

Task 14.2.1

Test Infrastructure for innovative calorimeters with organic and inorganic scintillator fibers

Follow-up since January 2019

E. Auffray, CERN EP_CMX
On behalf of task 14.2.1 group

Objectives

Setup test infrastructure for innovative calorimeters with optical readout Subtask 14.2.1:

Test benches for characterisation of organic and inorganic scintillator fibers for future calorimetry

- Development of test stations for the characterization of scintillation and wavelength-shifting fibers as well as optical and timing properties of organic and inorganic scintillator and fiber elements
- Construction of an absorber structure and a readout system to study different fiber types in test beams
- Development of devices to evaluate the radiation hardness of fibers and crystals at irradiation facilities

Groups involved:

Brunel, CERN, ETHZ (with TTU), INFN (Milano, Rome, Torino), Minsk, UniMIB, Vilnius

Task14.2.1 Activities

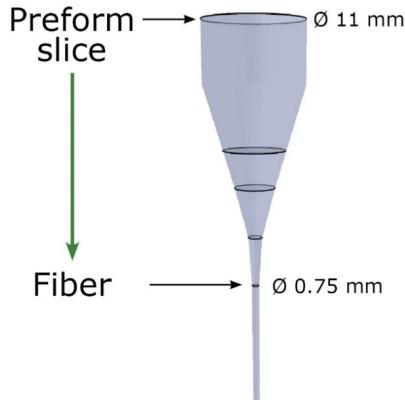
Characterization benches:

- Fiber development ongoing:
 - SiO₂ doped fibers: Milano, EThz together with Texas Tech University
 - Investigation garnet crystals YAG, LuAG and more recently GAGG with multiple codoping: Interest from LHCb calorimeter upgrade
- Timing
 - Vilnius & Minsk in collaboration with CERN:
 - setup of a “2 photon absorption” bench for timing investigation: Engineering inorganic scintillator properties to operate in high dose rate irradiation environment
 - Brunel:
 - investigation of the modification of the single-photon timing system to measure fiber

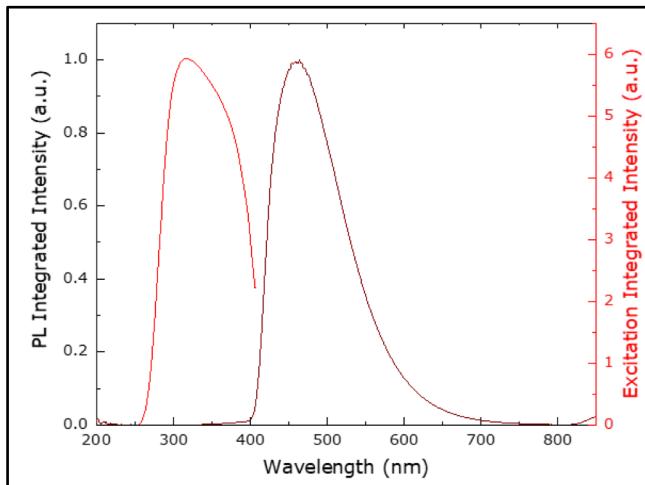
Rare Earth doped sol-gel silica fibers



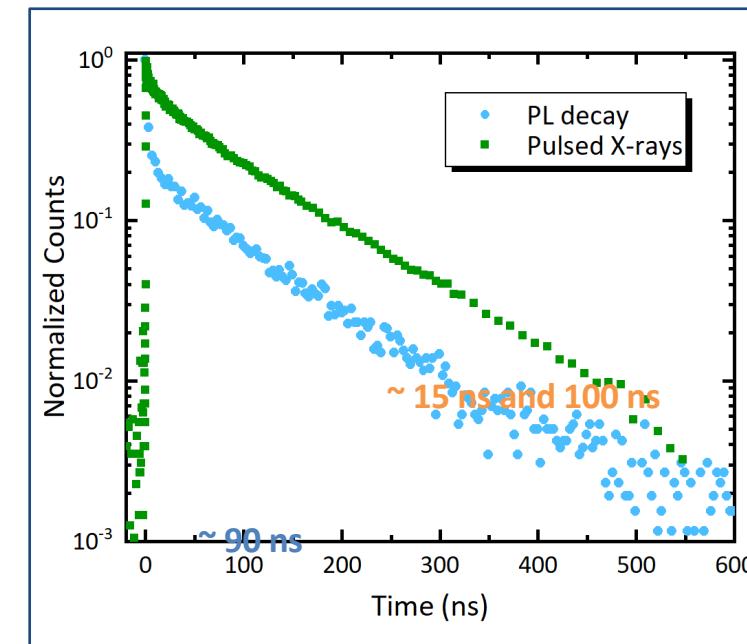
Drawing process of **sol-gel silica fluorinated cladded fibers**



Ce³⁺ excitation and emission spectra



PL and pulsed X-rays decays



During 2019:
Focus on Role of defects in Ce-doped sol-gel silica fibers (F. Cova PhD Thesis, paper in preparation)

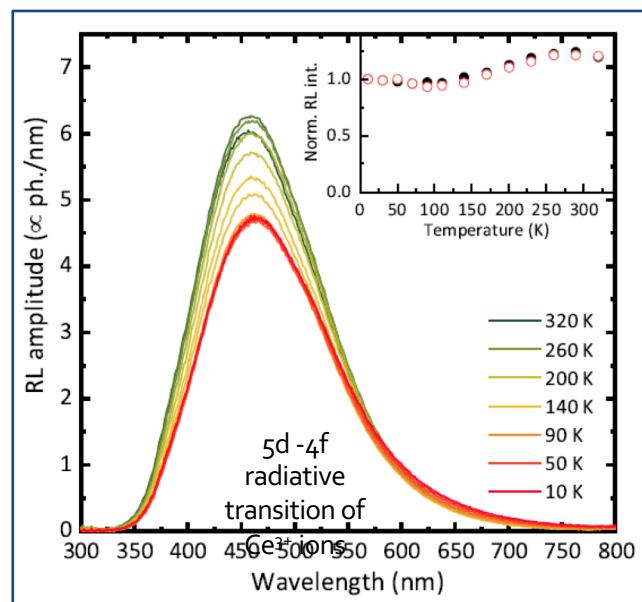
Role of defects in Ce-doped sol-gel silica fibers

Temperature dependent RL below 320K

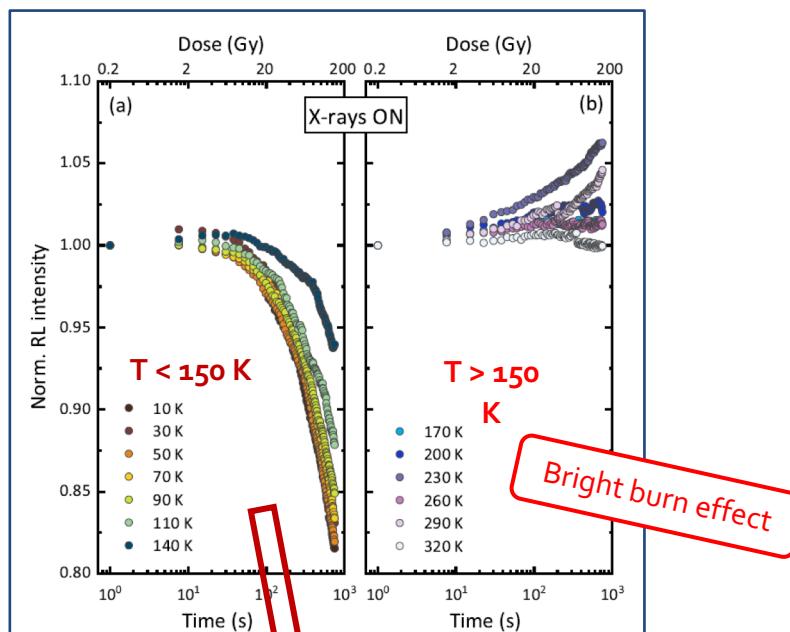
Progressive disappearance of competitive recombination channels and influence of traps



Stability of trapping defects strongly depends upon temperature



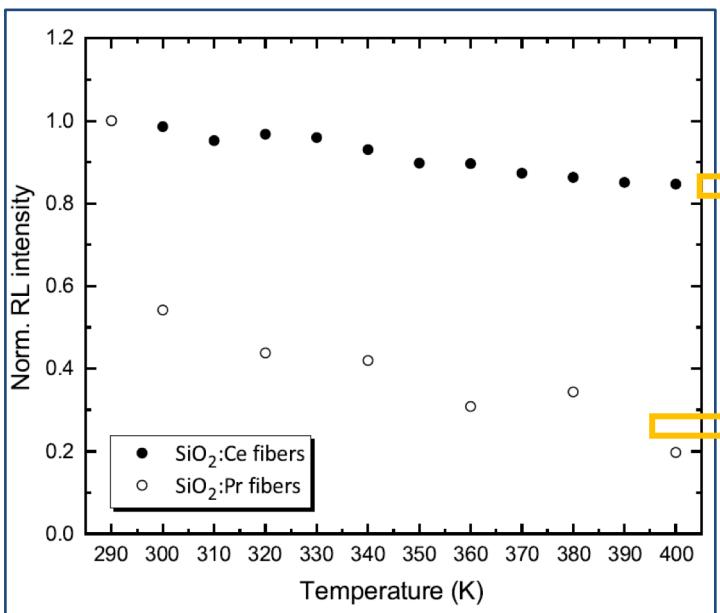
Sequences of RL measurements as a function of X-ray cumulated dose



- ✓ Radiation-induced defects self-absorbing the emitted light and unstable at high temperature
- ✓ Defects in proximity of Ce^{4+} ions inducing charge compensation inhibiting $\text{Ce}^{4+} \rightarrow \text{Ce}^{3+*}$ transition

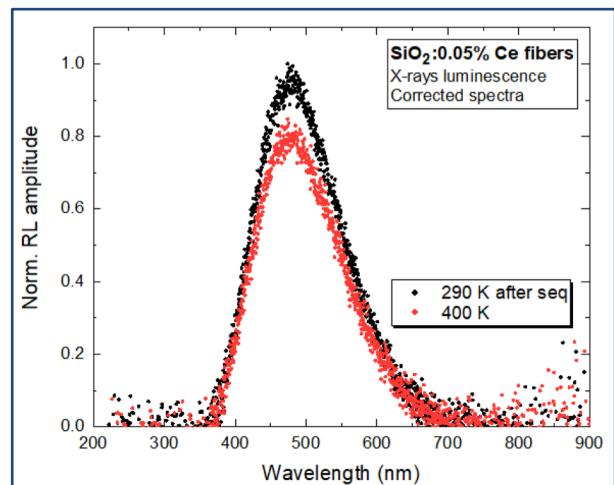
Role of defects in Ce-doped sol-gel silica fibers

Temperature dependent RL above 290K



Good stability of the RL signal over temperature for Ce-doped silica fibers

Strong thermal quenching of the RL signal for Pr-doped silica fibers



Phenomena occurring during the measurement:

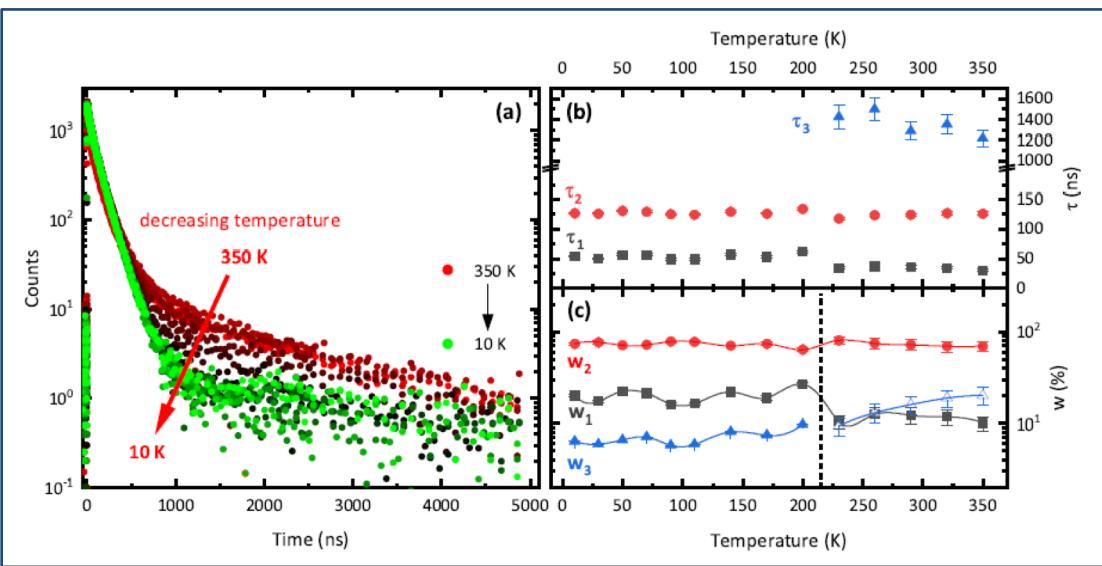
1. RL hysteresis due to prolonged irradiation
2. Recovery of the damage with time
3. Traps emptying induced by the high temperature



Possibility of a simultaneous *in situ* recovery of the radiation damage

Role of defects in Ce-doped sol-gel silica fibers

Scintillation kinetics versus temperature



The decay is a three-stage process characterized by:

1. Initial fast contribution of around 45 ns
2. Leading component of 125 ns
3. Third slow component
 - $T < 200 \text{ K}$
power law decay component
 - $T > 200 \text{ K}$
exponential decay in the μs time range



Power law time decay trend

The long component in the scintillation decay time reveals the presence of slower decay processes due to delayed radiative recombinations of electrons freed by defects acting as shallow traps and/or to emissions from intrinsic defects.

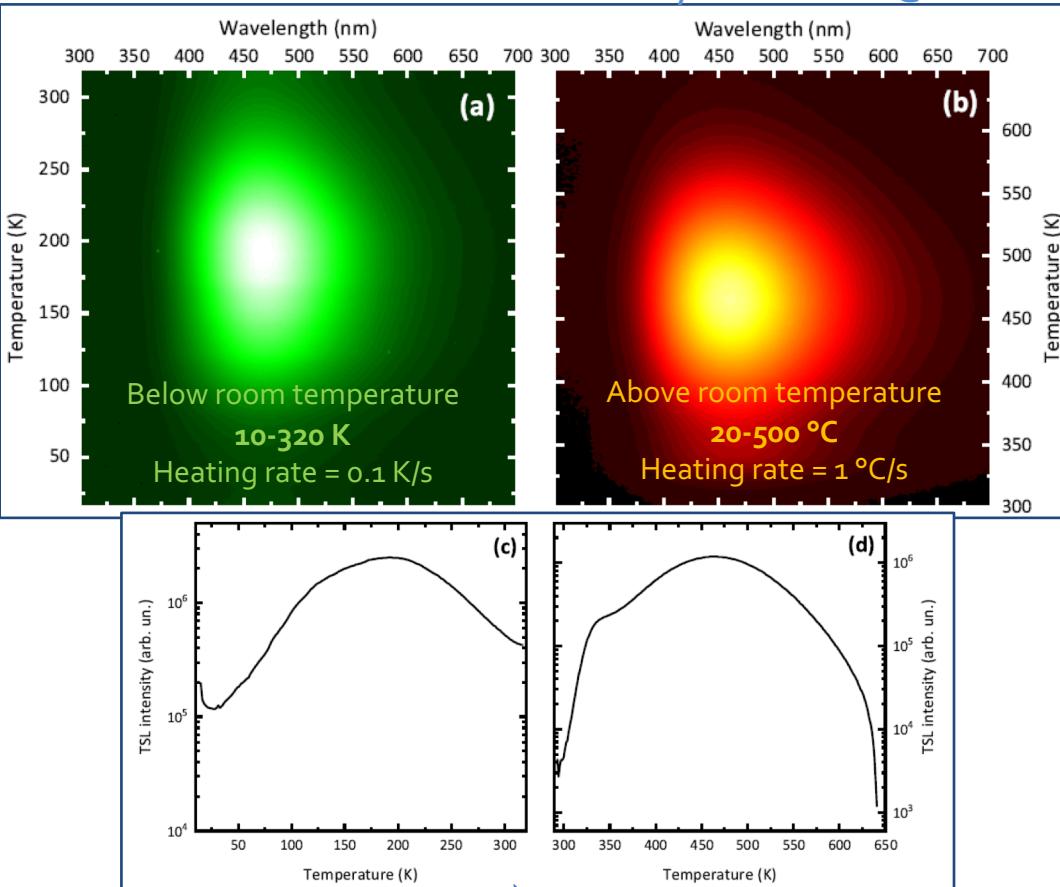
1. Recombination process involving detrapping to the delocalized bands of carriers from distributions of traps, typical of disordered systems
2. A thermal tunneling between traps and Ce centers

Role of defects in Ce-doped sol-gel silica fibers

Thermally Stimulated Luminescence

X ray irradiation @10K

X ray irradiation @RT

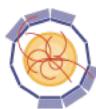


Broad TSL structure
on the entire
temperature range

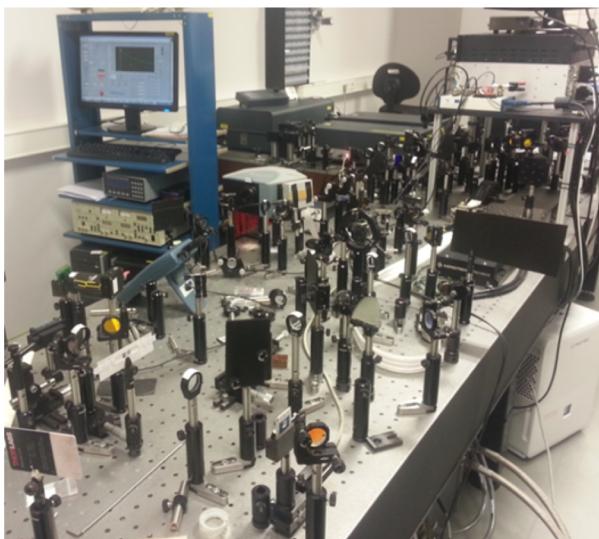
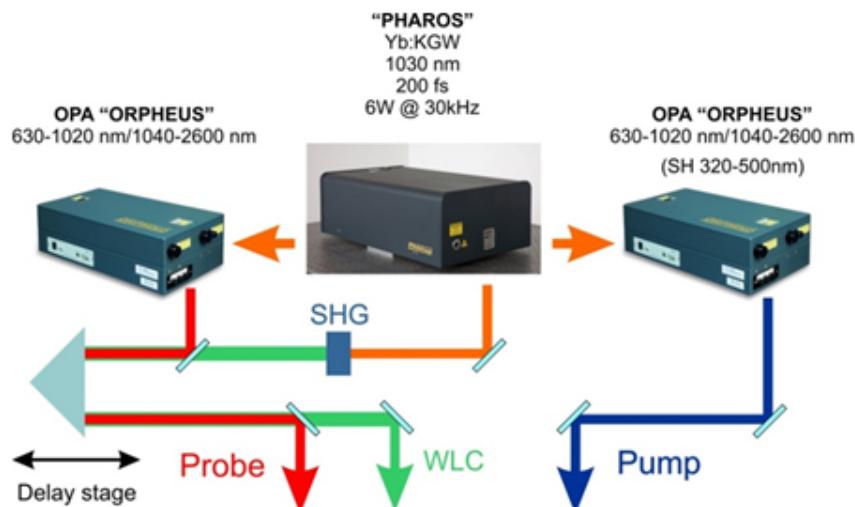
Traps responsible for the delayed
scintillation decay contribution are
reasonably in the 60 – 300 K region

The measurement consists in a collection of emission spectra measured at constant temperature intervals

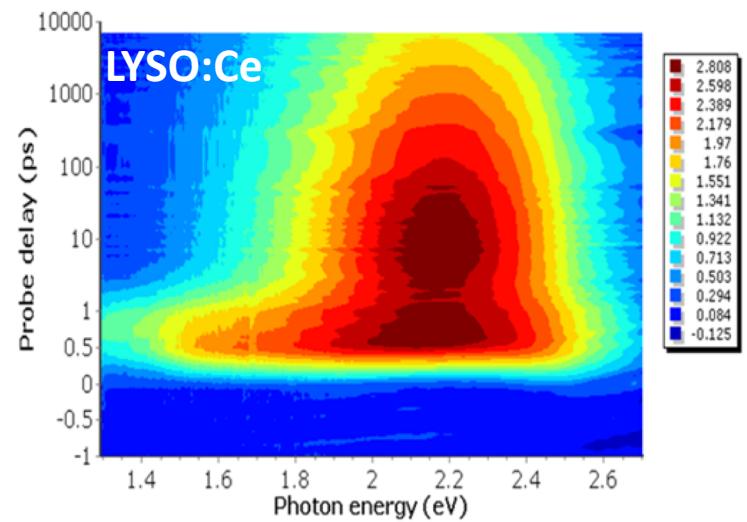
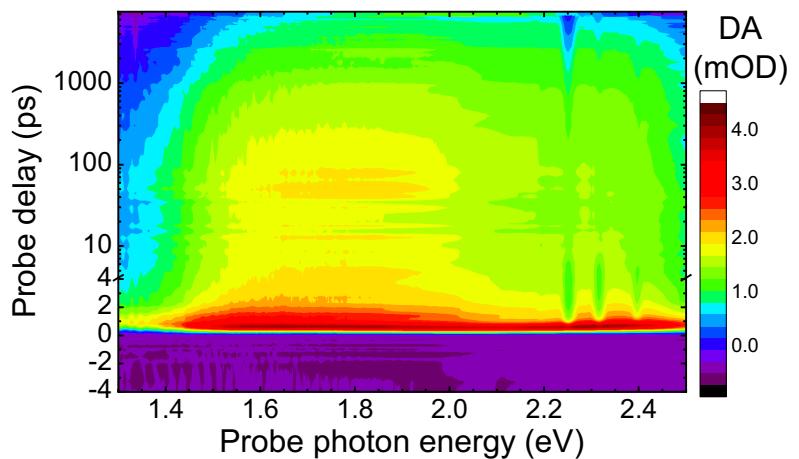
Only the characteristic Ce^{3+} emission is observed
→ Carriers released from traps recombine at Ce centers
→ TSL process in silica involves only electron traps



AIDA²⁰²⁰ Differential optical absorption setup

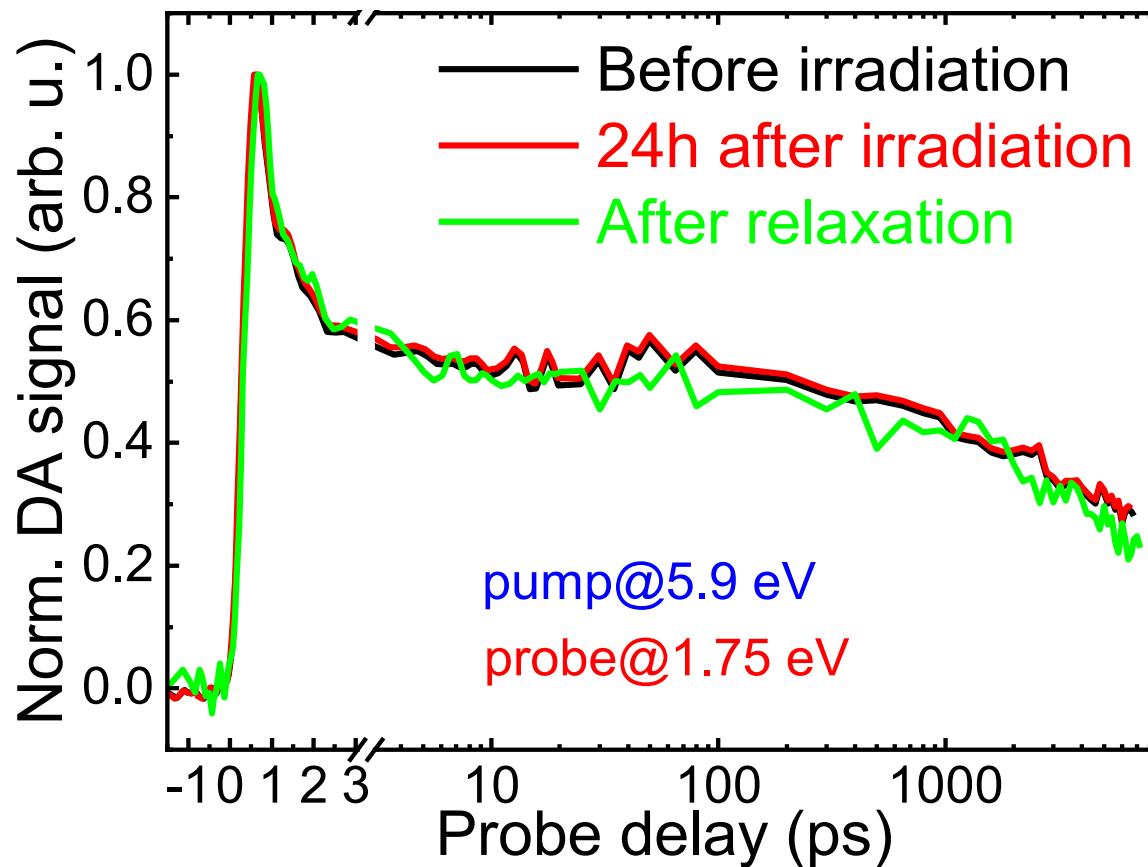


Time evolution of the spectrum of differential absorption induced by a short laser pulse

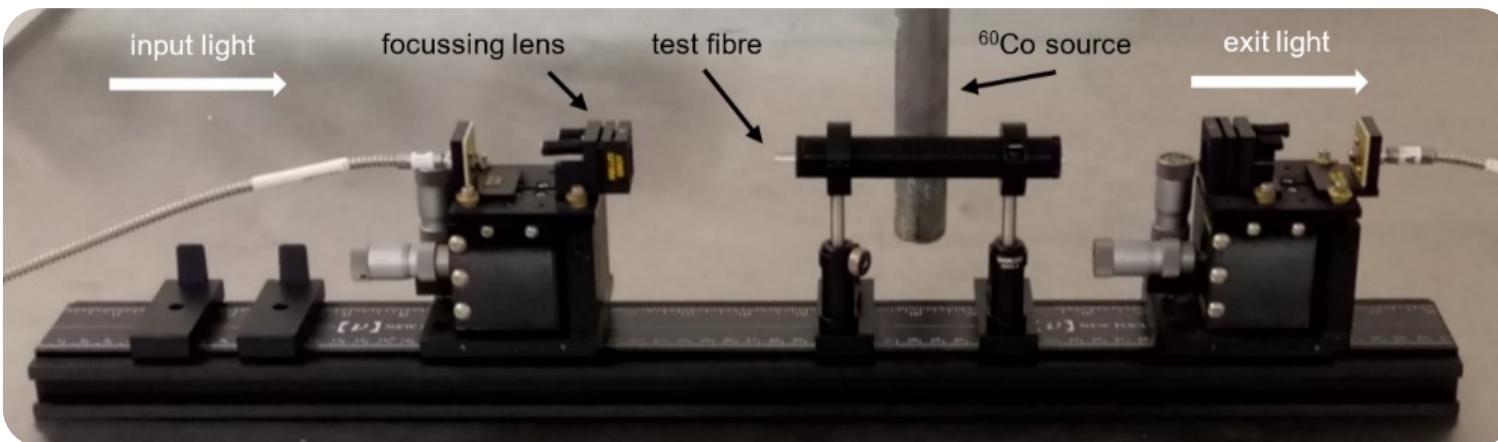


Kinetics of differential optical absorption in GAGG crystal

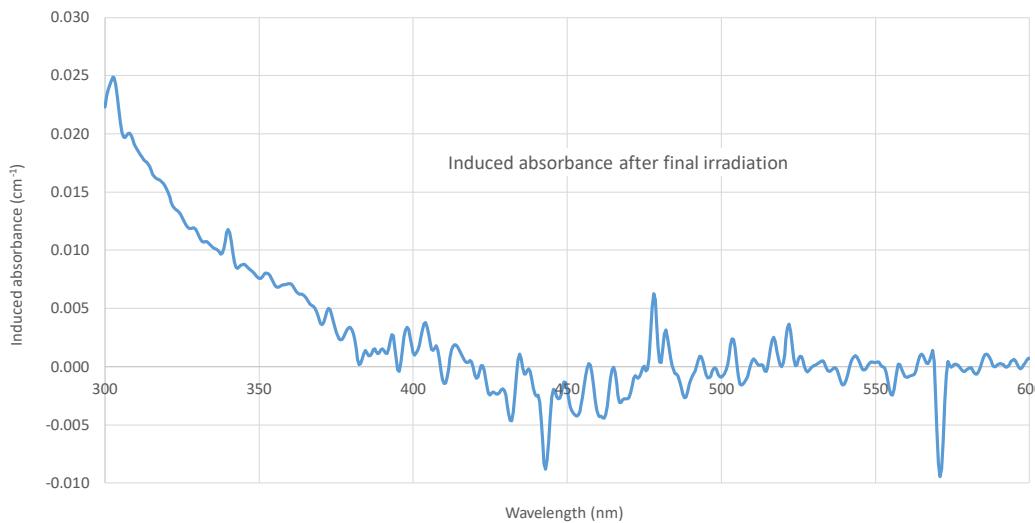
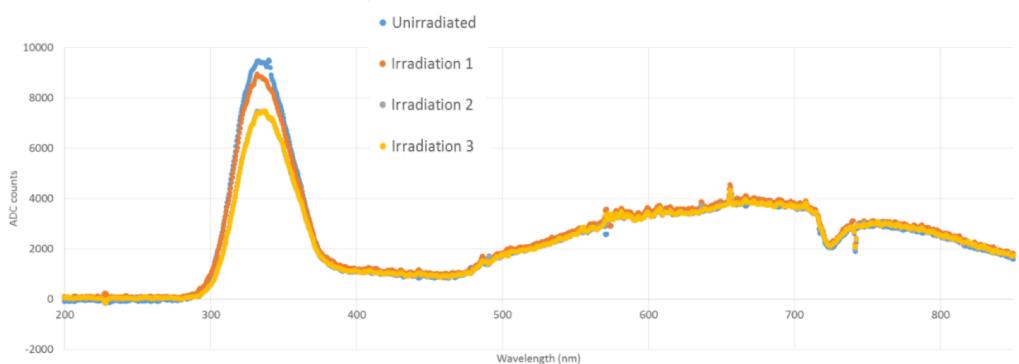
before irradiation, 24 hours after irradiation, and after spontaneous relaxation.



test-bench for real-time radiation damage measurements in scintillating and wavelength-shifting fibres



Continuous Gamma Irradiation



The transmission dip near 725 nm is due to the 40 m of high-OH silica fibre in the total light path.

The result of a three-day continuous gamma irradiation, to a total dose of approximately 0.44 kGy, of a 3 mm diameter silica rod. Data are dark count corrected.

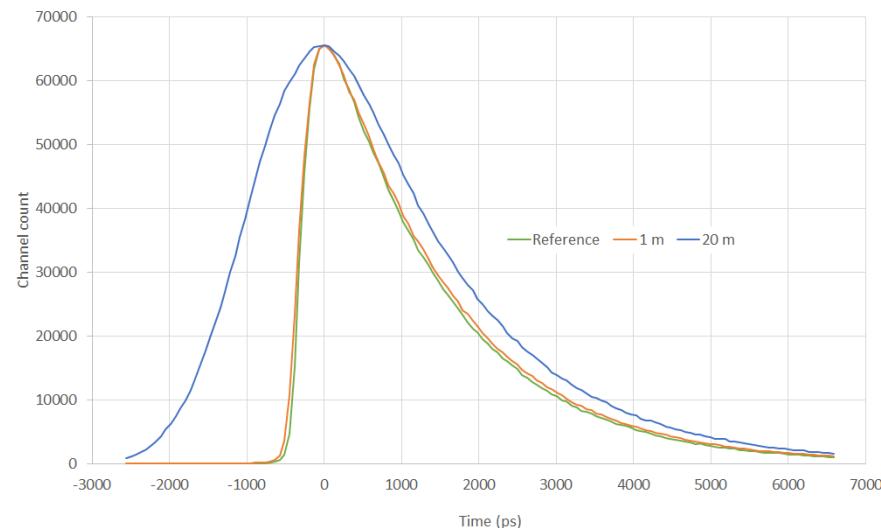
Real-Time Luminescence Measurement

We considered the possibility to measure in real-time the effect of radiation on fluorescent properties of scintillating and WLS fibres.

Using an 80 ps 377 nm diode laser, a fast SiPM based photon detector and a PicoHarp 300 time correlator the effect of time dispersion via the large core diameter multi-mode fibre was investigated.

We used 10 cm (reference), 1 m and 20 m long optical fibres and measured the decay time constant of a fast plastic scintillator (polystyrene with PPO and PPOP fluors) at 20 °C.

(n.b. the fibre test-bench was *not used* in these measurements)



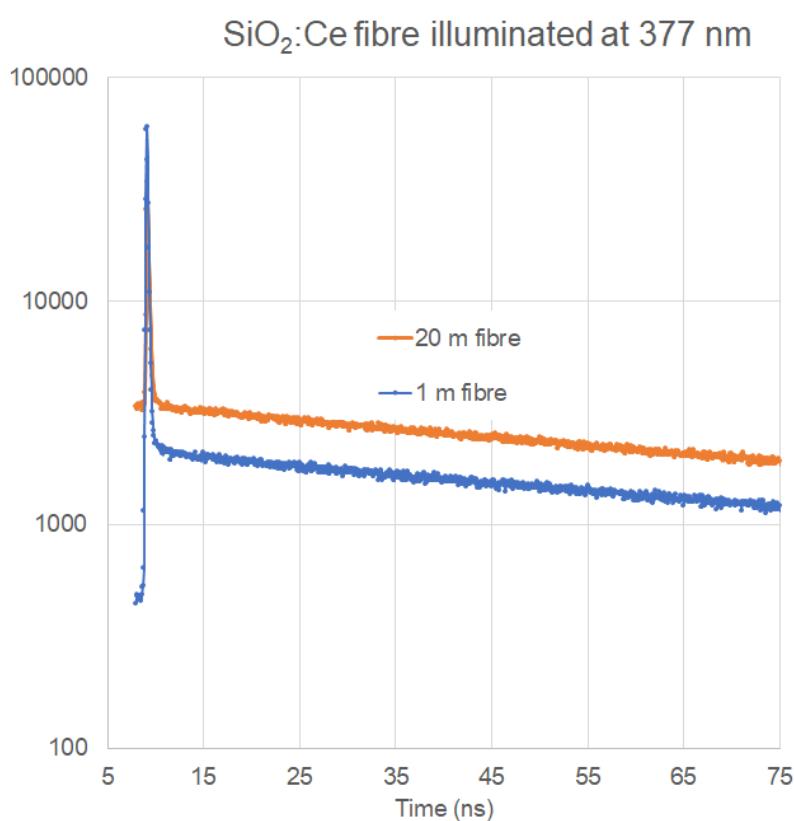
Fibre Length (m)	Decay Time (ns)	Error (ns)	Chi-square / DOF
0.1	1.53	± 0.01	6.0
1.0	1.57	± 0.01	8.8
20.0	1.64	± 0.01	6.3

Effect of fibre length on fitted decay constant (single exponential tail fit starting 1 ns after peak).

Using an 80 ps 377 nm diode laser, a fast SiPM based photon detector and a PicoHarp 300 time correlator the effect of time dispersion via the large core diameter multi-mode fibre was investigated **using the fibre test-bench** (excitation laser was free path in air).

1 m and 20 m long optical fibres were used with a 2 mm diameter cerium doped quartz fibre. The elastic scattered light (377 nm) was retained to demonstrate the effect on the IRF.

More data and fitting to determine systematic effects will be taken this month.



AIDA²⁰²⁰ Results presented in 2019 at IEEE NSS/MIC



Brunel University London | **Queen Mary University of London** | **AIDA²⁰²⁰**

A portable test-bench for real-time radiation damage measurements in scintillating and wavelength-shifting fibres

Peter R. Hobson^{a,b}, David R. Smith^a

^a Brunel University London, College of Engineering, Design and Physical Sciences, Kingston Lane, Uxbridge, Middlesex, UB8 3PH, UK
^b School of Physics and Astronomy, Queen Mary University of London, Mile End Road, London, E1 4NS, UK

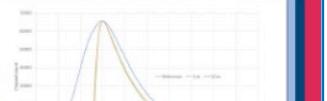
Motivation
A portable test-bench has been designed and constructed as part of the AIDA-2020 project [1] to enable the real-time measurement of radiation-induced absorption in scintillating and wavelength-shifting fibres typically used in the readout of fibre calorimeters or scintillating tiles such as those used in some hadron calorimeters. The test-bench has been designed to be used in a range of facilities, such as ^{60}Co irradiators or high-intensity test beam facilities, and can accommodate fibres with length up to 300 mm and diameter greater than 1.0 mm.

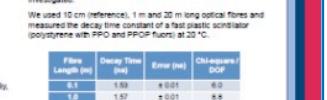
Test-bench Operation

Fibres are illuminated by a combined deuterium and halogen light source located at the end of the bench. A 0.25 NA radiation-tolerant quartz lens, light transmitted by an objective lens, and measured by an eyepiece lens with a linear CCD spectrometer covering a wavelength range from 350 nm to 850 nm. We simulated the sensitivity to misalignment using ZEMAX [2].

Experimental Results

The result of a four-day continuous gamma irradiation, to a total dose of approximately 0.44 kGy, of a 3 mm diameter commercial poly(methyl methacrylate) (PMMA) rod that was highly absorbing due to absorption at wavelengths shorter than 200 nm due to a UV absorbing additive.


The result of a three-day continuous gamma irradiation, to a total dose of approximately 0.44 kGy, of a 3 mm diameter silica rod. Data are dark count corrected [3]. The transmission dip near 720 nm is due to the 40 m of high-Zn silica fibre in the total light path.

We considered the possibility to measure in real-time the effect of radiation on fluorescent properties of scintillating and WLS fibres. Using an 80 ps 377 nm diode laser, a fast SiPM photo-sensor detector and a Pulse 200 time correlated single photon detection via the single core diameter multi-mode fibre was investigated.

We used 10 cm (reference), 1 m and 20 m long optical fibres and measured the decay time constant of a fast plastic scintillator (polystyrene with PPO and PPPO dyes) at 20 °C.

The effect of fibre length on fitted decay constant (single exponential tail fit starting 1 ns after peak).

Fibre Length (m)	Decay Time (ns)	Error (ns)	Chi-square / DDF
0.1	1.83	± 0.01	6.0
1.0	1.57	± 0.01	6.4
20.0	1.84	± 0.01	6.9

Acknowledgement
We acknowledge financial support for the development of the fibre test-bench via the AIDA-2020 collaboration which is funded by the EU Horizon 2020 Research and Innovation programme under Grant Agreement no. 654165.

Contact Information:
Prof. Peter Hobson
p.hobson@qmul.ac.uk
Tel: +44 (0)2078 826957

References:
[1] Advanced European Irradiations for Detectors in Accelerators (AIDA-2020). [Online]. Available: <http://aida2020.qmul.ac.uk/index.html>
[2] D. R. Smith, P. R. Hobson, "Spectrometer Testing: Dark Noise evaluation of Stellerized Black Comet spectrometer", Brunel University London, Uxbridge, UK, Brunel Spectrometer Testing, TM-2012-01, Feb. 2012. [Online]. Available: <http://cds.cern.ch/record/2701523>

P. R. Hobson, D. R. Smith

"A portable test-bench for real-time radiation damage measurements in scintillating and wavelength-shifting fibres"

<https://cds.cern.ch/record/2701523>

Task14.2.1 Activities

Test beam infrastructure

- Focus on a set-up for Electromagnetic calorimeter
 - Prototype of $\sim 3\text{Rm} * 3\text{Rm} * \text{maximum length} 30\text{cm}$
- ETHZ, INFN & TTU : preparation of sampling calorimeter :
 - Sampling calorimeter with CeF_3 plates and wavelength shifting Ce-quartz fibers
- CERN: development of a W/Cu absorber for SPACAL prototype ($6 * 6 * 20\text{cm}$) to test different types of fibers
- ETHZ& INFN : Common DAQ :

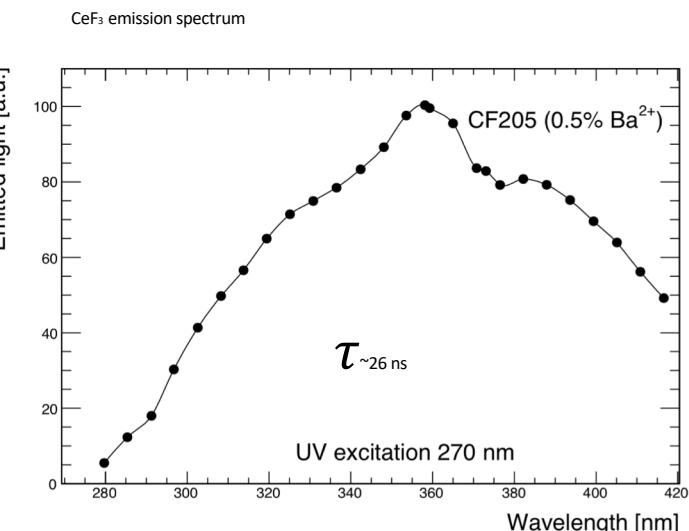
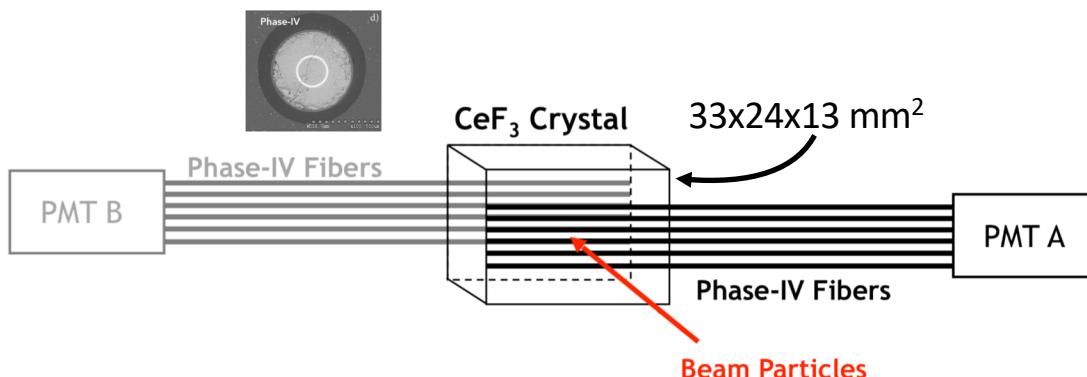
Study of Ce-doped fibers coupled to CeF₃

Team: ETHZ & TTU

Two sets of Phase-IV fibers are coupled to a CeF₃ crystal

New vs irradiated (100 kGy) bundle

Substantial overlap between the excitation of the SiO₂:Ce⁺³ and the emission band of the CeF₃



Abs peak: 329 nm	$R_M = 2.6 \text{ cm}$
$\rho = 6.16 \text{ g/cm}^3$	$\lambda_I = 25.9 \text{ cm}$
$X_0 = 1.68 \text{ cm}$	$n = 1.68$

N. Akchurin¹, N. Bartosik⁴, J. Damgov¹, F. De Guio¹, G. Dissertori³, E. Kendir²,
S. Kunori¹, T. Mengke¹, F. Nessi-Tedaldi³, N. Pastrone⁴, S. Pigazzini³, S. Yaltkaya²

¹Texas Tech University, ²Akdeniz University, ³ETH, Zurich, ⁴INFN-Torino,

JINST <https://doi.org/10.1088/1748-0221/14/06/T06006>

Compare irradiated vs unirradiated

Team: ETHZ & TTU

Two components of the signal:

direct excitation of the fibers by charged particles (**radio-luminescence**)

light from the crystal that excites the fibers (**photo-luminescence**)

Model the signal shape analytically (**different time characterization**)

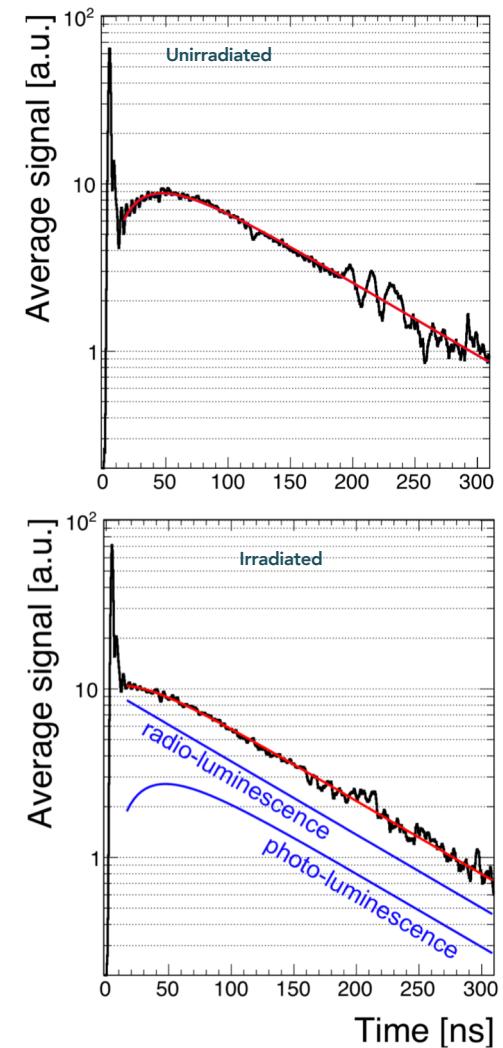
Unirradiated fiber is best described with a ~100% contribution from the photo-luminescence

Irradiated fiber suggests that only 1/4 of the total signal comes from photo-luminescence

Possible explanations:

loss of performance for both emission and transmission

reduced transmission of the scintillation light from cerium fluoride through the cladding of the fiber

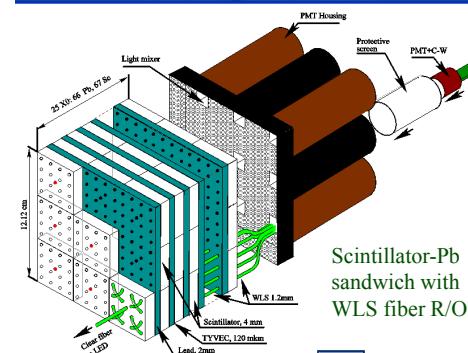
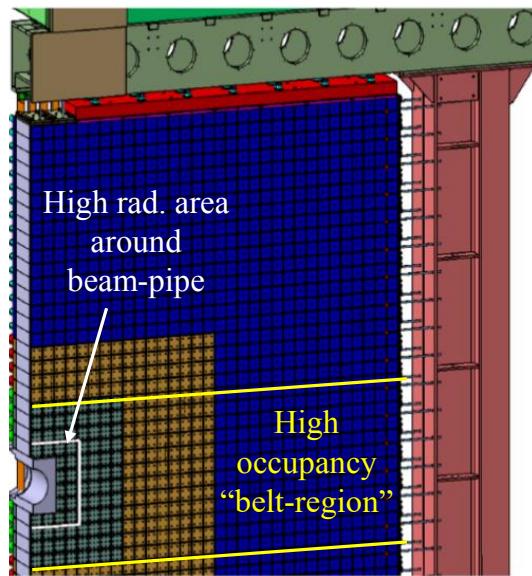


N. Akchurin¹et al., 2019 JINST 14 T06006

JINST <https://doi.org/10.1088/1748-0221/14/06/T06006>.

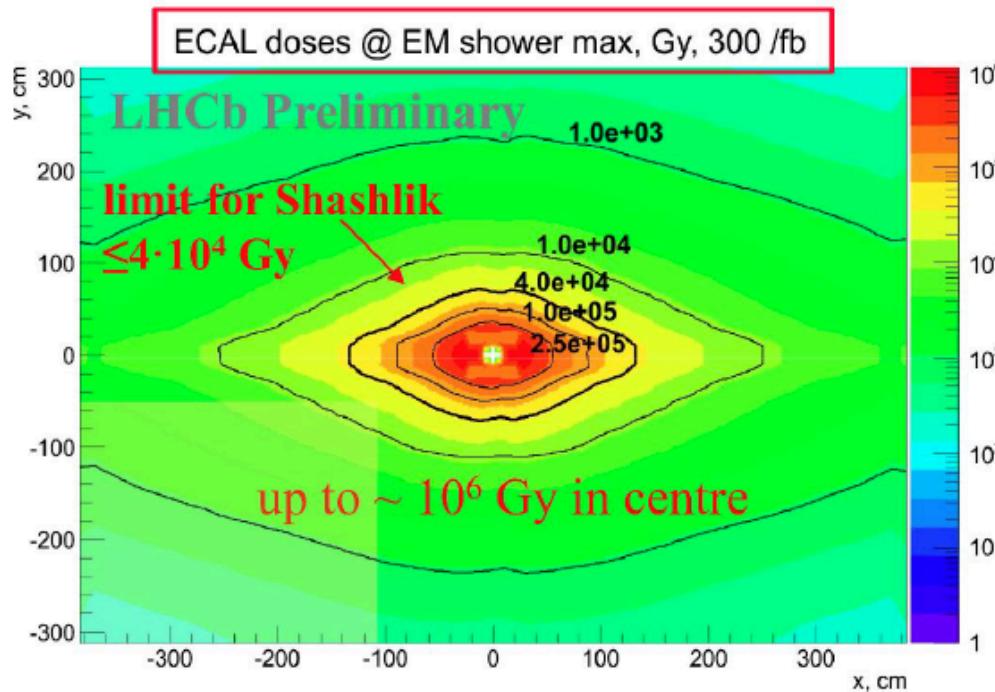
SPACAL R&D

Potential Future project: LHCb upgrade phase II



Shashlik ("skewer") technology:
 4mm thick plastic scintillating tiles (white)
 2mm thick Pb tiles (blue)
 WLS fibers running through the tiles

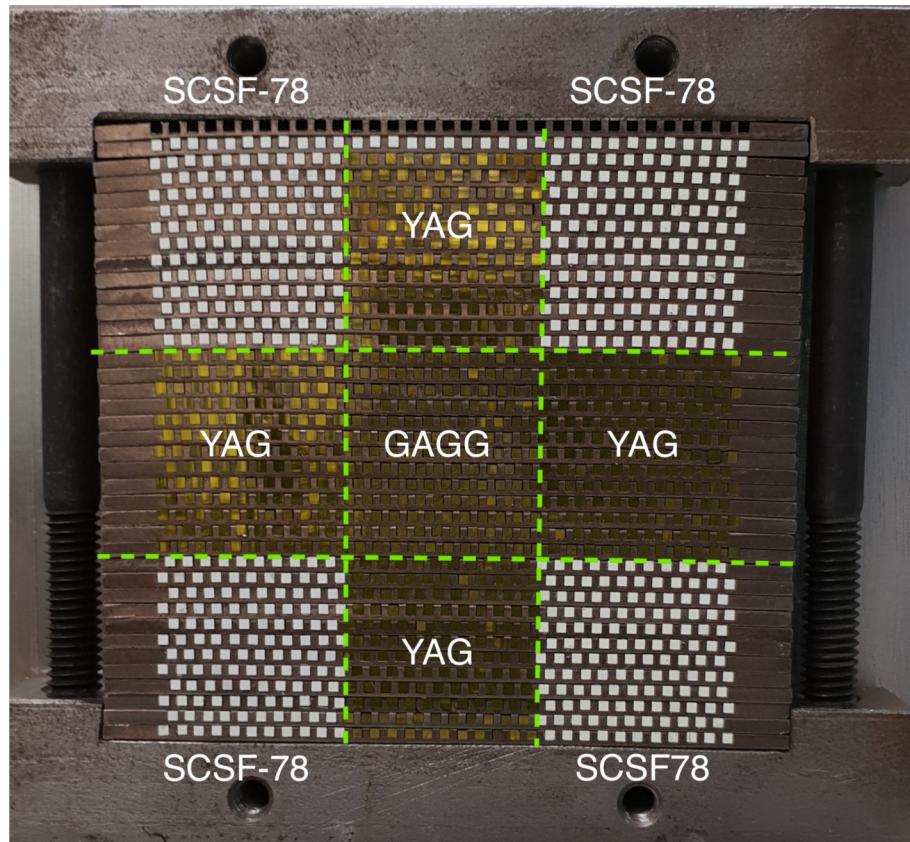
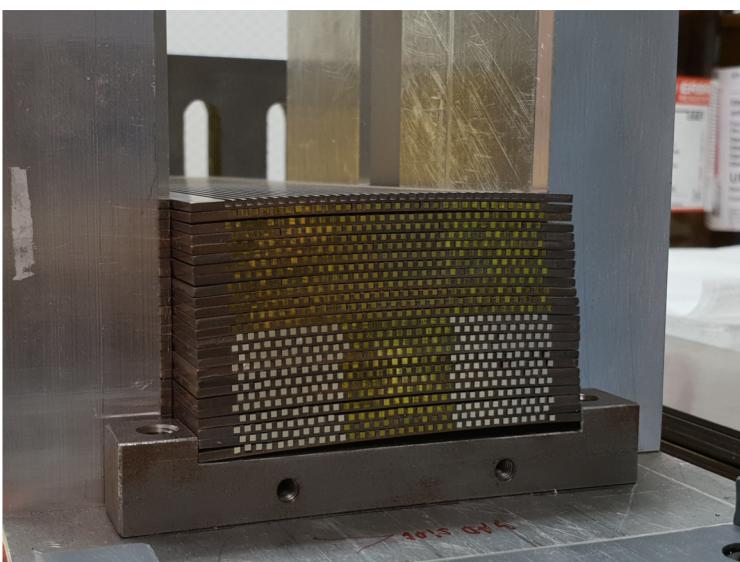
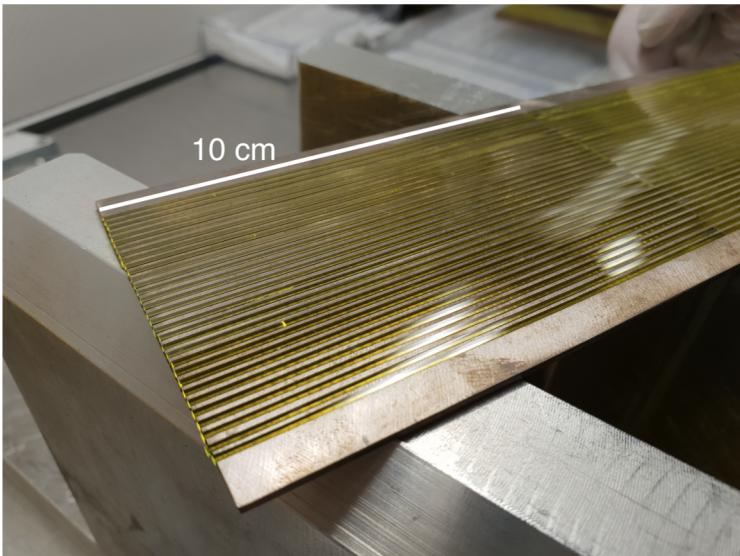
Motivation for LHCb calo upgrade



Detector requirements:

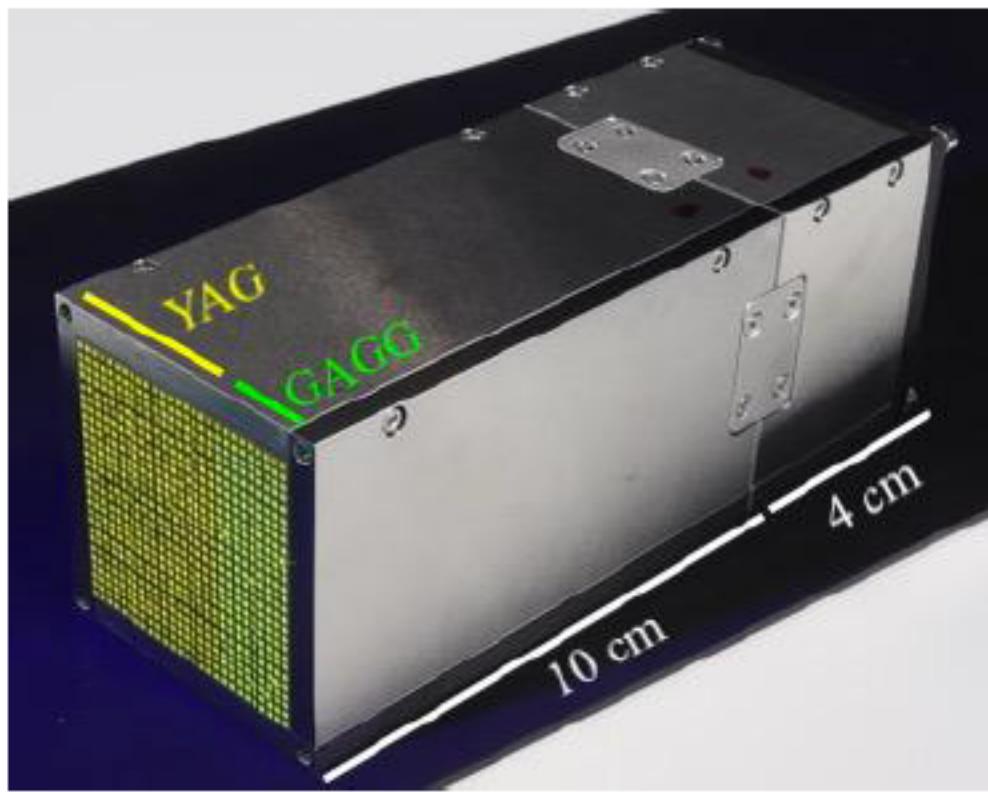
- High radiation hardness
- Smaller cell size and Moliere radius →
- Timing resolution tens of ps
- Good energy resolution

Crystal fibres could be a solution
⇒ R&D on SPACAL
between Crystal Clear & LHCb

Test @ CERN in october
2018

9 Cells made of 3 different materials
1x1 mm² scintillating fibers
Crystal bars grown with Czochralski method
⇒ Future R&D in frame of EP R&D WG3

Test in DESY in November 2019



More compact prototype:
Absorber Pure Tungsten made by
Crytur company

9 Cells $1.5 \times 1.5 \text{ cm}^2$ with longitudinal
segmentation 4+10cm of $1 \times 1 \text{ mm}^2$
crystal fibers

3 GAGG cells from FOMOS
6 YAG cells from Crytur

=> Work continues in frame LHCb upgrade, Crystal Clear and EP-RD WG3

Milestones & deliverables

Task14.2.1:

Milestone:

MS56 (due to M24): Commissioning of Fibre Test benches (Commissioning of the test benches for the evaluation and characterization of fibre elements for calorimeters) **done:**

2 documents:

- 1 Note with a detailed description of the benches:[AIDA-2020-NOTE-2017-004](#)
- A Summary for milestone document

Deliverable

D14.1 (due to M47): Documentation of the constructed and operational test facilities for scintillation and Cherenkov fibres, and report on their utilization and performance **done:**

2 documents:

- The deliverable: <http://cds.cern.ch/record/2665686>
- 1 Note with a detailed description of the benches:[AIDA-2020-NOTE-2019-014](#)

Publications

1. E. Auffray, M. Korjik, M.T. Lucchini, S. Nargelas, O. Sidletskiy, G. Tamulaitis, Y. Tratsiak, A. Vaitkevičius, Free carrier absorption in self-activated PbWO₄ and Ce-doped Y₃(Al_{0.25}Ga_{0.75})₃O₁₂ and Gd₃Al₂Ga₃O₁₂ garnet scintillators, *Optical Materials*, 58, 461-465 (2016).
2. E. Auffray, R. Augulis, A. Borisevich, V. Gulbinas, A. Fedorov, M. Korjik, M. T. Lucchini, V. Mechinsky, S. Nargelas, E. Songaila, G. Tamulaitis, A. Vaitkevičius, S. Zazubovich, Luminescence rise time in self-activated PbWO₄ and Ce-doped Gd₃Al₂Ga₃O₁₂ scintillation crystals, *J. Lumin.* 178, 54-60 (2016).
3. M.V. Korjik, E. Auffray, O. Buganov, A.A. Fedorov, I. Emelianchik, E. Griesmayer, V. Mechinsky, S. Nargelas, O. Sidletskiy, G. Tamulaitis, S.N. Tikhomirov, A. Vaitkevičius, Non-Linear Optical Phenomena in Detecting Materials as a Possibility for Fast Timing in Detectors of Ionizing Radiation, *IEEE Transactions on Nuclear Science*, 60, 2979-2984 (2016).
4. M. V Korjik, E. Auffray, Limits of Inorganic Scintillating Materials to Operate in a High Dose Rate Environment at Future Collider Experiments, *IEEE Transactions on Nuclear Science* 63, 2016, 552-563
5. M. Korjik, Limits of scintillation materials for future experiments at high luminosity LHC and FCC, *JINST* 12 (2017) C08021
6. G. Tamulaitis, A. Vaitkevičius, S. Nargelas, R. Augulis, V. Gulbinas, P. Bohacek, M. Nikl, A. Borisevich, A. Fedorov, M. Korjik, E. Auffray, Subpicosecond luminescence rise time in magnesium codoped GAGG:Ce scintillator, *Nuclear Inst. and Methods in Physics Research, A* 870, 25–29 (2017).
7. M.T. Lucchini, O. Buganov, E. Auffray, P. Bohacek, M. Korjik, D. Kozlov, S. Nargelas, M. Nikl, S. Tikhomirov, G. Tamulaitis, A. Vaitkevicius, K. Kamada, A. Yoshikawa, Measurement of non-equilibrium carriers dynamics in Ce-doped YAG, LuAG, and GAGG crystals with and without Mg-codoping, *J. Lumin.* 194, 1-7 (2017).
8. F. Cova, M. Fasoli, F. Moretti, N. Chiodini, K. Pauwels, E. Auffray, M.T. Lucchini, E. Bourret, I. Veronese, E. D’Ippolito, and A. Vedda, “Optical properties and radiation hardness of Pr-doped sol-gel silica: Influence of fiber drawing process”, *J. Lumin.* 192, 661-667 (2017).
9. F. Cova, F. Moretti, M. Fasoli, N. Chiodini, K. Pauwels, E. Auffray, M. T. Lucchini, S. Baccaro, A. Cemmi, H. Bártová, and A. Vedda, “Radiation hardness of Ce-doped sol-gel silica fibers for High Energy Physics applications”, *Opt. Lett.*, 43 (4), 903-906 (2018)
10. A. Marini for the CMS Collaboration, H4DAQ: a modern and versatile data-acquisition package for calorimeter prototypes test-beams, 2018 *JINST* 13 C02042
11. N. Akchurin et al, Cerium-doped scintillating fused-silica fibres, *JINST* 13, P04010 (2018)
12. F. Cova, M. T. Lucchini, K. Pauwels, E. Auffray, N. Chiodini, M. Fasoli, and A. Vedda, “Dual Cherenkov and Scintillation Response to High-Energy Electrons of Rare-Earth Doped Silica Fibers”, *Phys. Rev. Applied* 11, 024036
13. N. Akchurin et al, Cerium-doped scintillating fused-silica fibers as wavelength shifters, *JINST* 14 T06006 June2019
14. P. R. Hobson, D. R. Smith, "A portable test-bench for real-time radiation damage measurements in scintillating and wavelength-shifting fibres", poster presentation at the IEEE Nuclear Science Symposium, (2019).

Presentations (1)

1. G. Tamulaitis, E. Auffray, O. Buganov, A.A. Fedorov, M. V. Korjik, S. Nargelas, S.N. Tikhomirov, A. Vaitkevicius, Two photon absorption in scintillating crystals as a prospective process for timing measurements in ultrafast ionizing radiation detectors, 13TH International Conference on Inorganic Scintillators and their Applications, June 7-12, 2015, Berkeley, California, USA. (poster)
2. Francesco Micheli for the W-CeF₃ group
"High-Energy Electron Test Results of a Calorimeter Prototype Based on CeF₃ for HL-LHC Applications"
Talk in parallel session 31/10/2015 -7/11/2015, 2015 IEEE Nuclear Science Symposium & Medical Imaging Conference San Diego, California
3. A. Vaitkevičius, M. Korjik, H. Svidras, D. Dobrovolskas, E. Trusova and G. Tamulaitis, Study of luminescence properties in Ba-Si-O glasses with different dopants and BaO-SiO₂ ratios, The book of abstracts of the 9th International Conference on Luminescent Detectors and Transformers of Ionizing Radiation (LUMDETR), September 20-25, 2015 Tartu, Estonia.
4. R. Paramatti for the W-CeF₃ group
"Performance in electron beams of a tungsten-CeF₃ prototype for radiation- resistant high-energy physics calorimetry"
Parallel talk, VCI 2016, 14th Vienna Instrumentation Conference, Vienna, Austria
5. M.Schönenberger for the W-CeF₃ group
Performance Studies of a Tungsten-CeF₃ Sampling Calorimeter", Plenary talk, 19/5/2016, CALOR 2016, 17th International Conference on Calorimetry for High-Energy Physics, Daegu, S. Korea
6. A. Vedda, "Performances and applications of rare-earth doped silica-based scintillating fibers", invited lecture at CIMTEC 2016 Conference, " 5th International Conference on Smart and Multifunctional Materials structures and systems", Perugia, Italy, June 5-9, 2016.
7. G. Tamulaitis, E. Auffray, R. Augulis, O. Buganov, A. Fedorov, V. Gulbinas, M. Korjik, M.T. Lucchini, V. Mechinsky, S. Nargelas, E. Songaila, S. Tikhomirov, A. Vaitkevičius, Fast optical phenomena in self-activated and Ce-doped materials prospective for fast timing in radiation detectors, Book of Abstracts of the Fifth International Conference "Engineering of Scintillation Materials and Radiation Technologies", ISMART 2016, September 26-30, 2016, Minsk, Belarus. (invited)
8. F. Moretti et al., " Rare-Earth Doped Silica-Based Optical Fibers For High Energy Physics Detectors", invited lecture at the 5th International Conference ISMART
9. Francesca Nessi-Tedaldi for the W-CeF₃ group
Energy Resolution and Timing Performance Studies of a W-CeF₃ Sampling Calorimeter prototype with a Wavelength-Shifting Fiber Readout"
Plenary talk, 4/10/16IPRD 2016, 14th Topical Seminar on Innovative Particle and Radiation Detectors, Siena, Italy

Presentations (2)

10. F. Moretti et al., "Rare-Earth Doped Silica-Based Optical Fibers For High Energy Physics Detectors", invited lecture at EAGLES, "International Conference on Rare-Earth Doped Glass Materials and Fiber Lasers", MPNS COST Action MD1401, Trento (Italy), October 18-19, 2016.
11. G. Tamulaitis, E. Auffray, R. Augulis, A. Fedorov, V. Gulbinas, M. Korjik, M.T. Lucchini, V. Mechinsky, S. Nargelas, E. Songaila, A. Vaitkevičius, Fast luminescence response in self-activated and Ce-doped scintillation materials, IEEE NSS/MIC Conference, October 29 -- November 6, 2016, Strasbourg, France. (oral)
12. Francesco Micheli for the W-CeF₃ group, Talk in parallel session "Energy Resolution and Timing Performance Studies of a W-CeF₃ Sampling Calorimeter with a Wavelength-Shifting Fiber Readout" 2016 IEEE Nuclear Science Symposium & Medical Imaging Conference Strasbourg, France
13. Francesca Nessi-Tedaldi for the W-CeF₃ group, Talk in parallel session , "Energy Resolution and Timing Performance Studies of a W-CeF₃ Sampling Calorimeter prototype with a Wavelength-Shifting Fiber Readout", 2017 Int. Conf. on Technology and Instrumentation in Particle Physics 2017, Beijing, China
14. G. Tamulaitis, S. Nargelas, A. Vaitkevicius, M. Korjik, M. Lucchini, E. Auffray, Free carrier absorption for study of fast excitation transfer in scintillation crystals, 14th International Conference on Scintillating Materials and their Applications (SCINT 2017), 18-22 September, 2017, Chamonix, France (oral)
15. A. Vaitkevičius, S. Nargelas, E. Tratsiak, E. Trusova, M. Korjik, G. Tamulaitis, Luminescence properties of rare earth ions in novel garnets and glasses, 14 th International Conference on Scintillating Materials and their Applications (SCINT 2017), 18-22 September, 2017, Chamonix, France.
16. M. Korjik, V. Alenkov, A. Borisevich, K.T. Brinkmann, O. Buzanov, V. Dormenev, G. Dosovitskiy, A. Dosovitskiy, A. Fedorov, D. Kozlov, R. Novotny, G. Tamulaitis, V. Vasiliev , H.G. Zaunick, Significant improvement of GAGG based scintillation detector performance by control of the electronic excitation dynamics, 14th International Conference on Scintillating Materials and their Applications (SCINT 2017), 18-22 September, 2017, Chamonix, France.
17. F. Cova, N. Chiodini, M. Fasoli, K. Pauwels, E. Auffray, M. T. Lucchini, G. Bizarri, E. Bourret, S. Baccaro, A. Cemmi, A. Vedda, "Radiation hardness of Rare-Earth doped sol-gel silica fibers for High Energy Physics Detectors", 14th International Conference on Scintillating Materials and their Applications, SCINT 2017, Chamonix, France, 18-22 September 2017
18. A. Vaitkevičius, V. Marčiulionytė, E. Trusova, Y. Tratsiak, M. Korjik, G. Tamulaitis, Investigation of novel glasses and garnets doped with rare earth ions, 42nd Lithuanian National Physics Conference (LNFK-42): Program and Abstracts, 4-6 October, 2017, Vilnius, Lithuania, p. 211.

Presentations (3)

19. E. Auffray, M. Korjik, M. Lucchini, V. Mechinsky, S. Nargelas, G. Tamulaitis, A. Vaitkevičius, Free carrier dynamics in GAGG:Ce scintillation crystal with aliovalent cooping, IEEE 2017 Nuclear Science Symposium, 21-28 October, 2017, Atlanta, Georgia, USA.
20. G. Tamulaitis, E. Auffray, M. Korjik, S. Nargelas, A. Vaitkevicius, Exploitation of free carrier absorption in quest for ten picosecond target for time resolution of radiation detectors, 6th International Conference on Radiation and applications in various fields of Research, June 8-22, 2018, Ohrid, Macedonia. p. 239 (oral).
21. G. Tamulaitis, S. Nargelas, A. Vaitkevičius, E. Auffray, M. T. Lucchini, A. Gola, A. Mazzi, C. Piemonte, M. Korjik, A. Fedorov, V. Mechinsky, O. Sidletsky, Timing properties of GAGG:Ce and LSO:Ce scintillators with and without codoping, 10th International Conference on Luminescent Detectors and Transformers of Ionizing Radiation (LUMDETR), 9-14 September 2018, Prague, Czech Republic. (oral)
22. F. Cova, M. T. Lucchini, K. Pauwels, E. Auffray, N. Chiodini, M. Fasoli, F. Moretti, J. A. Mares, V. Jary, M. Nikl, A. Vedda, "Dual response of RE-doped sol-gel silica fibers to high energy electrons", 10th International Conference on Luminescent Detectors and Transformers of Ionizing Radiation, LumDetr 2018, Prague, Czech Republic, 9-14 September 2018 (oral)
23. A. Vaitkevičius, S. Nargelas, G. Tamulaitis, E. Auffray, M. T. Lucchini, M. Korjik, A. Fedorov, V. Mechinsky, O. Sidletsky, Timing properties of GAGG:Ce and LSO:Ce scintillators with and without codoping, 10th International Conference on Luminescent Detectors and Transformers of Ionizing Radiation (LUMDETR), 9-14 September 2018, Prague, Czech Republic.
24. S. Nargelas, A. Vaitkevičius, G. Tamulaitis, E. Auffray , M. Korjik, A. Fedorov, V. Mechinsky, O. Sidletsky, Influence of Mg codoping on excitation dynamics in GAGG:Ce scintillators, 10th International Conference on Luminescent Detectors and Transformers of Ionizing Radiation (LUMDETR), 9-14 September 2018, Prague, Czech Republic.
25. A. Vaitkevičius, S. Nargelas, M. T. Lucchini, E. Auffray, A. Fedorov, V. Mechinsky, M. Korjik, G. Tamulaitis, LSO and GAGG scintillators for precision timing, Advanced Properties and Processes in Optoelectronic Materials and Systems (Apropos 16), 10-12 Octoboer 2018, Vilnius, Lithuania.
26. G. Tamulaitis, S. Nargelas, A. Vaitkevičius, M. Lucchini, E. Auffray, A. Fedorov, V. Mechinsky, M. Korjik, "Transient phenomena in scintillation materials", Sixth International Conference "*Engineering of Scintillation Materials and Radiation Technologies*" (ISMART 2018), October 9–12, Minsk, Belarus (2018). (oral)
27. S. Nargelas, A. Vaitkevičius, M. Lucchini, E. Auffray, A. Fedorov, V. Mechinsky, M. Korjik, G. Tamulaitis, "Transient absorption technique as a tool for characterization of scintillator timing properties", Sixth International Conference "*Engineering of Scintillation Materials and Radiation Technologies*" (ISMART 2018), October 9–12, Minsk, Belarus (2018). (oral)

Presentations (4)

28. G. Tamulaitis, S. Nargelas, A. Vaitkevicius, V. Gulbinas, M. Korjik, D. Kozlov, V. Mechinsky, A. Gola, A. Mazzi, E. Auffray Hillemanns, M. Lucchini, C. G. Tully, Engineering of Ce-doped scintillation materials for high-energy physics experiments, IEEE Nuclear Science Symposium, 10-17 November 2018, Sydney, Australia. (oral)
29. E. Auffray, G. Dosovitskiy, M. Korzhik, M. Lucchini, S. Nargela, A. Fedorov, D. Kozlov, V. Mechinsky, G. Tamulaitis, A. Vaitkevicius, Study of mixed garnet scintillators for future particle physics experiments, IEEE Nuclear Science Symposium, 10-17 November 2018, Sydney, Australia. (oral)
30. F. Cova, J. Hostaša, V. Biasini, M. Fasoli, F. Moretti, E. Bourret, and A. Vedda, “Fabrication and Photo-Physical Characterization of Ce-doped $\text{Gd}_3(\text{Ga},\text{Al})_5\text{O}_{12}$ Transparent Ceramics”, 15th International Conference on Scintillating Materials and their Applications, SCINT 2019, Sendai, Japan, 29 September – 4 October 2019 (oral)
31. E. Auffray, Review of the recent development on single crystal garnets and amorphous SiO_2 -based scintillating fibres in the Intelum RISE project., 15th International Conference on Scintillating Materials and their Applications, SCINT 2019, Sendai, Japan, 29 September – 4 October 2019 (oral)
32. A. Vaitkevičius, S. Nargelas, V. Marčiulionytė, V. Mechinsky, D. Petrudec, V. Slegel, V. Gulbinas, M. Korjik, G. Tamulaitis, Investigation of Self-activated PWO and BGO Scintillators in Subpicosecond Domain, SCINT 2019 Conference on Scintillating Materials and their Applications, 29 September - 4 October 2019, Sendai, Japan.
33. G. Tamulaitis, S. Nargelas, M. Korzhik, Nonequilibrium carrier dynamics spectroscopy as a powerful tool to optimize timing properties of scintillation materials, IEEE Nuclear Science Symposium, 26 October - 02 November 2019, Manchester, United Kingdom. (oral).
34. E. Auffray, M. Korjik, D. Kozlov, N. Kratochwil, M. Lucchini, V. Mechinsky, S. Nargelas, J. Talochka, G. Tamulaitis, A. Vaitkevičius, High-Light-Yield and Radiation Tolerant Scintillation Materials for Future High Luminosity Experiments, IEEE Nuclear Science Symposium, 26 October - 02 November 2019, Manchester, United Kingdom. (poster)
35. P. R. Hobson, D. R. Smith, "A portable test-bench for real-time radiation damage measurements in scintillating and wavelength-shifting fibres", the IEEE Nuclear Science Symposium, (2019). <https://cds.cern.ch/record/2701523> (poster)