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 Gantry 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

Stimuli Pass Response

Lab Test Stand

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.

UNIT TEST FORMAL DESCRIPTION

SENSE_A <= NOK; 
wait for t_Response; 
END 
assert STATUS_C = NOK report * STATUS_C not as expected* severity FAILURE;

measure falling_edge(SIGNAL_1toRising_edge(SIGNAL_2) name "Sample measurement")

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 PXIe-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.

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.

RESULTS

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

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.

REFERENCES