# OpenLabNotes

## An Electronic Laboratory Notebook Extension for

OpenLabFramework

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Bari, October 14th 2015

IB2015
Integrative Bioinformatics

NETTAB

# Odense, Denmark

University of Southern Denmark

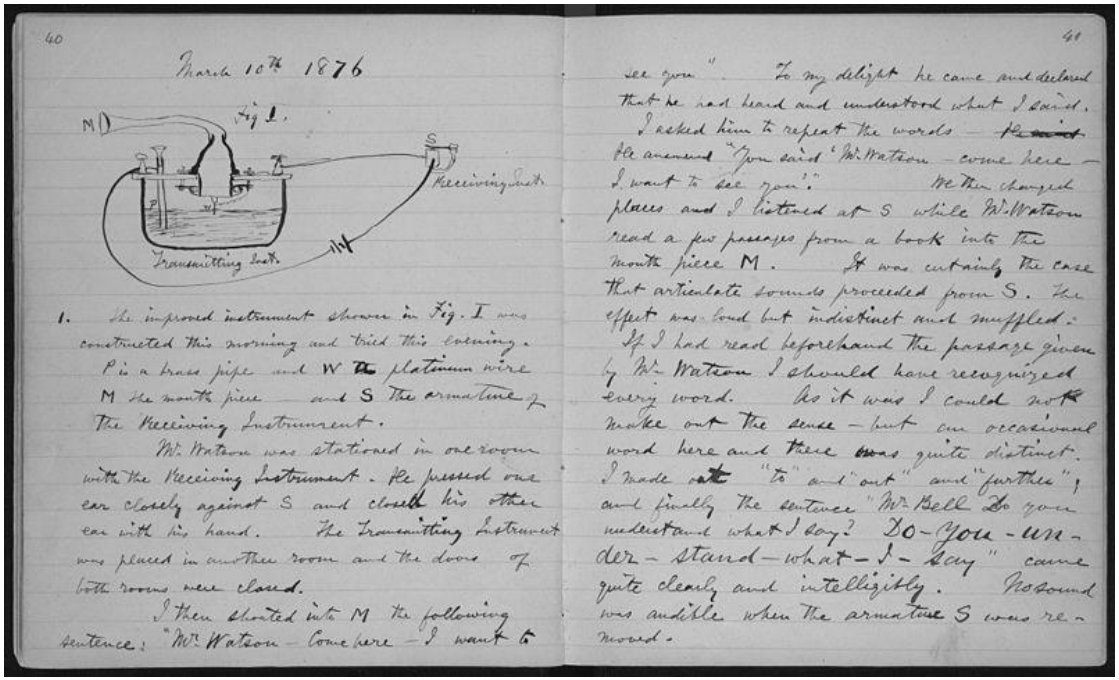
NanoCAN

# Saarbrücken, Germany

max planck institut informatik

# Paper Laboratory Notebooks

- Documentation of experimental work:
  - Setup
  - Results
  - Notes
- Reproducibility
- Legal proof for an invention



March 10th 1876

Fig 1.

M

S

Receiving Instr.

Transmitting Instr.

1. The improved instrument shown in Fig. I was constructed this morning and tried this evening. P is a brass pipe and W the platinum wire M the mouth piece — and S the armature of the Receiving Instrument.

Mr. Watson was stationed in one room with the Receiving Instrument. He pressed one ear closely against S and closed his other ear with his hand. The Transmitting Instrument was placed in another room and the doors of both rooms were closed.

I then shouted into M the following sentence: "Mr. Watson — Come here — I want to see you". To my delight he came and declared that he had heard and understood what I said.

I asked him to repeat the words — He answered "You said 'Mr. Watson — come here — I want to see you'." We then changed places and I listened at S while Mr. Watson read a few passages from a book into the mouth piece M. It was certainly the case that articulate sounds proceeded from S. The effect was loud but indistinct and muffled.

If I had read beforehand the passage given by Mr. Watson I should have recognized every word. As it was I could not make out the sense — but an occasional word here and there was quite distinct. I made out "to" and "out" and "further", and finally the sentence "Mr. Bell Do you understand what I say? DO-YOU-UN-DER-STAND-WHAT-I-SAY" came quite clearly and intelligibly. No sound was audible when the armature S was removed.

Page from a laboratory notebook of Alexander Graham Bell, 1876.

- Notebooks can get destroyed, lost, or stolen.
- Difficult to locate specific information, especially in case of staff changes.
- Difficult to incorporate already digitalized results.
- Difficult to share specific information.

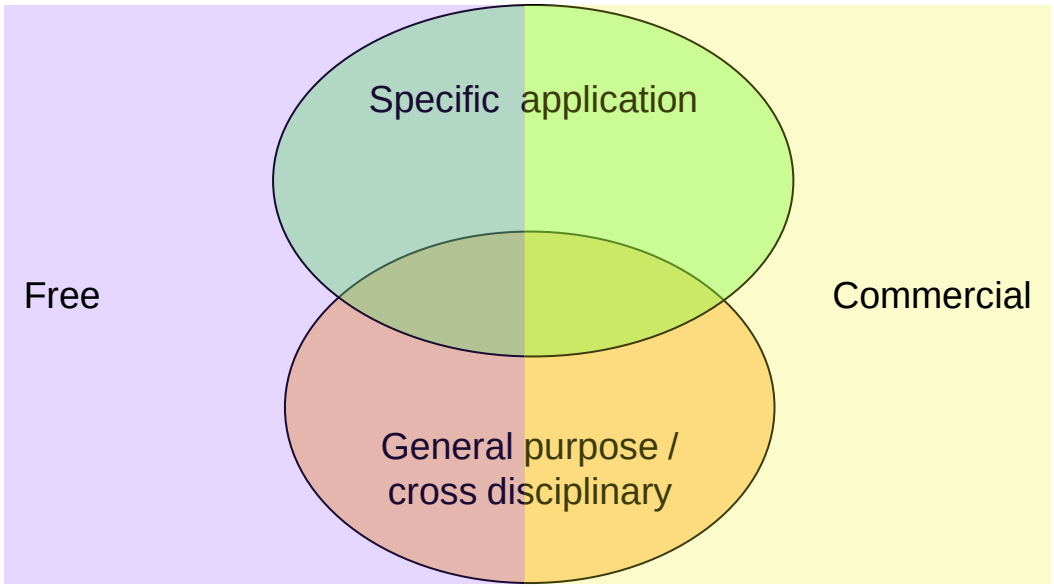
# Electronic Laboratory Notebooks (ELNs)

- Documentation of experimental work
- Reproducibility
- Rich text editor
- Full text search
- Document sharing
- Collaborative editing
- Automated backup
- Timestamps

- **For many years not considered a legal document**
- Commercial solutions quite expensive
- Difficult to set up and maintain
- Data migration issues

# Types of ELNs

International Agency for Research on Cancer ELN



# CFR21 part 11

U.S. Food and Drug Administration

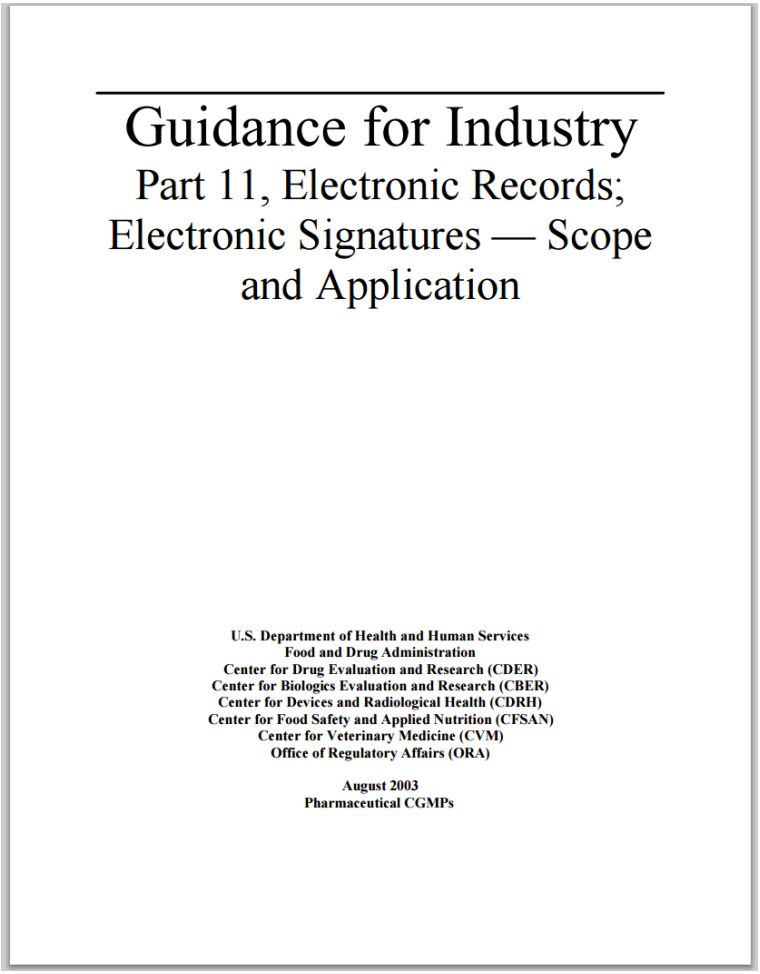
Applies to all FDA-regulated industries

Provides guidelines for

- Electronic records
- Electronic signatures

Primary intent is to make sure that any recorded information can not be falsified at a later point (e.g. scientific fraud)

How can this be achieved?



Guidance for Industry

Part 11, Electronic Records; Electronic Signatures — Scope and Application

U.S. Department of Health and Human Services
Food and Drug Administration
Center for Drug Evaluation and Research (CDER)
Center for Biologics Evaluation and Research (CBER)
Center for Devices and Radiological Health (CDRH)
Center for Food Safety and Applied Nutrition (CFSAN)
Center for Veterinary Medicine (CVM)
Office of Regulatory Affairs (ORA)

August 2003
Pharmaceutical CGMPs

# How to protect the data

Backend:
- Firewall
- Access limited to system administrators

Frontend:
- Identity:
  - User authentication
  - Access rules
  - Trusted authority, i.e. LDAP etc.

**Content:**
- **Digital signature**
- **Co-signing for patenting**

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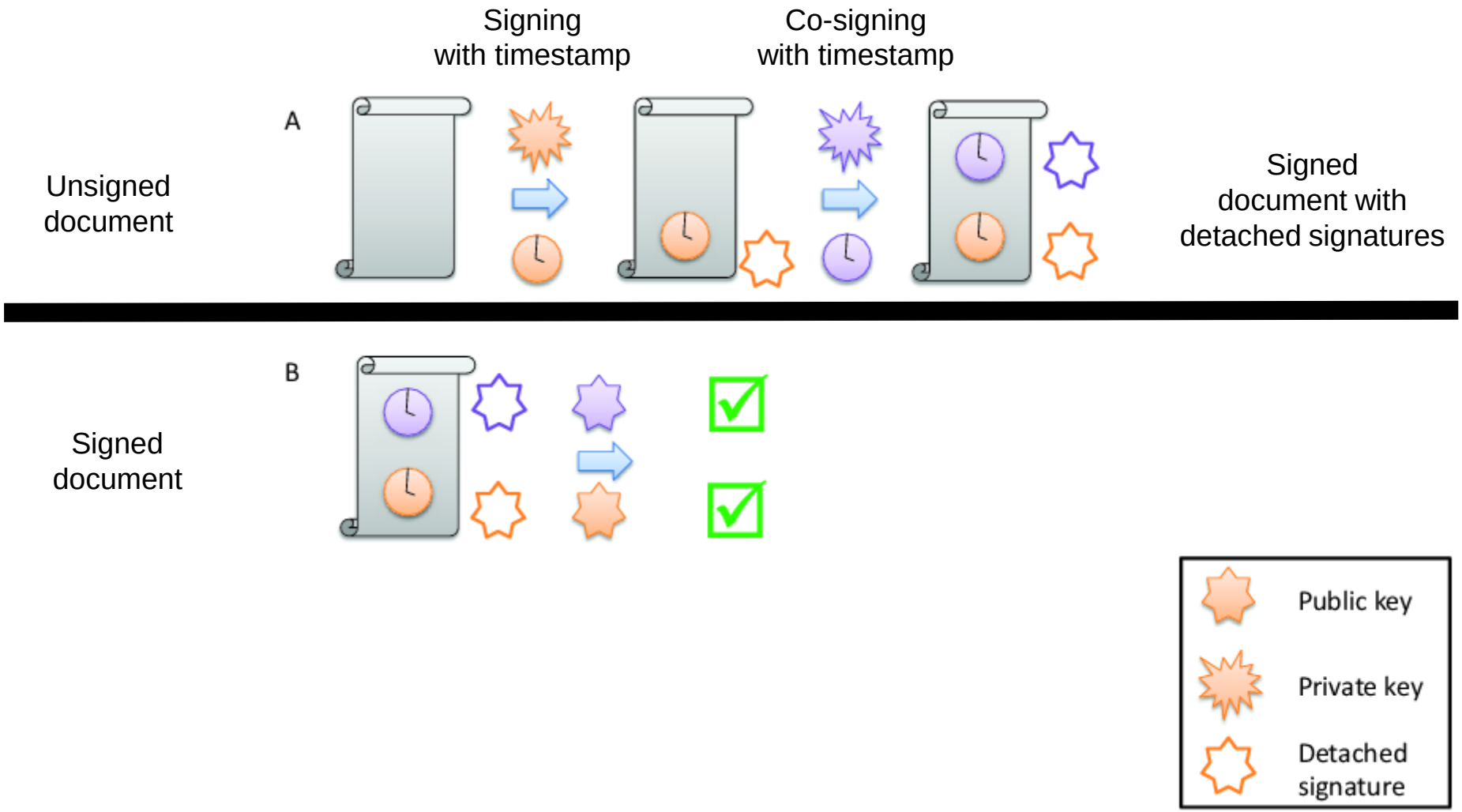
# Digital signature scheme



# OpenLabFramework

Laboratory Information Management System

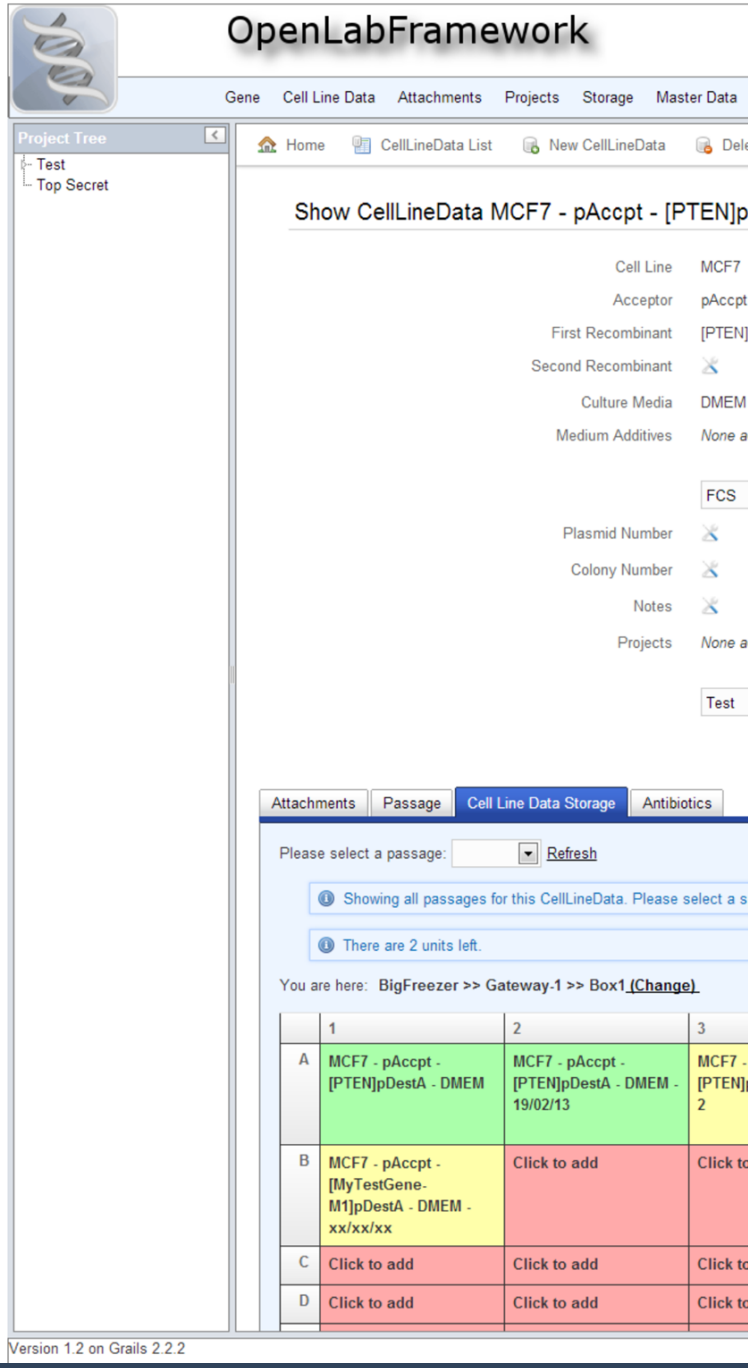
Web application based on Grails web application framework

Development started in 2010

Published in 2014

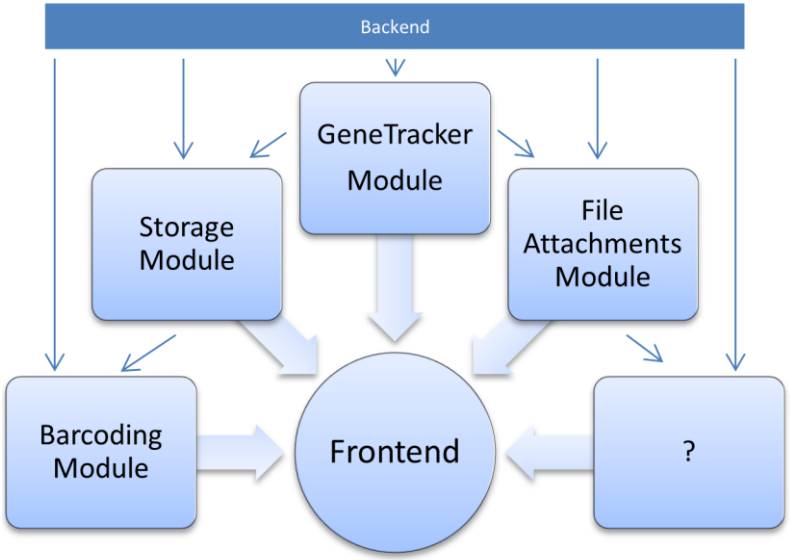
Developed for the functional genomics community, but

Generally usable as a sample management and tracking solution due to its modular structure

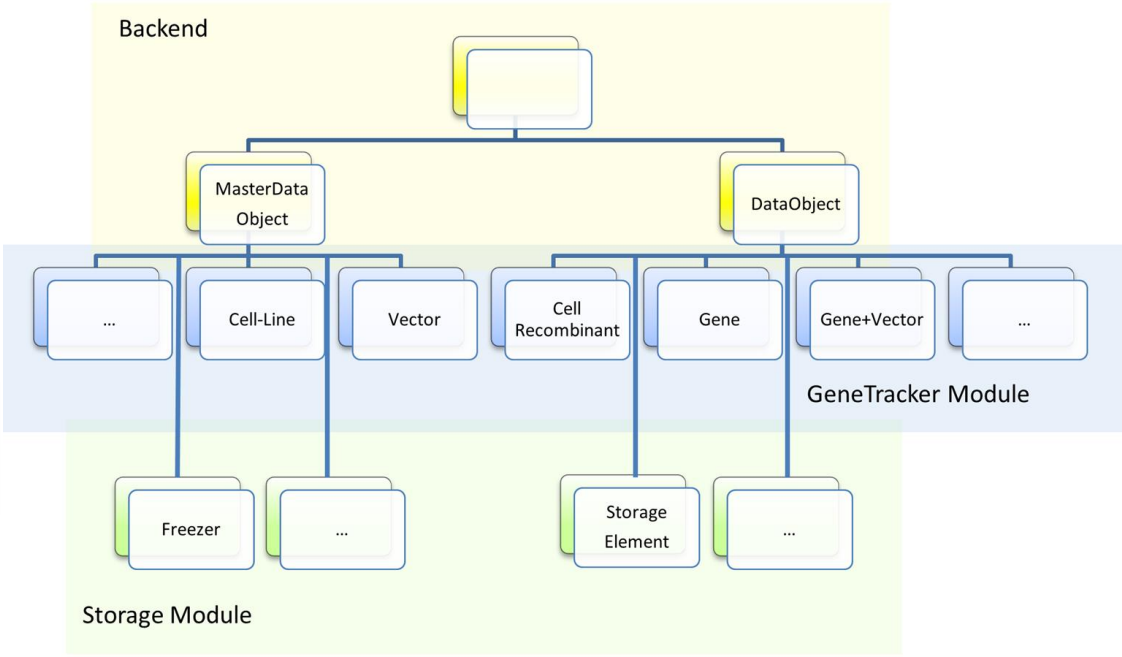


# OpenLabFramework

## Modular structure




## Class Hierarchy





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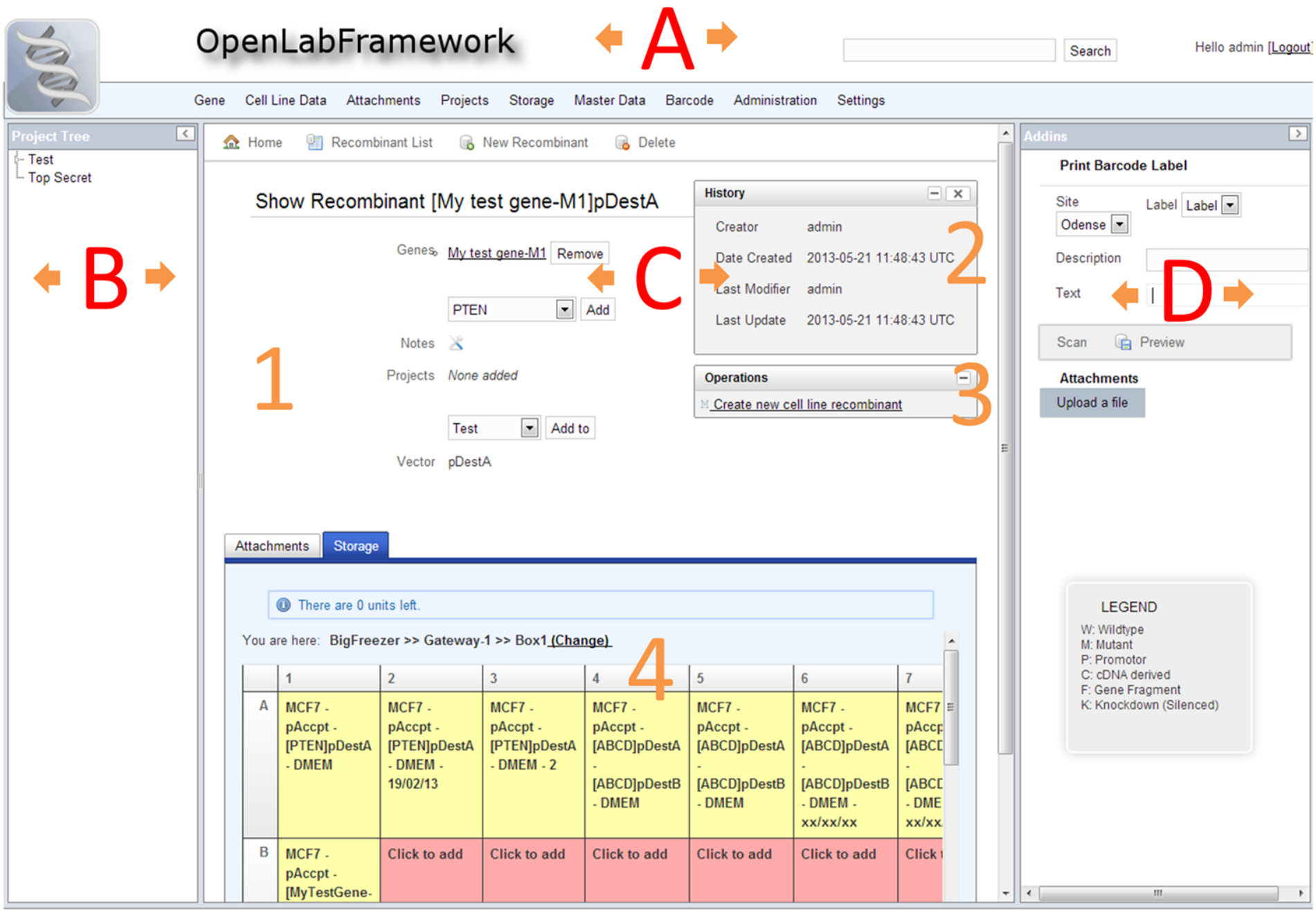
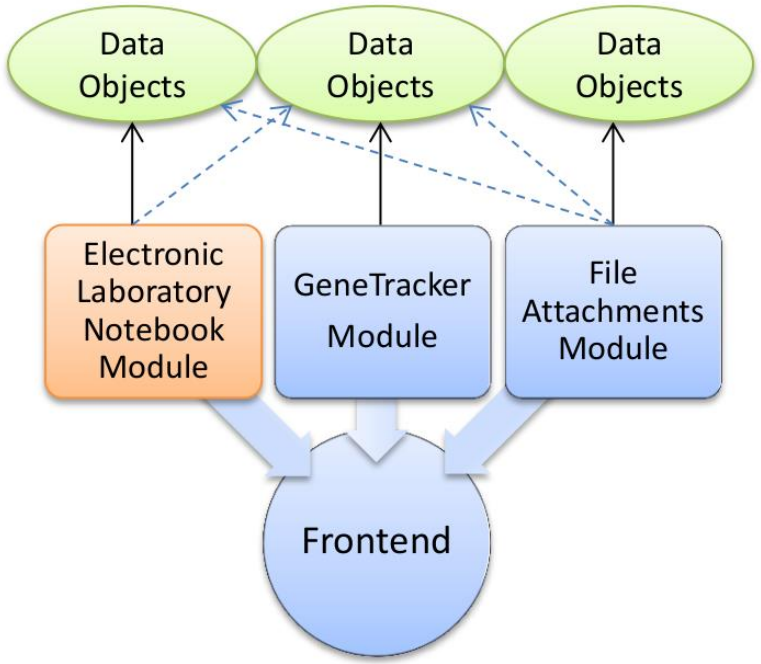
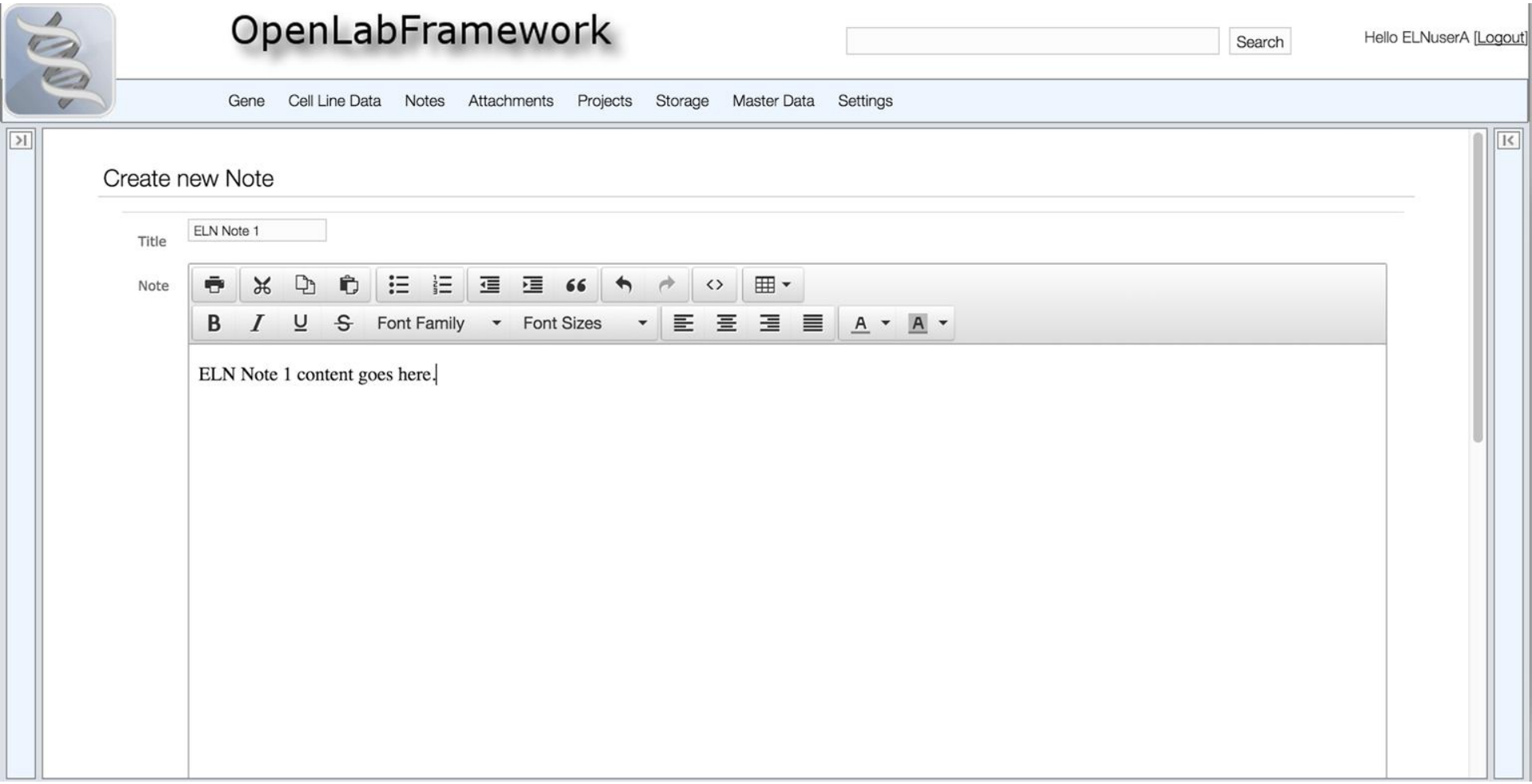

OpenLabFramework
A
Search
Hello admin [Logout]
Gene
Cell Line Data
Attachments
Projects
Storage
Master Data
Barcode
Administration
Settings
Project Tree
Test
Top Secret
B
Home
Recombinant List
New Recombinant
Delete
Show Recombinant [My test gene-M1]pDestA
Genes
My test gene-M1
Remove
PTEN
Add
Notes
Projects
None added
Test
Add to
Vector
pDestA
1
C
History
Creator
admin
Date Created
2013-05-21 11:48:43 UTC
Last Modifier
admin
Last Update
2013-05-21 11:48:43 UTC
2
Operations
Create new cell line recombinant
3
Addins
Print Barcode Label
Site
Odense
Label
Label
Description
Text
D
Scan
Preview
Attachments
Upload a file
Attachments
Storage
There are 0 units left.
You are here: BigFreezer >> Gateway-1 >> Box1 (Change)
4
1
2
3
4
5
6
7
A
MCF7 - pAccpt - [PTEN]pDestA - DMEM
MCF7 - pAccpt - [PTEN]pDestA - DMEM - 19/02/13
MCF7 - pAccpt - [PTEN]pDestA - DMEM - 2
MCF7 - pAccpt - [ABCD]pDestA - [ABCD]pDestB - DMEM
MCF7 - pAccpt - [ABCD]pDestA - [ABCD]pDestB - DMEM
MCF7 - pAccpt - [ABCD]pDestA - [ABCD]pDestB - DMEM - xx/xx/xx
B
MCF7 - pAccpt - [MyTestGene-
Click to add
Click to add
Click to add
Click to add
Click to add
LEGEND
W: Wildtype
M: Mutant
P: Promotor
C: cDNA derived
F: Gene Fragment
K: Knockdown (Silenced)
Version 1.2 on Grails 2.2.2

# OpenLabNotes as an ELN module for OpenLabFramework

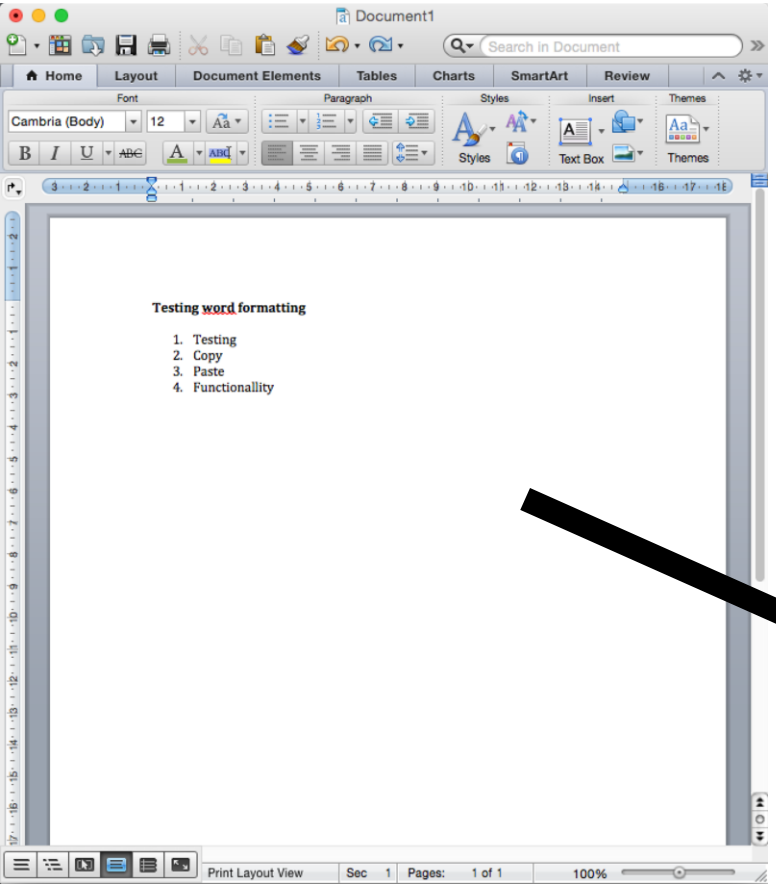
Documents in OpenLabNotes can interact with existing modules and their DataObjects out of the box.

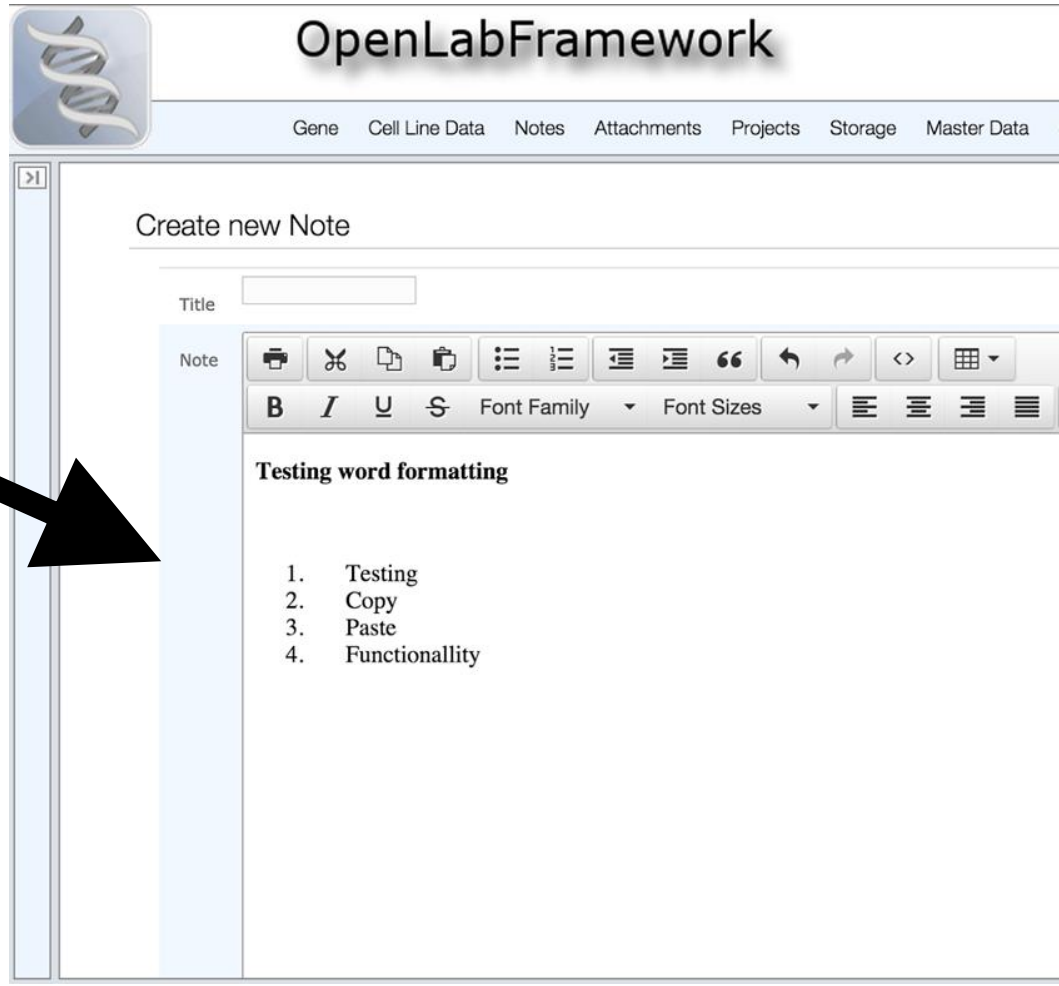


# Create Note


OpenLabFramework
Search
Hello ELNuserA [Logout]
Gene
Cell Line Data
Notes
Attachments
Projects
Storage
Master Data
Settings
Create new Note
Title
ELN Note 1
Note
Font Family
Font Sizes
ELN Note 1 content goes here.

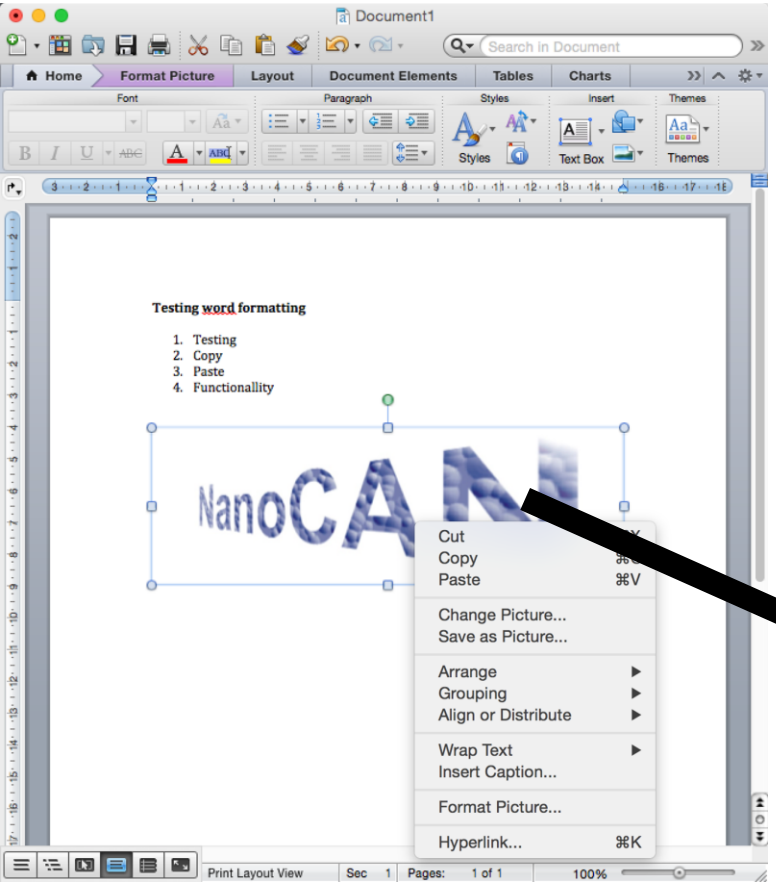
# Copy and Paste

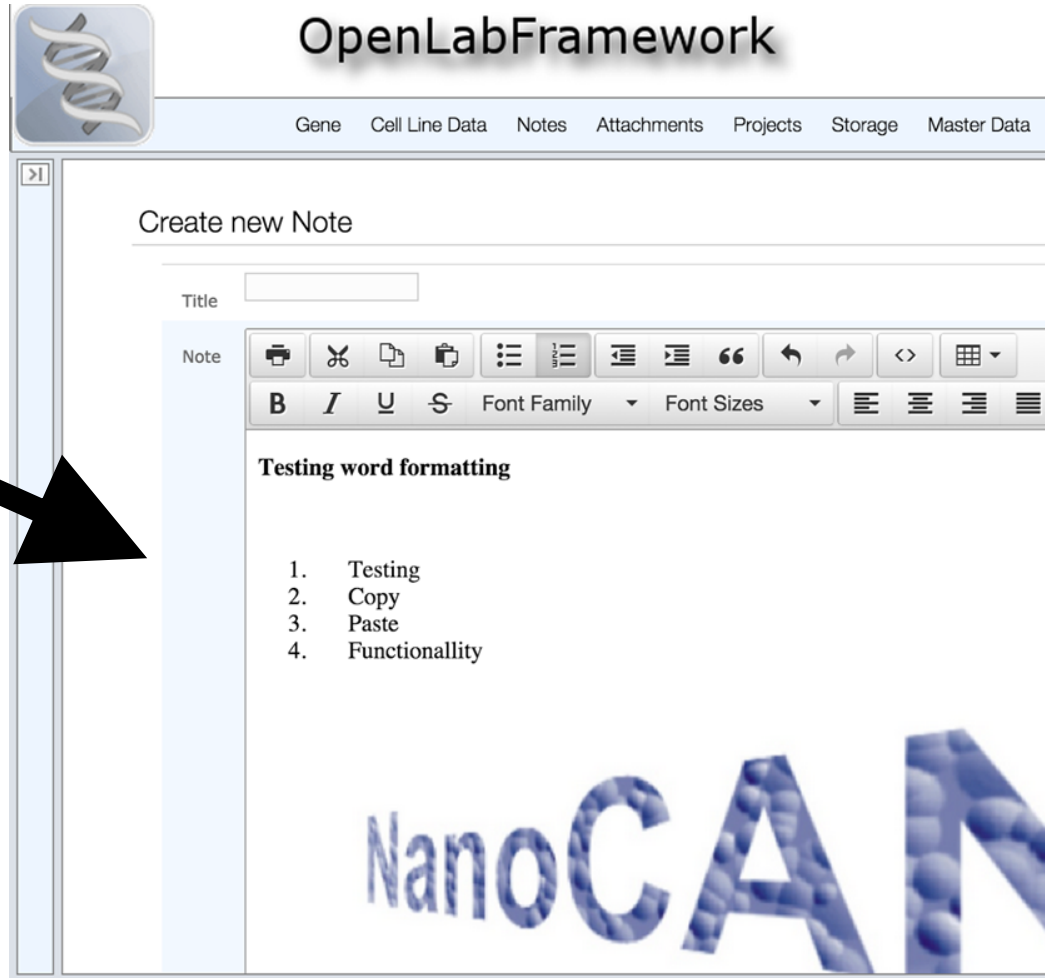



MS Office, Editor, Evernote, Web, ...

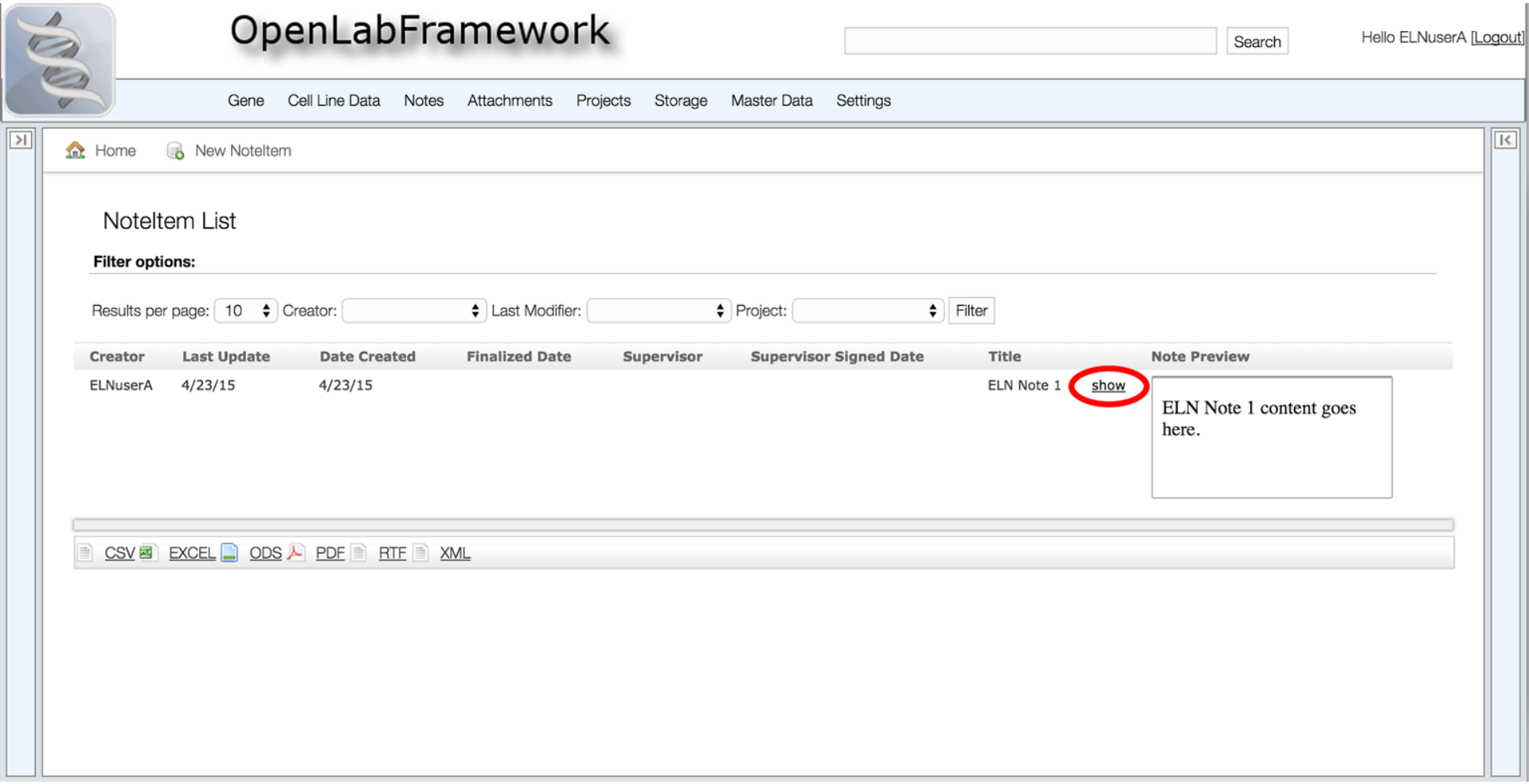
# Copy and Paste Images



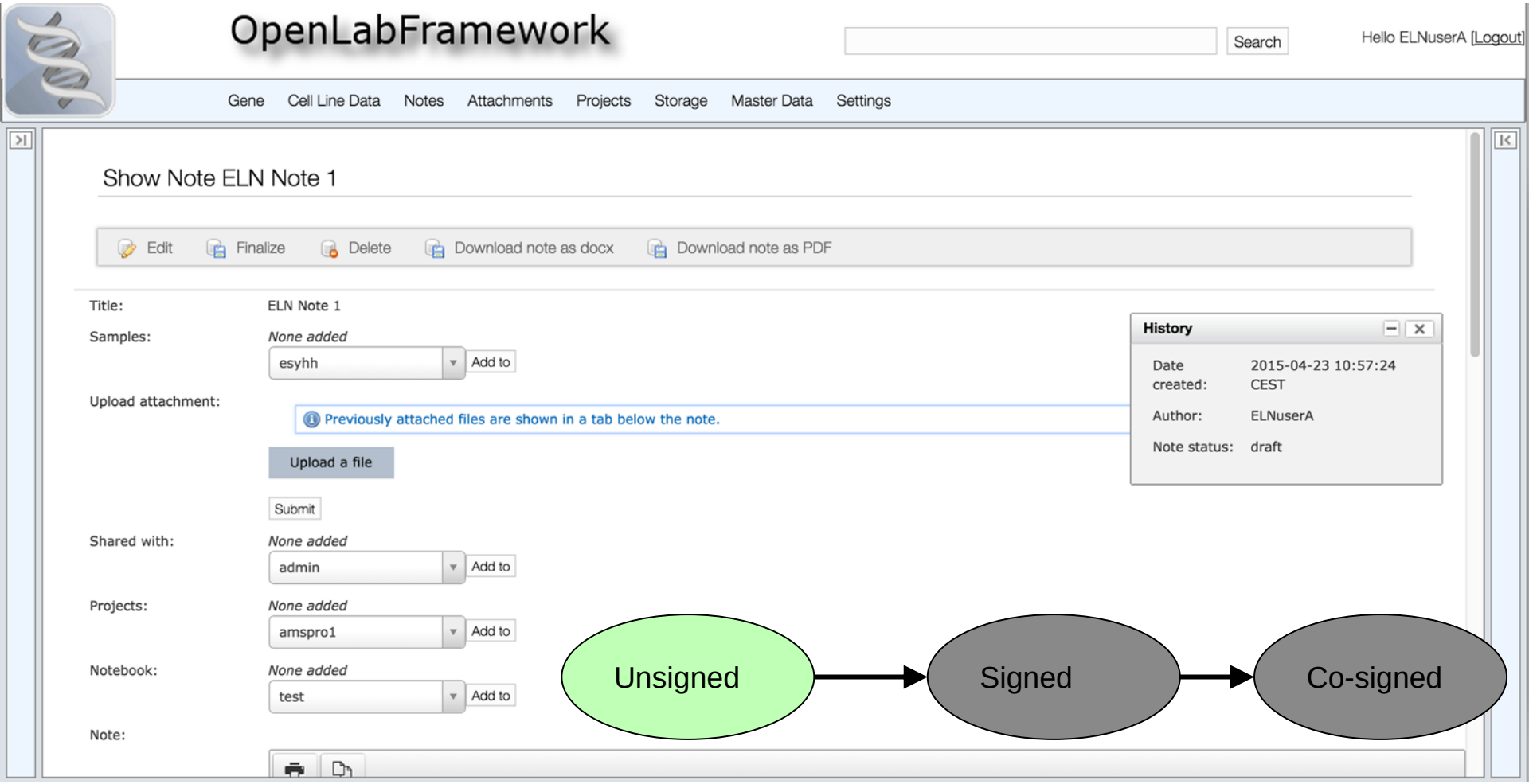




MS Office, Editor, Evernote, Web, ...

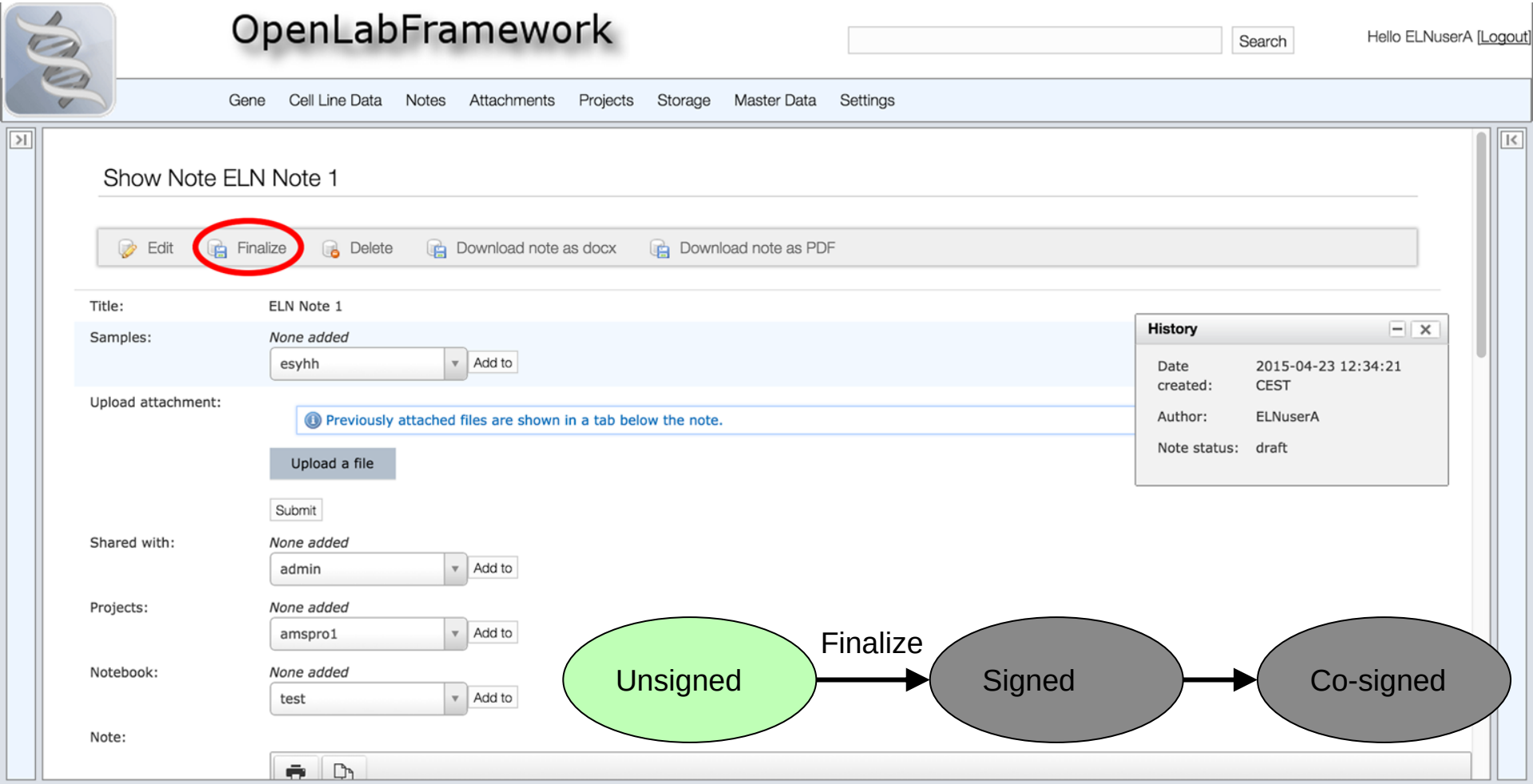
# List Notes


OpenLabFramework
Search
Hello ELNuserA [Logout]
Gene
Cell Line Data
Notes
Attachments
Projects
Storage
Master Data
Settings
Home
New NoteItem
NoteItem List
Filter options:
Results per page: 10
Creator:
Last Modifier:
Project:
Filter
Creator
Last Update
Date Created
Finalized Date
Supervisor
Supervisor Signed Date
Title
Note Preview
ELNuserA
4/23/15
4/23/15
ELN Note 1
show
ELN Note 1 content goes here.
CSV
EXCEL
ODS
PDF
RTF
XML

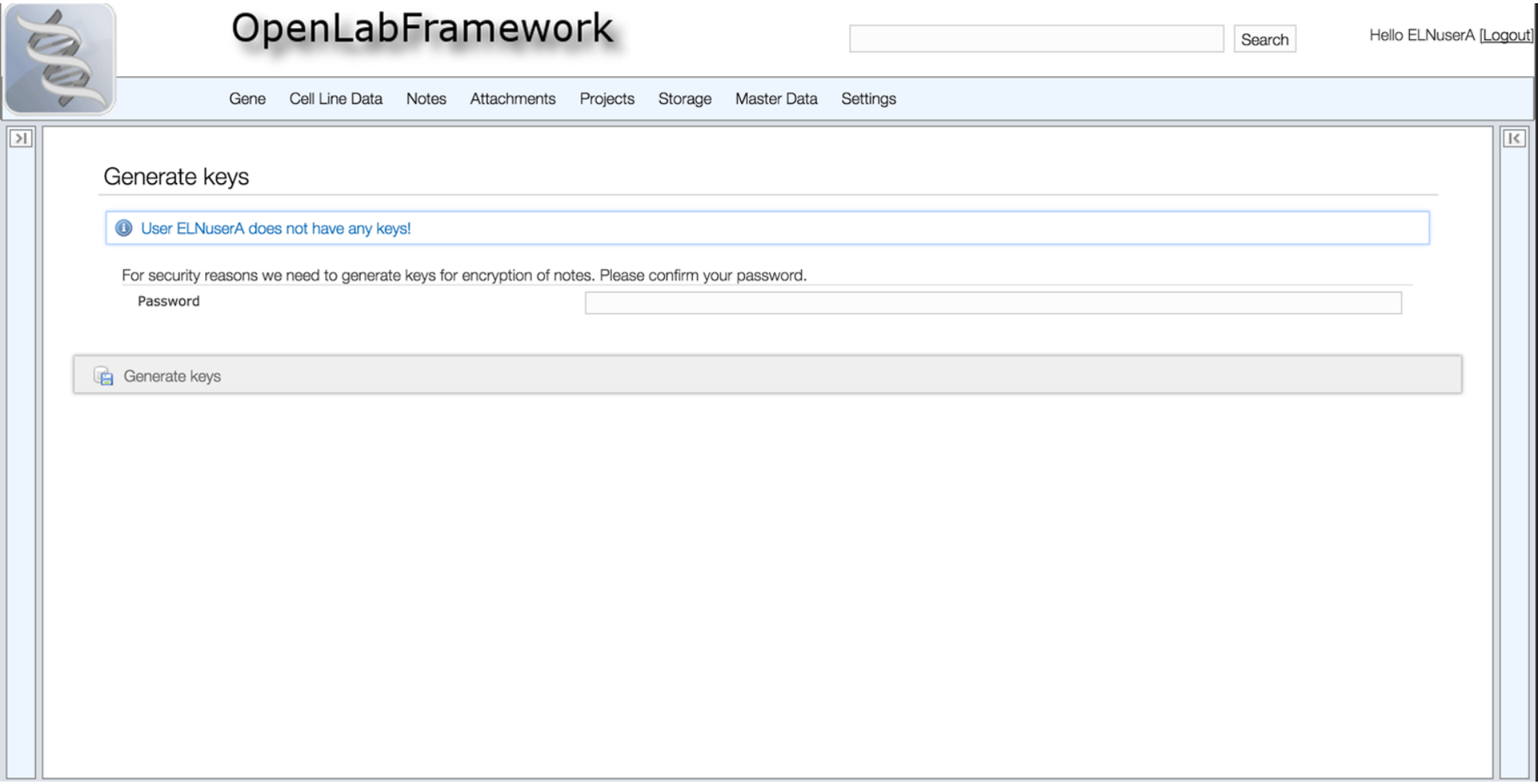
# Show Note


OpenLabFramework
Search
Hello ELNuserA [Logout]
Gene
Cell Line Data
Notes
Attachments
Projects
Storage
Master Data
Settings
Show Note ELN Note 1
Edit
Finalize
Delete
Download note as docx
Download note as PDF
Title:
ELN Note 1
Samples:
None added
esyhh
Add to
Upload attachment:
Previously attached files are shown in a tab below the note.
Upload a file
Submit
Shared with:
None added
admin
Add to
Projects:
None added
amspro1
Add to
Notebook:
None added
test
Add to
Note:
History
Date created:
2015-04-23 10:57:24 CEST
Author:
ELNuserA
Note status:
draft
Unsigned
Signed
Co-signed

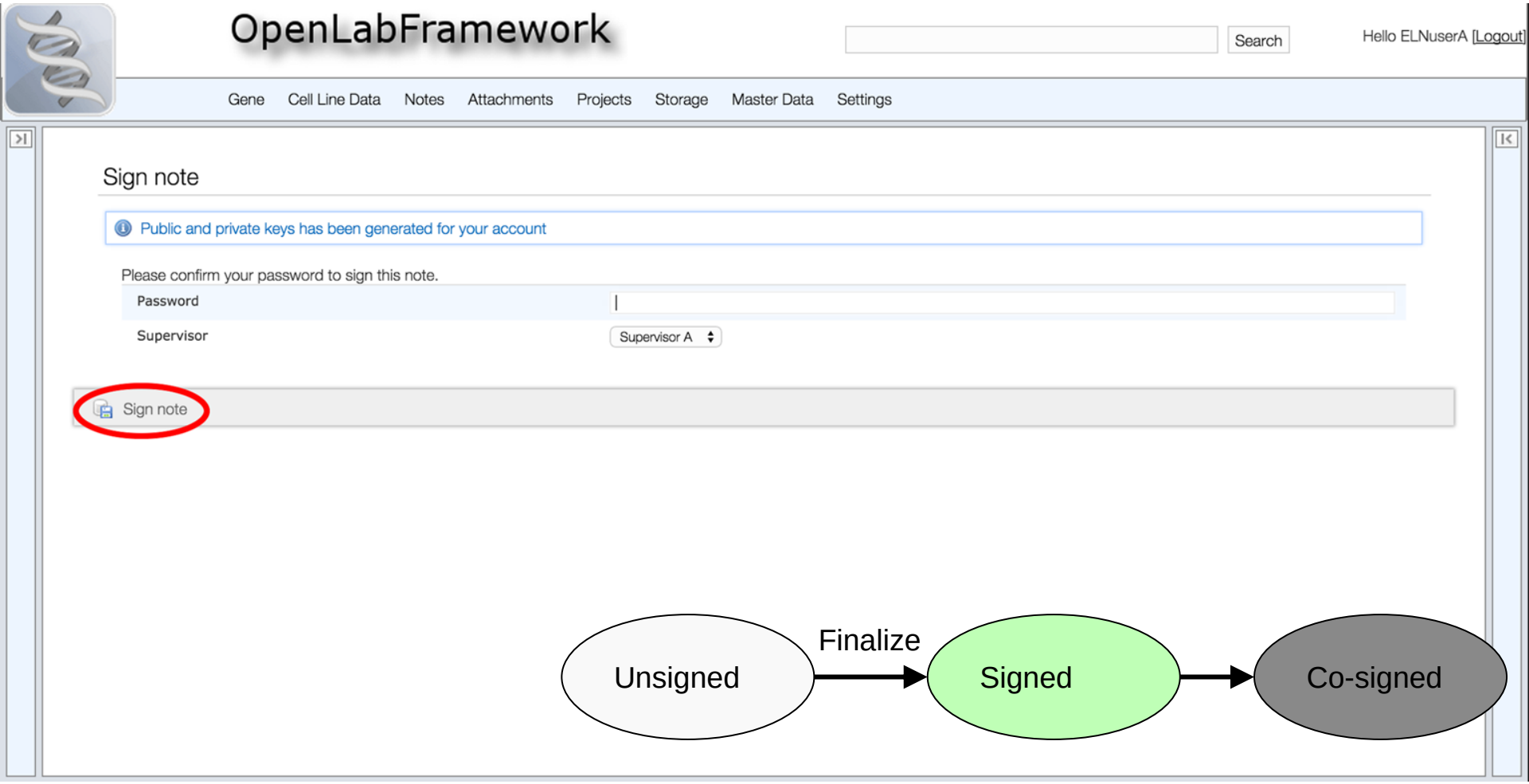
# Signing a Document



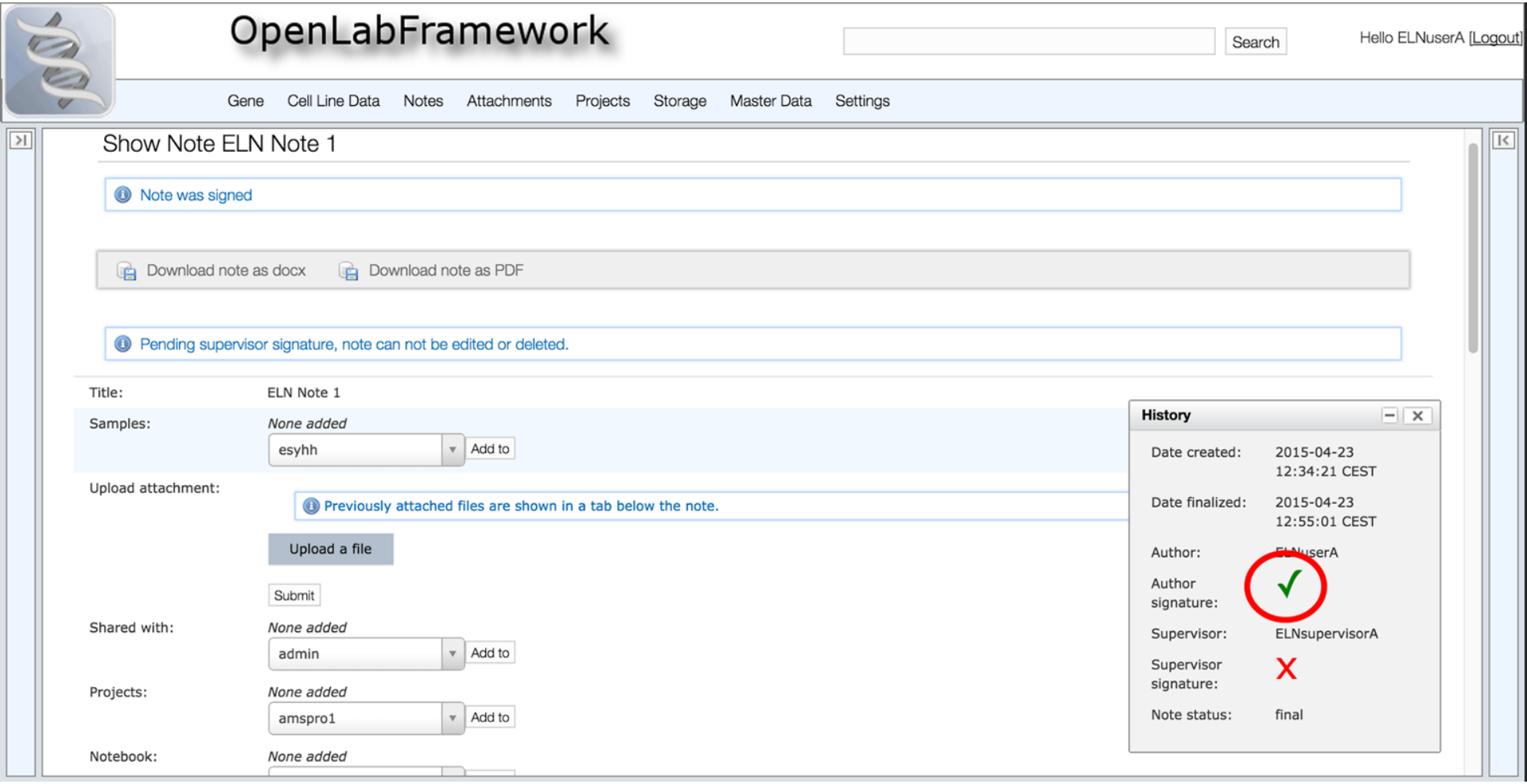
# Generate Public/Private Keys



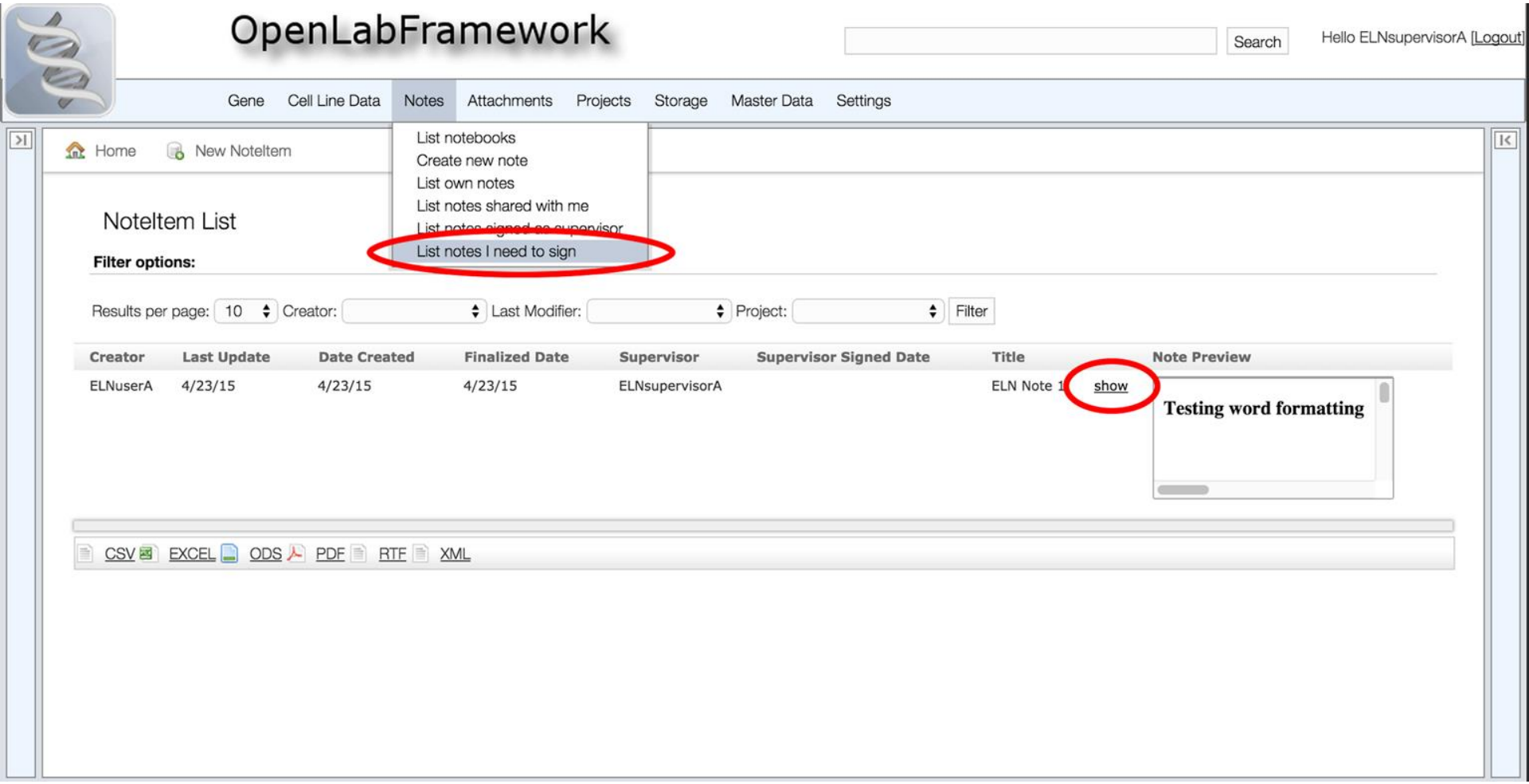
# Sign Note & Select Supervisor



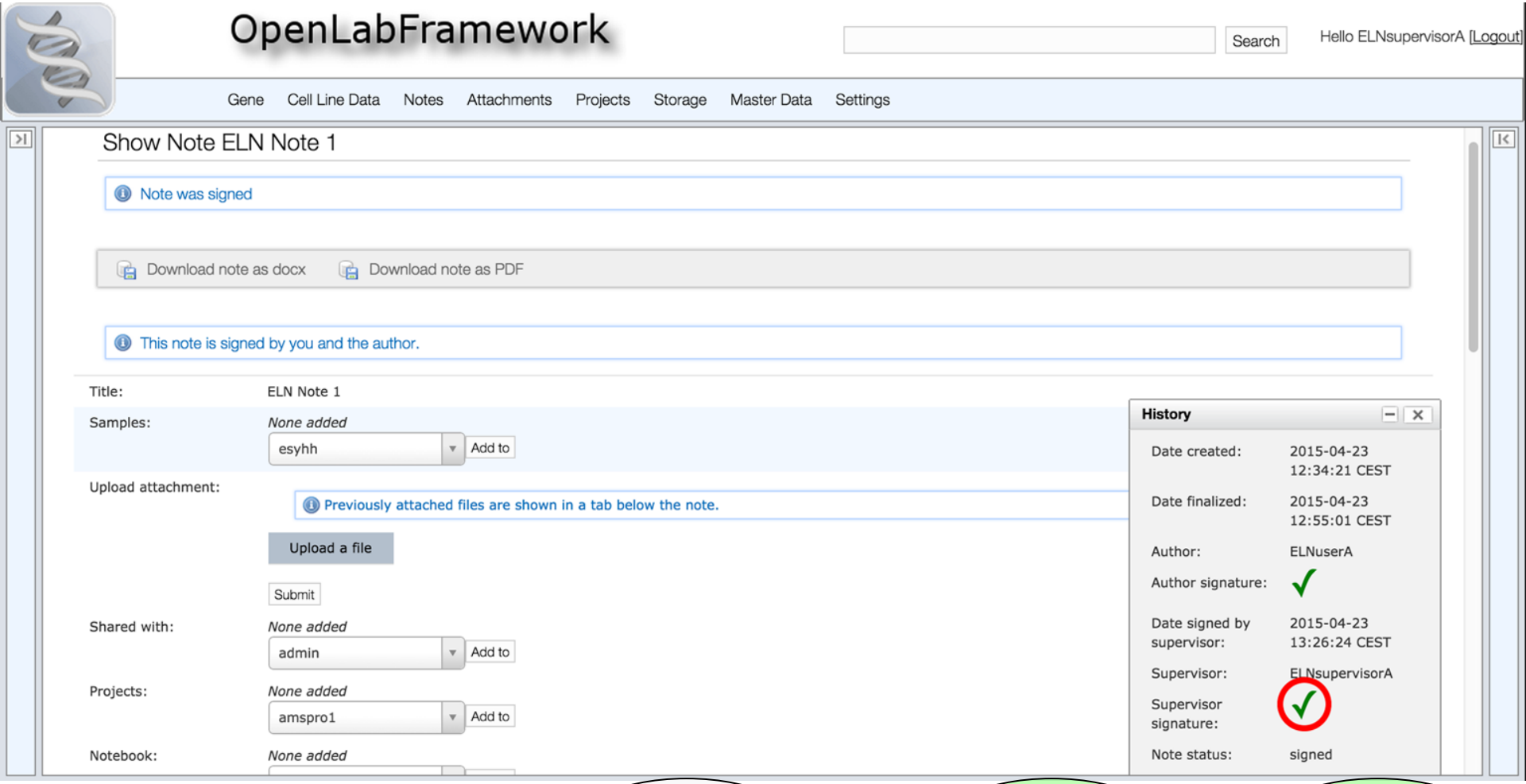
# Signature Checks



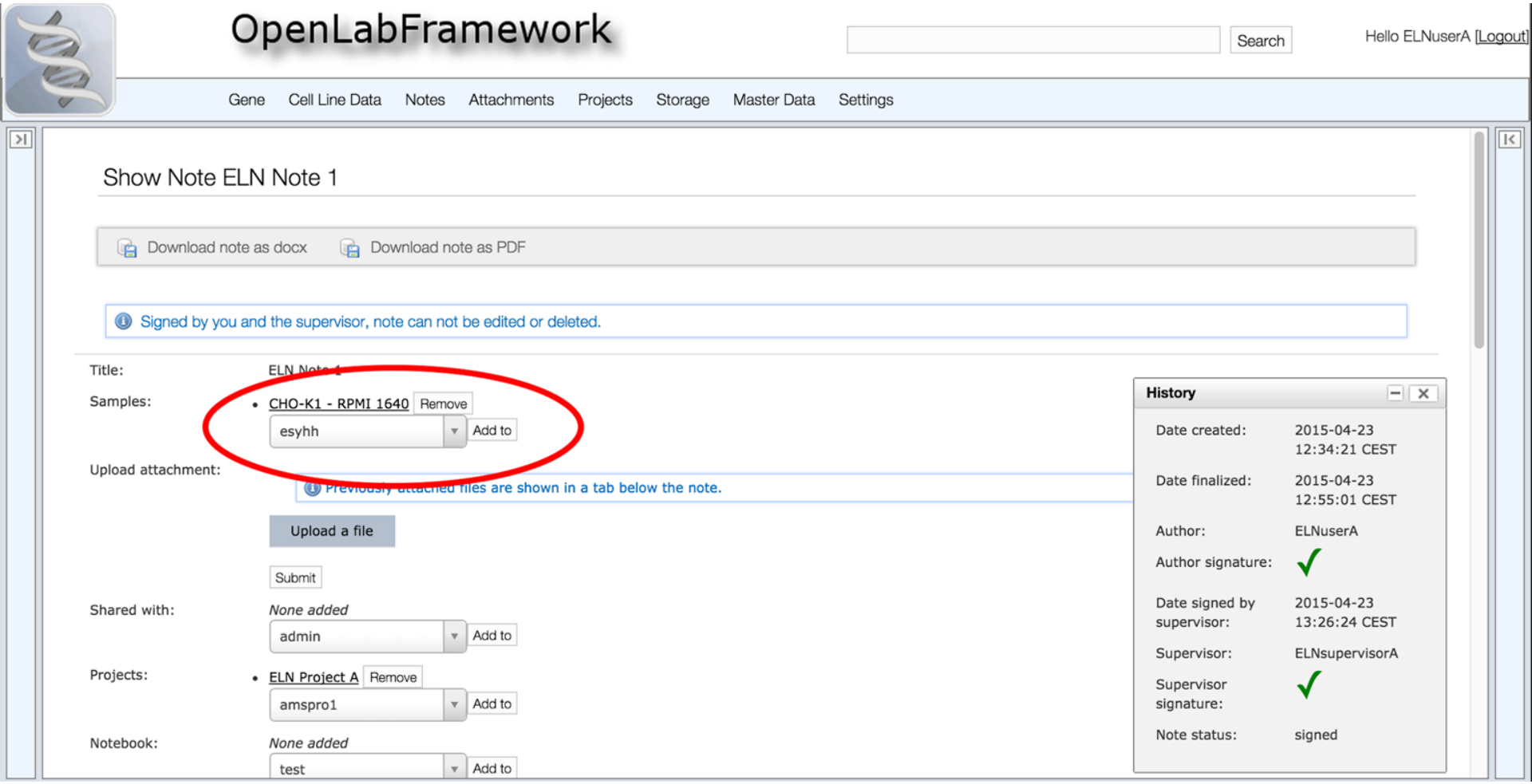
# Supervisor Signature



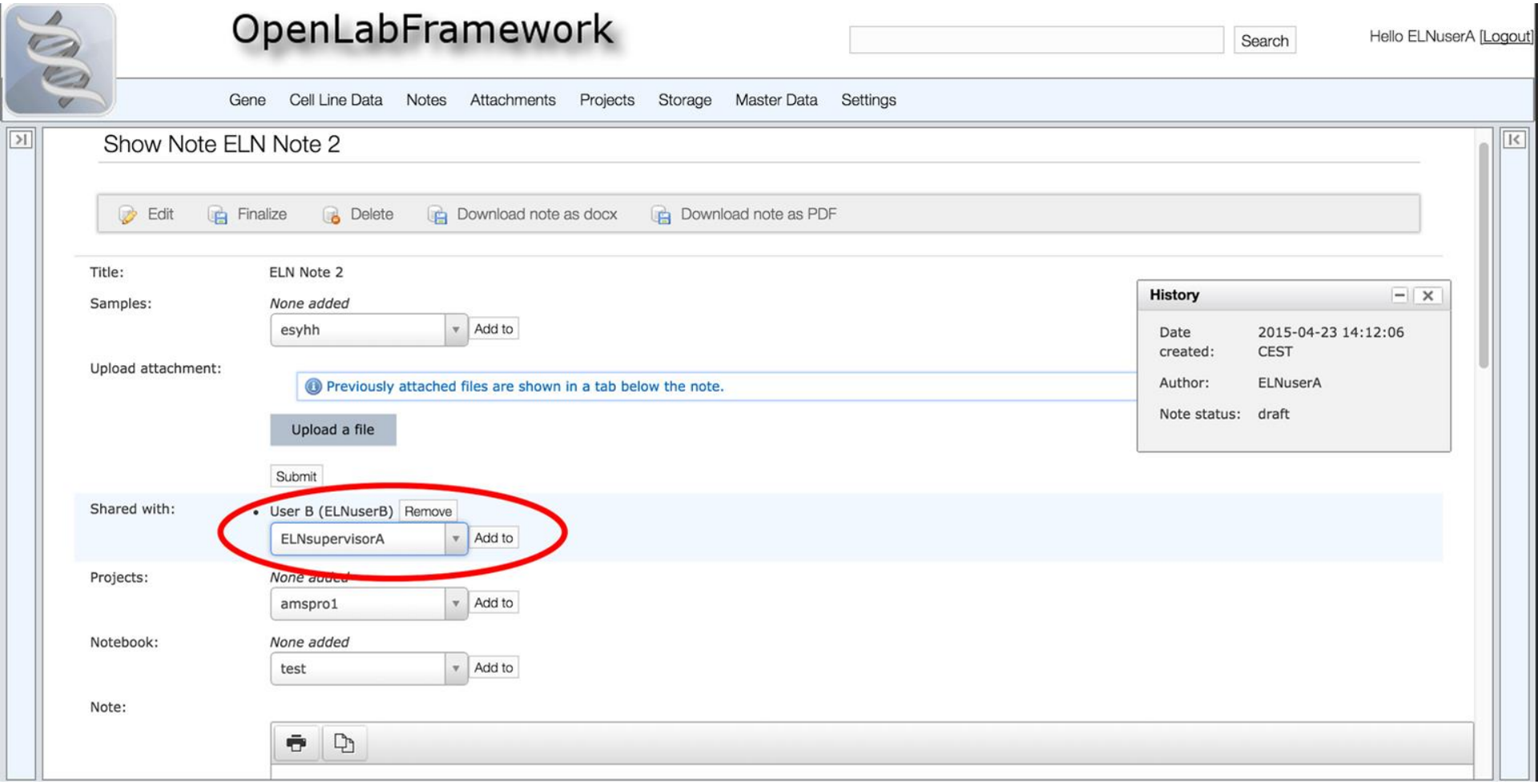
# Co-signed Document



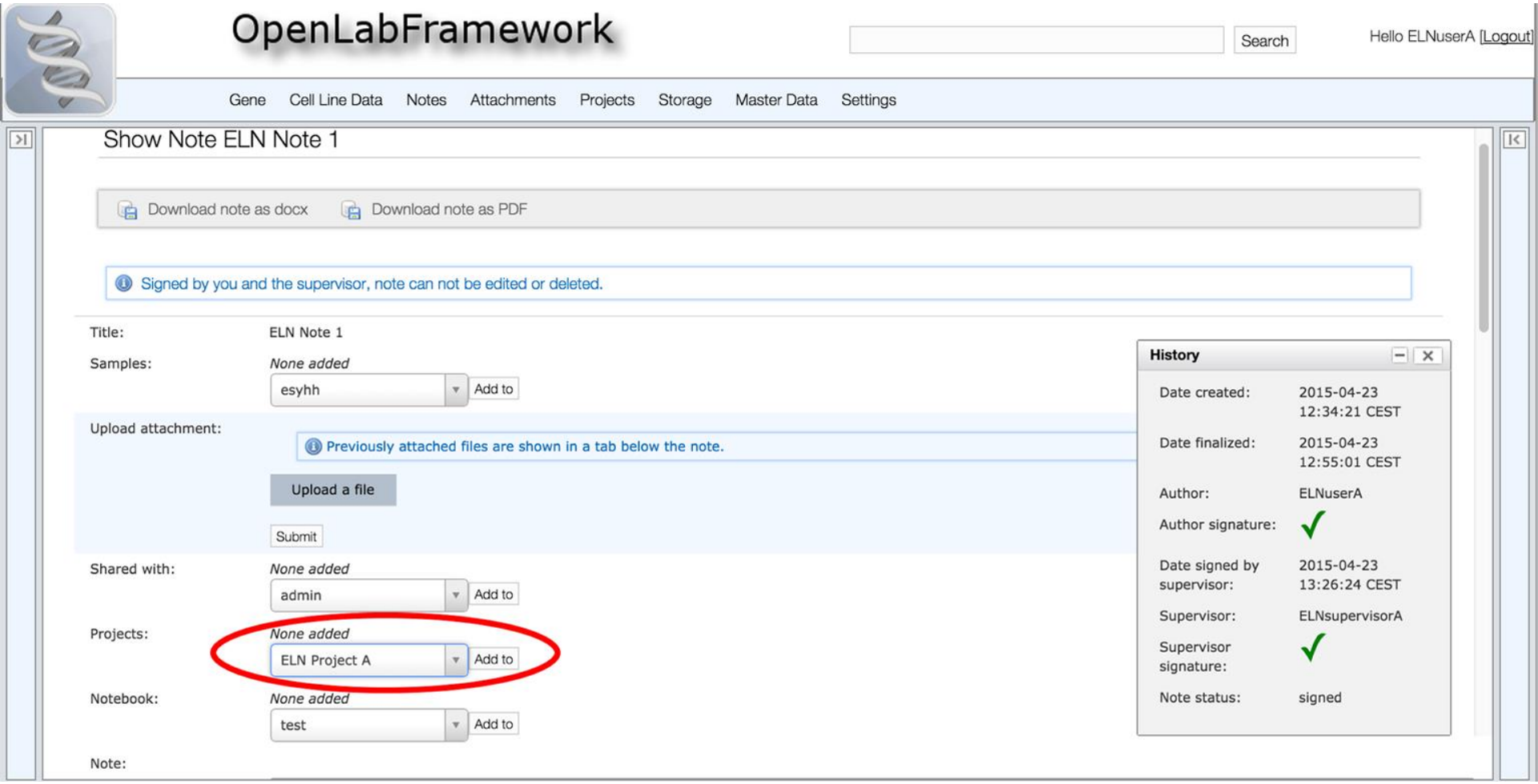
# Link Documents to Samples



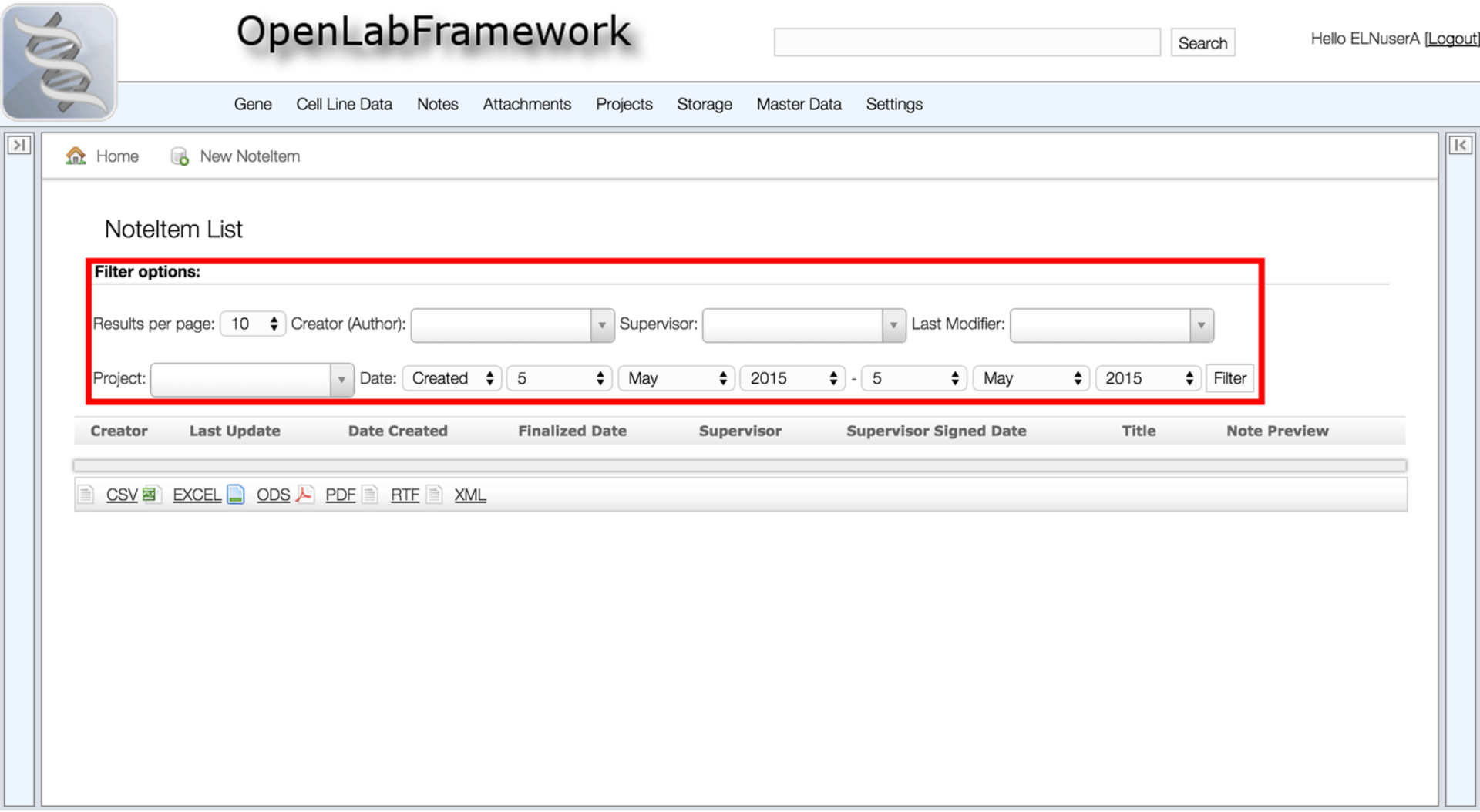
# Share Documents



# Add to Projects



# Filter Options



# Summary

Electronic Laboratory Notebooks will soon be standard for experimental research

Commercial solutions: Too expensive?

Free solutions: Data protection?

OpenLabNotes:

- Rich text editor
- Full text search and filter options
- Shareability and Export
- Digital signatures (co-signing)
- Documents organized in notebooks and projects
- Integrated with OpenLabFramework:
  - Direct reference to samples
  - Uploading additional documents
  - Single solution

# Open Challenges

Lack of integration with trusted authorities

ELN data format standard needed

More features:

- Editable copies of finalized documents
- Extend digital signature protection to attached documents
- User groups

Deployment challenging

Community adaptation

# Requirements & Availability

>= Java 6  with Java Cryptography Extension

Java web application server: Tomcat (6 or 7)

GitHub

https://github.com/NanoCAN/OpenLabFramework
https://github.com/NanoCAN/OpenLabNotes

docker

https://hub.docker.com/r/nanocan/openlabframework/

```
docker pull nanocan/openlabframework
```

# Acknowledgments

**Michael Franz**
Steffen Schmidt
Helle Christiansen
Jakub Trojnar
Mads Thomassen
Torben Kruse
Qihua Tan
Jan Baumbach
Jan Mollenhauer

LUNDBECKFONDEN

Rektorpuljen SDU2020

**Fonden til Lægevidenskabens Fremme**
***A.P. Møller og Hustru Chastine Mc-Kinney Møllers Fond til almene Formaal***

Region Syddanmark

Thank you for your attention