My trial to make a dosimeter with photomultiplier, scintillation and GR-SAKURA beta version
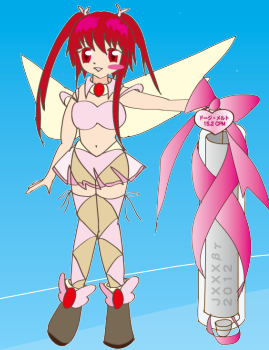
The 2nd producer meeting for Gadget Renesas Project
16th Jun. 2012

By Hirofumi Inomata,
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Remark: This document is revised for public disclosure, and it doesn't make ensure any quality or any safety for my works.

Self-introduction: I am …

* a hobbyist for making 3DCG, electronic DIY, playing Ganho ECO, … , and an IT Engineer in Japan. And making a dosimeter, also. My first work (the right photo) is at Chernobyl nuclear plant accident. Currently, having a little escalation for it.
* I am a very beginner for MPUs. In last year, having the first MPU use of mbed NXP LPC1768, and so my great surprise for very easy. A GR-SAKURA (with Renesas RX series) had given me the 2nd surprised one.
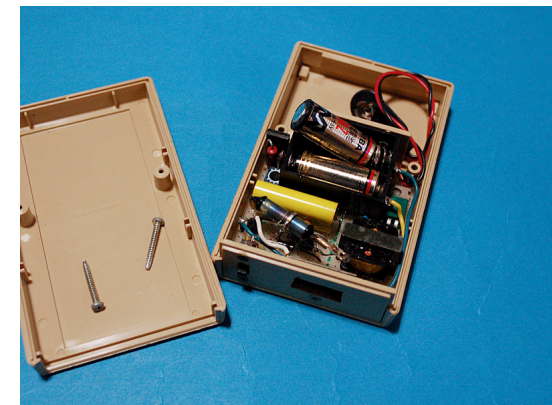
Motive of Producer
(beta tester program)
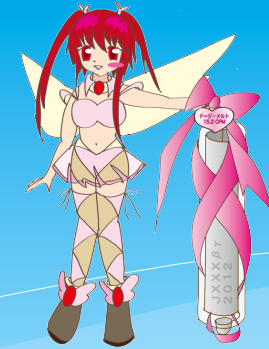
* An electronic DIY is one of my hobbies since the child. But, I have not been able to have a little time for enjoy it, currently. I was surprised for feel very easy and agility using a mbed NXP LPC1768 in last year (2011).

* So, I had big interest for Gadget Renesas Project and GR-SAKURA with pin-compatible with Arduino, when I had found it in my twitter time line. While I feel a little difficult with using MPUs except a mbed.
  In this time, tweets had said that it will be easy to use GA-SAKURA, and I had found an advertisement for its beta testers in my time line. So, I tried to join the beta tester program for a GR-SAKURA.

* Further more, in Just time, I had been looking for others with a little higher performance, because I have a little problem for making a dosimeter with using a mbed, while it have very slow sampling rate of its ADC & DAC.

# Plan for my trial
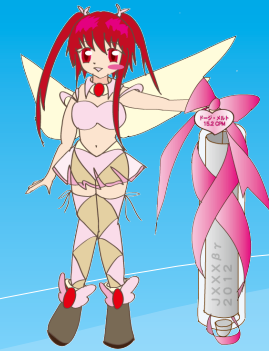
(my trial use in stead of mbed)

[Now work]
* I try to apply GA-SAKURA as a controller for a dosimeter that I had begin to make, just.
  So, I will introduce the making in this document.

[Future work] applying it for …
* Web server with Xbee WiFi
* One like a game watch
* Game controller tuned up for an online game
* Etc.

Overview of a dosimeter with photomultiplier and scintillation
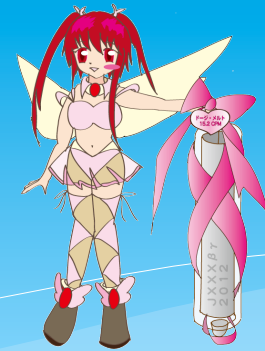
* A Photomultiplier has a function converting very faint light to electronic signal by Photoelectric effect, and great amplified.

* A scintillation material has a feature converting gamma-ray to faint light. Now, I use BGO crystals for my dosimeter.

* This DIY work will be converting gamma-ray by the BGO to light, and converting the light to electronic signal by the photomultiplier. And then MPU will capture the signal by its ADC, and will put result to MMC/SD memory.

Shopping the sensor device
(photomultiplier tube R-1548 and BGO scintillation)
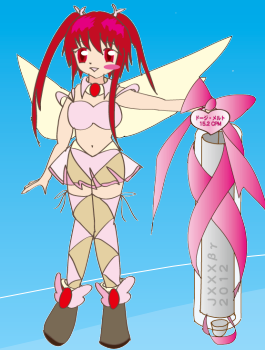
* I found and got a set of Hamamatsu photomultiplier tube R-1548 and BGO scintillation material in eBay. Currently, it very convenient to buy anything from eBay.
    * They seem to be used goods for the medical equipment.
    * Their datasheet are able to looked for in internet. So, this photomultiplier tube needs power supply with minus 1250V for use. (^^;
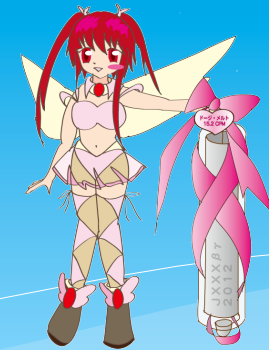
Shopping a high-voltage power supply module
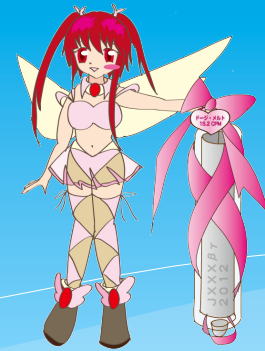
* By this work, I had had a little easiness by using a retail module of a high voltage DC-DC converter: Bellnics MHV12-2.0K1000N (variable output from 0V to 2KV, Max 1.0mA)
* So, I can get minus 1250V for the photomultiplier tube, by it.

Making a dosimeter (3)
Selection of MPU, mbed vs GR-SAKURA
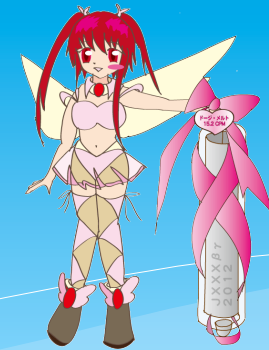
* At first, trying a mbed NXP LPC1768, so that I know a sampling rate of the ADC is very slow, about 100 micro-sec par sample. So, the wave form in the oscilloscope is stepped roughly(^^;

* In the next, trying GR-SAKURA, so that the sampling rate is about 10 micro-sec par sample. It may be almost good. I use it!
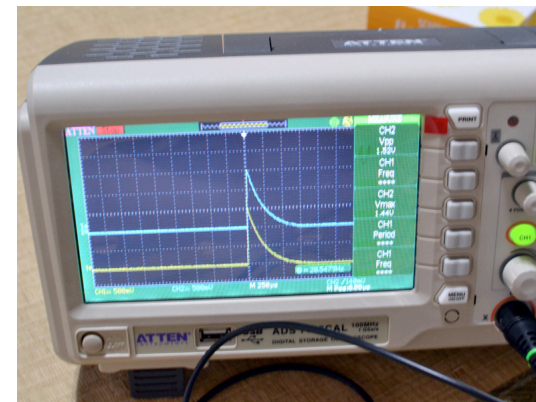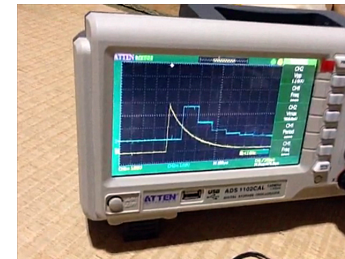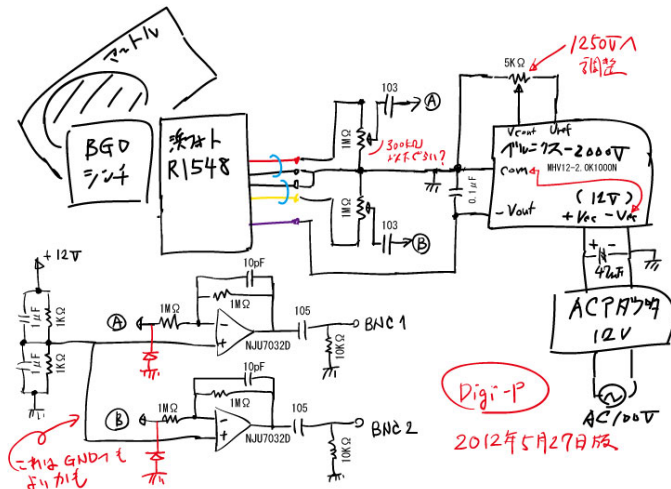
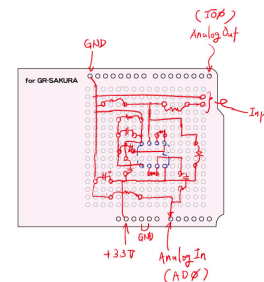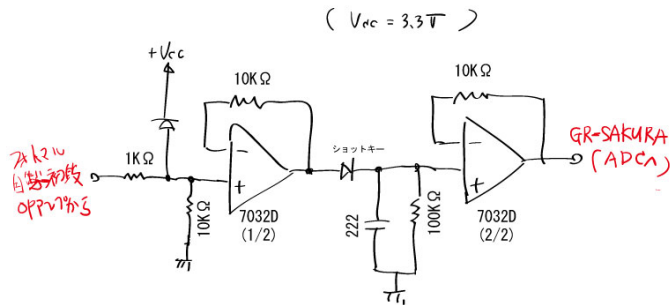# Circuit design for connecting MPU and the photomultiplier tube

浜フォト R1548+BGO シンチのテスト回路

R-1548+BGO の試し回路（信号変換部）

* This work needs to widen width (to about 100 micro-sec) of electronic pulse from the photomultiplier, and then to reduce its peek voltage within a range (0V to 3.3V) of the ADC, while , the max of raw pulse voltage have about 100V.

* So that, I had designed the circuit, roughly.

@C

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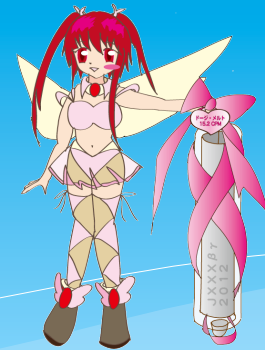## Making a dosimeter (5)
Well, ready to built a dosimeter. Let's do!
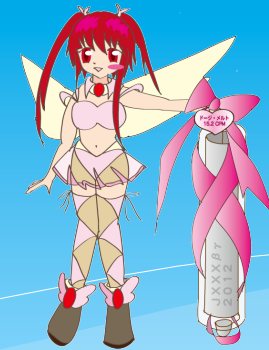
* A photomultiplier needs complete shading, and dealing 1250V is very danger. So that, a set of photomultiplier, scintillation, a high voltage power supply and the first step buffer amplifiers was put into a case (as the right photo).
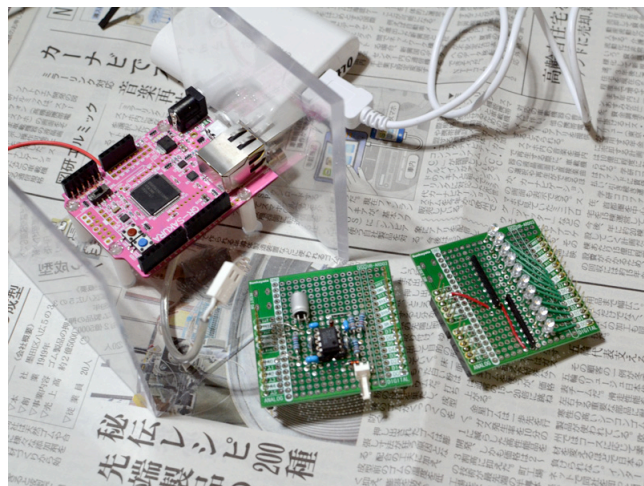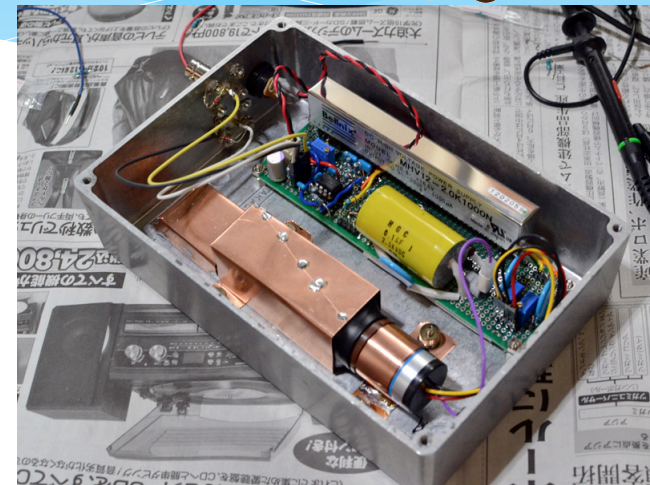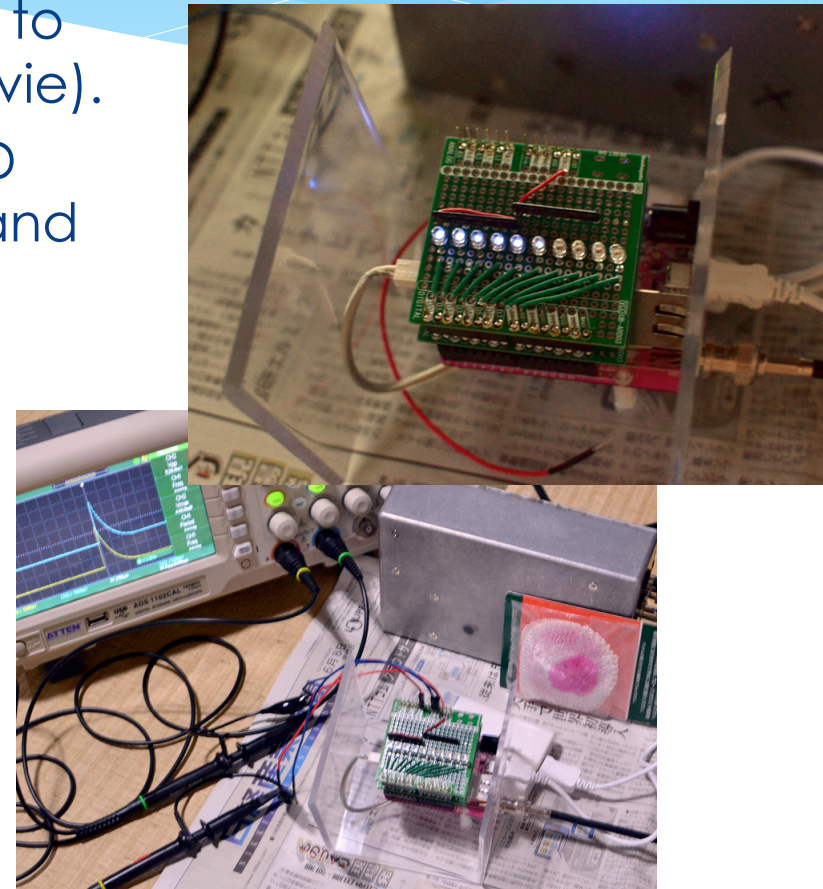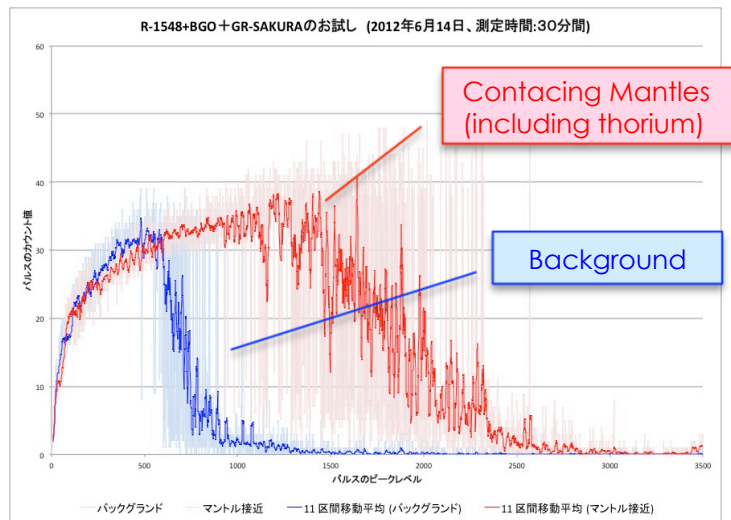

* GR-SAKURA and circuit for converting the pulse waveform, is put into a clear case (as the left photo).

* My work needs pin header with spacers for an ether socket on GR-SAKURA, between a shield

Making a dosimeter (6)
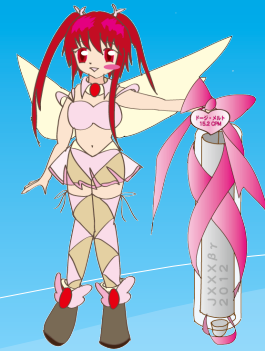# Complete to build, check it.

* Checking that it work right, so that LEDs flashed on and off. It seems to work right (See the attaching movie).

* Well, I got result from the MMC/SD memory attaching GR-SAKURA, and draw the below graph.

R-1548+BGO＋GR-SAKURAのお試し (2012年6月14日、測定時間:30分間)

Contacing Mantles (including thorium)

Background

パルスのカウント値

パルスのピークレベル
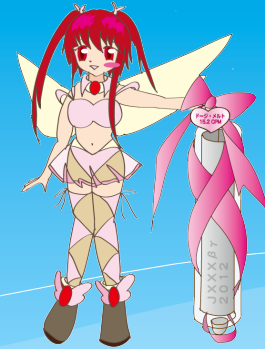
バックグランド　　マントル接近　　11 区間移動平均 (バックグランド)　　11 区間移動平均 (マントル接近)

Works pended, in this day

* In this day, I have not yet verified any result for my work. When I can have had a little time, I will do it. (^^;

* Now, I am feeling that It needs such data visualization as a graph, to understand the result. So that I may append a graphical LCD module to my work, in future.
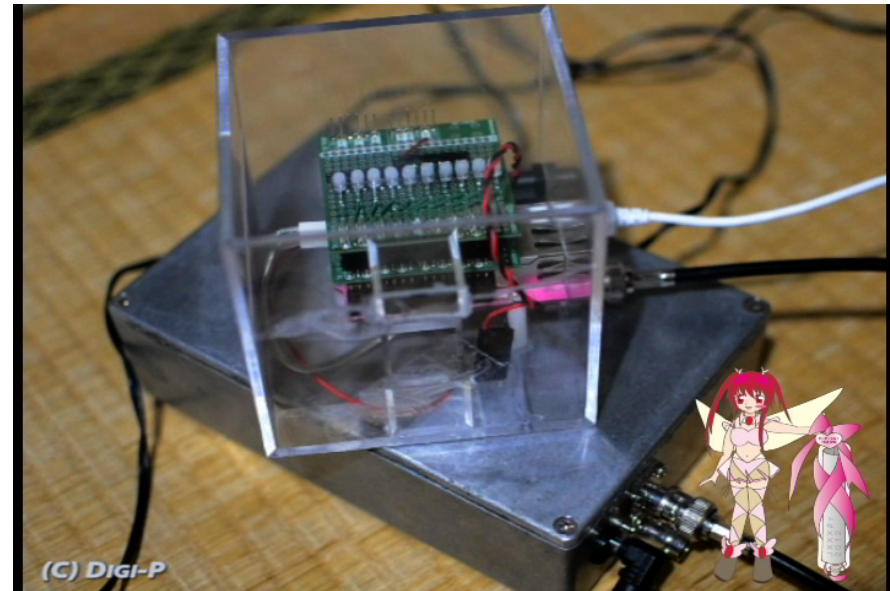
My impression

* I am feeling a GR-SAKURA easiness and high performance for electronic DIY using an ADC like this work, than mbed, in this day.
* In general, I am feeling surprising for easiness and very agility, about convenience using such MPU as GR-SAKURA, mbed, and so on. So, I can have made a dosimeter by only connecting electronic modules by wires. Then, Web-based software development environment is very useful and very convenient, used without any install to my PC or Mac.
* I hope that an electronic DIY has more easy and more massification, In near future.
* However, I may have made a more pleasant and funny thing except a dosimeter. It was a bad timing for GR-SAKURA(^^;
* I hope that many hobbyist enjoy electronic DIY with GR-SAKURA.
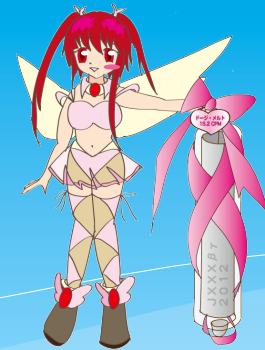
(*∧o∧)ノ Thank you!
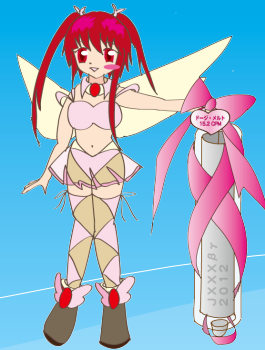
Finish,

Thank you!

I took the fifth prize -->

Mascot for my work of dosimeters

I am Meter Dosi (Meru, Dohzi, pronounced in Japanese), a mascot character of his works of dosimeters, designed by him.