PVcomB
Competence Centre Thin-Film- and Nanotechnology for Photovoltaics Berlin

HZB Helmholtz Zentrum Berlin

Handling of research data at PVcomB

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Outline

- Research at PvcomB
- Types of research data
- Traditional meta data handling
- Handling of data and meta data by Elab and PDVisA

Solar Energy Research at PVcomB

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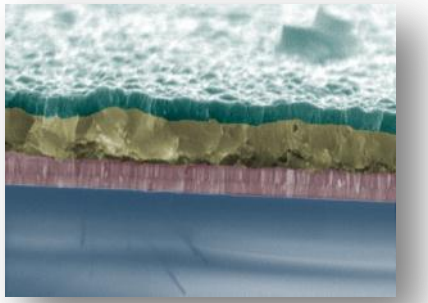
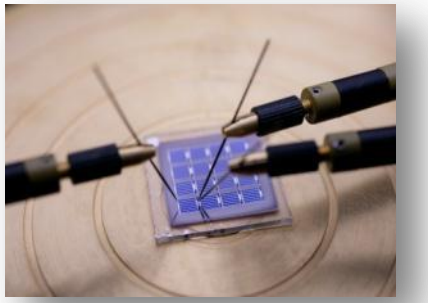
TRL 1 2 3 4 5 6 7 8 9

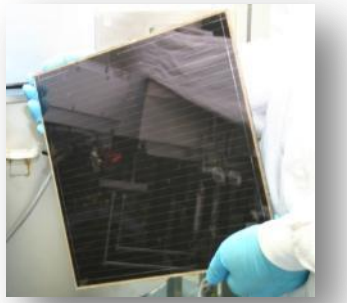
PVcomB

Fundamentals | **Development** | **Technology Transfer** | **Industrial Partners**

Discovery & Feasibility | Development & Validation | Integration into partner‘s system





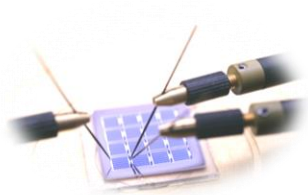


Topics

- Next Generation Solar Cells → CIGS, Si HJT, TF silicon & tandem concepts (e.g. Si/CIGS + perovskites)
- Water splitting → Solar Fuels
- Advanced Analytics → surface diagnostics, microscopy, in-situ XRD/XRF, XPS, XAS, XES (@BESSY)
  → materials, films & devices
  → field analyses of modules

Solar Energy Research at HZB

Fundamental Research



- novel device concepts
- improved conversion efficiencies
- cost effective solutions
- environmental sustainability & recycling

Technology Transfer

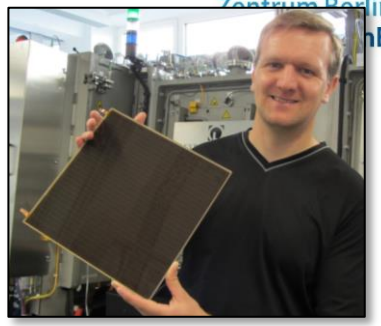
e.g. industrial inline sputter system (Leybold Optics)

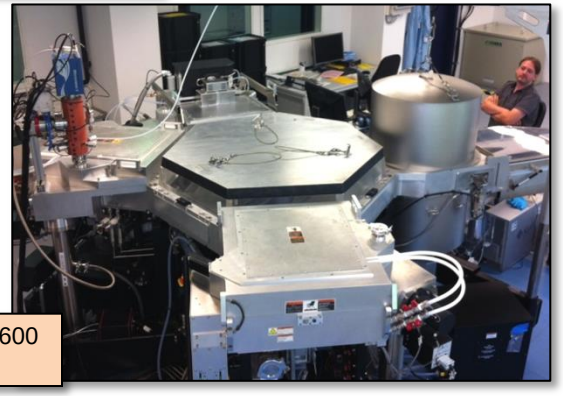
e.g. industrial 3 chamber PECVD deposition system (Applied Materials)

- up-scaling
- industry-oriented technologies
- complete modules
- advanced process analytics
- throughput & reliability
- education

Baseline concept for 30 x 30 cm² CIGS & silicon modules

Sputter Line A600 V7
Leybold Optics





PECVD cluster AKT1600
Applied Materials

Si Baseline

Glass substrates

Glass cleaning

ZnO:Al sputtering front contact

TCO coated glass

Cleaning

Etching

P1 laser scribe

Mo sputtering back contact

Cleaning

CIGS Baseline

P1 laser scribe

Cu/In /Ga sputtering

Active selenization and RTP

Chemical Bath Deposition CdS/KCN

Si deposition

P2 laser scribe

ZnO/Ag sputtering back contact

P3 laser scribe

P2 scribe

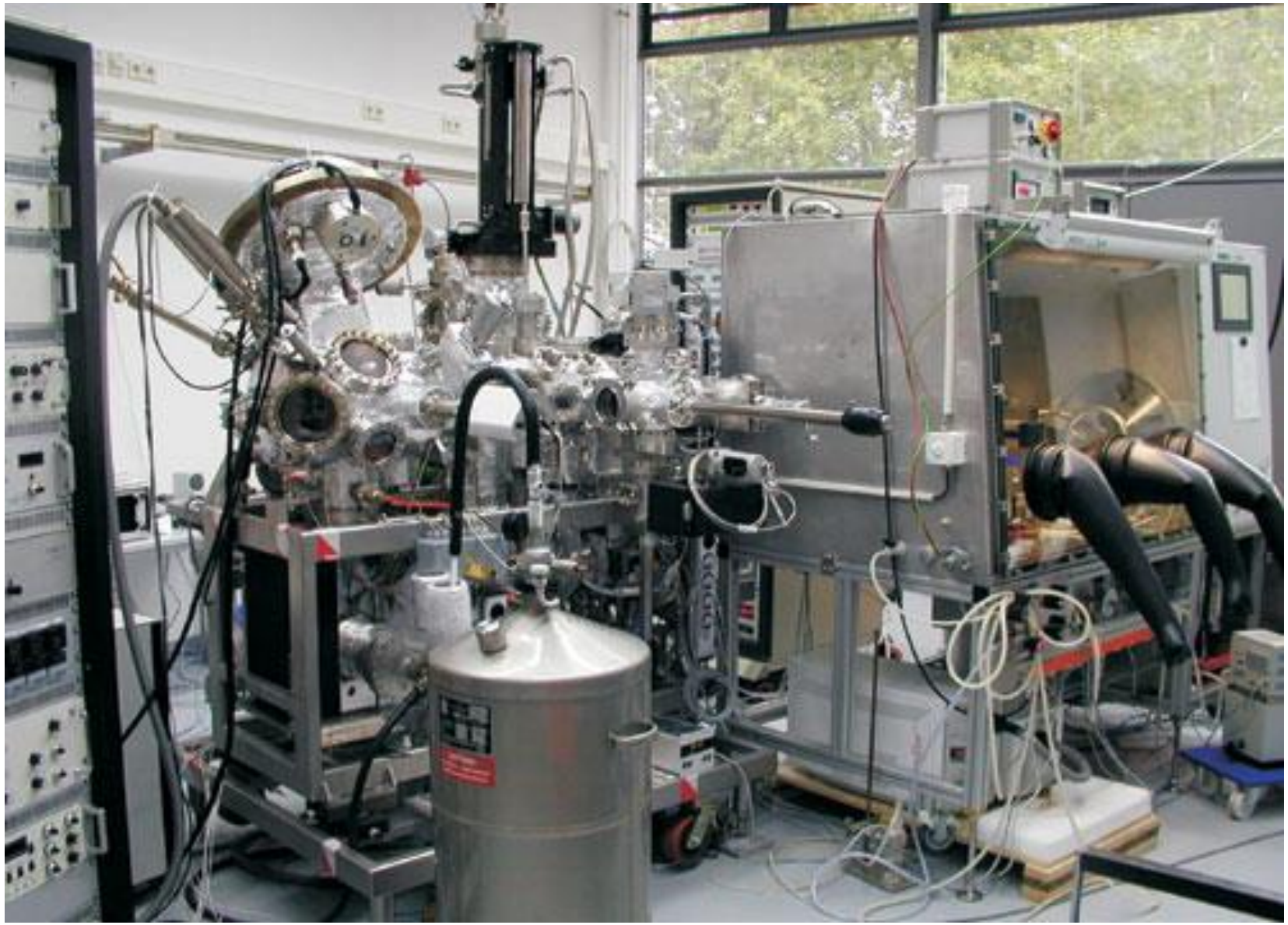
ZnO: i-ZnO sputtering front contact

P3 scribe

Encapsulation

Atmospheric pressure inline RTP
Smit Ovens

Surface analysis



THE PVCOMB OUTDOOR TEST FIELD

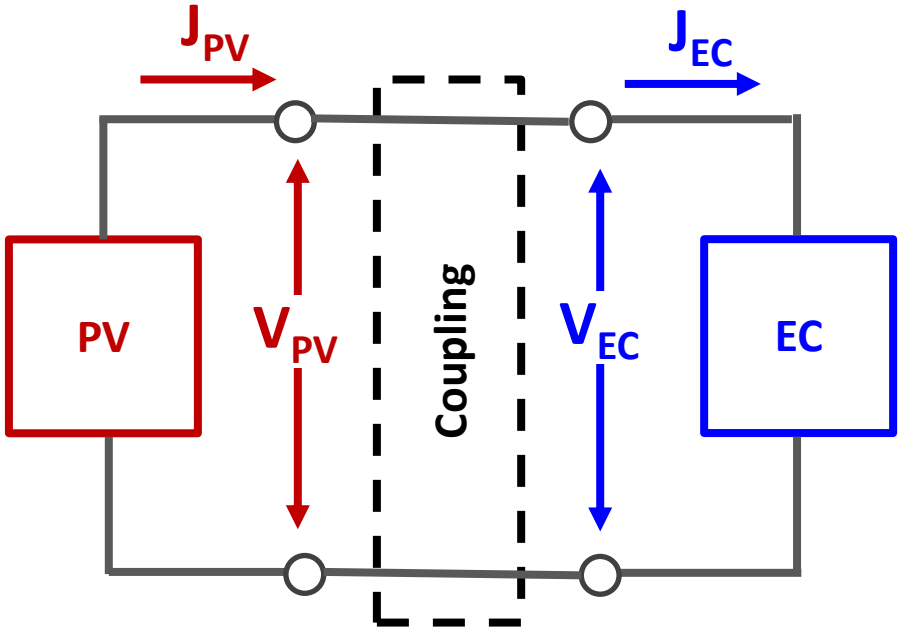
- Installation of flexible outdoor test field for solar modules (lab scale and industrial)
- Outdoor analyses of solar modules from in-house development and partners
- Complementary in- and outdoor characterization (IV, EL, thermography, low-light conditions, BIPV…)
- Public projects and bilateral partnerships.

PV-to-Fuels technology: Monolithically integrated PV-EC device

- Integrated PV-electrolyser cell device
- Direct transformation of sunlight into chemical fuel
- Storage solution for night time consumption
- Distributed generation
- Example heat and electricity production for households

- Prototype development (TRL 3…7)
- Long-term stabile and low-cost devices
- Up scaling (m^2 size)

Monolithically integrated PV-EC device



Data handling at PVcomB - data types

- Raw data from commercial spectrometers in various (specific) formats
- Raw data from home-built experiments (e.g. X-ray absorption spectroscopy)
- Experimental plans for device fabrication
- Device characterization data (j/V-measurements, EQE, V_{oc}/T…)

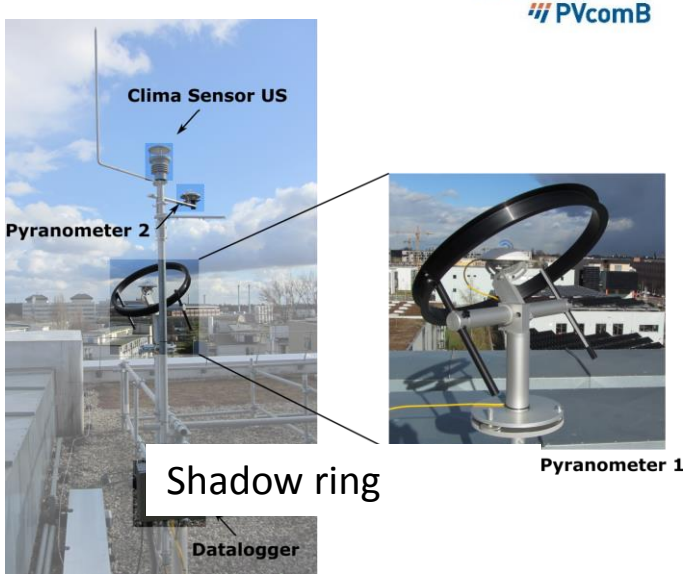
ELAB & PDVisA

- Log files from deposition machines and in-situ analytics
- Data from outdoor test field (device performance, insolation, temperature wind speed…)

IN CLOSE TEMPORAL TRACKING (SECONDS TO MINUTES)

- data of solar modules with a total of 32 sample holders (and being extended)
  - IV-scans
  - mpp-tracking data

- additional data
  - monitor cells in plane of modules
  - solar module rear side temperature
  - meteo data (global and diffuse irradiance, precipitation, wind speed, air temperature)
  - spectrally resolved irradiance



DATA IS STORED IN A DATABASE AND EVALUATED

NOTE THAT ADDITIONAL NON-AUTOMATED ADDITIONAL MEASUREMENTS ARE POSSIBLE

- regularly we take photographs to support in the analysis (data filtering e.g. for snow, occurrences like glass breakage)
- outdoor EL
- outdoor thermograph

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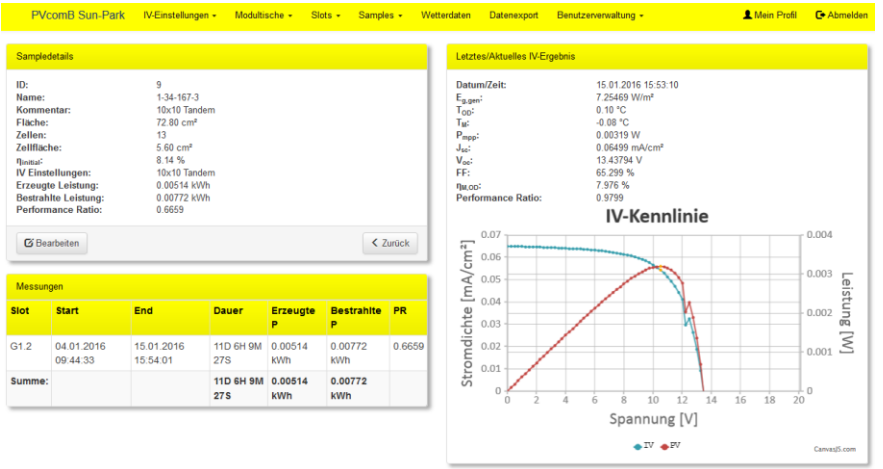
WE CHECK REGULARLY ONLINE WHETHER THE SYSTEM IS RUNNING.



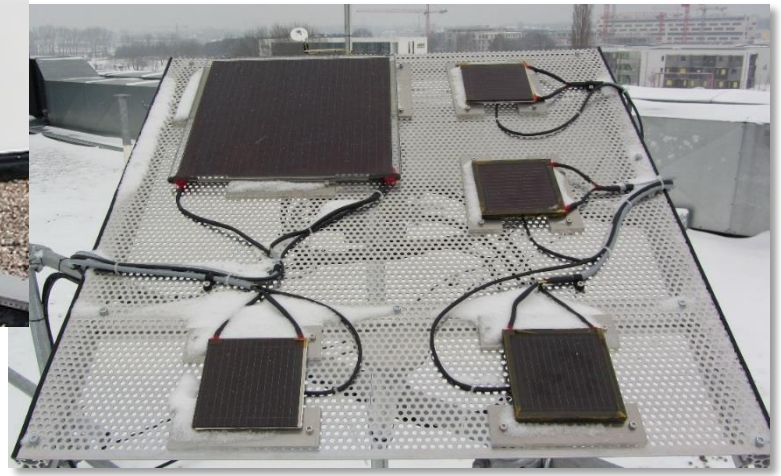
DATA IS FILTERED FOR ARTIFACTS, OUTLIERS, ETC.

THIS IS DONE PARTLY AUTOMATED

BUT CHECKED STEP BY STEP.

DATA IS THEN ANALYSED FOR

- temperature coefficients
- low light efficiency
- fingerprints of degradation
- etc



I WOULD BE INTERESTED IN

– support handling down- and uploads

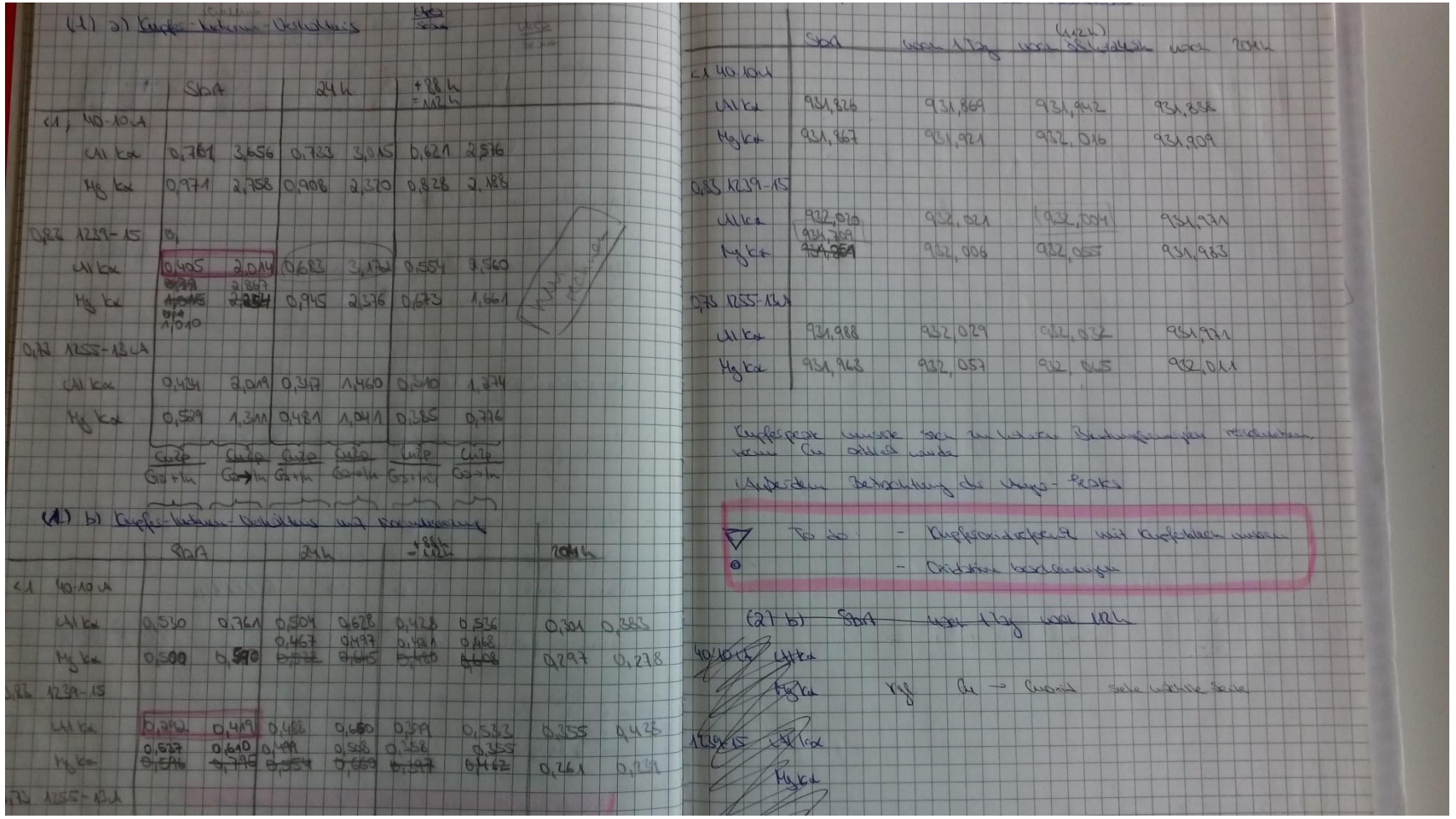
and

– alternatives to the MySQL data bank with the following requests:
  - **easy online access**
    including the option to show results of the analysis (applying the previous filters used) online with current data
  - **straight-forward embedding of existing and new analysis tools**
    (currently in MatLab but students ask for other languages)

Would InfluxDB be a good alternative?

Meta data handling

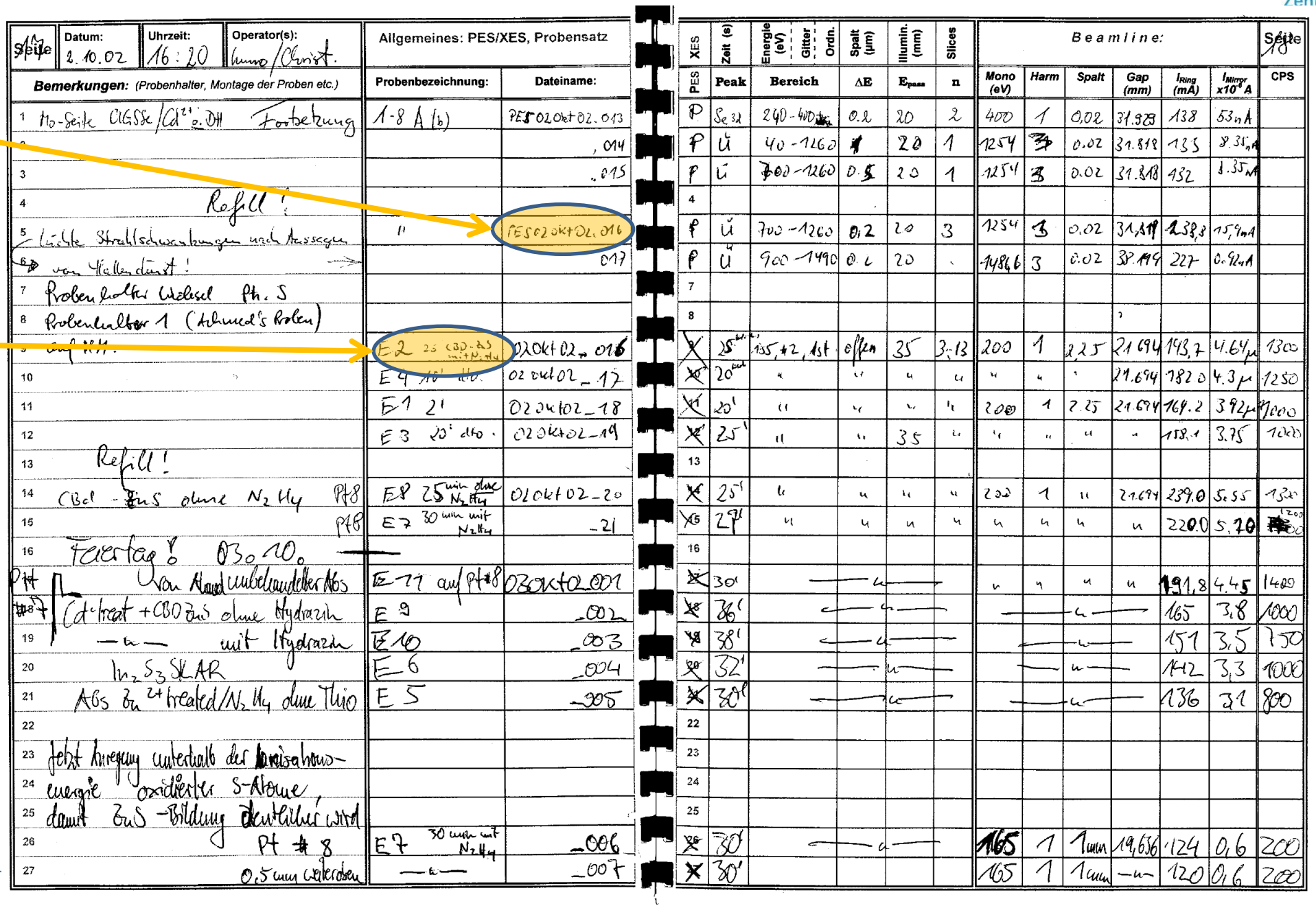
- Traditional, hand-written lab books for experiment descriptions, meta data, extra bits of information that don‘t fit into templates
- Indispensable in experimental sciences



CISSY lab book for X-ray based spectroscopy

Link to raw data

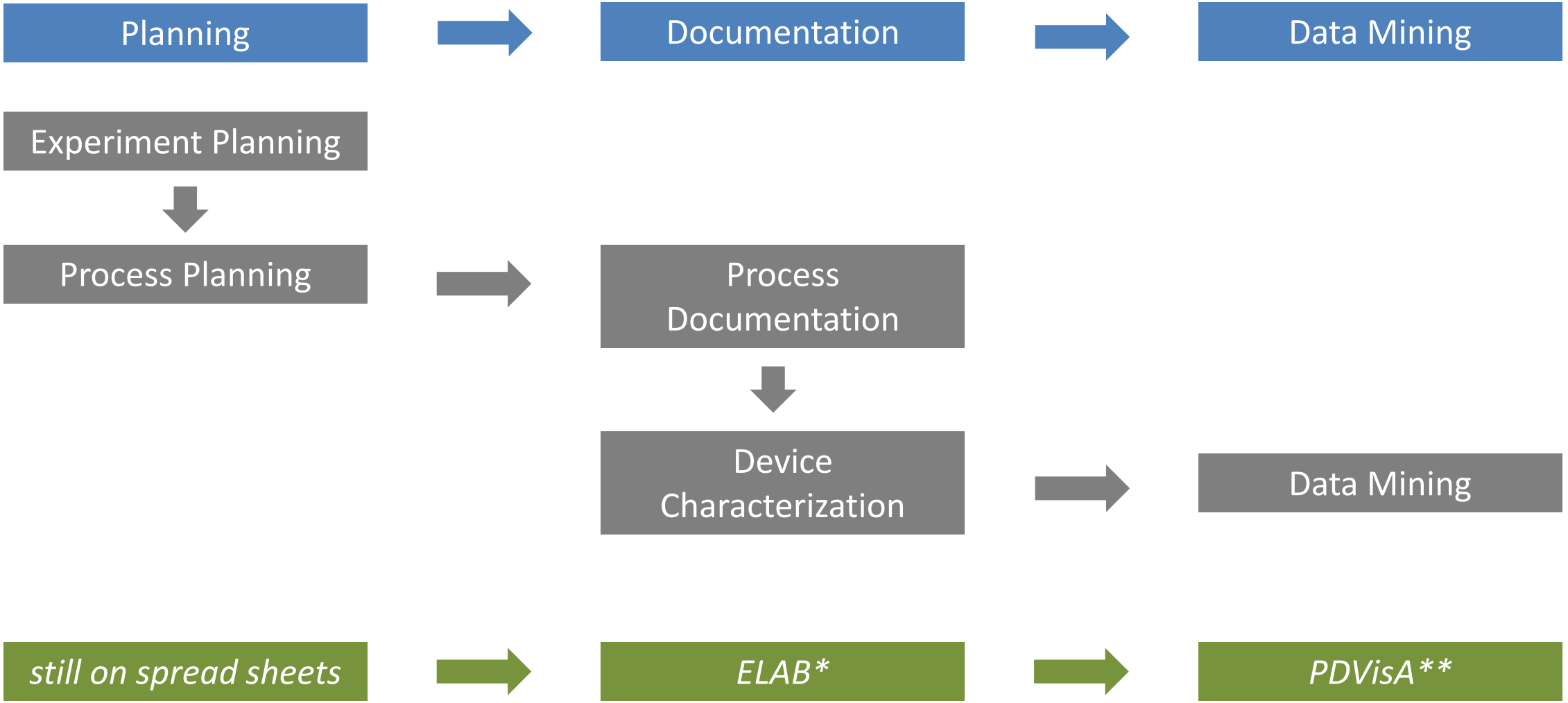
Link to sample history



Seite 17	Datum: 2.10.02	Uhrzeit: 16:20	Operator(s): Iwan/Christ.	Allgemeines: PES/XES, Probensatz	
	Bemerkungen: (Probenhalter, Montage der Proben etc.)			**Probenbezeichnung:**	**Dateiname:**
1	Mo-Seite CIGSSe/Cd^{2+} 2. DH Fortsetzung			1-8 A (b)	PES020ct02.013
2					.014
3					.015
4	Refill!				
5	Leichte Strahlschwankungen nach Aussagen			"	PES020ct02.016
6	von Müller dienst!				017
7	Probenhalter Wechsel Pt. 5				
8	Probenhalter 1 (Ahmed's Proben)				
9	auf Pt#7			E2 25 CBD-2S mit N_2H_4	020ct02_016
10				E4 10' dto.	02 oct 02_17
11				E1 2'	020ct02_18
12				E3 20' dto.	020ct02_19
13	Refill!				
14	CBD - 2S ohne N_2H_4		Pt8	E8 25 min ohne N_2H_4	020ct02_20
15			Pt8	E7 30 min mit N_2H_4	_21
16	Feiertag! 03.10.				
Pt#7	Cu-Mo-Seite CIGSSe/Cd^{2+} 2. DH			E11 auf Pt#8	030ct02_001
Pt#7	Cd-treat + CBD 2nS ohne Hydrazin			E9	_002
19	— " — mit Hydrazin			E10	_003
20	In_2S_3 SLAR			E6	_004
21	AGS 2n 24 treated/N_2H_4 ohne Thio			E5	_005
22					
23	jetzt Anregung unterhalb der Bandlücken-				
24	energie oxidierter S-Atome,				
25	damit ZnS-Bildung detektiert wird				
26	Pt # 8			E7 30 min mit N_2H_4	_006
27	0,5 mm entfernen			— " —	_007

XES	Zeit (s)	Energie (eV)	Gitter	Ordn.	Spalt (µm)	Illumin. (mm)	Slices	Beamline:						Seite
PES	Peak	Bereich			ΔE	E_{pass}	n	Mono (eV)	Harm	Spalt	Gap (mm)	I_{Ring} (mA)	I_{Mirror} x10^6 A	CPS
P	Se 3d	240-400			0.2	20	2	400	1	0.02	31.923	138	53 nA	
P	Ü	40-1260			2	20	1	1254	3	0.02	31.818	135	8.35 nA	
P	Ü	700-1260			0.5	20	1	1254	3	0.02	31.818	132	8.35 nA	
4														
P	Ü	700-1260			0.2	20	3	1254	3	0.02	31.819	238,3	15,9 nA	
P	Ü	900-1490			0.2	20	3	1486	3	0.02	32.199	227	0.92 nA	
7														
8														
X	25 min	155, +2, 1st			offen	35	3-13	200	1	2,25	21.694	143,7	4.64 µ	1300
X	20 min	"			"	"	"	"	"	"	21.694	782 0	4.3 µ	1250
X	20'	"			"	"	"	200	1	2.25	21.694	164.2	3.92 µ	1000
X	25'	"			35	"	"	"	"	"	"	158.1	3.75	1000
13														
X	25'	"			"	"	"	200	1	"	21.694	239.0	5.55	1320
X	27'	"			"	"	"	"	"	"	"	220.0	5.70	1200
16														
X	30'	— " —						"	"	"	"	191,8	4.45	1400
X	36'	— " —						— " —				165	3,8	1000
X	38'	— " —						— " —				151	3,5	750
X	32'	— " —						— " —				142	3,3	1000
X	30'	— " —						— " —				136	3,1	800
22														
23														
24														
25														
X	30'	— " —						165	1	1 mm	19,636	124	0,6	200
X	30'							165	1	1 mm	— " —	120	0,6	200

Data Management via ELAB* & PDVisA**



*ELAB: Marion Schröder and Volker Denzer

**Onno Gabriel and Tim Henckel

Experiment Planning

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Experiment ID

Group of samples

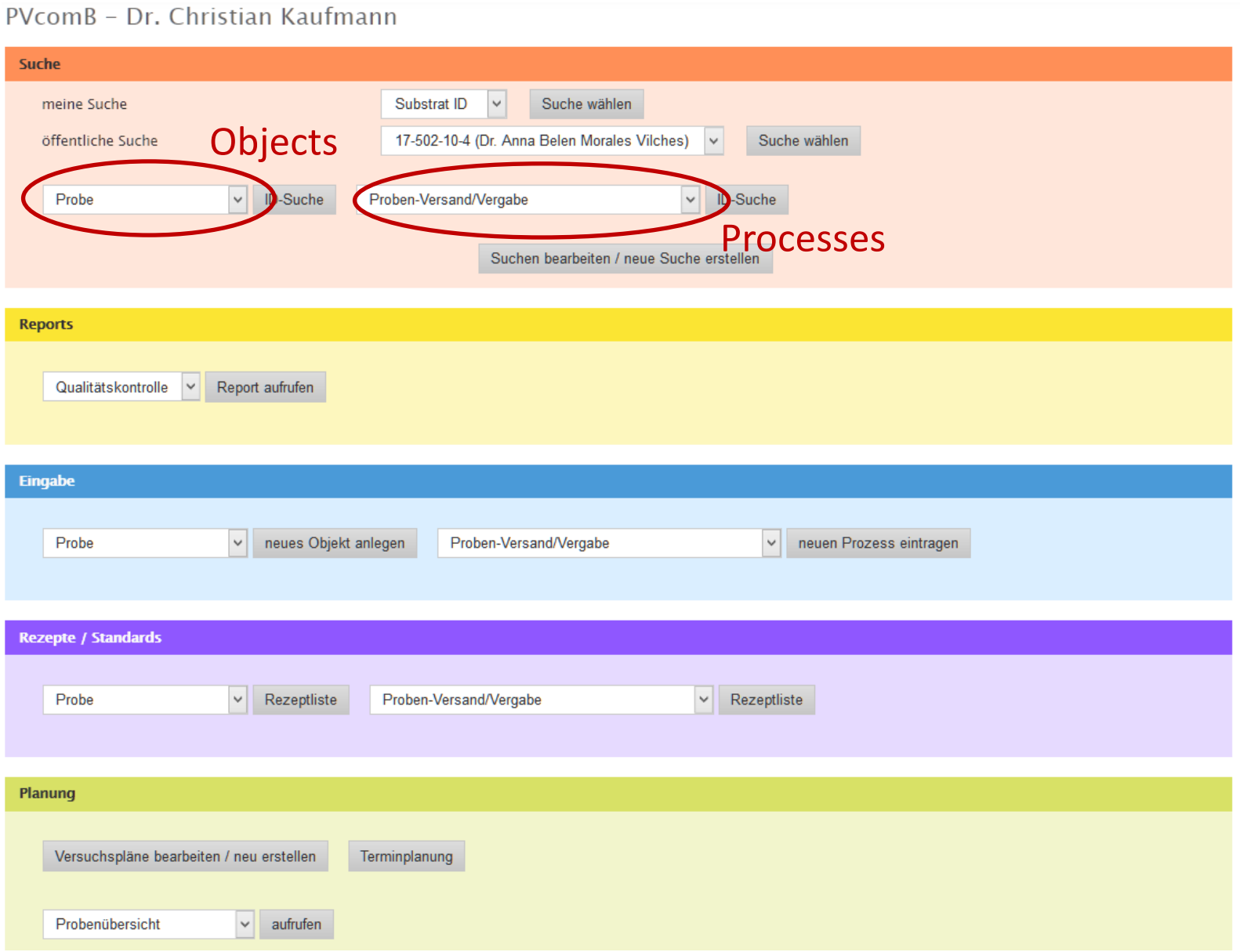
VP1320			Pre-Process			Variables x (Experiment)		Information									Analytics	
			1		2	1		1	2	3	4	5	6	7	8	9	1	2
lfd. no.	substrate ID	Part ID	glass	size	back contact	PVD-E Process	Pos	Se_T_res °C	Se_T_crack °C	Se_vent %	Cu_T_HL °C	Cu_T_EC °C	In_T_HL °C	In_T_EC °C	Ga_T_HL °C	Ga_T_EC °C	Dektak	XRD
1	4-4207-1	0	SGG Planiclear	50x50	PVD_Mo_01		1										•	
2	4-4207-2	0	SGG Planiclear	50x50	PVD_Mo_01	**VP1320_E1** (holder B)	2											
3	4-4207-3	0	SGG Planiclear	50x50	PVD_Mo_01	*LLS & ILR on*	3	345	360	80	pre process	pre process	pre process	pre process	pre process	pre process	•	
4	4-4207-4	0	SGG Planiclear	50x50	PVD_Mo_01	Se evaporation (3 ILR Wellen)	4											
5	4-4208-1	0	SGG Planiclear	20x20	PVD_Mo_01		5											
6	4-4207-5	0	SGG Planiclear	50x50	PVD_Mo_01		1										•	
7	4-4207-6	0	SGG Planiclear	50x50	PVD_Mo_01	**VP1320_E2** (holder B)	2											
8	4-4207-7	0	SGG Planiclear	50x50	PVD_Mo_01	*LLS & ILR on*	3	345	360	65	pre process	pre process	pre process	pre process	pre process	pre process	•	
9	4-4207-8	0	SGG Planiclear	50x50	PVD_Mo_01	Se evaporation (3 ILR Wellen)	4											
10	4-4208-2	0	SGG Planiclear	20x20	PVD_Mo_01		5											
11	4-4207-9	0	SGG Planiclear	50x50	PVD_Mo_01		1										•	
12	4-4207-10	0	SGG Planiclear	50x50	PVD_Mo_01	**VP1320_E3** (holder B)	2											
13	4-4207-11	0	SGG Planiclear	50x50	PVD_Mo_01	*LLS & ILR on*	3	345	360	38	pre process	pre process	pre process	pre process	pre process	pre process	•	
14	4-4207-12	0	SGG Planiclear	50x50	PVD_Mo_01	Se evaporation (3 ILR Wellen)	4											
15	4-4208-3	0	SGG Planiclear	20x20	PVD_Mo_01		5											
16	4-4207-13	0	SGG Planiclear	50x50	PVD_Mo_01		1										•	
17	4-4207-14	0	SGG Planiclear	50x50	PVD_Mo_01	**VP1320_E4** (holder B)	2											•
18	4-4207-15	0	SGG Planiclear	50x50	PVD_Mo_01	*LLS & ILR on*	3	345	360	65	pre process	pre process	1070	920	pre process	pre process	•	
19	4-4207-16	0	SGG Planiclear	50x50	PVD_Mo_01	In-Se coevaporation (3 ILR Wellen)	4											
20	4-4208-4	0	SGG Planiclear	20x20	PVD_Mo_01		5											
21	4-4207-17	0	SGG Planiclear	50x50	PVD_Mo_01		1										•	
22	4-4207-18	0	SGG Planiclear	50x50	PVD_Mo_01	**VP1320_E5** (holder B)	2											•
23	4-4207-19	0	SGG Planiclear	50x50	PVD_Mo_01	*LLS & ILR on*	3	345	360	38	pre process	pre process	1070	920	pre process	pre process	•	
24	4-4207-20	0	SGG Planiclear	50x50	PVD_Mo_01	In-Se coevaporation (3 ILR Wellen)	4											
25	4-4208-5	0	SGG Planiclear	20x20	PVD_Mo_01		5											
26	4-4207-21	0	SGG Planiclear	50x50	PVD_Mo_01		1										•	
27	4-4207-22	0	SGG Planiclear	50x50	PVD_Mo_01	**VP1320_E6** (holder B)	2											•
28	4-4207-23	0	SGG Planiclear	50x50	PVD_Mo_01	*LLS & ILR on*	3	345	360	65	1230	1100	pre process	pre process	pre process	pre process	•	
29	4-4207-24	0	SGG Planiclear	50x50	PVD_Mo_01	Cu-Se coevaporation (3 ILR Wellen)	4											
30	4-4208-6	0	SGG Planiclear	20x20	PVD_Mo_01		5											

Process Planning

Samples from the various experiments are assigned to various deposition tools and processing times

PVD Processplan			CW 22			2019				from	27.05.2019	to	02.06.2019				
Setup	*Operator*		*Recipe*					*VP*									
Day	VP	IDE-IP	ID part	Substrate	Size	Cleaning	Barrier/ Backcontact	Position	PVD-Absorber	Additional Comments (Allocation, Sending, Quality I...)	WCT / Buffer	TCO	Grid	R / AR-Coating / R	IV	EQE	Quality II
MO 27.5	Bruce								Maintenance								
	Emily	TM		Cu-Se Evaporation (Rate measurement)					VP1320_E7 (sample holder B)								
	1320	4-4207-25	0	Planiclear	50x50	strnd	PVD_Mo_01	Pos. 1	**PVD-E0008**	-> Analytik							
	1320	4-4207-26	0	Planiclear	50x50	strnd	PVD_Mo_01	Pos. 2	**3 ILR Wellen Cu-Se (490°C)**	-> Analytik							
	1320	4-4207-27	0	Planiclear	50x50	strnd	PVD_Mo_01	Pos. 3	Se: 345°C/360°C/65%	-> Analytik							
	1320	4-4207-28	0	Planiclear	50x50	strnd	PVD_Mo_01	Pos. 4	In: pre-process								
	1320	4-4208-7	0	Planiclear	20x20	strnd	PVD_Mo_01	Pos. 5	Cu: 1450°C/1200°C								
	Bruce								Ga: pre-process								
	Emily								Maintenance								
TU 28.5																	
	Bruce								Bake out								
	Emily	TM		Ga-Se Evaporation (Rate measurement)					VP1320_E8 (sample holder B)								
	1320	4-4207-29	0	Planiclear	50x50	strnd	PVD_Mo_01	Pos. 1	**PVD-E xxx**	-> Analytik							
	1320	4-4207-30	0	Planiclear	50x50	strnd	PVD_Mo_01	Pos. 2	**3 ILR Wellen Ga-Se (300°C)**	-> Analytik							
	1320	4-4207-31	0	Planiclear	50x50	strnd	PVD_Mo_01	Pos. 3	Se: 345°C/360°C/65%	-> Analytik							
	1320	4-4207-32	0	Planiclear	50x50	strnd	PVD_Mo_01	Pos. 4	In: pre-process								
	1320	4-4208-8	0	Planiclear	20x20	strnd	PVD_Mo_01	Pos. 5	Cu: pre-process								
	Bruce								Ga: 1165°C/1030°C								
	Emily								Bake out								
WE 29.5																	
	Bruce	JL		standard CIGSe					VP1296_PVD_B_Standard-Process_2019 (TB TK CAK)								
	1296	4-4209-16	0	Planiclear	50x50	strnd	PVD_Mo_01	Pos. 1		-> PL (vor u. nach CdS)/GDOES/XF	CdS_CBD_PVD_01						
	1296	4-4209-17	0	Planiclear	50x50	strnd	PVD_Mo_01	Pos. 2		-> PL (vor u. nach CdS + nach IV)	CdS_CBD_PVD_01	ZAO_Zelle_PVD_01	PVcomB_01		stand		
	1296	4-4209-18	0	Planiclear	50x50	strnd	PVD_Mo_01	Pos. 3	**PVD-B 1841**		CdS_CBD_PVD_01	ZAO_Zelle_PVD_01	PVcomB_01		stand		
	1296	4-4209-19	0	Planiclear	50x50	strnd	PVD_Mo_01	Pos. 4	Ko_B_03-3	-> Blanka	CdS_CBD_PVD_01	ZAO_Zelle_PVD_01	Photolithographie	MgF2	einzel		
	1296	4-4209-20	0	Planiclear	50x50	strnd	PVD_Mo_01	Pos. 5			CdS_CBD_PVD_01	ZAO_Zelle_PVD_01	PVcomB_01		stand		
	1296	4-4209-21	0	Planiclear	50x50	strnd	PVD_Mo_01	Pos. 6		-> SEM/XRF							
	1296	4-4209-22	0	Planiclear	50x50	strnd	PVD_Mo_01	Pos. 7									
	Emily	TM		Ga-Se Evaporation (Rate measurement)					VP1320_E9 (sample holder B)								
	1320	4-4207-33	0	Planiclear	50x50	strnd	PVD_Mo_01	Pos. 1	**PVD-E xxx**	-> Analytik							
	1320	4-4207-34	0	Planiclear	50x50	strnd	PVD_Mo_01	Pos. 2	**3 ILR Wellen Ga-Se (300°C)**	-> Analytik							
	1320	4-4207-35	0	Planiclear	50x50	strnd	PVD_Mo_01	Pos. 3	Se: 345°C/360°C/65%	-> Analytik							
	1320	4-4207-36	0	Planiclear	50x50	strnd	PVD_Mo_01	Pos. 4	In: pre-process								
	1320	4-4208-9	0	Planiclear	20x20	strnd	PVD_Mo_01	Pos. 5	Cu: pre-process								
	Bruce	TB		RbF PDT			RTP_RbF-PDT_II_With S (PR,RK,EW,GF)		Ga: 1050°C/650°C								
	1311	2-166-11	2	Planiclear	50x50	strnd	RTP_Mo_01	Pos. 1	**PVD-B 1842**	s. RTP							
									RbF-PDT @ 280°C								
									TRbF: 590/690°C								
									VSCS: 0.5 mm für 10 min								
									+ 5 min anneal ohne Se								
	Bruce	TB		RbF PDT			RTP_RbF-PDT_II_With S (PR,RK,EW,GF)										
									PVD-B 1843								
									RbF-PDT @ 280°C								

Electronic Lab Book (ELAB) – I



ELAB

Database in which objects are associated with processes.

Both are fully customizable, i.e. descriptive parameters can be defined as needed.

So far „planning“ is not fully integrated, but integration is forseen.

Electronic Lab Book (ELAB) – II

Sample Type

Fabrication

Characterization

After objects are created manually, most data is uplaoded automatically via upload tools from the deposition or characterization set-ups.

ELAB also supports grouping of samples into experiments.

Electronic Lab Book (ELAB) – III

HZB Helmholtz Zentrum Berlin
PVcomB

Nr. 1296 **Name** PVD_B_Standard-Process_2019 (TB,TK,CAK)

PVD / Inlineselenisierung	Prozessrezept	Bemerkung	Prozesstyp	T2-Substrat [°C]	Ga/(Ga+In)	Cu/(Ga+In)	Schichtdicke [µm]	Substrate	Pufferschicht / ALD TFS 500	TCO-dyn	Voc [mV] Best	Voc [mV] Median	Jsc [mA/cm²] Best	Jsc [mA/cm²] Median	FF [%] Best	FF [%] Median	Wirkungsgrad [%] Best	Wirkungsgrad [%] Median
PVD-B 1714	Ko-B 3.2	KW03		529.9				4-4187-10-0	1495 PVD 1:25	887 ca. 40nm i-ZnO/150nm ZAO (PVD-Standard 2015)	643.3	642.5	36.0	35.3	72.0	72.6	16.7	16.5
								4-4187-11-0	1495 PVD 1:25	887 ca. 40nm i-ZnO/150nm ZAO (PVD-Standard 2015)	650.2	650.6	35.5	35.4	74.1	73.8	17.1	17.0
								4-4187-12-0	1495 PVD 1:25	887 ca. 40nm i-ZnO/150nm ZAO (PVD-Standard 2015)								
								4-4187-13-0										
								4-4187-14-0										
								4-4187-14-1		892 ca. 40nm i-ZnO/150nm ZAO (PVD-Standard 2015)	555.4	555.4	38.5	35.7	63.9	66.0	13.7	13.3
								4-4187-14-2		892 ca. 40nm i-ZnO/150nm ZAO (PVD-Standard 2015)	561.0	556.0	35.4	35.3	66.8	65.6	13.3	12.7
								4-4187-8-0	1495 PVD 1:25									
								4-4187-9-0	1495 PVD 1:25	887 ca. 40nm i-ZnO/150nm ZAO (PVD-Standard 2015)	643.1	643.1	34.6	34.8	74.2	72.9	16.5	16.4
PVD-B 1720	Ko-B 3.2	Die ersten 226s ohne Selen, Kupferphase sehr lang (3,3 Wellen) KW04		530				4-4187-22-0	1499 PVD 1:25									
								4-4187-23-0	1499 PVD 1:25	892 ca. 40nm i-ZnO/150nm ZAO (PVD-Standard 2015)	629.2	625.2	29.4	29.1	28.9	27.8	5.3	5.1
								4-4187-24-0	1499 PVD 1:25	892 ca. 40nm i-ZnO/150nm ZAO (PVD-Standard 2015)	606.7	605.6	24.9	23.8	24.9	24.7	3.8	3.5

Easy, comfortable display of device results for experiment analysis.

Electronic Lab Book (ELAB) – IV

Projektgruppe	Beschreibung	Mitglieder
ALD Prozess	Kompletter ALD Prozess sichtbar (ALD TSF 500 Private)	Dorbandt, Iris
CIGSSe	Komplette CIGSSe Gruppe	Bertram, Tobias Bunn, Bianka Calnan, Sonya Dorbandt, Iris Erfurt, Darja Farias Basulto, Guillermo Ghaderi, Sakineh Hartig, Manuel Jost, Marko Kadiatou, Coulibaly Kaufmann, Christian Kirsch, Michael Klenk, Reiner Knoop, Silvio Kodalle, Tim Körner, Stefan Lauche, Jakob Lauermann, Iver Mack, Karolina Maticiuc, Natalia Mayer-Stillrich, Katja Münchenberg, Tim Naddour, Anas Reyes Figueroa, Pablo Itzam Riedel, Maximilian Salami, Zanyar Setzchen, Max Steinkopf, Lars Stutzke, Stefanie Ulbrich, Carolin Waack, Erik Wang, Yajie Wenisch, Robert Yetkin, Hasan Arif
Masdar PV	Projekt	Calnan, Sonya Stannowski, Bernd
PV to Fuels Technology	PV to Fuels Technology	Aschbrenner, Stefan Bao, Fuxi Calnan, Sonya Kemppainen, Erno
SunPlugged	Bilaterale Kooperation PVcomB<->Sunplugged	Bertram, Tobias Kaufmann, Christian Lauche, Jakob Münchenberg, Tim Weinberger, Nikolaus

Definition of project teams allows for exclusive visibility of sample and processing details in order to rule-out confidentiality issues.

PDVisA for Data Mining – I

PDVisA 2.0 — PVcomB Data Visualization + Analysis

Latest Measurements | Experiments | Sample History | Sample Mapper | Data Correlator | Curve Plotter | Account ChristianK | Administration

Experiment "VP_1188 nice try 2 (CAK,TB,TK)"

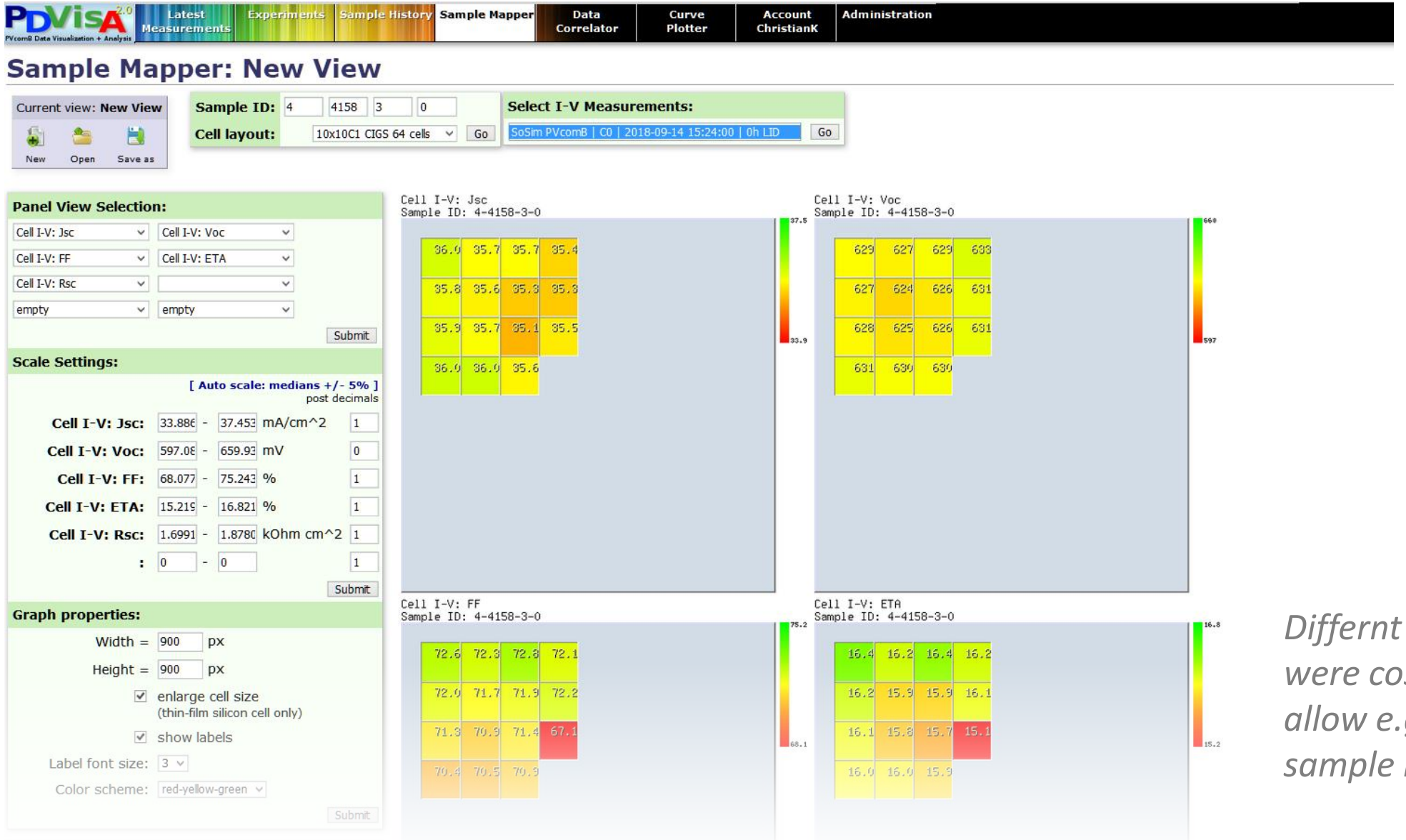
Experiment name:	VP_1188 nice try 2 (CAK,TB,TK)
Description:	
Started on:	30.08.18 17:16:15
Owner:	ELabMetrologer
Status:	processing
ELAB-Import:	[ELab]

ELAB supplies PDVisA with data for data analysis, again supporting sample grouping in experiments.

Connected Samples

Project	Batch	Substrate	Part	Sample ID	Sample Description	Best I-V Result
4	4158	1	0	[4-4158-1-0]	Mo_02 | B1611 | CGI_fin=0.9 | 300/530 | CdS+stdZAO | SchMa	Cell #11: ETA = 16.5 % / FF = 73.0 % / Voc = 628 mV / Jsc = 36.1 mA/cmÂ²
4	4158	2	0	[4-4158-2-0]	Mo_02 | B1611 | CGI_fin=0.9 | 300/530 | CdS+ZnMgO+ZAO | SchMa	Cell #34: ETA = 15.3 % / FF = 70.3 % / Voc = 619 mV / Jsc = 35.3 mA/cmÂ²
4	4158	3	0	[4-4158-3-0]	Mo_02 | B1611 | CGI_fin=0.9 | 300/530 | CdS+stdZAO | SchMa	Cell #11: ETA = 16.4 % / FF = 72.6 % / Voc = 629 mV / Jsc = 36.0 mA/cmÂ²
4	4158	4	0	[4-4158-4-0]	Mo_02 | B1611 | CGI_fin=0.9 | 300/530 | Anneal+CdS+stdZAO | SchMa	Cell #32: ETA = 15.6 % / FF = 71.2 % / Voc = 635 mV / Jsc = 34.6 mA/cmÂ²
4	4158	5	0	[4-4158-5-0]	Mo_02 | B1611 | CGI_fin=0.9 | 300/530 | Anneal+CdS+ZnMgO+ZAO | SchMa	Cell #34: ETA = 14.8 % / FF = 69.2 % / Voc = 614 mV / Jsc = 34.9 mA/cmÂ²
4	4158	6	0	[4-4158-6-0]	Mo_02 | B1617 | CGI_fin=0.9 | 400/530 | CdS+stdZAO | SchMa	Cell #42: ETA = 15.3 % / FF = 69.7 % / Voc = 628 mV / Jsc = 35.0 mA/cmÂ²
4	4158	7	0	[4-4158-7-0]	Mo_02 | B1617 | CGI_fin=0.9 | 400/530 | CdS+ZnMgO+ZAO | SchMa	Cell #31: ETA = 14.7 % / FF = 68.5 % / Voc = 615 mV / Jsc = 35.0 mA/cmÂ²
4	4158	8	0	[4-4158-8-0]	Mo_02 | B1617 | CGI_fin=0.9 | 400/530 | CdS+stdZAO | PhotoLitho	–
4	4158	9	0	[4-4158-9-0]	Mo_02 | B1617 | CGI_fin=0.9 | 400/530 | Anneal+CdS+stdZAO | SchMa	Cell #21: ETA = 15.2 % / FF = 70.2 % / Voc = 623 mV / Jsc = 34.8 mA/cmÂ²
4	4158	10	0	[4-4158-10-0]	Mo_02 | B1617 | CGI_fin=0.9 | 400/530 | Anneal+CdS+ZnMgO+ZAO | SchMa	Cell #11: ETA = 14.6 % / FF = 69.2 % / Voc = 606 mV / Jsc = 34.8 mA/cmÂ²
4	4158	11	0	[4-4158-11-0]	Mo_02 | B1618 | CGI_fin=0.9 | 300/600 | CdS+stdZAO | SchMa	Cell #21: ETA = 16.8 % / FF = 72.9 % / Voc = 686 mV / Jsc = 33.6 mA/cmÂ²
4	4158	12	0	[4-4158-12-0]	Mo_02 | B1618 | CGI_fin=0.9 | 300/600 | CdS+ZnMgO+ZAO | SchMa	Cell #11: ETA = 16.2 % / FF = 73.2 % / Voc = 656 mV / Jsc = 33.7 mA/cmÂ²
4	4158	13	0	[4-4158-13-0]	Mo_02 | B1618 | CGI_fin=0.9 | 300/600 | CdS+stdZAO | SchMa	Cell #31: ETA = 0.0 % / FF = 25.1 % / Voc = 21 mV / Jsc = 0.0 mA/cmÂ²
4	4158	14	0	[4-4158-14-0]	Mo_02 | B1618 | CGI_fin=0.9 | 300/600 | Anneal+CdS+stdZAO | SchMa	Cell #12: ETA = 16.0 % / FF = 71.5 % / Voc = 670 mV / Jsc = 33.4 mA/cmÂ²
4	4158	15	0	[4-4158-15-0]	Mo_02 | B1618 | CGI_fin=0.9 | 300/600 | Anneal+CdS+ZnMgO+ZAO | SchMa	Cell #41: ETA = 16.0 % / FF = 73.5 % / Voc = 649 mV / Jsc = 33.5 mA/cmÂ²
4	4158	16	0	[4-4158-16-0]	Mo_02 | B1619 | CGI_fin=0.9 | 400/600 | CdS+stdZAO | SchMa	Cell #31: ETA = 16.8 % / FF = 71.8 % / Voc = 673 mV / Jsc = 34.9 mA/cmÂ²
4	4158	17	0	[4-4158-17-0]	Mo_02 | B1619 | CGI_fin=0.9 | 400/600 | CdS+ZnMgO+ZAO | SchMa	Cell #11: ETA = 16.4 % / FF = 72.7 % / Voc = 661 mV / Jsc = 34.1 mA/cmÂ²

PDVisA for Data Mining – II



Diffrent tools, which were costom designed allow e.g. to look at sample homogeneity, ...

PDVisA for Data Mining – III

PDVisA 2.0 | Latest Measurements | Experiments | Sample History | Sample Mapper | Data Correlator | Curve Plotter | Account ChristianK | Administration

Data Correlator: New View

Current view: **New View**

New | Open | Save as

Groups: G1 G2

Add new group

Settings of Group 1

Delete this group

Sample Basis

Experiments

Select user(s): Charles J Hages, Christian A Kaufmann, Christof Schulz, Darja Erfurt, ELabMetrologer — Submit

Select experiment(s):

2018-12-04 | VP_1256 RbInSe2 on CIGS (ELabMetrologer)
2018-11-27 | VP_1289 Singleshot_Test_and_Misc (ELabMetrologer)
2018-11-14 | VP_1274 Vacuum tranfer CIGSe (ELabMetrologer)
2018-11-12 | VP_1284 PVD_Cooling ramps (TB, CAK) (ELabMetrologer)
2018-09-06 | VP_1222.3 PVD_RbF Status Quo 3 (TK,TB,CAK) (ELabMetrologer)

Submit

Sample Description Filter

Sample description: does not contain — GaOx

Filter by Sample IDs:

Enter ID ranges (e.g. "1,3" or "1-9" or "1,3,5-9"):

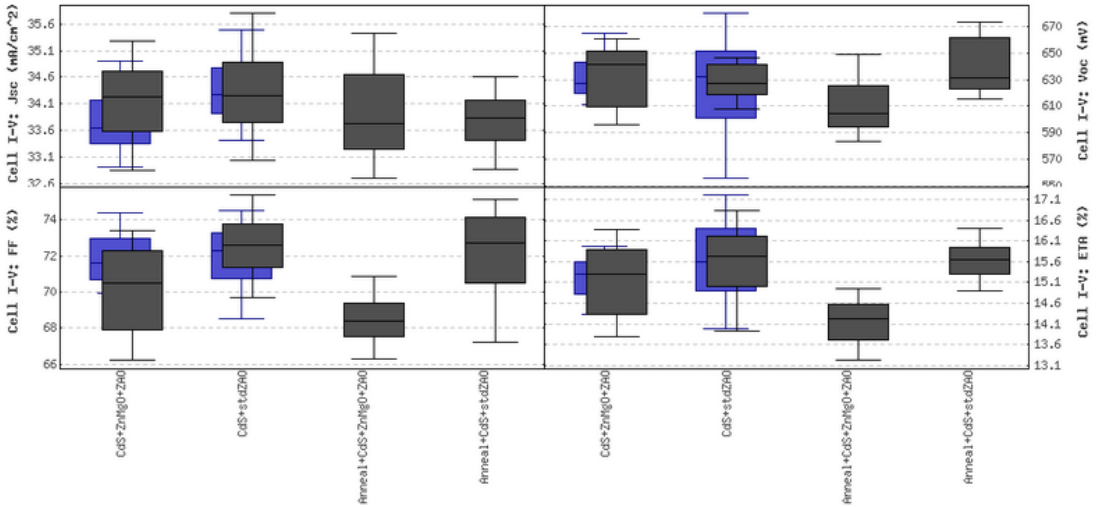
Project ID:
Batch ID: 4160,4172,4173
Run ID:
Coupon ID:
Cell #:

Filter Cell I-V Data

Device: SoSim PVcomB, Flasher PVcomB

Data Refresh | Show Graphs | Graph Settings | Data Tables | Statistics

Some measurements hidden



Select Data Accumulation Parameter ("x axis")

accumulate by [Batch-ID | Run-ID | Coupon-ID]
[Description (Experiment)]
[Measurement Date]
[AKT Process Date]

Group Legend

Mo_1
Mo_2

Sample Legend

ID	Descri
4-4158-1	Mo_02 B1611 CGI_fin=0.9 300/530 CdS+stdZAO SchMa
4-4158-2	Mo_02 B1611 CGI_fin=0.9 300/530 CdS+ZnMgO+ SchMa
4-4158-3	Mo_02 B1611 CGI_fin=0.9 300/530 CdS+stdZAO SchMa
4-4158-4	Mo_02 B1611 CGI_fin=0.9 300/530 Anneal+CdS+ SchMa
4-4158-5	Mo_02 B1611 CGI_fin=0.9 300/530 Anneal+CdS+ SchMa
4-4158-6	Mo_02 B1617 CGI_fin=0.9 400/530 CdS+stdZAO SchMa
4-4158-7	Mo_02 B1617

... data binning for further analysis.

Conclusion

We strongly support data archiving and data publication, but believe that it only makes sense if the available data is comprehensively documented, i.e. an entire sample/process history is available.

Thank you!