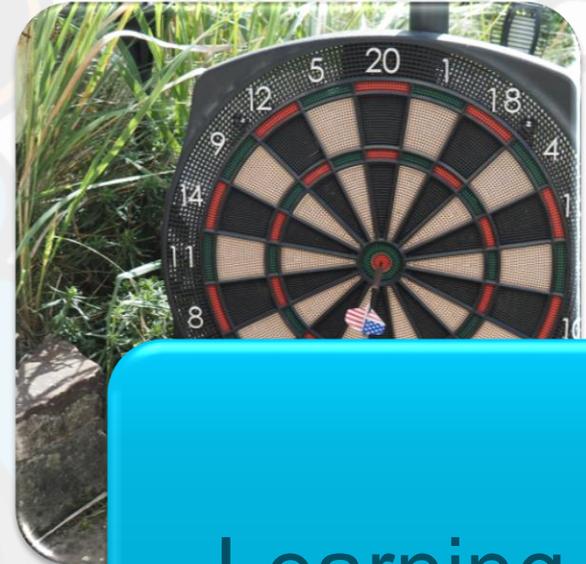




INTRODUCTION OF THE FPGA VISION REMOTE LAB

Marco Winzker, Andrea Schwandt
Institute of Visual Computing, Bonn-Rhein-Sieg University



Event	Start date	End date	Origin	Coord address
ne V@FPGA experiments	2019-08-06 21:54:50	2019-08-06 21:56:32	202.3.77...	Cyclone_Vlaboratory1@core
ne V Demo@FPGA experiments	2019-08-06 21:52:23	2019-08-06 21:54:24	202.3.77...	Cyclone_V_Demo:laboratory1
ne V Demo@FPGA experiments	2019-08-06 21:50:08	2019-08-06 21:52:10	202.3.77...	Cyclone_V_Demo:laboratory1
ne V@FPGA experiments	2019-07-05 17:41:48	2019-07-05 17:46:51	93.226.200	Cyclone_Vlaboratory1@core
ne IV@FPGA experiments	2019-07-05 17:41:39	2019-07-05 17:41:43	93.226.200	Cyclone_IVlaboratory2@exp
ne IV@FPGA experiments	2019-07-05 17:28:18	2019-07-05 17:33:19	93.226.200	Cyclone_IVlaboratory2@exp
ne IV@FPGA experiments	2019-07-05 17:22:55	2019-07-05 17:27:56	93.226.200	Cyclone_IVlaboratory2@exp
ne V@FPGA experiments	2019-07-05	2019-07-05	93.226.200	Cyclone_Vlaboratory1@core

The FPGA
Vision
Remote
Lab –
Making-of

Learning
Goals

Learning
Analytics

Upload FPGA binary and start experiment

FPGA Core Current:

94.5 mA

(Core Supply Voltage is 1.2 V)

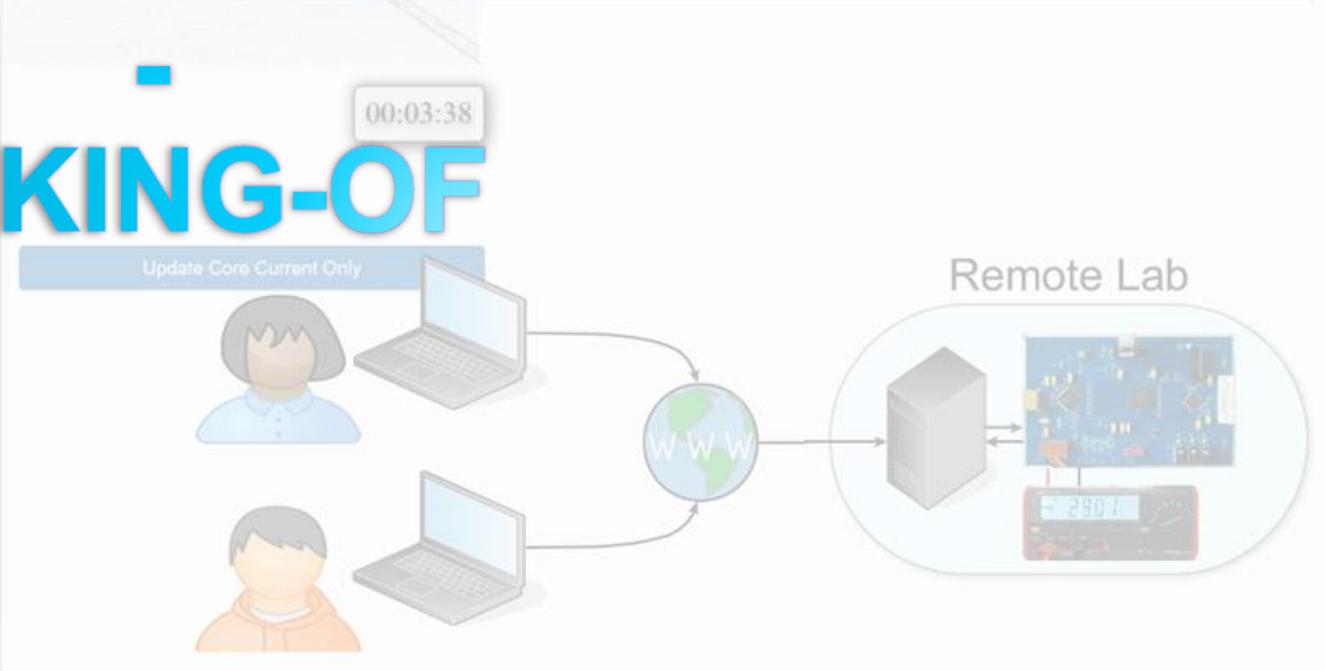


THE FPGA VISION REMOTE LAB

<< < Select input image > >>

Item	Experiment	Date	End date	View
...	C-10 Demo	2023-01-24 10:20:08	2023-01-24 10:20:08	View
...	C-10 Video	2023-01-24 14:32:02	2023-01-24 14:32:02	View
...	C-10 Video	2023-01-24 14:31:46	2023-01-24 14:31:18	View
...	C-10	2023-01-24 14:31:31	2023-01-24 14:31:24	View
...	C-10 Video	2023-01-24 12:32:07	2023-01-24 12:32:10	View
...	C-10 Video	2023-01-24 12:31:53	2023-01-24 12:32:00	View
...	C-10 Video	2023-01-24 12:31:46	2023-01-24 12:31:38	View
...	C-10 Video	2023-01-24 12:31:32	2023-01-24 12:31:31	View
...	C-10 Demo	2023-01-24 12:31:30	2023-01-24 12:31:47	View

MAKING-OF

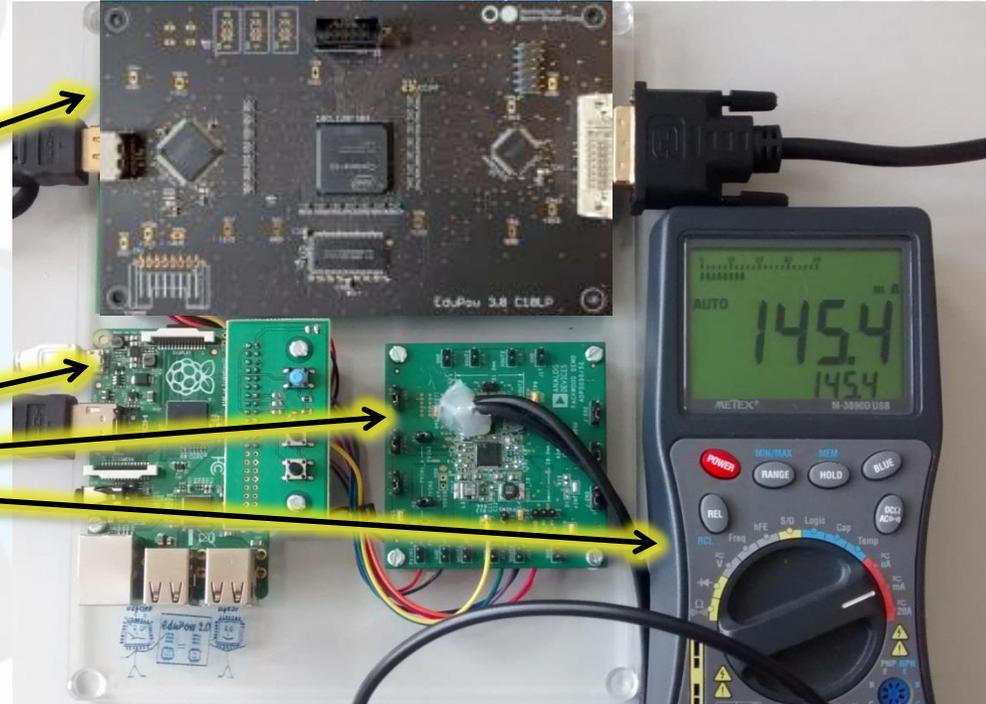




- Development of board for module „Energy Efficient Microelectronic Systems“

FPGA Design
developed at H BRS

Available
components



FPGA Vision

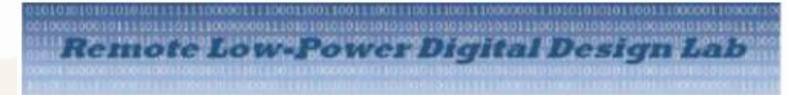
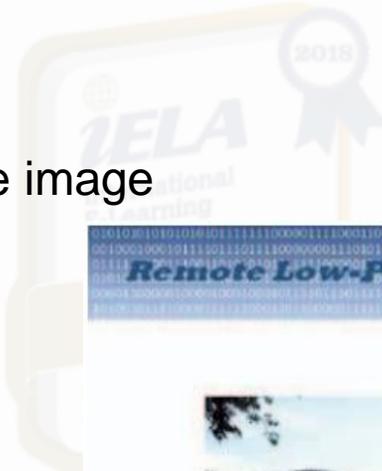
Coming Soon

⇒ since January 2020, BRS can be accessed as Open Educational Resource (OER)

- Lab hardware available via Internet
 - ⇒ Students can access the lab hardware independent from time and their current whereabouts



Global Online Laboratory Consortium



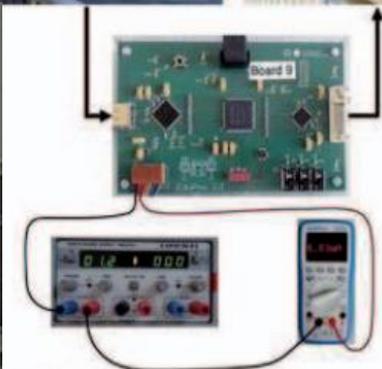
Bonn-Rhein-Sieg
University
Welcome, AbuShanab
Logout



- Prototype for proof of concept designed
 - in-house development
 - possibility to log-in, upload one compiled FPGA design and one image
 - fundamental presentation of results
 - basic session handling
 - log-in locks the system for three minutes
 - no queuing
- Used and evaluated by students during summer terms 2016 and 2017
- Evaluation confirms proof of concept



Shatha Abu Shanab successfully
completes her doctorate



Design Lab Version 1.0
Applied Sciences, Sankt Augustin, Germany



What do we need for a successful remote lab?

- OER (Open Educational Resource) distribution
- reliable availability
 - 24/7
 - long-term
- usability
 - comfortable session handling
 - straightforward user interface
 - experiments with interactive control elements



consider students' perspective



FPGA Vision



- Usage of the WebLab-Deusto Remote Lab Management System
 - ✓ user handling and queuing already implemented
 - ✓ data logging for learning analytics available
 - ⇒ concentration on the design of the experiment (hardware, software and user interface)
- Straightforward user interface of experiment page
 - starting with the most important input elements, e.g., where users can upload binaries, on top of the page
 - logical, coherent arrangement of in- and output elements
 - provision of several images and the possibility to upload own pictures as input image for the FPGA



... to the FPGA Vision Remote Lab

The screenshot shows a web browser window titled "Lab - Cyclone IV" with the URL [https://fpga-vision-lab.h-brs.de/web/lab/labs/FPGA_experiments/Cyclone IV/#](https://fpga-vision-lab.h-brs.de/web/lab/labs/FPGA_experiments/Cyclone_IV/#). The page header includes the Hochschule Bonn-Rhein-Sieg logo, the "FPGA VISION" logo, and a "Log out" button. A navigation button "Back to My experiments" is visible. The main content area features the title "Cyclone IV (FPGA experiments)" and a "Finish" button. The central video player displays a grayscale image of a road with lane lines. The lane lines are highlighted with green and red lines, indicating the detection of lane boundaries. At the bottom of the video player, there are three control buttons: "Program Default Design", "Update Output Image and Core Current", and "Update Core Current Only".

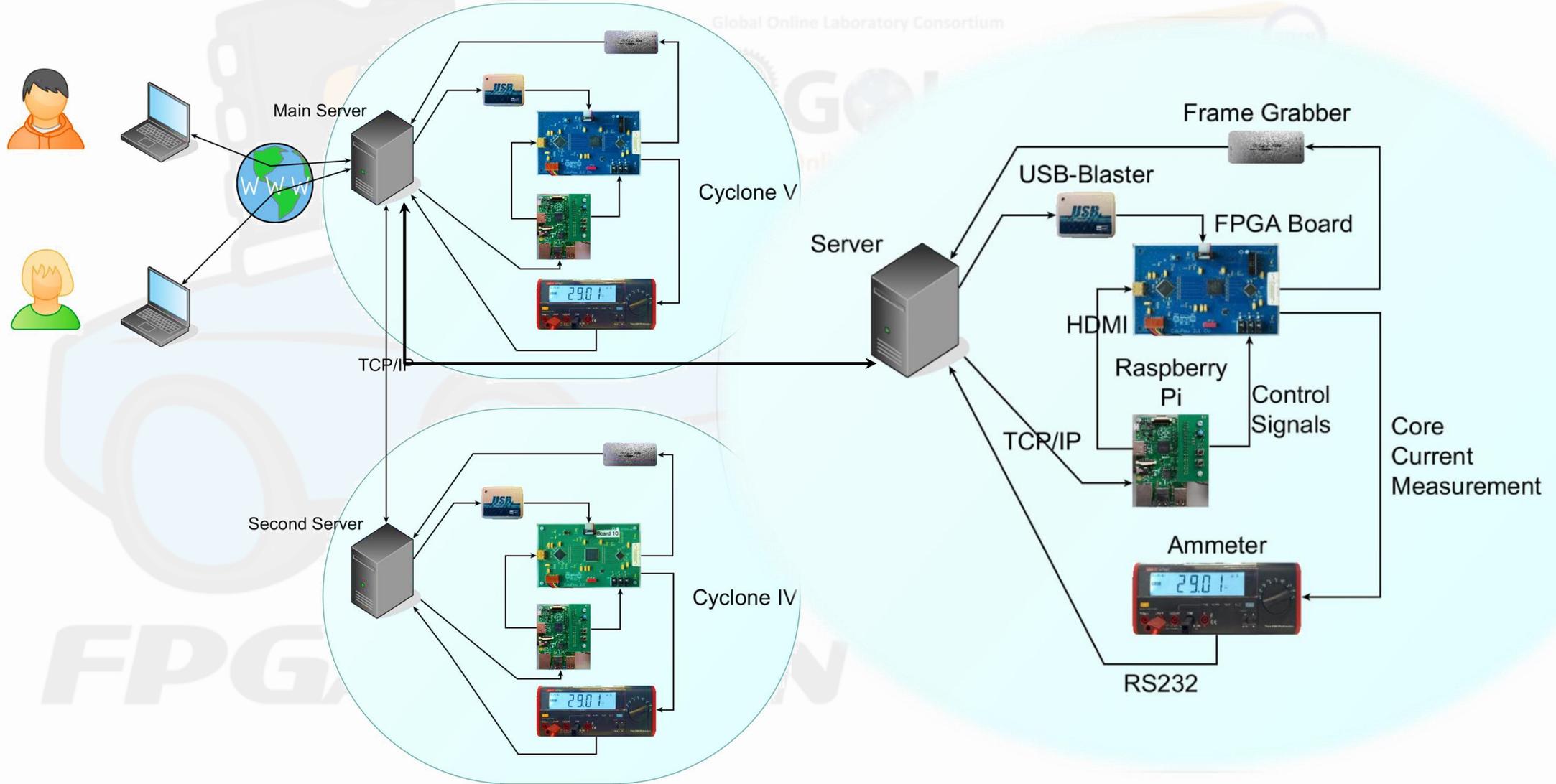


FPGA



Structure of the FPGA Vision Remote Lab

Global Online Laboratory Consortium





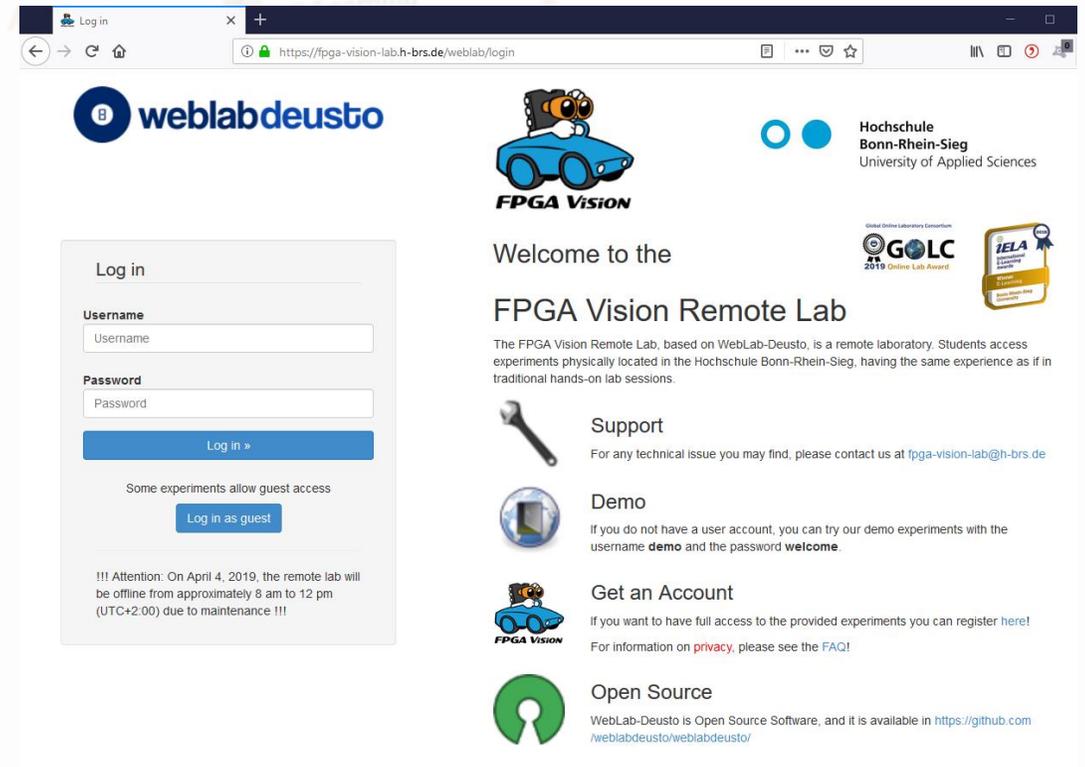
Hardware of the FPGA Vision Remote Lab



FPGA Vision



- remote lab is open to other universities and individuals
- demo experiments accessible without registration
- free user registration
- short video lectures on YouTube complete the learning offer



Log in

Username
Username

Password
Password

Log in »

Some experiments allow guest access

Log in as guest

!!! Attention: On April 4, 2019, the remote lab will be offline from approximately 8 am to 12 pm (UTC+2:00) due to maintenance !!!

Support
For any technical issue you may find, please contact us at fpga-vision-lab@h-brs.de

Demo
If you do not have a user account, you can try our demo experiments with the username **demo** and the password **welcome**.

Get an Account
If you want to have full access to the provided experiments you can register here!
For information on **privacy**, please see the **FAQ!**

Open Source
WebLab-Deusto is Open Source Software, and it is available in <https://github.com/weblabdeusto/weblabdeusto/>



Approach for distance education

- Video lectures for instructions
- Remote-lab for applying the knowledge
 - ⇒ Our name for this combination of formats: **Remote-lab-lecture**
- Open educational resource (CC-BY)

Seven video lectures

- Between 3 and 15 minutes

- English with subtitles



3x3 Sobel Filter

$$G_x = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$$
$$G_y = \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix}$$
$$G = \sqrt{G_x^2 + G_y^2}$$

You have a matrix for horizontal
and for vertical processing.



- subtitles in different languages

3x3 Sobel Filter

$$G_x = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$$

$$G_y = \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix}$$

$$G = \sqrt{G_x^2 + G_y^2}$$

You have a matrix for horizontal and vertical processing, working on a 3-by-3 image region.

Self-Checking Testbench

```

    graph LR
      Stimuli(stimuli file) --> Design[design under verification]
      Design --> Compare[compare]
      Compare --> Protocol(protocol)
      Reference(reference file) --> Compare
      Testbench(testbench) --> Design
  
```

і у нас є інший файл, в якому ми маємо очікуваний результат.

Los invito a este videocurso sobre procesamiento gráfico,

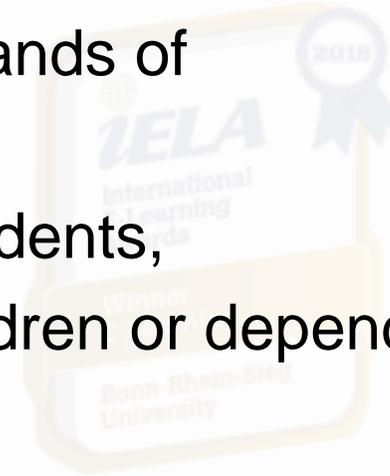
أدعوكم إلى فيديو تعليمي حول معالجة الصور



LEARNING GOALS



- State-of-the-art education should consider demands of
 - students in need of more time,
 - more learning opportunities for ambitious students,
 - flexible schedules for students caring for children or dependents in need of care.
- Providing remote labs is one possibility to meet these conditions:
 - possibility to work with real hardware
 - available 24/7
 - accessible via internet
 - ⇒ independence of time and space



Feedback on the FPGA Vision Remote Lab:

- Possibility to finish tasks from hands-on lab. ⇒ **profit for thorough students**
- We have more time to experiment, more than in the hands-on lab. ⇒ **opportunities for ambitious students**
- Work with real FPGAs at home. ⇒ **enhanced possibilities providing flexibility**
- Independence from time and location.

⇒ **students exploit the additional learning opportunity and like working with the FPGA Vision Remote Lab**

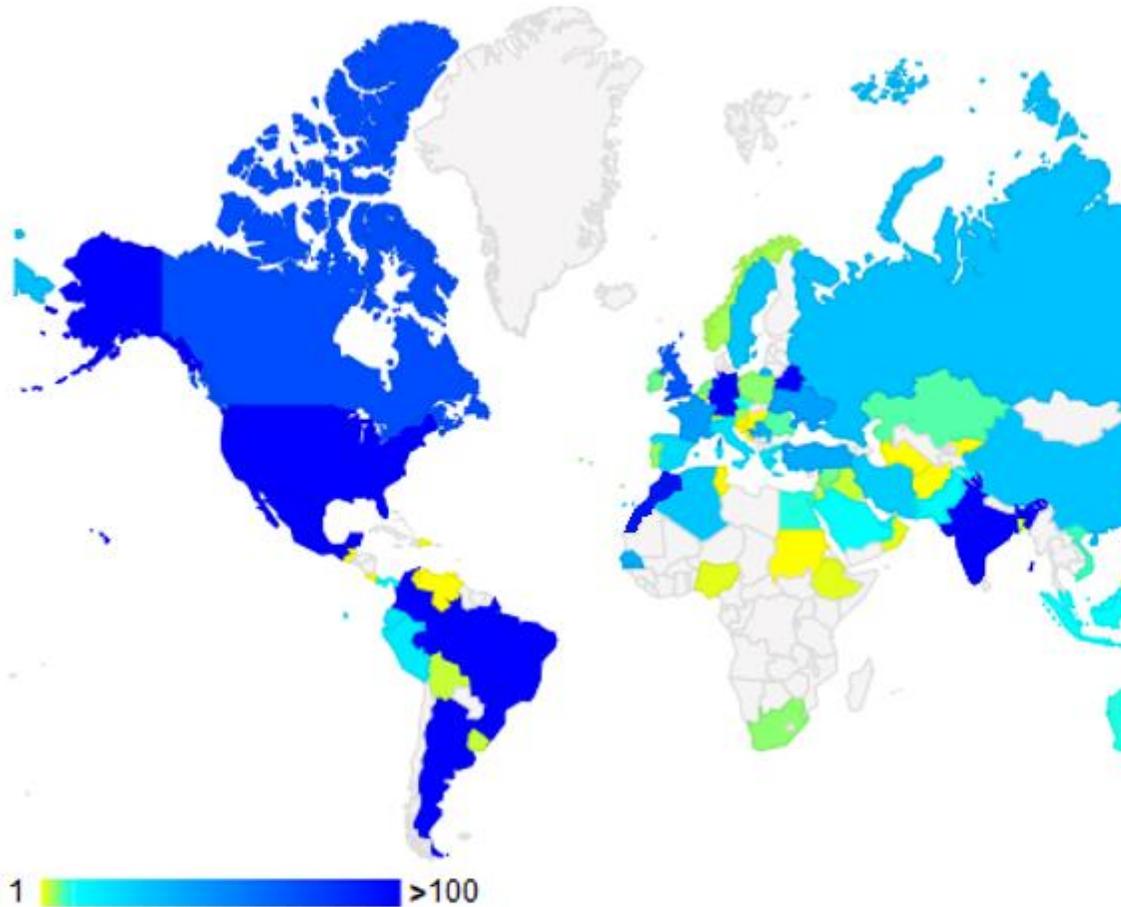




**Hochschule
Bonn-Rhein-Sieg**
University of Applied Sciences

Cyclone V Demo@FPGA experiments	2019-08-06 21:52:23	2019-08-06 21:54:24	202.3.77.100	Cyclone_V_Demo:laboratory1@core_host	Details
Cyclone V Demo@FPGA experiments	2019-08-06 21:50:08	2019-08-06 21:52:10	202.3.77.100	Cyclone_V_Demo:laboratory1@core_host	Details
Cyclone V@FPGA experiments	2019-07-05 17:41:48	2019-07-05 17:46:51	93.226.200.100	Cyclone_V:laboratory1@core_host	Details
Cyclone IV@FPGA experiments	2019-07-05 17:41:39	2019-07-05 17:41:43	93.226.200.100	Cyclone_IV:laboratory2@exp_host	Details
Cyclone IV@FPGA experiments	2019-07-05 17:28:18	2019-07-05 17:33:19	93.226.200.100	Cyclone_IV:laboratory2@exp_host	Details
Cyclone IV@FPGA experiments	2019-07-05 17:22:55	2019-07-05 17:27:56	93.226.200.100	Cyclone_IV:laboratory2@exp_host	Details
Cyclone V@FPGA experiments	2019-07-05 16:32:03	2019-07-05 16:37:05	93.226.200.100	Cyclone_V:laboratory1@core_host	Details
Cyclone V@FPGA experiments	2019-07-05 16:26:50	2019-07-05 16:31:53	93.226.200.100	Cyclone_V:laboratory1@core_host	Details
Cyclone V@FPGA experiments	2019-07-05 16:21:38	2019-07-05 16:26:39	93.226.200.100	Cyclone_V:laboratory1@core_host	Details
Cyclone V Demo@FPGA experiments	2019-07-05 15:54:16	2019-07-05 15:54:42	93.226.200.100	Cyclone_V_Demo:laboratory1@core_host	Details

LEARNING ANALYTICS



- accesses from 250 countries (stats March 2022)

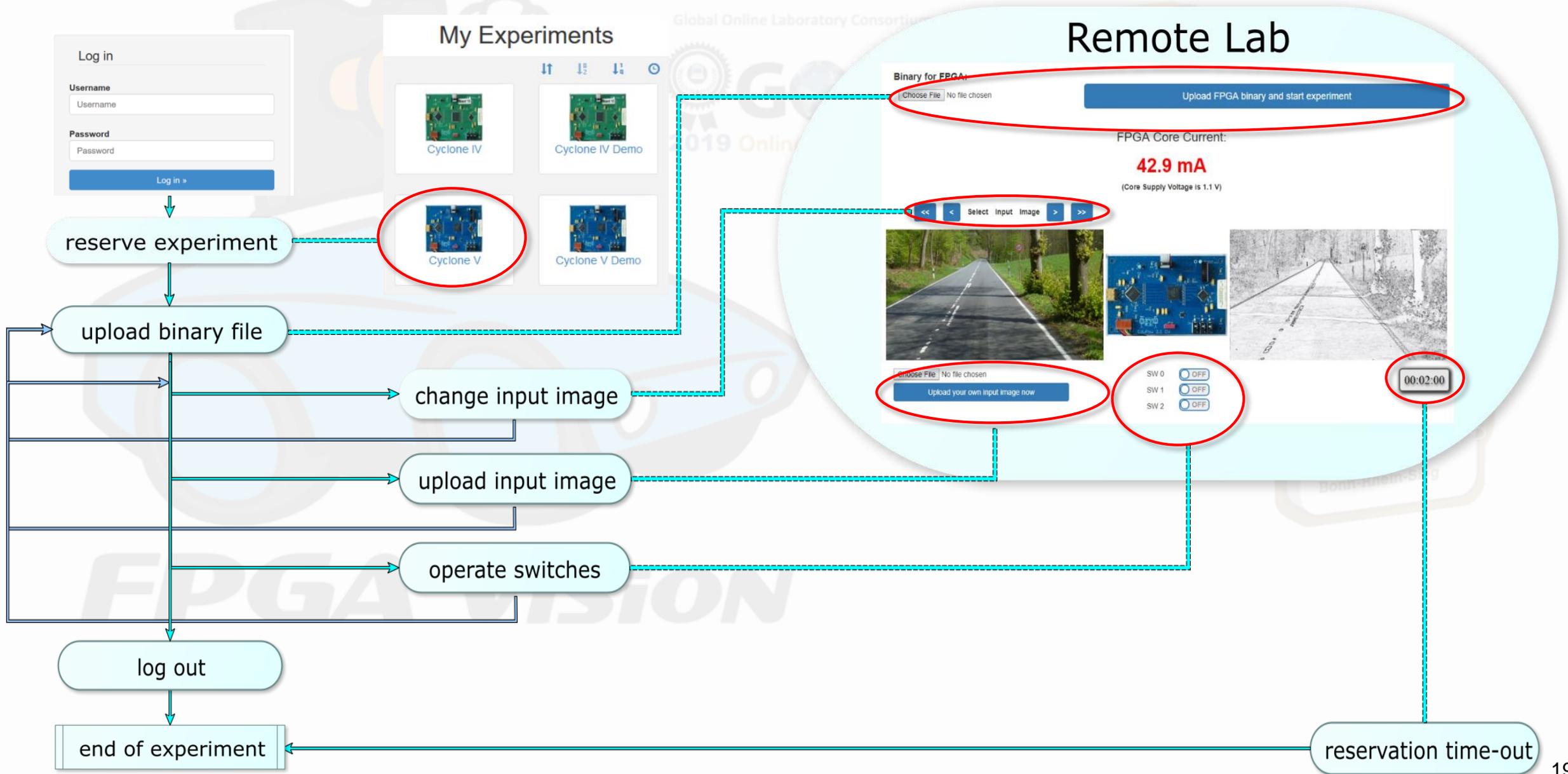
User	Experiment	Start date	End date	Origin	Coord address	Details
	Cyclone V@FPGA experiments	2019-08-06 21:54:50	2019-08-06 21:56:32	202.3.77.	Cyclone_V:laboratory1@core_host	Details
	Cyclone V Demo@FPGA experiments	2019-08-06 21:52:21				ails
	Cyclone V Demo@FPGA experiments	2019-08-06 21:50:21				ails
	Cyclone V@FPGA experiments	2019-08-06 17:41:44				ails
	Cyclone IV@FPGA experiments	2019-08-06 17:41:33				ails
	Cyclone IV@FPGA experiments	2019-08-06 17:28:17				ails
	Cyclone IV@FPGA experiments	2019-08-06 17:22:59				ails
	Cyclone V@FPGA experiments	2019-08-06 16:32:00				ails
	Cyclone V@FPGA experiments	2019-08-06 16:26:59				ails
	Cyclone V@FPGA experiments	2019-08-06 16:21:33				ails
	Cyclone V Demo@FPGA experiments	2019-08-06 15:54:17				ails
	Cyclone V@FPGA experiments	2019-08-06 15:53:22				ails
	Cyclone IV Demo@FPGA experiments	2019-08-06 15:52:17				ails

Details

Login	
Full name	
Experiment	Cyclone V@FPGA experiments
Start date	2019-08-06 21:54:50
End date	2019-08-06 21:56:32
Origin	202.3.77.
Device	Cyclone_V:laboratory1@core_host
Web browser	Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/75.0.3770.142 Safari/537.36
Mobil	False
Facebook	False
Language	en
Referer	https://fpga-vision-lab.h-brs.de/weblab/web/pub/fpgavision_CV.html?locale=en&c=https://fpga-vision-lab.h-brs.de/weblab/labs/FPGA%20experiments/Cyclone%20V/config.json
Server	route1
Reservation identifier	666f71a2-32a7-4bef-b123-550c7e869064
Country	IN
City	Kanpur



User Activity in a Remote Lab Scenario

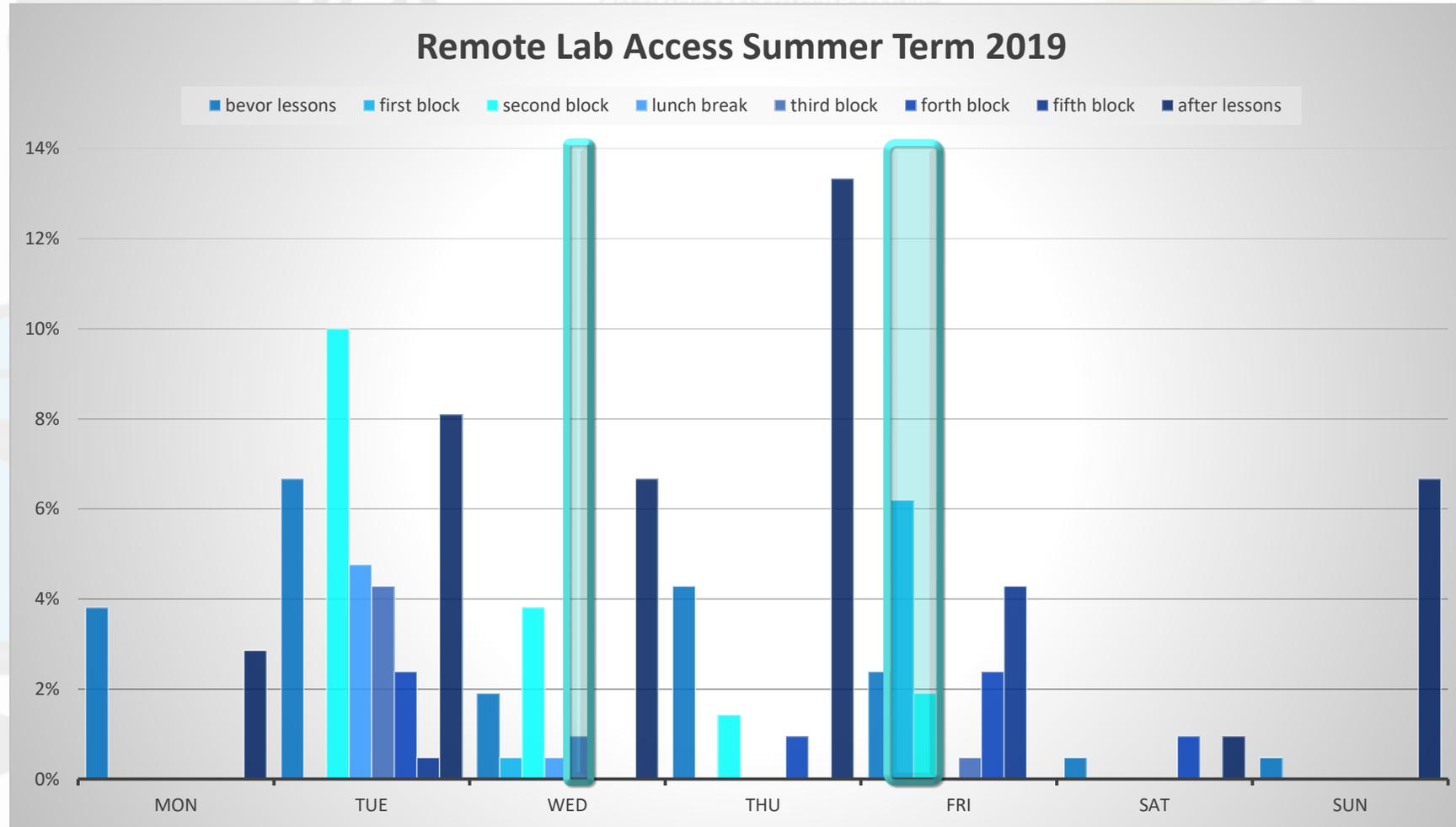




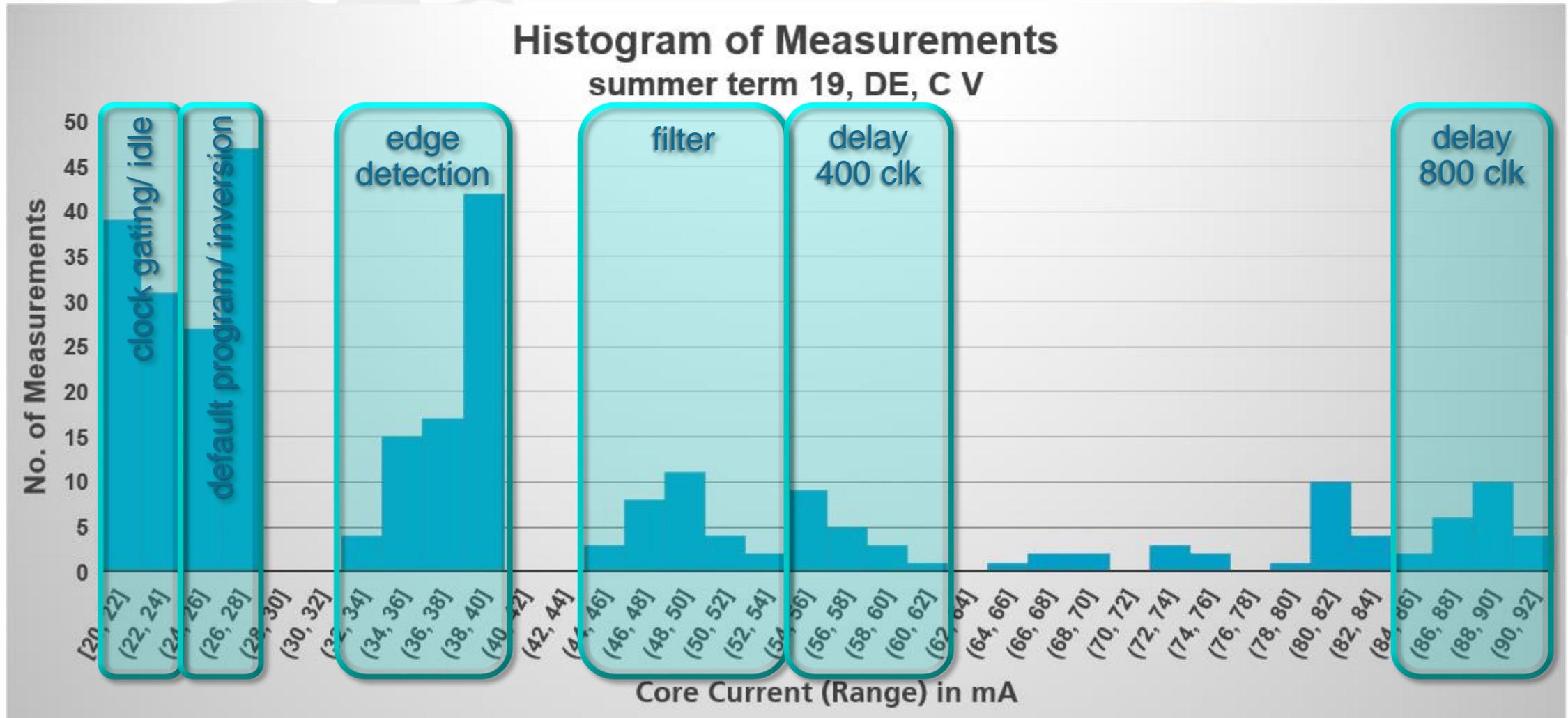
Interactions

Timestamp before	Timestamp after	Request	Response	Link
2020-03-27 19:34:47.795138	2020-03-27 19:34:47.805783	@@@initial::request@@@	{"back": "https://fpga-vision-lab.h-brs.de/web/lab/labs/FPGA%20experiments/C%20V%20all/?finished=true"}	N/A
2020-03-27 19:34:47.795138	2020-03-27 19:34:47.805783	@@@initial::response@@@	CV1	N/A
2020-03-27 19:34:48.058673	2020-03-27 19:34:49.076684	sw0_off	command received switch00	N/A
2020-03-27 19:34:49.078635	2020-03-27 19:34:50.099244	sw1_off	command received switch10	N/A
2020-03-27 19:34:50.100094	2020-03-27 19:34:51.117394	sw2_off	command received switch20	N/A
2020-03-27 19:34:51.118612	2020-03-27 19:34:52.144532	image_home	command received img_home	N/A
2020-03-27 19:35:00.243167	2020-03-27 19:35:00.260547	None (<file not stored>)	Your bit file is transferred...	Download
2020-03-27 19:35:00.307408	2020-03-27 19:35:00.886652	program	An Error (3) occurred!! Please be sure to chose the appropriate bit-file for the Cyclone V (5CEBAA2F17C6N)	N/A
2020-03-27 19:35:16.339341	2020-03-27 19:35:16.397050	bit_file.sof (<file not stored>)	Your bit file is transferred...	Download
2020-03-27 19:35:16.442392	2020-03-27 19:35:21.464961	program	Done	N/A
2020-03-27 19:35:22.722767	2020-03-27 19:35:22.918895	update	Image update processed	N/A
2020-03-27 19:35:22.965646	2020-03-27 19:35:24.295887	measure	50.44 mA	N/A
2020-03-27 19:37:49.096090	2020-03-27 19:37:59.192677	@@@finish@@@	None	N/A





⇒ students exploit the remote lab to prepare and finish their experiments



- measurement data shows variety of experiment types

The FPGA Vision Remote Lab

- online since Jan. 2018
- availability over 99.75 %
- more than 10 000 experiments performed (total)
- analyzation of over 950 experiments for learning analytics

- ⇒ evaluation results show students' acceptance of the remote lab
- ⇒ log in data shows the remote lab's usage in addition to lab hours
- ⇒ measurement results show the type of experiments performed



Visit us at:
<https://www.h-brs.de/fpga-vision-lab>

Global Online Laboratory Consortium



 FPGA Vision

Bronze
E-Learning
Experience

Hochschule
Bonn-Rhein-Sieg