European Linear Accelerator Challenge

Competition Handbook

First Edition

Version 1.0.0

Release Date: 2025.09.09

Acceleration through innovation

Contents

Changelog

Version	Date	Changes
0.1	2025.09.01	Initial pre-release
0.2	2025.09.02	Scoring system
0.3	2025.09.02	Committee declaration
0.4	2025.09.02	Formatting
0.5	2025.09.07	Safety guidelines
1.0.0	2025.09.09	First version

v0.1 – First pre-release of the ELIAC Handbook.
v0.2 – Scoring has been set via points into a 1400-point system.
v0.3 – Added the committee declaration.
v0.4 – Asymmetric formatting and custom fonts.
v0.5 - Safety guidelines updated and extended.
v1.0.0 – First releasable version.

Abbreviations

Abbreviation	Definition
BPM	Beam Position Monitor
CAD	Computer-Aided Design
CET	Central European Time
CEST	Central European Summer Time
DC	Direct Current
ELIAC	European Linear Accelerator Challenge
EM	Electromagnetic
FEL	Free Electron Laser
LINAC	Linear Accelerator
LLRF	Low-Level Radio Frequency
MIT	Massachusetts Institute of Technology (License)
MVL	Minimum Viable LINAC
PCB	Printed Circuit Board
RF	Radio Frequency
RMS	Root Mean Square
UPV	Universitat Politècnica de València

I Introduction

I.1 Purpose

I.1.1

The European Linear Accelerator Challenge (ELIAC) is the first international academic challenge focused on particle accelerators, specifically on the design and development of an electron Linear Accelerator (LINAC). This initiative aims to foster collaboration between teams from different countries and specialties, while facing the challenge of developing a particle acceleration system with potential applications in different industry and research fields.

I.1.2

ELIAC is not limited to the development of a specific linear accelerator model, but also aims to strengthen international synergies in the academic and research fields, promoting teamwork, innovation, and knowledge exchange among students and professionals from different disciplines.

I.2 Technical Approach

I.2.1

The electron linear accelerator (LINAC) was selected as the foundational model due to its relative structural simplicity and modular nature, characteristics that make it an ideal starting point for an academic competition of this kind.

I.2.2

Unlike circular accelerators such as cyclotrons or synchrotrons, a LINAC is based on a linear design that facilitates scalability and allows for more precise control of the energy delivered to the particles.

I.3 Educational Philosophy

I.3.1

The approach emphasizes a bottom-up development process, where degree and master's students take an active role in every stage: from electromagnetic design and particle dynamics simulation to RF component selection, vacuum system integration, and beam diagnostics.

I.3.2

The educational objectives pursued are:

1. Development of technical skills in advanced simulation tools
2. Hands-on learning through practical application
3. Interdisciplinary collaboration experience
4. Professional development in a research environment

I.4 Competition Scope

I.4.1

The competition focuses on the design and simulation of electron LINAC prototypes. Physical construction is encouraged for demonstration purposes but is not scored. Teams design complete systems while specializing in areas of strength.

I.4.2

There are no constraints on beam energy or accelerator length, provided designs are safe and serve a stated objective. Teams must define a specific application context for their design.

OC Organization and Contact

OC.1 Organization Entity

OC.1.1

Innova Physics is a student-led initiative born at the Universitat Politècnica de València, focused on designing, building, and sharing cutting-edge projects in accelerator physics and engineering.

OC.1.2

Innova Physics is part of Generación Espontánea, the university's Design Factory, a program for supporting outstanding student teams.

OC.2 Official Contact Information

OC.2.1

1. Official Email: info@innovaphysicsupv.com
2. Official Website: www.innovaphysicsupv.com/eliac
3. LinkedIn: Innova Physics UPV
4. Instagram: @innovaphysicsupv

OC.3 Communication Channels

OC.3.1

All official communications regarding ELIAC will be conducted through:

1. Official website (primary information hub)
2. ELIAC mailing list (direct team communication)
3. Live sessions and webinars (Q&A and reviews)

OC.3.2

Teams are responsible for maintaining active access to all channels and remaining informed of official communications throughout the competition.

OC.4 Guidelines Updates

OC.4.1

These guidelines are subject to revision throughout the competition. Amendments may be introduced based on feedback or technical clarifications arising during official milestones.

OC.4.2

All modifications will be evaluated and approved by the organizing committee and formally communicated through official channels. Teams are responsible for remaining informed of updates.

P Participation

P.1 Team Eligibility

P.1.1 Participant Requirements

1. Each participant may be a member of one team only
2. Only undergraduate or master's degree students are eligible
3. Doctoral candidates and postgraduates may not join competing teams
4. Participants may compete for maximum five competition cycles from first registration
5. Team members must be at least 18 years old

P.1.2 Team Composition

1. Each team must designate one Team Captain as primary contact
2. Teams may have maximum 50 members
3. Members organize internally by skills and project needs
4. At least one Faculty Advisor required per team

P.1.3 Institutional Limitations

1. Each university may register one official team only
2. Multi-university teams permitted under single host institution
3. Teams must develop projects independently
4. Faculty advisors limited to mentorship role only

P.2 Team Roles

P.2.1 Team Captain

The Team Captain serves as official representative and primary contact with the organizing committee. Responsibilities include:

1. Coordinating all official communications
2. Ensuring timely documentation submission
3. Representing team in briefings and reviews
4. Overseeing internal coordination

Captain changes require written justification and committee approval.

P.2.2 Faculty Advisor

Each team requires at least one Faculty Advisor affiliated with the host institution. The advisor provides academic guidance and institutional support but must not directly develop technical deliverables. All core design and documentation must remain student responsibility.

P.2.3 Technical Advisory

While not mandatory, teams are strongly encouraged to have at least one faculty advisor with relevant background in physics, electrical engineering, or related fields.

P.3 Intellectual Property

P.3.1

All technical designs, simulations, and documentation submitted to ELIAC will be released under MIT License. Teams retain full attribution rights.

P.3.2

Teams may publish work independently only after official publication in ELIAC proceedings. The organizing committee reserves rights for educational and promotional use with attribution.

P.4 Code of Conduct

P.4.1

All participants must maintain professional standards:

1. Academic integrity: All work must be original to the team
2. Professional behavior: Respectful interaction required
3. Fair competition: Sabotage or unfair practices prohibited

P.4.2

The organizing committee reserves the right to:

1. Issue warnings for minor infractions
2. Deduct 10-50 points for conduct violations
3. Disqualify teams for serious breaches with written justification

Appeals must be submitted within 48 hours of notification.

P.5 Competition Integrity

P.5.1

The organizing committee commits to maintaining fair and unbiased evaluation through:

1. Conflict of interest declarations
2. Standardized evaluation rubrics
3. Neutral institutional stance
4. Transparent scoring with feedback

P.6 Collaboration Policy

P.6.1

Teams may freely share general knowledge and published resources. Inter-team physics discussions are encouraged.

P.6.2

Prohibited: Direct sharing of simulation files, custom code, or CAD models between teams. Extensive external assistance that replaces student effort. Teams must disclose significant external contributions.

P.7 Withdrawal and Substitution

P.7.1

Team withdrawal permitted up to 30 days before final submission. No registration refunds after this date.

P.7.2

Member substitution allowed with restrictions:

1. Before preliminary submission: Unlimited with notification
2. After preliminary submission: Maximum 2 with justification
3. After final submission: Medical emergency only

All changes require faculty advisor approval and official documentation.

AR Application and Registration

AR.1 Key Dates

AR.1.1

Milestone	Date
Registration Opens	September 15, 2025
Registration Closes	December 15, 2025
Preliminary Design Report	February 28, 2026
Intermediate Review	April 10, 2026
Final Documentation	May 30, 2026
Competition Event	July 20-25, 2026

AR.1.2

All deadlines are at 23:59 CEST on the specified date. Late submissions subject to penalties as outlined in Section P.

AR.2 Required Documentation

AR.2.1 At Registration

1. Team information form
2. Faculty advisor declaration
3. Member roster with student IDs
4. Preliminary project scope (500 words)

AR.2.2 Phase 1 Submission (February 28, 2026)

1. Preliminary Design Report (5-10 pages)
2. Initial concept sketches
3. Feasibility assessment
4. Preliminary simulations

AR.2.3 Phase 2 Submission (April 10, 2026)

1. Progress report (3-5 pages)
2. Updated simulations with validation
3. Peer review participation confirmation
4. Revised timeline

AR.2.4 Final Submission (May 30, 2026)

1. Complete technical paper (15-25 pages)

2. Executive summary (2 pages)
3. Poster (A0 format, PDF)
4. Presentation slides (20 slides maximum)
5. Simulation files (optional, for archival)

AR.3 Registration Fees

AR.3.1

Registration fees will be placed when the location and accommodations of the competition are known, and after the proper discussion with the different teams through a dedicated meeting where all the details will be discussed.

AR.4 Cancellation Policy

AR.4.1

After March 1, 2026, no refunds except for force majeure

AR.4.2

Cancellation requests must be submitted in writing with faculty advisor confirmation. Force majeure cases are evaluated individually by the organising committee.

ES Event Structure

ES.1 Competition Timeline

ES.1.1

The competition follows a three-phase structure designed to ensure orderly progression while allowing time for development, review, and adjustments:

1. **Phase 1 - Registration and Initial Concepts**: Teams register and submit preliminary designs, establishing project scope and approach.
2. **Phase 2 - Intermediate Review and Feedback**: Progress review with feedback from organizing committee and peer teams.
3. **Phase 3 - Final Presentation and Awards**: In-person event with presentations, workshops, and awards ceremony.

ES.1.2

Intermediate phases allow teams to receive feedback and make adjustments before final presentation, helping resolve doubts and improve results.

ES.2 Event Format

ES.2.1 Schedule Overview

The competition culminates in a five-day event (July 20-25, 2026):

1. Day 1: Registration, opening ceremony, welcome reception
2. Day 2-3: Technical presentations by teams
3. Day 3-4: Expert workshops and industry talks
4. Day 4: Hardware demonstrations (optional)
5. Day 5: Awards ceremony and closing

ES.2.2 Technical Presentations

Each team receives 20 minutes presentation time plus 10 minutes Q&A. Presentations evaluated by expert jury and contribute to final scoring.

ES.2.3 Workshops and Talks

Invited speakers from research institutions and industry provide:

1. Technical workshops on accelerator physics
2. Career development sessions
3. Industry application perspectives
4. Research collaboration opportunities

ES.3 Location and Logistics

ES.3.1

Event location to be announced by March 2026. Venue selection criteria:

1. Presentation facilities for 50+ attendees
2. Workshop spaces for parallel sessions
3. Optional demonstration areas with power and safety infrastructure
4. Accommodation options nearby
5. International accessibility

ES.3.2

Logistics support includes:

1. Visa invitation letters for international participants
2. Accommodation recommendations
3. Local transportation information
4. Dietary requirement accommodations

ES.4 Safety Requirements

ES.4.1

All activities must comply with venue safety regulations and local laws. Specific requirements:

1. Emergency evacuation procedures briefing mandatory for all attendees
2. Safety equipment provided for demonstration areas
3. First aid personnel on-site during event hours
4. Insurance requirements as specified in registration

ES.4.2

Teams planning hardware demonstrations must notify organizers as soon as possible and no less than 60 days in advance for safety review and venue coordination.

ES.5 Networking Opportunities

ES.5.1

Structured networking sessions include:

1. Team poster sessions
2. Industry meet-and-greet
3. Alumni network introductions
4. Research collaboration discussions
5. Social events and cultural activities

TR Technical Requirements

TR.1 Minimum Viable LINAC (MVL)

TR.1.1

All teams must design a complete electron LINAC system. While complexity may vary, every submission must include all fundamental subsystems:

1. **Electron Source** (20% of score): Minimum DC thermionic gun design, advanced options include RF photocathode or field emission
2. **Acceleration Section** (30% of score): Minimum single cavity or drift tube, advanced multi-cell structures encouraged
3. **RF System** (20% of score): Minimum conceptual power coupling, complete LLRF and feedback systems preferred
4. **Vacuum & Diagnostics** (10% of score): Basic pressure calculation and one diagnostic minimum
5. **Integration & Controls** (10% of score): Block diagram minimum, full control system design encouraged
6. **Innovation Bonus** (10% of score): Novel approaches in any subsystem

TR.1.2

Teams weak in one area may compensate with excellence in others, but all subsystems must be addressed to qualify.

TR.2 Software Requirements

TR.2.1 Recommended Open Source Tools

1. **EM Design**: openEMS, MEEP, or equivalent
2. **Beam Dynamics**: ASTRA, elegant, OPAL
3. **Particle Transport**: GEANT4 (mandatory for radiation studies)
4. **Electronics**: KiCad (mandatory for PCB design)
5. **Thermal/Structural**: CalculiX, Code_Aster
6. **Vacuum**: MOLFLOW+ for pressure distribution

TR.2.2 Accepted Commercial Tools

1. **EM Design**: CST Studio Suite, ANSYS HFSS, COMSOL
2. **Beam Dynamics**: GPT (General Particle Tracer), TRACK
3. **Electronics**: Altium
4. **Thermal/Structural**: ANSYS, COMSOL

Teams using commercial software must provide version numbers and verify license validity.

TR.3 Validation Requirements

TR.3.1

All teams must demonstrate software competence and simulation accuracy through standardized benchmarks:

1. **Standard Cavity Test**: Simulate a published reference cavity (e.g., 1.3 GHz TESLA cell) and show agreement within 5% of published parameters
2. **Beam Transport Validation**: Model simple drift space focusing and compare with analytical solutions
3. **Convergence Studies**: Demonstrate mesh independence for all electromagnetic simulations
4. **Parameter Sensitivity**: Show design robustness through parameter sweeps

TR.3.2

Validation results must be included as appendix in technical paper. Inadequate validation subject to point deductions.

TR.4 Documentation Standards

TR.4.1 Technical Paper Requirements

1. **Abstract** (200-300 words): Clear statement of objectives and achievements
2. **Introduction & Objectives** (1-2 pages): Context and specific goals
3. **Theoretical Background** (2-3 pages): Relevant physics and engineering principles
4. **System Design** (6-10 pages): Detailed description of all subsystems
5. **Simulation Methodology** (2-3 pages): Software tools, settings, validation
6. **Results & Analysis** (3-5 pages): Performance metrics and optimization
7. **Safety & Fabrication** (1-2 pages): Practical considerations
8. **Conclusions**: Summary and future work
9. **References**: IEEE format required

TR.4.2 Format Specifications

1. **Length**: 15-25 pages excluding references and appendices
2. **Format**: A4 paper, 11pt font, 1.5 line spacing
3. **Margins**: 25mm all sides
4. **File**: PDF format, maximum 25MB
5. **Language**: English (UK or US spelling acceptable)
6. **Figures**: High resolution, properly captioned and referenced

TR.5 Design Constraints

TR.5.1

While innovation is encouraged, designs must respect physical laws and engineering feasibility:

1. Maximum surface electric field justified by breakdown studies
2. Thermal loads addressed with cooling solutions
3. Vacuum requirements achievable with specified pumping
4. Power consumption within reasonable limits
5. Materials commercially available

TR.5.2

Exotic acceleration schemes (plasma, dielectric, etc.) permitted but require thorough justification and complete system design including drivers.

E Evaluation

E.1 Scoring Framework

E.1.1 Component Scoring Distribution

Component	Weight
Electron Source	200
Acceleration Section	300
RF System	200
Vacuum & Diagnostics	100
Integration & Controls	100
Innovation Bonus	100
Total	**1000**

E.1.2 Evaluation Criteria per Component

Each component evaluated on five dimensions:

1. **Physics Accuracy** (30%): Correct application of principles, valid assumptions
2. **Design Completeness** (25%): All necessary elements addressed
3. **Simulation Quality** (20%): Convergence, validation, parameter studies
4. **Innovation** (15%): Creative solutions and novel approaches
5. **Documentation** (10%): Clarity, completeness, reproducibility

E.2 Innovation Weighting

E.2.1

Innovation scoring rewards novel approaches over standard solutions:

1. **90-100 points**: Completely novel approach, potentially publishable
2. **70-80 points**: Significant modification of existing concepts
3. **50-60 points**: Creative combination of known techniques
4. **30-40 points**: Minor variations on standard designs
5. **0-20 points**: Direct copy of existing accelerator

E.2.2

Teams copying existing designs without innovation will lose against lesser-performing novel ideas. Innovation must be justified with clear advantages or unique applications.

E.3 Jury Composition

E.3.1

Jury members must declare conflicts of interest. Members with direct connections to participating teams recuse from evaluating those teams.

E.4 Evaluation Process

E.4.1 Document Review

Technical papers evaluated before event using standardized rubrics. Each paper reviewed by minimum three jury members independently.

E.4.2 Presentation Assessment

Live presentations evaluated for:

1. Technical content clarity (40%)
2. Response to questions (30%)
3. Visual aids quality (15%)
4. Time management (15%)

E.4.3 Final Scoring

1. Technical paper: 1000 of total score
2. Oral presentation: 300 of total score
3. Poster quality: 100 of total score

E.5 Awards and Recognition

E.5.1 Competition Awards

1. **ELIAC Champion**: Highest overall score
2. **Innovation Award**: Most novel technical approach
3. **Best Newcomer**: Top score among first-time institutions
4. **Component Excellence**: Best design in specific subsystem
5. **People's Choice**: Voted by event participants

E.5.2 Special Mentions

1. Best simulation methodology
2. Most thorough validation
3. Best safety analysis
4. Outstanding presentation
5. Best international collaboration

E.6 Peer Review Process

E.6.1

Post-event peer review ensures fairness and accuracy:

Timeline	Activity
Days 1-7	Papers available to volunteer reviewers
Days 8-9	Review submissions compiled
Days 10-11	Committee evaluates flagged issues
Day 12	Final results published
Day 30	Winners' papers submitted for magazine
Day 60	ELIAC Magazine published

E.6.2

Reviewers may flag calculation errors, uncited prior art, safety concerns, or academic integrity issues. Committee investigates all flags before finalizing results.

PA Penalties and Appeals

PA.1 Late Submissions

PA.1.1 Penalty Schedule

Late submission penalties apply to all deliverables:

1. 1-24 hours late: 5 points deducted
2. 24-48 hours late: 10 points deducted
3. 48-72 hours late: 20 points deducted
4. Beyond 72 hours: Submission not accepted

PA.1.2 Grace Period

Technical difficulties may qualify for one-time 24-hour grace period without penalty. Request must be submitted before original deadline with evidence of issue.

PA.2 Technical Non-Compliance

PA.2.1 Missing Requirements

1. Missing subsystem (per MVL requirements): 20 points
2. Inadequate validation benchmarks: 10 points
3. Incomplete documentation section: 5-15 points based on severity
4. Format violations (page limit, file size): 5 points
5. Missing team information: 3 points

PA.2.2 Academic Integrity

1. Plagiarism: Immediate disqualification
2. Undisclosed external assistance: 25-50 points based on extent
3. False data or results: Disqualification
4. Inter-team collaboration beyond allowed: 20 points per team

PA.3 Conduct Violations

PA.3.1

Professional conduct violations result in:

1. First warning: Written notice, no penalty
2. Second warning: 10 points deducted
3. Third violation: 25 points deducted
4. Severe violation: Immediate disqualification

PA.3.2

Severe violations include harassment, sabotage, safety violations, or actions bringing competition into disrepute.

PA.4 Appeal Process

PA.4.1 Submission Requirements

Appeals must be submitted within 48 hours of penalty notification and include:

1. Specific penalty being contested
2. Detailed justification for appeal
3. Supporting evidence or documentation
4. Requested remedy
5. Faculty advisor endorsement

PA.4.2 Review Process

1. Appeals reviewed by three-member panel excluding original decision maker
2. Panel may request additional information
3. Decision provided within 72 hours
4. Panel decision is final

PA.5 Force Majeure

PA.5.1

Extraordinary circumstances beyond team control may qualify for penalty waiver:

1. Natural disasters affecting team location
2. University closure or strike
3. Serious medical emergency of multiple team members
4. Government travel restrictions

PA.5.2

Force majeure claims require official documentation and committee approval. Alternative arrangements may include extended deadlines or remote participation.

PA.6 Remediation

PA.6.1

Teams may request opportunity to correct minor violations:

1. Format corrections: 24 hours, 3-point penalty

2. Missing signatures or forms: 48 hours, 5-point penalty
3. Validation additions: Before final submission only

PA.6.2

Remediation not available for late submissions, plagiarism, or safety violations.

PD Physical Demonstrations

PD.1 Demonstration Categories

PD.1.1 Level 0: Virtual Demonstration

No physical hardware required. Teams present:

1. CAD models and renderings
2. Simulation animations
3. Virtual reality walkthroughs
4. Video demonstrations from home institution

No special safety requirements or advance notice needed for Level 0.

PD.1.2 Level 1: Static Display

Physical hardware without power. Requirements:

1. Transport documentation with customs declarations
2. Assembly/disassembly procedures
3. Material safety data sheets for all components
4. Display area maximum 2m × 2m
5. Team responsible for setup/teardown

PD.1.3 Level 2: Powered Demonstration

RF testing without beam. Strict requirements:

1. 60-day advance notice mandatory
2. Complete risk assessment (form ELIAC-DEMO-002)
3. Insurance certificate (€1,000,000 minimum coverage)
4. Two qualified operators (one must be faculty/staff)
5. Emergency stop system demonstration video

PD.2 Safety Protocol for Powered Demonstrations

PD.2.1 Pre-Event Requirements (T-60 days)

1. Submit initial demonstration request
2. Provide system specifications and schematics
3. Identify all hazards and mitigation measures
4. Submit operator qualifications

PD.2.2 Pre-Event Requirements (T-30 days)

1. Submit complete safety documentation package

2. Provide test reports from certified laboratory
3. Insurance documentation finalized
4. Transport arrangements confirmed
5. Venue technical requirements verified

PD.2.3 On-Site Safety Inspection

Day 1 requirements before operation permitted:

1. Safety inspection by committee and venue officer
2. Interlock system verification
3. RF leakage test (<1 mW/cm^2 at 5cm)
4. Grounding verification (<0.1Ω)
5. Emergency stop functionality test
6. Signage and barriers installed

PD.3 Operating Limits

PD.3.1

Maximum permitted parameters for demonstrations:

1. RF Power: 100W continuous or 1kW pulsed (10% duty cycle)
2. Voltage: 5kV DC, 1kV AC RMS
3. Vacuum: No turbomolecular pumps in public areas
4. Cryogenics: Maximum 5 liters liquid nitrogen
5. Laser: Class 2 maximum in open areas

PD.3.2

Public must be maintained minimum 2 meters from equipment. Operators must wear appropriate PPE. Committee observer required during all operations.

PD.4 Case-by-Case Evaluation

PD.4.1

Teams requesting demonstrations beyond standard categories undergo individual review:

1. Novel demonstration types considered
2. Additional safety measures may be required
3. Venue capabilities determine feasibility
4. Educational value weighed against risk
5. Committee decision final

PD.4.2

Approval does not guarantee demonstration if venue conditions change or safety concerns arise during setup.

PD.5 Liability and Insurance

PD.5.1

Teams assume full responsibility for:

1. Equipment damage during transport or demonstration
2. Personal injury resulting from team equipment
3. Third-party claims arising from demonstration
4. Venue damage caused by team activities

PD.5.2

University or team insurance must explicitly cover competition activities. Proof required before demonstration approval.

PD.6 Recognition for Demonstrations

PD.6.1

While demonstrations don't affect competition scoring, special recognition provided:

1. Best Hardware Implementation award
2. Innovation in Construction award
3. Feature in ELIAC Magazine hardware section
4. Video documentation for competition archive
5. Industry networking opportunities

PU Publication

PU.1 ELIAC Magazine

PU.1.1 Publication Schedule

Annual ELIAC Magazine published 60 days post-event containing:

1. Top three papers per scoring category
2. Award winner profiles
3. Technical highlights and innovations
4. Workshop and keynote summaries
5. Hardware demonstration features
6. Industry perspectives and sponsorship recognition
7. Next edition announcements

PU.1.2 Submission Requirements

Winners selected for publication must provide:

1. Camera-ready paper version (template provided)
2. High-resolution figures and images
3. Author biographies (100 words per author)
4. Team photograph
5. Popular science summary (500 words)

Submission deadline: 30 days post-event.

PU.2 Open Access Repository

PU.2.1

All competition submissions archived in public repository:

1. Technical papers (all teams)
2. Posters (PDF format)
3. Presentation slides (with team permission)
4. Winners' simulation files (upon request)
5. Video recordings of presentations

PU.2.2

Repository hosted at: www.innovaphysicsupv.com/eliac/archive
Materials available under MIT License with proper attribution required.

PU.3 Publication Rights

PU.3.1 Team Rights

1. Teams retain all intellectual property rights
2. May publish independently after ELIAC Magazine release
3. Can present at conferences with ELIAC acknowledgment
4. May file patents based on innovations

PU.3.2 Competition Rights

1. Non-exclusive right to publish in proceedings
2. Educational use in future competitions
3. Promotional use with attribution
4. Archival for historical record

PU.4 Citation Guidelines

PU.4.1

Papers should be cited as:

[Author Names], "[Paper Title]," in Proceedings of the European Linear Accelerator Challenge (ELIAC), [Year], pp. [pages].

PU.4.2

BibTeX entry template:

```
@inproceedings{teamname2026,
  author = {Last, First and Last, First},
  title = {Paper Title},
  booktitle = {Proceedings of ELIAC},
  year = {2026},
  pages = {xx--yy},
  publisher = {Innova Physics UPV}
}
```

PU.5 Media Coverage

PU.5.1

Teams agree to reasonable media engagement:

1. Press release cooperation
2. Interview availability during event
3. Social media content sharing
4. Photography and video permissions

PU.5.2

Teams may opt out of individual media activities but must allow event documentation.

PU.6 Long-term Preservation

PU.6.1

Competition materials preserved for:

1. Historical documentation of accelerator education
2. Reference for future competitions
3. Educational resource for new teams
4. Industry collaboration evidence
5. Academic research on innovation

PU.6.2

Digital preservation follows best practices with redundant storage and format migration as needed.

A Document Templates

A.1 Faculty Advisor Declaration

ELIAC 2026 - Faculty Advisor Declaration

I, ____________________________ (Name), holding the position of ____________________________ at ____________________________ (Institution), hereby declare that:

1. I agree to serve as Faculty Advisor for Team ____________________________
2. I confirm all team members are eligible students at the institution
3. I will provide academic guidance and institutional support
4. I will not directly develop technical deliverables
5. I will ensure team compliance with safety regulations
6. I accept responsibility for team conduct at competition events

Signature: ____________________________ Date: ________________

A.2 Team Registration Form

ELIAC 2026 - Team Registration

Team Name:	____________________________
Institution:	____________________________
Country:	____________________________
Team Captain:	____________________________
Captain Email:	____________________________
Captain Phone:	____________________________
Faculty Advisor:	____________________________
Number of Members:	____________________________

Project Scope (500 words maximum):

____

____

____

A.3 Risk Assessment Form (Hardware Demonstrations)

ELIAC 2026 - Risk Assessment for Physical Demonstrations

Section 1: System Description

1. System type and specifications
2. Operating parameters (voltage, power, frequency)
3. Physical dimensions and weight
4. Required utilities (power, cooling, gases)

Section 2: Hazard Identification

1. Electrical hazards
2. RF radiation exposure
3. Mechanical hazards
4. Chemical hazards
5. Other risks

Section 3: Risk Mitigation

1. Engineering controls
2. Administrative controls
3. Personal protective equipment
4. Emergency procedures

Section 4: Operator Qualifications

1. Primary operator credentials
2. Secondary operator credentials
3. Training documentation

A.4 Peer Review Form

ELIAC 2026 - Post-Competition Peer Review

Reviewer Name:	______________________________
Affiliation:	______________________________
Paper Reviewed:	______________________________

Review Categories:

1. Technical Accuracy (Correct/Minor Issues/Major Issues)
2. Prior Art Citation (Complete/Incomplete/Missing)
3. Safety Considerations (Adequate/Insufficient/Dangerous)
4. Academic Integrity (No Concerns/Minor Concerns/Major Concerns)

Detailed Comments:

B Technical Glossary

B.1 Accelerator Components

Accelerating Cavity Resonant metallic structure where electromagnetic fields accelerate particles. Can be normal-conducting or superconducting.

Beam Position Monitor (BPM) Diagnostic device that measures the transverse position of the particle beam within the beampipe.

Buncher RF cavity operating at low energy to compress particle bunches longitudinally before main acceleration.

Cathode Electron-emitting surface in an electron gun. Can be thermionic (heated), photocathode (laser-driven), or field emission.

Coupler Device for transferring RF power from transmission line into accelerating cavity. Can be capacitive, inductive, or waveguide-based.

Electron Gun Source of electrons for acceleration. Includes cathode, extraction electrode, and focusing elements.

Faraday Cup Simple beam diagnostic that collects all beam current for measurement.

Klystron High-power RF amplifier tube commonly used to drive accelerating structures.

Quadrupole Magnet with four poles used for transverse beam focusing. Focuses in one plane while defocusing in the other.

RF Window Vacuum barrier transparent to RF power, typically made of ceramic or sapphire.

Solenoid Cylindrical coil producing longitudinal magnetic field for beam focusing, especially at low energy.

Waveguide Hollow metallic tube for RF power transmission with low loss.

B.2 Performance Metrics

Beam Loading Reduction in cavity voltage due to energy extraction by the beam.

Duty Cycle Ratio of pulse duration to repetition period for pulsed operation.

Emittance Measure of beam quality in phase space. Product of beam size and angular divergence. Units: mm-mrad.

Energy Spread RMS or FWHM variation in particle energies within the beam. Expressed as percentage or absolute value.

Gradient Accelerating electric field strength, typically expressed in MV/m. Key figure of merit for accelerating structures.

Quality Factor (Q) Ratio of stored energy to energy loss per RF cycle. Indicates cavity efficiency.

Repetition Rate Frequency of beam pulses, typically in Hz.

Shunt Impedance Measure of cavity efficiency relating voltage gain to power consumption. Units: MΩ/m.

Transit Time Factor Efficiency factor accounting for particle velocity change during acceleration.

Wake Field Electromagnetic field left behind by beam that can affect following particles.

B.3 Simulation Terms

Convergence Study Systematic refinement of mesh or parameters to ensure simulation accuracy.

Eigenmode Natural resonant mode of electromagnetic cavity.

Mesh Discretization of geometry for numerical simulation.

Particle-In-Cell (PIC) Simulation method tracking individual particles in self-consistent fields.

S-Parameters Scattering parameters describing RF network behavior.

Space Charge Collective electromagnetic field of beam affecting particle dynamics.

B.4 Operational Terms

Conditioning Process of gradually increasing cavity field to eliminate field emission sites.

Interlock Safety system preventing operation under unsafe conditions.

Multipacting Resonant secondary electron emission limiting achievable field.

Quench Loss of superconductivity due to heating or excessive field.

Vacuum Breakdown Electrical discharge in vacuum at high field strength.

C Safety Guidelines

These guidelines will be enforced on all applicable hardware; it is the responsibility of the demonstrating team to be informed of them and of their system adhering to them reliably and with a reasonable tolerance.

C.1 Electrical Safety

C.1.1 Voltage Classifications

All voltages in nominal RMS.

1. **Low Voltage A (LVA)**: <50V AC, <120V DC
2. **Low Voltage B (LVB)**: 50-1000V AC, 120-1000V DC
3. **High Voltage A (HVA)**: 1kV-50kV
4. **High Voltage B (HVB)**: >50kV

C.1.2 Required Safety Measures

1. All circuits must have overcurrent protection
2. Emergency stop buttons accessible within 1 meter
3. Lockout/tagout procedures for maintenance
4. Ground fault circuit interrupters for portable equipment
5. Frequency-dependent grounding (see Section C.1.3)
6. Insulated tools for work above 50V
7. Clear labeling of voltage levels
8. Arc flash analysis required for systems >240V

C.1.3 Grounding Requirements

1. **DC Systems**: $<0.1\Omega$ to earth ground
2. **<1 MHz**: Single-point grounding
3. **1-10 MHz**: Transition zone, paths $<\lambda/20$
4. **>10 MHz**: Multi-point grounding
5. **RF Systems**: Wide copper straps, not round wires
6. **Klystrons**: Separate RF and DC grounds, connected at one point

C.1.4 Personal Protective Equipment

1. Medium Voltage: Class 0 gloves + 8 cal/cm^2 arc suit (NFPA 70E)
2. High Voltage: Class 2 gloves + calculated arc rating (IEEE 1584)
3. Safety glasses or face shield (ANSI Z87.1)
4. Insulated footwear for HV work
5. Remove conductive jewelry

C.2 RF Safety

C.2.1 Exposure Limits

IEEE C95.1-2019 standard applies:

1. **30-100 MHz**: 2 W/m^2
2. **100-400 MHz**: f/50 W/m^2 (where f is in MHz)
3. **400-2000 MHz**: 10 W/m^2
4. **2-300 GHz**: 10 W/m^2 (reduced from 20 W/m^2)
5. Time-averaged over 6 minutes for pulsed operation

C.2.2 RF Safety Measures

1. RF leakage measurements required before operation
2. Shielded enclosures for high-power systems
3. Interlocks on access doors
4. RF warning signs and lights
5. Personal RF monitors for operators
6. Minimum 2-meter public exclusion zone

C.3 Radiation Safety

C.3.1 Dose Limits

Following ICRP 103 recommendations:

1. **Radiation Workers**: 20 mSv/year
2. **General Public**: 1 mSv/year
3. **Controlled Areas**: >0.1 mSv/week (NCRP 144)
4. **Design Goal**: <0.5 mSv/year in controlled areas (NCRP 147)

C.3.2 Radiation Monitoring for Demonstrations

1. Pre-operation radiation survey required with documented baseline
2. Continuous monitoring during operation with a visible display
3. Maximum dose rates:
   (a) Public areas: 2.5 μSv/h
   (b) Operator position: 10 μSv/h
   (c) Boundary: 0.5 μSv/h
4. Automatic shutdown if any limit is exceeded
5. Post-operation survey to verify no activation
6. All readings documented and retained for 5 years

C.3.3 Activation Products

1. **Be-7**: 1 year cooling period required
2. **Na-22**: 10 years cooling period required
3. Storage and handling per IAEA SSG-59 guidelines

C.3.4 Monitoring Requirements

1. Personal dosimetry: Monthly badge exchange (10 CFR 20)
2. Area monitors in all controlled areas
3. Extremity badges for hands-on work
4. Survey meters available during operations

C.4 Vacuum Safety

C.4.1 Implosion Hazards

1. Glass viewports must be protected with mesh or shields
2. Vacuum chambers must have pressure relief devices
3. No modifications to certified vacuum vessels
4. Regular inspection for fatigue or damage

C.4.2 Pump Safety

1. Mechanical pumps: exhaust vented properly
2. Turbomolecular pumps: secured against rotor failure
3. Oil-free pumps preferred for public demonstrations
4. Pressure gauges must be operational
5. Oxygen monitoring for enclosed spaces

C.5 Cryogenic Safety

C.5.1 Liquid Nitrogen Handling

1. Maximum 5 liters for demonstrations
2. Appropriate Dewar vessels only
3. -196°C rated gloves + face shield (ANSI Z87.1)
4. Adequate ventilation to prevent oxygen displacement
5. Oxygen monitors required in confined spaces
6. No sealed containers

C.6 Laser Safety

C.6.1 Classifications and Requirements

1. Class 1: Safe under all conditions
2. Class 2: Safe for momentary viewing (<0.25s)
3. Class 3R: Restricted, requires controls

4. Class 3B and 4: Not permitted in demonstrations

C.6.2 Control Measures

1. Beam stops required
2. No specular reflective surfaces in beam path
3. Warning signs and indicator lights
4. Protective eyewear if Class 3R used

C.7 Emergency Procedures

C.7.1 Incident Command System

All emergencies managed through defined roles:

1. **Safety Officer**: Scene commander
2. **Technical Lead**: Equipment shutdown
3. **Medical Officer**: Casualty care
4. **Communications**: External liaison

C.7.2 Electrical Shock

1. Do not touch victim if still in contact with source
2. De-energize circuit at main disconnect
3. Call emergency services (112 in EU)
4. Begin CPR if trained and victim unresponsive
5. Use AED if available
6. Document incident within 48 hours

C.7.3 RF Exposure

1. Immediately shut down RF source
2. Remove person from exposure area
3. Seek medical evaluation even if asymptomatic
4. Document exposure level and duration
5. Report per incident investigation procedures

C.7.4 Vacuum Failure

1. Move away from vacuum vessel
2. Shut down pumps if safe to do so
3. Ventilate area if oil mist present
4. Check for injuries from flying debris
5. Initiate incident investigation

C.8 Training Requirements

C.8.1 Minimum Training for Operations

At least one of the operators must comply with one of the trainings, except for the general electrical safety, which all operators must be trained on.

1. General electrical safety: 4 hours + competency test
2. System-specific training: 8 hours + hands-on evaluation
3. Radiation safety: 16 hours + written and practical exam
4. Emergency response procedures: 4 hours + drill participation
5. Annual refresher training required
6. **Total minimum**: 40 hours with assessment

C.8.2 Documentation

1. Training records with test scores maintained permanently
2. Risk assessment per ISO 31000 before operations
3. Arc flash analysis (updated every 5 years)
4. Shielding verification (annual)
5. Operating procedures posted at demonstration
6. Emergency contact numbers displayed
7. Incident investigation reports within 48 hours

C.9 Safety Management System

C.9.1 Required Elements

1. Written safety program document
2. Hazard identification and risk assessment
3. Safety training program with competency verification
4. Incident investigation procedures with root cause analysis
5. Corrective action tracking system
6. Regular safety audits and inspections
7. Management review and continuous improvement

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