

BGO irradiation test

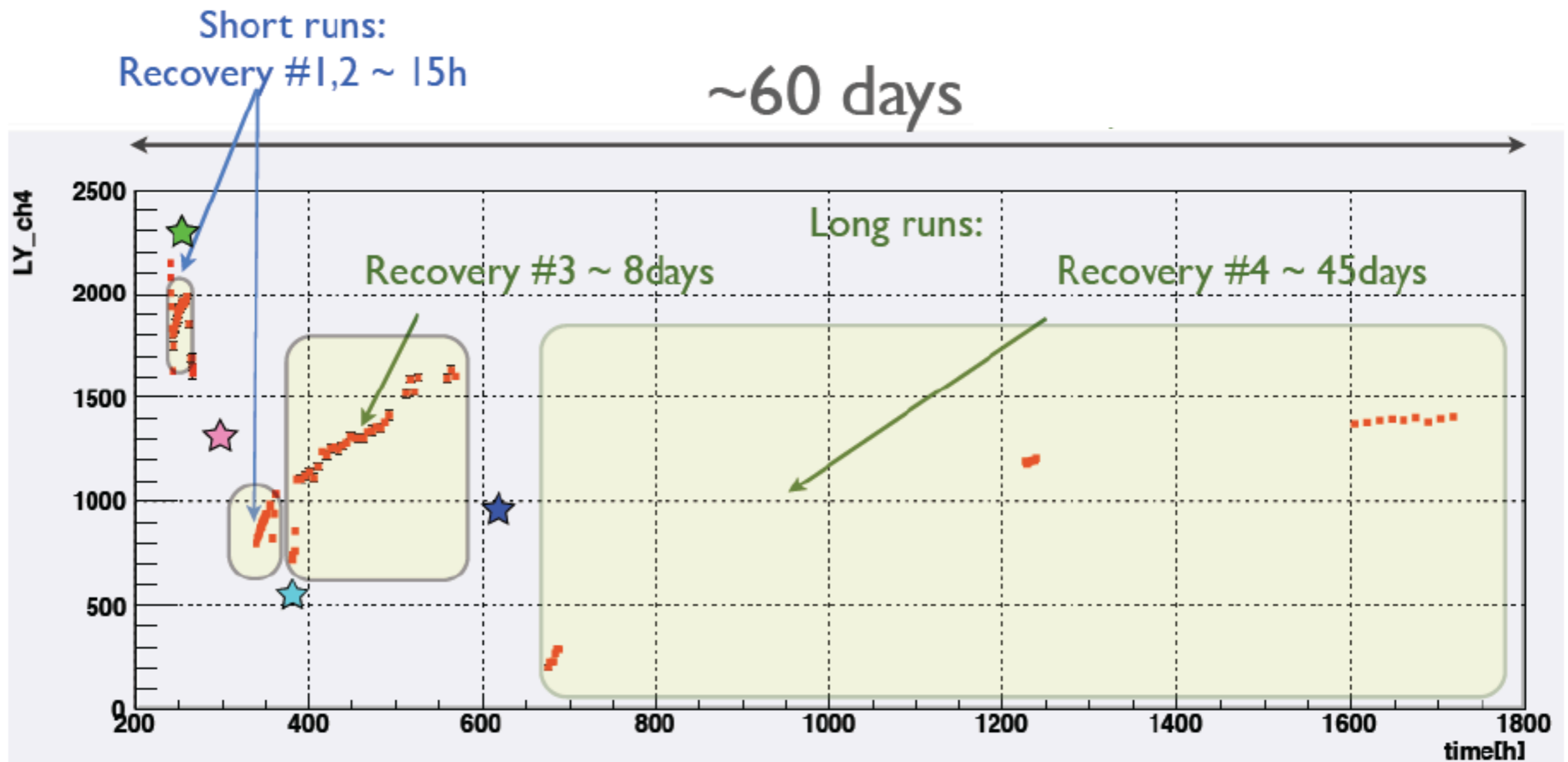
INFN Roma - SuperB group

The 2011 irradiation test

- ✓ In 2011 we tested 4 BGO crystals at Calliope Irradiation Facility:
 - ✓ Crystal samples:
 - 2 BGO from L3 experiment (2.2x2.2x18cm³)
 - 2 BGO from SICCAS (brand new) (2.5x2.5x16cm³)
 - ✓ They had been exposed to dose rate from few rad/h to Mrad/h;
 - ✓ During the test, the irradiation was interrupted and the crystal was measured:
 - ✓ the response of the crystal to a ⁶⁰Co source was studied to evaluate the variation in the crystal light yield.
 - ✓ the transmission of the light through the crystals was measured as a function of the light wave length.
 - ✓ Data have been acquired for long periods and we have been able to study in details the recovery performance of the crystals

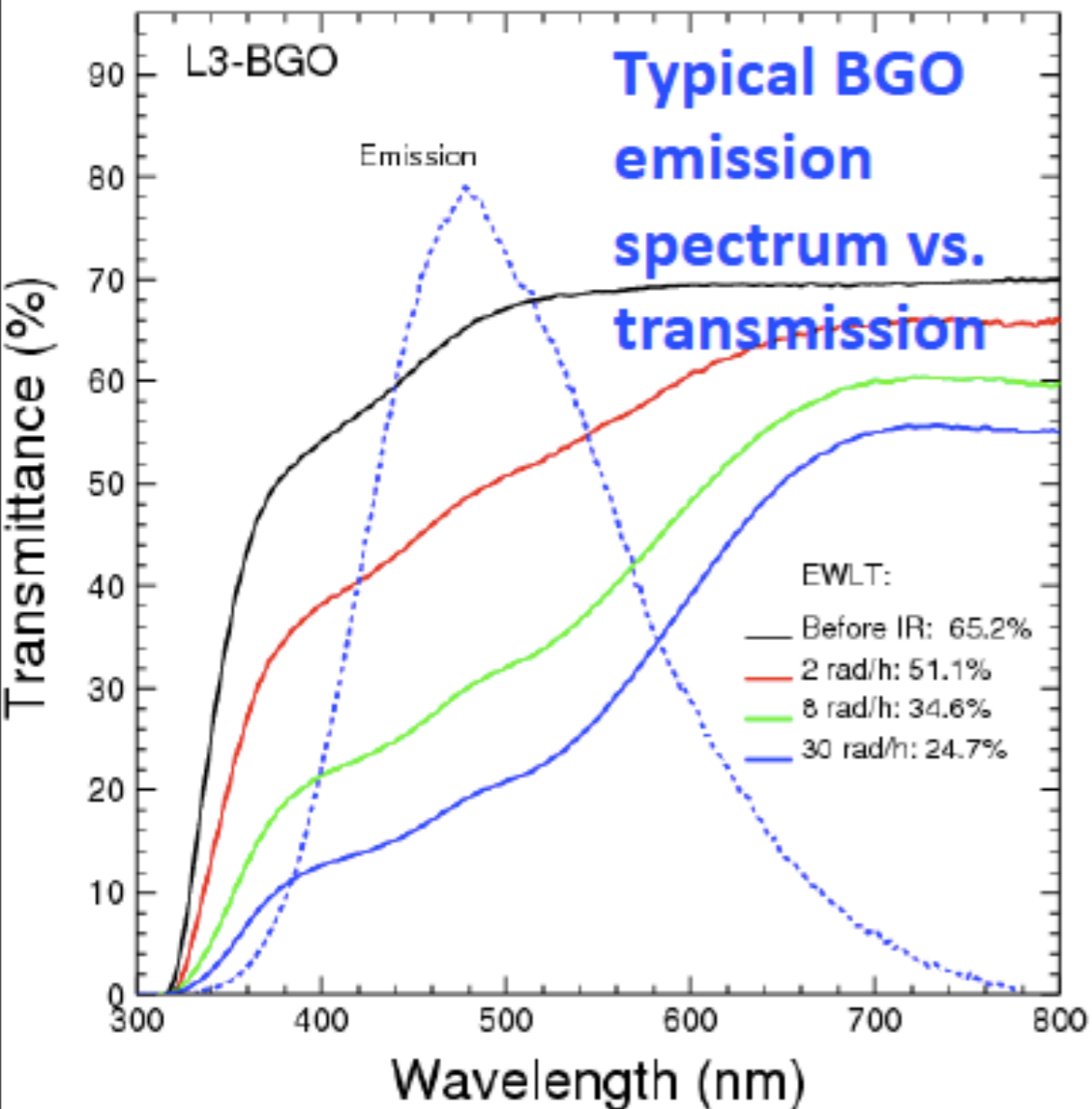
The 2011 irradiation test

- ✓ An example of the data acquired.

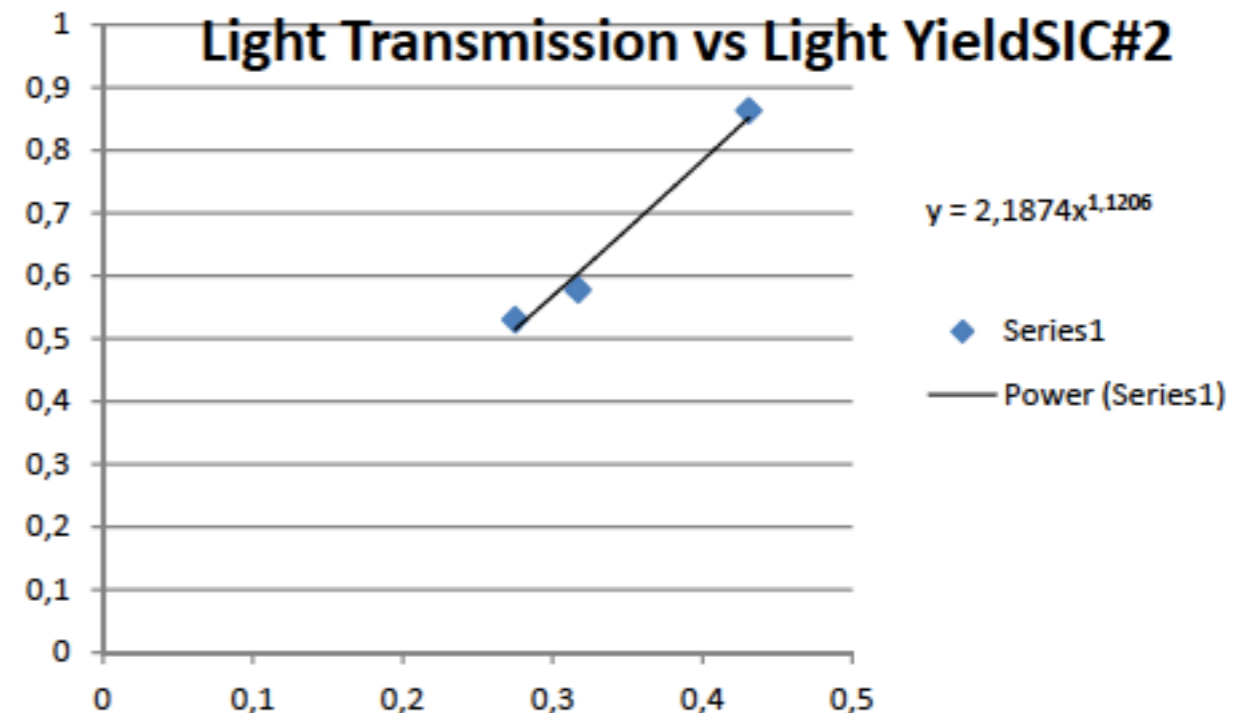


Light transmission studies

- ✓ Examples of the results of the measurements of the light transmission



- ✓ A good correlation was found between the measurements of the response to the ^{60}Co source and the variation of the light transmission efficiency.



Summary on LY losses

	After first irradiations	After 91 h irradiation	40 days after 91 h irradiation
SIC-1	-45% 10h@10rad/h	-16% (-53% from beginning) 91 h @ 1.5 rad/h	-35% from beginning
SIC-2	-60% 31h@10rad/h	-37% (-75% from beginning) 91 h @ 230 krad/h	-70% from beginning
L3-1	-44% 31h@10rad/h	-86% (-92% from beginning) 91 h @ 230 krad/h	-40% from beginning
L3-2	-21% 10h@10rad/h	-60% (-69% from beginning) 91 h @ 10 rad/h	-19% from beginning

BGO crystal have shown very large LY drop (-50% -90%) and good recovery capability

Conclusion of 2011 test

No visible effect from short low-rate irradiation (rad/h) after high dose, high dose-rate irradiation ($\geq 1\text{krad}@10\text{rad/h}$) of BGO crystals.

This should be confirmed by low-rate irradiations once the LY has reached its recovery plateau.

- Light Yield and Light Transmission trends are in agreement;
- Few more information from BGO to be extracted;

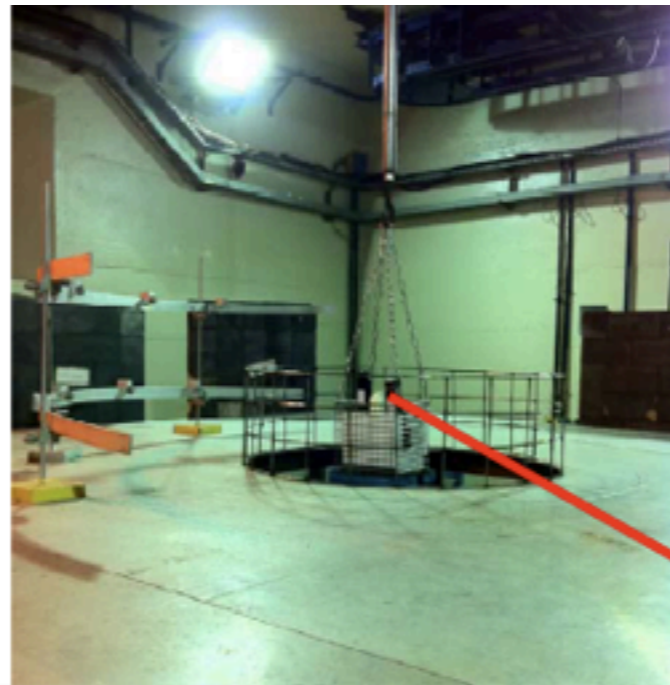
Further investigation with new irradiation campaign would add knowledge to these effects:

- once the LY has reached its recovery plateau, further measurements after low-rate irradiations would confirm the high radiation dose conditioning
- prolonged low-rate irradiation would allow to measure the LY drop saturation

2012 Experimental setup

- ✓ The same 4 BGO crystals have been re-tested at Casaccia for long time at low dose rate to evaluate the LY stability;

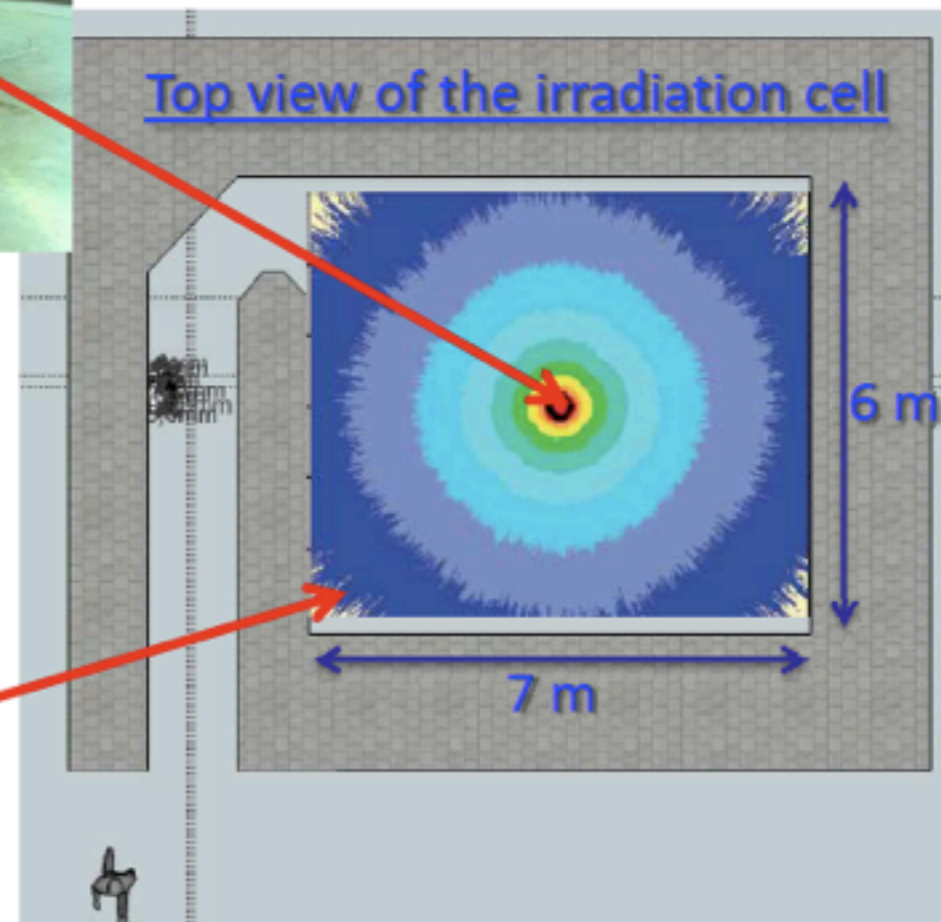
- ✓ The BGO crystals were irradiated in a lead box



**Source centre:
230 krad/h dose rate**



**In a lead box
inside the cell:
1,5 rad/h dose rate**

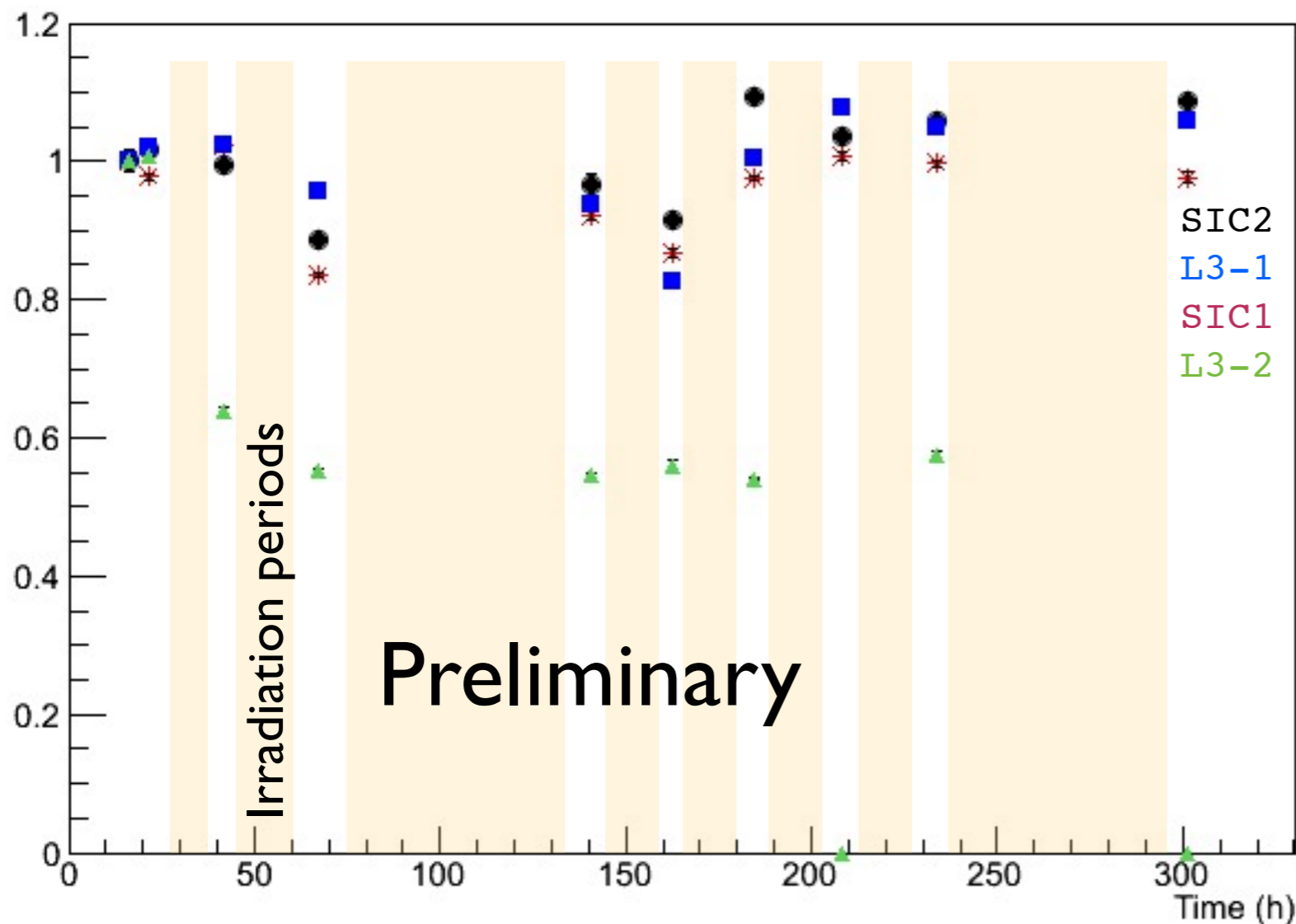


The irradiations

- ✓ The test lasted two weeks;
- ✓ The BGO crystals have been irradiated for 12 days i.e. 288 hours (9:18 of 14 Nov -> 9:46 26 Nov):
 - ✓ 255 hours of irradiation (88.5%);
 - ✓ 33 hours of measurements (11.5%);
- ✓ At a dose rate of 1.5 rad/h about 380 rad were integrated by the each crystal.
- ✓ This time the crystals had to be dismounted from the PMT during the irradiation.
- ✓ The data analysis has just started and the results are therefore very preliminary.

Results of LY measurements

- ✓ The plot shows the responses of the crystals to a ^{60}Co radioactive source normalized before the beginning of the test;
- ✓ Time intervals between two points are irradiations periods (in orange);



Two observations:

1) I think that the differences between the points taken at the same time are an evaluation of the uncertainties of the measurements (mainly due to the mount/unmount method);

2) L3-2 (green points) has had problems (fake contact ?) during the whole test. We also had to substitute the PMT. I won't be surprised if the jump is only an instrumental effect

Within the uncertainties the no drop of the crystal LY appeared after almost 400 rad

Conclusion

- ✓ The Casaccia test in 2011 showed that BGO crystals have large light yield drop (and a good recovery) when irradiated at high dose rate;
- ✓ The same test gave the hint that after a large irradiation the BGO LY doesn't change too much if exposed to low rate radiation;
- ✓ Data analysis is just started. For the moment no visible deterioration of the BGO LY was found after a total dose of almost 400 rad at 2rad/h dose;
- ✓ Results from the analysis of the transmission efficiency measurement will be precious to check this result.