# Application WP3: Straw Chambers

# Inputs from DRD1-Wires/Straw Groups

- Tables with R&D Tasks
- R&D Projects towards MoU
- Open Discussion

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# WP3: Straw Chamber Application

## (R&D Tasks according to ECFA Roadmap)

| # | Task | Performance Goal | DRD1 WGs | ECFA DRDT | Comments | Deliv. next 3y | Interested Institutes |
|---|---|---|---|---|---|---|---|
| T1 | Optimize straw materials and technology | - Develop thin films and metallization<br>- Resistance to ageing<br>- Low cross-talk<br>- Establish material relaxation control<br>- Gas leakage control<br>- Compatible with operation in vacuum | WG1, WG3 (3.1C, 3.2B), WG6, WG7 (7.1-4) | 1.1<br>1.2<br>1.3 | | - Design and production of materials<br>- Production of straw tubes | MPP, CERN, JU-Krakow, U Manchester, U South Carolina, U Hamburg |
| T2 | Develop small-diameter straw tubes (< 4 mm) for highest rate capability | - Rate capability >500 kHz/cm$^2$<br>- Fast timing (<50ns)<br>- Charge load >10 C/cm | WG1, WG7 (7.1-3) | 1.1<br>1.2<br>1.3 | - Wire centering<br>- Electrostatic stability<br>- Establish assembly techniques and tools<br>- Ultrasonic-welding PET<br>- Straw tracker mechanics | - Straw materials and tube design<br>- Film tube production<br>- Establish the straw-tube assembly technique<br>- Prototype setup with several channels | |
| | Develop straw tubes of 5 mm-diameter | - Faster timing (<100 ns)<br>- High rate capability, $\mathcal{O}$(100 kHz/cm$^2$) | | | | | MPP, HUJI, INFN-PV, AGH-Krakow, JU-Krakow, CERN, U Bursa, U Manchester, U South Carolina, KEK-IPNS |
| | Develop ultra-thin film walls | - < 20 µm thickness<br>- $X/X_0 \sim 0.02\%$ per straw<br>- Film metallization<br>- New film materials and new technologies (e.g. nano-fibre) | | | | | INFN-PV, JU-Krakow, U Manchester, U South Carolina, KEK-IPNS |
| | Develop ultra-long straws (up to 4 m) | - Establish good mechanical properties | | | | | HUJI, INFN-PV, JU-Krakow, CERN, U Manchester, U South Carolina, INP-Almaty, U Hamburg |
| T3 | Optimize straw tracker mechanics | - Develop self-supporting modules<br>- Control relaxation<br>- Develop a method for straw alignment | WG1, WG3 (3.2E), WG6, WG7 (7.1) | 1.1<br>1.2<br>1.3 | - Design of all mechanical tools<br>- QA | - Develop assembly technique<br>- Prototype construction | MPP, HUJI, JU-Krakow, CERN, U Bursa, U Manchester, FZJ-GSI-U Bochum, U Hamburg, U South Carolina, IFIN-HH |

R&D Tasks

- New materials and technologies
- Broad range of applications covered by T2 sub-tasks
  - Smaller diameter straws
  - Ultra-thin film walls
  - Ultra-long straws with thin walls
- Straw tracker mechanics

ECFA DRD Themes

- DRDT 1.1 - Improve time and spatial resolution for gaseous detectors with long-term stability
- DRDT 1.2 - Achieve tracking in gaseous detectors with dE/dx and dN/dx capability in large volumes with very low material
- DRDT 1.3 - Develop environmentally friendly gaseous detectors for very large areas with high-rate capability

# WP3: Straw Chamber Application

## (R&D Tasks according to ECFA Roadmap)

| # | Task | Performance Goal | DRD1 WGs | ECFA DRDT | Comments | Deliv. next 3y | Interested Institutes |
|---|---|---|---|---|---|---|---|
| T4 | Optimization of electronic readout and ASIC development | - Time readout with sub-ns precision<br>- Leading and trailing edge time readout | WG5, WG7 (7.1-2) | 1.1<br>1.2 | - Dedicated R&D on ASIC | - ASIC development<br>- Development of readout system | INFN-PV, MPP, HUJI, JU-Krakow, AGH-Krakow, CERN, U Bursa, U Manchester, U South Carolina, INP-Almaty |
| T5 | 3D/4D-Tracking and PID via dE/dx | - Spatial resolution <150 µm<br>- $T_0$-determination with ≈ns resolution<br>- p/K/π-separation at p<1 GeV/c | WG1 WG4 WG7 | 1.1<br>1.2 | | - Development of SW algorithms<br>- Analysis of (in-beam) test data | MPP, INFN-LE, INFN-PV, AGH-Krakow, JU-Krakow, CERN, U Manchester, Istinye U, FZJ-GSI-U Bochum, INP-Almaty, U Hamburg |
| T6 | Longevity | - Ageing resistance > 1 C/cm for thin-wall straws<br>- Ageing resistance > 10 C/cm for straws and highest particle rates | WG1, WG3 (3.2B), WG7 (7.2) | 1.1 | Test at various DRD1 test facilities | Prototype measurements | MPP, CERN, JU-Krakow |
| T7 | Software | - Straw tube simulation and calibration<br>- Event simulation<br>- Pattern recognition<br>- Tracking and PID<br>- Tracker alignment | WG4 | 1.1, 1.2 | - Garfield, Geant<br>- Alignment, e.g. Millepede<br>- Real-time processing | - Development of new analysis algorithms and applications to (in-beam) test data | FZJ-GSI-U Bochum, CERN, U South Carolina, INP-Almaty, U Hamburg, U Aveiro, Istinye U, IFIN-HH |

Table 5: WP3 (Part II) - a work package on inner and central tracking with PID (b. Straw Chambers). Applications: future electron colliders (FCC-ee, CEPC), FCC-hh, FAIR, Dark Matter, rare event searches, and neutrino physics. *The mentioning of Institutes in the draft should be considered exclusively as a preliminary expression of interest or as potential involvement given the role of the institute in the field. Please contact us if your Institute should be added or removed from the*

R&D Tasks

- Electronic Readout, ASIC
- 3D/4D Tracking, PID by dE/dx
- Longevity
- Software developments

  (incl. groups w/o straw production activity)

DRD1 - WG association to tasks

- WG1 - Technologies
- WG3 - Gas, Materials
- WG4 - Modelling, Simulations
- WG5 - Electronics
- WG6 - Production, Technology Transfer
- WG7 - Laboratories, Facilities

# WP3: Straw Chamber Projects

## (Further Interest / Projects)

- Interest to establish new straw production site
  (ultrasonic welding technology, thin-wall straws)
- Variety of R&D projects with thin-wall straws,
  12-30 µm thin film, diameter 5-20 mm, lengths up to 4 m

R&D activities already ongoing..

- Ultra-thin 12 µm and 5mm diameter straws
- Prototyping extremely-thin 5-10 µm straw material, nano-fibre graphite

- Straw tracker prototype tests at CERN ongoing
  - Busy schedule to complete large detector set-up in next years
  - High interest in DRD1 activity

# WP3: Straw Projects Towards MoU

## (Discussions ongoing)

- Several groups with interest in series of tasks
- Institute clusters with common projects
- Groups with interest in specific single task
- Groups covering multiple technologies, e.g. drift tubes and RPC

- R&D projects towards MoU in 2023, as annex to proposal
  - 4D+PID low-weight straw tracker in Hadron physics (2024-2026)
  - Further discussions with other groups ongoing
  - ..

# R&D Project Sheets (Draft) Towards MoU

## (Annex to DRD1 Proposal in 2023, Duration 2024-26)

**Extended WP template**

Name1, Name2, Name3,...

On behalf of the groups described in the annex

**Work package project title: .....**

April the 1st 2023

**DESCRIPTION OF THE PROJECT (AND POSITIONING W.R.T. THE ROADMAP)**

..

**Tasks and deliverables:**

**T1: Resistive material**
D1.1: material test
D1.2: production prototype
D1.3; *industrialisation*
...

**T2:**
D1.1:
...

**LIST OF PARTICIPATING INSTITUTES/LABS WITH A SHORT DESCRIPTION**

**INSTITUTE 1**

The contact person of Institute 1 is ....

Institute 1 has xxx members. It has an extensive track record in ....

Main R&D interests...

**INSTITUTE 2**

**APPENDIX: PARTICIPATING INSTITUTES AND THEIR RESOURCES**

***In the following we ask for sufficient information about the project. This information will be used in the final proposal of the DRD1. However, most of the information (i.e. everything below "Confidential Information") will be kept confidential. This information will only be known to the WP coordinator, the proposal team and to a small set of reviewers that will be determined by the future DRDC. This table should cover the period 2024-2026. To cover the period beyond we may provide an updated template. Until then you can use a free format for the years ≥ 2027.***

| Project name ..... - input to WPx on … | |
|---|---|
| Task(s) | |
| Deliverable(s) | |
| Description of Technology | .... |
| Targeted DRDT | 1.2 |
| Supporting DRD1 WGs | |
| Performance goals | |
| Planned dates | 2024 - 2026<br>..... |

| Resources - Confidential Information | |
|---|---|
| Existing R&D Framework and/or list of contributors | E.g. AIDA, Institute 1, Institute 2,..... |
| Description of contribution to technological task/deliverable | Institute 1:<br>- *T1: IBF studies*<br>  - *Perform simulation*<br>  - *10x10 cm2 prototype measurements*<br>- *T2: Low-noise FEE*<br>  - *Characterisation with 10x10 cm2 prototype*<br>- ...<br>Institute 2:<br>Institute 3:<br>.... |
| FTE Contributions already covered or expected to continue (Phys., Eng./Dev. and Techn.). | Institute 1:<br>Institute 2:<br>Institute 3:<br>.... |
| Proposed new FTE request (Phys., Eng./Dev. and Techn.) | Institute 1:<br>Institute 2:<br>Institute 3:<br>.... |
| "Materials" and facilities (in terms of funding and/or existence) already covered or expected to continue | Institute 1:<br>Institute 2:<br>Institute 3:<br>.... |
| Proposed "materials" (non-FTE) funding to be requested | Institute 1:<br>Institute 2:<br>.. |

# Open Discussion

- What do you need to set up MoU
- Project organization, controlling
- Funding resources
- Confidential information of resources
- ..

*Tight time schedule: DRD1-Wires/Straw group started 2023, R&D projects discussions since Mar-2023 ..*

*.. but many R&D interests exist*