DRD1-WG2: Applications

Drift chambers
Straw chambers

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2. Applications

Select application areas connected to the research activity of your group

Answered: *69*

A. (Muon) Tracking and Triggering Systems: 42 (20.69%)

B. Inner and central tracking with particle identification capability (drift, straw, TPC,..): 33 (16.26%)

24 + 9

C. Calorimetry: 12 (5.91%)

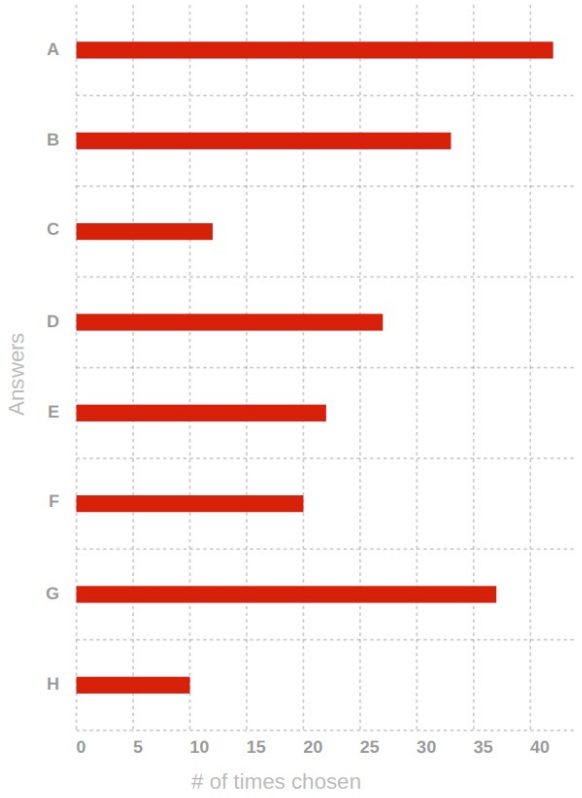
D. Photon detection: 27 (13.30%)

E. Time of Flight : 22 (10.84%)

F. TPCs for rare event searches: 20 (9.85%)

G. Fundamental research and applications beyond HEP (including industrial applications): 37 (18.23%)

H. Other: 10 (4.93%)



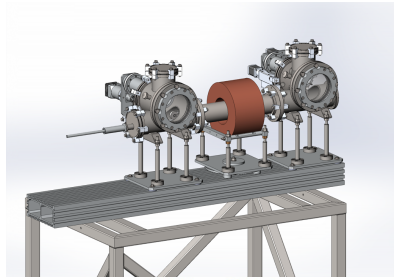
Large volume Drift Chambers: **main challenges**

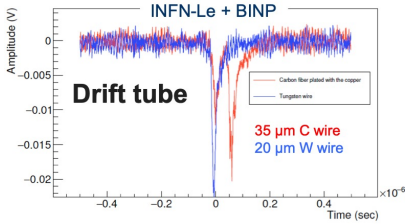
- **Electrostatic stability** condition: $\frac{\lambda^2}{4\pi\varepsilon}\frac{L^2}{w^2} < wire\ tension < YTS \cdot \pi r_w^2$

λ = linear charge density (gas gain)
L = wire length, r_w wire radius, w = drift cell width
YTS = wire material yield strength

The proposed drift chambers for FCC-ee and CEPC have lengths **L = 4 m** and plan to exploit the **cluster counting** technique, which requires gas gains **~5×10^5**.
This poses serious constraints on the drift cell width (**w**) and on the wire material (**YTS**).

⇒ **new wire material studies**





- **Non-flammable gas / recirculating gas systems**

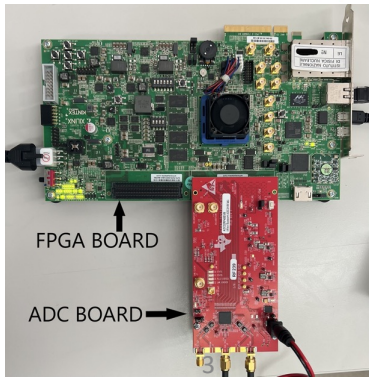
Safety requirements (**ATEX**) demands stringent limitations on flammable gases;
Continuous increase of **noble gases cost**

⇒ **gas studies**

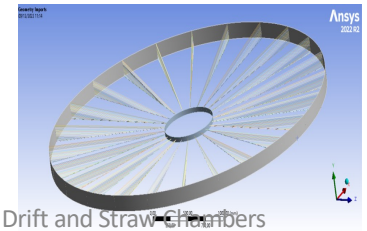
- **Data throughput**

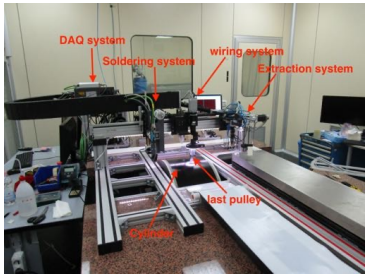
Large number of channels, high signal sampling rate, long drift times (slow drift velocity), required for **cluster counting**, and high physics trigger rate (Z_0-pole at FCC-ee) imply data transfer rates in excess of **~1 TB/s**

⇒ **on-line real time data reduction algorithms**



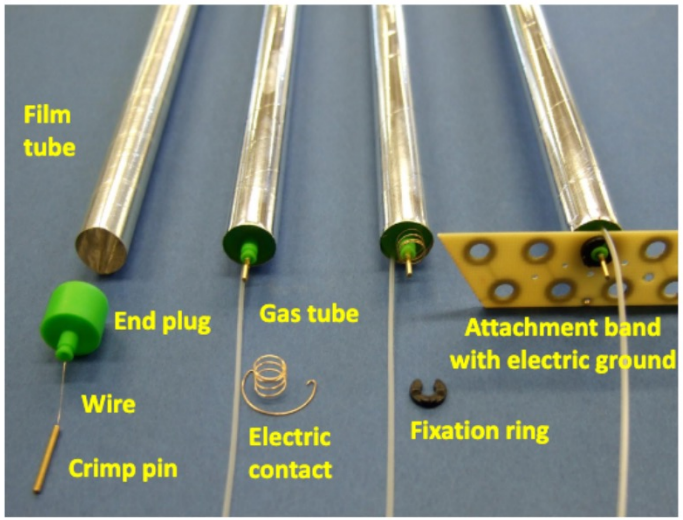
- **New wiring systems for high granularities / / new end-plates / new materials**





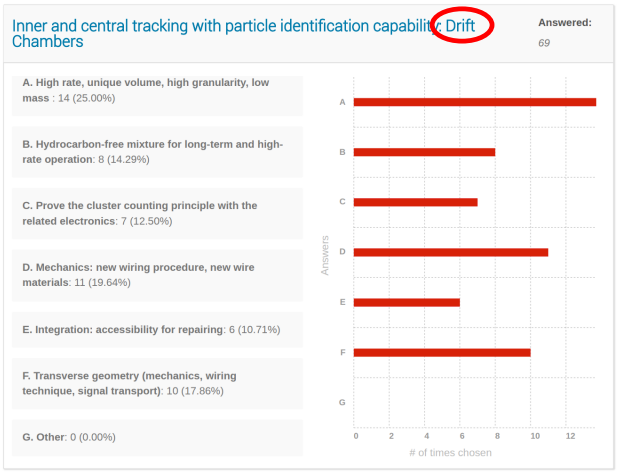
Large volume Straw Chambers: **main challenges**

- **Thinner, smaller diameter, longer tubes**
  Currently 6+6 µm mylar + 3 µm glue + 2x0.5 µm Al
  Short drift times, granularity
  $\mathcal{O}$(1 m) length
- **Mechanical stability**
  Self supporting techniques
- **Creep under tension**
  Mechanical stability with time
- **Gas leakage**
  Operation in vacuum
- **Non-flammable gas / recirculating gas systems**
  Same as for drift chambers

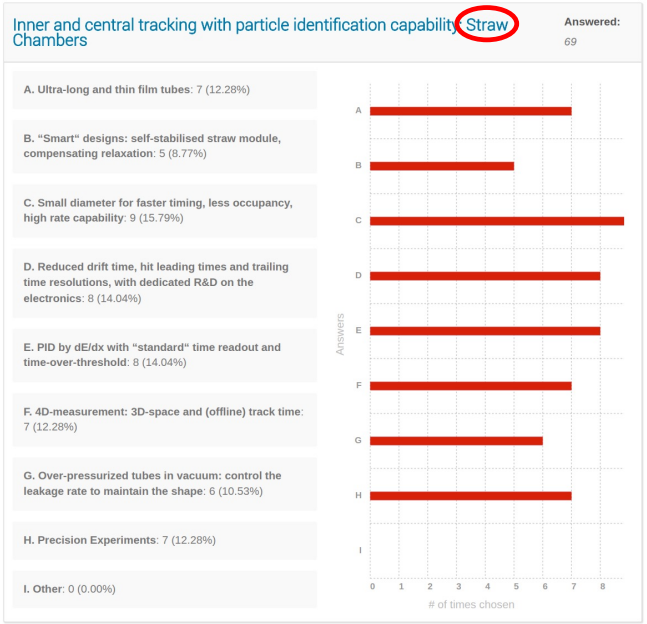


24 out of 69 Institutions (35%), 12 have manifested interest for Drift (50%) 5 for Straw (20%) chambers, 7 for both (30%)

Topics of interest



High rate, granularity, low mass
Wiring procedures, new wires
Cluster counting (dN/dx)
Hydrocarbon free mixtures



Small diameter (short drift time)
Long and thin tubes (mech. stability)
4D measurement and dE/dx
Over-pressure tubes (in vacuum)

Available facilities (drift and straw chambers)

24 Institutions

177 Topic choices

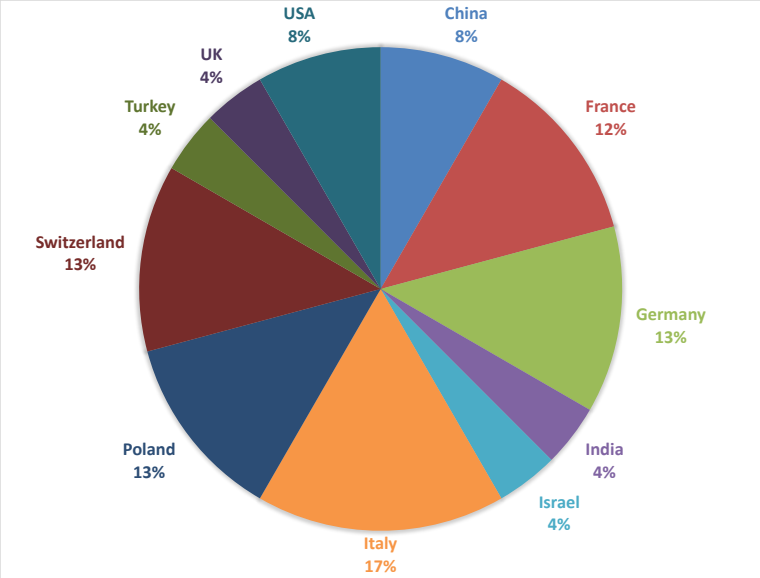
21	Detector Characterization Laboratory
14	Manufacturing and Production Workshop
14	Assembly Facilities
20	Clean Rooms
13	Gas system design and production
18	Mechanical Workshop
19	Electronics Workshop
11	Analysis Laboratory
5	Metrology Laboratory
21	Radioactive Sources (active, passive)
9	Irradiation Facilities
9	Test Beam
3	Other

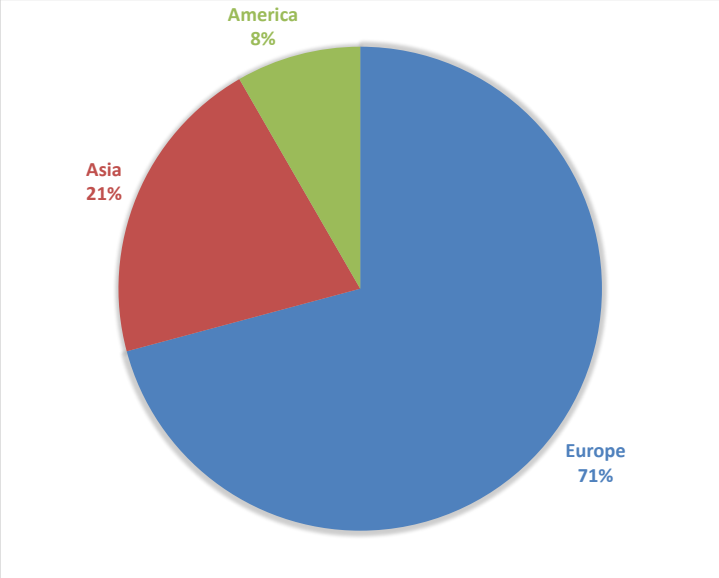
Almost all Institutions have access to facilities:
- **Detector Characterization laboratory**
- **Clean rooms**
- **Mechanical and Electronics Workshops**
- **Radioactive sources**

Most have:
- **Manufacturing, production and assembly**
- **Gas system design and production**

Not a negligible number of:
- **Test beams**
- **Irradiation facilities**

24 Institutions - Geographical distribution (drift and straw chambers)





Personnel: **168** permanent fte/y + **69** temporary fte/y over 24 institutions
(*caveat! highly dishomogeneous answers crossing different technologies*)

Intersections with **WG3: Gas and Material Studies**

24 Institutions
163 Topic choices

9	Gas Properties (e.g. cross-section, chemical characterization, measurements)
9	Eco-gases studies
5	Light emission in gases
12	Gas recuperation and recirculation systems
14	Gas systems
10	Sealed detectors and systems
12	Resistive electrodes
3	Solid converters
6	Photocathodes (novel, ageing, protection)
5	Novel materials (e.g. nanomaterials)
9	Material properties for detector and infrastructures
15	Light (low material budget) materials
16	Precise mechanics
14	Ageing
16	Outgassing
6	Radiation hardness
	Other

Comments:
- **Main topics: gas related**
- **Low material budget, precise machanics, novel materials and material properties**
- **Aging and outgassing**

but also:
- **Light emission in gases**
- **Solid converters**
- **Photocathodes**

(*caveat about cross-contaminations!*)

Intersections with **WG4: Detector physics, simulations, and tools**

24 Institutions
75 Topic choices

18	**Detector Physics (modelling and simulations)**
18	**Detector Performance Studies (modelling and simulations)**
10	**Software development and maintenance**
8	**Gas Properties Databases (e.g. cross-sections) - Use and/or Maintenance**
21	**Detector design**
	Other

Relevant simulation and software:
11 Garfield++
9 GEANT4
4 ANSYS
3 ROOT
2 SolidWorks
15 Other softwares

COMSOL?, Key4Hep?

Interests:
2 Institutions in software developments
13 Institutions in supporting common development

Intersections with **WG5: Electronics for gaseous detectors**

24 Institutions

265 Topic choices

16	Analog Electronics
15	Digital Electronics
13	Discrete Readout Front End Electronics
12	Multichannel Integrated (ASIC) Readout Front End Electronics
9	Pixels
11	FE input protection
9	Spark Quenching
14	Charge readout
5	Photon readout
8	Waveforms and Digitizer
6	Cluster Counting
11	Signal Processing
13	Timing
13	High rate
12	Low noise
8	Wide Dynamic Range
10	Grounding and shielding
10	Calibration
10	Triggerless systems
7	General purpose Data Acquisition systems
2	SoC based sensor readout
12	FPGA based readout/trigger
9	High Voltage Systems and High Voltage distribution schemes
4	High resolution floating ammeters
9	Monitoring and control systems
7	Dedicated lab instrumentation
3	LV Powering
7	Cooling
	Other

Very high interests in a large variety of electronics aspects

Involved in Electronics Development?

13 institutions yes

Would you be willing to contribute or support common developments in the context of the DRD1 collaboration?

16 institutions yes

Do you have access at your institute to experts and services that can support common activities in the collaboration?

17 institutions yes

Do you have experience and industrial contacts for custom made electronics production?

9 institutions yes

Intersections with **WG6: Detector Develop., Manufact. and Prod.**

24 Institutions

Do you have production capabilities at your institute?

15 institutions yes

Is your group planning to produce detectors (components) or to support facilities (in your institute or external) that can do it?

19 institutions yes
(most institutions well equipped)

Are you interested in financially supporting the development of existing or future facilities?

6 institutions yes

Interest in existing or potential production and facilities

65 Topic choices

- 21 CERN EP-DT Micro Pattern Technology (MPT) Workshop
- 7 Saclay MPGD workshop
- 5 RPC/MRPC workshop
- 7 Wire chambers workshop
- 12 Novel detector production methods
- 12 CERN EP Thin Film & Glass service (photocathodes, coratings, ceramic)
- 1 Other

Choices not fitting drift or straw chambers main requirements

Knowledge Dissemination

42 Topic choices

- 18 Seminar
- 16 Courses
- 7 Training from industrial partners
- 1 Other

Relationships of your group with industry

24 Topic choices

- 8 Development of new manufacturing processes
- 4 Responsible of Technology Transfer
- 8 Production
- 4 Other

Intersections with **WG7: Common Test Facilities**

Detector Characterization Facilities of interest for your research

24 Institutions
111 Topic choices

18 **General purpose detector development laboratories**
16 **Ageing Study Facility**
12 **Gas studies facility**
10 **Irradiation facility**
15 **Test beam facility**
6 **Chemistry and material laboratory**
15 **Clean Room**
18 **Instrumentation for common detector characterization (e.g. gas, DAQ, HV systems)**
1 **Other**

Access and use of common facilities and services

- Test beams (CERN, DESY, PSI, LNL) LNF?
- Ageing and irradiation (COSY (p), Cs137, X-rays, LENA, CNAO, ion and heavy ion beams)
- Clean rooms (many)
- Electronic shop
- Machine shop
- Wiring machines, UV lasers, electron microscopes and X-ray analysis
- Detector construction and characterization (many)

- Is your institute interested in contributing to the management and operation of existing/planned facilities/services? 7 yes
- Is your institute interested in contributing and/or financially supporting the development/construction of specific services for existing or new facilities? 7 yes
- Is your institute interested in contributing and/or financially supporting the usage of specific services that you may need? 10 yes

Possible projects, not specific of a particular detector design, around which different institutes could cluster

- **Mechanics: new wiring procedures, new wire materials**

  11 different institutions from **China, France, Germany, Israel, Italy, Switzerland, UK, USA**

- **Prove the cluster counting principle with related electronics**

  7 different institutions from **China, France, Italy, USA** - Transversal over several working packages:
  - **Gas studies**: cluster time separation ⇨ primary ionization, drift velocity, diffusion for hydrocarbon-free gases.
  - **Electronics**: high bandwidth, high gain (custom ASIC?) front-end; high sampling rate, high resolution digitizers; on-line, real time peak finding algorithms on FPGA (ML?) to reduce data throughput and for track trigger.
  - **Simulation software**: cluster size population not well represented in available software packages for Helium
  - **Beam tests** for particle identification ⇨ **π/K** separation, crucial relevance for FCC-ee/CEPC and Flavor Factories

- **"Standard" straw tube unit – Technology transfer to industry**

  "standard": thinnest walls, metal coating, end plugs, diameter, custom length

- **Electronics:**

  Short drift time, time stamping, time over threshold for dE/dx