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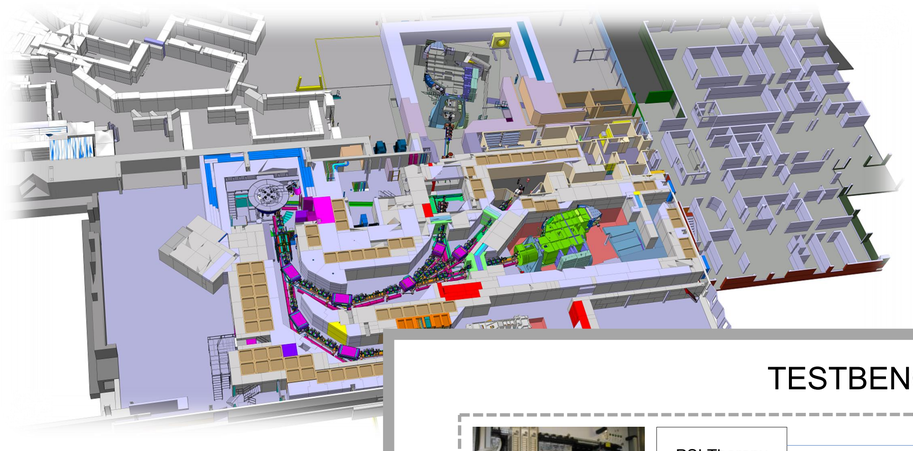
ICALEPCS2017 Barcelona · Spain, October 8-13 · Palau de Congressos de Catalunya

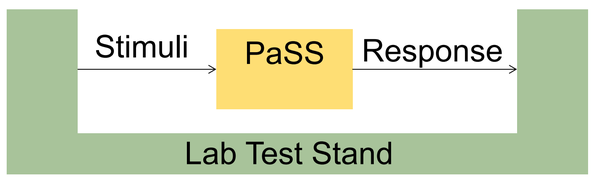
DEVELOPMENT OF A PXI BASED TEST STAND FOR AUTOMATIZATION OF THE QUALITY ASSURANCE OF THE PATIENT SAFETY SYSTEM IN A PROTON THERAPY CENTRE

INTRODUCTION

At PSI cancer patients are being treated using proton therapy for a number of indications. The facility currently includes a fixed beam line for eye treatment, operating since 2010 and Gantries 1 and 2 since 1996 and 2013 respectively. A new Gantry 3 is being commissioned. Each of the areas include a Patient Safety System, that needs to be thoroughly tested.



PASS UNIT TESTING



TESTBENCH SOFTWARE

LabView written. Modular and extendable.

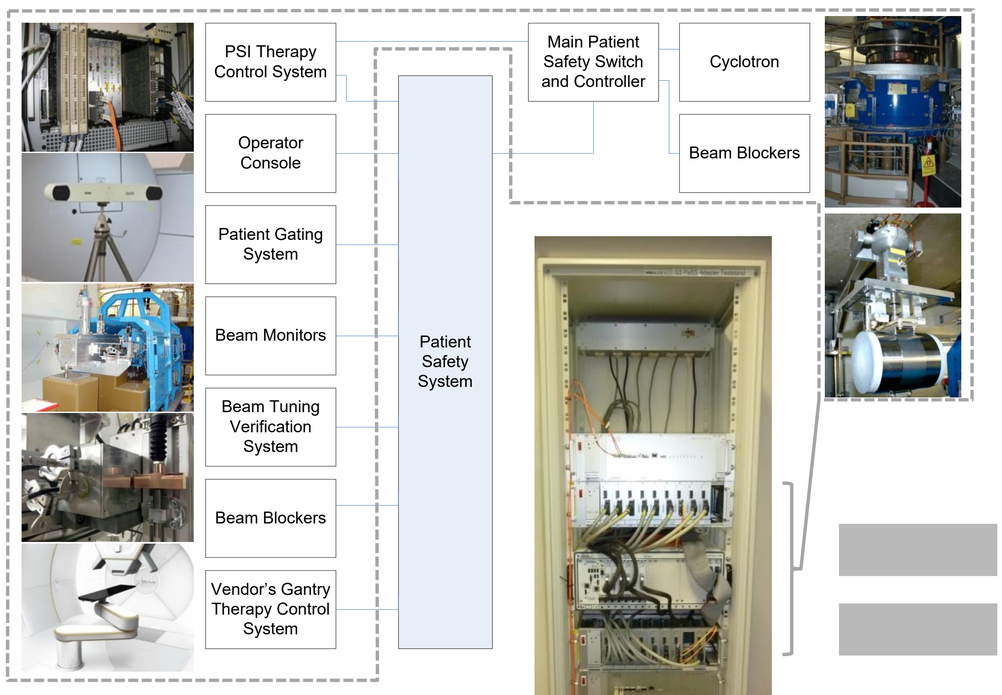
Synchronously stimulate and monitor hundreds of signals at 1MHz.

Dynamic HW configuration using XML configuration file.

Executes tests in formal description language (possible support for others).

Fully autonomous sequential execution.

TESTBENCH HARDWARE



The brain is a NI´s PXI crate with multiple IO cards. The signal lines are driven using fast PXIe-6535 cards clocked at 1MHz. Slower PXI-6509 were used for slow control. An in-house designed 19 inch backplane is used to route the digital IO pins to the corresponding PaSS signals. Plugins are used to convert the 5V digital signals to into optical signals, 24V digital lines, 5V TTL or three wire redundant current loops.

UNIT TEST FORMAL DESCRIPTION

```
SENSOR_A  <= NOK;
wait for  t_Response;
ELEMENT_B <= OK;
```

Sequential stimuli

```
assert STATUS_C = NOK report " STATUS_C not as
expected" severity FAILURE;
```

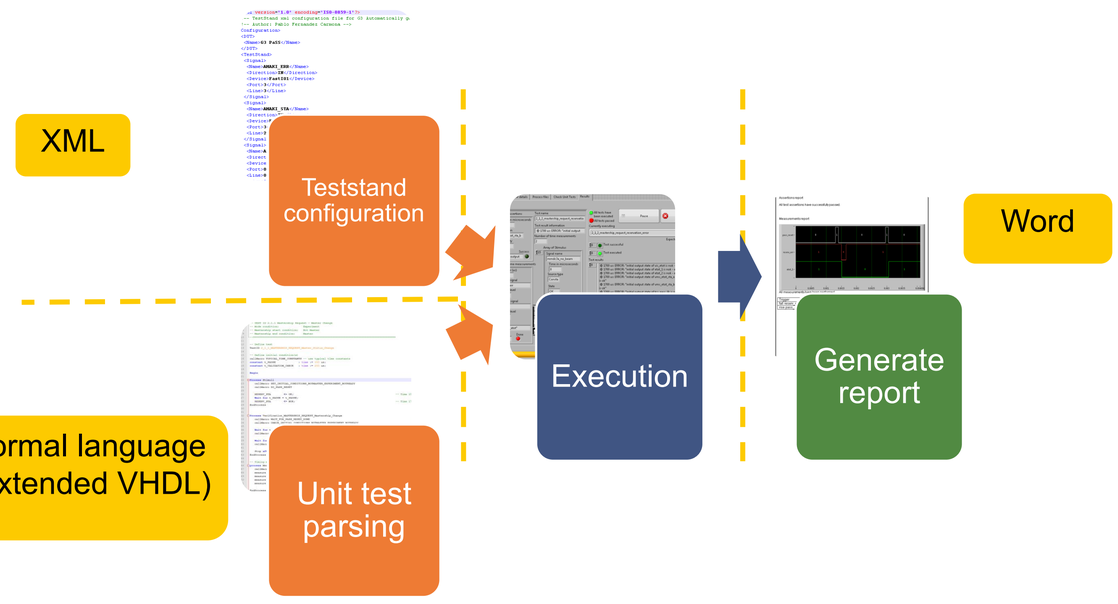
Assertions

```
measure falling_edge(SIGNAL_1)to
rising_edge(SIGNAL_2) name "Example measurement";
```

Measurements

```
DefineMacro TYPICAL_TIMES
constant t1  : time := 50 us;
EndMacro
```

```
Process Stimuli
  Loop
     Tag Condition_1
        callMacro MY_MACRO_1
     EndTag
     Tag Condition_2
        callMacro MY_MACRO_2
     EndTag
  EndLoop
EndProcess
```



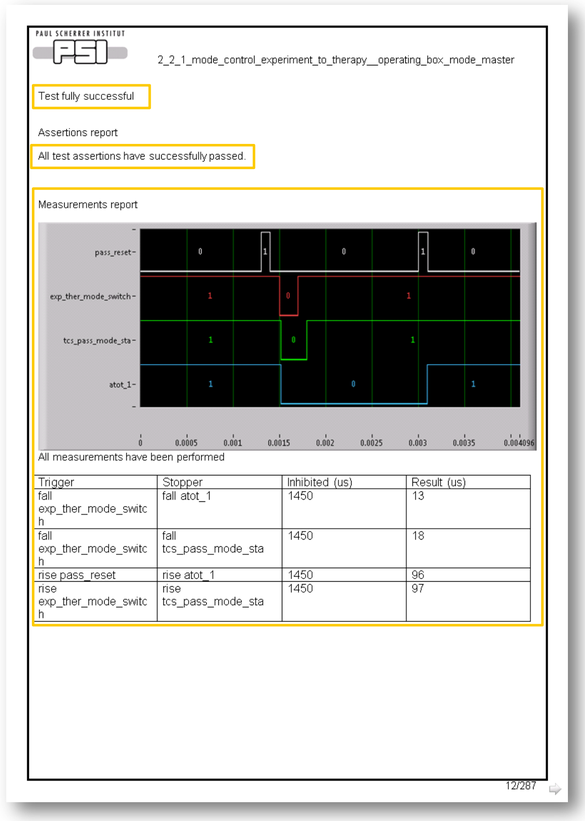
REPORTING

After sequential execution of all unit tests, a report is generated automatically. Includes:

- Execution success.
- Pass/Fail information. Were all the assertions true?.
- Time measurements results.

The report for our new Gantry 3 contains 287 pages and includes 278 different tests cases.

Unit tests execution plus report generation takes 4 minutes.



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2_2_1_mode_control_experiment_to_therapy__operating_box_mode_master

Test fully successful

Assertions report

All test assertions have successfully passed.

Measurements report

All measurements have been performed

Trigger	Stopper	Inhibited (us)	Result (us)
fall exp_ther_mode_switch	fall atot_1	1450	13
fall exp_ther_mode_switch	fall tcs_pass_mode_sta	1450	18
rise pass_reset	rise atot_1	1450	96
rise exp_ther_mode_switch	rise tcs_pass_mode_sta	1450	97

12/287

RESULTS

	New Test stand	Former testing
Unit test specification	3 weeks • Test description document • Formal language	3 weeks • Test description document including timing diagrams
Hardware setup	½ day	1 day
PaSS unit test execution	4 minutes	1 hour per test case 2 weeks in total
Signal stimuli	≤ 400 per PXI chassis Daisy chainable	Manipulations in real system or ≤ 40 signals in lab
Signal monitoring	≤ 400 per PXI chassis Daisy chainable	Limited to 48 signals logic analyzer

CONCLUSION

At PSI, a test stand has been developed to automate part of the QA of the Patient Safety System of our newly installed Gantry 3. It is fast, precise and extendable. The unit tests are described in a formal language and reports are generated automatically upon execution of all test cases.

By automating the unit testing of PaSS, an increased level of safety has been achieved. It allows very complete tests scenarios and the beam time available for patients can be substantially increased, by reducing the requirements for this QA. The development cycles in upgrades and bug fixing have also been shortened, therefore reducing costs.

CONTACT
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