Gianmarco Bruno - Curriculum vitae

Personal Data

Full name:	Gianmarco Bruno
Place and date of birth:	Casale Monferrato (Italy), 5th February 1979
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Education

11/2008 – 03/2012 PhD in Physics at the University of L'Aquila (Italy)
PhD Thesis: *Neutron background studies for direct dark matter searches in the Gran Sasso Underground Laboratory.*
Supervisor: Dr. W. Fulgione

09/1998 – 12/2004 Degree in Physics at the University of Torino (Italy)
Degree Thesis: Monitoring of the low energy (E ≥ 0.8 MeV) counting rate with the Large Volume Detector at the Gran Sasso National Laboratory.
Supervisor: Prof. O. Saavedra

Current position

11/2017– 08/2021 Research associate at New York University Abu Dhabi,
Saadiyat Island, Abu Dhabi, United Arab Emirates
PI: Prof. Francesco Arneodo

Past positions

12/2015 – 12/2017 Senior post-doc at the INFN – Laboratori Nazionali del Gran Sasso,
Via G. Acitelli 22, 67100 Assergi (AQ), Italy.
Supervisor: Dr. W. Fulgione

06/2014 – 12/2015 post-doc at the University of Münster.
Institute for Nuclear Physics, Wilhelm-Klemm-Straße 9, D-48149 Münster, Germany.
Supervisor: Prof. C. Weinheimer

03/2012 – 03/2014	post-doc at the INFN – Laboratori Nazionali del Gran Sasso, Via G. Acitelli 22, 67100 Assergi (AQ), Italy. Supervisor: Dr. W. Fulgione

Fellowships

09/2008 – 03/2012	PhD Fellowship University of L'Aquila (Italy)
2007 – 2008	Post Graduated fellowship INFN-POR "Study and development of a data acquisition system to monitor the time-stability of a scintillation detector"
2005 – 2006	Financial grant from the IFSI-INAF of Turin (Italy).

Expertise and knowledge

Research Keywords (chronologically):

photosensors, gamma detection, neutrino detection with large scintillation experiment, radon detection, neutron detection, proportional counters, seasonal variations, dark matter direct detection with noble liquid TPC, gas purification and monitoring of electronegative impurities, distillation of liquid, krypton removal, radon removal, new detection techniques for supernovae neutrino, SiPM, muon tracking, control system for cryogenic experiments.

Commission of Responsibilities:

- 2010: **Technical Coordinator** of the LVD experiment. *(in charge up to Nov 2017 [1])*
- 2014: **Co-leader** of the XENON1T **purification working group** (*in charge up to Nov 2017*)
- 2015: **Operations Manager** of the XENON100 experiment (*in charge up to Nov 2017*)
- 2016: **Run Coordinator** of the LVD experiment (*in charge up to Nov 2017*)
- 2016: INFN **Local responsible** of the LVD experiment (*in charge up to Nov 2017*)

Peer review:

[1]When the candidate moved to New York University Abu Dhabi

- 2016-2018: **reviewer** for Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment (ISSN: 0168-9002).

Research Activity

The candidate started working in science just after his graduation in 2005, when he was involved in research activity thanks to a financial grant from the National Institute of Astrophysics (INAF) of Turin, as a member of the LVD Collaboration. LVD is a 1 kton liquid scintillator detector running in Hall A of the Gran Sasso Laboratory (LNGS) since 1992, which observes our Galaxy searching for neutrinos from core collapse supernovae. Since the beginning LVD has been equipped with a low-energy (E thr ~ 500 keV) asynchronous trigger for monitoring purposes, in addition to the trigger designed for neutrino detection. Thanks to the absence of a 4π shielding around the experiment, counting rates recorded regularly at such a low threshold represents a valuable source of information about the background level due to natural radioactivity in one of the main experimental halls of the LNGS. Time dependence of the event rate has been one of the candidate items of study.

The analysis of a 12-years-long time-series, obtained from the detector running in stable conditions from 1997 to 2009, revealed new informations on the background evolution through years. In particular, regular pattern have been identified. Daily, weekly and seasonal modulation of the gamma background were spotted and correlated with ^{222}Rn concentration in air. The candidate presented the results of this study in 2009, at the 11th TAUP conference, in Rome[2].

In 2007 he got a INFN-POR 12-months fellowship for studying the performance of a Gd-doped scintillator counter, in terms of neutron detection efficiency and stability. He realized the data acquisition and analysed most of the data. The results of these studies can be found in[3] and were presented by the candidate at the national congress of the Italian Physical Society (SIF)[4].

A similar detector, surrounded by a 4π veto and placed above ground, has been used, a couple of years later, for measuring the atmospheric neutron flux at the LNGS external site[5].

In the same period he developed a novel technique to quantify the neutron detection efficiency of the LVD scintillation counters using the natural presence (and its variations in the air of the experimental hall) of the radionuclide ^{222}Rn. This result is particularly interesting for evaluating the neutrino detection efficiency of the LVD experiment, made by a large number of counters. This results was presented at the national congress of the Italian Physical Society in 2007[6].

[2] *Long-term study of low energy counting rate with the Large Volume Detector*, **G.Bruno**, J. Phys. Conf. Ser. 203 (2010) 012091

[3] *Performances and stability of a 2.4 ton Gd organic liquid scintillator target for anti-ν_e detection*, I. R. Barabanov et al., JINST 5, P04001 (2010)

[4] *Risultati di un test effettuato su un campione di 3 ton di scintillatore drogato con Gd nell'ambito dell'esperimento LVD*, **G.Bruno** per la collaborazione LVD, XCII Congresso Nazionale SIF

[5] *Direct measurement of the atmospheric neutron flux in the energy range 10-500 MeV*, A.Bonardi et al., Astropart. Phys. 34 (2010) 225-229

[6] *Sull'uso del ^{222}Rn nella calibrazione di rivelatori modulari di particelle*, **G.Bruno** and W.Fulgione, XCIII Congresso Nazionale SIF, Pisa

In the same period he investigated the possibility of using the LVD array as an active veto with respect to its core, where a dark matter detector could be hosted[7]. In this occasion he collaborated to map the neutron and gamma flux in different places of the underground laboratories. During this campaign he improved his skills in radiation detection, becoming familiar also with detectors based on inorganic scintillators (e.g. NaI, Li-6-doped ZnS) and with proportional counters using ^{3}He and BF_3.

In 2008 he was awarded a PhD fellowship by the University of L'Aquila. During his PhD he continued to investigate the neutron background in the underground laboratory. Neutrons are particularly dangerous for dark matter experiments because through elastic scattering off target nuclei might mimic a WIMP signal. His work covered all the aspects needed to perform the measurement, including: setting up the detector, electronics and data acquisition, taking data, calibration and simulation, analysis of the data and their interpretation. He studied in detail the light output response of this specific scintillator to neutron-induced nuclear recoils (i.e. quenching effect)[8]. The analysis of 1.5 years of data produced one of the most accurate spectrum of the fast neutron component ever measured in the LNGS[9].

Since 2009 he is member of the XENON collaboration and participated in writing the **MAX** proposal and the **XENON1T Technical Design Report**.

In 2010 he became technical coordinator of the LVD neutrino telescope and responsible of the maintenance of the supernova neutrino detector keeping these positions up to 2017 when he moved to NYUAD..

In 2011, the candidate spent several months in the Nevis laboratory of the Columbia University testing a cryogenic system based on a residual gas analyser and a cold trap. The goal of this test was measuring the presence of impurities in Xe (Kr in particular) down to the ppt level, which was the level of purity required by the XENON1T dark matter experiment. In the following years he repeatedly visited the Nevis laboratory, where he had the opportunity to gain competences which put him among a restricted number of persons to be called in case of extra-ordinary intervention on the XENON100 experiment, running at that time in the Gran Sasso Laboratory.

In 2012 he got a 2-years INFN post-doctoral research grant for working in the XENON project. He started collaborating with the Muon-Veto working group, realizing an automatic data acquisition system to measure the gains, at regular time intervals, of the PMTs (Hamamatsu R5912) to be installed in the water-tank of the XENON1T experiment. Moreover He developed the custom-made FPGA firmware of the VME trigger-modules to match the muon-veto trigger requirements.

He contributed to the analysis of the XENON100 data that led to the publication of the most stringent limit (at that time) on spin-independent interactions of WIMPs with nuclei[10,11]. In particular he measured the light yield of LXe at the reference energy of 122 keV by fitting the detector response to spe-

[7] *The LVD experiment as a low background facility in the Gran Sasso Laboratory*, F.Arneodo, G.Bari, A.Bonardi, **G.Bruno**, S.Fattori, W.Fulgione, P.Giusti et al., J. Phys. Conf. Ser. 136 (2008) 042082

[8] *Light output response of the LVD liquid scintillator to neutron-induced nuclear recoils*, **G.Bruno,** , *JINST **8** (2013) T05004*

[9] *Flux measurement of fast neutrons in the Gran Sasso underground laboratory*, **G.Bruno** and W. Fulgione, Eur. Phys. J. C (2019) 79: 74.

[10] *Dark Matter Results from 100 Live Days of XENON100 Data*, E.Aprile et al. [XENON100 Collaboration], *Phys. Rev. Lett. 107, 131302 (2011)*

[11] *Dark Matter Results from 225 Live Days of XENON100 Data*, E.Aprile et al. [XENON100 Collaboration], Phys. Rev. Lett. 109, 181301 (2012)

cific energy lines ranging from 40 keV up to 2600 keV (due to gammas emitted by different isotopes or produced by de-excitation of ^{129}Xe and ^{131}Xe after neutron inelastic scattering).

Despite all this commitments in the XENON collaboration, he continued his activity in LVD. In particular, participating to the LVD measurement of the CNGS neutrino velocity. He was involved in upgrading the electronics for that specific measurement and in evaluating the complex and delicate systematics[12].

In 2014 he got a 3-years post-doctoral research grant from the Westfälische Wilhelms-Universität Münster (Germany) for joining the research group of Prof. C. Weinheimer. In the new group he familiarized with all the aspects related to purification of noble gases. Either purification from electronegative contaminants and removal of long-lived Krypton isotope by using cryogenic distillation. He was been appointed as co-leader of the purification working group of XENON1T, one of the central systems of the experiment. It acts as a gas manifold, where the xenon gas is purified by 2 zirconium-alloy hot getters and circulated at a speed of about 80 standard litres per minute (slpm). The gas is then redirected to the other subsystems e.g: cryogenics, cryostat, ReStox and distillation column. He participated to the development and successful commissioning of the purification system after moving it from the university of Muenster to the LNGS.

The XENON1T distillation column is another masterpiece of hardware made by the Muenster group, it has been designed to remove Kr from Xe but we investigated also the possibility of using it in "reverse mode" to distil Rn out of Xe.

At that time (2015) Gianmarco was in charge as **operation manager** of the XENON100 experiment which has been exploited to perform important R&D studies in view of the upcoming XENON1T.

One of these studies concerned the online ^{222}Rn removal by cryogenic distillation[13], in which a significant reduction of the background due to the radon progeny was demonstrated by operating the column.

During that period he had the privilege of coordinating other important calibrations campaign (e.g. a dissolved ^{220}Rn source and gaseous CH_3T source), whose results have been published in[14,15].

In 2016 he was awarded a senior-level postdoc fellowship for joining once more the xenon group at LNGS. Up to the end of 2017 (when he moved to Abu Dhabi for starting his new position) he was co-leader of the purification working group of XENON1T, as well as **LNGS local responsible** and **run coordinator** of the LVD experiment. In this period he participated to a campaign of measurements at the National Metrology Institut in Braunschweig (Germany) aiming at characterizing the neutron generator that was going to be used for the nuclear recoil calibration of XENON1T[16]. His contribution to this work consisted in unfolding of the data recorded by a Ne-213 liquid-scintillator detector.

[12] *Measurement of the Velocity of Neutrinos from the CNGS Beam with the Large Volume Detector*, N.Y.Agafonova et al. [LVD Collaboration], Phys. Rev. Lett. 109, 070801 (2012)

[13] *Online ^{222}Rn removal by cryogenic distillation in the XENON100 experiment*, E.Aprile et al. [XENON100 Collaboration] Eur. Phys. J. C 109, 77:358 (2017)

[14] *Results from a calibration of XENON100 using a source of dissolved radon-220*, E.Aprile at al. [XENON100 Collaboration], Phys. Rev. D 95, 072008 (2017)

[15] *Signal Yields of keV Electronic Recoils and Their Discrimination from Nuclear Recoils in Liquid Xenon*", E.Aprile at al. [XENON100 Collaboration], Phys. Rev. D 97, 092007 (2018)

Beside his commitments for XENON, he continued to work for LVD, where his experience in frequency analysis was applied to the muon time series analysis[17].

He was also involved in the early phase of the MOSCAB experiment giving his contribution in evaluating the intrinsic neutron background[18].

In November 2017 he moved to Abu Dhabi for an appointment as Research Associate at the Abu Dhabi branch of the New York University. In Abu Dhabi he started dealing with a muon tracker, realizing the 3D-track reconstruction and developing a GEANT4 simulation of the detector[19]. He is involved in characterizing photodetectors which are promising for future low background experiments (e.g. the 4th generation of VUV SiPM made by Hamamatsu)[20]. He simulated charge spectra from standard calibration sources produced by a $CeBr_3$ crystal which will be soon launched in space for a mission aiming at the detection of terrestrial gamma ray flashes[21].

Last but not least Gianmarco wrote an application based on a real-time embedded industrial controller for monitoring and controlling a cryogenic system which is soon going to be used for testing electronics at liquid xenon temperature[22].

[16] *Characterization of a deuterium-deuterium plasma fusion neutron generator*, R. Lang et al., Nucl. Instrum. And Meth. A879 (2018) 31-38

[17] *Characterization of the varying flux of atmospheric muons measured with the Large Volume Detector for 24 years*, N. Yu. Agafonova et al. [LVD Collaboration], Phys. Rev. D 100, 062002

[18] *MOSCAB: A geyser-concept bubble chamber to be used in a dark matter search*, [MOSCAB Collaboration], Eur. Phys. J. C77 (2017) no.11, 752

[19] *Measurement of cosmic muons angular distribution in Abu Dhabi at sea level*, F.Arneodo et al., Nucl. Instrum. and Meth, 936, 242-243, (2019)

[20] *Cryogenic readout for multiple VUV4 Multi-Pixel Photon Counters in liquid xenon*, F.Arneodo et al., Nucl. Instrum. and Meth, 893, 117-123, (2018)

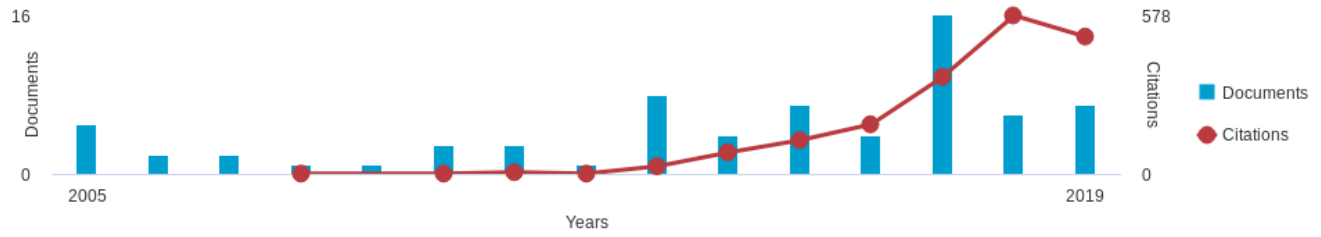
[21] *Characterisation of a $CeBr_3$ (LB) detector for space application*, F.Arneodo et al., JINST 14, P09017 (2019)

[22] In preparation.

Publications in international peer-reviewed journals

Overview:

Gianmarco Bruno has in total:	74 publications
Total citations:	>1850 (powered by scopus)
H-index:	19 (powered by scopus)
Authorship table:	3 corresponding author



Conference and Seminar Contributions:

- Risultati di un test effettuato su un campione di 3 ton di scintillatore drogato con Gd nell'ambito dell'esperimento LVD, G.Bruno on behalf of the LVD Collaboration, XCII Congresso Nazionale SIF, Sept. 2006, Turin.
- Sull'uso del ^{222}Rn nella calibrazione di rivelatori modulari di particelle, G.Bruno and W. Fulgione, XCII Congresso Nazionale SIF, Sept. 2007, Pisa.
- Long-term study of low energy counting rate with the Large Volume Detector, G.Bruno on behalf of the LVD Collaboration, TAUP XI interntional conference, Rome, July 2009.
- Time variation of the neutron background rate measured in the Gran Sasso Underground Laboratory", G.Bruno, F. Arneodo, W. Fulgione, TAUP, Munich (Germany), September 2011.
- Neutron Background studies for direct dark matter searches in the Gran Sasso Underground Laboratory, G.Bruno, Seminars at INFN-MiB, December 2013.
- Purification System and Purity Monitoring, G.Bruno, 6th DARWIN workshop at Weizmann Institute of Science, Rehovot (Israel), January 2015.
- Recent results from XENON100, G. Bruno, invited talk at the 50th Recontres de Moriond, electroweak session, La Thuile (Italy), March 2015.

- The XENON1T Dark Matter Search, G. Bruno, talk at the Alpine LHC physics Summit, Obergurgle (Austria), April 2017.

- Measurement of Cosmic Muons angular distribution in Abu Dhabi at sea level, G.Bruno et al., PM2018 - 14th Pisa Meeting on Advanced Detectors, La Biodola, Isola d'Elba (Italy), 27 May – 02 June 2018.

- CRYSTALX: CRYogenic Setup for Tests At Liquid Xenon temperature, G.Bruno, 8th DARWIN workshop at the University of Zurich, Zurich (Switzerland), December 2018.

Place and date:

Done in Abu Dhabi, October 12th, 2019