

Irradiation Test on undoped CsI

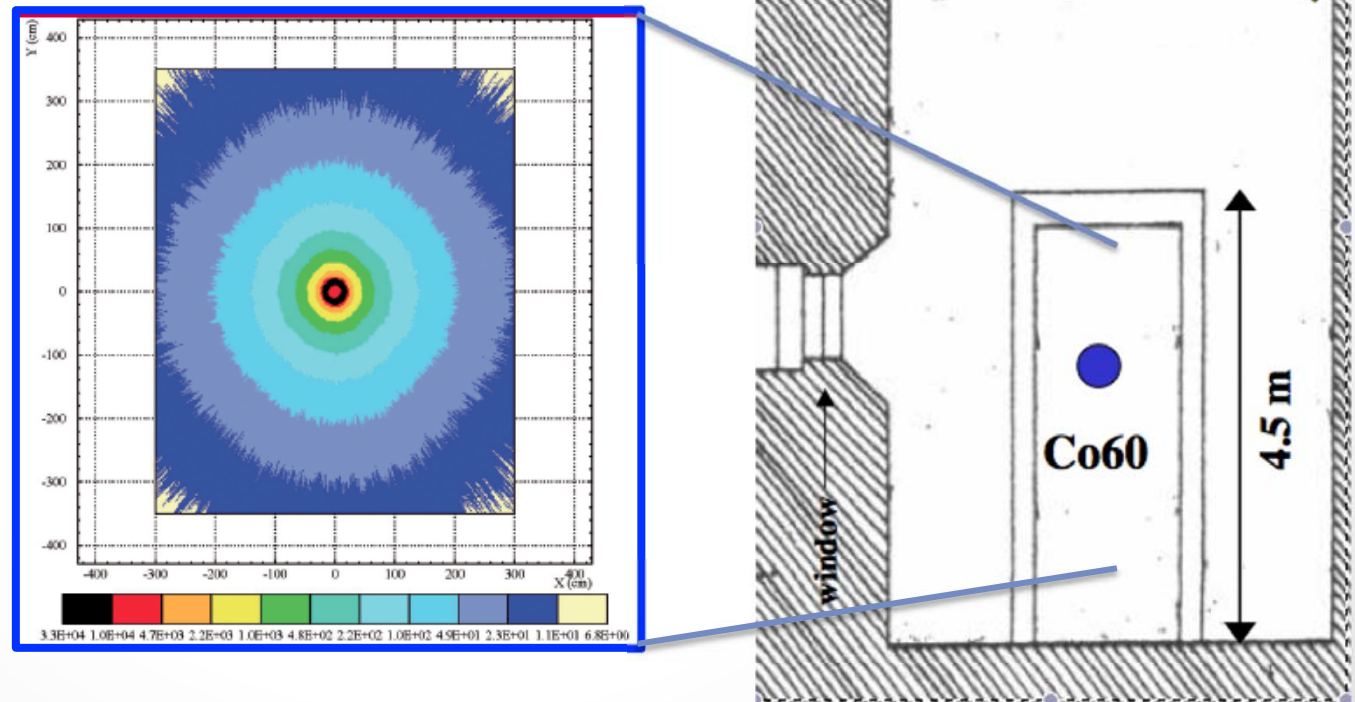
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Introduction

- Study the radiation hardness of undoped CsI crystals
- Expected dose rate @ SuperB 0.35 Krad/year
 - Total expected dose after 10 years 3.5Krad (18Krad with x5 safety factor)
- CsI doesn't recover radiation induced damage
- CsI radiation hardness could be dependent on the impurity concentration.

Calliope facility

- ^{60}Co γ -source (mean energy 1.25MeV)
- Different dose rates available



Crystal Tested

- 3 CsI produced by Amcrys
 - 5x5x30 cm³
- 1 CsI produced by SICCAS
 - 5x5x30 cm³
 - High level of Thallium impurity

Irradiation Summary

CsI-AMC01		
Expo. Time	Dose Rate	Total Dose
16h	26.8rad/h	430rad
16.7h	193rad/h	3.65Krad
64.8h	5.4Krad/h	353Krad

CsI-AMC03		
Expo. Time	Dose Rate	Total Dose
17.8h	26.8rad/h	480rad
16h	26.8rad/h	905rad
15h	26.8rad/h	1310rad
16.7h	26.8rad/h	1755rad
64.8h	26.8rad/h	3490rad

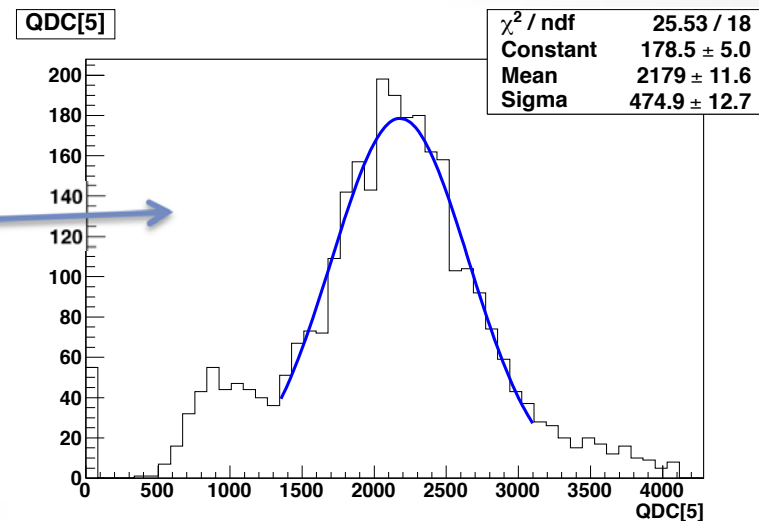
CsI-AMC02		
Expo. Time	Dose Rate	Total Dose
17.8h	8rad/h	142rad
16h	8rad/h	270rad
15h	8rad/h	390rad
16.7h	8rad/h	523rad
64.8h	8rad/h	1042rad

CsI-SIC01		
Expo. Time	Dose Rate	Total Dose
17.8h	26.8rad/h	480rad
15h	26.8rad/h	880rad
70.8h	26.8rad/h	2775rad

Measurements Setup

- Transmittance
 - Perkin-Elmer UV/Visible Spectrophotometer
 - Only transverse measurement possible (crystals too long)
- Light Yield
 - Each crystal is read by a PMT
 - 5 μ Ci ^{60}Co source
 - Signal Integrated over 2 μ s (same gate as BGO)
 - Each channels is auto-triggered

Signal example

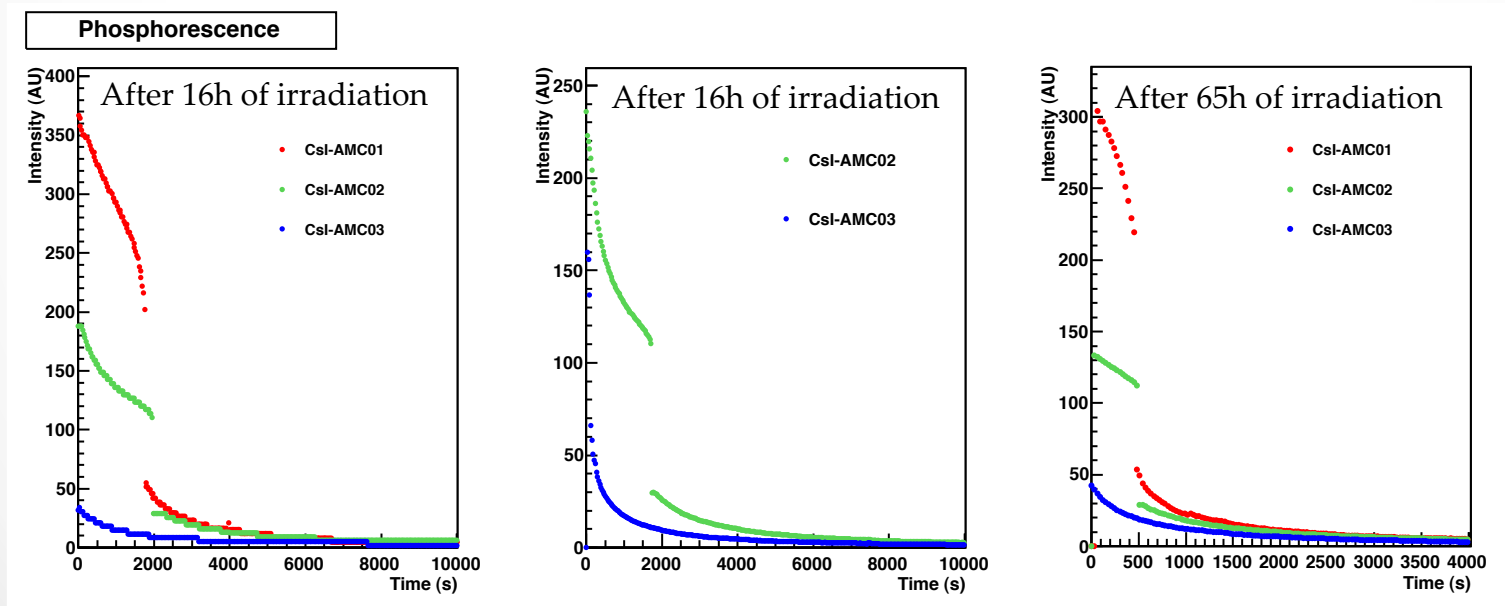


Phosphorescence

- Each crystal after irradiation show a phosphorescence emission
- Emission monitored with PMT current (sampling 30s)
- AMCRYS crystals need 2/3 hours before scintillation measurement can be performed
- SICCAS crystal need much more time (~24h), probably this is due to the high level of Thallium

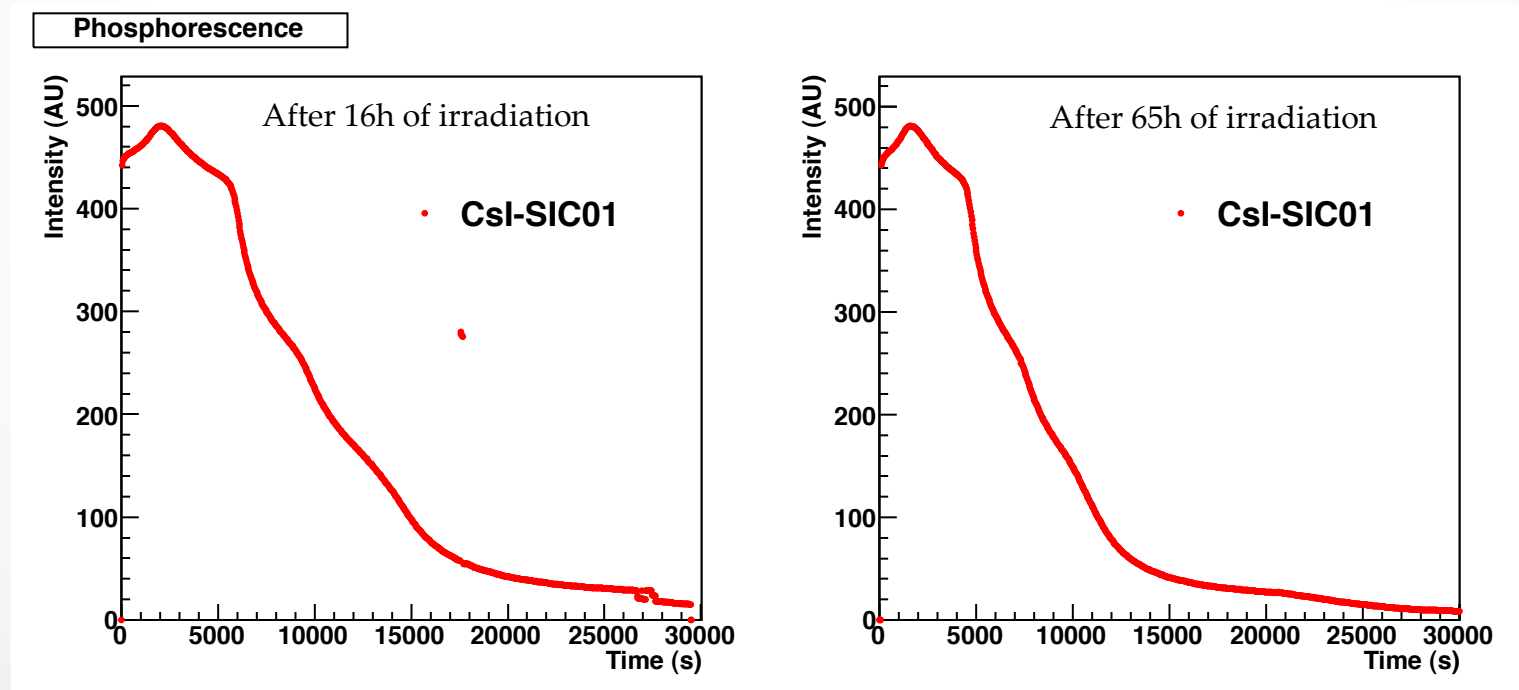
Phosphorescence (II)

- Phosphorescence has a very strange behavior
- Each crystals show a very rapid drop of the phosphorescence, AMC01 and AMC02 after ~30m, AMC03 after few minutes
 - For AMC03 this can be notice only in the middle plot
 - This time is comparable with the time needed to bring the cristal from the irradiation zone to the measurement setup



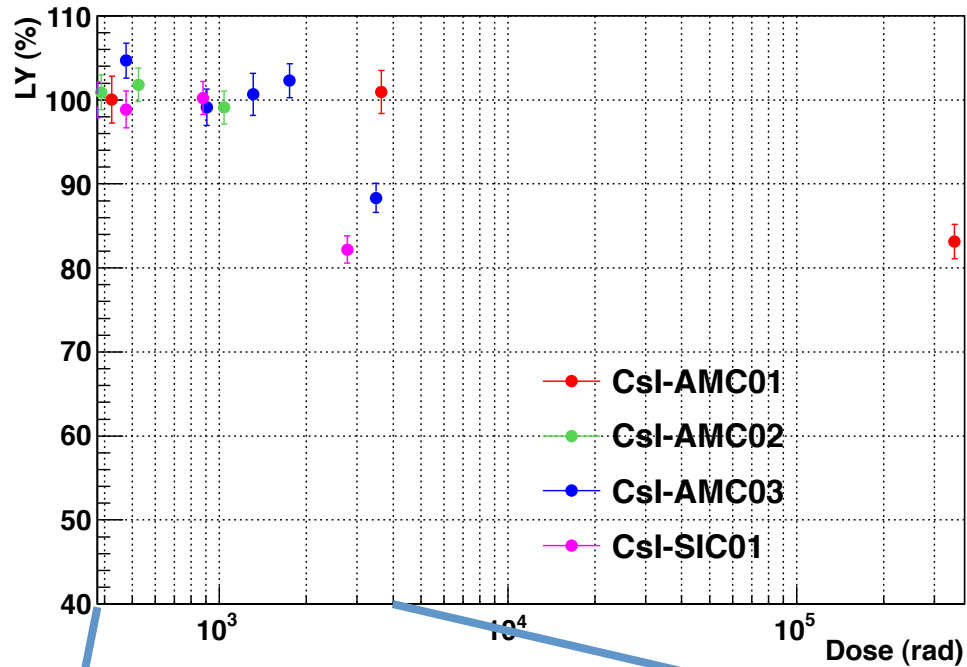
Phosphorescence (III)

- The SICCAS crystal doesn't show the very fast drop like AMCRYS but has a complex decay process



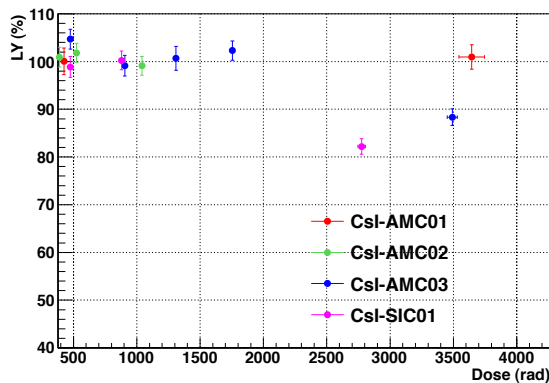
LY Loss

CsI RadHardness



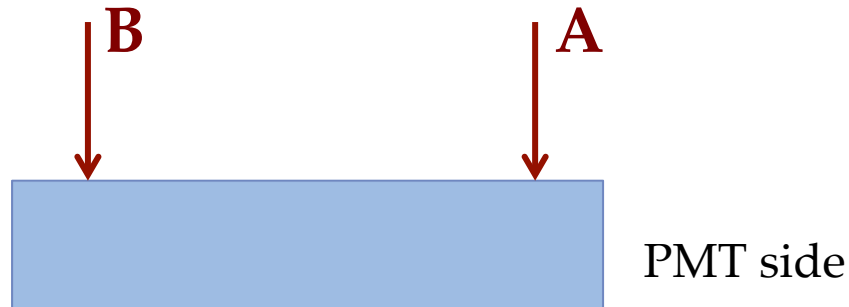
- All crystals have a stable LY up to 2Krad
- At 3Krad AMC03 and SIC01 have a loss of about 16-18%
- AMC01 is stable up to 4Krad and has a lost of 18% at 350Krad

CsI RadHardness



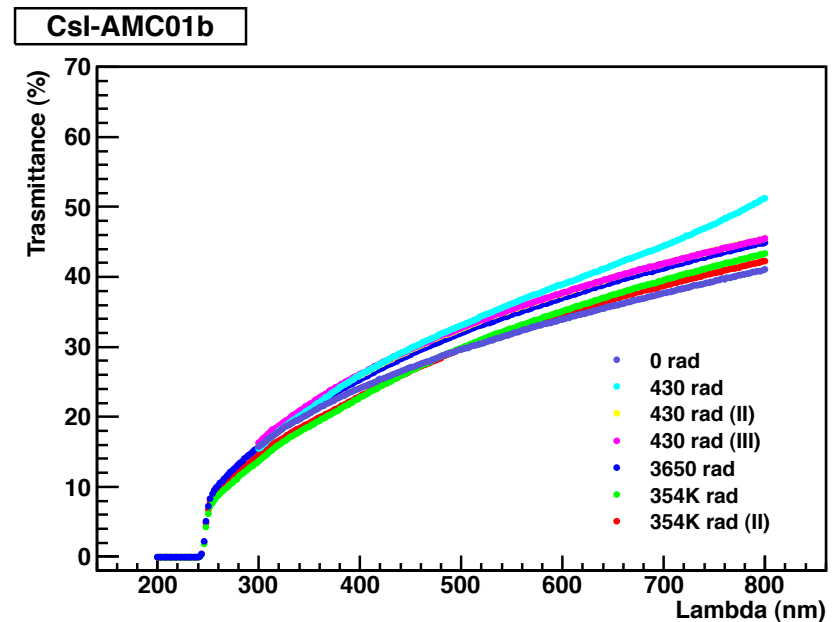
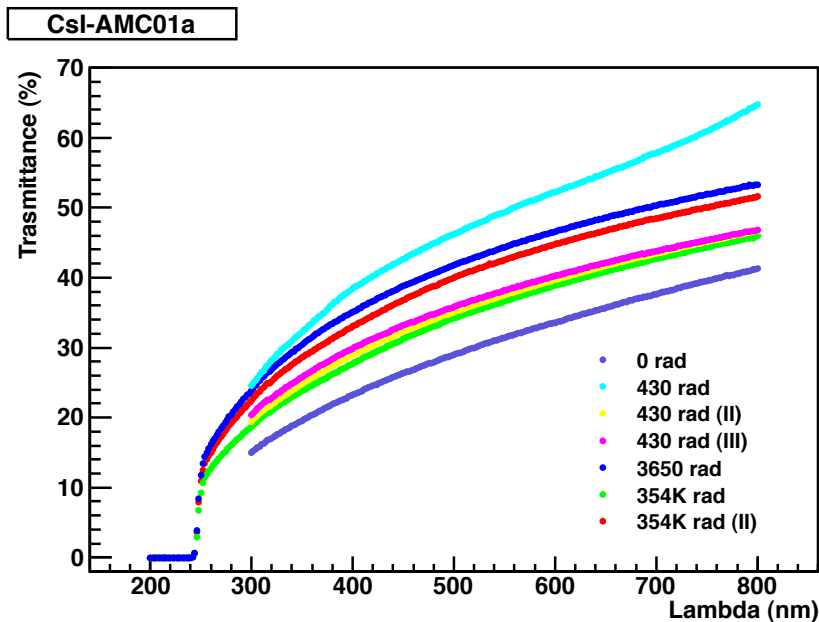
Transmittance

- Only transverse measurements can be performed
 - Crystal is too long for the Spectrophotometer
- Transmittance measured on two points



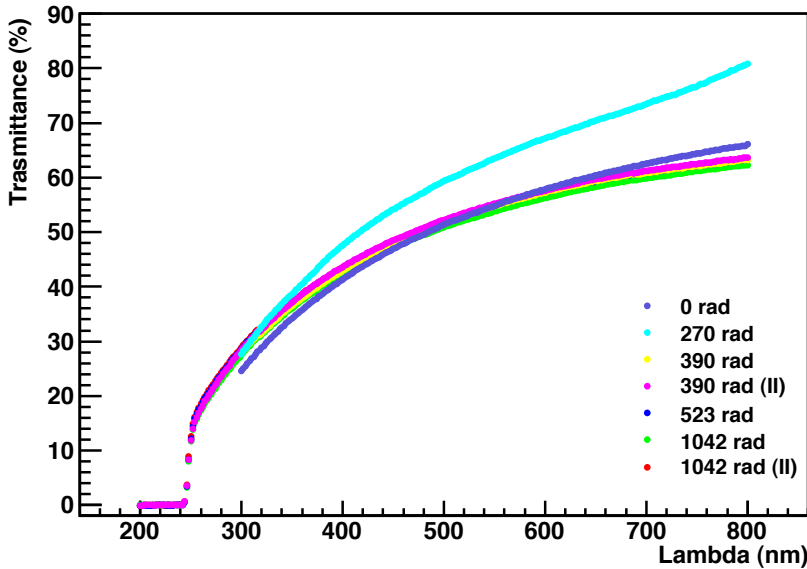
Transmittance AMC01

- After the first irradiation (light blue line) the transmittance became higher (?)
- T measurement goes up and down without any correlation with the absorbed dose
 - Have we done something wrong?

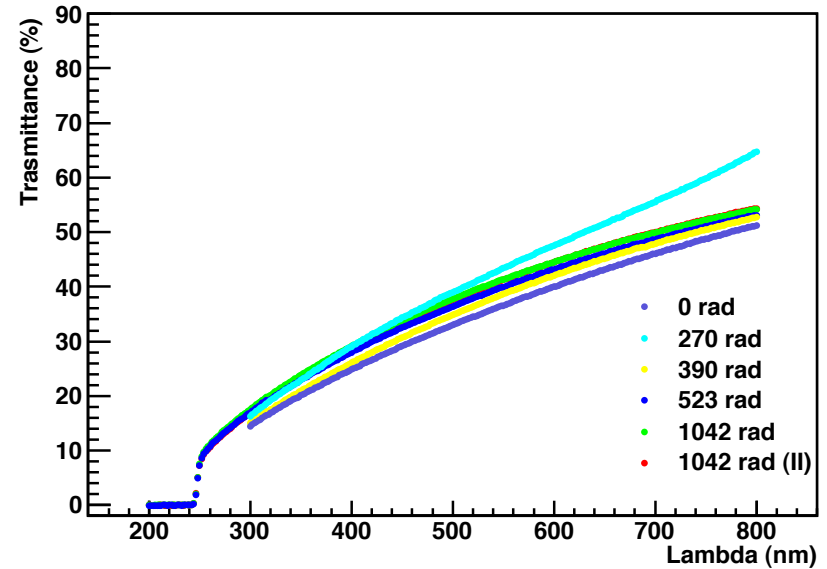


Transmittance AMC02

Csl-AMC02a

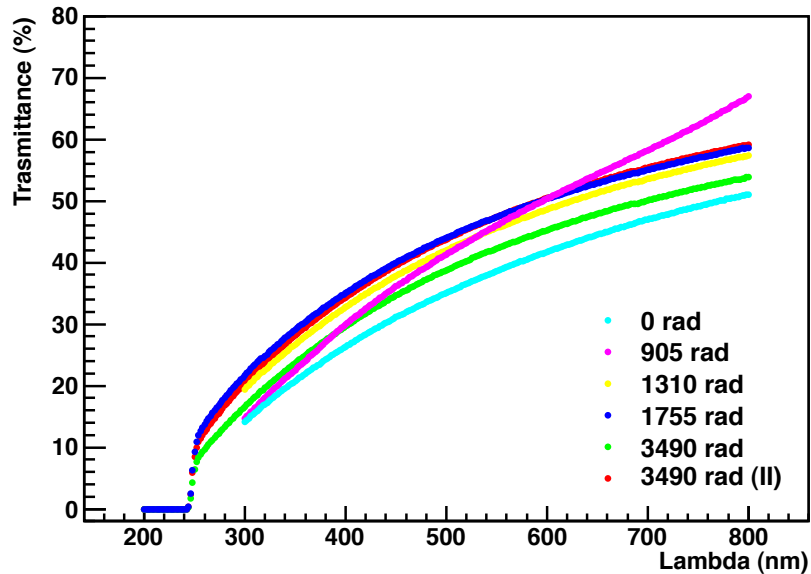


Csl-AMC02b

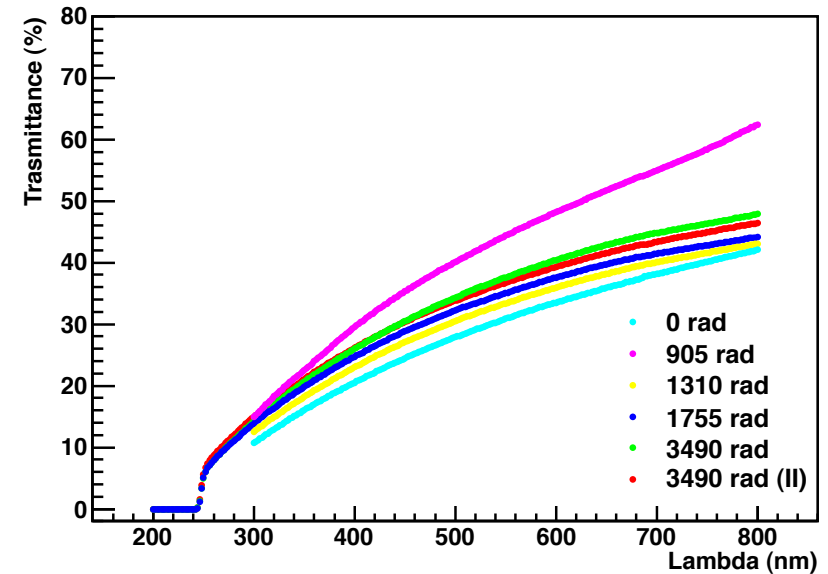


Transmittance AMC03

Csl-AMC03a

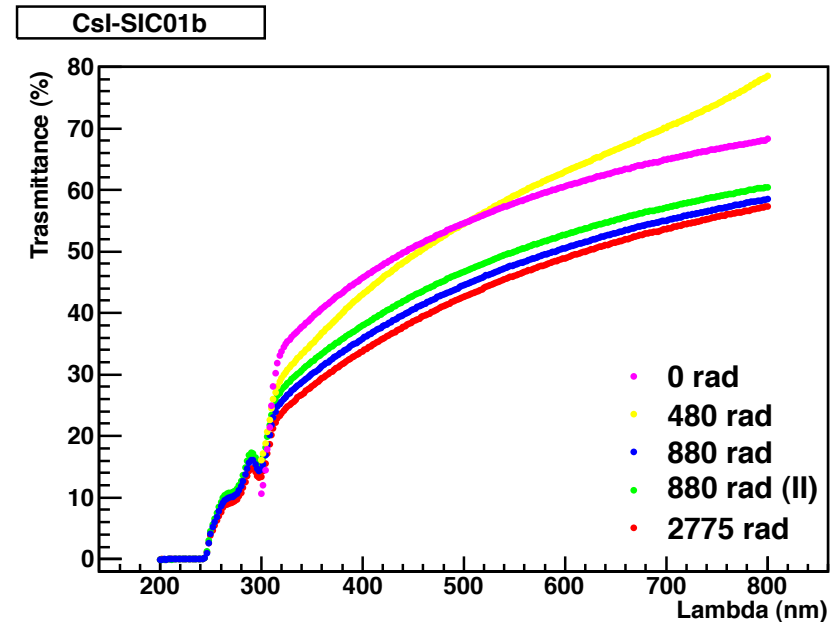
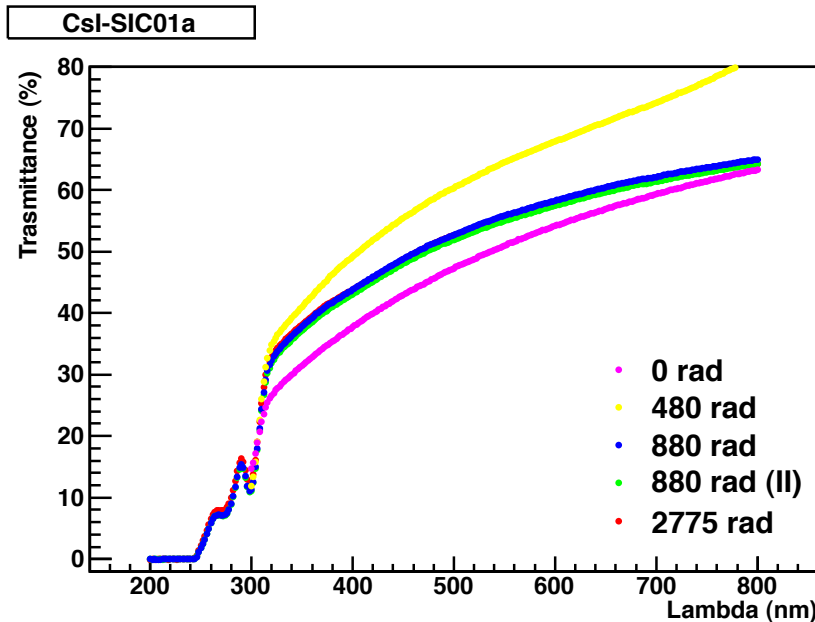


Csl-AMC03b



Transmittance SIC01

- Here the absorption peaks due to the Thallium contamination (around 300 and 270 nm) are visible



Conclusions

- Four different crystal of two different producers test up to 4Krad (1 up to 300Krad)
 - SICCAS crystal has Tl impurity
- Phosphorescence observed in all crystal
 - Amcryst Csl need ~3h to lose phosphorescence
 - SICCAS Csl need ~16h (probably due to Tl contamination)
- Light Yield losses:
 - AMC01 lost ~18% of LY @300Krad, stable up tp 4Krad
 - AMC03 lost 12% @ 3Krad
 - SICCAS lost 16% @ 3Krad
 - AMC02 stable up to 1Krad
- Transmittance
 - Transmittance measurements seem to be not correlated to the dose absorption
 - More test to be done to understand what happen