Open source hardware and KiCAD

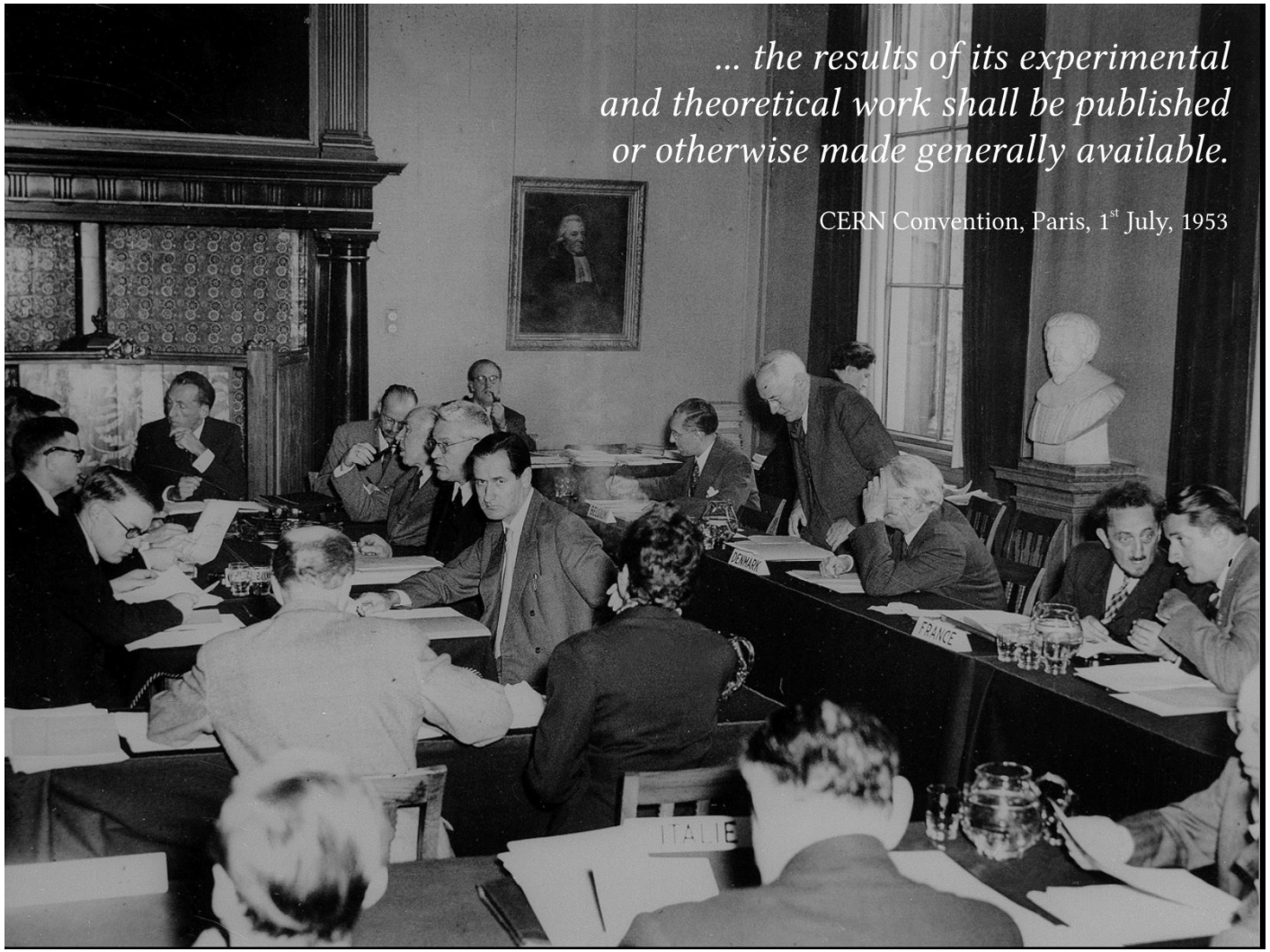
Erik van der Bij
BE-CO Hardware and Timing section
CERN, Geneva, Switzerland

Geneva, 21 November 2018

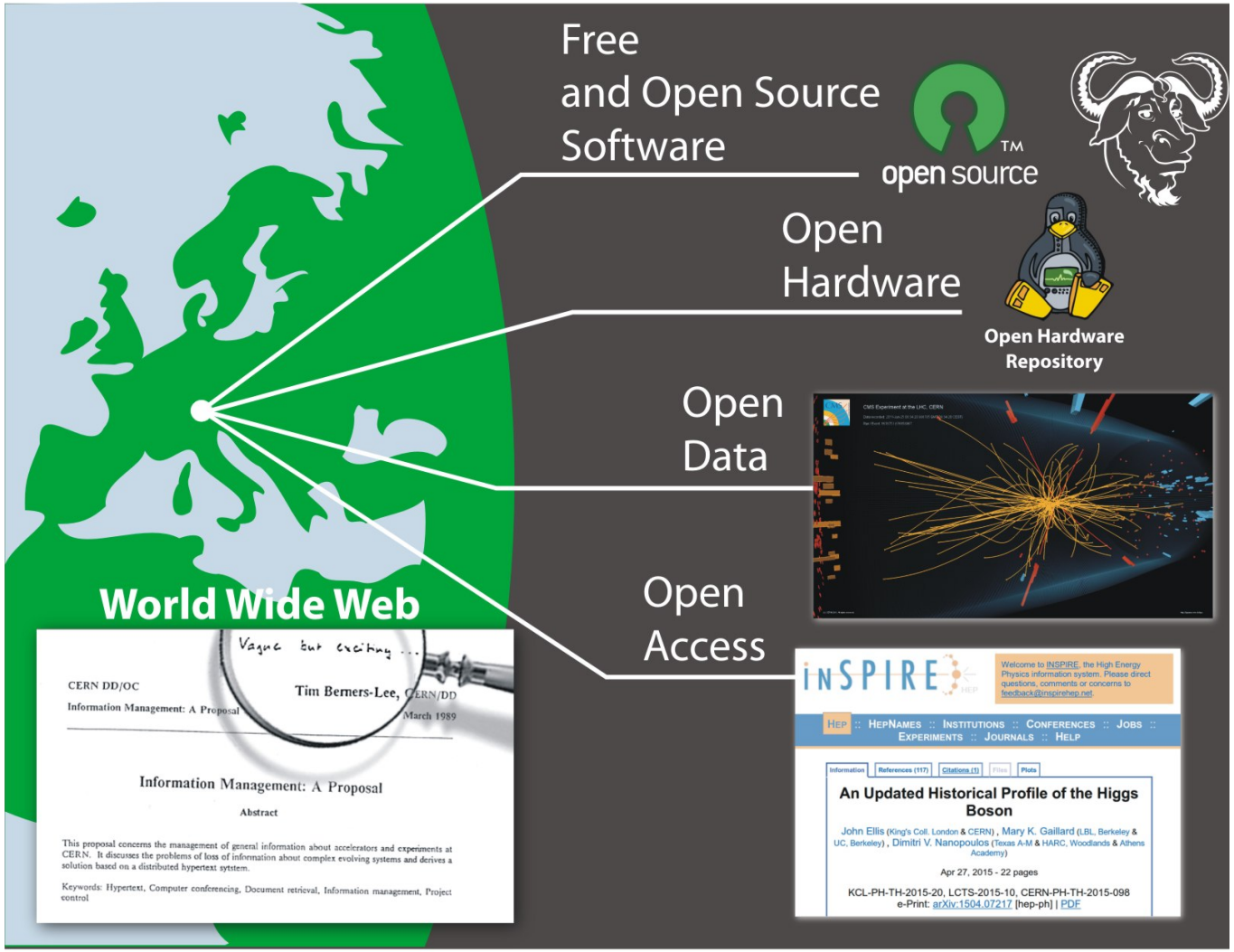
Outline

Outline

Dissemination



How to interpret one's dissemination mandate in the 21st century



Outline

Why we use Open Hardware

Design re-use

- When it's Open, people are more likely to re-use it.
- When it's Open, people are much more likely to contribute.

Peer review

- Get your design reviewed by experts all around the world.
- Therefore the designs will become better.

Dissemination of knowledge

- One of CERN's key missions!

Why we use Open Hardware

Get a design just the way we want it

- We specify fully the design.

Healthier relationship with companies

- No vendor-locked situations. Companies selected solely on the basis of technical excellence, good support and price.

Spend money where you or your funding agencies want

- Makes life easier for public institutions.
- Opens the door to smaller companies with good local support.

CERN Open Hardware License – ohwr.org/cernohl

Provides a solid legal basis

- Developed by Knowledge and Technology Transfer Group at CERN.
- Open Software licences not usable (GNU, GPL, . . .).

Practical: makes it easier to work with others

- Upfront clear: anything you give is available to everyone.
- Everyone can use it for free.
- No strings attached. *Really!*

CERN Open Hardware License – ohwr.org/cernohl

Same principles as Open Software

- Anyone can see the source (design documentation).
- Anyone is free to study, modify and share.
- Any modification and distribution under same licence.
- Persistence makes everyone profit from improvements.

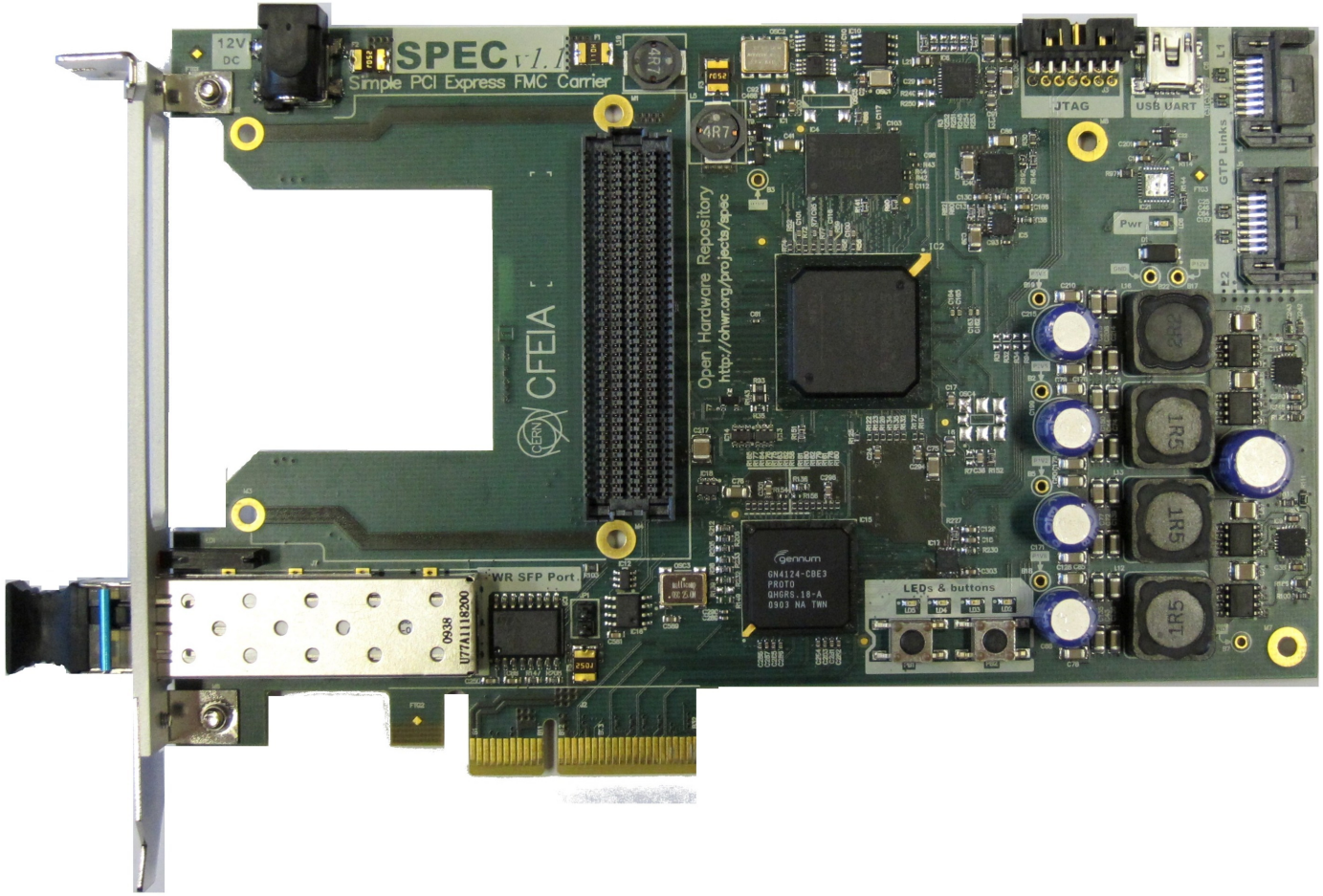
Hardware production

- When produce: licensee is invited to inform the licensor.

Outline

Example: SPEC - Simple PCI Express FMC carrier

Made in Spain, The Netherlands, Greece & Poland



Example of a project in the Open Hardware Repository – ohwr.org

Simple PCIe FMC carrier (SPEC) OPEN HARDWARE REPOSITORY

- Overview
- Activity
- Mailing List
- Roadmap
- Work packages
- News
- Repository
- Wiki
- Members
- Documents
- Project settings

Overview

Project description

A simple 4-lane PCIe carrier for a low pin count FPGA Mezzanine Card (VITA 57). It supports the White Rabbit timing and control network. Commercially available. Linux and Labview drivers available for some mezzanine cards.
More info at the Wiki page

Edit

Members

Manager: Erik van der Bij; Javier Serrano; Matthieu Cattin; Tomasz Wlostowski
Developer: Alessandro Rubini; Benoit Rat; Carlos Gil Soriano Federico Vaga; Grzegorz Daniluk; Grzegorz Kasprowicz; Mar Brückner; Ralf Wischnewski; Samuel Iglesias Gonsálvez
Reporter: Cesar Prados; Dietrich Beck

Member View all members

Project details

- Subprojects: Getting Started with the SPEC, Simple PCIe FMC carrier (SPEC) - Software, SPEC box 1 Node, SPEC Box 3 Nodes (Rack 19")

Latest news

SPEC Fan design files released

Be Open

Use OHR to the fullest

- Document everything on OHR:
  - schematics, mechanics, status.
- Discuss over mailing list. Already from start of project.
- Document design review results.
- Track Issues and detected bugs.

Don't be afraid to show mistakes!

- E.g. SPEC: 107 Issues documented, 57 still 'Open'.
- Issues may help others when adapting a design.
- OHR becomes a teaching tool.

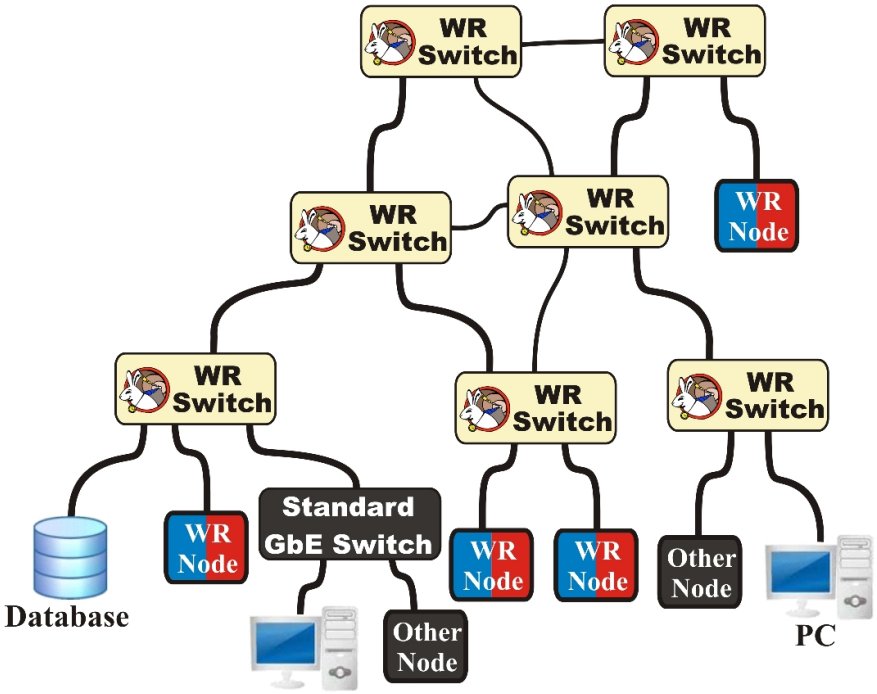
Re-use of the SPEC design

White Rabbit – Innovation with Open approach

- Started at CERN and GSI high-energy physics labs.
- Everything Open: hardware, gateware, software.
- Made extensive use of small companies to develop.
- Companies develop and sell products based on it.

White Rabbit – is Ethernet

- Bandwidth: 1 Gbps
- Single fiber medium
- Up to 10 km links
- WR Switch: 18 ports
- Ethernet features (VLAN) & protocols (SNMP)
- Synchronization:
  - accuracy better than 1 ns
  - precision (tens of ps sdev skew max)

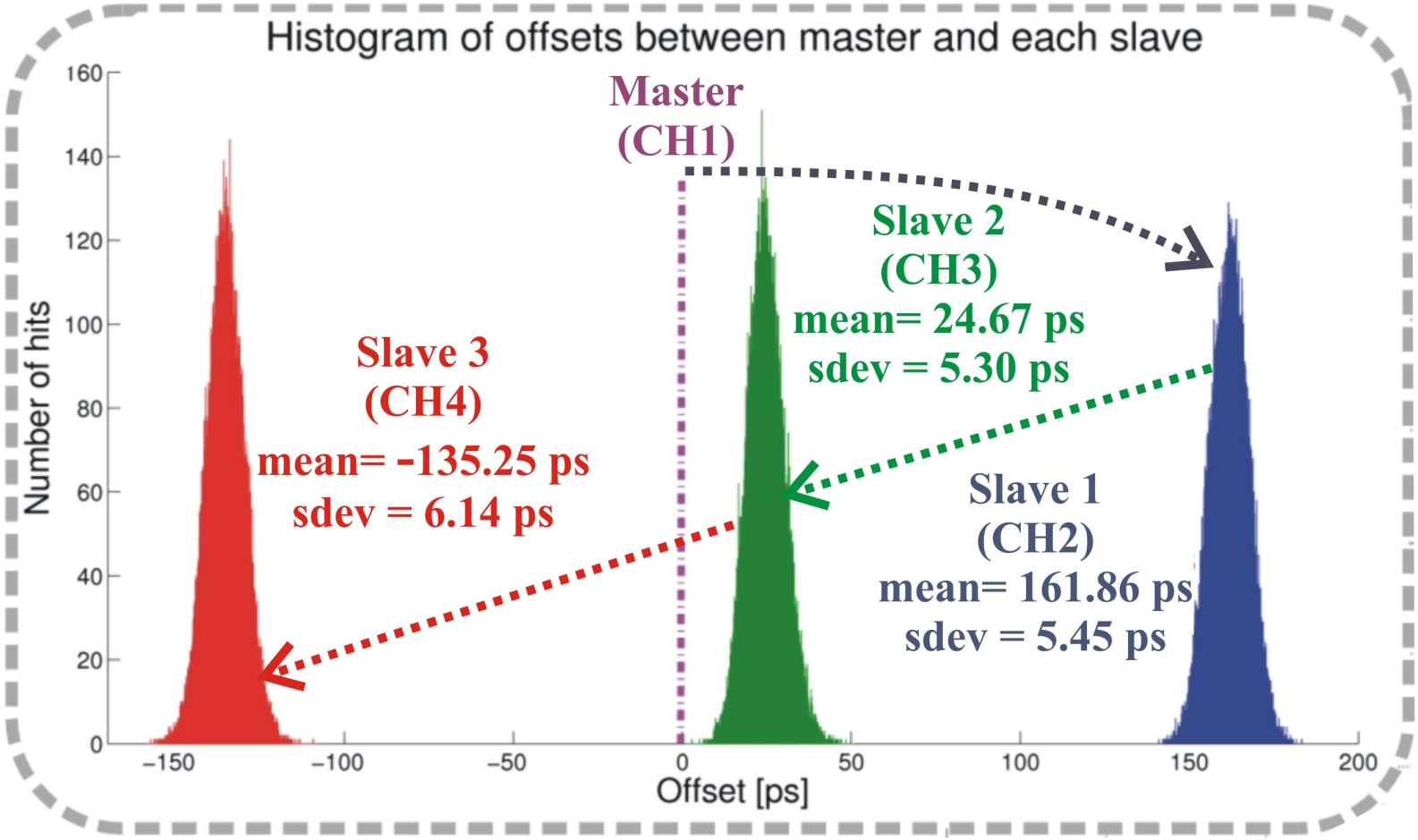


WR time transfer performance: lab tests

3 cascaded switches

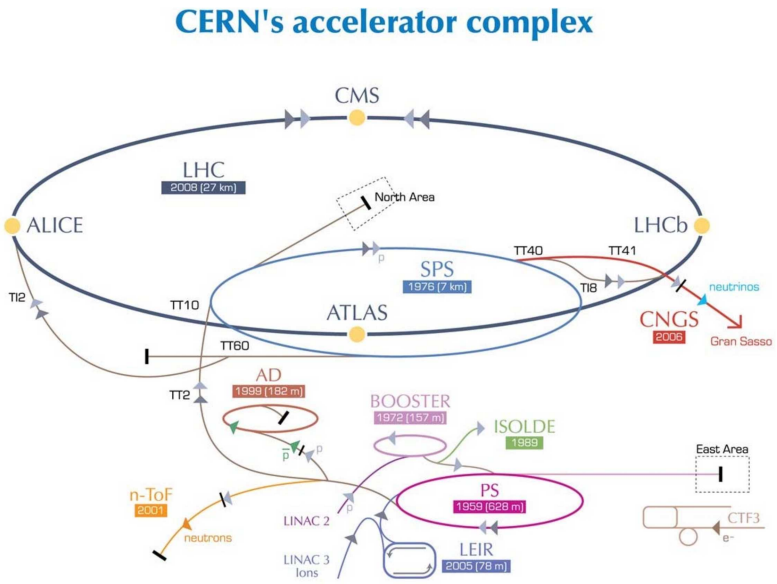
WR time transfer performance: lab tests

3 cascaded switches



White Rabbit applications

- Particle accelerators
  - **CERN (Switzerland/France)**
  - **GSI (Germany)**



White Rabbit applications

- Particle accelerators
  - CERN (Switzerland/France)
  - GSI (Germany)
- Cosmic ray & neutrinos detectors
  - **LHAASO (China)**
  - **HiSCORE (Siberia)**
  - **KM3NET (Mediterranean)**
- Metrology laboratories
  - **MIKES (Finland, 950 km)**
  - **VSL (Netherlands)**
- Other
  - **Deutsche Bank (Germany)**
  - **Vodafone (Netherlands, 320 km)**

Dutch Metrology Institute

All users: `www.ohwr.org/projects/white-rabbit/wiki/WRUsers`

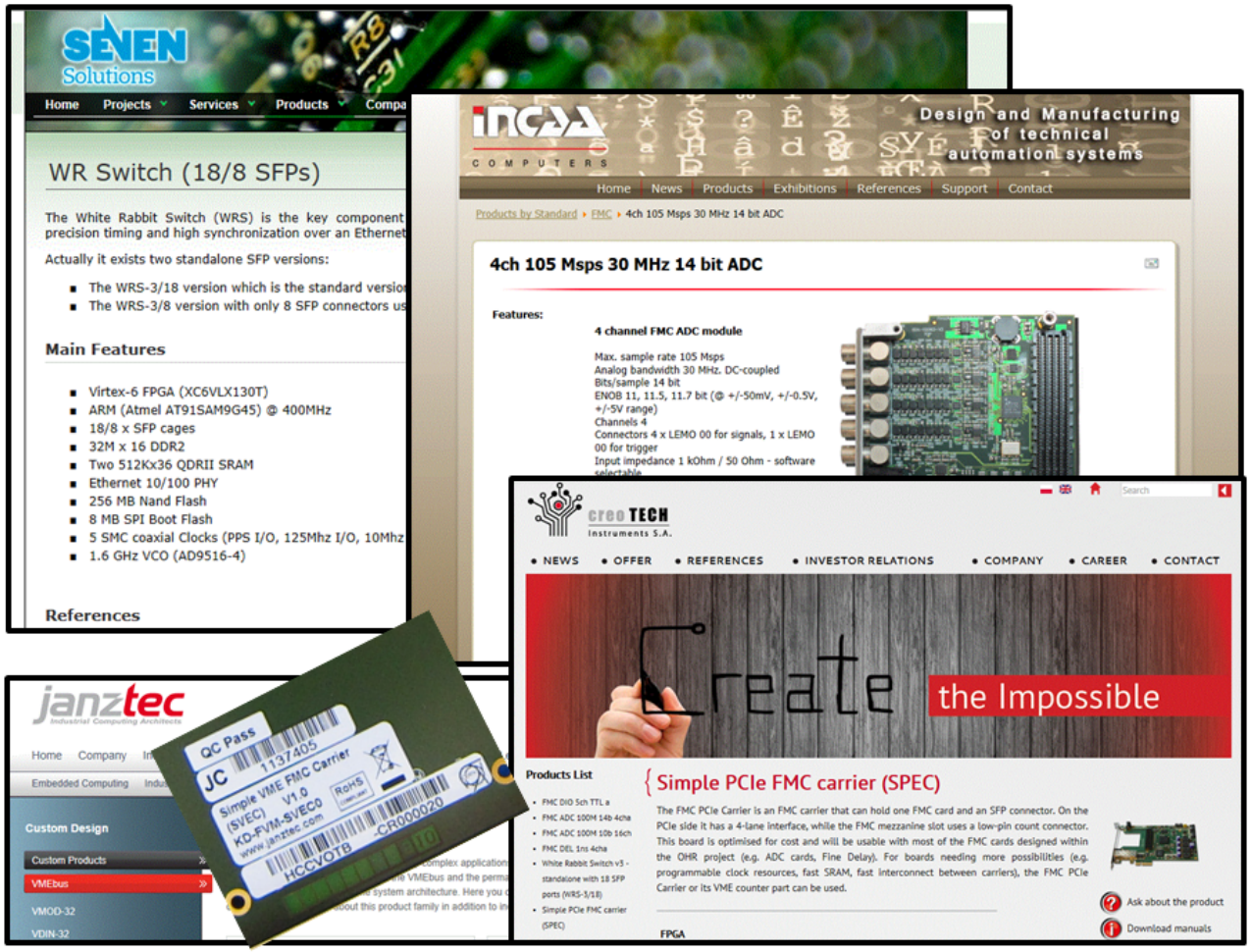
Business models

Dispelling the commercial vs open myth

	Commercial	Non-commercial
Open	**Winning combination. Best of both worlds.**	Whole support burden falls on developers. Not scalable.
Proprietary	Vendor lock-in.	Dedicated non-reusable projects.

Where the rubber meets the road

Nine years of experience at CERN



Many CERN groups share their designs on ohwr.org

Large variety of electronics. Some examples

- FMC carriers: VME, PXIe, PCIe, AMC, ATCA, pizzabox **(BE-BI, BE-CO, BE-RF, EP-ESE, EN-SMM, TE-ABT)**
- FMC mezzanines: ADC, DAC, TDC, Fine Delay, DIO **(BE-CO, BE-RF, TE-ABT, TE-EPC)**
- Data centre environmental sensor **(IT-ST)**
- Metrology grade ADC **(TE-EPC)**
- Radtol LED safety lighting **(EN-EL)**
- Trigger/Timing logic unit for beam tests **(EP-UCM)**
- Gateware: VME64x core, uRiscV core, general cores

Other reference info shared on ohwr.org

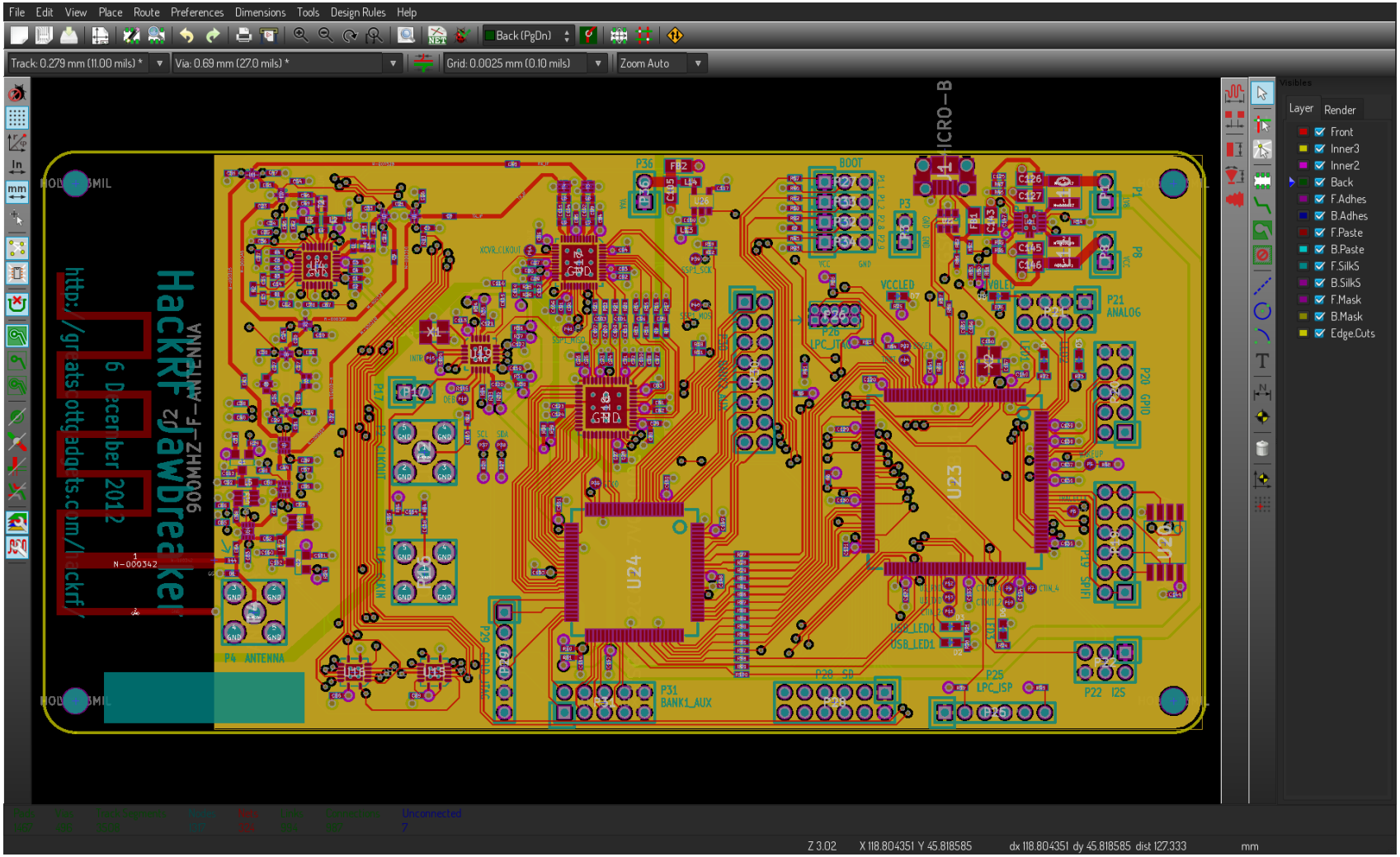
FMC catalogue, Electronics training

- FMC: links to standard, components and catalogue https://www.ohwr.org/projects/fmc-projects/wiki.
- Electronics Design https://www.ohwr.org/projects/ed/wiki.
  - Schematics design review checklist.
  - Sites to find components.
  - Tips for outsourcing.
  - Links to resources for electronics (books, training).
  - Links to tips from other departments and places.

Outline

Free-as-in-freedom design tools

The last hurdle to efficient sharing - kicad-pcb.org



Free-as-in-freedom design tools

Currently hard to share a design

- Proprietary tools use incompatible formats.
- No 'open' PCB design tools of sufficient quality and ease of use exist.
- Collaboration between institutes and companies obstructed.

Tools should be free and open to be able to share

Basically the community is missing a *gcc* for hardware.

KiCAD

Goals

- Do for PCB design what *gcc* did for software.
- Get KiCAD on par with mid-range proprietary tools.
- Be able to design most of our PCBs in KiCAD.

CERN's continuation to lead in Open Hardware

- Have received support from CERN KT fund.
- Orson Suminski, Tom Wlostowski and subcontractors made big advancements.
- CERN & Society received donations to support.
- KiCAD community progresses independently as well.
- Design office gave useful feedback.

KiCAD

Status

- We started five years ago.
- Positive comments from users.
- Version 5 is recently released.
- KiCAD is getting pretty good, but not good enough yet.

Progressing steadily

- We'll get there slowly but steadily.
- You may help to let it happen faster.

`www.ohwr.org/projects/cern-kicad/wiki`

Outline

Conclusions

Open Hardware on ohwr.org

- Many CERN groups use it.
- More return to society and is fun!
- Check if you can reuse a design.
- Your project can also be hosted.
- A vast experience is shared.

KiCAD

- It is usable for simple projects.
- If you want to help advance: contact us.