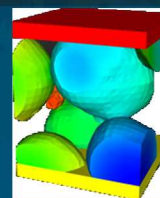
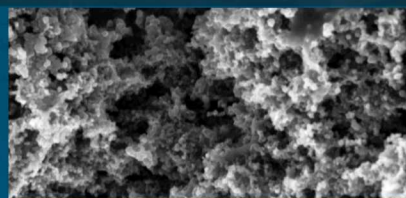
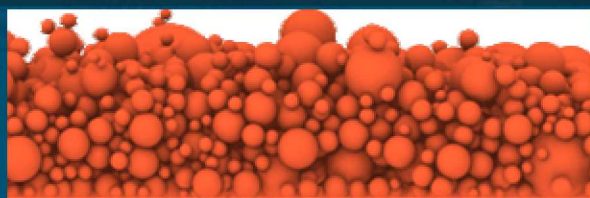
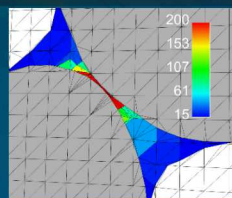
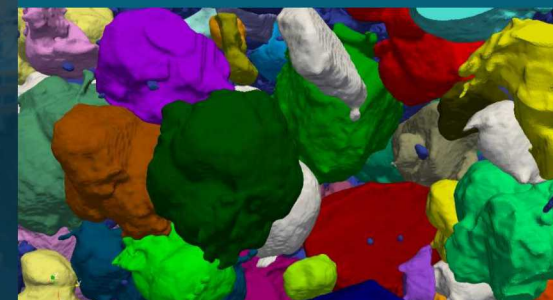


Battery Data Storage Project Status



PRESENTED BY

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February, 2019

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3 | Data solutions being addressed to some degree now are siloed

Integrate battery tester solution with complementary data

Data Management

- Common storage
- Common naming architecture
- Searchable database

Data Integrity

- Firewall barrier
- Automated backup through firewall
- Redundant remote storage

Data Handling

- Common architecture
- Analytic toolset
- Open source desktop software

Current project, scope and budget request

Currently tasked with creating a scoping study which is unfunded.

- ❑ Need funds to continue scoping study that will identify needed deliverables and funds
- ❑ Need 100k to carry out current data formatting tool and narrowly focused analytics piece as a case study for larger effort

We are scoping with NG staff and PSTG:

- ❑ Current battery tester data needs
- ❑ Identify metadata hierarchy for data elements that might ultimately need to be externally linked
- ❑ Identify common vocabulary across data sources
- ❑ Create a naming architecture guide
 - ❑ Globally unique identifier --GUID

Project fit in 2000

Where does this fit in current funded thrusts?

- Central Data Systems effort in 2500
- Information architecture project in 2577

What are similar projects out there?

- RFA
- Active ceramics project

What tools can we learn from/feed into potentially?

- Granta – Materials database not appropriate for our data streams
- Solumina
- RFA (maybe?)
- PTS (Product Tester System) used in NG

Problem statement for battery tester data piece

PSTG operates battery testers from many vendors (Arbin, Bitrode, Maccor)

- Data is exported in different formats, column labels, etc – primary in spreadsheets

Operators/PIs have different ways they post-process or analyze the data

- Excel macros, Matlab scripts, hand calculations, etc.
- No common definitions of capacity fade, etc.

Data is not stored/archived systematically

- BatLab server, but stored in flat files in organization system defined by PI

Metadata is not indexed for easy searching/reuse

- Cell type, discharge profile, etc.

7 Goals and requirements

Develop a software solution to address these data archival shortcomings

Solution should be

- Non-commercial – free and open-source
- Intuitive user interface
- Easy (enough) to install and set up
- Able to run on a desktop for personal use, or on a server for institutional use
- Extensible (with minimal code effort) to additional data formats and post-processing types

Required capabilities

- Import data in native tester formats
- Augment data with built-in calculations and user-provided metadata
- Store data in a common data format, archived in software and directly available to user
- Store metadata in searchable database for later data retrieval
- Provide consistent post-processing calculations and professional plotting of the data

Data available

Data Information	Systems		
	Maccor	Arbin	Bitrode
Start Date	x	x	x
Filename/location	x		
Procedure/Test Name	x	x	x
Procedure/Test Description		x	x
Procedure Database			x
Channel Number		x	x
Data Point (Rec#, Data Point, etc.)	x	x	
Time (DP time, Date Time, etc.)	x	x	
Test Time	x	x	x
Step Time	x	x	x
Step Number	x	x	x
Cycle Number	x	x	x
Current	x	x	x
Voltage	x	x	x
Charge Capacity		x	x
Charge Energy		x	x
Discharge Capacity		x	x
Discharge Energy		x	x
AH	x		x
WH	x		x
State	x		
End Condition	x		
dV/dt		x	
Resistance	x	x	x
Aux Voltage 1 - ?	x	x	x
Aux Temperature 1 - ?	x	x	x

Data Information	Systems		
	Maccor	Arbin	Bitrode
Statistics Tab/Information			
Cycle Number	x	x	x
Cycle Type	x	x	x
Voltage(V)	x	x	x
Current(A)	x	x	x
Charge_Capacity(Ah)	x	x	x
Discharge_Capacity(Ah)	x	x	x
Charge_Energy(Wh)	x	x	x
Discharge_Energy(Wh)	x	x	x
Internal Resistance(Ohm)	x	x	x

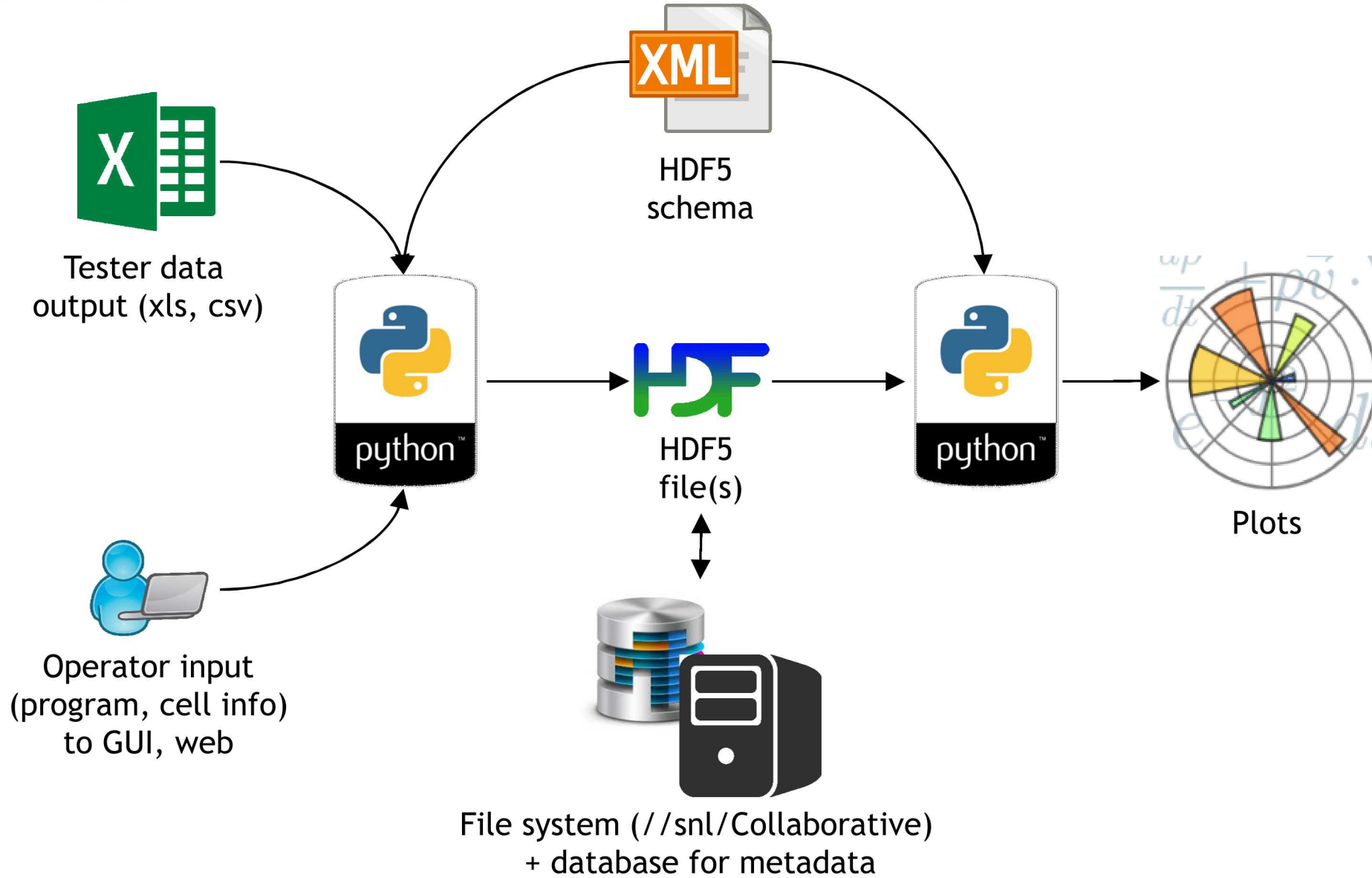
Metadata examples

General Information (Program)
Project Lead
Project Name
Project Type
P/T
Year
Month
Day
Time of Day

General Information (Cell)
Battery Manufacturer
Cell Type
Cell Model #
Cathode Formulation
Cathode Date
Anode Formulation
Anode Date
Separator
Electrolyte
Nominal Voltage
Operating Voltage Range
Maximum Current
Nominal Energy
Operating Temperature
Weight/Mass
Physical Dimensions (L x W x H)
Impedance
Capacity Rates
C-Rate Definition
Nominal Capacity
Maximum Discharge Power
Cycle Life
Round Trip DC Efficiency
Charge/Discharge Modes
IP Rating
Shipping Testing
Certifications

General Information (Tester)
Battery Tester Manuf.
Battery Tester Model #
Battery Tester S/N
Battery Tester System Assigned # (Sys 1, System 2, etc.)
Battery Tester S#
Battery Tester PSL Asset #
Battery Tester Firmware Version
Battery Tester Software Version
Operator
Thermal Chamber
CPU S#
CPU OS
BLDG #
Room#

The solution



Battery tester data storage and archival

Concept: Create a tool for archival of tester data in a common data format to enable consistent analysis

Today's D:	08/06/2015	Date of Test:	09/15/2014	Filename:	C:\Maccor	Procedure:	18650_50c	50	CYC
Rec#	Cyc#	Step	TestTime	StepTime	Amp-hr	Watt-hr	Amps	Volts	
1	0	1	0	0	0.00	0.00	0.00	4.0	
2	0	1	0.001388944	0.001389	0.00	0.00	0.00	4.0	
3	0	1	0.002777889	0.002778	0.00	0.00	0.00	4.0	
4	0	1	0.004166833	0.004167	0.00	0.00	0.00	4.0	
5	0	1	0.005555778	0.005556	0.00	0.00	0.00	4.0	
6	0	1	0.006944722	0.006945	0.00	0.00	0.00	4.0	
7	0	1	0.008333667	0.008334	0.00	0.00	0.00	4.0	
8	1	4	0.008350278	1.66E-05	0.00	0.00	0.20	4.0	
9	1	4	0.341684167	0.333351	0.07	0.27	0.14	4.0	
10	1	4	0.675018056	0.666684	0.09	0.36	0.03	4.0	
11	1	4	0.796265111	0.787931	0.09	0.38	0.02	4.0	
12	1	5	0.796274056	8.94E-06	0.00	0.00	0.20	4.0	
13	1	5	1.129607944	0.333343	0.07	0.27	0.20	4.0	
14	1	5	1.462941833	0.666677	0.13	0.54	0.20	3.0	
15	1	5	1.796275722	1.000011	0.20	0.81	0.20	3.0	
16	1	5	2.129609611	1.333345	0.27	1.06	0.20	3.0	

Input data (CSV, XLSX) includes tabular test data and metadata

Home Upload New Data Visualize Data

Step 2 of 3

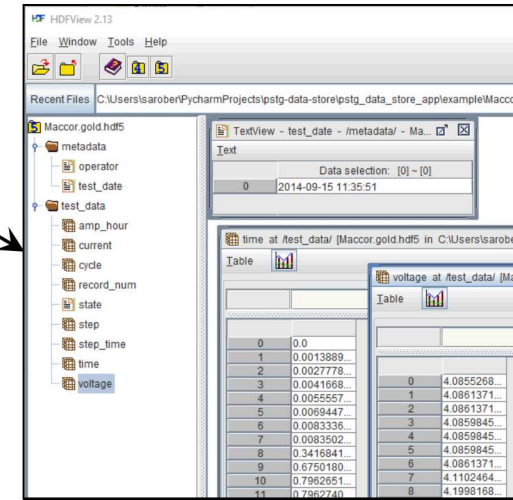
Output base file name: Maccor

Operator: Joe Sandian

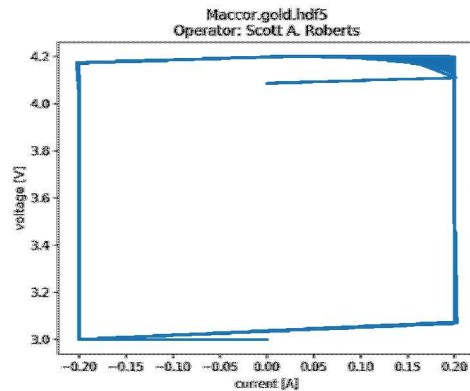
Test Date: 2014-09-15 11:35:51

Submit

Web interface to upload data, enter metadata



Data converted to common format, stored in HDF5



Data output to plots, excel

Home Upload New Data Visualize Data

Step 2 of 3

Output base file name (without extension): Maccor.gold

Plot Picture Format: PNG

X-Axis: Current

Y-Axis: Voltage

Submit

Web interface to post-process

Completion status:

- Data format definition
- Basic conversion, post-processing routines
- Web + standalone interface

Upcoming work:

- Calculation of derived quantities (capacity loss)
- Data archival, metadata in searchable database
- Comparison/plotting of multiple data sets

DEMO!

<http://pstg-data.sandia.gov:81>

Discussion topics

Are we on the right track?

What else must be incorporated to make this a useful capability

- Database searching, file retrieval, and plotting
- Small bits of generalization, cleanup

Additional capabilities?

- Additional post-processing calculations (e.g. capacity fade)
- Additional metadata fields (e.g. cell type)
- Side-by-side analysis/comparison of multiple data sets
- Joining multiple experiments (long cycles) into a single file

Staffing

Open source release and publication?

Application to SNL data