



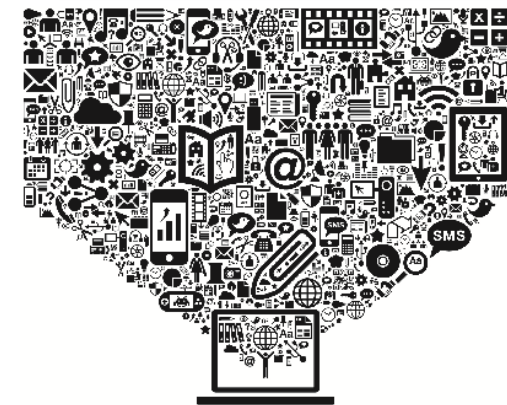
# Testing the Test



# Outline

## 1. Experiment 3

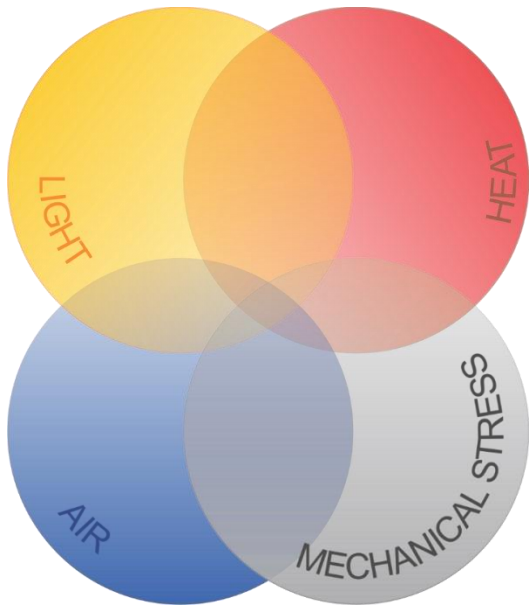
## 2. Databases



# Experiment 3: Testing the Test

## Description:

Comparison of degradation conditions using (close to) identical samples



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Consensus stability testing protocols for organic photovoltaic materials and devices

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ARTICLE INFO

ABSTRACT

Procedures for testing organic solar cell devices and modules with respect to stability and operational lifetime are described. The description represents a consensus of the discussion and conclusions reached during the first 3 years of the international consensus on OPV stability (IOS). The procedures include discussions for light, heat, humidity, mechanical, and radiation testing and thermal cycling testing, as well as guidelines for reporting data. These procedures are not meant to be

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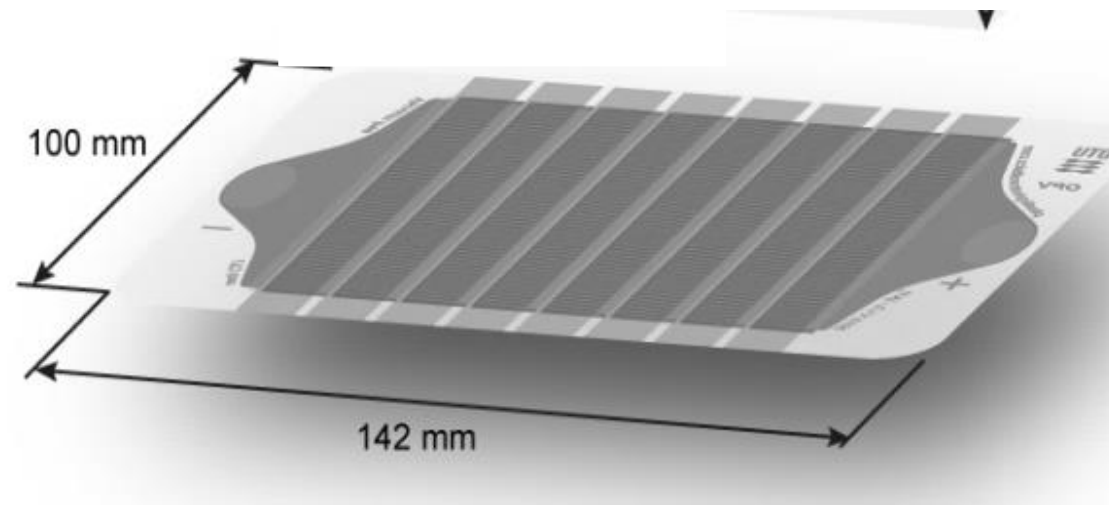
# Experiment 3: aim & approach

- Compare setups to execute stability studies according to ISOS protocols/guidelines by COST Action members (WG3)
- Compare different levels of protocols/guidelines
- Use highly reproducible samples with narrow standard deviation in performance as well as variation in processing conditions

# Experiment 3: Sample

DTU **module**

Or alternative ...



# Experiment 3: Aging conditions

## ISOS protocols, levels & conditions

ISOS protocol	level		
	1	2	3
Dark ISOS-D	'shelf'	T:65/85 °C	RH: 85%
Outdoor ISOS-O	Sunlight, ambient Solar sim MPP/V <sub>oc</sub>	Sunlight (in-situ)	Sunlight & solar sim. MPP
Lab. Weathering ISOS-L	Light soak, ambient	T:65/85 °C	RH: ~50%
Thermal cycling ISOS-T (dark)	T range: RT-65°C  Hot plate / Oven	Oven / Env. Chamber	T range: -40 - 85 °C RH: ~55% Env. chamber
Solar-therm.-hum. ISOS-LT	Solar/thermal cycling Light soak T range: RT-65°C  Weathering chamber	S/T/Humidity  T range: 5-65 °C RH: ~50% Env. cham+solar sim.	S/T/H/Freeze  T range: -25 - 85 °C

# Experiment 3: Aging conditions

## ISOS protocols, levels & WG3 members

ISOS protocol	1	level 2	3
Dark ISOS-D	Rudjer B Institute ICCF	TU Ilmenau Tech. Uni. Cartagena	TÜBITAK NPL
Outdoor ISOS-O	UNAM Wroclaw Research Centre EIT+	ICN2 U. Ilmenau	IADP ev
Lab. Weathering ISOS-L	Mcast Vilnius University		
Thermal cycling ISOS-T (dark)	Uni Rovira I Virgili Uni. Oxford		
Solar-therm.-hum. ISOS-LT	ICL, KAU		DTU Bangor Uni.

To be completed with you!

# Experiment 3: Structure

Fabrication (WG2): DTU / ...

Degradation:  
Aging according to  
ISOS D, O, L, T, LT  
  
@ all groups WG3  
groups

Data  
analysis

Joint  
decision

Non-destr.  
Char. (WG4)

Destr. Char.  
(WG5)



# Experiment 3: Timeline

Prep.: groups, samples, setups, database(s),  
file formats, conversion tools (Nov. – Dec.)

Processing  
&  
WG3 groups  
Jan

Distribution  
& Database  
Jan

ALT  
Feb

Data  
Analysis  
April

(non)  
Destructive  
Characterization  
April - June

# Experiment 3 - (detailed) protocol

## Experiment document

ISOS-5 Round Robin  
Protocol for testing device performance

Read through this document before performing the measurements:

Introduction									
<b>Sample Description</b>	<p>A suitcase (36.1 x 28.9 x 16.5 cm) will be delivered, which contains three roll to roll coated organic photovoltaic modules and a polycrystalline Si module. All the samples are fixed on a platform. The following items are included in the suitcase:</p> <ul style="list-style-type: none"><li>Platform with samples (contains 4 samples)</li><li>Integrated Thermocouple</li><li>Rods for angle adjustments</li><li>Multimeter</li><li>Connection wires</li><li>Spare battery</li><li>Copy of the protocol</li><li>Copy of the illustrated measurement procedure</li><li>Short version copy of the reporting form</li><li>A letter describing the content and the purpose of the suitcase (for the customs)</li></ul>								
<b>Sample Dimensions</b>	<table><tbody><tr><td>Medium OPV module labeled "Cell 1":</td><td>9 x 10 cm</td></tr><tr><td>Small OPV module labeled "Cell 2":</td><td>5 x 10 cm</td></tr><tr><td>Large OPV module labeled "Cell 3":</td><td>13 x 13 cm</td></tr><tr><td>Si module labeled "Si ref cell":</td><td>8 x 15 cm</td></tr></tbody></table>	Medium OPV module labeled "Cell 1":	9 x 10 cm	Small OPV module labeled "Cell 2":	5 x 10 cm	Large OPV module labeled "Cell 3":	13 x 13 cm	Si module labeled "Si ref cell":	8 x 15 cm
Medium OPV module labeled "Cell 1":	9 x 10 cm								
Small OPV module labeled "Cell 2":	5 x 10 cm								
Large OPV module labeled "Cell 3":	13 x 13 cm								
Si module labeled "Si ref cell":	8 x 15 cm								
<b>Sample Transportation</b>	<p>The sample shipment date will be correlated with the receiving party prior to the shipment and the partner will receive a notification on the day of shipment. The testing of the samples should be performed as soon as possible when the suitcase is received. The suitcase has to be shipped onward to the next party in the RR loop after receiving the data approval and the corresponding shipping address from the RR coordinators. A notification email has to be sent to the next receiving party with information about the shipment (forward the email to the coordinators of RR at <a href="mailto:roundrobin@plasticphotovoltaics.com">roundrobin@plasticphotovoltaics.com</a> as well).</p>								
<b>Outdoor Conditions</b>	<p>Measurement as close to noontime as possible is recommended. Maximum of one week is given to each participant for choosing a day with the best weather forecast (clear sky). If NO good weather is achieved within the given week, then contact the coordinators for</p>								

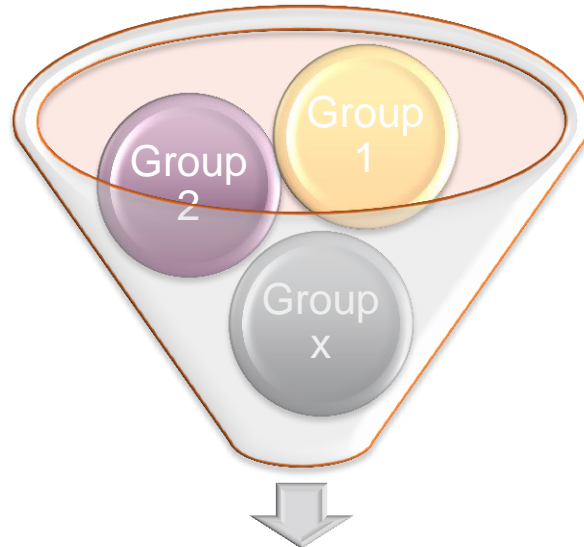
Page 1 of 4

Aim,  
Approach,  
Sample,  
Contacting,  
Measurement details,  
Reporting format,  
Equipment, settings,  
Timeline,  
Data analysis

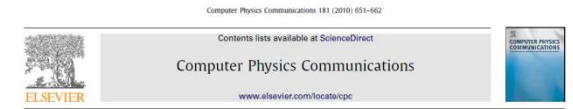
Gevorgyan, DTU,  
ISOS 6, Chambery, 2013

# Experiment 3 - Reporting

Reporting data									
*Measurement place	ECN, Netherlands								
*Measurement conducted by	Wiljan Verhees ( <a href="mailto:verhees@ecn.nl">verhees@ecn.nl</a> )								
*Measurement date	08.03.2012								
Specimen producer and number	ISE Si PD007 2010								
Specimen description	Si photodiode encapsulated in a special holder with an integrated RTD sensor. Both PV and RTD require LEMO connectors for measurement. LEMO connector is supplied with specimen for PV (4-point) measurement, but not for RTD.								
Mismatch factor	0.995								
PV parameters	<table border="1"> <thead> <tr> <th>Isc (mA)</th> <th>Voc (V)</th> <th>FF (%)</th> <th>Pmax (mW)</th> </tr> </thead> <tbody> <tr> <td>13.28</td> <td>0.621</td> <td>80.2</td> <td>6.62</td> </tr> </tbody> </table>	Isc (mA)	Voc (V)	FF (%)	Pmax (mW)	13.28	0.621	80.2	6.62
Isc (mA)	Voc (V)	FF (%)	Pmax (mW)						
13.28	0.621	80.2	6.62						
Active Area	1 cm <sup>2</sup> (provided by producer)								
Masking	No masking applied								
Additional PV parameters	<table border="1"> <thead> <tr> <th>Jsc (mA/cm<sup>2</sup>)</th> <th>PCE (%)</th> </tr> </thead> <tbody> <tr> <td>13.28</td> <td>6.62</td> </tr> </tbody> </table>	Jsc (mA/cm <sup>2</sup> )	PCE (%)	13.28	6.62				
Jsc (mA/cm <sup>2</sup> )	PCE (%)								
13.28	6.62								
Device Temperature during meas.	26.8 ± 0.2 °C								
Connection type	4-point measurement								
Reporting additional data									
Light source spectrum	Class AAA (Wacom)								
Reference device type	RSID2 solar cell with KG3 filter								
IV scan range	-1 V to +1 V (101 points)								
Spectral response measurement	No bias light, Chopper frequency 73 Hz								
Temperature measurement	RTD sensor integrated inside specimen								
Deviations from protocol	XXX								
Comments	XXX								



Database (Rera & DTU)



## On the communication of scientific data: The Full-Metadata Format

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**ABSTRACT**  
 In this paper, we introduce a scientific format for text-based data files, which facilitates storing and communicating tabular data sets. The so-called Full-Metadata Format builds on the widely used INI-standard and is based on four principles: readable self-documentation, flexible structure, fail-safe compatibility, and searchability. As a consequence, all metadata required to interpret the tabular data are stored in the same file, allowing for the automated generation of publication-ready tables and graphs and the semantic searchability of data file collections. The Full-Metadata Format is introduced on the basis of three comprehensive examples. The complete format and syntax are given in the appendix.  
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### 1. Introduction

In the last few years an increasingly sophisticated experimental infrastructure has evolved enabling scientists to share not only knowledge but also primary data via scientific publications [1–3]. With this increase in sharing primary or processed scientific data the lack of intuitive and well defined data formats for simple tabular data has become increasingly obvious. For complex data sets like those dealt with in the earth sciences, adequate binary formats like the Network Common Data Form (netCDF [4]) or the Hierarchical Data Format (HDF [5]) are well established [6], and the publication of observational geophysical data in World Data Centres has developed into an effective mechanism for data exchange [8]. Another example is the information technology infrastructure for handling the data of the ATLAS experiment [9], where the event data is mainly stored in the ROOT file format [10]. For less complex data structures, like tabular which are typically encountered in many parts of natural and technical sciences, no single standard format has evolved.

The success of the HDF and netCDF relies on the fact that these formats are well defined and integrate smoothly into the workflow of scientists in different laboratories. Although these formats are capable of storing and documenting simple tabular data, the

overhead of work needed to process binary files generally poses a barrier to the use of these formats in fields where complex data structures are seldomly dealt with.

A natural requirement of a standardized file format for tabular data is that it allows scientists to add observations, notes, parameter specifications and analysis results by editing in clear text using any given text editor. This constitutes what most of the data formats used in laboratories around the world have in common. However, as text files are easy to handle, every laboratory, working group or even scientist has an individual format of documenting scientific results with text-based formats. While this is completely sufficient in a short term perspective, it becomes intractable with the tendency of research projects to rely on the cooperation of international consortiums involving many different laboratories. Furthermore, in publishing scientific results, there is an increasing demand to also provide processed data as supplementary data or even to publish primary data in OpenData repositories [2]. Thus, there is a need for a common data format for tabular data which is:

**Readable and self-documented:** The data should be written in the same way the scientist is accustomed to reading it, as e.g. in a laboratory notebook. It should be clear, text based and processable with any word processing tool. The file format should include sections which allow the scientist to document the data and its origin, and this to such an extent that no other source be re-

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 doi:10.1016/j.cpc.2009.11.014

From: Rera systems  
 Maritz Riede  
 Verhees, ECN

# Outline

1. Experiment 3

2. Database

**RERA SOLUTIONS**  
PV MEASUREMENT SYSTEMS

# **ReRa Solutions**

**PV-DB Experiment storage system**

# Situation

Each member generates measurements on samples/modules

This can be all sort of measurements: EQE, IV, EL, HALL, and many more

It is very complicated to define one format to be used by everybody for all measurement setups using fixed fields and records

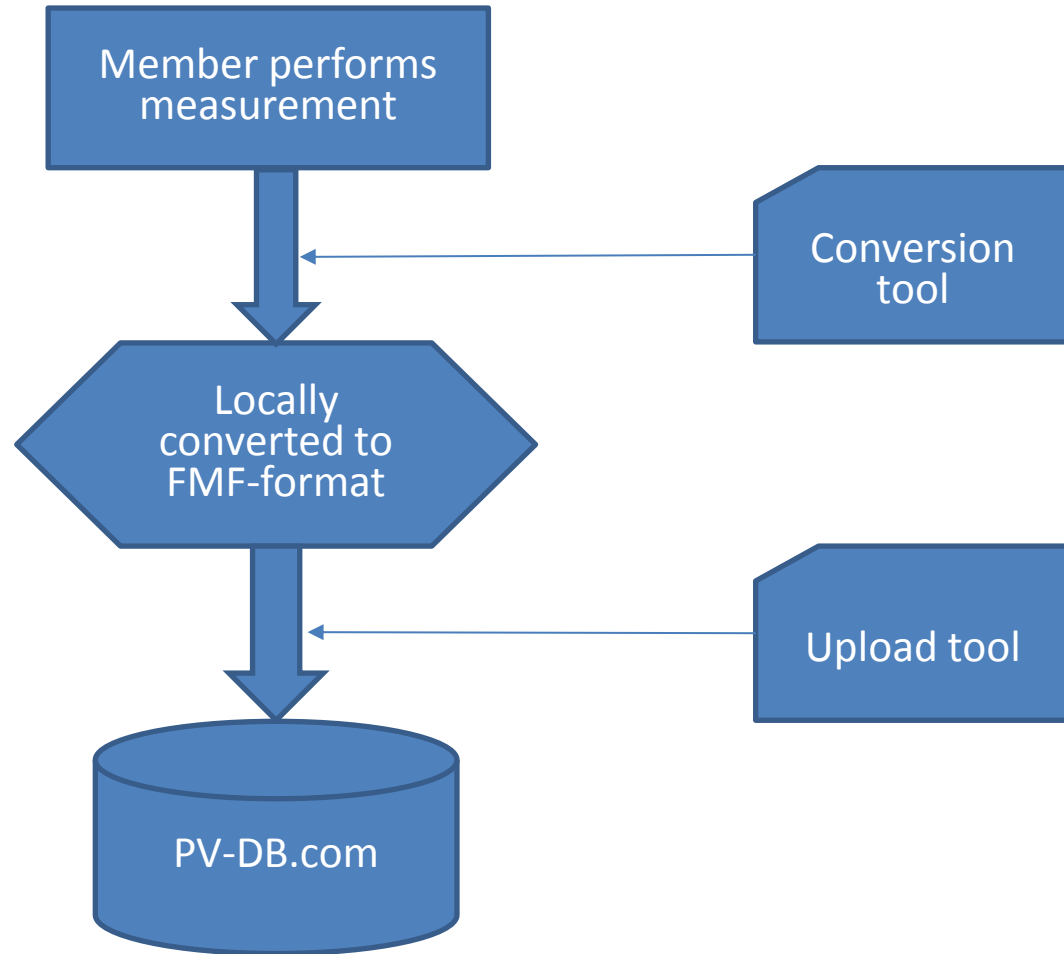
Solution: Full-Metadata Format (FMF) by Moritz Riede et al. This is a self documenting, flexible format to store tabular data

ReRa operates an online storage system for these files: [www.pv-db.com](http://www.pv-db.com)

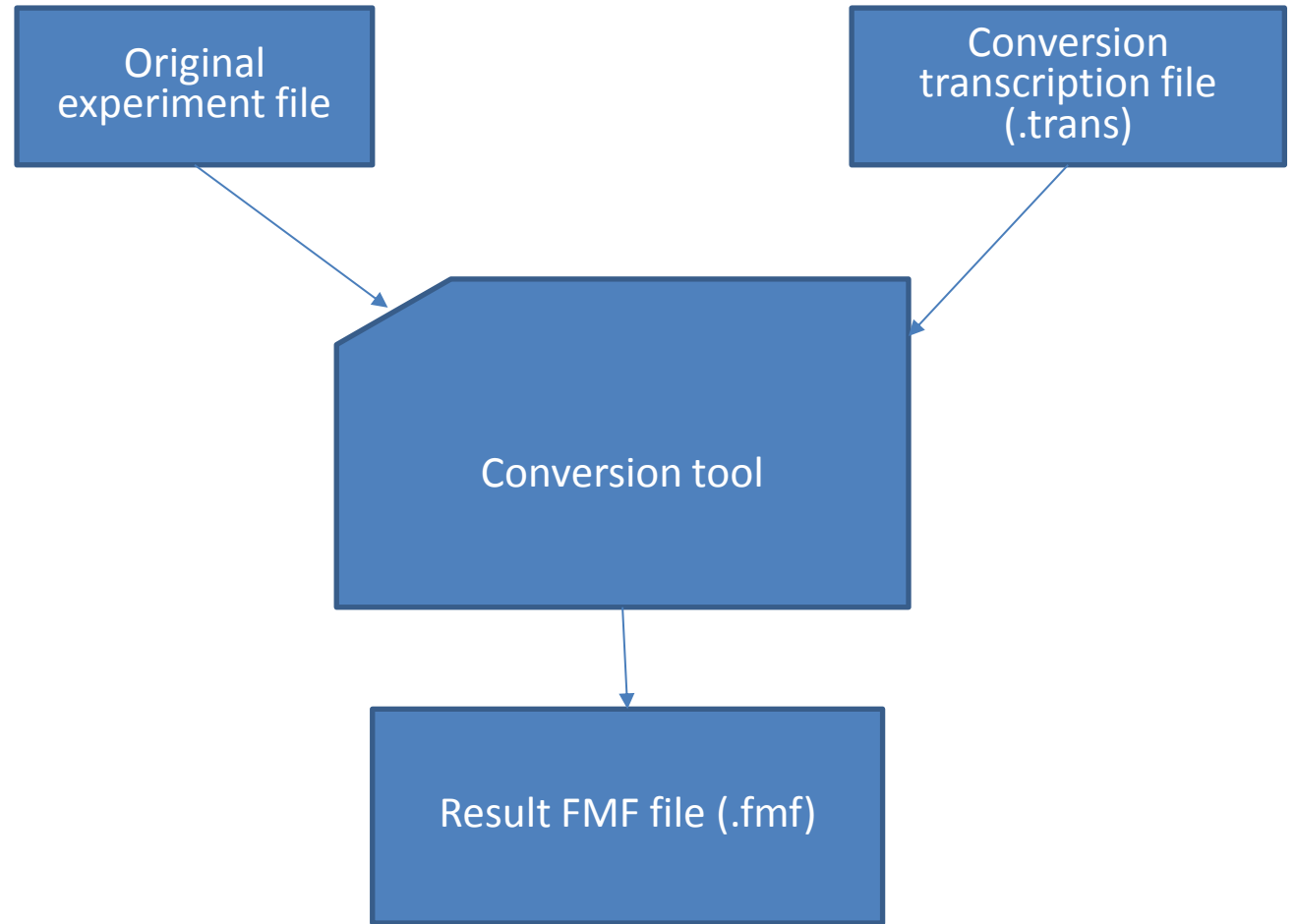
First focus: **Get the data in there!**

Second: Analyze and visualize the data

# Dataflow



# Conversion tool





# Experiment types

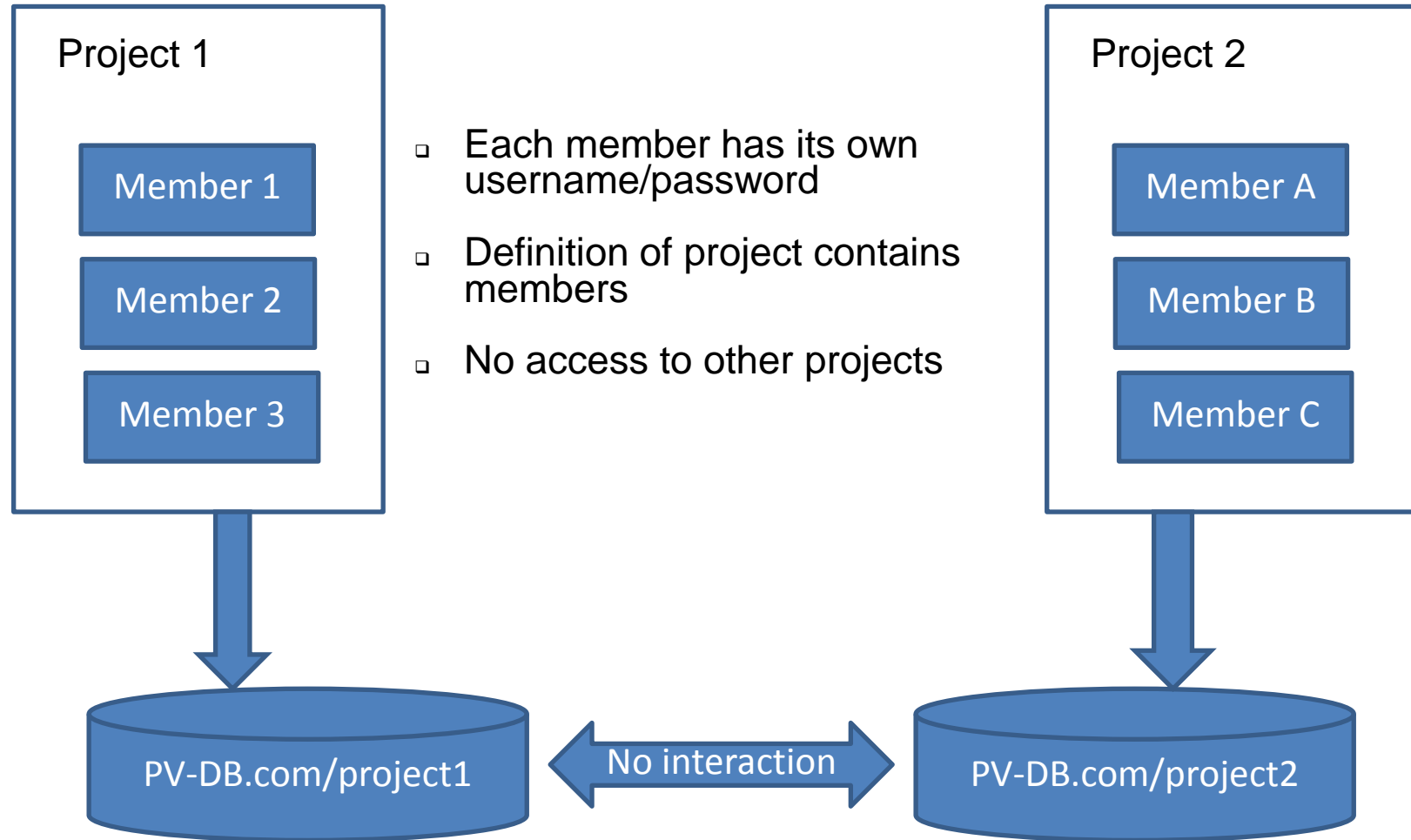
- We need to define some common experiments and their fmf representation (EQE, IV, EL, HALL??)
- In principle any fmf file can be stored, but if the structure is unknown it is difficult to represent the contents

# Agreements

Flexible format is nice, but some agreements should be made in order to search and analyze the data

- Sample name
- Measurement types
- Header format
- Fixed fields
- This needs to be defined in a document

# Authentication



# Access rights

- Each project has 1 Experiment Coordinator (EC), which is one of the members.
- The EC has read/write access to all files in the project
- The EC can add/remove other members and apply read/write access rights.
- A member always has read/write access rights on its own files
- A member only has read access on the other members' files when this is allowed for by the EC