



# 3<sup>RD</sup> EPS-TIG **MAKER** EVENT IN MONTENEGRO



- 3th EPS-TIG Hands-on Science, Technology and Interfaces Event
- Organized by EPS-TIG Group
- Recognized by EPS



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**& 1st Montenegro Detector R&D for Future Accelerators  
Summer School**

Contact person: Gordana Lastovicka-Medin, University of Montenegro  
[gordana.medin@gmail.com](mailto:gordana.medin@gmail.com)

**Petrovac, Hotel Palas,  
Montenegro, 7-9 July 2023**

# Topics

**Ultrafast  
spectroscopy**

**Timing  
detectors**

**Laser  
plasma  
accelerator  
physics**



**EU laser  
facility: ELI  
Beamlines**

**Technique of  
transient currents:**

**Single photon  
Absorption & Two  
Photon Absorption**

**Terahertz  
Physics**



+

Student's Net-working  
Co-Creating a new knowledge  
Collaborative work



# Speakers

## Event Chair



Petrovac, Montenegro  
July 2023.



**Gordana Medin**



**Faculty of Natural Sciences and Mathematics,  
University of Montenegro**

**Gordana Laštovička-Medin** is an internationally oriented, experimental particle physicist with great working experience in large High Energy Physics (HEP) international collaborations (ARGUS, HERA-B, H1 at DESY); she also significantly contributed to the LCFI and ILC scientific papers by collaborating with University of Oxford. She completed her MSc in Nuclear and Particle Physics and PhD in Experimental; Particle Physics, both at the University of Ljubljana in Slovenia. She held a postdoc position in High Energy Physics at the University of Humboldt and at the DESY Zeuthen. She is currently leading Montenegro's RD50 (Radiation hard semiconductor devices for very high luminosity colliders) group at CERN, contributing to R&D in Si-based state-of-the art timing detectors for CMS and ATLAS experiments) and in R&D of state-of-the art instrumentation techniques for the detector characterisation.

G. L. Medin is employed as a full professor at the Faculty of Natural Sciences and Mathematics at the University of Montenegro in Montenegro. She is mother to two girls, Michaela and Nina,

G. L. Medin was also in charge for organization of the 42<sup>nd</sup> Workshop of the CERN RD50 Collaboration in Montenegro (20<sup>th</sup> -23<sup>rd</sup> of June 2023).

# →→→ Speakers

## Demonstrator & Designer of Experiments

Petrovac, Montenegro  
July 2023.



**Mateusz Rebarz**



### ELI Beamlines, ELI ERIC, Czech Republic

**Mateusz Rebarz** is an experimental physicist specializing in time-resolved spectroscopy in molecules and condensed matter. He received Ph.D. degree in Physics from Nicolaus Copernicus University (Torun, Poland) in 2007. From 2008 to 2010 he worked as a postdoctoral fellow at Free University of Brussels (ULB, Belgium) in Organic Chemistry and Photochemistry group. Then, he moved to Laboratory of infrared and Raman spectroscopy – LASIR (Lille, France) where he worked as CNRS researcher until 2014. Since 2015 he is a researcher at ELI Beamlines facility (Prague, Czech Republic) in Department of Structural Dynamics.

His research interests focus on nonlinear optics and their applications to ultrafast phenomena studied by ultrafast (femtosecond) spectroscopy (absorption, emission, Raman scattering, ellipsometry). His other interests cover also photonics and optoelectronics. He has 20 years of hands-on experience in construction and development of laser-based spectroscopic setups as well as writing of control system software.

# →→→ Speakers

Petrovac, Montenegro  
July 2023.



**Markus Nordberg**

**Head of Resources Development of the  
Development and Innovation Unit (IPT-DI) at CERN,  
Switzerland**



Dr. MARKUS NORDBERG is the Head of Resources Development of the Development and Innovation Unit (IPT-DI) at CERN, Switzerland. In addition to coordinating multi-disciplinary innovation projects at IdeaSquare at CERN ([cern.ch/Ideasquare](http://cern.ch/Ideasquare)), he is also the coordinator the EU-funded sensor and imaging R&D&I initiative called ATTRACT ([www.attract-eu.com](http://www.attract-eu.com)) aiming at both scientific and societal impact of disruptive co-innovation. Prior to this function, he served 12 years as the Resources Coordinator of the ATLAS project at CERN ([www.atlas.ch](http://www.atlas.ch)). He has also served as Visiting Senior Research Fellow at the Centrum voor Bedrijfseconomie, Faculty ESP-Solvay Business School, University of Brussels, and as a member of the European Physical Society, Strategic Management Society and the Association of Finnish Parliament Members and Scientists, TUTKAS. He has a degree both in Physics and in Business Administration.



# ➡➡➡ Speakers



## World Cafe moderator



Eugenio Nappi

INFN, Italy



Istituto Nazionale di Fisica Nucleare

**E. Nappi** is a staff researcher at the INFN and, since 2002, he has been Director of Research. Member of the Executive Committee of INFN from 2012 to 2020, he served as Vice President of INFN from January 2019 to July 2020. Since the beginning of his career, he has had a keen interest in the experimental aspects of CERN physics programme of ultra-relativistic collisions of heavy ions. In this field, he was among the founders of the ALICE experiment at the LHC. During the thirty years spent in ALICE, he has occupied the highest managerial positions; he has been member of the Management Board of ALICE since 1998, year in which he was the recipient of a two-year scientific associateship at CERN to serve the experiment as deputy-spokesperson. As member of the Executive Board of INFN, from 2012 to 2020, he oversaw the INFN activities in the field of Nuclear Physics and represented the Italian Ministry of Education and Research (MIUR) in the European Spallation Source (ESS) ERIC Council, in the F4E Governing Board for the ITER project in Cadarache (France) and in the General Assembly of the ELI-ERIC. In the last three years, at the end of his term as Vice President of INFN, he has taken the coordination of the INFN-E project meant to develop innovative technologies in the field of nuclear energy. In recognition of the acquired international renown, he was elected member of the IUPAP Nuclear Physics Panel C-12 in 2014, on which he has served until 2021, and member of the Executive Committee of EPS in 2019, on which he is still serving. Last but not least, following his interests in the field of accelerators, he has been chair of the TIARA (Test Infrastructure and Accelerator Research Area) Council since 2019. TIARA is a Consortium of the major European Institutions involved in the research in nuclear and particle physics. TIARA's mission is to support the setting-up of joint R&D programmes and education and training in the field of Accelerator Science and Technology in Europe.



# →→→ Speakers

## Invited Speakers

Petrovac, Montenegro  
July 2023.



### Massimo Ferrario

Project Leader of EuPRAXIA@SPARC\_LAB  
( plasma accelerator project)

INFN-LNF (Italy)

**Massimo Ferrario** is currently Senior Scientist at INFN, coordinator of the SPARC\_LAB facility at the Frascati INFN Laboratories where the first FEL lasing driven by a plasma accelerator has been recently demonstrated. He is also Project Leader of the EuPRAXIA@SPARC\_LAB design study which is the particle beam driven pillar of the EuPRAXIA project. In the last 30 years Massimo has been working in the field of high brightness photoinjectors, free electron lasers and advanced accelerator concepts including plasma accelerators. He is co-chair of the workshops series: "European Advanced Accelerator Concepts" together with Dr. R. Assmann (DESY/INFN) since 2013. He is a member of the CERN Accelerator School (CAS) where he has given several lectures about the Physics of High Brightness Beams and Advanced Accelerator Concepts. He is also currently teaching "High Brightness Beam Physics" at the University of Roma "La Sapienza" for the Accelerator Physics PhD program.



Istituto Nazionale di Fisica Nucleare



### Abstract

**Accelerating the future**  
Massimo Ferrario  
INFN-LNF

High energy particle beams with extreme luminosities and ultra-bright beams for energetic radiation sources are ubiquitous tools for studying the structure of matter in a wide range of spatial and temporal scales. Last century saw huge progress in the development of very efficient radio-frequency based accelerators. However, these require large scale research infrastructures in order to reach highest beam energies, such as the Large Hadron Collider (LHC). In order to reduce the size, costs and complexity of these facilities, particle and laser driven plasma wakefield acceleration are very promising alternatives. Intense R&D is still required so that the output beam quality can match the performance of cutting edge RF accelerators. In this talk we will introduce the new acceleration techniques mechanisms and we will discuss the most interesting results and applications obtained so far, including a description of the new accelerator facility EuPRAXIA based on plasma modules to be built in the next decade.



# Speakers

## Invited Speakers

Petrovac, Montenegro  
July 2023.



### Abstract

Intense THz fields generated by laser-driven particle acceleration

Luc Bergé  
Commissariat à l'Énergie Atomique et aux Énergies Alternatives  
CEA, DAM, DIF - 91297 ArpaJon - France  
& Université Paris-Saclay, CEA, LMCE, 91680 Bruyères-le-Châtel, France

Terahertz pulses are very popular because of their numerous applications, for example in security screening, medical imaging, time-domain spectroscopy and remote detection [1]. Located between microwaves and optical waves in the electromagnetic spectrum, terahertz waves can now be exploited in molecular spectroscopy from plasma emitters produced by femtosecond laser pulses ionizing gases such as air.

At non-relativistic laser intensities, gas plasmas created by two-color optical pulses supply suitable emitters free of any damage. Electrons are tunnel ionized by the asymmetric light field usually composed of a fundamental wavelength and its second harmonic [2]. The resulting "photocurrent" polarized in the laser direction generates an ultrabroadband terahertz radiation, which finds direct applications in the coherent spectroscopy of complex molecules [3]. At relativistic intensities, plasma waves trigger a strong longitudinal field used in laser-wakefield acceleration. Accelerated electrons crossing the plasma-vacuum interface then emit coherent transition radiation operating in the terahertz band [4], which may be optimized by, e.g., increasing the laser wavelength [5].

This talk will review the different physical mechanisms involved in the terahertz emission by laser-gas and laser-solid interaction at moderate or relativistic intensity. First, recent results on the plasma-based terahertz spectroscopy of materials will be presented in the context of the project ALTESSE. Second, new perspectives in the production of ultra-intense terahertz pulses from electron and ion acceleration in relativistic plasmas will be discussed. Finally, THz radiation originating from the ponderomotively driven electron dynamics in strongly magnetized plasmas [6] will be addressed. We shall demonstrate via particle-in-cell simulations that THz pulses transmitted in this regime can reach field strengths  $> 100$  GV/m and allow laser-to-THz conversion efficiencies exceeding 1% by adjusting the B-field strength and the background electron plasma density.

- [1] M. Tonouchi, Nat. Photon. **1**, 9691 (2007).
- [2] K.-Y. Kim, A. J. Taylor, J. H. Glowia, and G. Rodriguez, Nat. Photonics **2**, 605 (2008).
- [3] L. Bergé, K. Kaltenecker, S. Engelbrecht, A. Nguyen, S. Skupin, L. Merlat, B. Fischer, B. Zhou, I. Thiele, and P. U. Jepsen, Europhys. Lett. **126**, 24001 (2019).
- [4] J. Déchard, A. Debayle, X. Davoine, L. Gremillet, and L. Bergé, Phys. Rev. Lett. **120**, 144801 (2018).
- [5] J. Déchard, X. Davoine, and L. Bergé, Phys. Rev. Lett. **123**, 264801 (2019).
- [6] C. Tailliez, X. Davoine, A. Debayle, L. Gremillet, and L. Bergé, Phys. Rev. Lett. **128**, 174802 (2022).

**LUC BERGE**



#

Commissariat à l'Énergie Atomique, France  
EPS président (CEA)

**Luc Bergé** graduated in mathematics and physics from the Universities of Toulouse and Paris-Sud, Orsay, France. In 1989, he received his PhD in theoretical physics, devoted to the strong Langmuir turbulence in laser-driven fusion plasmas. In 1990, he was employed as research scientist at CEA (French Commission for Atomic Energy and Alternative Energies). Working first on parametric instabilities in plasmas, he then turned to nonlinear optics in 1995. In 1997, he passed his Habilitation thesis on wave collapse in physics. He next devoted his research to the filamentation of ultrashort laser pulses in transparent media and related properties such as supercontinuum generation and pulse self-compression, which he pioneered in the early 2000. More recently, Luc Bergé focused his scientific activities on terahertz pulse generation induced by femtosecond pulses in gases. With his team he is exploring new ways to produce energetic THz waves by using ultra-intense laser pulses. Also involved in experimental efforts on innovative detection methods, Luc Bergé coordinates the French ANR project ALTESSE, which is devoted to ultrabroadband terahertz spectroscopy of molecules. Luc Bergé's research activities have been expressed in 160 articles, six book chapters and more than 180 conferences ( $> 110$  invited). He was elected Fellow of The Optical Society (OSA) in 2009, Fellow of the European Physical Society in 2016, Fellow of the European Optical Society (EOS) in 2018 and Fellow of the American Physical Society (APS) in 2019. He received the DGA-Young Researcher Prize in 1997, the second Bull-Fourier Prize in 2012 and the 2018 Gentner Kastler Prize jointly attributed by the German and French Physical Societies. He is Director of Research at CEA Direction Ile de France, where he is heading a laboratory dedicated to radiation-matter interaction. Luc Bergé served as Chair of the Quantum Electronics and Optics Division of the EPS until 2017. He was General coordinating Chair of the conference CLEO/Europe-EQEC 2015. Elected a member of the Executive Committee of the EPS, he was in charge of its Associate Membership policy and of the Equal Opportunities Committee. Since April 2021, he has been the President of the European Physical Society.



# ➡➡➡ Logistic help



**Jovana Doknić**

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**Vanja Backović**

[backovicvanja12@gmail.com](mailto:backovicvanja12@gmail.com)



**Ivona Božović**

[bozovic.ivona2710gmail.com](mailto:bozovic.ivona2710gmail.com)

Students of Physics, University of Montenegro, Members of the CERN RD50 Collaborative





First day

Lectures

Petrovac, Montenegro  
July 2023.



08:00h-09.00h	Registration	
9:00h -9:10h 9:10h -9:30 h 9:30h -10:10h	<b>Welcome (G. Medin)</b> <b>Dusan Medin: Montenegro from West to East (talk open to local society)</b> <b>Markus Nordberg: The importance and role of serendipity in instrumentation innovation (talk open to the local society)</b>	
10:10h-10:50h  10:50 – 11:30	<b>Lecture 1:</b> <b>Massimo Ferrario: Accelerating the future</b>  <b>Lecture 2:</b> <b>Luc BERGE: Intense THz-fields generated by laser-driven particle accelerators</b>	
11:30h-12:00h	Coffee break	
12:00h-13:15h	<b>Lecture 3: Mateusz Rebarz</b>	<b>Extreme Light Infrastructure: what is ELI</b>
	<b>Lecture 4 &amp; Virtual Tour: Mateusz Rebarz</b>	<b>Virtual tour: Commented 3D walking through experimental halls of ELI Beamlines facility</b>
13:15h-15:00h	Lunch break	



**15:00h-  
16:00h**

**Lecture 5:  
Mateusz Rebarz: Ultrashort laser pulses: applications in science, industry  
and medicine  
Lecture 6:  
Gordana Medin: Introduction to Transient Current Technique and Timing  
Sensors- LGADs: preparation for experiment 2**

**16:00h-  
16:30h**

**Coffee break**

**16:30h-  
17:40h**

**Lecture 7:  
Mateusz Rebarz: Introduction to optical spectroscopy: preparation for  
Experiment 1  
  
Lecture 8 with Virtual tour: Femtosecond spectroscopy: transient  
absorption (30-45 min.)**

**17:40h-  
18:00h**

**Coffee break**

**18:-00 -17:30 h**

**Local excursion -evening walking tour**



# ➔➔➔ Program

Second day

Hands-on Activities

<b>09:00 – 10:30</b>		<b>Student's self-introduction + poster presentation where they will highlight achievement on which they are the most proud</b>
<b>10:30h-13:30h</b>		<b>Exp 1</b>
<b>13:30h-14:30h</b>		<b>Lunch break</b>
<b>14:30h - 17:30h</b>		<b>Exp 1/Exp 2</b>
<b>17:30h - 21h:</b>		<b>Excursion</b>



# →→→ Program

## Third day

## Hands-on Activities

09:00h-09:30h	<b>Coffee break</b>
09:30h-13:30h	Exp 2
13:30h-15:00h	<b>Lunch break</b>
<b>15:00h-17:00h</b>	<b>Café World</b> Round table discussions A few problems will be set and students will be asked to work on solution designs
<b>17:00 - 18:30</b> <b>18:30</b>	<b>Show case</b> <b>Closing</b>



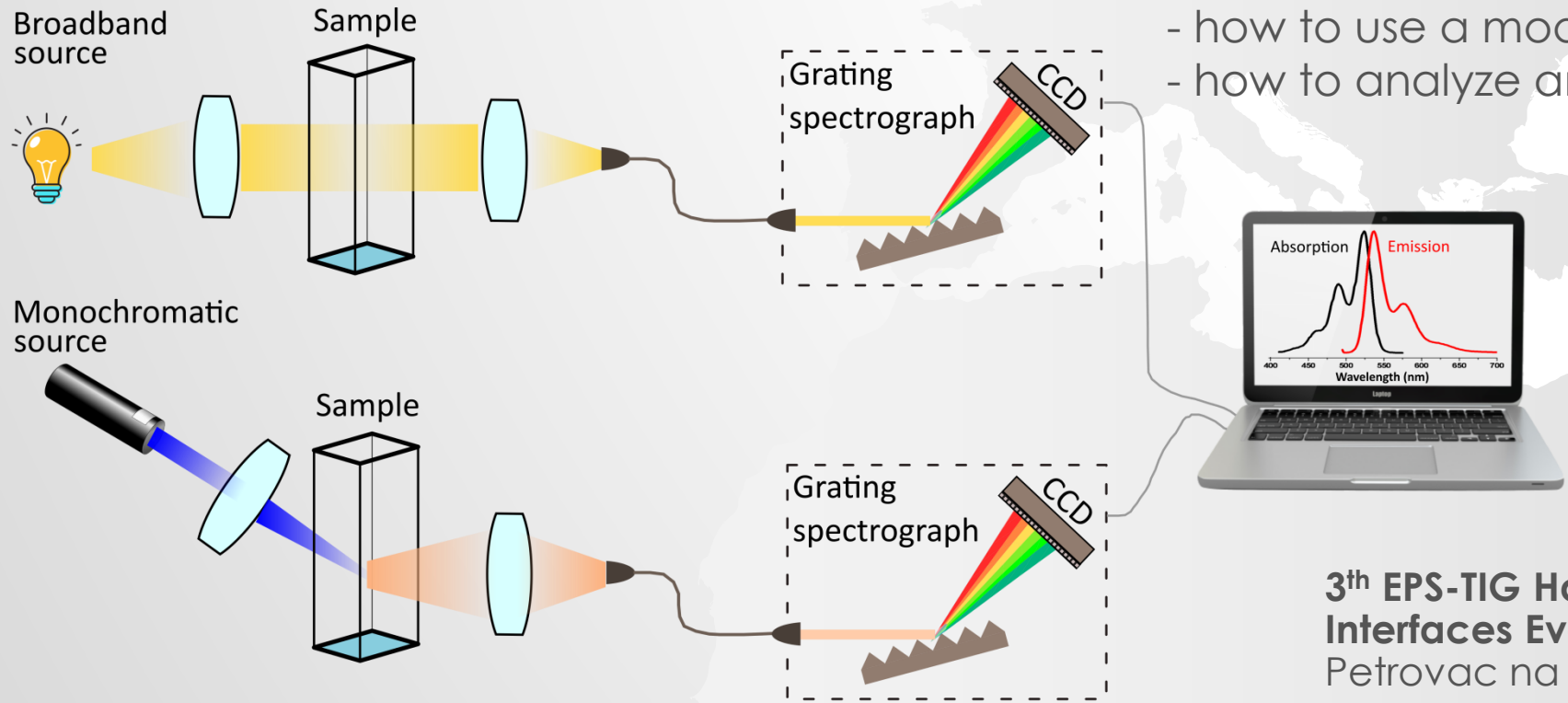


# ➡➡➡ Experiments

## EXP 1: Absorption and emission spectroscopy

Target:  
Building the experimental setup to measure steady state absorption and emission spectra of the example samples + data visualization

- Things to learn:
- how to mount and use different optical elements
  - how to build and align simple optical setup
  - how to use a modern compact spectrometer
  - how to analyze and visualize experimental data

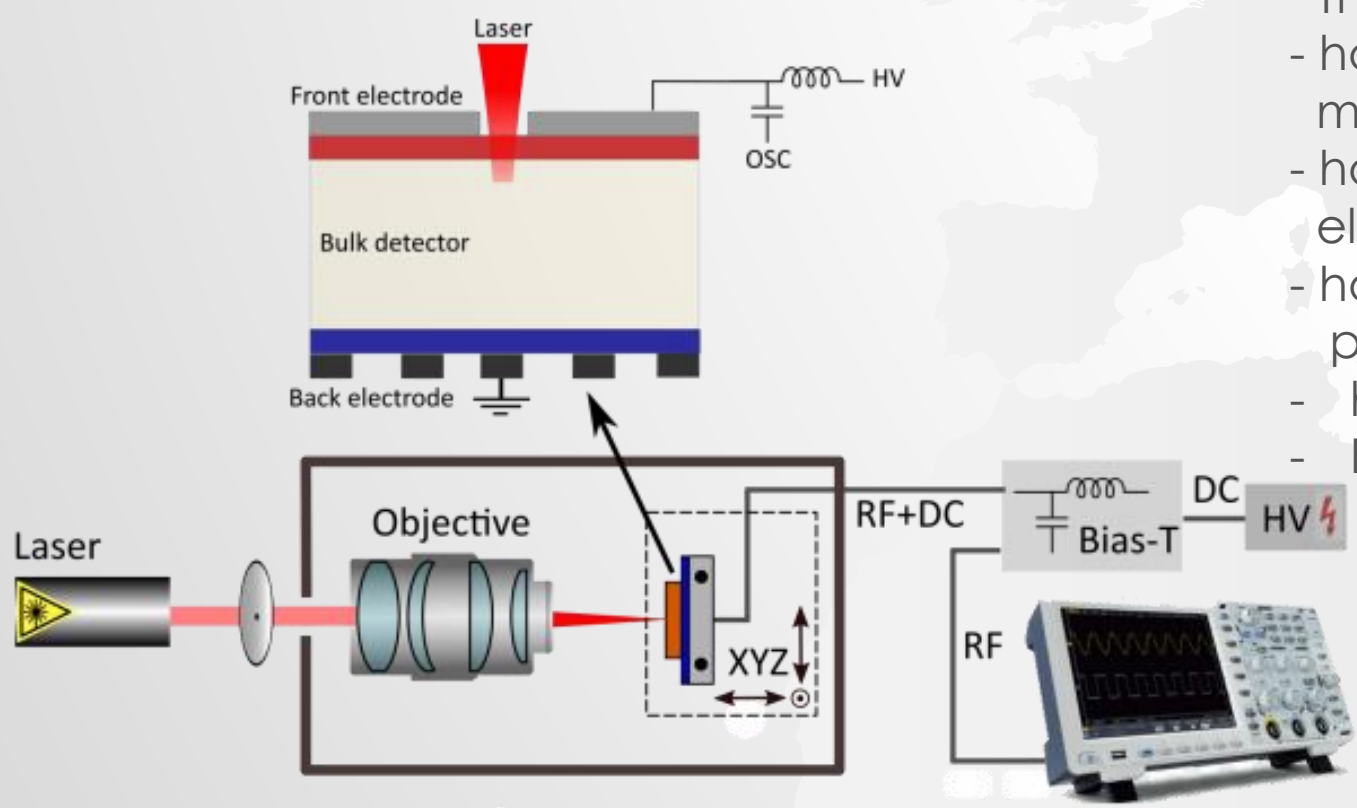


# ➡➡➡ Experiments

## EXP 2: Transient Current Technique

Target:

Building the experimental setup to measure transient signal induced by short laser pulses in an example particle detector + data visualization



Things to learn:

- how to mount and use different optical elements: mirrors, lenses, beam splitters, filters etc.
- how to connect and use different electronics elements: detector, T-bias, oscilloscope
- how to build and use simple imaging system for positioning and alignment of the detector
- how to analyze and visualize experimental data
- How to test timing sensors (LGADs)

# Technology and Innovation Group (TIG)

Technology and Innovation Group (TIG) of the European Physical Society organizes an annual event called «EPS-TIG Hands-on Science, Technology and Interfaces Event».

Event offers to young physicists and engineers a new practical skill in hardware, software, and interfaces with prepared experiments.

The first event was held in CERN in 2019, and the second in 2022 also in CERN.

The third EPS-TIG Hands-on Event will be in Montenegro (7-9 July 2023, Petrovac na moru). Its aim is to support young students from the Balkan countries. It is also open to students from EU countries and other parts of world.



# PETROVAC

A nighttime photograph of a resort in Petrovac. The scene is dominated by a large, dark, forested hillside in the background. In the middle ground, several multi-story buildings with light-colored facades and dark shutters are illuminated from within, casting a warm glow. A prominent white building with a central arched entrance and a balcony is particularly noticeable. To the right, a red neon sign is visible. In the foreground, a calm body of water reflects the lights from the buildings and the sky. On the left, a beach area is visible with numerous closed blue beach umbrellas and a few people. The overall atmosphere is serene and luxurious.



# VENUE: HOTEL PALAS













# **STUDENTS' NET-WORKING WHILE EXPLORING HIKING ROUTES TO THE THREE DISTINCTIVE BEACHES**

<https://trip101.com/article/three-beaches-of-petrovac-montenegro-three-different-experiences>

# 2 LOCAL EXCURSIONS





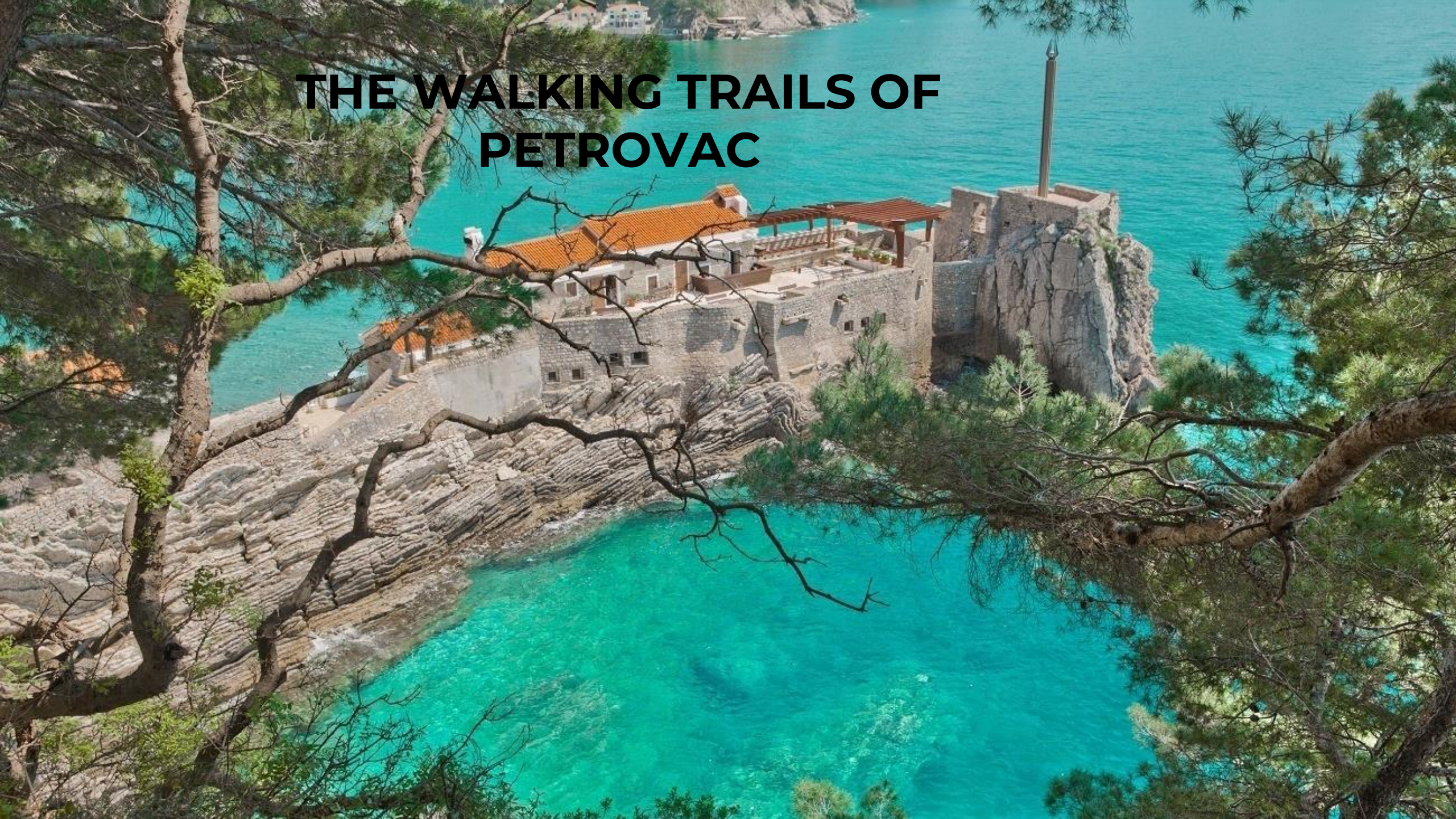
# 1<sup>st</sup> Excursion



Walking trail to Perazića Do



# THE WALKING TRAILS OF PETROVAC





<https://montenegro-for.me/2020/10/the-walking-trails-of-petrovac/>









FROM PETROVAC, THERE IS A PICTURESQUE PATH THAT LEADS THROUGH THE FOREST AND ALONG THE COAST TO THE BEACH OF PERAZIĆA DO AND FURTHER UPWARDS TO THE [REŽEVIĆI MONASTERY](#) (3 KM + 150 M CLIMBING). AS WE HAD VISITED THIS 14TH-CENTURY MONASTERY BEFORE, WE JUST MADE THE WALKING TOUR TO PERAZIĆA DO, WHICH WAS AROUND 2 KM FROM THE TOWN (IN ONE DIRECTION).

WE WILL START OUR WALK BEHIND THE MONTE CASA HOTEL. THERE IS A CLEAR SIGNPOST AND A PATH THAT WILL TAKE US UPHILL THROUGH PINE FORESTS AND MEDITERRANEAN VEGETATION. THE PATH IS PAVED AND PROTECTED BY SIDE WALLS; COMING FROM THE FOREST, IT CONTINUE DIRECTLY ALONG STEEP CLIFFS ABOVE THE SEA, FROM WHERE WE WILL HAVE A MAGNIFICENT VIEW OF THE ISLANDS. IT IS VERY QUIET UP THERE: SO WE CAN T ENJOY THE SOUND OF THE WAVES AND THE SCREECHING OF THE seagulls..



# **2<sup>ND</sup> EXCURSION**

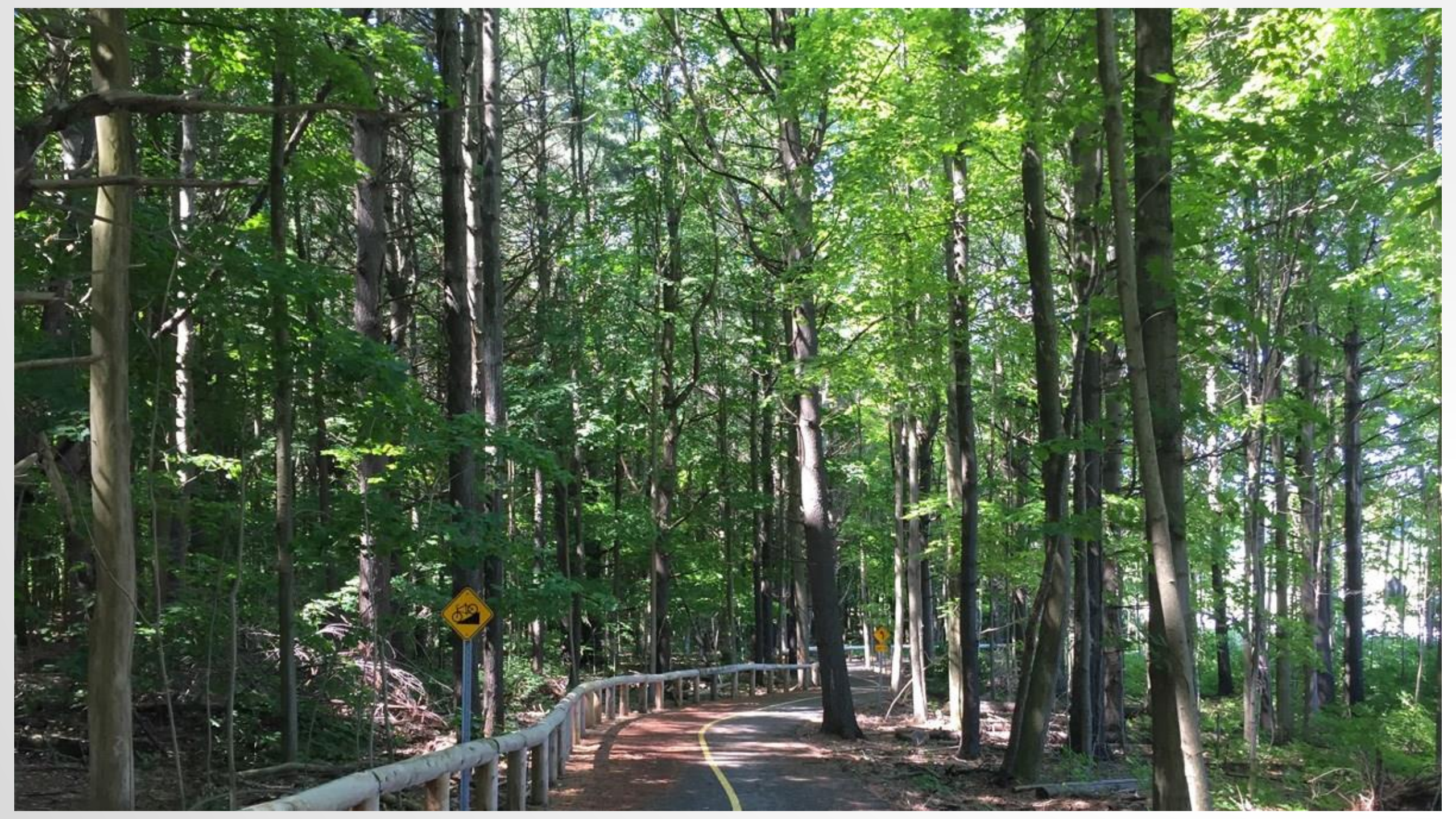
**Walking tour:  
Petrovac city beach –  
Lucice beach –  
Buljarice – Monastery  
Gradiste**























**LAST POINT:**

**MONASTRY GRADATE  
IN BULJARICE**

<https://www.youtube.com/watch?v=Nys7dEfz9kw>

[Манастир Градиште - Виртуелна тура  
\(manastirgradiste.me\)](https://manastirgradiste.me)

And some other monasteries

<https://www.youtube.com/watch?v=c1wBV1bejgo>















# SOME MORE INFO ABOUT WALKING TOURS: PETROVAC CITY BEATCH- LUCICE - BULJARICA

## **Video: Walking tour around and through Petrovac**

<https://www.youtube.com/watch?v=bjAzlM2UC2A>  
<https://www.youtube.com/watch?v=IfUfXuuGPEg>

## **Vider-Lucice beach**

<https://www.youtube.com/watch?v=nLoVubkC6Dw>

<https://www.youtube.com/watch?v=zrbxPSQknQU>  
(in polish)

## **Video : Buljarice**

<https://www.youtube.com/watch?v=8K0Jz8Y3ynk>

<https://www.youtube.com/watch?v=XjKHRDt-3x0>

<https://www.youtube.com/watch?v=s2ZMIFn0zeU>

## **Video: Montenegro – Czech/Polish?**

[https://www.youtube.com/watch?v=v4O\\_pouAMVs](https://www.youtube.com/watch?v=v4O_pouAMVs)

# EXTRA ACTIVITIES ON BEACH

- Mural design & painting:
- Designing the tattoo image!
  - collaborative work of students in the late evening hours
  - As reflection on what the EPS-TIG is.



Competition: who will reach the island Katic first 😊

