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## Literature Review

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# Particle Identification in Modern Cherenkov Detectors

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### Abstract

With major detector assemblies lining up for construction at high-energy facilities such as EIC, technologies for particle identification are becoming ever more relevant. This review motivates the theory of the field, introduces the technologies behind modern Cherenkov detectors, and discusses the implementation of these detectors into upcoming experiments. Emphasis is placed on ..... Persistent challenges include ..... We conclude by outlining promising future developments for .....

*Keywords:* Particle Identification, Cherenkov Detectors, DIRC, RICH, PANDA, EIC, GSI

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## Contents

|           |  |          |
|-----------|--|----------|
| <b>1</b>  | <b>Introduction</b>  | <b>3</b> |
| <b>2</b>  | <b>Theoretical Foundations</b>   | <b>3</b> |
| 2.1       | Cherenkov Radiation . . . . .  | 3        |
| 2.2       | Relativistic Kinematics . . . . .  | 3        |
| 2.3       | Optical Detector Theory . . . . .  | 3        |
| 2.4       | Particle Physics Motivation . . . . .  | 3        |
| 2.5       | Statistical Event Reconstruction Methods . . . . .                           | 3        |
| 2.6       | Radiation-Matter Interactions . . . . .                                      | 3        |
| <b>3</b>  | <b>Photomultipliers</b>  | <b>3</b> |
| 3.1       | MCP-PMTs . . . . .   | 3        |
| 3.2       | SiPMs . . . . .  | 3        |
| 3.3       | LAPPDs . . . . .   | 3        |
| 3.4       | HRPPDs <b>might get cut</b> . . . . .  | 3        |
| <b>4</b>  | <b>Photon Optics <b>might get cut</b></b>                                    | <b>3</b> |
| 4.1       | Lenses and Reflections . . . . .   | 3        |
| 4.2       | Laser Calibration . . . . .  | 3        |
| <b>5</b>  | <b>Ring Imaging Cherenkov Detectors (RICH)</b>                               | <b>3</b> |
| <b>6</b>  | <b>Detection of Internally Reflected Cherenkov Light (DIRC)</b>              | <b>3</b> |
| <b>7</b>  | <b>Neutrino Identification with Cherenkov Detectors <b>might get cut</b></b> | <b>3</b> |
| 7.1       | Atmospheric Muons . . . . .  | 3        |
| 7.2       | Water Cherenkov Detectors . . . . .  | 3        |
| <b>8</b>  | <b>Applications at Future Facilities</b>                                     | <b>3</b> |
| 8.1       | PANDA DIRC at FAIR . . . . .   | 3        |
| 8.2       | hpDIRC at ePIC Brookhaven . . . . .  | 3        |
| 8.3       | Other Proposed Far Future Detectors <b>might get cut</b> . . . . .           | 3        |
| <b>9</b>  | <b>Current Challenges and Limitations</b>                                    | <b>3</b> |
| 9.1       | ML PID . . . . .   | 3        |
| 9.2       | High Rate Environments . . . . .   | 3        |
| 9.3       | Radiation Damage . . . . .   | 3        |
| 9.4       | Budget Constraints . . . . .   | 3        |
| <b>10</b> | <b>Emerging Technologies</b>   | <b>3</b> |
| 10.1      | HRPPDs . . . . .   | 3        |
| 10.2      | Advanced Optics . . . . .  | 3        |
| 10.3      | New Materials . . . . .  | 3        |
| <b>11</b> | <b>Summary</b>   | <b>3</b> |

## **1. Introduction**

### **2. Theoretical Foundations**

*2.1. Cherenkov Radiation*

*2.2. Relativistic Kinematics*

*2.3. Optical Detector Theory*

*2.4. Particle Physics Motivation*

*2.5. Statistical Event Reconstruction Methods*

*2.6. Radiation-Matter Interactions*

### **3. Photomultipliers**

*3.1. MCP-PMTs*

*3.2. SiPMs*

*3.3. LAPPDs*

*3.4. HRPPDs might get cut*

### **4. Photon Optics might get cut**

*4.1. Lenses and Reflections*

*4.2. Laser Calibration*

### **5. Ring Imaging Cherenkov Detectors (RICH)**

### **6. Detection of Internally Reflected Cherenkov Light (DIRC)**

### **7. Neutrino Identification with Cherenkov Detectors might get cut**

*7.1. Atmospheric Muons*

*7.2. Water Cherenkov Detectors*

### **8. Applications at Future Facilities**

*8.1. PANDA DIRC at FAIR*

*8.2. hpDIRC at ePIC Brookhaven*

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### **9. Current Challenges and Limitations**

*9.1. ML PID*

*9.2. High Rate Environments*

*9.3. Radiation Damage*

*9.4. Budget Constraints*

### **10. Emerging Technologies**

*10.1. HRPPDs*

*10.2. Advanced Optics*

*10.3. New Materials*

### **11. Summary**

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## **References**

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