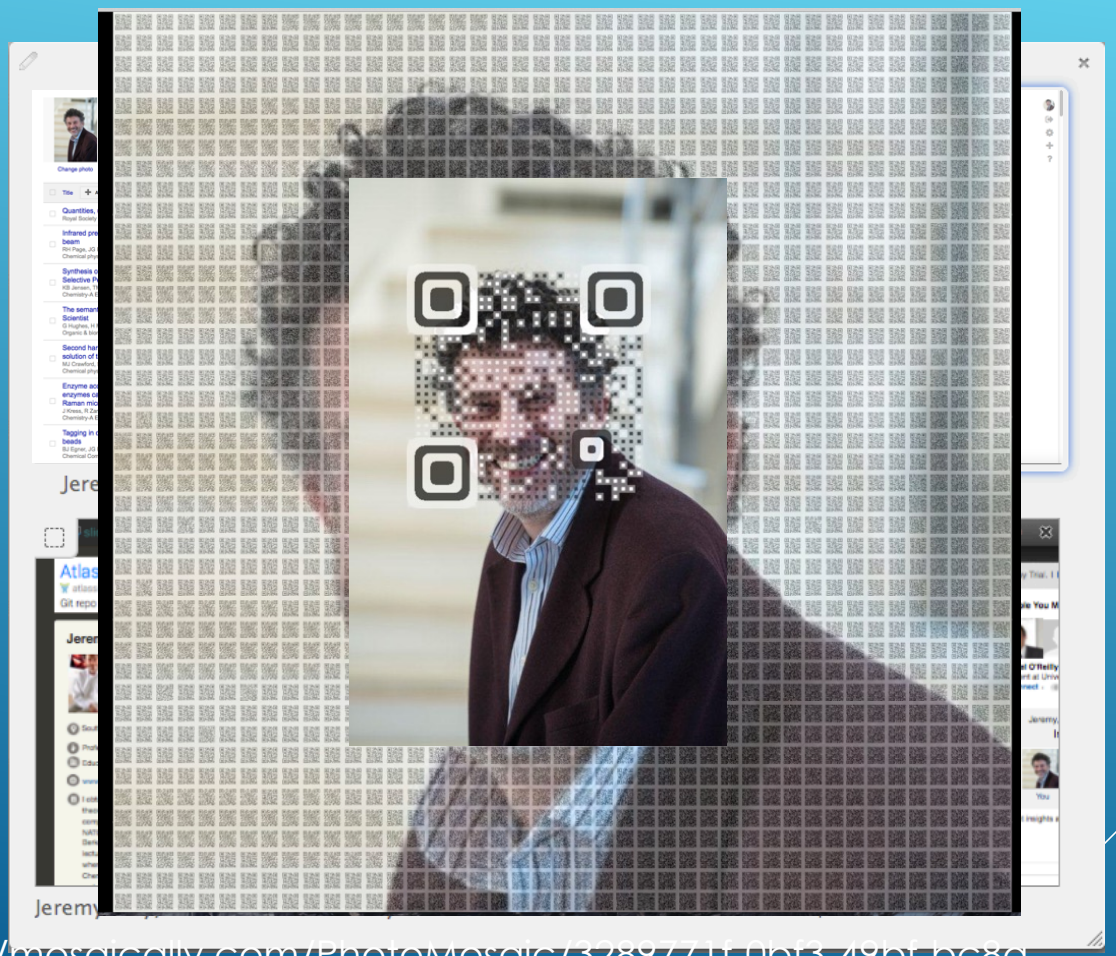
DEVELOPING AN OPEN SOURCE ELN TO SUPPORT OPEN & INTERDISCIPLINARY SCIENCE

Jeremy G. Frey

University of Southampton

@profechem

A Chemist's Digital Aura



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Chemists escape labs via mobiles

By Jo Twist
BBC News science and technology reporter

A blend of mobile technology and award-winning software is letting scientists finally escape the lab.

The system is not smart enough to actually buy a round yet

The software, called "middleware", lets different computer systems talk to each other securely and instantaneously.

As part of a national e-Science project in the UK, it is being used to let Southampton University chemists monitor experiment conditions from mobiles.

Sensors in the lab pick up any changes in the environment so the system can alert chemists, wherever they are.

"It replaces the traditional notebook with some electronic form

The three Norns (Fates)

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Laboratory notebooks in the digital era: the role of ELNs in record keeping for chemistry and other sciences

Colin L. Bird, Cerys Willoughby and Jeremy G. Frey*

Cite this: *Chem. Soc. Rev.*, 2013, **42**, 8157

Received 30th March 2013

DOI: 10.1039/c3cs60122f

www.rsc.org/csr

Egyptian evidence of scientific records dates back almost 50 centuries. In more recent times da Vinci and Faraday provide role models for scrupulous recording of ideas, observations, and conclusions. Their medium was paper, but despite the quality of their notebooks, we cannot turn the clock back. Our primary purpose is to review the influences of the digital era on scientific record keeping. We examine the foundations of the emerging opportunities for preserving and curating electronic records focussing on electronic laboratory notebooks (ELNs), with an emphasis on their characteristics and usability.

Introduction

The origin of science itself is a subject for philosophical discussion; so dating the first recording of a scientific endeavour must almost inevitably also be a matter for speculation. However, we do know of an instance of recorded occupational medicine that has been attributed to the Egyptian architect, physician, and statesman Imhotep (27th century BCE), based on a study of the Edwin Smith papyrus.[1]

The History of Science article in Wikipedia covers the development of science and scientific methodology from the ancient civilisations through to the modern era, and includes several examples of the recording of information in a manner that we could regard as scientific. Observations were represented numerically as well as in narrative form, for example the recording of astronomical information in Mesopotamia.[2] There is also historical evidence of the reuse and repurposing of

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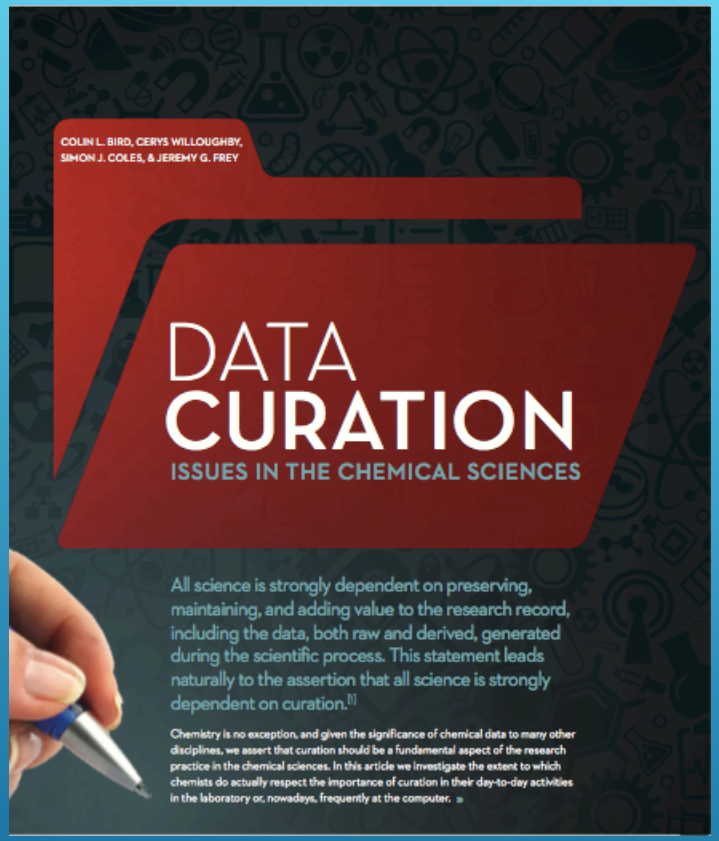
Colin L. Bird

Having obtained his BSc and PhD in Chemistry at the University of Southampton, Colin Bird joined IBM UK Laboratories. After contributing to IBM's electrochromic display technology, he transferred to the IBM UK Scientific Centre to develop advanced image and visualisation applications. His work on content-based image retrieval led to a one-year secondment in 1999 back to the University of Southampton. On returning to IBM, he was involved in various aspects of information management, specialising in classification and metadata, and became an information architect. When he left IBM, he resumed his collaboration with Professor Jeremy Frey on e-Research projects, which began in 2000 as an industrial partner for the CombeChem project.

Cerys Willoughby

Cerys Willoughby obtained her BSc in Geology from the University of Wales, Aberystwyth and her MSc in Environmental Sciences from University of Wales, Swansea. After spending some time teaching teenagers and adults, she joined IBM UK Laboratories as a software engineer. Working in a variety of roles in the company she specialised in usability and information architecture. She began collaborating with Professor Jeremy Frey in 2007 as a guest lecturer on usability and accessibility for an e-Research course and is currently undertaking a part time PhD at the University of Southampton.



Chemical Science

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Cite this: *Chem. Sci.*, 2015, **6**, 1614

Experiences with a researcher-centric ELN†

Katrina A. Badiola,[a] Colin Bird,[b] William S. Brocklesby,[c] John Casson,[d] Richard T. Chapman,[e] Simon J. Coles,[b] James R. Cronshaw,[a] Adam Fisher,[b] Jeremy G. Frey,*[b] Danmar Gloria,[f] Martin C. Grossel,[b] D. Brynn Hibbert,[f] Nicola Knight,[b] Lucy K. Mapp,[b] Luke Marazzi,[b] Brian Matthews,[d] Andy Milsted,[bh] Russell S. Minns,[b] Karl T. Mueller,[g] Kelly Murphy,[g] Tim Parkinson,[h] Rosanne Quinnell,[a] John S. Robinson,[h] Murray N. Robertson,[a] Michael Robins,[a] Emma Springate,[e] Graham Tizzard,[b] Matthew H. Todd,[a] Alice E. Williamson,[a] Cerys Willoughby,[b] Erica Yang[d] and Paul M. Yioja[a]

Electronic Laboratory Notebooks (ELNs) are progressively replacing traditional paper books in both commercial research establishments and academic institutions. University researchers require specific features from ELNs, given the need to promote cross-institutional collaborative working, to enable the sharing of procedures and results, and to facilitate publication. The LabTrove ELN, which we use as our exemplar, was designed to be researcher-centric (*i.e.*, not only aimed at the individual researcher's basic needs rather than to a specific institutional or subject or disciplinary agenda, but also able to be tailored because it is open source). LabTrove is being used in a heterogeneous set of academic laboratories, for a range of purposes, including analytical chemistry, X-ray studies, drug discovery and a biomaterials project. Researchers use the ELN for recording experiments, preserving data collected, and for project coordination. This perspective article describes the experiences of those researchers from several viewpoints, demonstrating how a web-based open source electronic notebook can meet the diverse needs of academic researchers.

Received 17th July 2014
Accepted 20th October 2014

DOI: 10.1039/c4sc02128b

www.rsc.org/chemicalscience

1 Introduction

Electronic Laboratory Notebooks (ELNs) are progressively replacing traditional paper books for keeping the experimental record,[1] especially in commercial research establishments. Important drivers for this change are the need to comply with regulatory requirements and the desire to protect and expand intellectual property (IP); structured notebook systems should provide the necessary audit trails.[2] ELNs offer considerably more to researchers and to research groups than do systems that offer only content management and sharing facilities. ELNs unite the objects that comprise the record of research and preserve the provenance of each object and its contribution to the overall narrative.

The 2013 review of laboratory notebooks in the digital era (by three of the authors)[1] not only explores the history and the expanding use of electronic laboratory notebooks but also presents the results of a comprehensive survey of the literature relating to ELNs. It is clear from the survey and from considerations of the scientific applications for which ELNs have been deployed that digital notebooks come in a range of embodiments. The distinction between commercial and academic institutions is but one aspect; in many cases the designers of ELNs have adapted both the input and output to match the specific applications for which the ELNs are used. Most ELNs, especially the major commercial offerings, are proprietary. There is, however, increasing interest in open source implementations, as they enable individual laboratories or institutions to tailor the operation and the data preservation to suit their particular needs. The review also examines the social and technical issues that combine to influence moves from paper to digital notebooks.

There are many concerns in the academic environment with the adoption of digital notebooks. The obvious issues of cost are significant but more fundamental are the concerns with the

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[e]Central Laser Facility, STFC Rutherford Appleton Laboratory, Chilton, Didcot, Oxfordshire, OX11 0QX, UK
[f]School of Chemistry, UNSW Australia, Sydney, NSW 2052, Australia
[g]Penn State University, Department of Chemistry, University Park, 104 Chemistry Building, PA, USA
[h]Electronics and Computer Science, University of Southampton, Southampton, SO17 1BJ, UK

† Electronic supplementary information (ESI) available. See DOI: 10.1039/c4sc02128b

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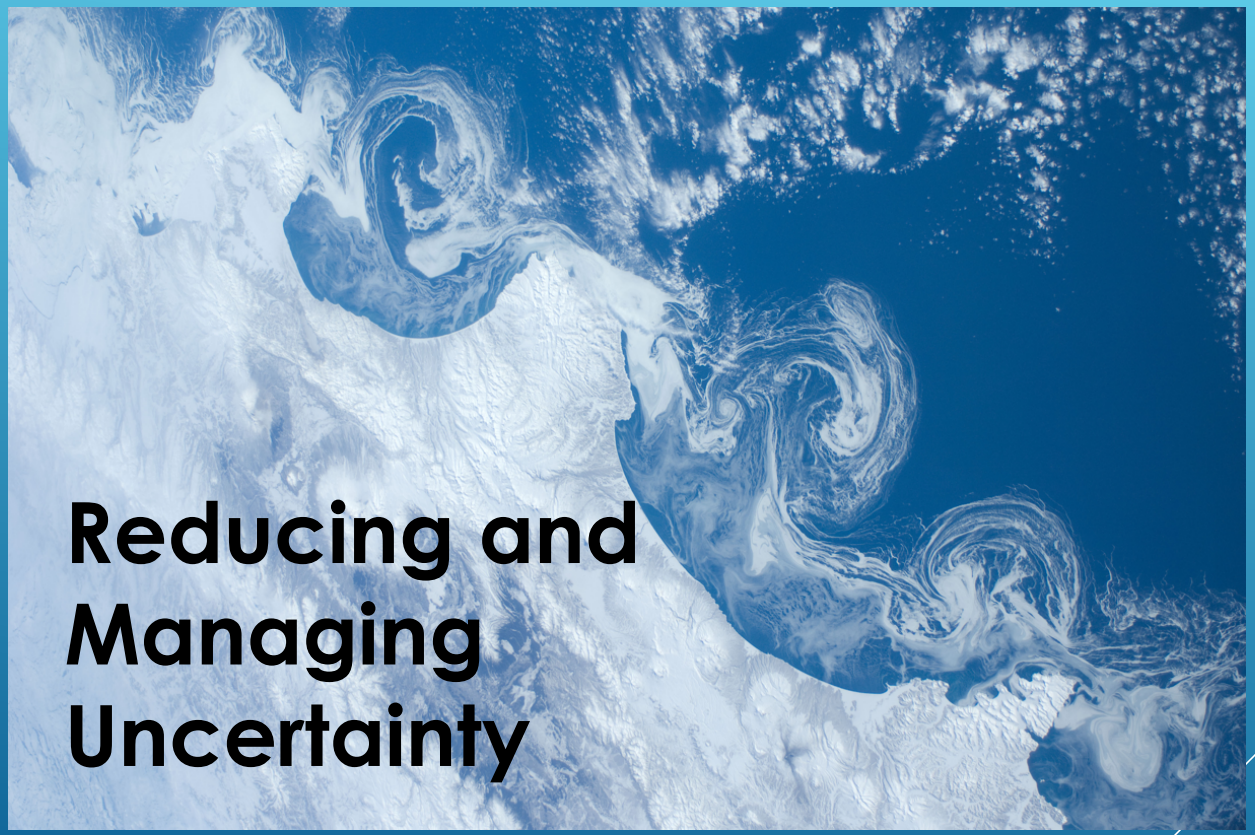
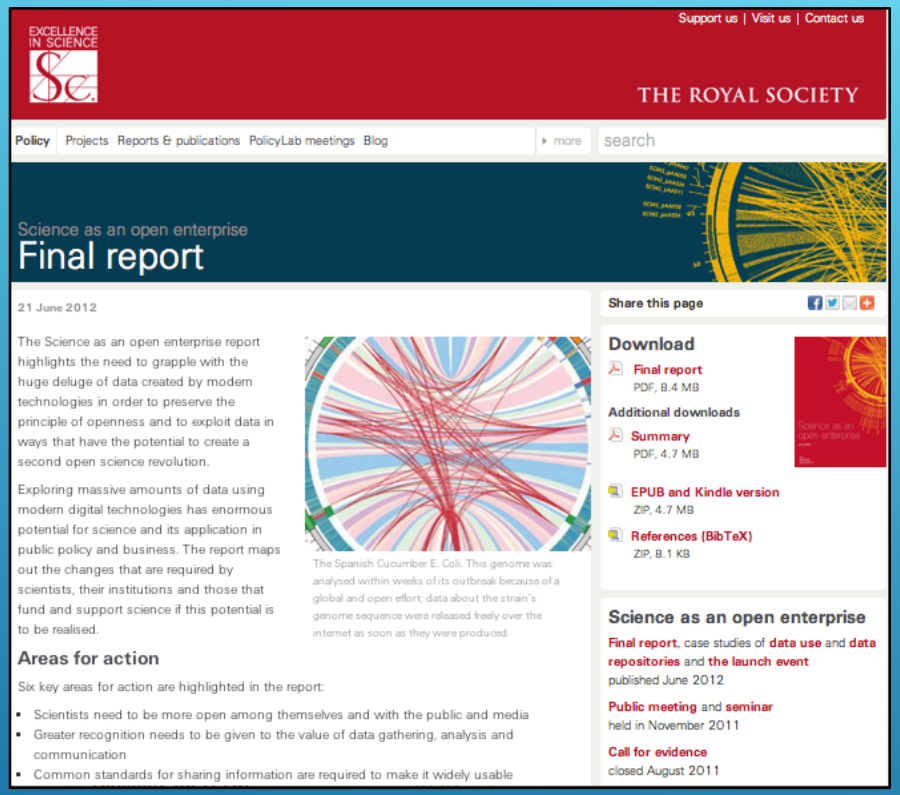
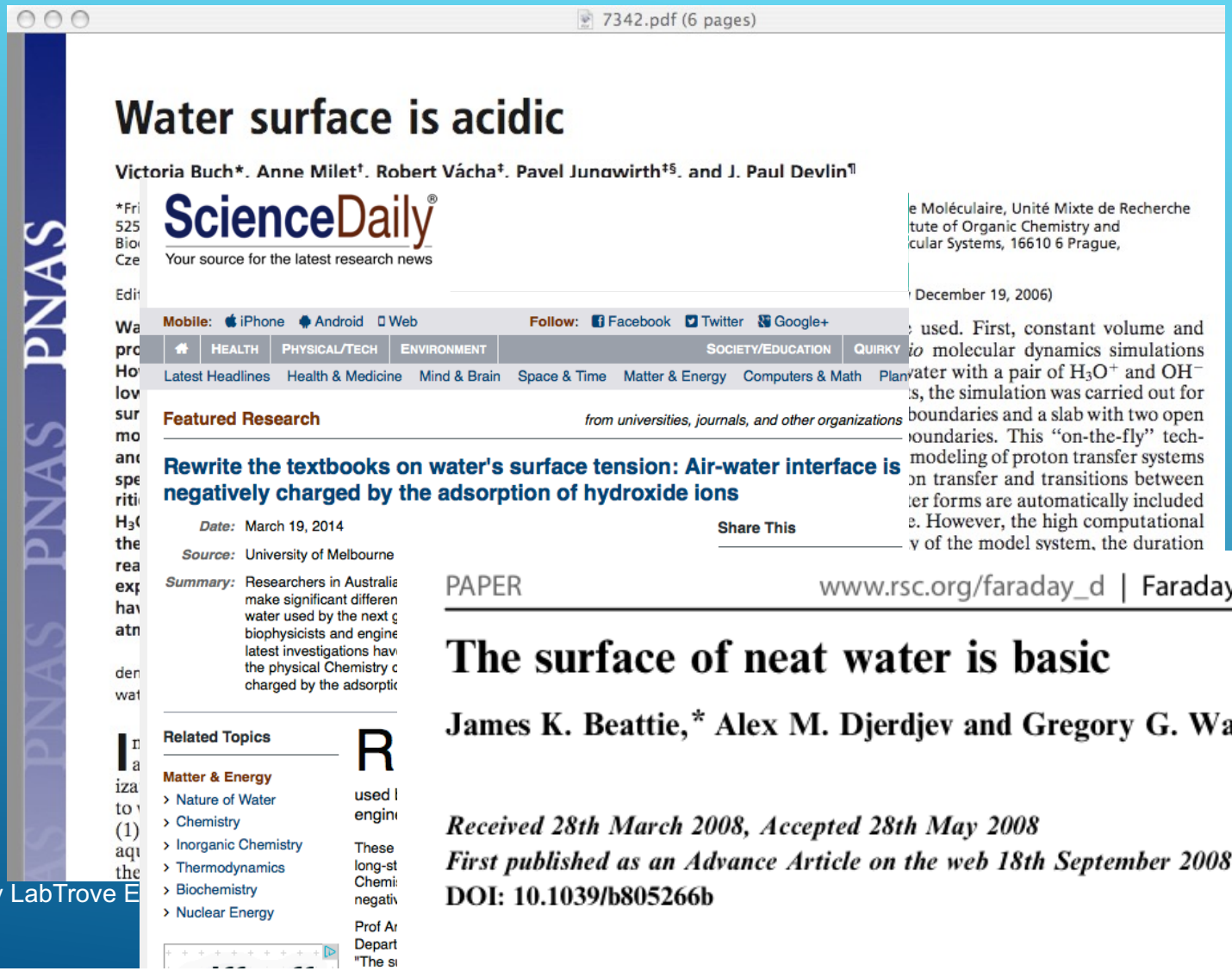


Reducing and Managing Uncertainty



StructureGate

Intelligent Open Access to Data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Water surface is acidic
Victoria Buch*, Anne Milet†, Robert Vácha‡, Pavel Jungwirth‡§, and J. Paul Devlin¶
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Rewrite the textbooks on water's surface tension: Air-water interface is negatively charged by the adsorption of hydroxide ions
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Source: University of Melbourne
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December 19, 2006)
used. First, constant volume and
molecular dynamics simulations
water with a pair of H_3O^+ and OH^-
s, the simulation was carried out for
boundaries and a slab with two open
oundaries. This "on-the-fly" tech-
modeling of proton transfer systems
on transfer and transitions between
er forms are automatically included
e. However, the high computational
y of the model system, the duration
PAPER
www.rsc.org/faraday_d | Faraday Discussions
The surface of neat water is basic
James K. Beattie,* Alex M. Djerdjev and Gregory G. Warr
Received 28th March 2008, Accepted 28th May 2008
First published as an Advance Article on the web 18th September 2008
DOI: 10.1039/b805266b

If only I knew exactly how she did this experiments

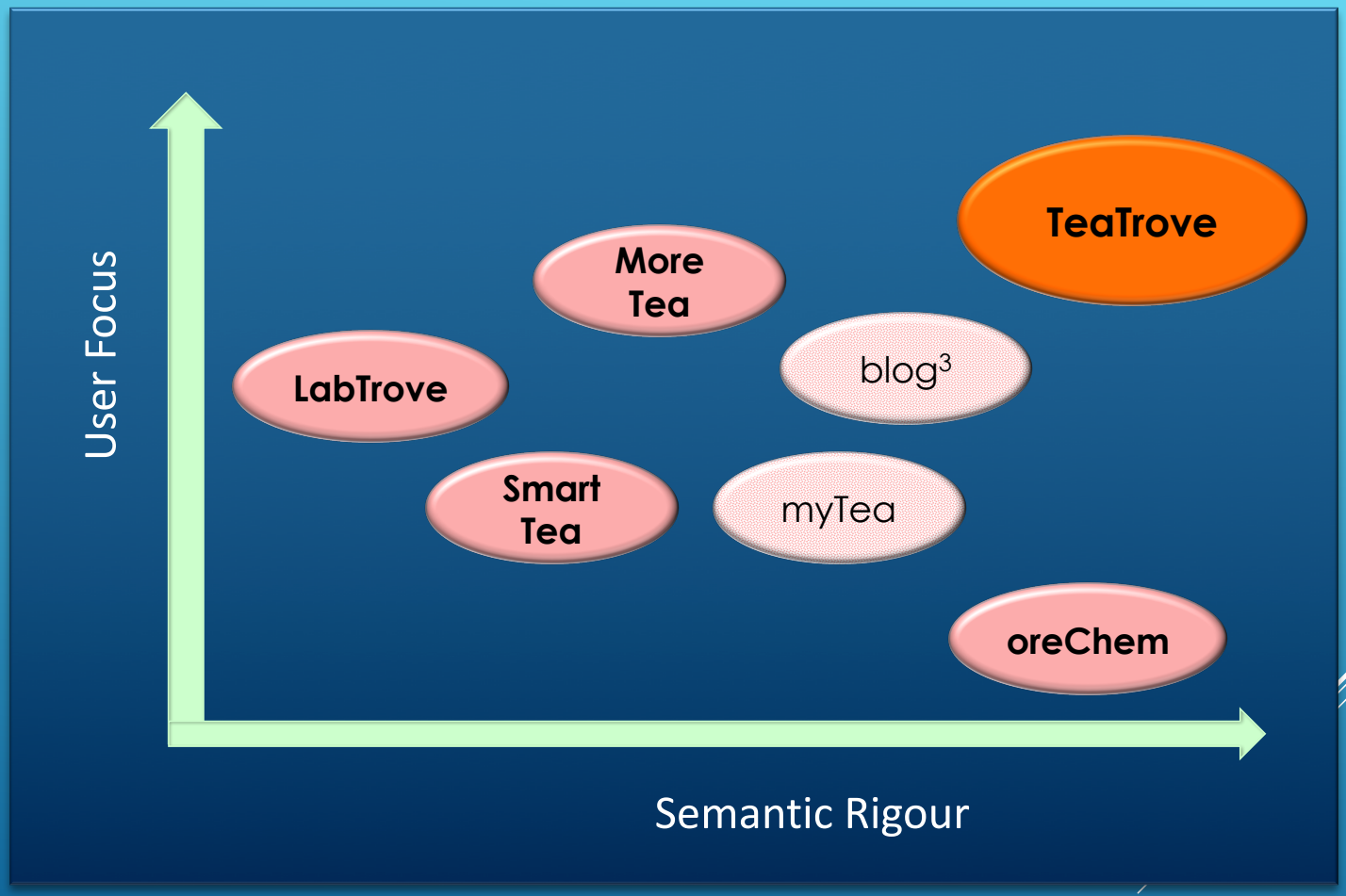
I wish I had recorded things at the start the way I do now…..

I know all this supplementary information could be useful but will people really remember the format? Is it worth all the hassle?

I wish I could get the numbers from this graph - the pdf is not much use.

Typical Laboratory

WHATS THE STORY IN BALAMORY, WOULDN'T YOU LIKE TO KNOW?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Smart Tea
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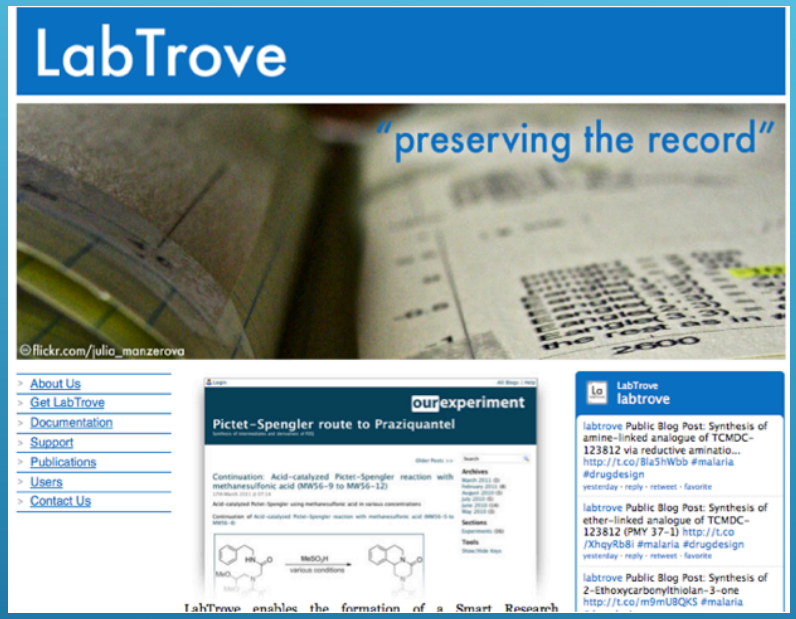
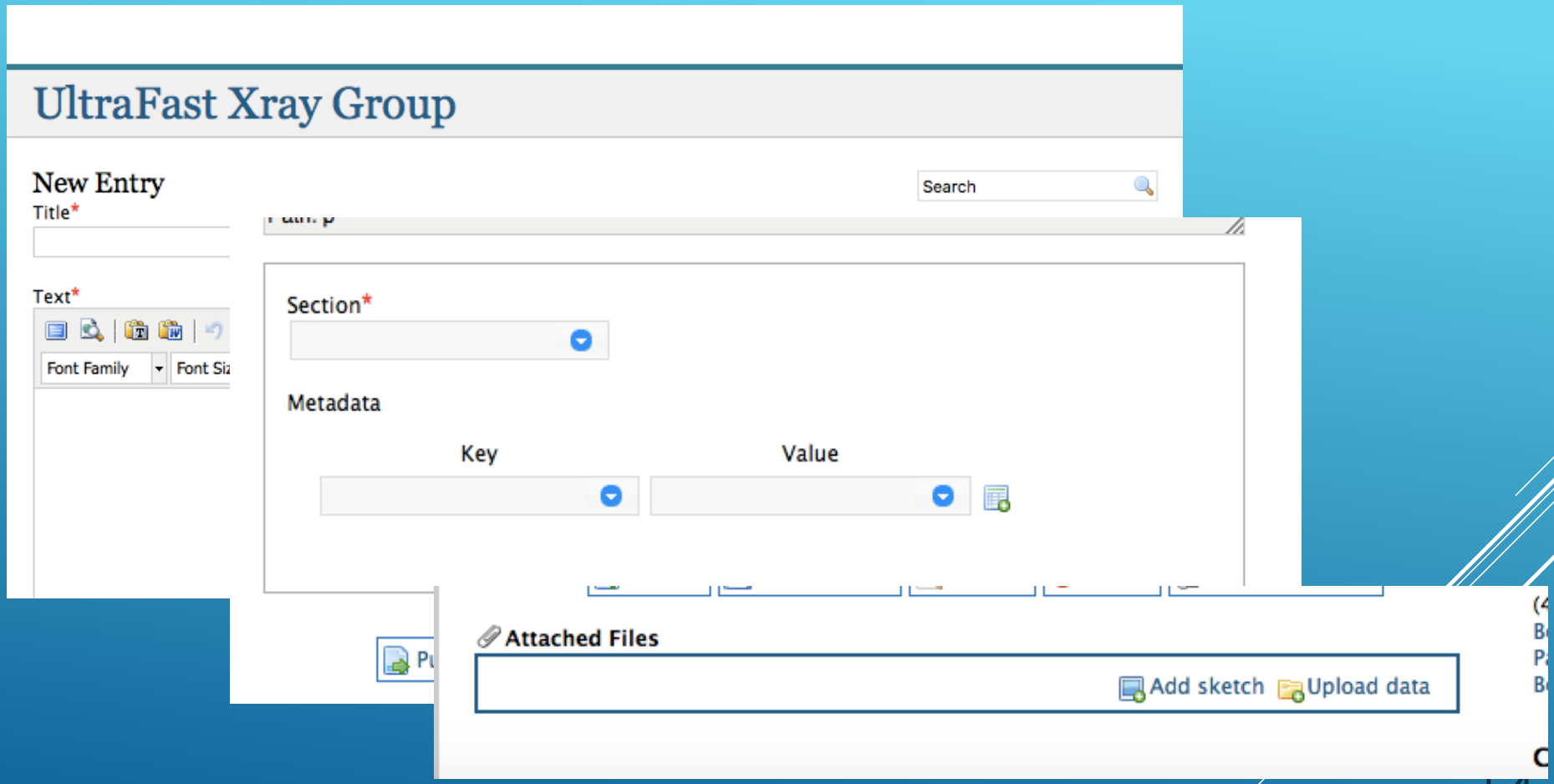
The Trove Software



www.labtrove.org

OPEN SOURCE WEB BASED

- LabTrove - E-Science and Jisc Funding
- Open Source Software – code available
- Hosted on Southampton servers or researchers own hardware
- Entries stored as ASCII XML, Files native format
- Support for basic research needs in a flexible way
- Allow researchers to use their own tools
- Export and Archive abilities
- Business Model and Community


UltraFast Xray Group
New Entry
Search
Title*
Text*
Font Family
Section*
Metadata
Key
Value
Attached Files
Add sketch
Upload data

Transformation of plasmid JRH4712/66 into BW25141 by electroporation

11th December 2006 @ 14:31

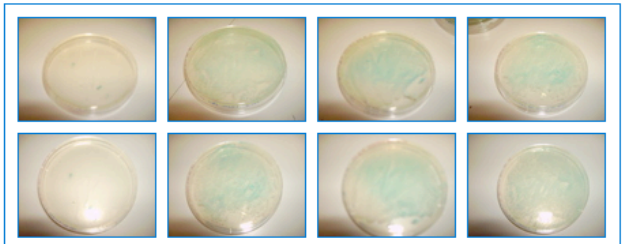
Transformations were set up according to the following protocol:
LB Ampicillin arabinose plates and SOC medium were warmed to 37 °C briefly before the arabinose plates were spread with X-glu (80 µL, 1:1 X-glu and LB) and allowed to continue warming.

BW25141 cells, plasmid JRH4712/66, p042, and electroporator cuvettes were cooled on ice. Items were added to the cuvettes as follows

-	1	+ve ctrl	-ve ctrl
BW25141	40 µL	40 µL	40 µL
plasmid 4712/66	4 µL	0 µL	0 µL
p042	0 µL	4 µL	0 µL

Cuvettes were electroporated at 1.75 kV, immediately had SOC medium (950 µL) added and the transformant transferred to eppendorf. The transformants were incubated at 37 °C for one hour with shaking. The transformants were diluted 1 in 20 with LB and 100 µL added to LB amp arabinose plates and incubated at 37 °C overnight.

Data



Jennifer Hale | Beta-glucuronidase | Comments (3)

Archives

January 2007 (24)
December 2006 (11)
November 2006 (5)

Sections

beta-galactosidase preparation and assays (18)
Beta-glucuronidase (18)
Data (Formatting) (1)
Software discussions (2)
Starting materials and reagents (1)

Lab Book Ref

JRH4712-63 (1)
JRH4712-64 (2)
JRH4712-66 (1)

Test digestions to check the activity of two batches of EcoRI and NcoI

22nd January 2007 @ 11:57

Lab Book Ref: jrh4712-89
Sample Parent: jrh4712-80_blue
Sample Parent2: jrh4712-80_white
Digestions were set up as follows:

-	1	2	3	4	5	6	7	8	9	10	11
4712/80 blue	8 µL	-	-	8	-	-	-	8 µL	-	-	-
4712/80 white	-	8 µL	-	-	8 µL	-	-	-	8 µL	-	-
p042	-	-	5 µL	-	-	5 µL	5 µL	-	-	5 µL	5 µL
water	7.5 µL	7.5 µL	10.5 µL	7.5 µL	7.5 µL	10.5 µL	10 µL	7.5 µL	7.5 µL	10.5 µL	10 µL
*Eco*RI buffer	2 µL	2 µL	2 µL	-	-	-	2 µL	2 µL	2 µL	2 µL	2 µL
NEB buffer 4	-	-	-	2 µL	2 µL	2 µL	-	-	-	-	-
BSA	2 µL	2 µL	2 µL	2 µL	2 µL	2 µL	2 µL	2 µL	2 µL	2 µL	2 µL
*Eco*RI (a)	0.5 µL	0.5 µL	0.5 µL	-	-	-	0.5 µL	-	-	-	-
*Nco*I	-	-	-	0.5 µL	0.5 µL	0.5 µL	0.5 µL	-	-	-	0.5 µL
*Eco*RI (b)	-	-	-	-	-	-	-	0.5 µL	0.5 µL	0.5 µL	0.5 µL

*Eco*RI (a) assay date 2/05
*Eco*RI (b) assay date 7/05

Digestions were incubated in a waterbath at 37 °C for 3 hours.

Archives

January 2007 (24)
December 2006 (11)
November 2006 (5)

Sections

beta-galactosidase preparation and assays (18)
Beta-glucuronidase (18)
Data (Formatting) (1)
Software discussions (2)
Starting materials and reagents (1)

Lab Book Ref

JRH4712-63 (1)
JRH4712-64 (2)
JRH4712-66 (1)
jrh4712-76 (1)
jrh4712-77 (1)
jrh4712-78 (1)
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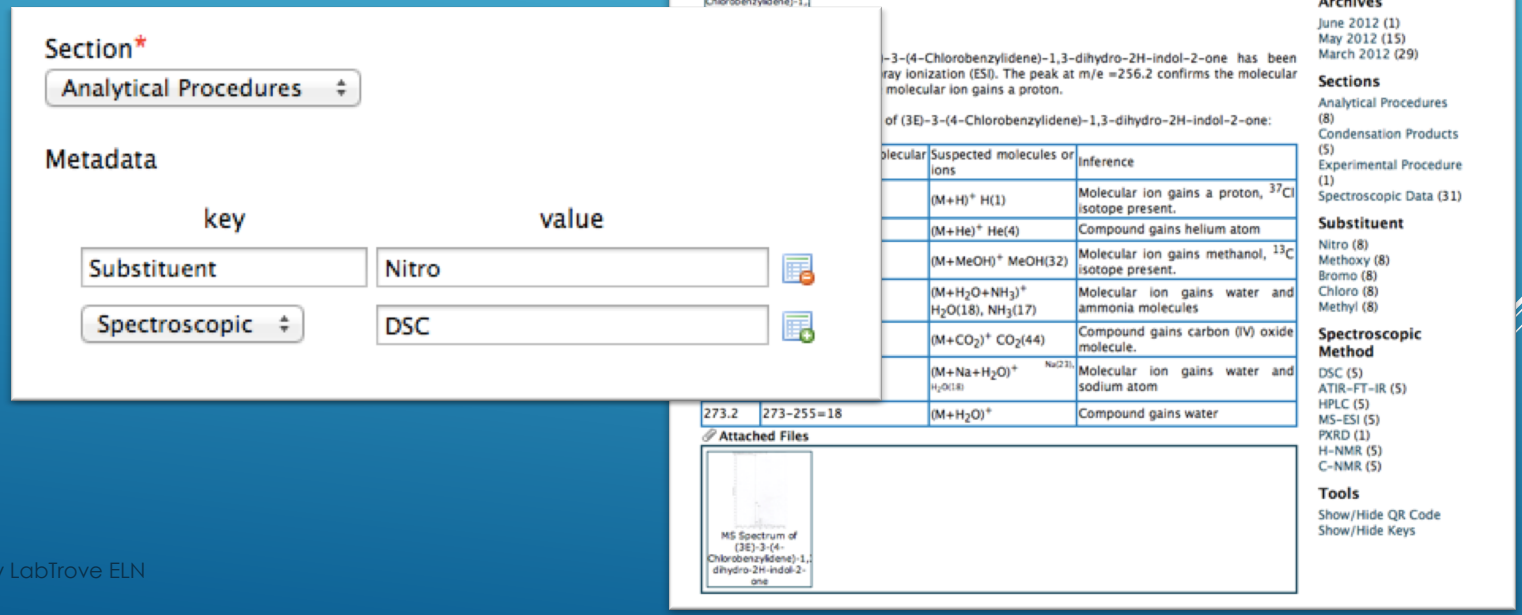
jrh4712-85 (1)
4712-88 (1)
jrh4712-89 (1)
4712-86 (1)
jrh4712-87 (1)
4712-90a (1)

Product

jrh4712-74 (1)
jrh4712-76 (1)
jrh4712-76a (1)

LABTROVE AND USER DEFINED METADATA



Comment on Figures

Here are main steps.

1. Oil pump – adapter – pressure gauge. After 7 min pressure **5.0e-4 mbar**
2. Oil pump – metal tube (about 2 meters) – adaptor – pressure gauge. After 30 min pressure **5.8e-4 mbar**
3. Oil pump – trap (no alumina) – metal tube (~2 pressure **5.0e-4 mbar**
4. Oil pump – trap (no alumina) – metal tube (~2 m – adaptor – pressure gauge. After 15 min pressure **7.**
5. Oil pump – trap (no alumina) – metal tube (~2 r gauge, –gate valve with adaptor and pressure gauge).
6. I have changed alumina and placed it back into added. After 1 h pressure **1.2e-3 mbar**

Configuration as previously, just with alumina in the t

7. Then Ed moved the oil pump into the lab so we c

Here is the part which we were connecting with the better understanding.

setup

oil pump – trap (alumina) – metal tube (~2 m) – 4-way – 1 closed
– pressure gauge
– gate valve – adapter – small turbo pump – EUV char

setup

Colours: Black Blue Red Green Eraser Cancel Comment Submit Comment

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08:17:37 13 Jan 17 – Frey J.G.

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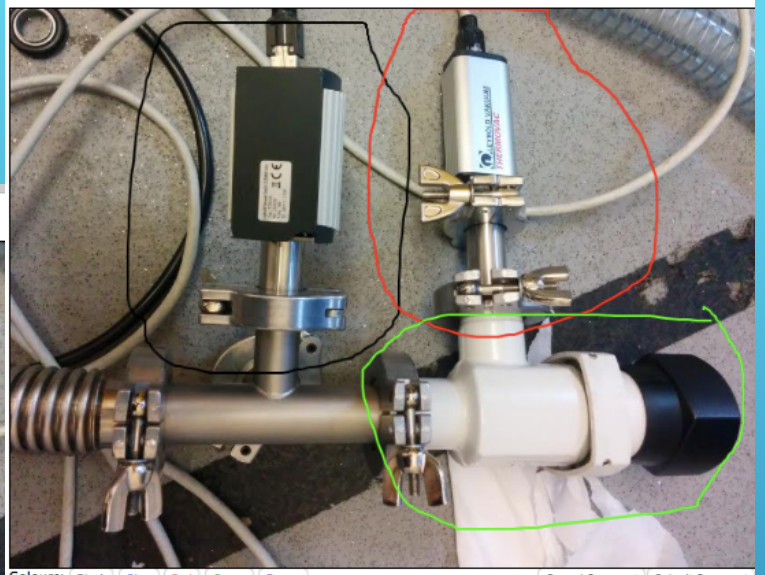
setup



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Linking

Bi-directional linking can extended to a group of Troves

Far field single atom spectra

6th September 2016 @ 07:42

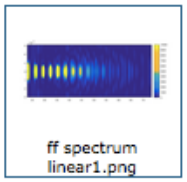
Just a footnote about what Dell has been doing in his MSc project. Ages ago we did this with the wrong transforms, and I've been meaning to do it again ever since the Artemis run where we got data from Ne which had nice detailed spectra – .....

Links to relevant posts are here:

A few key things from the Artemis run

far-field quantum path interference for a single 1-D atom – Oct 2009!

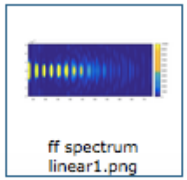
We're using 7fs pulses with inintensity 3e14 at peak here, 800nm. Spot size is 50um. Fixed CEP, too. Predicted cutoff is 75 eV-ish.



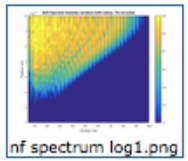
ff spectrum linear1.png

this is the linear plot, for comparison with the Artemis stuff – you can see that we see clear harmonics up to about 45 eV, not 75.

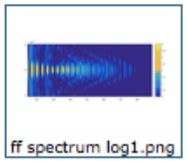
Attached Files



ff spectrum linear1.png



nf spectrum log1.png

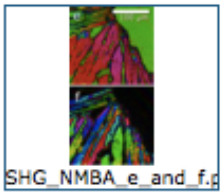


ff spectrum log1.png

However, in the real SHG data, if you look at (e) and (f) it's clear that the SHG phase (f) is varying very fast compared to the line

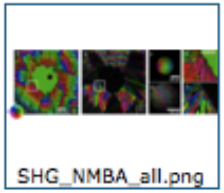
So what's varying? A variation small given that the *x* and *z* i orientation effect, but it's very

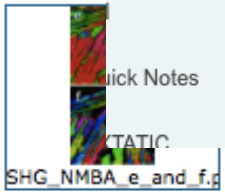
Is this obvious to anyone out like the phase jump could b causes the sign of d to change



[my link:NMBA properties (We

Attached Files





Brocklesby W.S. | Edit Entry | SHG CDI | Comments (3)

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NMBA properties

Thursday, 7 May 2015 10:00

Just exploring these - from Bailey93. What could the maximum delta k be?
Fig 6 has the refractive indices

De $\Delta k = k_{2\omega} - 2k_{\omega} = \frac{2\pi}{400nm} \cdot n_{2\omega} - \frac{2\pi}{800n}$

So $\Delta k = \frac{2\pi}{400nm}(n_{2\omega} - n_{\omega})$, $L = 7\mu$

WSB Matlab Autoblog

Matlab stuff produced by Bill's machine, sometimes with his help.

Older Entries >>

Search

fe_transmission.m

8th November 2016 @ 10:09

matlab code:

```
%Fe_transmission.m
%looking at using Iron to get differential absorption.
constants;
lambda0 = 800e-9;
q = 31:2:41;
lambda = lambda0 ./q;
stuff = 'fe';
%stuff = 'ca';
%stuff = 'k'
[eV, k, alpha] = get_index2(stuff);
l = h * c ./ (eV * e);
t = 0.5e-8; % film thickness
trans = exp(-alpha * t);
phi = k * t;  %note routine returns k not delta
figure(10)
%yyaxis left
plot(l*1e9,trans)
xlabel('wavelength /nm')
ylabel('trnsmission');
yyaxis right
plot(l*1e9,phi)
ylabel('phase shift');
title(sprintf('%s film, %g nm thick, harmonics 31-41 of %g nm', stuff, t*1e9, lam
xlim([15 35])
```

This Notebook

New Entry
Notebook Settings
Timeline View
Export Notebook
Feed (+Comments)

Archives

November 2016 (6)
August 2016 (3)
May 2016 (2)
April 2016 (1)
March 2016 (5)
January 2016 (8)
November 2015 (5)
October 2015 (5)
(more)

Authors

Brocklesby W.S. (340)

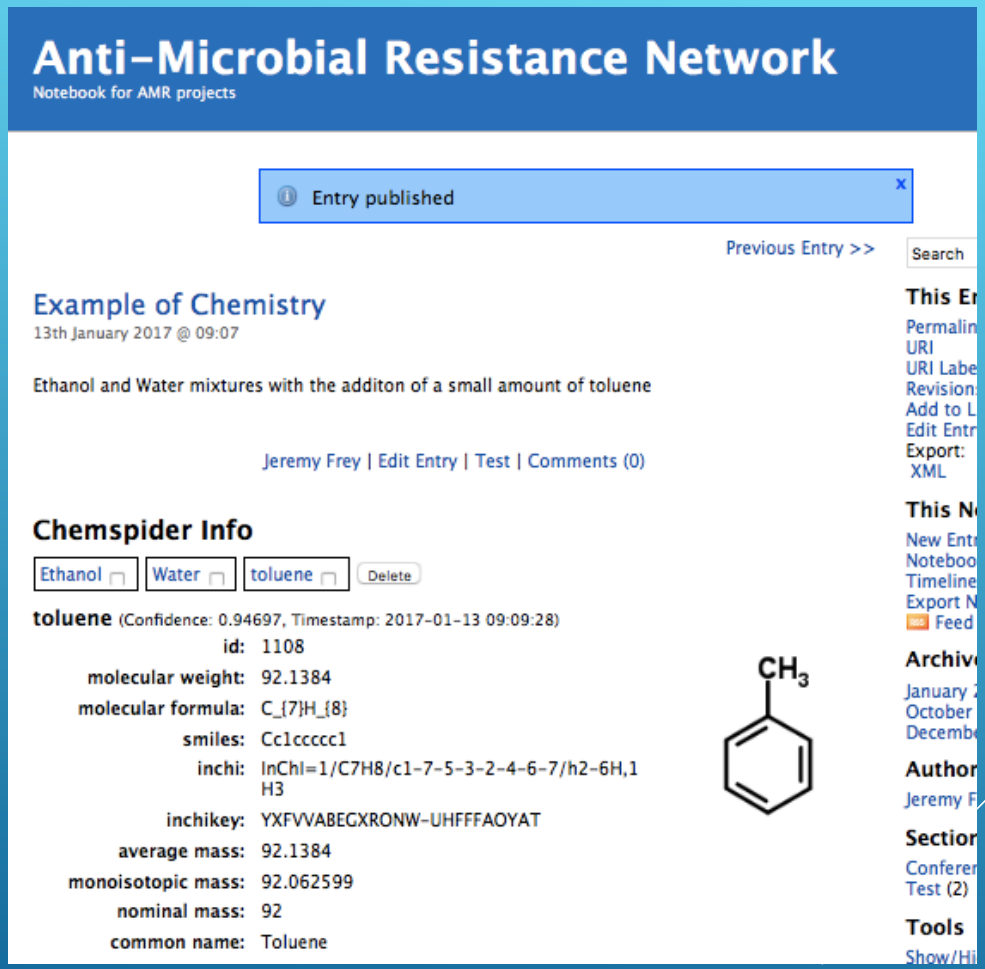
Sections

jets and cells (1)
Matlab Autoblogging (339)

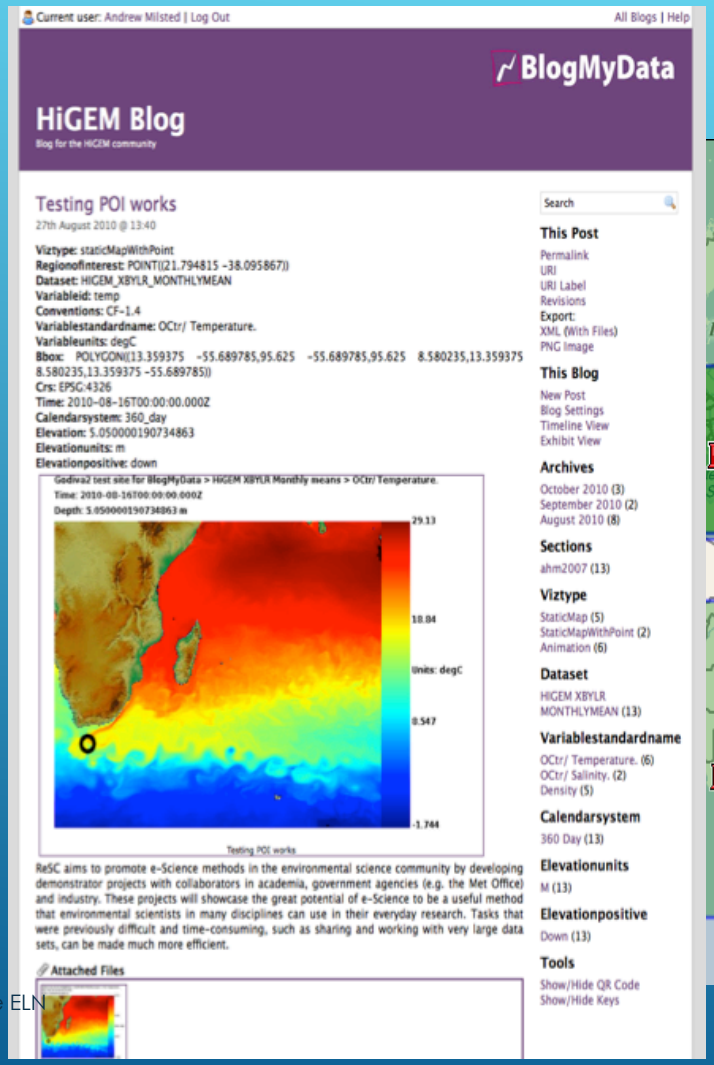
Tools

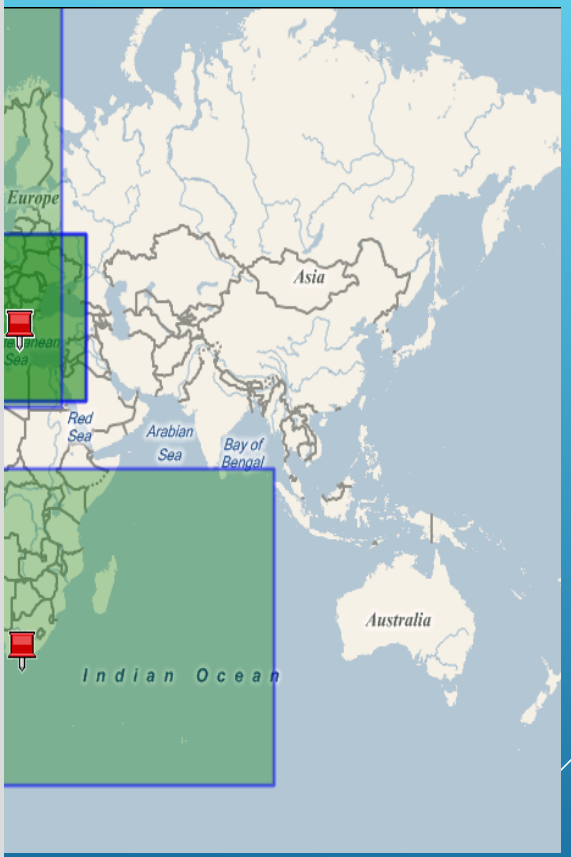
Show/Hide Keys

Text Analysis and Lookup Services



BlogMyData Project - Godiva





Tpp Methyl ester Hydrolysis:- Methord 2

9th April 2009 @ 16:50

Lab Note Book Or Experiment Code: FDH-5405-E7P26
Post Type: Methord_2
Procedural Step: Methord_2
Date Of Experiment: 27-11-08
Experiment Name: Tpp_Methyl_ester_Hydrolysis
Experiment Code:FDH/5405/E7P26
Date of Experiment:27/11/08

- reaction mixture added to 100ml of DCM
- solid formed...disolved in DCM/MeOH + water and evaporated to near dryness
- re desolved in 200ml choroform+20ml meOH, sonicated most desolved.
- 3oml water added mysells leeding to sold problems and poor seperation seen.
- 100ml water added now gives clear layer with mysells below
- transfered to bigger 500ml sep funnle.

this picture taken directly after transferance

- aprox. 30ml 2Mhydrocloric added to give emitate seperation. and turn porphyrin protenated green.
- much bettter behavd now....loverly shade of green too.

protonated prophyrin with 2M HCL

- HCL reextracted with 100ml CHCl3.
- fluffy brown noted between interface. contaminant?
- organic rinced5 times 100ml water. first rinc turns it back to puple

now purple organic with aqueous

- water re-extracted into chloroform 100ml and rince 5 times h2o.
- organicfractions combined and dryed over anhydrous sodium sulfate

27-11-08 (2)
30-11-08-1-12-08 (1)

Experiment Name

Prepartation Of Fulleropyrrolidin Alcohol:-Planning And Saftey (8)
Preparation Of N-Glycine (amino-Ethoxy-Ethanol) Tert Butyl Acetate (4)
Preparation Of P-tert Butly (bis[cyanomethoxy)dihydroxy]) Calix (2)
Preperation Of Mono Para Methyl Ester Meta Tetra Phenyl Porphyrin (10)
Removal Of A Protecting Group To Give [(hydroxyethoxy)ethyl Amino] Acetic Acid Repeat Ed (2) (4)
Removal Of A Protecting Group To Give [(hydroxyethoxy)ethyl Amino] Acetic Acid (5)
Prepartation Of Fulleropyrrolidin Alcohol (repeat 2) (3)
Prepartation Of Fulleropyrrolidin Alcohol (repeat 2) (1)
Tpp Methyl Ester Hydrolysis (5)

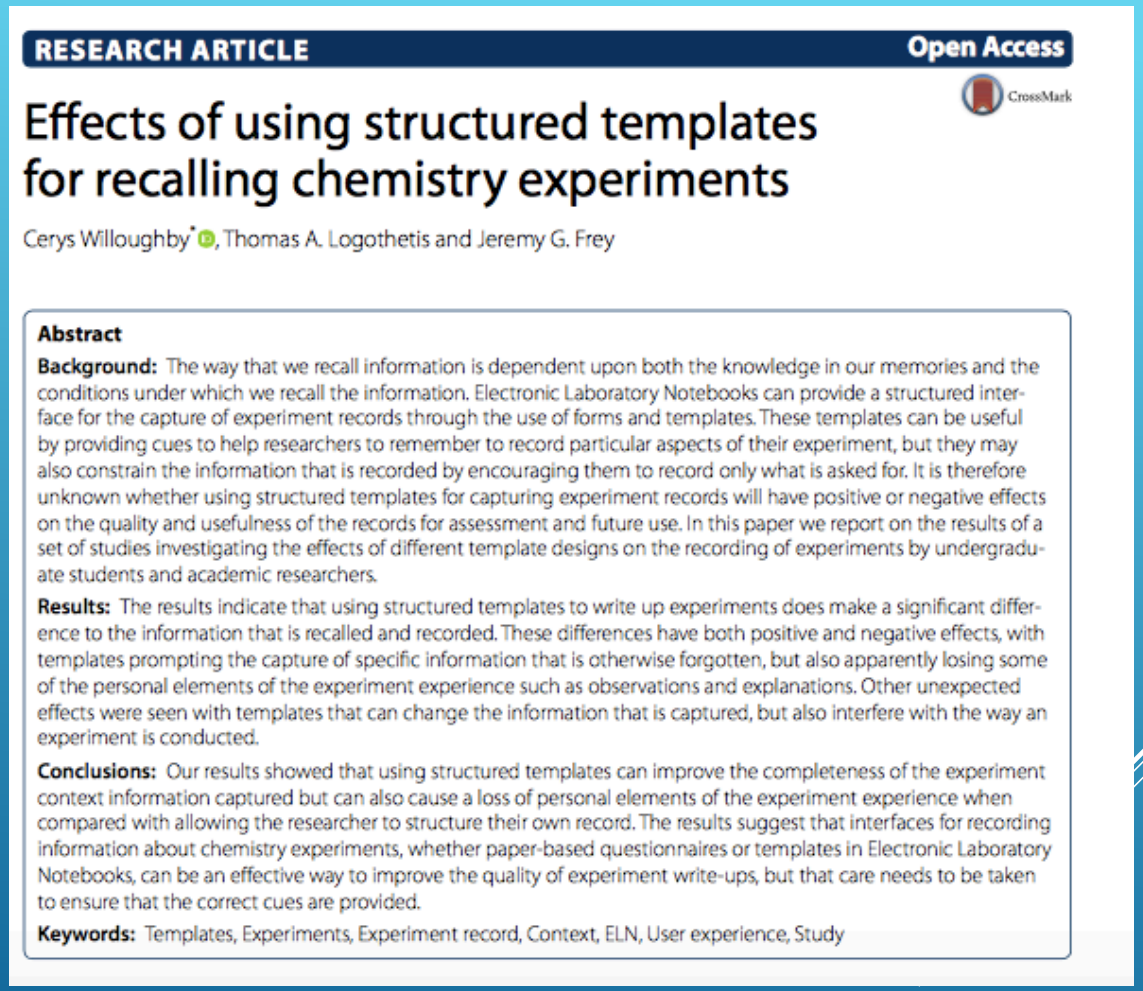
Chemical

Dichloromethane (1)
Triethylamine (1)
2-(2-Aminoethoxy)ethanol (1)
Template (1)
TertButylbromoacetate (1)
Tert Butyl 2 (2 (2 Hydroxyethoxy)ethylamino)acetate (1)
SodiumHydroxide1M (1)
Buckminsterfullerene (1)
Paraformaldehyde (1)
Toluene (1)
2-(2-(2-hydroxyethoxy)ethylamino)acetic Acid (1)
Fulleropyrrolidin Alcohol (1)
Pyrrole (1)
Methyl4-formylbenzoate (1)
Benzaldehyde (1)
Chloroform (1)
BoronTrifluorideEtherate (1)
2,3-Dichloro-5,6 Dicyano-1,4-Benzoquinone (1)
5-4-Methyl Benzoate
10,15,20-tri Phenyl Porphyrin

Jeremy Frey LabTrove ELN

Accessibility and Usability

Templates



RESEARCH ARTICLE Open Access

Effects of using structured templates for recalling chemistry experiments

Cerys Willoughby*, Thomas A. Logothetis and Jeremy G. Frey

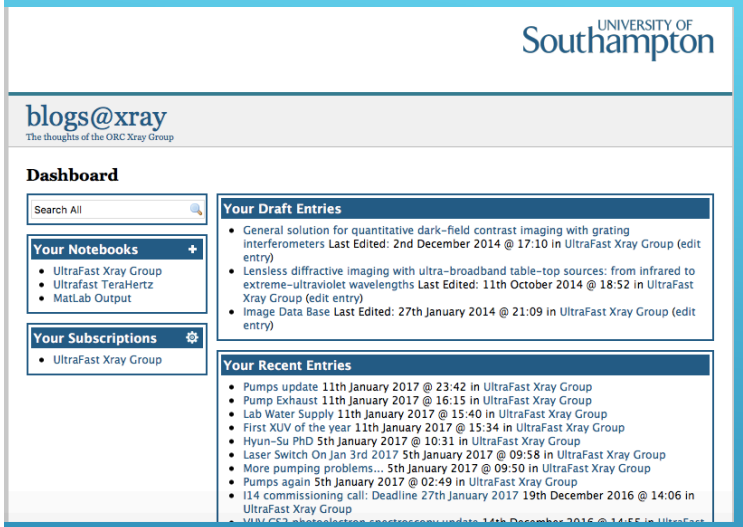
Abstract

Background: The way that we recall information is dependent upon both the knowledge in our memories and the conditions under which we recall the information. Electronic Laboratory Notebooks can provide a structured interface for the capture of experiment records through the use of forms and templates. These templates can be useful by providing cues to help researchers to remember to record particular aspects of their experiment, but they may also constrain the information that is recorded by encouraging them to record only what is asked for. It is therefore unknown whether using structured templates for capturing experiment records will have positive or negative effects on the quality and usefulness of the records for assessment and future use. In this paper we report on the results of a set of studies investigating the effects of different template designs on the recording of experiments by undergraduate students and academic researchers.

Results: The results indicate that using structured templates to write up experiments does make a significant difference to the information that is recalled and recorded. These differences have both positive and negative effects, with templates prompting the capture of specific information that is otherwise forgotten, but also apparently losing some of the personal elements of the experiment experience such as observations and explanations. Other unexpected effects were seen with templates that can change the information that is captured, but also interfere with the way an experiment is conducted.

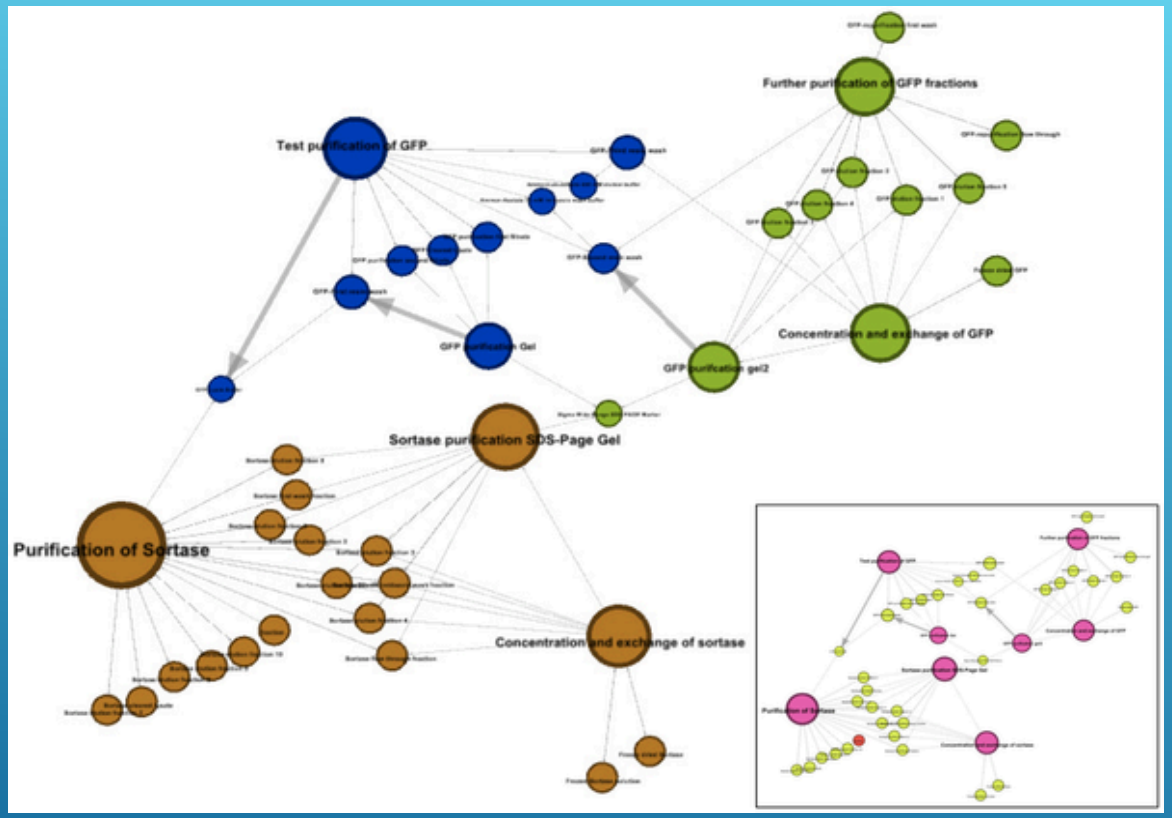
Conclusions: Our results showed that using structured templates can improve the completeness of the experiment context information captured but can also cause a loss of personal elements of the experiment experience when compared with allowing the researcher to structure their own record. The results suggest that interfaces for recording information about chemistry experiments, whether paper-based questionnaires or templates in Electronic Laboratory Notebooks, can be an effective way to improve the quality of experiment write-ups, but that care needs to be taken to ensure that the correct cues are provided.

Keywords: Templates, Experiments, Experiment record, Context, ELN, User experience, Study



discussion

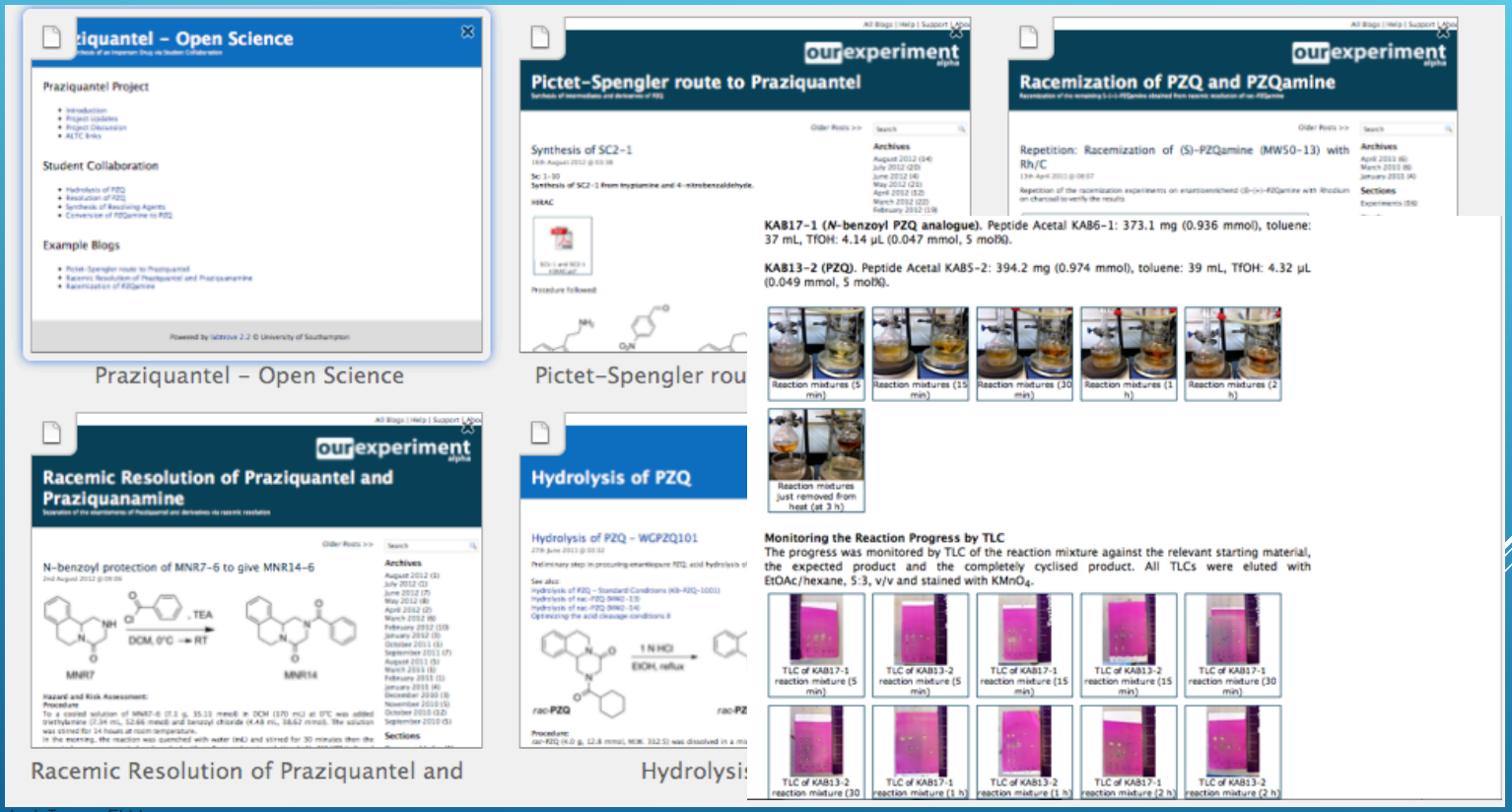
Figure 7. Visualization of posts as a network of resources.



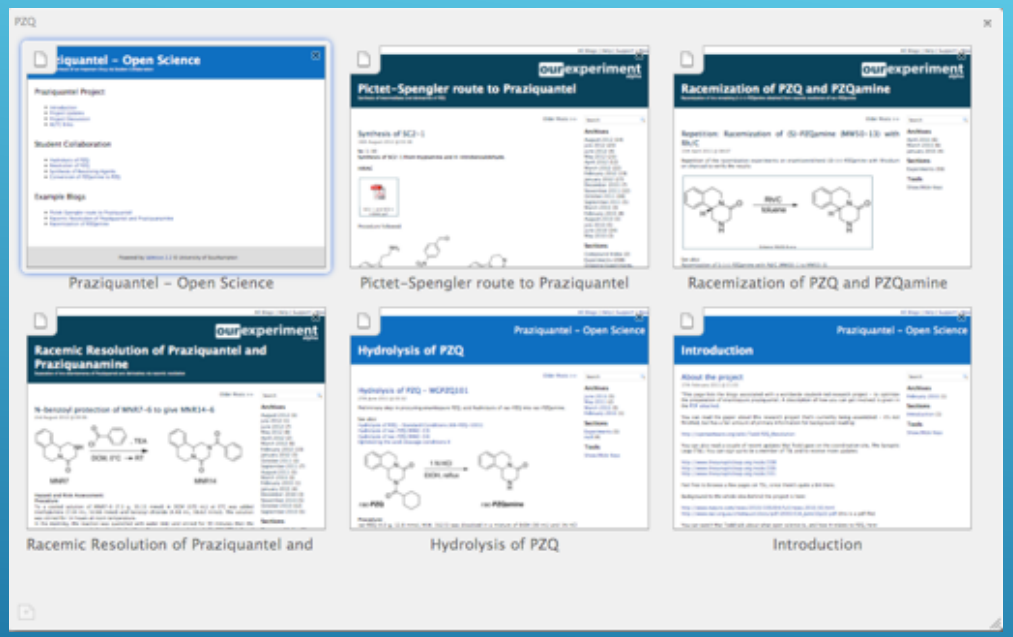
Milsted AJ, Hale JR, Frey JG, Neylon C (2013) LabTrove: A Lightweight, Web Based, Laboratory "Blog" as a Route towards a Marked Up Record of Work in a Bioscience Research Laboratory. PLoS ONE 8(7): e67460. doi:10.1371/journal.pone.0067460
http://www.plosone.org/article/info:doi/10.1371/journal.pone.0067460

ARCHIVE

LabTrove Open Notebooks
Mat Todd's Malaria Project



LabTrove Notebooks

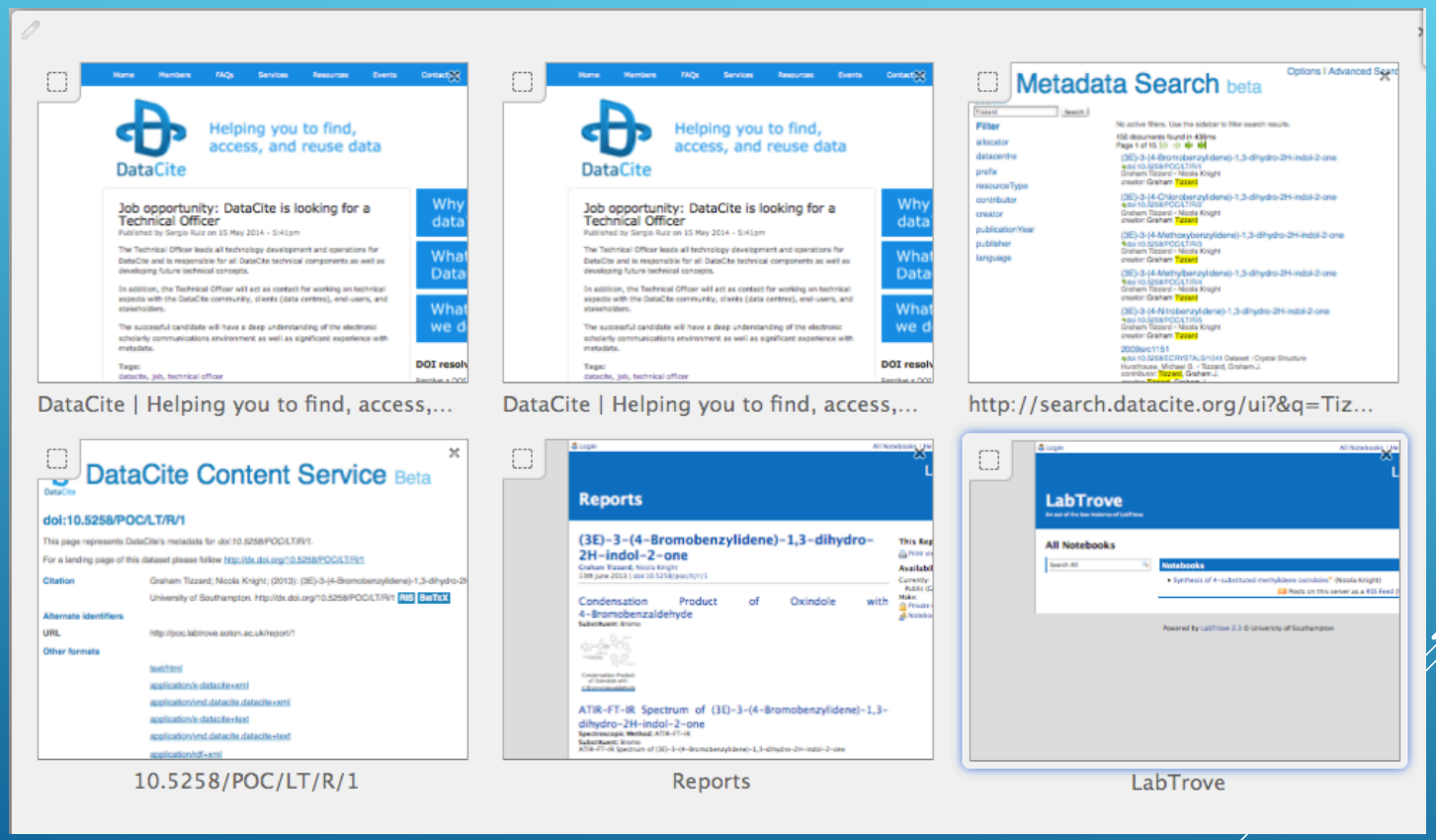


Select entries (all)

Export as HTML "static" copy

Zip and send to repository

DataCite DOI



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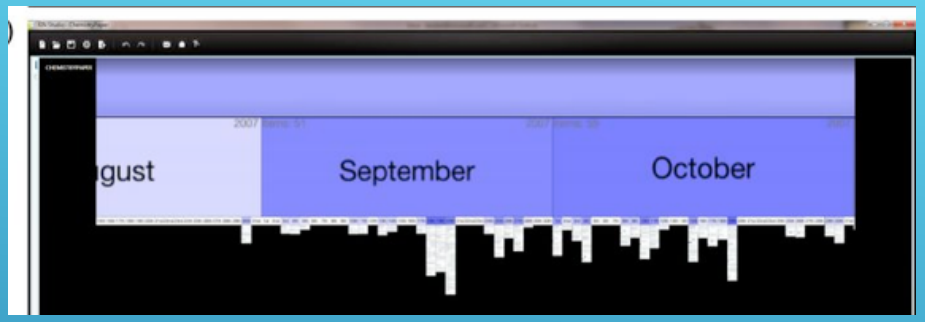
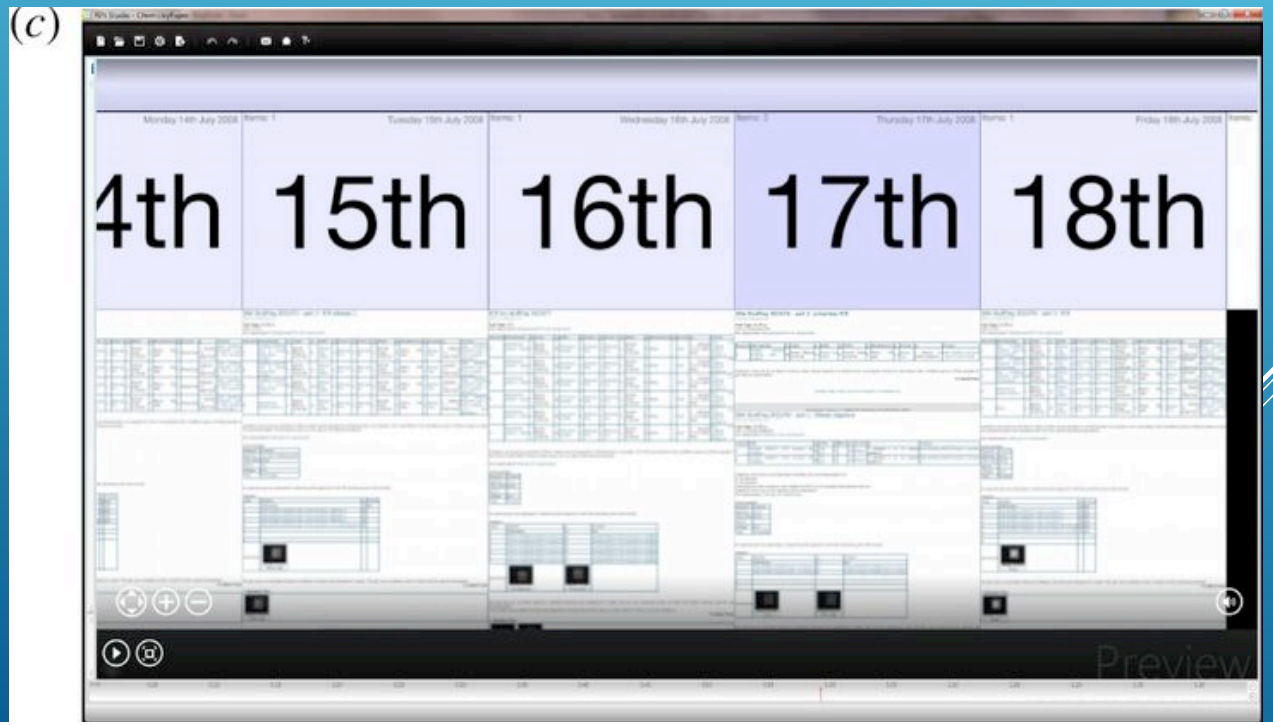
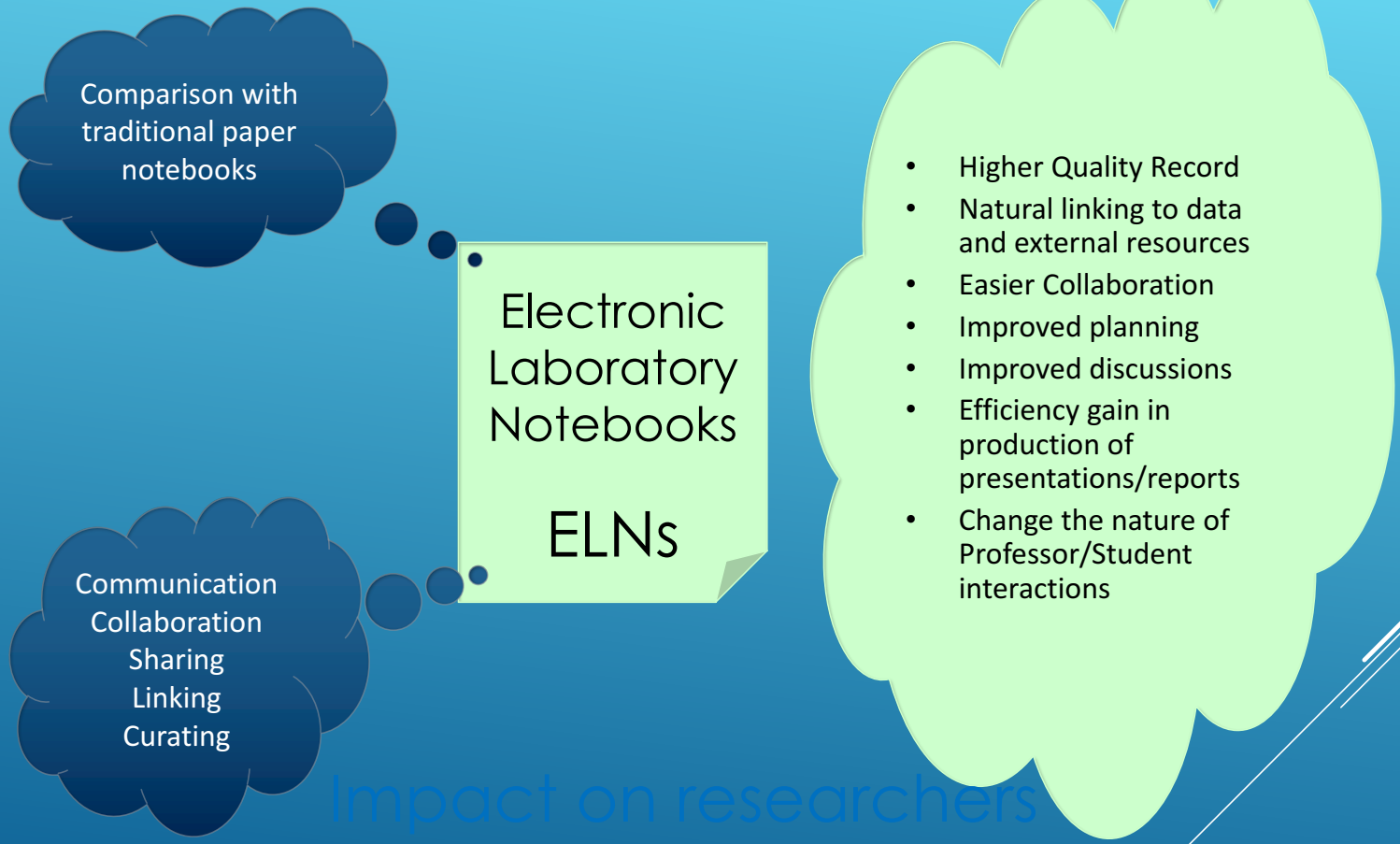


Use of Deep Zoom technique




Comparison with traditional paper notebooks
Electronic Laboratory Notebooks
ELNs
Communication
Collaboration
Sharing
Linking
Curating
Higher Quality Record
Natural linking to data and external resources
Easier Collaboration
Improved planning
Improved discussions
Efficiency gain in production of presentations/reports
Change the nature of Professor/Student interactions
Impact on researchers

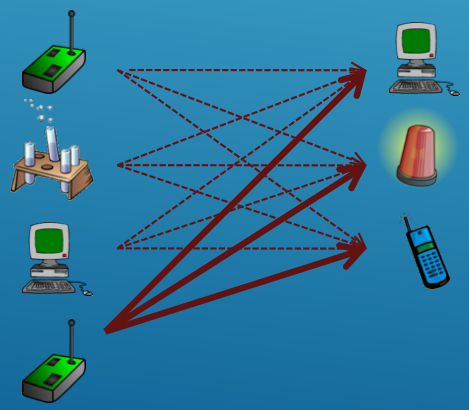
- ELN is not something to be considered in isolation
- Needs to be considered as part of a whole (digital) lab ecosystem

LAB ECOSYSTEM

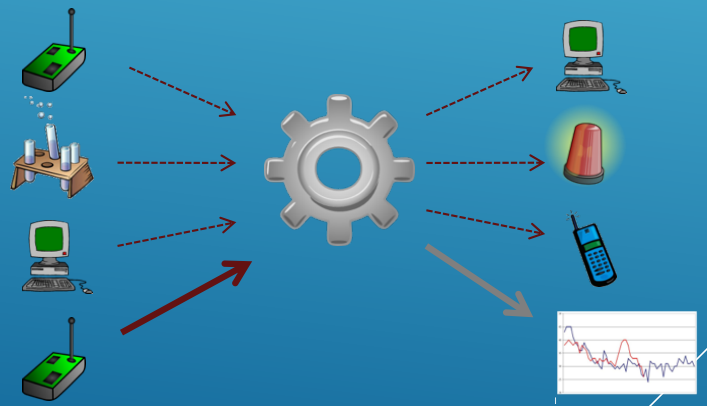
Middleware: The SRF LabBroker Software:

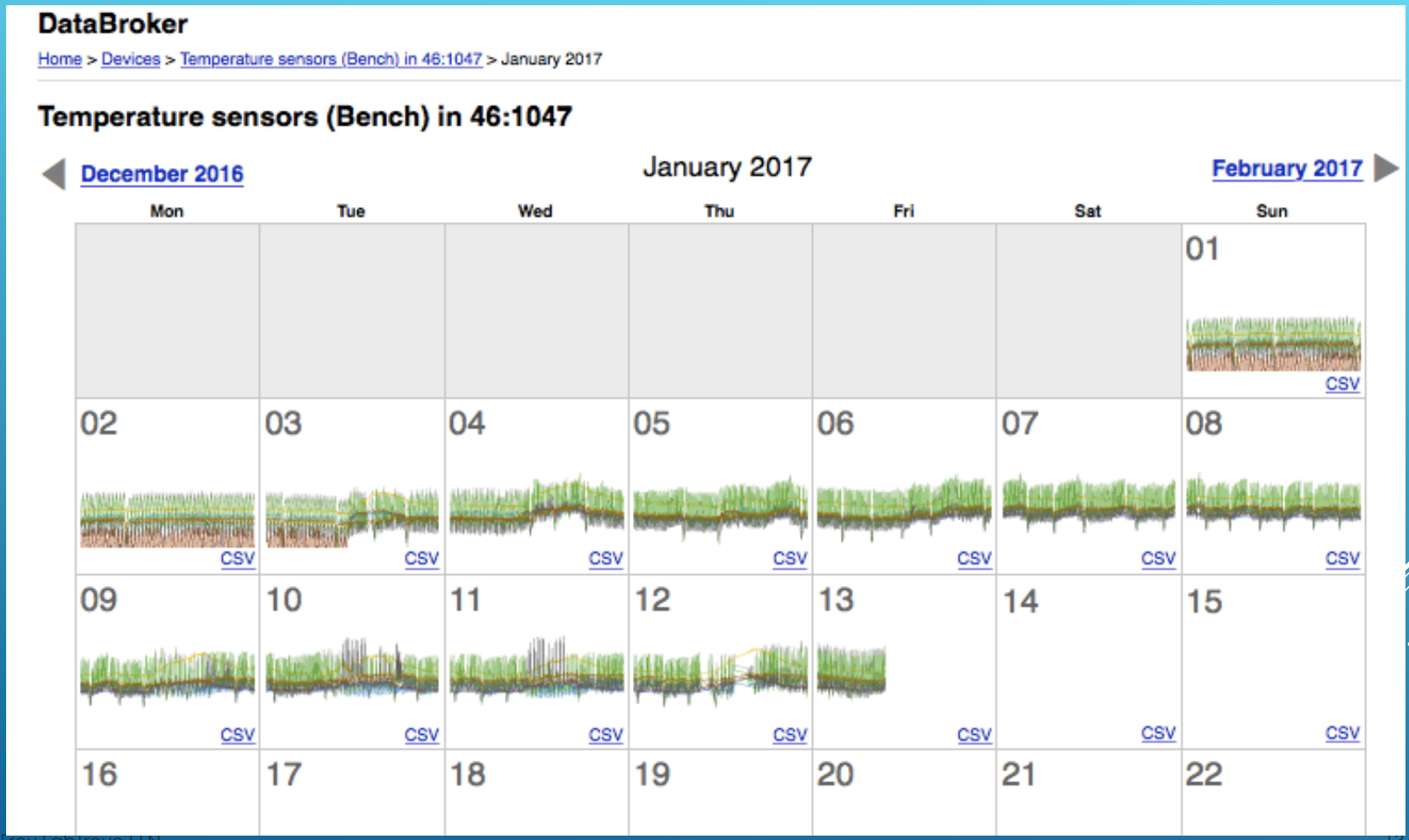
Get the data into the Trove before the users even look

- Without middleware



- With middleware




DataBroker
Home > Devices > Temperature sensors (Bench) in 46:1047 > January 2017
Temperature sensors (Bench) in 46:1047
December 2016
January 2017
February 2017
Mon
Tue
Wed
Thu
Fri
Sat
Sun
01
02
03
04
05
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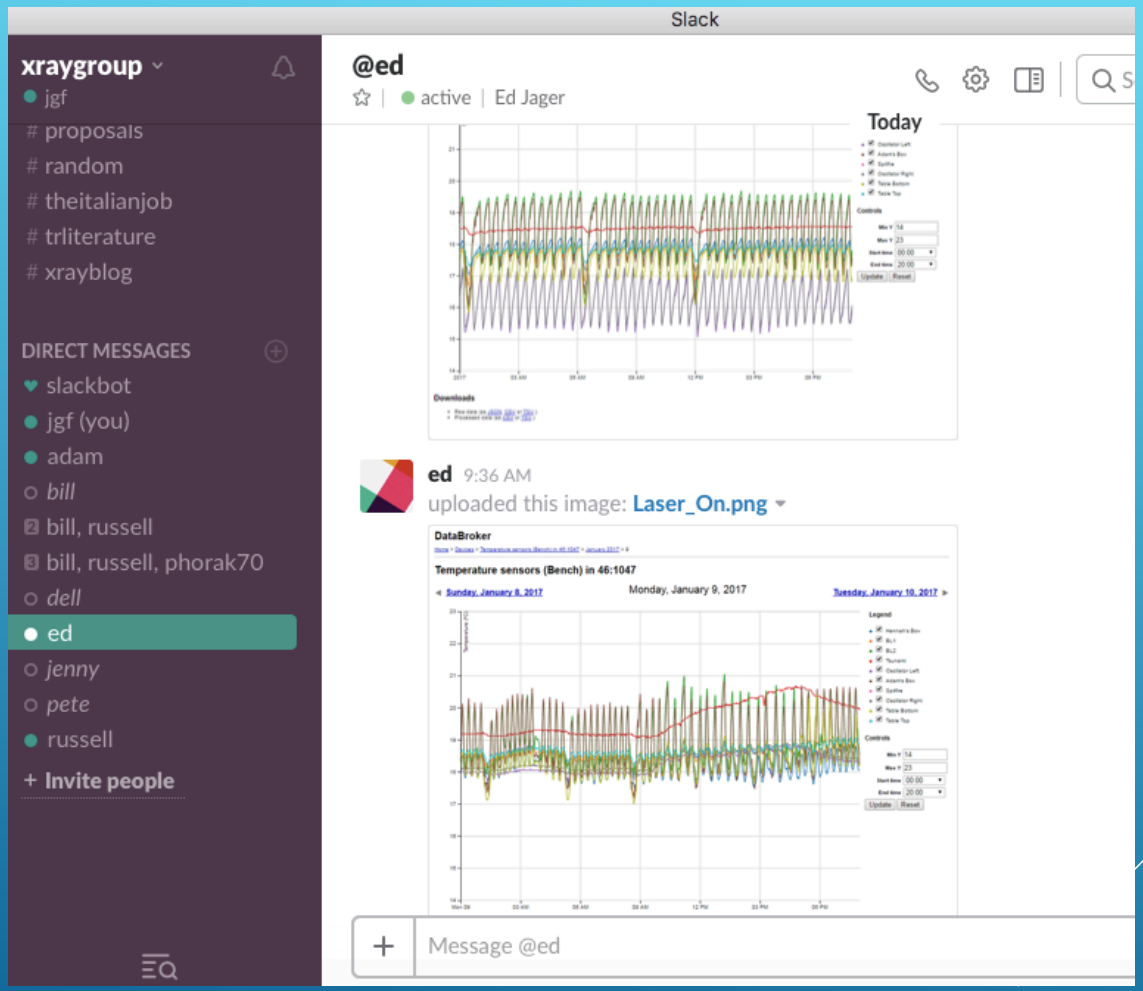
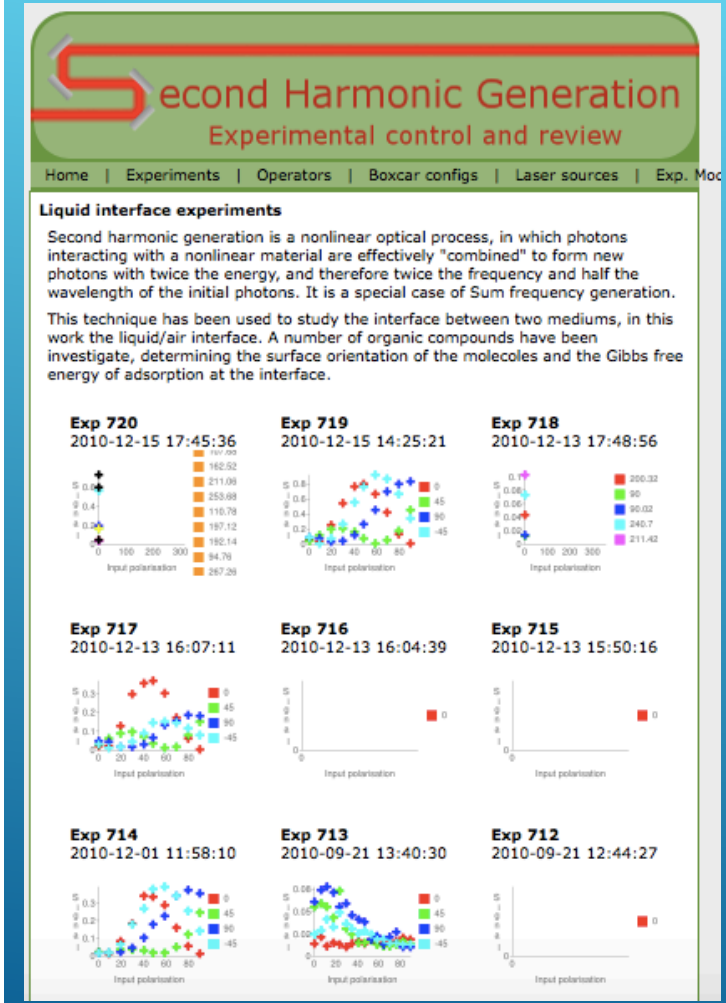
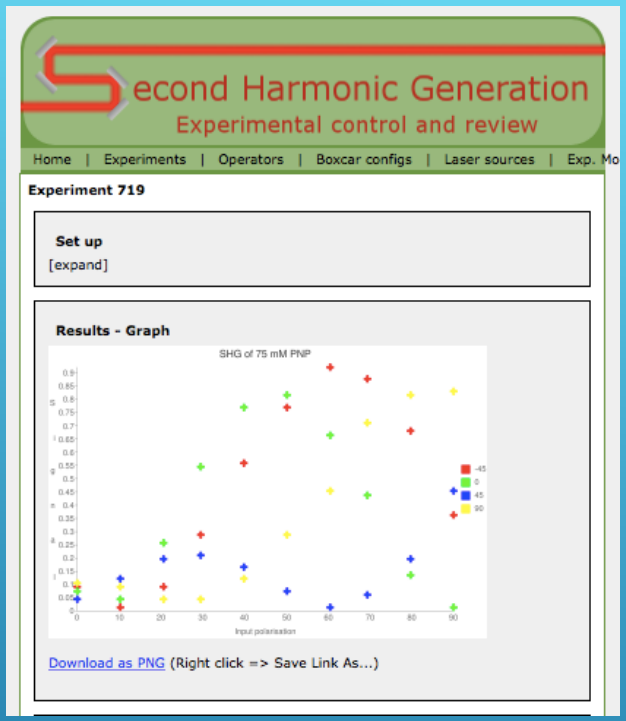
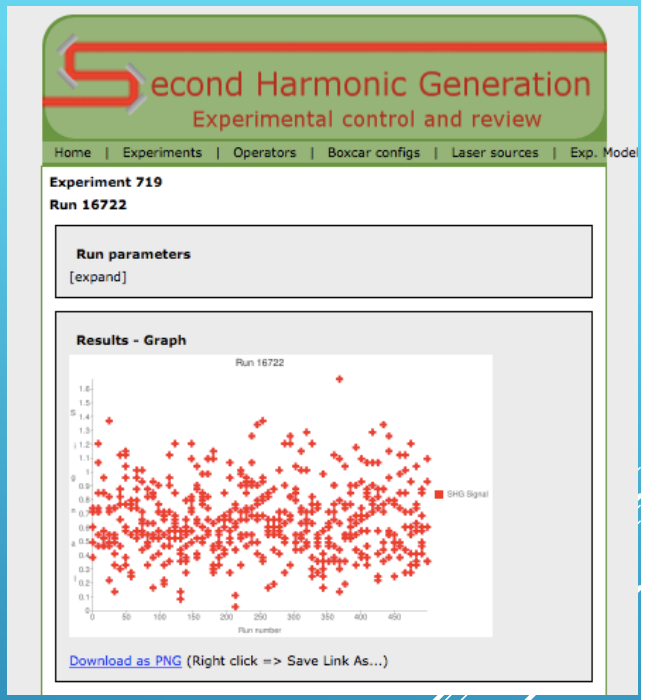
CSV

SLACK


Slack
xraygroup
jgf
proposals
random
theitalianjob
trliterature
xrayblog
DIRECT MESSAGES
slackbot
jgf (you)
adam
bill
bill, russell
bill, russell, phorak70
dell
ed
jenny
pete
russell
+ Invite people
@ed
active | Ed Jager
Today
ed 9:36 AM
uploaded this image: Laser_On.png
DataBroker
Temperature sensors (Bench) in 46:1047
Monday, January 9, 2017
Message @ed

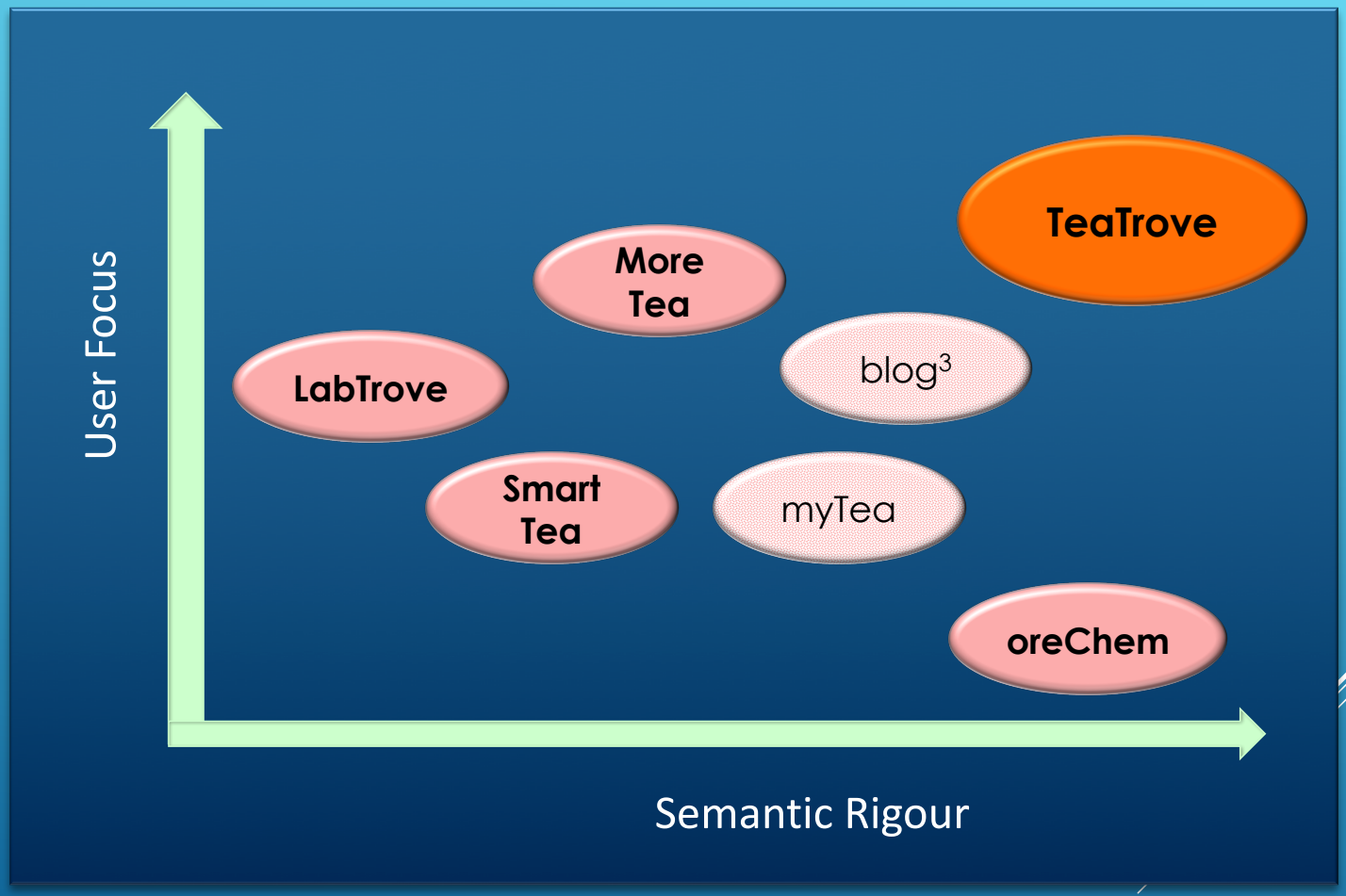






Experimental data & analysis available via a database

FUTURE


User Focus
TeaTrove
More Tea
LabTrove
blog3
Smart Tea
myTea
oreChem
Semantic Rigour


HIGH
WINDS
MAY
EXIST
cc: Rich Anderson - https://www.flickr.com/photos/99105016@N00

Ontology

Research to Product

We must speed up the knowledge discovery process

All I am saying is that now is the time to develop the technology to deflect an asteroid

Thank you for listening

Trust me Mort - no electronic communications superhighway, no matter how vast and sophisticated, will ever replace the art of the schmooze