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Frontiers in Science

Lead article proposal

May 2025



Introducing Frontiers in Science

Launched in 2023, *Frontiers in Science* is Frontiers' flagship multidisciplinary, flagship, open access journal focused on scientific advances accelerating solutions to global challenges. Impactful lead articles by renowned researchers are enriched by unique hubs of multi-audience content to help ensure transformational science reaches everyone.

The journal publishes impactful peer-reviewed lead articles, invited from internationally renowned researchers, on scientific and technological advances addressing global challenges in human and planetary health. These are enriched by unique hubs of multi-audience content that create bridges between researchers, decision-makers, innovators, and the public—empowering people across all areas of science, policy, and society to share and build on these advances.

Reflecting its mission, Frontiers in Science has a panoramic scope encompassing human health and well-being, climate change, ecology and biodiversity, urban development, agriculture, food, water, and energy systems, computing, and social and economic sciences. The journal also invites lead articles exploring the many intersections between these fields.

Frontiers in Science is operated by a multidisciplinary team of professionals with expertise in scientific research, scientific publishing, scientific programming, scientific events, public policy, public engagement, science communication, and graphic design.

Frontiers in Science lead articles

Frontiers in Science lead articles describe transformational advances and important new paradigms in science and technology. Going beyond a state-of-the art review, lead articles add novel and impactful insights to the body of literature. Typically, they offer a roadmap for the future direction of relevant and emerging fields of research, addressing challenges, solutions, and societal implications. We also publish a limited number of articles describing original research or new research tools (e.g., Shichkova et al. 2025) falling within the mission of the journal. We may also consider hybrid articles that present original analyses to support new recommendations or solutions (e.g., see Shindell et al. 2024)

Lead articles reflect the interdisciplinarity and internationalism necessary to provide scientific solutions to global challenges. Under the leadership of world-renowned researchers, author panels are expected to include all relevant disciplines and to take a global perspective. Due consideration should also be given to gender and generational balance.

Specification:

- Lead Articles can be structured as best suited to the aim, scope, and content of the article. In general, authors explain the key challenges they aim to address, present the novel scientific paradigms, and then the implications for practice, policy, or research within their field and/or for society at large.
- Lead articles are typically 5000–8000 words long
- The Frontiers in Science editorial office provides support in the design and production of high-quality scientific figures and illustrations for all articles.

For each lead article, the Frontiers in Science editorial office appoints at least two internationally eminent, independent field experts as reviewers and a senior field expert to act as the handling editor overseeing the peer review process.

Accepted Lead Articles are published fully open access, thereby benefiting from Frontiers' open-access policies, and at no cost to authors (i.e., no article processing charges apply).

Multi-audience article hubs

Each Lead Article is enriched by a diverse hub of content that extends its reach and impact across multiple audiences – providing further context, connecting communities, and sparking global conversations.

Hub contents include:

- Editorials by authorities from academia, policy, and civil society
- Viewpoints by influential researchers in the field, including the lead article's peer reviewers
- Frontiers Forum Deep Dive, an online scientific webinar where authors discuss the article and hub content with academic peers and key stakeholders from around the world
- Policy Outlooks from policy experts, published by Frontiers Policy Labs
- World Economic Forum online article
- lay explainer, infographics, and a video communicating the lead article's main concepts to a broad audience
- article version for kids, published by Frontiers for Young Minds
- press materials.

The Frontiers in Science editorial office is responsible for organizing and collating all hub contents, in collaboration and consultation with lead article authors. No article charges apply for any hub content.

Lead article: proposal

[Date]

Please return your proposal to the Frontiers in Science Editorial Office at: frontiersinscience@frontiersin.org

Article proposer	Kenneth LONG; Imperial College London/STFC
Article draft title	*The LhARA initiative; a transformational approach to precision, personalised particle-beam therapy*
'Elevator pitch'	*[Please explain the key concepts of the proposed article and their transformational importance in up to three sentences]* The lead article will present the scientific motivation for the LhARA initiative and the programme of technological innovation by which the collaboration seeks to: • Demonstrate laser-hybrid proton/ion beams in a facility dedicated to biological research; • Transform the delivery of proton and ion-beam therapy by harnessing the unique properties of laser-driven proton and ion beams; and to • Make 'best in class' treatments available to the many by developing a fully-automated system that removes the requirement for a large gantry, thereby reducing footprint and increasing capacity and throughput. The article will make the case that successful prosecution of the initiative will deliver a definitive, systematic study of radiobiology and create transformative capabilities for the exploration of fundamental science as well as societal and industrial impact.
Key messages	*[Please detail three or more key messages you think your article will be cited for by the scientific community]* 1. Vision for the exploitation of laser-driven proton and ion beams for science, innovation and society; 2. Clear articulation of the case for, and the programme by which, fundamental biolical process that underpin the efficacy of radiotheraly can be illucidated by exploiting the unique time, spatial, and spectral properties of laser-driven proton and ion beams serving beyond-state-of-the-art end-stations in a fully automated facility; 3. Presentation of a consistent specification of the laser-hybrid accelerator system required to deliver the definitive, systematic programme of radiobiology outline in 2;

	4. Specification of the laser-driven source, plasma-lens focusing and fixed-field accelerator systems together with the definition of the R&D programme required to develop the technologies; 5. Analysis of the range of applications exploiting pulsed-proton and ion beams that may benefit from the laser-hybrid accelerator technique; and 6. Description of the LhARA vision for the development of an eco-system in which co-investment allows the co-creation of technologies that: a. Deliver scientific, clinical or other benefit in the short and medium terms; and b. Produce the drive and momentum necessary to secure the resources to execute curiosity driven research and the R&D necessary to take break-through techologies from Technology Readiness Level 0 to the point at which the co-creation eco-system can develop the technologies for commercial clinical deployment.
Scientific audience	*[Please share some insights on whom you anticipate as the primary audience of your Lead Article in the scientific community]* 1. Laser-plasma and accelerator science communities: a. Vision for the exploitation of laser-driven proton and ion beams for science, innovation and society; 2. Radiobiology, live-cell imaging and real-time super-resolution microscopy communities: a. Clear articulation of the case for, and the programme by which fundamental biolical processes that underpin the efficacy of radiotheraly can be illucidated by exploiting the unique time, spatial, and spectral properties of laser-driven proton and ion beams serving beyond-state-of-the-art end-stations in a fully automated facility; 3. Scientific and healthcare technology policy and decisin makers: a. Presentation of a consistent specification of the laser-hybrid accelerator system required to deliver the definitive, systematic programme of radiobiology outline in 2.

Concept and outline	*[Please outline the concept and thesis of your proposed article. Please ensure to explain the timeliness and transformational nature of the science presented – i.e., maximizing both scientific and societal impact).* Cancer affects 1 in 2 people wordwide and its prevalence is increasing. The present rate of approximately 10 million death from cancer per year[1] is projected to rise by a third by 2040[2]. Radiotherapy is needed in half of cancer patients and is instrumental in 40% of cancer cures. Globally there is insufficient access to radiotherapy and it is estimated that 1 million lives per year could be saved if access to radiotherapy could be provided. External beam thereapy with photons is the mainstay of clinical radiotherapy. Particle beam thereapy (PBT) is extending the clinical role of radiotherapy. In addition to extending the indications that can be treated, there are currently many barriers to the full exploitation of the potential of PBT, particulalry with high energy ions. Today, particle-beam therapy is delivered at relatively low dose rate (around 1 Gy/min) in a limited range of temporal and spatial distributions. There is evidence that the efficacy of particle-beam therapy can be substantially improved if the dose is delivered at higher, ultra-high dose rates ("FLASH" therapy) and/or in multiple spatially distinct beams (spatially-fractionated radiotherapy, SFRT). These results indicate that a new facility incorporating a highly flexible, multiple-ion source is required to enable the fundamental research needed to understand fully the biological effects induced by proton and ion beams and to realise the full potential of particle-beam therapy. The LhARA facility will open up key new areas of biological and biomedical research, including the synergistic influence of the immune system on the cellular response to radiation damage, and will allow investigation of the personalisation of particle-beam therapy for the particular patient. Advances in laser technology now allow high-power pulsed lasers to be used to drive the production of intense bursts of protons and ions. The energy and instantaneous flux produced by a laser-driven proton or ion source exceed those avaiable using conventional discharge techniques by orders of magnitude. It is therefore possible to conceive of a compact hybrid accelerator system in which a laser-driven source is used to serve a state-of-the art accelerator system. The temporal, spatial, and spectral characteristics of the laser driven beam are qualitatively and quantitatively different to those that can be provided by conventional techniques. By proving the principle of the laser-hybrid techniques the collaboration seeks to bring a new capability for curiosity-driven explotation of the natural world and to create a new tool for scientific and technological innovation.
Author list*	*[Please indicate the co-authors you propose to involve and why]* Propose the following lead authors on behalf of the LhARA collaboration: Kenneth LONG, Yolanda PREZADO, Jason PARSONS, Patricia PRICE, Richard AMOS, Tracy UNDERWOOD, and Colin WHYTE: Vision, science, technology and co-creation cases: • Laser-driven beams for science and innovation (KL); • Potential for discovery in fundamental biology through the use of laser-driven proton and ion beams (YP, JP);

	• Opportunity for the LhARA initiative to transform capability in proton and ion beam therapy and radiotherapy in general (PP, RA); and • Benefits of execution of LhARA initiative through the creation of a co-creation eco-system (TU, CW). Extension of the author list should be considered as the full content of the lead article and multi-audience article hub develops. Members of the LhARA collaboration will contribute articles to the article hub.
Key references	*[Please list the 10 most seminal references relating to the content of your article]* 1. Aymar, Galen, Tobias Becker, Stewart Boogert, et al. 'LhARA: The Laser-Hybrid Accelerator for Radiobiological Applications'. Frontiers in Physics 8 (September 2020). https://doi.org/10.3389/fphy.2020.567738. 2. Ahmed, H., M. Alderton, R. A. Amos, et al. ITRF / LhARA Conceptual Design Report. Report. UKRI, 2026. https://epubs.stfc.ac.uk/work/64272701. 3. All Party Parliamentary Group on Radiotherapy, "Elevating radiotherapy in the National Cancer Plan" URL: https://radiotherapy.org.uk/wp-content/uploads/2026/02/APPGRT_Elevating-radiotherapy-in-the-cancer-control-plan.pdf 4. Niloy R Datta, Susanne Rogers, and Stephan Bodis. "Challenges and Opportunities to Realize "The 2030 Agenda for Sustainable Development" by the United Nations: Impelications for Radiation Therapy Infrastructure in Low- and Middle-Income Countries". In: International Journal of Radiation Oncology*Biology*Physics 105.5 (2019), pages 918–933. issn: 0360-3016. doi: https://doi.org/10.1016/j.ijrobp.2019.04.033. url: http://www.sciencedirect.com/science/article/pii/S0360301619306972 5. Thomas Mee et al. "The use of radiotherapy, surgery and chemotherapy in the curative treatment of cancer: results from the FORTY (Favourable Outcomes from RadioTherapY) project". In: The British Journal of Radiology 96.1152 (October 2023). issn: 1748-880X. doi: 10.1259/bjr.20230334. url: http://dx.doi.org/10.1259/bjr.20230334. 6. May Abdel-Wahab et al. "Radiotherapy and theranostics: a Lancet Oncology Commission". In: The Lancet Oncology 25.11 (November 2024), e545–e580. issn: 1470-2045. doi: 10 . 1016 / s1470 - 2045(24) 00407 - 8. url: http : / / dx . doi . org / 10 . 1016 / S1470 - 2045(24)00407-8. 7. Vincent Favaudon et al. "Ultrahigh dose-rate FLASH irradiation increases the differential response between normal and tumor tissue in mice". In: Science Translational Medicine 6.245 (July 2014). issn: 1946-6242. doi: 10.1126/scitranslmed.3008973. url: http://dx.doi.org/10.1126/scitranslmed.3008973. 8. Stefanie Girst et al. "Proton Minibeam Radiation Therapy Reduces Side Effects in an In Vivo Mouse Ear Model". In: International Journal of Radiation Oncology*Biology*Physics 95.1 (May 2016), pages 234–241. issn: 0360-3016. doi: 10.1016/j.ijrobp.2015.10.020; url: http://dx.doi.org/10.1016/j.ijrobp.2015.10.020.

Handling editor*	*[If possible, please nominate up to 3 eminent experts who may be invited on your behalf to act as handling editor for your article]* Rajeev PATTATHIL (STFC/RAL/CLF) Katia PARODI (LMU) Rock MACHIE (Leo Cancer Care)
Peer reviewers*	*[If possible, please nominate up to 5 eminent experts who may be invited to peer review your article and to write an accompanying Viewpoint]* Ulrich SCHRAMM (HZDR) Michael LAMONT (CERN) Antonio ZOCCOLI (INFN) Brita SINGERS SØRENSEN (Aarhus) Michael BAUMANN (DKFZ)
Editorial*	*[We welcome your suggestions for individuals who could write an Editorial on the broader scientific, policy, or societal context]* Rock Machie and possibly inpt form RTUK for patient input
Policy Outlook commentary	*[We welcome your suggestions for individuals who could write a Policy Outlook commentary related to your article]* Global Coalition for Radiotherapy representative (to ensure international input) and describe where fit with international cancer continuum

* Frontiers is committed to scientific publishing diversity, inclusivity, and equity. Please take these aspects into account in your nominations.

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Tel +41 (0)21 519 17 00
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