# Training Plan: Electrochemical Remediation of Mechanically Deformed Straw Tube Edges for the COMET Tracker

## 1.Introduction:

### Scientific Problem:

Mechanical cutting of ultra-thin straw tubes often results in "burring" or compressive deformation where the edges become semi-closed or jagged. In the COMET experiment, this prevents the precise insertion of end-plugs. Traditional mechanical deburring is too aggressive for 12 μm.

### Current Research:

JINR's straw tracker group is currently optimizing the assembly of Phase-I and Phase-II trackers. This project introduces electrochemical etching as a non-contact "chemical scalpel" to remove excess metallic coating and deformed material at the tube's edge.

### Applied Tasks:

- Quantifying the degree of "semi-closing" deformation using high-resolution microscopy.
- Developing a localized electrochemical bath to selectively etch deformed metal at the tube opening.
- Evaluating the impact of etching on the integrity of the internal metallization.

## 2. Postgraduate Research Objectives:

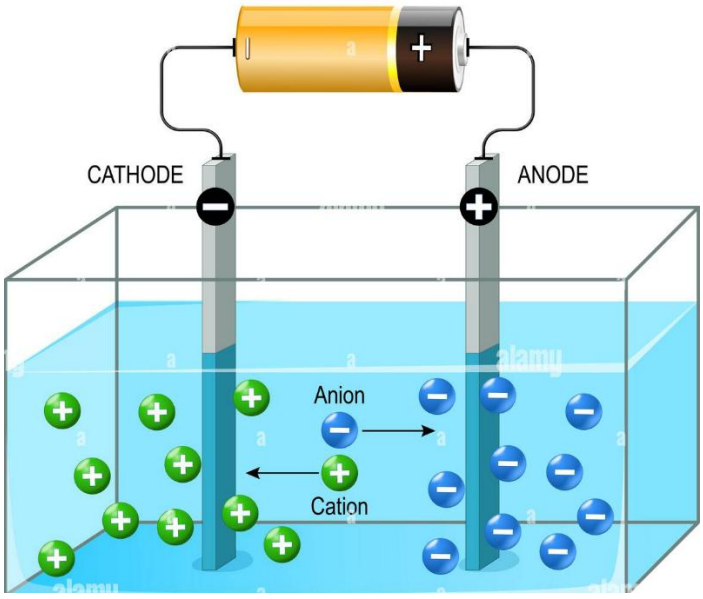
**The student will:**

- **Investigate Deformation Mechanics:** Study how mechanical shear affects thin-film metal composites.
- **Process Optimization:** Determine the optimal electrolyte concentration and pulse current to "clean" edges.
- **Quality Assurance:** Develop a standard operating procedure (SOP) for JINR's assembly lines to ensure 100% tube openness.

## 3. Project Work Description:

### 3.1 Setup

- **Working Electrode:** The straw tube edge itself, acting as the anode.
- **Counter Electrode:** A precise circular cathode inserted partially into the tube to focus the etching current on the deformed inner rim.
- **Electrolyte**: A mild alkaline or salt solution (e.g., KOH) that removes metal.



### 3.2 Measurement Procedure

1. **Deformation Baseline:** Measure the effective inner diameter of 50 straw tubes post-mechanical cut.
2. **Etching Trials:** Apply low-voltage DC or pulsed current. The student must monitor the "opening rate" in real-time.
3. **Edge Characterization:** Use **optical microscope** to ensure the edge is smooth and perpendicular, facilitating a "perfect fit" for end-plugs.

### 3.3 Results Presentation

- **Morphological Study:** Before-and-after optical microscope images of the "semi-closed" vs. "restored" edges.
- **Tolerance Analysis:** Statistical data showing the improvement in end-plug insertion force and alignment.
- **Draft Publication:** A technical note for **COMET Collaboration** internal review.

## 4.Student Preparation Requirements:

- Background in **Material Science** or **Experimental Particle Physics**.
- Experience with **Electrochemical Systems**.
- Understanding of the COMET tracker's requirements for spatial resolution.

## 4. Recommended Literature:


1. Electrochemical etching of metal wires in low-stress electric contact using a liquid metal electrode to fabricate tips for scanning tunneling microscopy, T Nishimura, **AMA Hassan,** M Tomitori - Applied surface science, 2013
2. **Tsverava, N., et al.** (2024). "Development and property study of the 12 m thick straw tubes..." arXiv:2403.18097.
3. **Podhorský, et al.** "Electrolytic Plasma Polishing of Pipe Inner Surfaces." *MDPI Materials*.
4. **KEK/J-PARC.** "COMET Phase-I Technical Design Report.


## 6. Project Management:

- **Participants**: 1 Postgraduate student (Individual Research).
- **Manger of the training:**


**A. Professor. Dr. Amer Mahmoud Amer Hassan**
**Senior Researcher at Sector of rare processes**
**Joint Institute for Nuclear Research (JINR)**