



nan●FIP project

Components Validation

ProASIC3 Rad Test Campaigns

PSI Apr 2011 | **Preliminary** tests | Test setup qualification

PSI Dec 2011 | **Large scale** tests | Design σ estimation

PSI Apr 2013 | **Batches** validation | Device TID and σ characterization

Batch#1: 5'000 ProASIC3 preconfigured and laser marked

Batch#2: 5'000 ProASIC3 unconfigured

ProASIC3 Rad Test Campaigns

PSI Apr 2011 | **Preliminary** tests | Test setup qualification

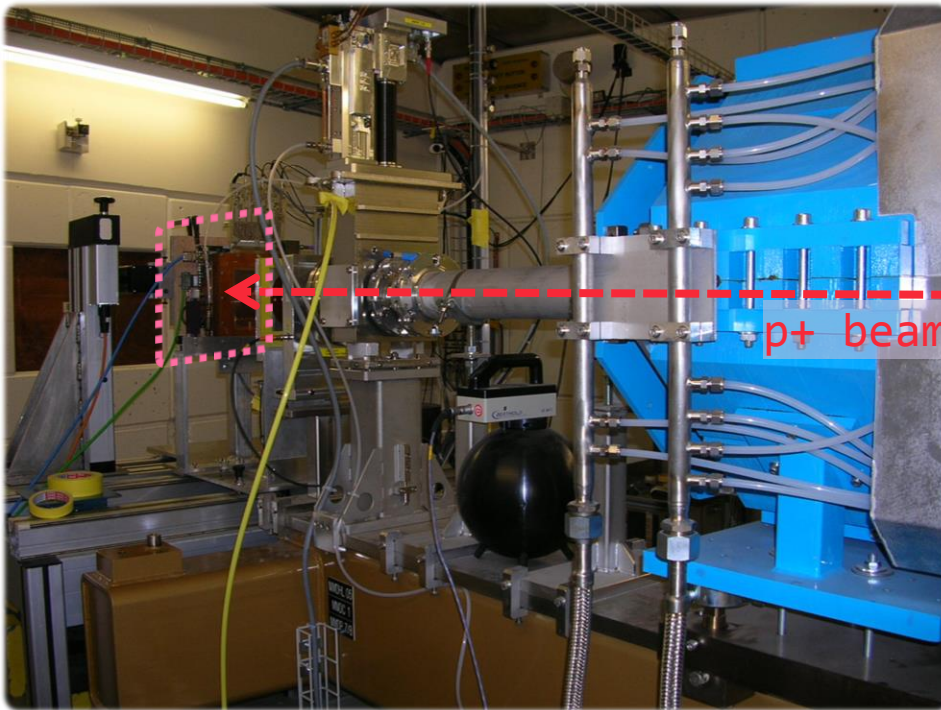
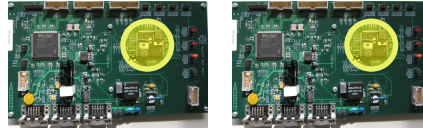
PSI Dec 2011 | **Large scale** tests | Design σ estimation

PSI Apr 2013 | **Batches** validation | Device TID and SEE characterization

Batch#1: 5'000 ProASIC3 preconfigured and laser marked

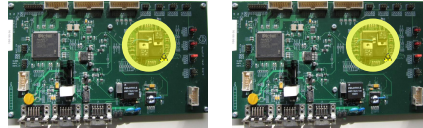
Batch#2: 5'000 ProASIC3 unconfigured

o Sample size: 2



Preliminary tests PSI April 2011

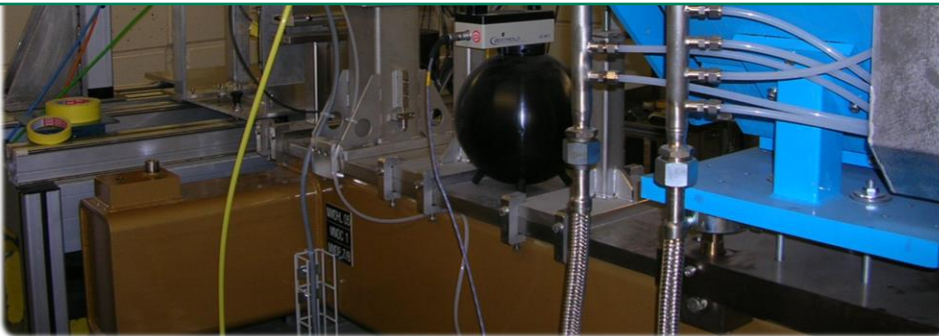
- o Sample size: 2



- o **Reliable setup**

- o **No SEE**

- o **TID 400 Gy** agrees with tests by the manufacturer



Preliminary tests PSI April 2011

Rad Test Campaigns

PSI Apr 2011 | **Preliminary** tests | Test setup qualification

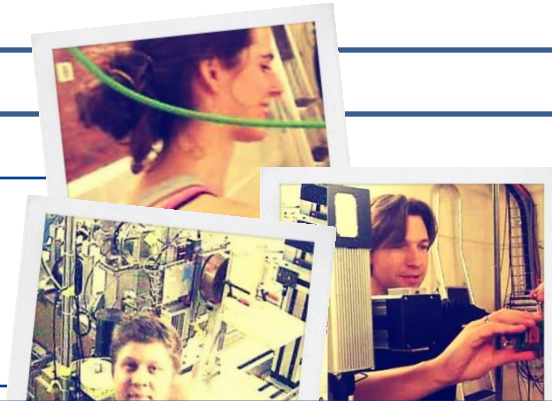
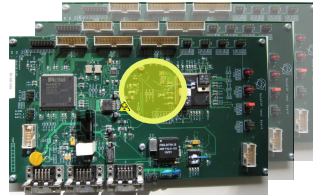
PSI Dec 2011 | **Large scale** tests | Design σ estimation

PSI Apr 2013 | **Batches** validation | Device TID and SEE characterization

Batch#1: 5'000 ProASIC3 preprogrammed and laser marked

Batch#2: 5'000 ProASIC3 unprogrammed

o Sample size: **14**



o nanoFIP design $\sigma < 1e-13 \text{ cm}^2$

o nanoFIP design **TID 400 Gy**

o nanoFIP design **without TMR** $\sigma \sim 7e-11 \text{ cm}^2$

o ProASIC3 **reconfiguration unit** TID limit 200 Gy

Rad Test Campaigns

PSI Apr 2011 | **Preliminary** tests | Test setup qualification

PSI Dec 2011 | **Large scale** tests | Design σ estimation

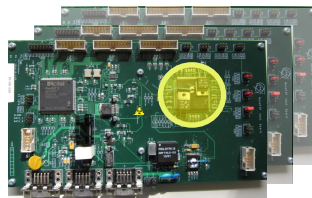
PSI Apr 2013 | **Batches** validation | Device TID and σ characterization

Batch#1: 5'000 ProASIC3 preconfigured and laser marked

Batch#2: 5'000 ProASIC3 unconfigured



- Sample size: 10



- Batch#1 $\sigma < 1e-13 \text{ cm}^2$

- Batch#1 TID > 400 Gy

- **Batch#1 qualified!**



Batches validation PSI March 2013

Rad Test Campaigns

PSI Apr 2011 | **Preliminary** tests | Test setup qualification

PSI Dec 2011 | **Large scale** tests | Design SEE estimation

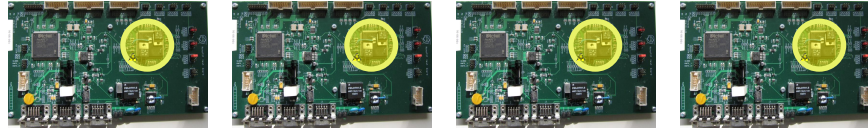
PSI Apr 2013 | **Batches** validation | Device TID and σ characterization

Batch#1: 5'000 ProASIC3 preconfigured and laser marked

Batch#2: 5'000 ProASIC3 unconfigured



o Sample size: **4**



o Batch#2 $\sigma < 4e-12 \text{ cm}^2$

o Batch#2 **TID** > 400 Gy

o No influence of **heating** (50°C) while irradiating

⇒ Pending irradiation of **6 more devices**



nan●FIP project
FieldDrive | FieldTR





- **4'000** purchased devices
 - **No lot tracking** by Alstom
 - FieldDrive **analog** and **digital** part
-
- **No dedicated tests**, but there is some **confidence**
 - Several groups tested at **CNGS, LHC**
 - Parasitically tested 2 devices; up to 400 Gy and up to 700 Gy

FieldDrive | FieldTR test proposal



- Study of failures of the **analog** part
 - **Fraunhofer**; irradiation of **complete boards**
 - ~**5** nanoFIPdiag boards



- Study of failures of the **digital** part
 - **PSI** targeted beam
 - ~**5** nanoFIP test boards



Conclusions

- o nanoFIP ProASIC3 **Batch#1 validated!** 5'000 devices available

- o Unconfigured **ProASIC3 Batch#2** 6 devices **pending** to be tested

- o High confidence levels from previous testing

- o FieldDrive/ FieldTR organise **dedicated testing**

- o Discussion on sample size/ samples selection



WorldFP

Extras

A large, blurred funnel-shaped graphic in the background, composed of many small, overlapping lines in various colors (red, blue, green, yellow) that converge towards a point at the bottom. The background is a light blue gradient.

Extras

Radiation Tests Target

PSI facility, p+ 250MeV

$2.1e9 \text{ p+}/\text{cm}^2/\text{Gy}$

300 Gy lifetime of an Actel ProASIC3 device

$6.3 e11 \text{ p+}/\text{cm}^2$ with each device

$6.3 e12 \text{ p+}/\text{cm}^2$ with 10 decices

$$\sigma_{\text{nanoFIP}} = \sim 1e-13 \text{ cm}^2$$

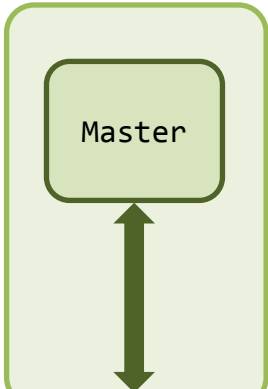
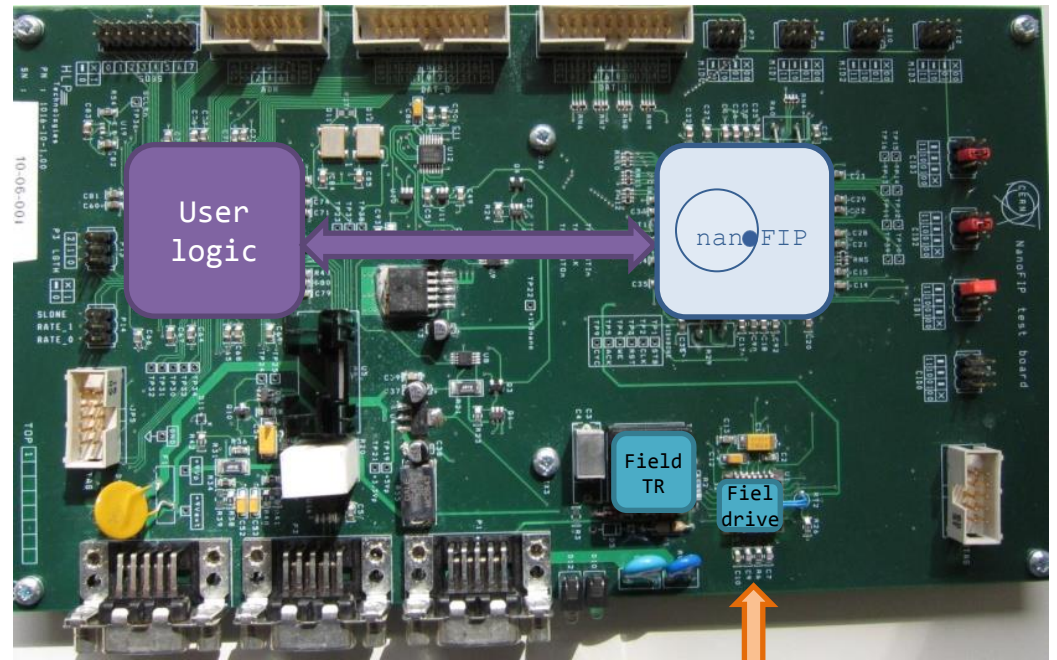
LHC

5000 nanoFIPs in the LHC

$$\sigma_{\text{system}} = \sim 5e-10 \text{ cm}^2$$

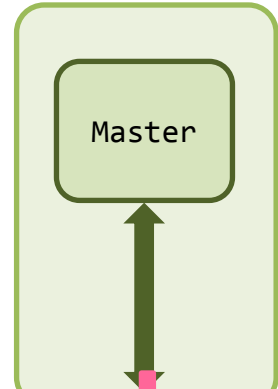
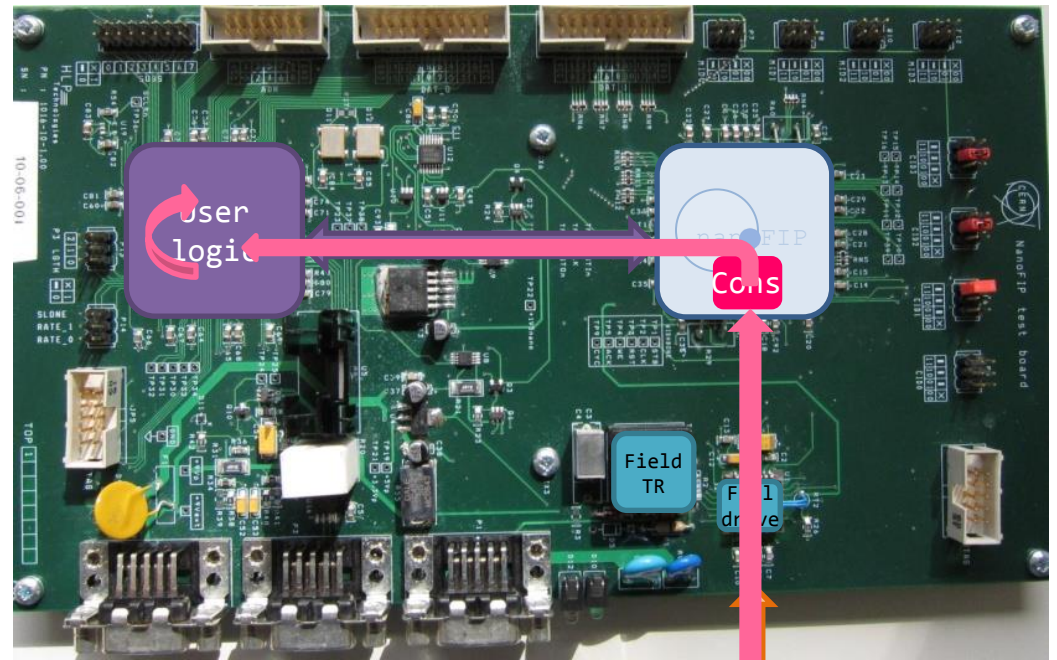
10 SEE / year

Test Setup

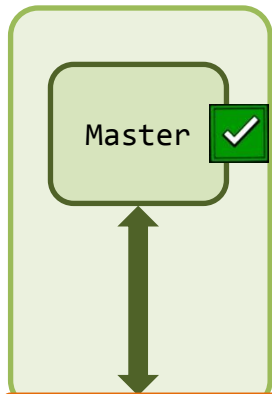
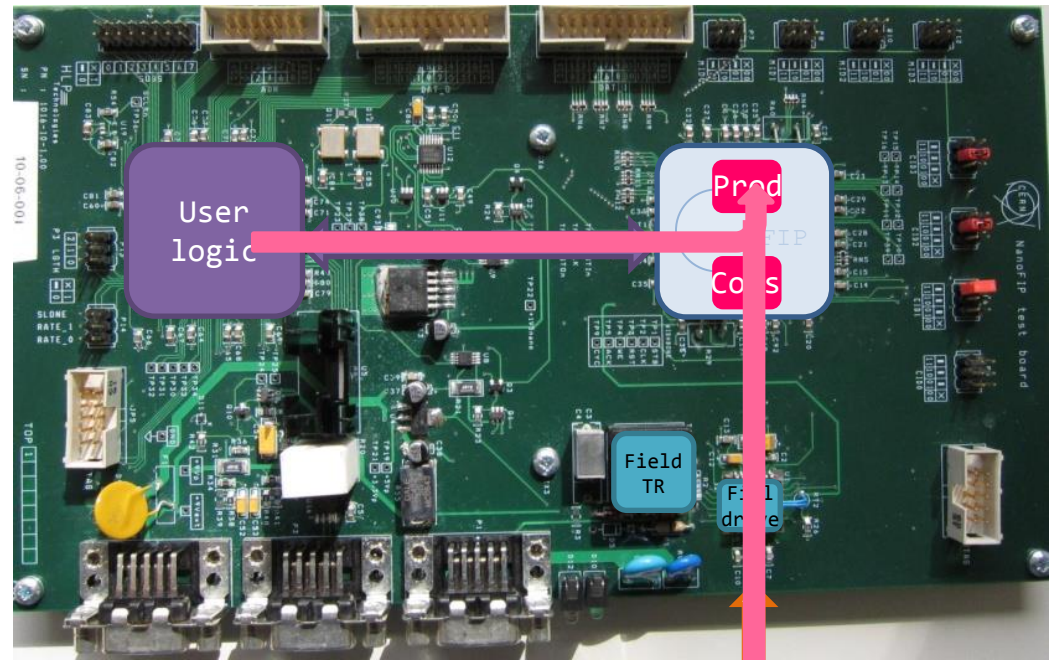


FIELDBUS

Test Setup



Test Setup

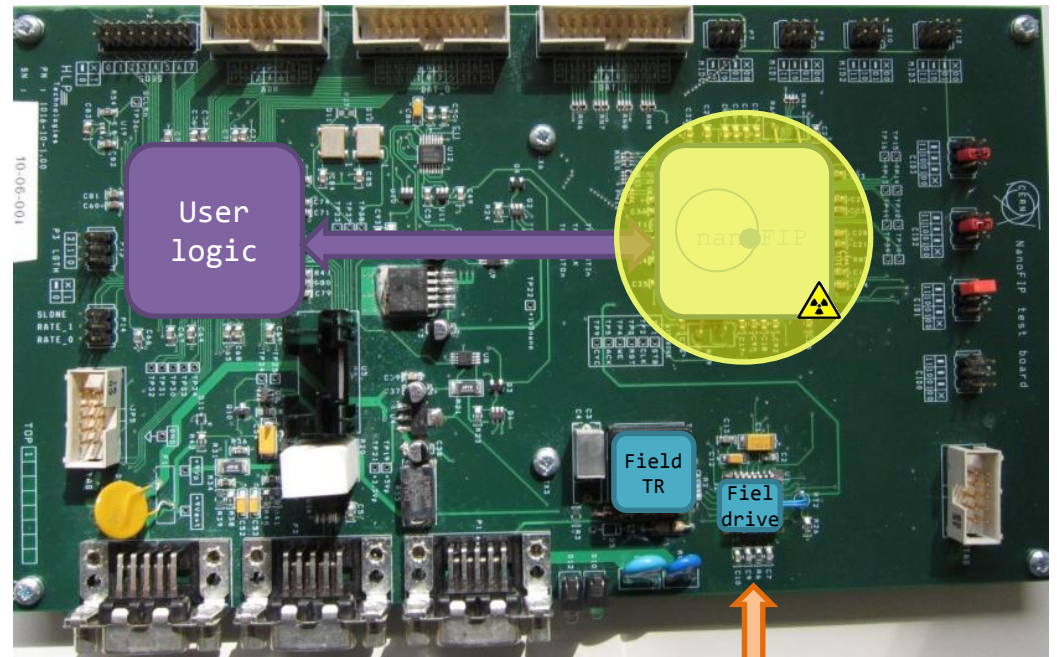


FIELDBUS

Test Setup

Control Room

Master



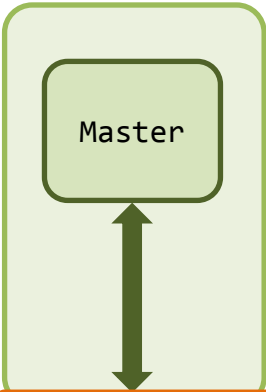
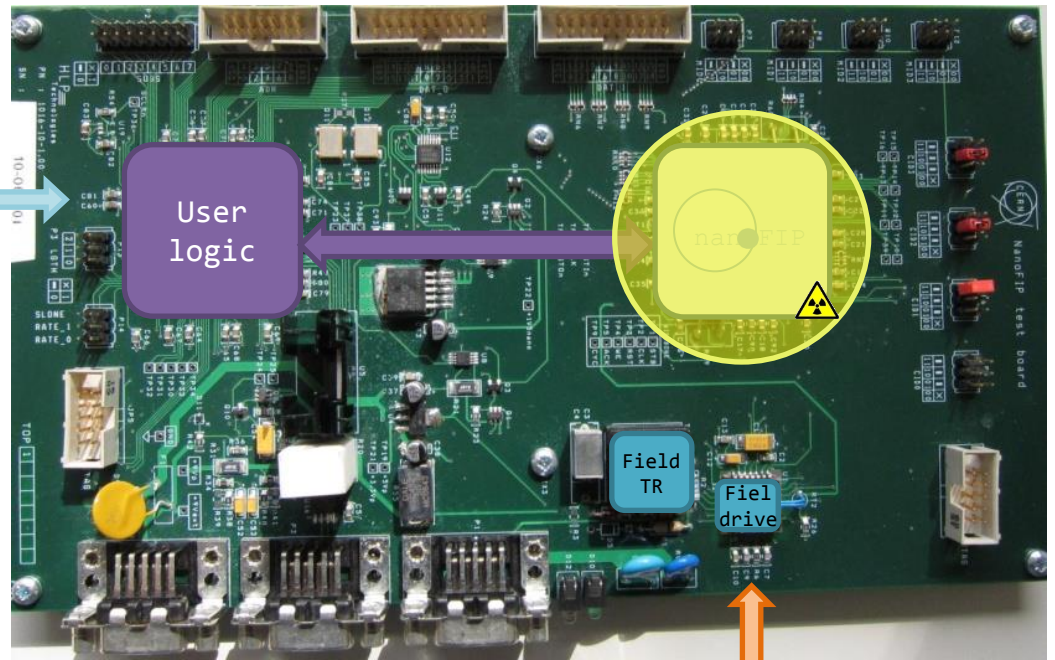
FIELD BUS

Test Setup

Control Room



9V 50mA



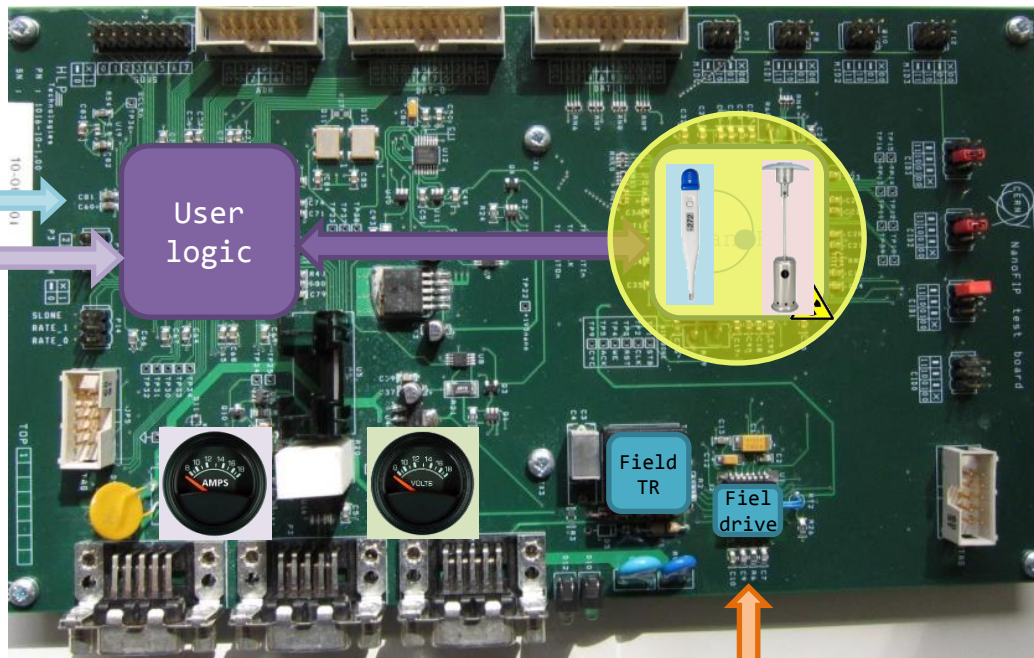
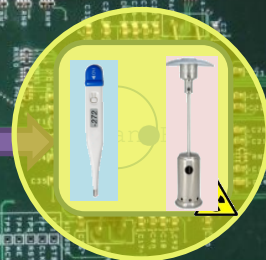
Test Setup

Control Room



9V 50m
RS 232 50m

User logic



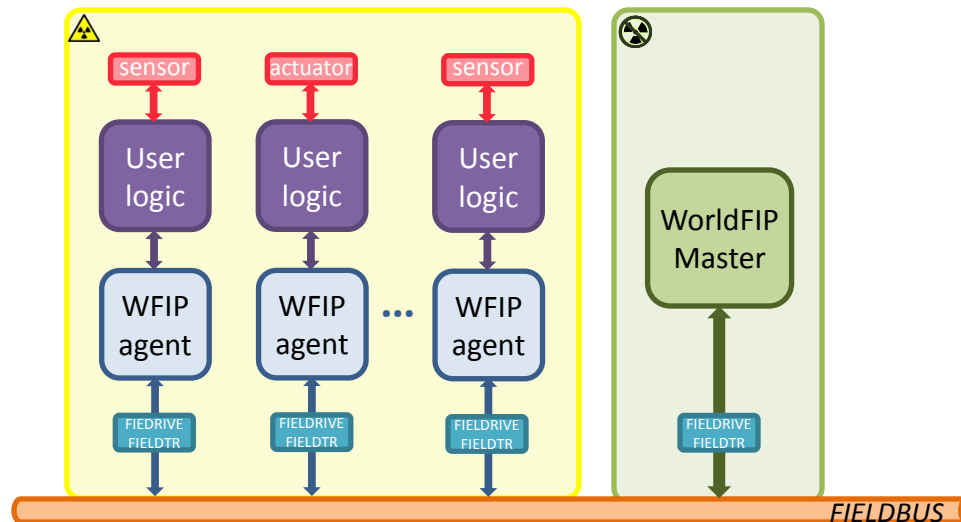
Master

↑
FIELD BUS

WorldFIP, microFIP & nanoFIP (I)

- WorldFIP is a **real-time fieldbus** used at CERN's LHC for a variety of control systems: Cryogenics, Power Converters, Quench Protection, Beam Instrumentation, Radiation Monitoring, Survey
- More than **10000** WorldFIP client **nodes** (agents) and **200** WorldFIP **master** nodes installed in the LHC
- WorldFIP was selected because of the good performance of its agents under **radiation**

WorldFIP Architecture



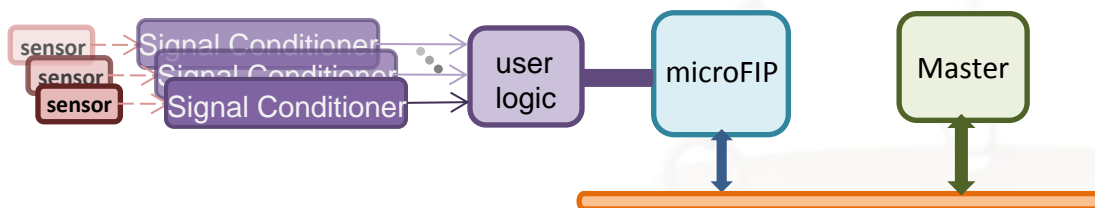
nanoFIP vs. microFIP

nanoFIP is:

- **Tailored** to users' needs
- Common use of the chip and **centralized** support
- **rad-tol** by design
- nanoFIPs and microFIPs can **co-exist** under the same Master
- Expected demand **>2000** components

nanoFIP is **not**:

- Backwards **compatible** for the user



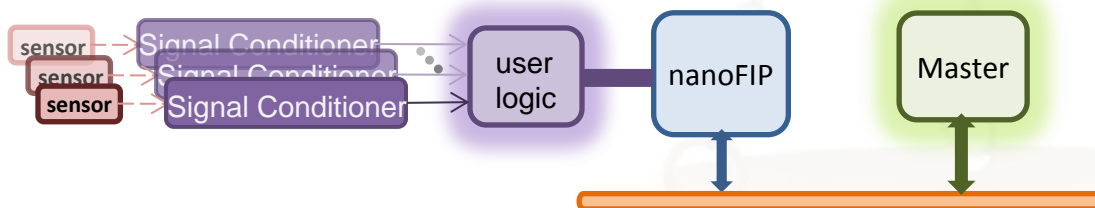
nanoFIP vs. microFIP

nanoFIP is:

- **Tailored** to users' needs
- Common use of the chip and **centralized** support
- **rad-tol** by design
- nanoFIPs and microFIPs can **co-exist** under the same Master
- Expected demand **>2000** components

nanoFIP is **not**:

- Backwards **compatible** for the user











Project Organization & Some History

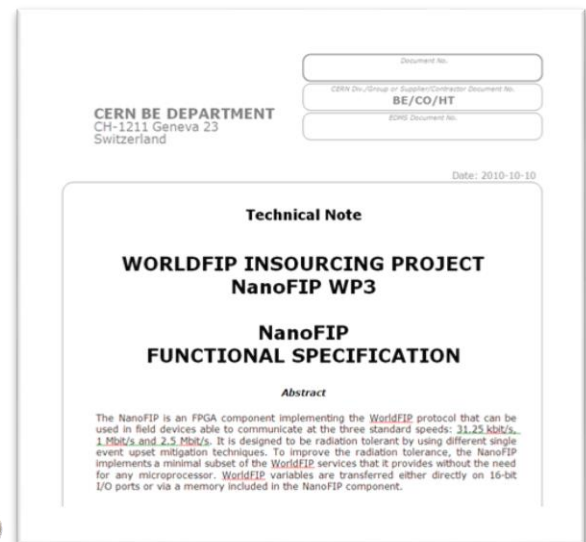
Concerns for the long-term availability of ALSTOM's components; WorldFIP Taskforce set up. (2006)

Taskforce conclusions: No technological alternative & in-sourcing of WorldFIP technology. (2007)

ALSTOM-CERN contract with CERN purchasing ALSTOM's design information. (2008)

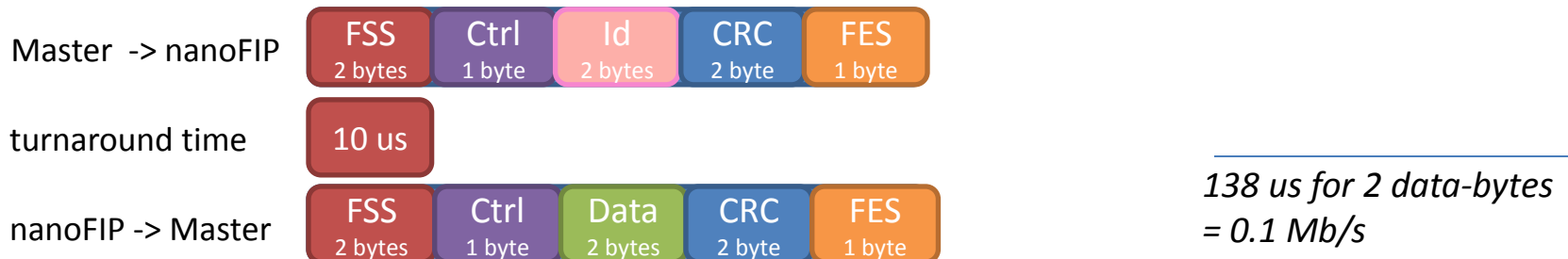
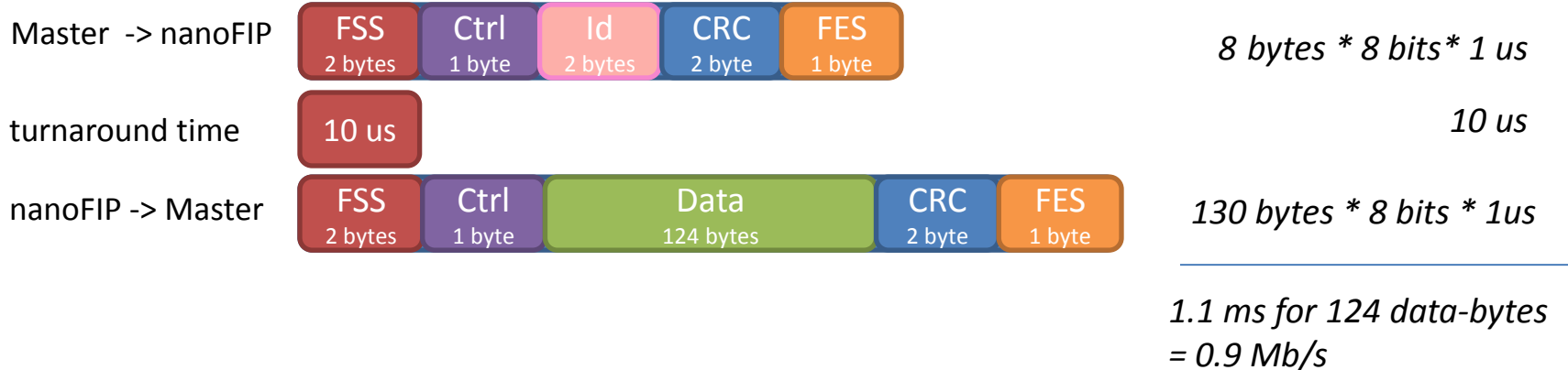
Project divided in different Work Packages: (2009)

- WP1: microFIP code preliminary interpretation (*B. Todd, TE/MPE & E. van der Bij*) 
- WP2: project management documentation for the in-sourcing (*E. van der Bij*) 
- WP3: functional specifications for microFIP's replacement (*E. van der Bij*) 
- WP4: rewrite & extend microFIP VHDL code 
- WP5: write new code (*P. Alvarez & E. Gousiou*) 
- WP6: test bench creation (*G. Penacoba, TE/CRG*) 
- WP7: design of a board for functional and radiation tests (*HLP, France*) 
- WP8: Radiation tests (*CERN RadWG EN/STI & E. Gousiou*) 



WorldFIP Frames

Communication throughput for 1Mbps:



Project Status

Majority voter circuit:

