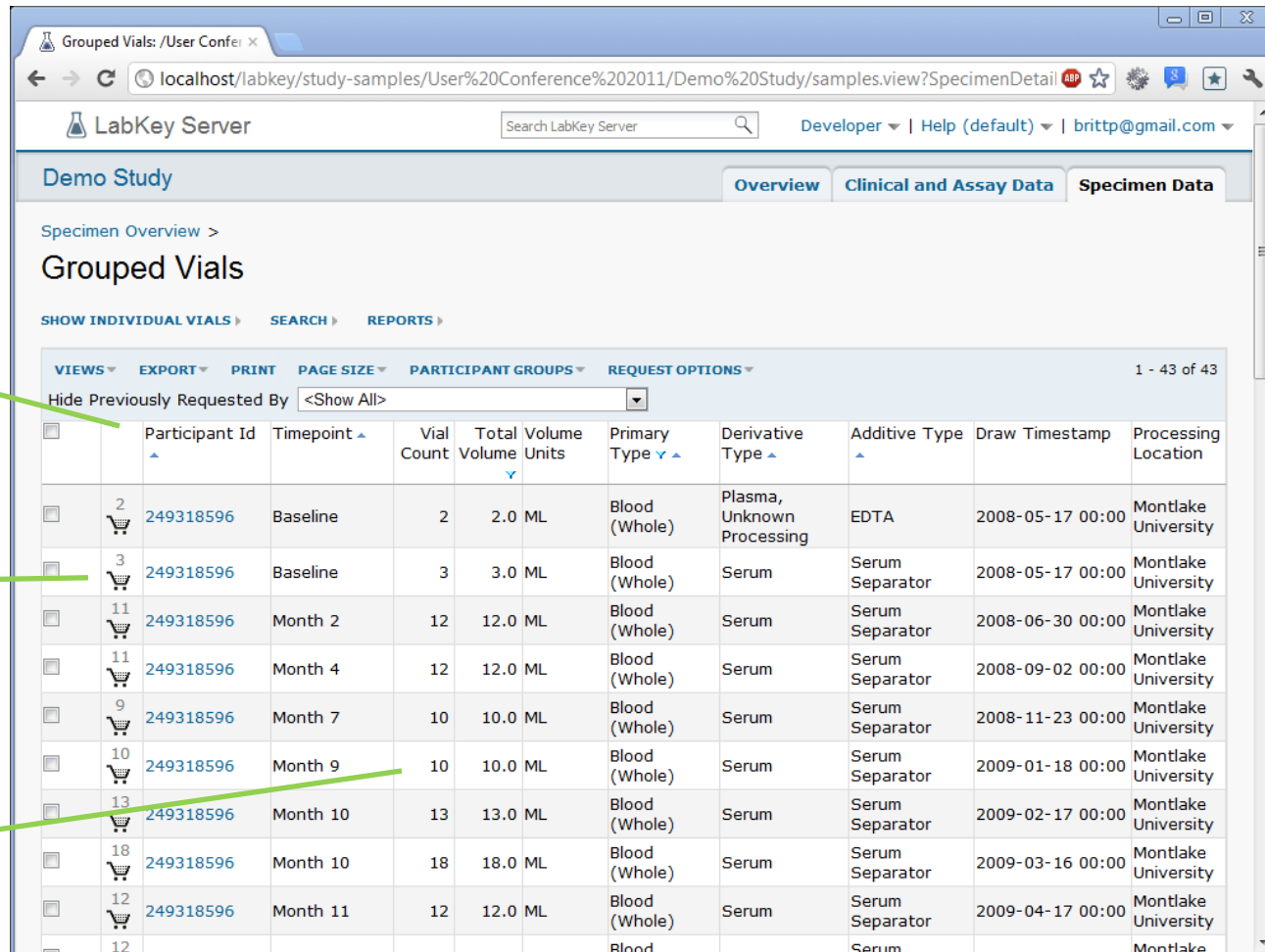
Specimen views: grouped/draw view

- Grouped view shows one row per participant/visit/type

Sort and
filter via
headers

Request
options

Aggregate
information:
Vial count &
total volume



Grouped Vials: /User Conference %202011/Demo %20Study/samples.view?SpecimenDetail

LabKey Server

Search LabKey Server

Developer | Help (default) | brittp@gmail.com

Demo Study

Overview Clinical and Assay Data Specimen Data

Specimen Overview >

Grouped Vials

SHOW INDIVIDUAL VIALS SEARCH REPORTS

VIEWS EXPORT PRINT PAGE SIZE PARTICIPANT GROUPS REQUEST OPTIONS 1 - 43 of 43

Hide Previously Requested By <Show All>

		Participant Id	Timepoint	Vial Count	Total Volume	Volume Units	Primary Type	Derivative Type	Additive Type	Draw Timestamp	Processing Location
	2	249318596	Baseline	2	2.0	ML	Blood (Whole)	Plasma, Unknown Processing	EDTA	2008-05-17 00:00	Montlake University
	3	249318596	Baseline	3	3.0	ML	Blood (Whole)	Serum	Serum Separator	2008-05-17 00:00	Montlake University
	11	249318596	Month 2	12	12.0	ML	Blood (Whole)	Serum	Serum Separator	2008-06-30 00:00	Montlake University
	11	249318596	Month 4	12	12.0	ML	Blood (Whole)	Serum	Serum Separator	2008-09-02 00:00	Montlake University
	9	249318596	Month 7	10	10.0	ML	Blood (Whole)	Serum	Serum Separator	2008-11-23 00:00	Montlake University
	10	249318596	Month 9	10	10.0	ML	Blood (Whole)	Serum	Serum Separator	2009-01-18 00:00	Montlake University
	13	249318596	Month 10	13	13.0	ML	Blood (Whole)	Serum	Serum Separator	2009-02-17 00:00	Montlake University
	18	249318596	Month 10	18	18.0	ML	Blood (Whole)	Serum	Serum Separator	2009-03-16 00:00	Montlake University
	12	249318596	Month 11	12	12.0	ML	Blood (Whole)	Serum	Serum Separator	2009-04-17 00:00	Montlake University
	12						Blood	Serum			Montlake

■ Single Participant Report

249320127 (Vial Count)								
		Baseline	Month 2	Month 6	Month 7	Month 8	Month 9	Month 10
Blood (Whole)	PBMC Cells, Viable	7	11	8	6	3	11	9
	Serum	8	6	7	7	7	12	6

■ Participant collections by type

Blood (Whole) (Vial Count)										
	Baseline	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9
249318596	5		12		12			10		10
249320107	12		22		10				14	
249320127	15		17				15	13	10	23
249320489	18	17	14			19	17			
249320897	10		6	8	6		12			12
249325717	14	18		24				6		

Research Lab Specimen/Data Flows



Specimen requests: request creation

VIEWS ▾
Hide Prev

2

[+]

2

[+]

11

[+]

11

[+]

11

[+]

11

[+]

11

[+]

11

[+]

6

[+]

Request Vial

Select request: 15 ▾

CREATE NEW REQUEST ▸

Request 15

Created: 2011-10-25 14:46:12

Created By: brittp@labkey.com

Destination: Montlake University

Request status: Not Yet Submitted

Vials Currently in Request

<input type="checkbox"/>	Participant ...	Global Unique Id ▾	Timepo...	Primary Type	Derivative Ty...	Additive T...
<input type="checkbox"/>	249320127	87444063.2604.6...	Month 8	Blood (Whole)	PBMC Cells, ...	Heparin
<input type="checkbox"/>	249320127	87444063.2604.6...	Month 8	Blood (Whole)	PBMC Cells, ...	Heparin
<input type="checkbox"/>	249320127	87444063.2604.6...	Month 8	Blood (Whole)	PBMC Cells, ...	Heparin
<input type="checkbox"/>	249320127	87444063.2604.6...	Month 8	Blood (Whole)	Serum	Serum Se...
<input type="checkbox"/>	249320127	87444063.2604.6...	Month 8	Blood (Whole)	Serum	Serum Se...
<input type="checkbox"/>	249320127	87444063.2604.6...	Month 8	Blood (Whole)	Serum	Serum Se...
<input type="checkbox"/>	249320127	87444063.2604.6...	Month 8	Blood (Whole)	Serum	Serum Se...
<input type="checkbox"/>	249320127	87444063.2604.6...	Month 8	Blood (Whole)	Serum	Serum Se...
<input type="checkbox"/>	249320127	87444063.2604.6...	Month 8	Blood (Whole)	Serum	Serum Se...
<input type="checkbox"/>	249320127	87444063.2604.6...	Month 8	Blood (Whole)	Serum	Serum Se...
<input type="checkbox"/>	249320127	87443987.2404.6...	Month 9	Blood (Whole)	PBMC Cells, ...	Heparin
<input type="checkbox"/>	249320127	87443987.2404.6...	Month 9	Blood (Whole)	PBMC Cells, ...	Heparin
<input type="checkbox"/>	249320127	87443987.2404.6...	Month 9	Blood (Whole)	PBMC Cells, ...	Heparin
<input type="checkbox"/>	249320127	87443968.2404.5...	Month ...	Blood (Whole)	PBMC Cells, ...	Heparin

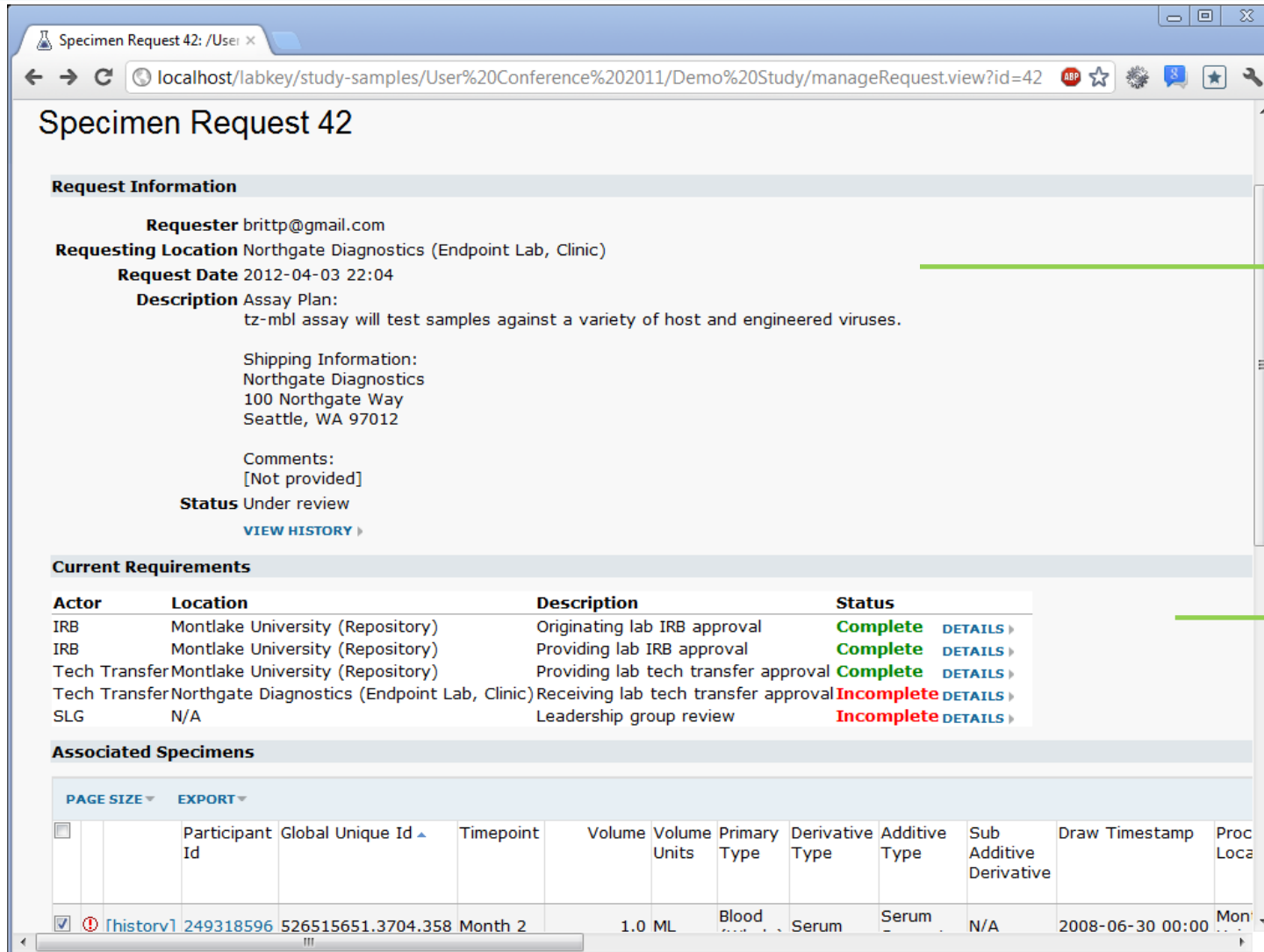
ADD 526517443.2604.266 TO REQUEST

REMOVE CHECKED VIALS

MANAGE REQUEST ▾

CLOSE

Specimen requests: request status



Specimen Request 42

Request Information

Requester brittp@gmail.com
Requesting Location Northgate Diagnostics (Endpoint Lab, Clinic)
Request Date 2012-04-03 22:04
Description Assay Plan:
tz-mbl assay will test samples against a variety of host and engineered viruses.

Shipping Information:
Northgate Diagnostics
100 Northgate Way
Seattle, WA 97012

Comments:
[Not provided]

Status Under review
[VIEW HISTORY >](#)

Current Requirements

Actor	Location	Description	Status	
IRB	Montlake University (Repository)	Originating lab IRB approval	Complete	DETAILS >
IRB	Montlake University (Repository)	Providing lab IRB approval	Complete	DETAILS >
Tech Transfer	Montlake University (Repository)	Providing lab tech transfer approval	Complete	DETAILS >
Tech Transfer	Northgate Diagnostics (Endpoint Lab, Clinic)	Receiving lab tech transfer approval	Incomplete	DETAILS >
SLG	N/A	Leadership group review	Incomplete	DETAILS >

Associated Specimens

PAGE SIZE ▾ EXPORT ▾

		Participant Id	Global Unique Id ▲	Timepoint	Volume	Volume Units	Primary Type	Derivative Type	Additive Type	Sub Additive Derivative	Draw Timestamp	Proc Loca
<input checked="" type="checkbox"/>	[history]	249318596	526515651.3704.358	Month 2	1.0	ML	Blood	Serum	Serum	N/A	2008-06-30 00:00	Mon

Read-only
details,
history,
and status

Transparent
request
approval
workflow

Lab Data Flows

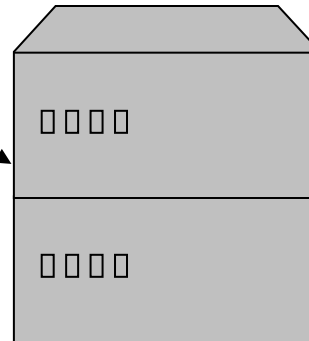
Lab Data Process



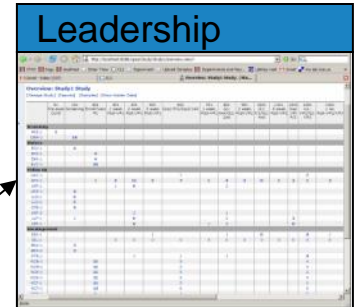
Assays

1. Request Specimens
2. Run Assay
3. Upload Spreadsheet and Metadata
4. Automated Transform and Analysis (optional)
5. Review
6. Copy to Study

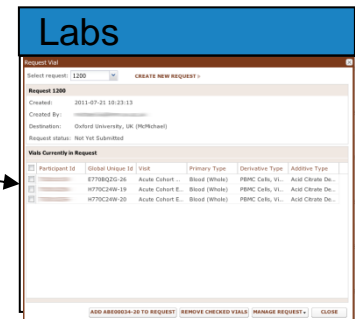
Atlas Web + Database Servers



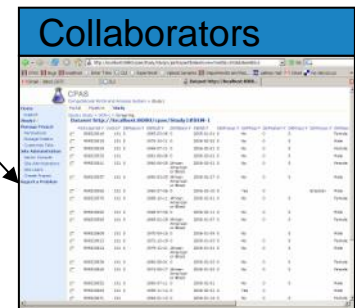
Data Viewers



Participant ID	Global Unique ID	Visit	Primary Type	Derivative Type	Additive Type
87180220-24	Acute Culture	Blood (Heparin)	PBMC Culture, Vi...	Acute Culture	
87180220-24	Acute Culture	Blood (Heparin)	PBMC Culture, Vi...	Acute Culture	
87180220-24	Acute Culture	Blood (Heparin)	PBMC Culture, Vi...	Acute Culture	



Participant ID	Global Unique ID	Visit	Primary Type	Derivative Type	Additive Type
87180220-24	Acute Culture	Blood (Heparin)	PBMC Culture, Vi...	Acute Culture	
87180220-24	Acute Culture	Blood (Heparin)	PBMC Culture, Vi...	Acute Culture	
87180220-24	Acute Culture	Blood (Heparin)	PBMC Culture, Vi...	Acute Culture	

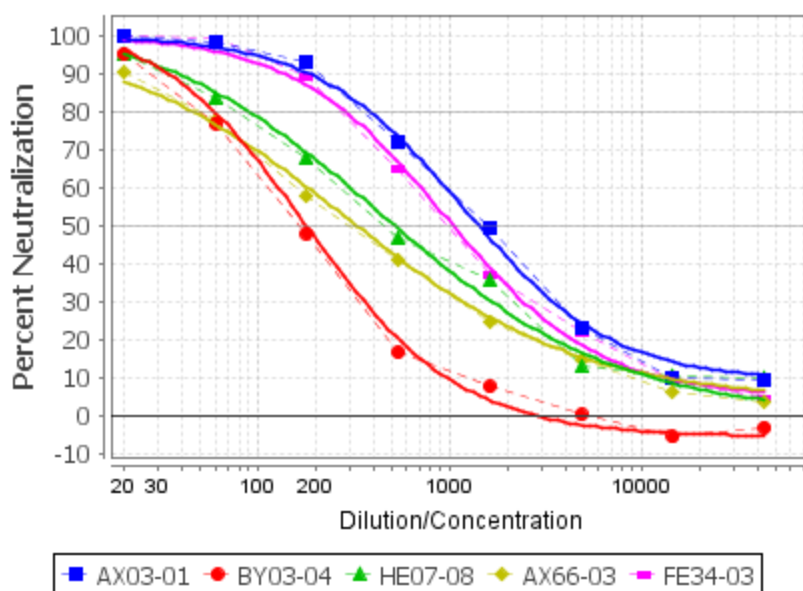


Participant ID	Global Unique ID	Visit	Primary Type	Derivative Type	Additive Type
87180220-24	Acute Culture	Blood (Heparin)	PBMC Culture, Vi...	Acute Culture	
87180220-24	Acute Culture	Blood (Heparin)	PBMC Culture, Vi...	Acute Culture	
87180220-24	Acute Culture	Blood (Heparin)	PBMC Culture, Vi...	Acute Culture	

Assays: upload example

Run Summary: m0902051;3997-1.xls

Assay Id m0902051;3997-1.xls **Experiment Performer** Britt
Created 2012-03-13 12:00:03.731 **Curve Fit Method** Five Parameter
Created By brittp@labkey.com **Batch** 2012-03-13 batch 3



Range 108120
Virus Control 109095 ± 5%
Cell Control 975 ± 6%

	Cutoff Dilutions			
	Curve Based		Point Based	
	50%	80%	50%	80%
AX03-01	1353	357	1547	354
BY03-04	188	55	165	50
HE07-08	492	93	456	77
AX66-03	306	45	294	48
FE34-03	988	301	963	270

Specimen ID	Dilution Factor	Initial Dilution	Method	Fit Error	AUC	PositiveAUC
AX03-01	3.0	20.0	Dilution	2.2	0.570	0.570
BY03-04	3.0	20.0	Dilution	2.5	0.270	0.286
HE07-08	3.0	20.0	Dilution	3.4	0.437	0.437
AX66-03	3.0	20.0	Dilution	2.1	0.391	0.391
FE34-03	3.0	20.0	Dilution	2.2	0.525	0.525

Demographic Data

Assay Data

Specimen Data

Participant	Gender	CD4+	Hemoglobin	Specimen	Available?
249318596	Male	420	12.2	5390.204.36	Yes
249320107	Female	344	13.2	2493.404.56	Yes
249320127	Male	897	21.0	2493.323.33	Yes
249320489	Male	234	16.4	2493.789.44	No
249320897	Female	893	12.9	5266.440.61	Yes

Clinical and assay data homepage

Demo Study

Overview

Participants

Clinical and Assay Data


























Specimen Data

Data Views ▾

name, category, etc.



☐ Mine

Name	Details	Data Cut Date	Status	Modified	Author
Assays					
 ELISpotAssay		2012-04-20		2012-10-15	
 Luminex Assay 100				2012-06-16	
 NAbAssay					
Exams					
 Demographics				2012-11-15	
 Grid View: Demographics + HIV				2010-07-23	
 Grid View: Physical + Demographics				2011-03-20	
 Participation and Genetic Consent				2012-11-10	
 Physical Exam				2012-11-15	
Reports					
 Average CD4+ Levels Per Cohort					
 Lymphocyte / CD4 Scatter					
 Lymphocyte Count: Disease Progression without ARV					
 Viral Load / CD4 Scatter					

Study Data Tools



NEW TIME CHART



NEW PARTICIPANT REPORT



PARTICIPANT LIST



STUDY NAVIGATOR

CHAVI 001 > Study Overview >

Dataset: Binding Antibody, All Visits

VIEWS ▾ PARTICIPANT GROUPS ▾ EXPORT ▾ PAGE SIZE ▾ VIEW SPECIMENS																			1 - 100 of 282			Next >	Last
<input type="checkbox"/>	Participant ID ▲	Sequence Num ▲	Draw Date	Enrollment date	Assay ID	Isotype	Antigen	Coat Lot	Dilution	Concentration	Reading	St. Dev.	No Antigen	No Ant. St. Dev.	QC Titer 50	Plate ID	Network	Protocol	Assay Type				
<input type="checkbox"/>		101.0	20-Jun-06	20-Jun-06	JTL 61-38	IgA	CONT 140 CF	#2	10		0.394	0.013			151450.0	3	CHAVI	1	ELISA				
<input type="checkbox"/>		102.0	27-Jun-06		JTL 61-38	IgA	CONT 140 CF	#2	10		0.387	0.034			151450.0	3	CHAVI	1	ELISA				
<input type="checkbox"/>		103.0	05-Jul-06		JTL 61-38	IgA	CONT 140 CF	#2	10		0.408	0.016			151450.0	3	CHAVI	1	ELISA				
<input type="checkbox"/>		104.0	12-Jul-06		JTL 61-38	IgA	CONT 140 CF	#2	10		0.417	0.0070			151450.0	3	CHAVI	1	ELISA				
<input type="checkbox"/>		105.0	20-Jul-06		JTL 61-38	IgA	CONT 140 CF	#2	10		0.436	0.014			151450.0	3	CHAVI	1	ELISA				
<input type="checkbox"/>		106.0	14-Aug-06		JTL 61-38	IgA	CONT 140 CF	#2	10		0.52	0.0020			151450.0	3	CHAVI	1	ELISA				
<input type="checkbox"/>		107.0	07-Sep-06		JTL 61-38	IgA	CONT 140 CF	#2	10		0.634	0.03			151450.0	3	CHAVI	1	ELISA				
<input type="checkbox"/>		108.0	10-Oct-06		JTL 61-38	IgA	CONT 140 CF	#2	10		0.227	0.076			151450.0	3	CHAVI	1	ELISA				
<input type="checkbox"/>		109.0	29-Nov-06		JTL 61-38	IgA	CONT 140 CF	#2	10		0.574	0.01			151450.0	3	CHAVI	1	ELISA				
<input type="checkbox"/>		110.0	26-Feb-07		JTL 61-38	IgA	CONT 140 CF	#2	10		0.413	0.084			151450.0	3	CHAVI	1	ELISA				
<input type="checkbox"/>		101.0	20-Jun-06	20-Jun-06	JTL 61-38	IgA	GP41	J15/6J13R	10		0.833	0.034			19790.0	4	CHAVI	1	ELISA				
<input type="checkbox"/>		102.0	27-Jun-06		JTL 61-38	IgA	GP41	J15/6J13R	10		0.531	0.024			19790.0	4	CHAVI	1	ELISA				
<input type="checkbox"/>		103.0	05-Jul-06		JTL 61-38	IgA	GP41	J15/6J13R	10		0.531	0.015			19790.0	4	CHAVI	1	ELISA				

Time chart



Participant View

CHAVI 001 > Study Overview > Dataset: Binding Antibody, All Visits >

Participant - [REDACTED]

[NEXT PARTICIPANT](#) ▶ [SEARCH FOR \[REDACTED\]](#) ▶

[All Datasets](#)

[Specimen Timeline](#)

[Clinical Data](#)

[Requested Specimens](#)

[All Specimens](#)

[Binding Antibodies](#)

[Cytokines](#)

[Clinical Data](#)

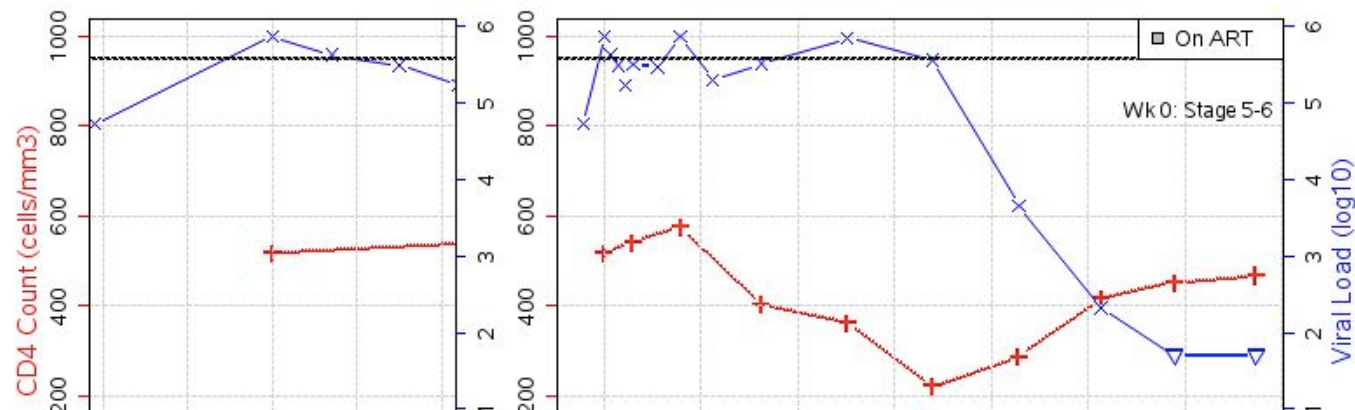
CRF Data

[EXPORT TO EXCEL](#)

Cohort:	Confirmed Acute
Age:	18
Gender:	Female
Race:	White
Tribe:	
Clade:	

▽ Result 'Less Than' Value --- Est Viral Load Set Point
△ Result 'Greater Than' Value

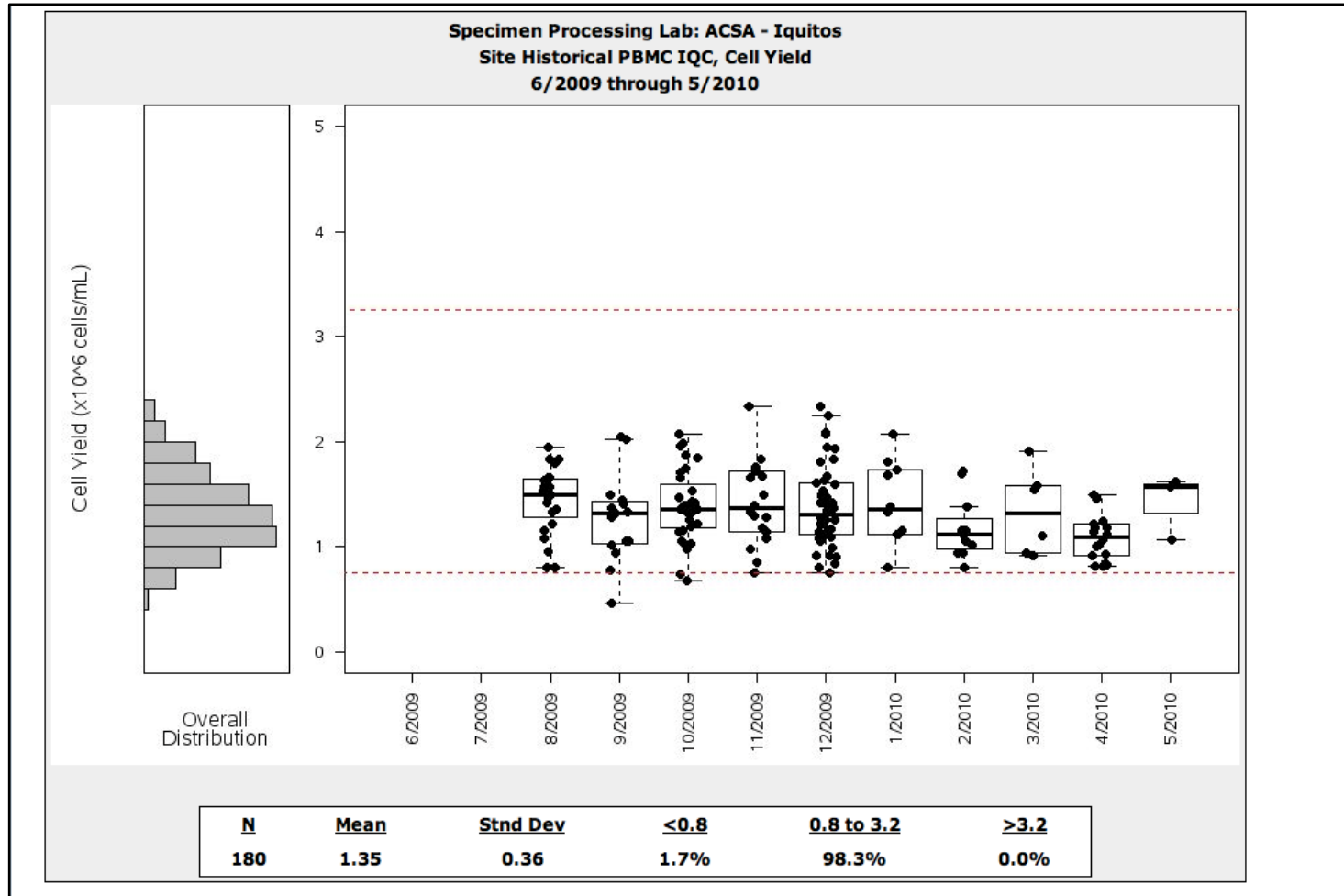
[REDACTED] - Confirmed Acute



- Dozens of small applications needed for different groups
 - Most used data already in LabKey System
 - But custom workflows, reports & analysis required
- LabKey provided an API and simple application building tools to leverage this data

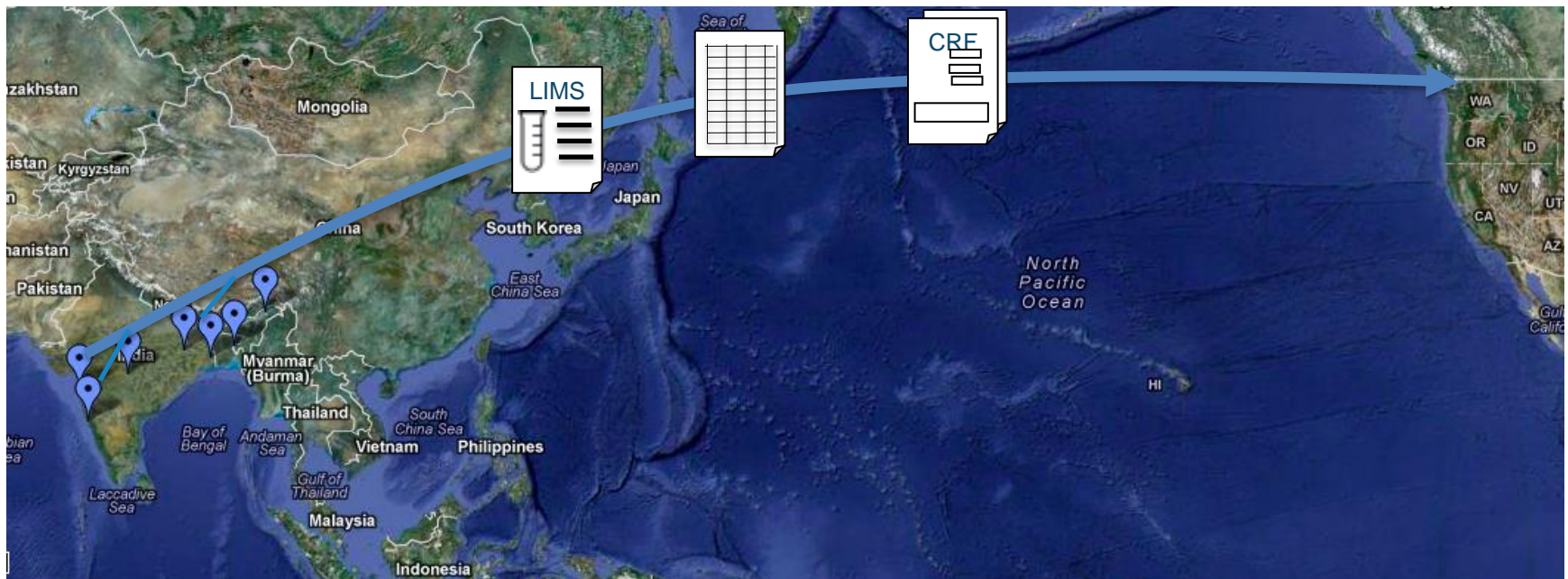
- HIV Vaccine Trials Network
 - ~ 50 Sites
 - ~ 50 Protocols, ~10 currently active
- PBMCs are generated at site-affiliated labs
 - Yields and quality were an issue
- Report yields across sites
 - Each site can see their own yields
 - Central lab can evaluate all sites

Internal Quality Control for Sample Processing



- International Center of Excellence for Malaria Research
 - Studying Malaria Evolution in India
 - PI: Pradeep Rathod
- Collecting Clinical, Specimen and Assay Data
 - Different infrastructure
 - But data coordination needs are very similar
- Specimens cannot leave India

International Center of Excellence in Malaria Research Malaria Evolution in South Asia PI: Pradip Rathod, University of Washington



Data Reuse & Ancillary Studies

Study Initiation

1. Hypothesis generation
2. Proposal review
3. Creation of protocol or plan

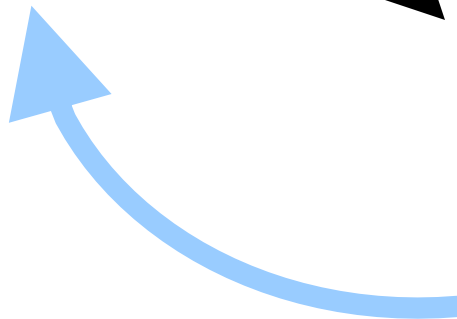
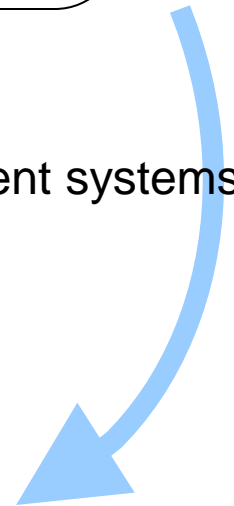
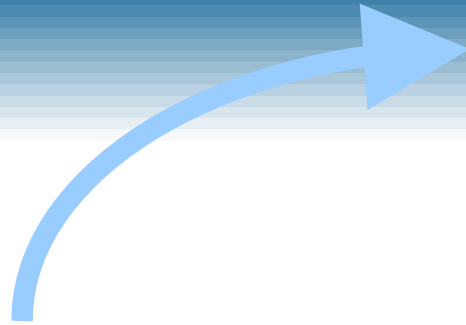
Study Execution

4. Consent verification or acquisition
5. Retrieval of existing data
6. Delivery & analysis of specimens
7. Data integration

Nelson et al, Ancillary study management systems
a review of needs
BMC Med Inform Decis Mak Jan 2013

Results Sharing

8. Data/specimen repatriation
9. Publication



■ Tools for tracking information about studies

Study Tracking System >

Admin

Study Data Entry: Borrow cytokine chemokine

Study Overview

Assay(s)

Team Members

SCHARP

Atlas Admin

Other Tools

Stat Task List

Study Tasks

	Task Description	Date Completed
[edit]	Sampling Plan from SCHARP	28-Dec-2009

Sample Set Tasks

Task Description	Sample Set(s) Used	
Sample set(s) for Borrow Chemokine		Add Sample Set
Sample set(s) for Borrow Cytokine		Add Sample Set

LDO Task List

Assay Tasks: Borrow Chemokine

	Task Description	Date Completed
[edit]	Data Uploaded for Borrow Chemokine	
[edit]	Data Imported for Borrow Chemokine	
[edit]	Data QCd for Borrow Chemokine	
[edit]	Data Sent to Stat for Borrow Chemokine	
[edit]	Analysis Complete for Borrow Chemokine	

Assay Tasks: Borrow Cytokine

	Task Description	Date Completed
[edit]	Data Uploaded for Borrow Cytokine	
[edit]	Data Imported for Borrow Cytokine	
[edit]	Data QCd for Borrow Cytokine	
[edit]	Data Sent to Stat for Borrow Cytokine	
[edit]	Analysis Complete for Borrow Cytokine	

- Scientific Leadership Low/Late Adopters
- Assay Pipelines Need to be very Low Overhead
 - Can work for high throughput assays
- Data sharing is fraught with issues
 - Frequently data & specimen use restrictions
 - “Ownership” of specimens and data is disputed
 - Investigators don’t trust others to interpret data properly

- Software is Relevant for Global Health Projects
- Coordination
- Reproducibility
- Data Reuse

If you use LabKey Server for your research, please reference these publications about the platform:

General Use: Nelson EK, Piehler B, Eckels J, Rauch A, Bellew M, Hussey P, Ramsay S, Nathe C, Lum K, Krouse K, Stearns D, Connolly B, Skillman T, Igra M. [LabKey Server: An open flow source platform for scientific data integration, analysis and collaboration](#). BMC Bioinformatics 2011 Mar 9; 12(1): 71.

Ancillary Studies: Nelson EK, Piehler, B, Rauch A, Ramsay S, Holman D, Asare S, Asare A, Igra M.
Ancillary study management systems: a review of needs. BMC Med Inform Decis Mak Jan 2013

Proteomics: Rauch A, Bellew M, Eng J, Fitzgibbon M, Holzman T, Hussey P, Igra M, Maclean B, Lin CW, Detter A, Fang R, Faca V, Gafken P, Zhang H, Whitaker J, States D, Hanash S, Paulovich A, McIntosh MW: [Computational Proteomics Analysis System \(CPAS\): An Extensible, Open-Source Analytic System for Evaluating and Publishing Proteomic Data and High Throughput Biological Experiments](#). Journal of Proteome Research 2006, 5:112-121.

Flow Cytometry: Shulman N, Bellew M, Snelling G, Carter D, Huang Y, Li H, Self SG, McElrath MJ, De Rosa SC: [Development of an automated analysis system for data from flow cytometric intracellular cytokine staining assays from clinical vaccine trials](#). Cytometry 2008, 73A:847-856.



LabKey Software™
PARTNERS IN SCIENCE

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Any questions?

- LabKey is a “professional open source” software company
 - 23-person team (and growing)
- Background is in commercial software development
 - Lead technical roles on SQL-Server, Visual Basic, Excel, Access, BEA WebLogic, and Amazon’s Data Warehouse
 - Team members hold 25+ software patents

- LabKey solutions are built around LabKey Server
 - Open source software (Apache 2.0 license)
 - Freely downloadable, no license fees
 - Over \$10 million invested in the platform to date
- Open source is more than a licensing model
 - **Cost:** past work is leveraged by all
 - **Operations:** best-practices are built-in and shared
 - **Grants:** funders appreciate sustainable infrastructure
 - **Publications:** methods papers/sections are straightforward

- Modern researchers face growing data challenges
 - Increased data volume
 - Millions of results from thousands of high throughput assay runs
 - Increased data variety
 - Clinical, demographic, assay, and specimen data
 - Increased requirements for collaboration
 - Investigators are specialized and distributed
- LabKey partners with researchers to address these issues
 - Data management
 - Data integration
 - Distributed collaboration