

GEFE project status

Manoel Barros Marin on behalf of the GEFE Team

EP-ESE/SY-BI Collaboration Seminar
(14/06/2021)



SY-BI

GEFE project status

Outline:

- **Introduction**
- **The GEFE project**
- **Summary**



GEFE project status

Outline:

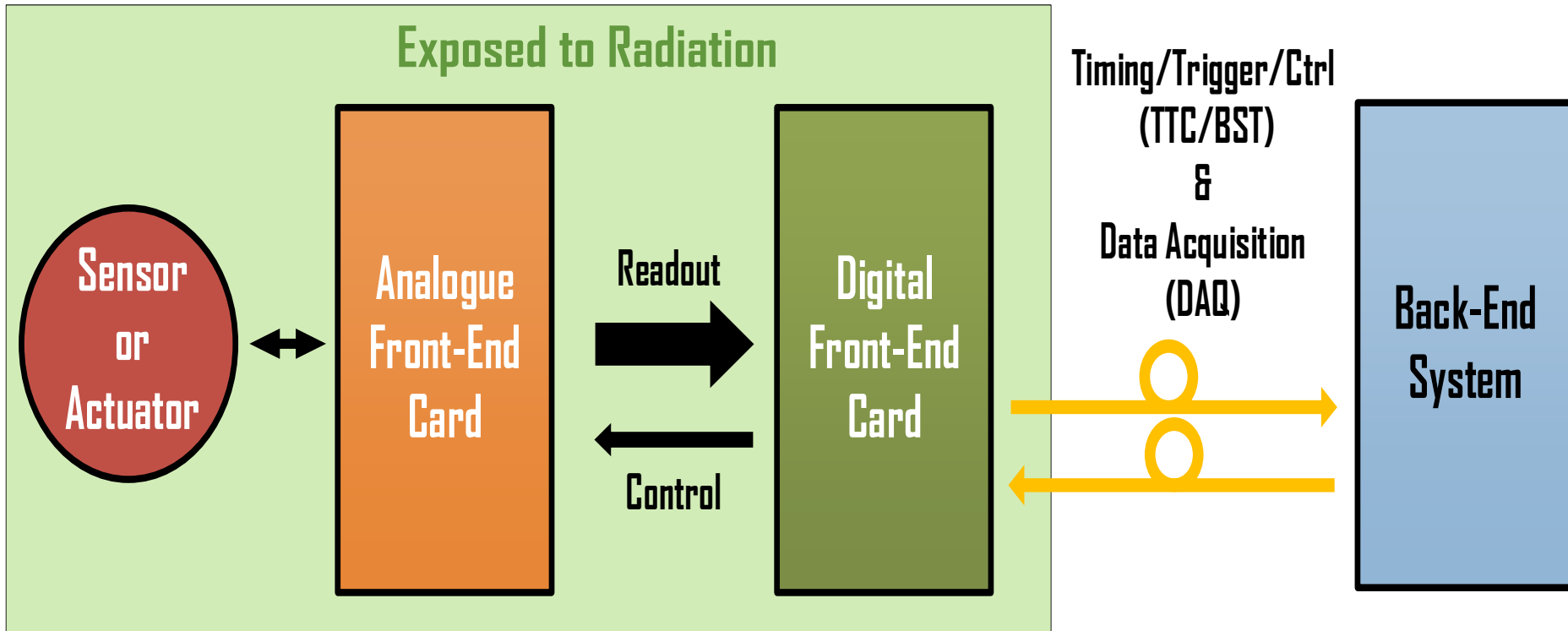
- **Introduction**
- The GEFE project
- Summary



Introduction

Electronics for Beam Instrumentation

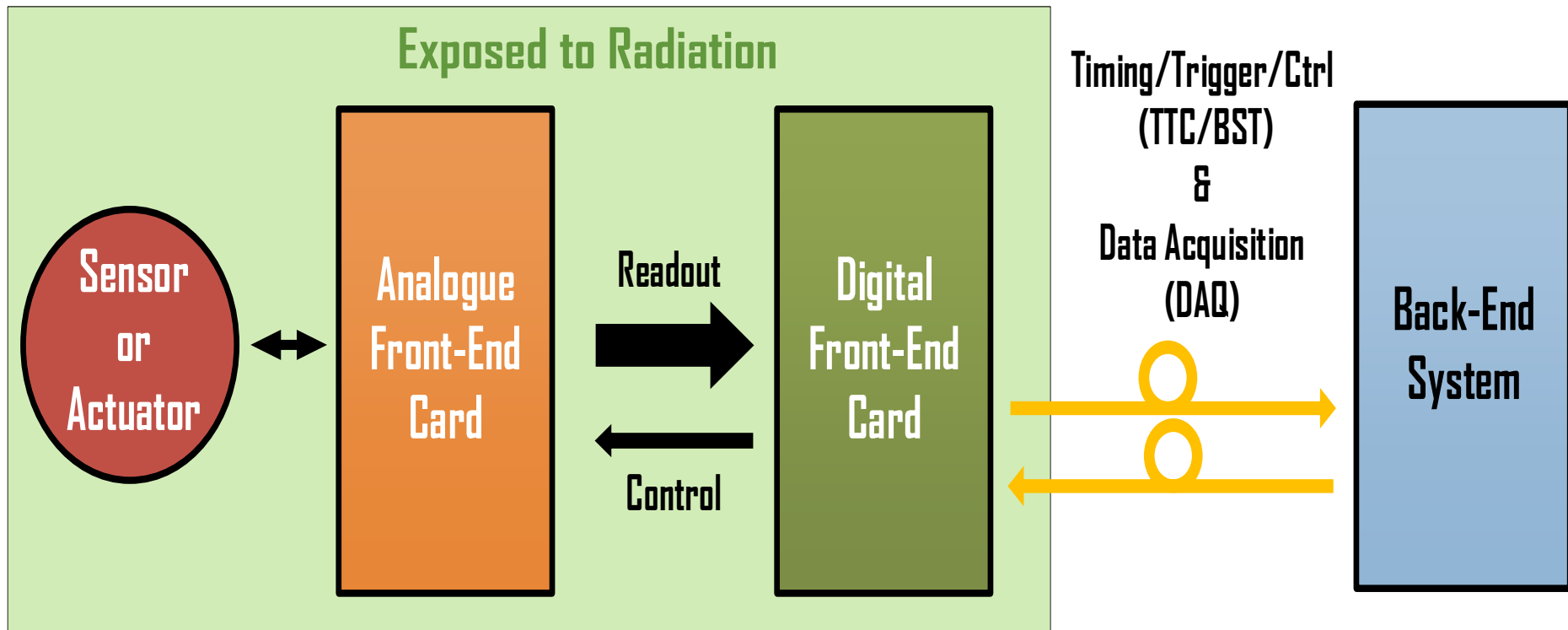
- **Similar architecture** in different BI projects



Introduction

Electronics for Beam Instrumentation

- **Similar architecture** in different BI projects



Also similar to EP-ESE projects

Introduction



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Motivation

Common Back-End & Common Digital Front-End (DFE)

Facilitates:

- Design & Implementation
- Maintenance
- etc.

Introduction



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Motivation

Common Back-End & Common Digital Front-End (DFE)

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- etc.

Reusing existing resources when possible

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The GEFE project



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Our approach

- For the **HardWare**:
 - **Typical procedures** for rad-hard electronic devices (e.g. simple design, rad-hard components)
 - **Know-how** about radiation hardness **from other groups** (e.g. EP-ESE, SY-EPC, R2E)
 - Use of **active components already qualified** in terms of radiation hardness:
 - GBT-Versatile Link ecosystem (e.g. **VTRx**, **GBTx**)
 - Microsemi **ProAsic3** FPGA
 - Other active components (e.g. BJT, Schmitt-Trigger)

Reports from:

- EP-ESE (CERN)
- SY-EPC (CERN)
- R2E (CERN)
- ESA
- REDW (IEEE)
- etc.

The GEFE project



Our approach

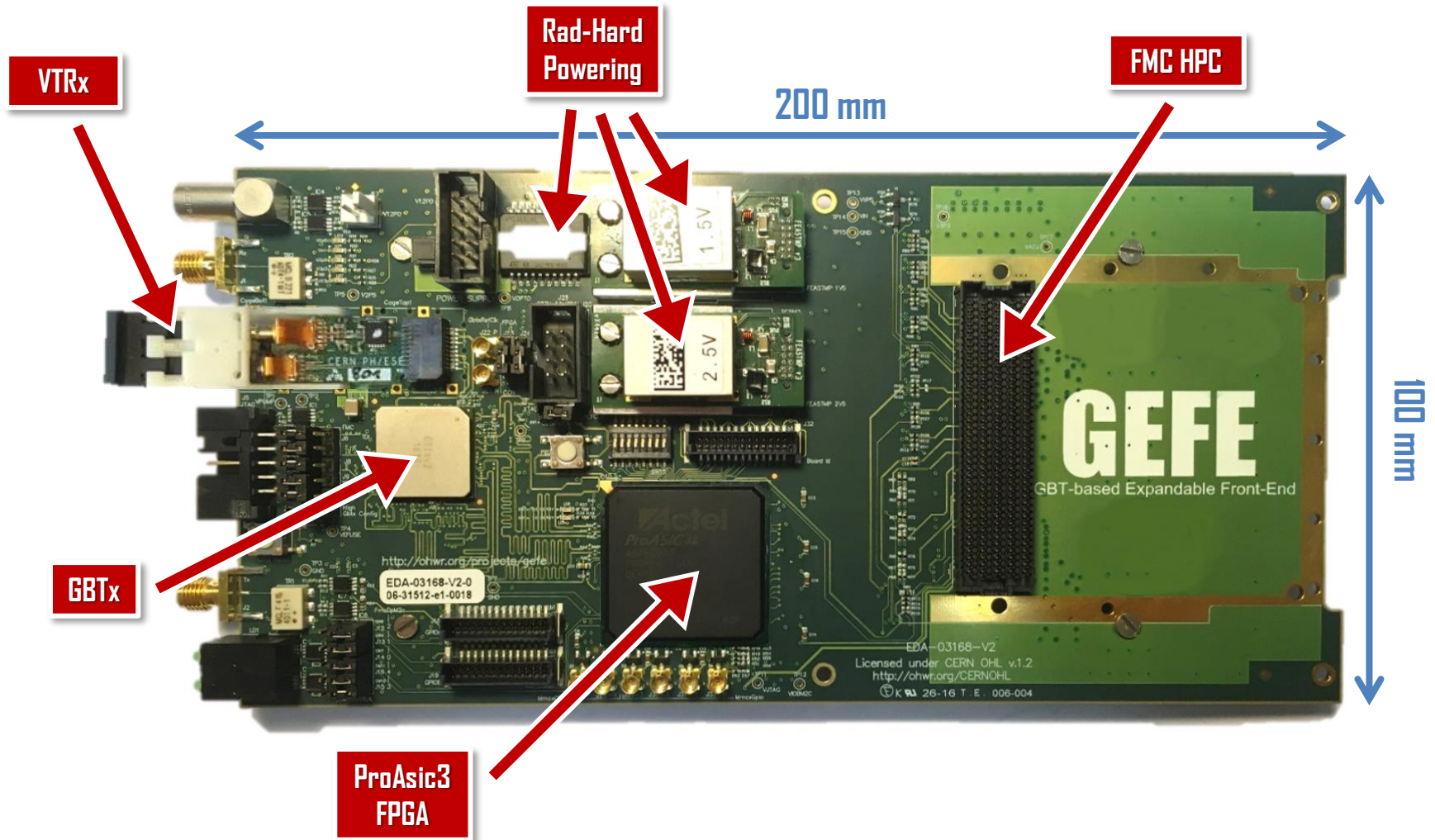
- For the **Community**:
 - **Regular meetings** with the different teams
 - **Specifications** (User Guide)
 - **Open HardWare Repository** (OHWR) Wiki
 - Updates through **email lists**:
 - Email list for all GEFE community: gefe@ohwr.org
 - Email list for GEFE community from CERN only: gefe-community@cern.ch

The GEFE project



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The GBT-based Expandable Front-End (GEFE)



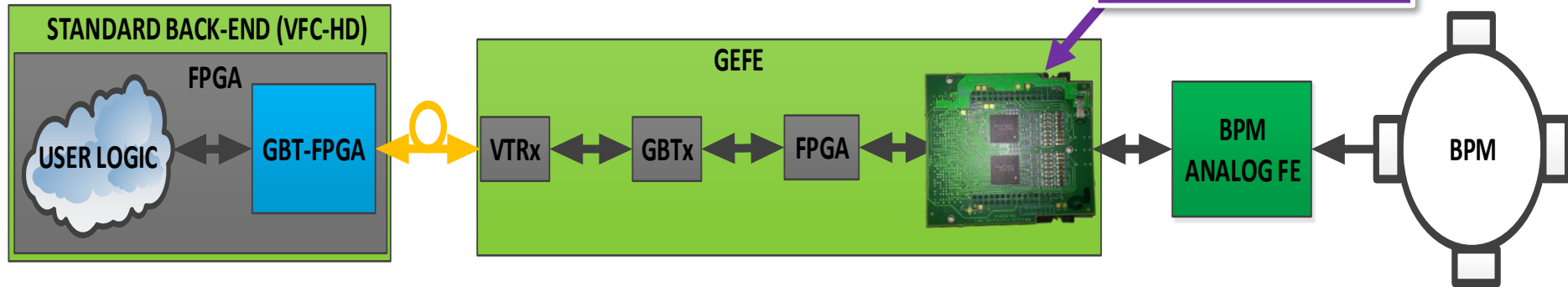
The GEFE project



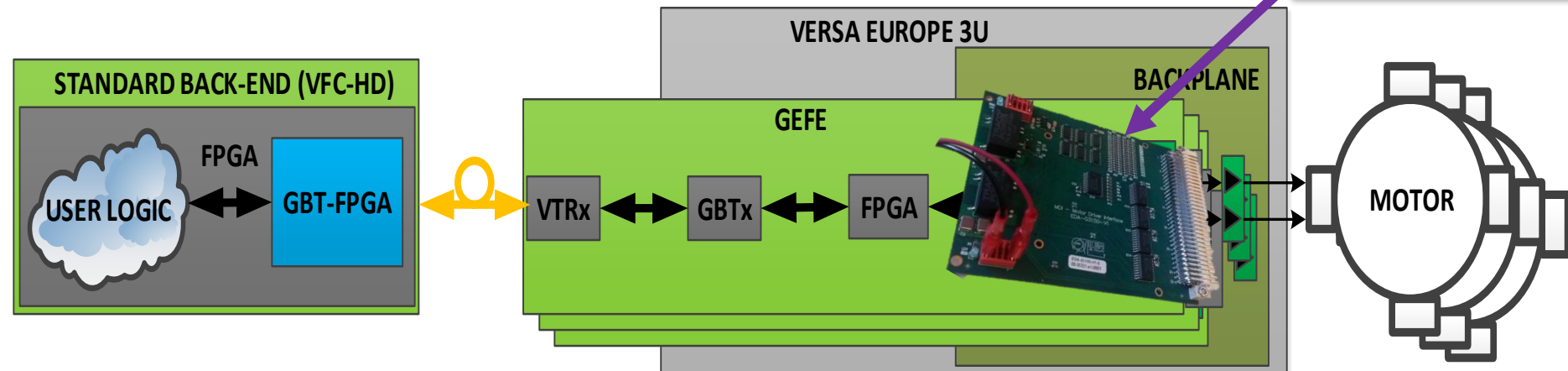
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GEFE-based projects examples

- A Logarithmic Position System (**ALPS**) (New SPS BPM) (SY-BI-QP):



- Motor Controller with Optical Interface (**MCOI**) (SY-BI-PM):

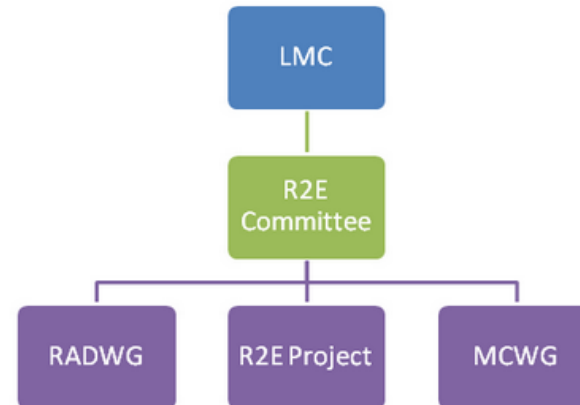


The GEFE project



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Radiation Tests & Monitoring



- **Radiation Working Group (RADWG):**
 - Provides support for the **assessment of radiation tolerance** of electronic equipment
 - **Radiation test** campaigns, installation of **radiation monitors, etc.**
 - Regular **meetings**
- **Measurements and Calculations Working Group (MCWG):**
 - Aims at **improving the knowledge** of the radiation fields in accelerators at CERN
 - **Simulations & Measurements** comparisons
 - Regular **meetings**

The GEFE project



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Radiation Tests & Monitoring

- Active components (except FPGA) test:
 - Collaboration between CERN SY-BI & RADWG
 - Carried out in 2015/2016 at the Paul Scherrer Institut (PSI)
 - In beamline of COMET cyclotron:
 - Proton beam
 - 250 MeV
- Radiation levels:
 - Total Ionizing Dose (TID) up to 750 Gy
 - Fluence up to $9.31 \cdot 10^{11}$ p/cm²



COMET cyclotron at PSI



The GEFE project



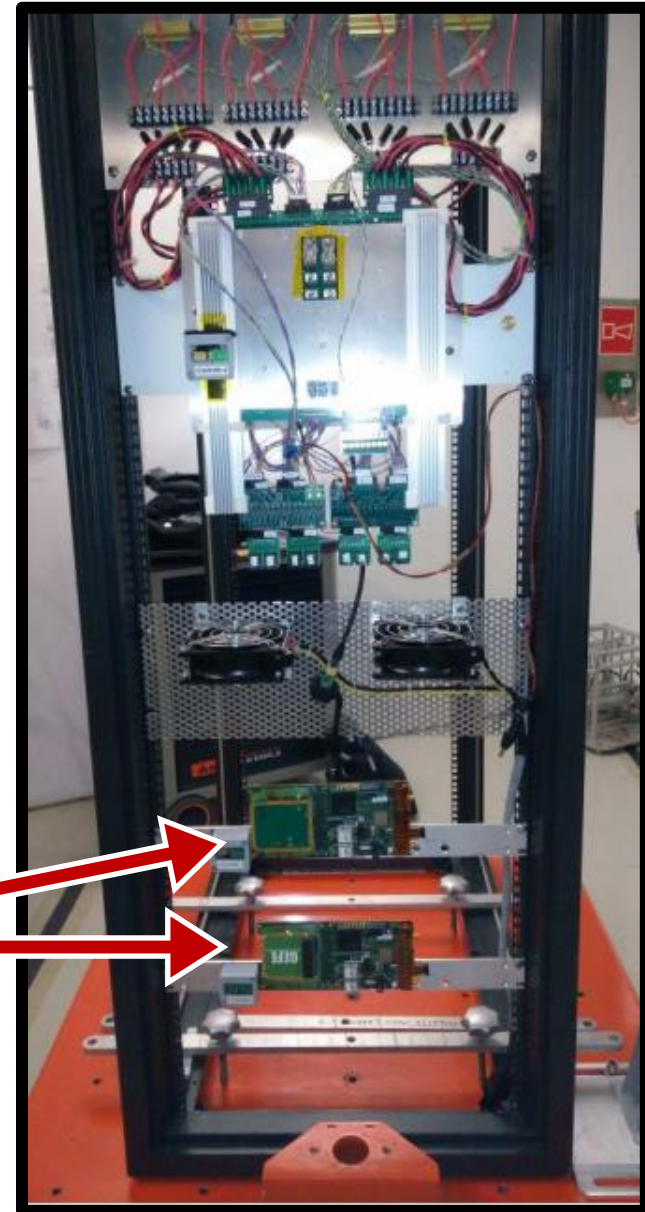
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Radiation Tests & Monitoring



- Board level test:
 - Collaboration between CERN SY-BI & RADWG
 - Carried out at CHARM
 - Mixed radiation field
 - Radiation levels:
 - Total Ionizing Dose (TID) up to ~ 750 Gy
 - Fluence up to $13.64 \cdot 10^{11}$ HEH/cm²
 - Two test campaigns:
 - GEFE prototype qualification (June 2016)
 - Production FPGAs qualification (June 2017)

GEFE



The GEFÉ project



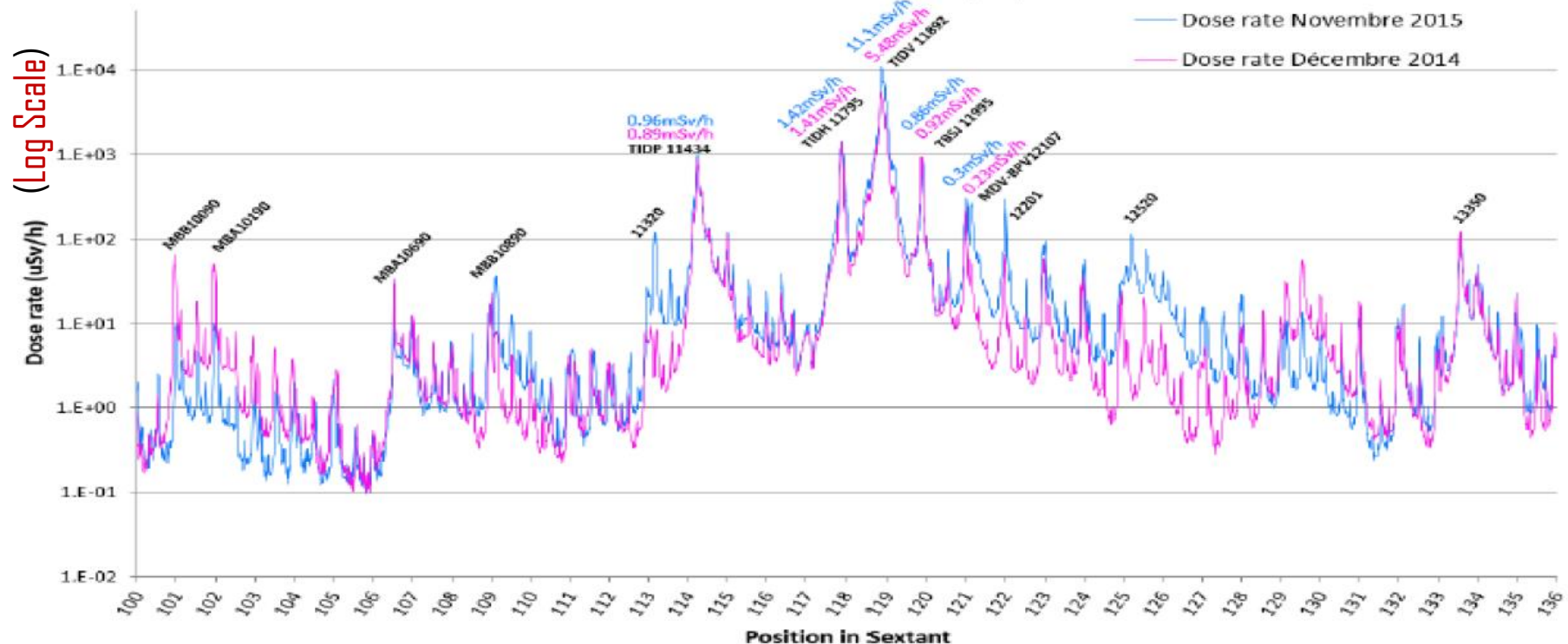
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Radiation Tests & Monitoring

- Radiation levels in SPS:
 - Maximum expected TID at selected positions (<10): ~1 kGy over 10 years
 - Latest RP survey results does not match the previous one (and foreseen to continue...)

SPS - Sextant 1

SEXTANT 1 - Comparaison entre Décembre 2014 et Novembre 2015
Activité rémanente fin du Run Physique



The GEFE project

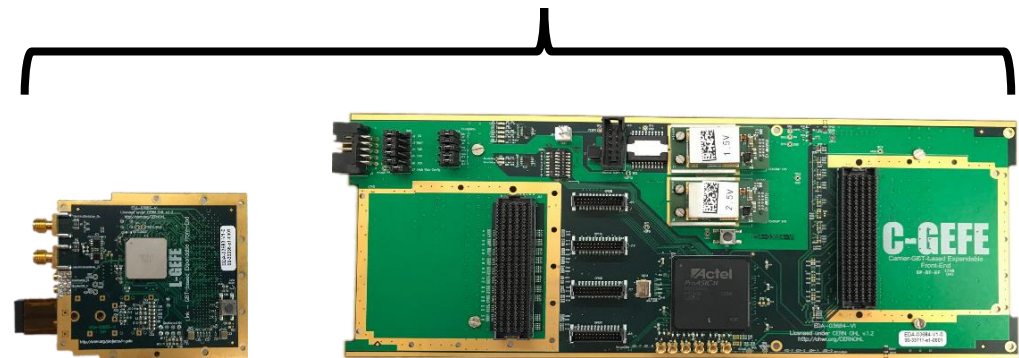
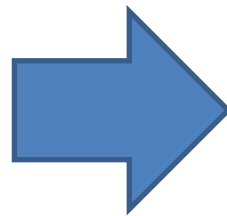
Radiation Tests & Monitoring



The GEFE project

Split GEFE (S-GEFE)

- The Split GEFE (**S-GEFE**) is an **evolution of the GEFE** board
- **Same functionality** as GEFE but **split in two boards**:
 - Link GEFE (**L-GEFE**):
 - FMC featuring **exotic components** from CERN EP-ESE (**GBTx, VTRx**)
 - Rad-hard by design up to **TID levels of >10 kGy**
 - Carrier GEFE (**C-GEFE**):
 - FMC carrier card featuring **COTS** (e.g. Proasic3 FPGA)
 - Rad-tolerant up to **TID levels of <750 Gy**
- The **L-GEFE and C-GEFE may be used independently**



The GEFE project



Status

- Project started in 2015 and successfully finished in 2019
- GEFE:
 - Fully operational
 - Radiation test successfully passed
 - 87 fabricated
- S-GEFE:
 - L-GEFE & C-GEFE fully operational
 - Radiation test do not required
 - 270 fabricated and 50 ordered
 - Components in stock for 30 more

The GEFE project



Status

- **Community:**
 - **Specification** available (it may be used as User Guide)
 - **Open HardWare Repository** (DHWR) Wiki and **Email Lists** (DHWR & CERN e-group)
 - Projects in the GEFE community:
 - A Logarithmic Position System (**ALPS**) (SPS BPM) (SY-BI-QP)
 - Motor Controller Optical Interface (**MCOI**) (SY-BI-PM)
 - Function Generator Controller Lite (**FGClite**) (SY-EPC-CCE)
 - **Beam Wire Scanners** (SY-BI-BL)
 - **RADWG test board** (BE-CEM-EPR)
 - Beam Gas Ionization (**BGI**) monitors (SY-BI-BL)
 - Distributed I/O Tier (**DIOT**) (BE-CEM-EDL)

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Summary



SY-BI

- **Motivation:**
 - Similar architecture and radiation environment in different projects at CERN
 - Common Back-End (VFC-HD) & Common Rad-Hard Digital Front-End (GEFE & S-GEFE)
- **The GEFE project:**
 - GEFE & S-GEFE boards
 - Community of users
 - More than 400 boards (GEFE + S-GEFE)
 - Used in 7 projects (either for prototyping or operation)
 - Successfully finished
- **GEFE features the RadHard components from EP-ESE (e.g. GBTx, VTRx, FEASTMP)**
- **Radiation tests & monitoring with the help of R2E (RADWG & MCWG)**

Summary



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Big THANK YOU
to our colleagues from
EP-ESE and R2E

**Any
Question?**



BE-BI