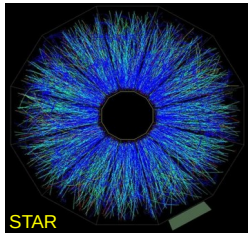
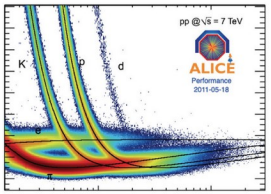


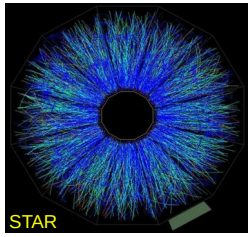


Work Package 4 - Inner and Central Tracking with PID, TPCs

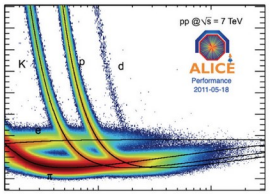
Francisco Garcia, Jochen Kaminski

DRD1 – CM 2
17.06.2024
CERN

UNIVERSITÄT BONN



Contact



General communication is planned to be done via e-groups:

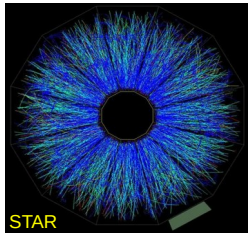
DRD1-WP4 (@cern.ch) email-list/e-group with everybody, who is interested
Self-subscription possible – only 12 people currently

DRD1-WP4-Institutes (@cern.ch) PIs of the institutes – sensitive administrative material
(in particular financial issues will be discussed here – no self subscription)

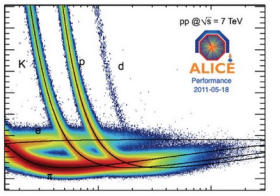
DRD1-WP4-Leaders (@cern.ch) WP leaders (currently: Francisco and Jochen)

And of course individual email-adresses also work:

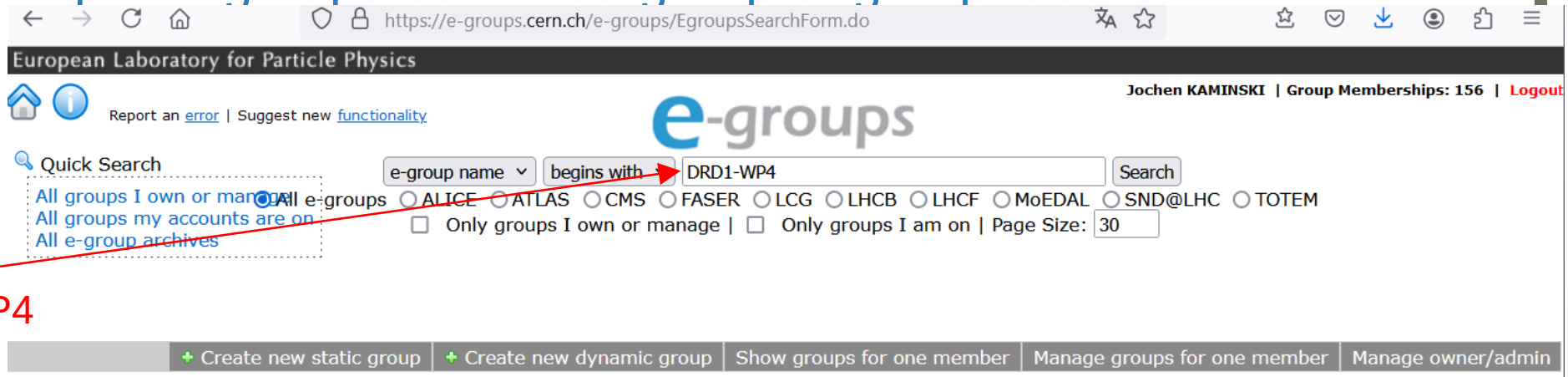
Francisco Garcia (Helsinki Institute of Physics)
francisco.garcia@cern.ch,
Jochen Kaminski (University of Bonn)
kaminski@physik.uni-bonn.de



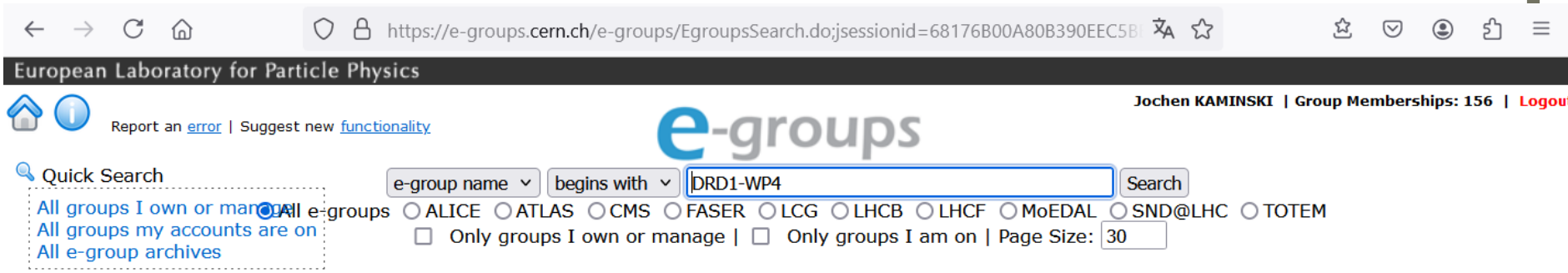
e-groups



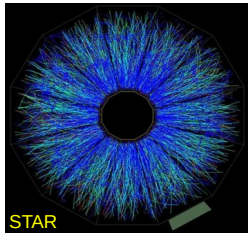
https://e-groups.cern.ch/e-groups/EgroupsSearchForm.do



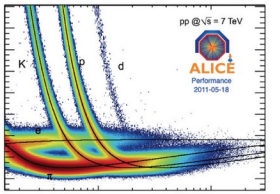
Write:
DRD1-WP4



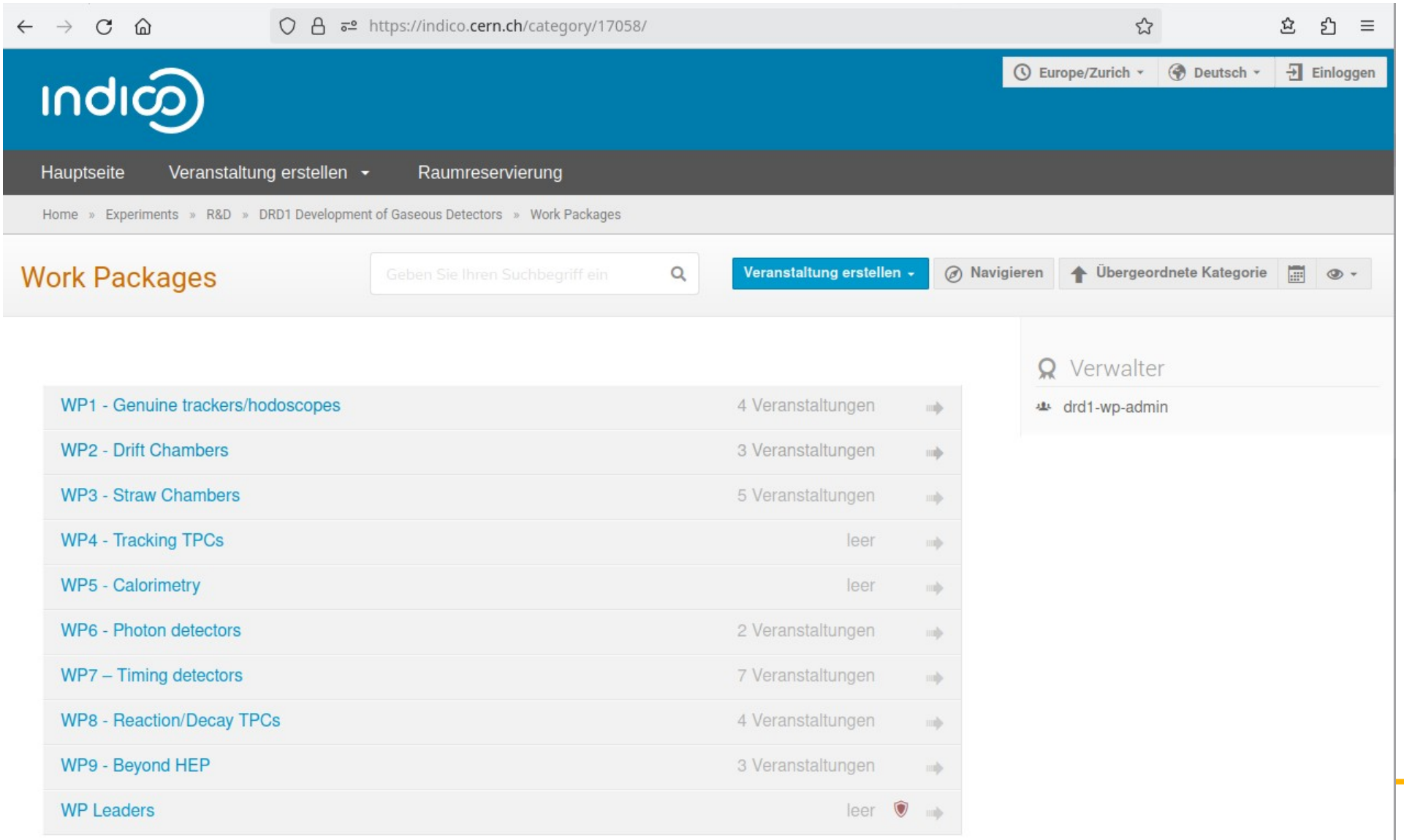
Self-subscription
is possible

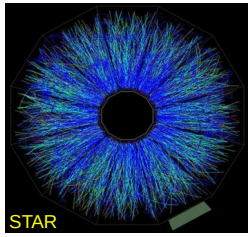


indico

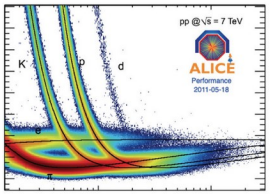


https://indico.cern.ch/category/17058/

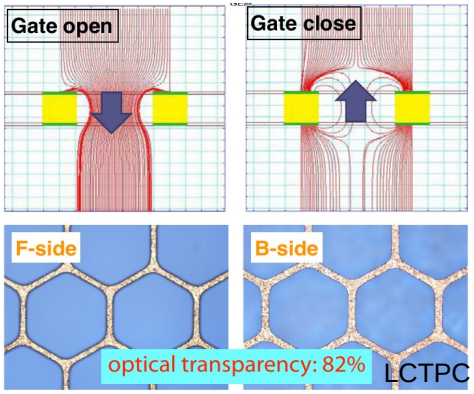


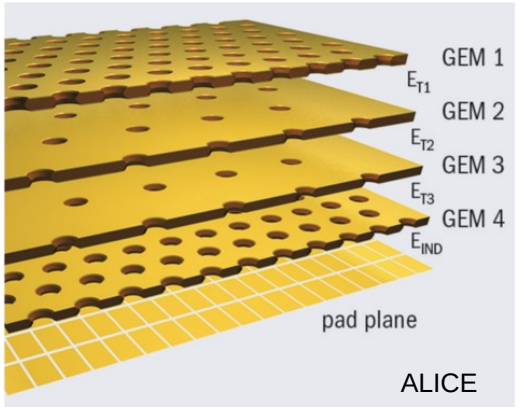


Task 1: IBF Reduction

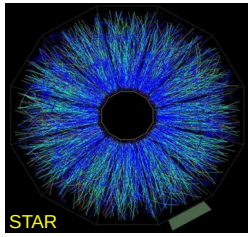


Ion backflow reduction is the most challenging task for every TPC. Future experiments at high rates will require a continuous read out excluding the option of active gating. Therefore, the task started by the ALICE collaboration should be continued and new ideas should be developed and studied aiming for values of gain×IBF < 1-5.

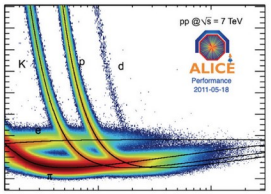




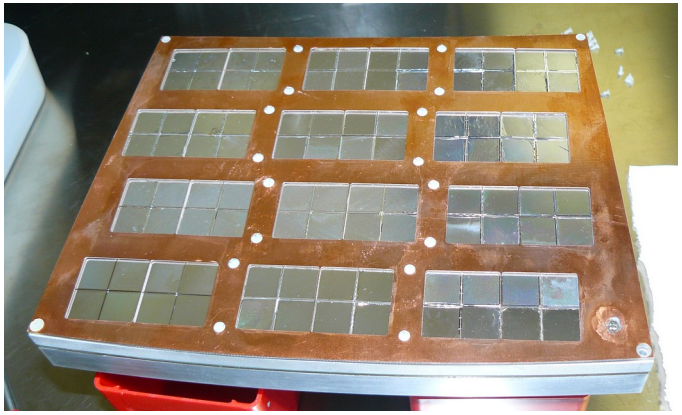
Description of task: Ion Backflow is defined as the number of ions reaching the drift volume over the number of ions created in the gas amplification. To minimize the electrical field distortions in the drift volume, the IBF has to be as low as possible. Depending on the experimental requirements active or passive measures to reduce the IBF can be taken. Most challenging is the passive reduction as only static fields can be used to guide the ions. This is necessary for a continuous readout of TPCs. In this task both approaches shall be studied to find solutions for both options.

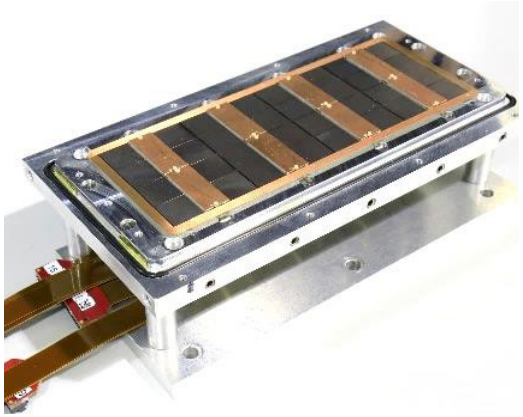


Task 2: Development of pixelTPC

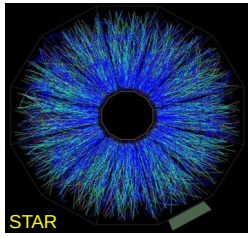


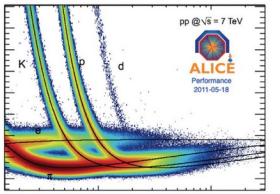
A highly pixelized readout, where a large fraction of single primary electrons can be resolved, is a very promising candidate for future experiments as a maximum of space and dE/dx information can be gained. Building and operation of such devices is very challenging and therefore different ideas will be tested and discussed. Also the IBF of these devices has to be optimized (overlapping with task 1.)





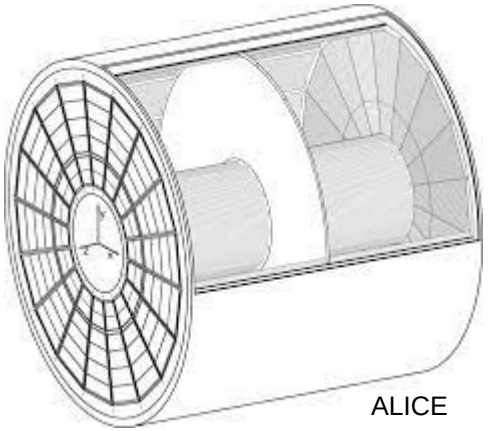
Description of task: A highly pixelized TPC readout promises the best possible resolution in both space and energy only limited by the diffusion. Therefore, this approach should be studied in more detail in this task. Various approaches will be tested and the structures shall be optimized with respect to resolution and IBF.



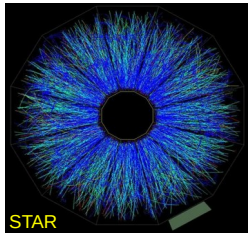


Task 3: Optimization of the amplification stage and its mechanical structure, and development of low X/X0 field cages

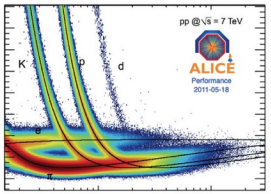
In this task mostly mechanical aspects are considered to further improve the strong points of TPCs like very low and homogenous material budget, how to integrate cooling and powering in an endplate, etc.
Possible ideas are to investigate a resistive layer (CVD?) as field cage and to study materials for insulation and mechanical stability of both the cylinder as well as the endcap.


ALICE

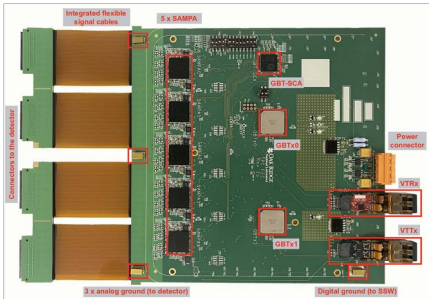
Description of task: One additional advantage of TPCs is their light and homogenous structure. Filled only with gas, they have no mechanical structures except the field cage (here both the electrical and mechanical aspects are referred to) and the endcaps. In this task new ideas shall be developed and investigated to further increase the homogeneity of the FC and to lower the material budget of both components.



Task 4: FEE for TPCs

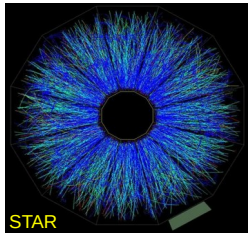


In particular many smaller experiments suffer from the lack of suitable electronics. We, therefore, suggest to find / design + produce / implement / buy and test suitable ASICs, which can read out a TPC and then implement them in the SRS, which is a wid spread readout system used by many groups already. In this way, electronics for small experiments or lab tests and lab setups would be available for all groups.

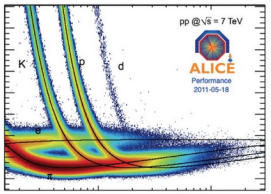


SAMPA-based readout electronics of ALICE, CERN

Description of task: The traditional TPC readout is based on a continuous sampling of the baseline and signals after an event trigger. This concept is not applicable any more for a continuous readout, but a self-triggered zero-suppressed readout has to be used. Nevertheless, sampling of the signals is highly favored to identify double tracks, measure dE/dx more precisely and to get hints of the longitudinal diffusion. Standard tracking electronics does not fulfill these requirements and dedicated TPC electronics is necessary. Most of this electronics, however, is experiment specific and not easily available and usable. Therefore, this task is dedicated to develop an SRS-based readout system for smaller scale experiments and test setups with TPCs. It also includes the development of low power electronics and Front End Electronics cooling.



Task 5: Gas Mixture

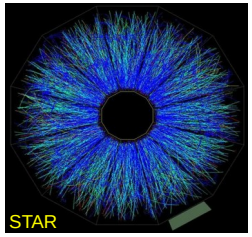


Requirements on the gas are usually driven by the experimental setup and the physics requirements.

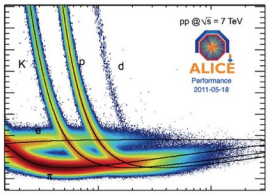
We will therefore contribute to the gas database planned in WG 3 with a specific focus on typical TPC aspects like low transverse diffusion. Also, environmental impact and gas pressure are of interest.


Wikipedia

Description of task: Because of the long drift distances (up to 2.5 m) specific gas mixtures with low diffusion coefficients are needed to improve the spatial resolution of a TPC. As most tracking TPCs are embedded in a magnetic field parallel to the electric drift field, gases with a high ωτ are sought, because the transverse diffusion is suppressed in this configuration. In this task new gases suitable for TPC applications are studied. A particular attention will be given to a low environmental impact (e.g. low GWP) and the effect of varying the gas pressure will also be studied.



Deliverables and Milestones



D1. Demonstrator MPGD-TPC commissioned for studies of tracking performance at high rates using different types of amplification stages and readout electronics. This deliverable is related to the assembling of a TPC prototype, using any type of MPGD amplification stages and also readout electronics, to target high rate capability. This was based on the feedback given by most of the groups, where it was stated the assembling of various types of MPGD- based TPCs.
The main idea behind this deliverable is to group all the different prototypes into one, which can be available for different tracking studies and in synergy with the groups involved.

D2. Report on Ion backflow studies as a function of particle rate including measurements and simulations for its reduction.

D3. Report on the tracking performance with using high density readout electronics and different readout structures with large dynamic range.

D4. Construction of new highly pixelized readout structures.

D5. Develop new high-density electronics for TPCs for both pixelized and standard pad readout with low-power consumption, low noise, high dynamic range and Cooling.

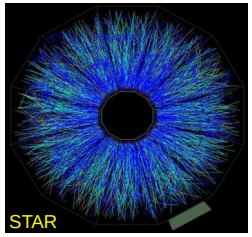
M1. Demonstrator MPGD-TPC produced and ready to be commissioned.

M2. Setup for IBF measurements are ready to measure.

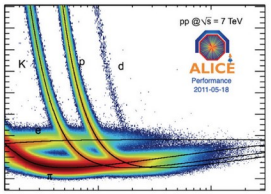
M3. Prototype including readout structure and electronics ready for test beam.

M4. First prototypes of pixelized structures - not necessarily functional.

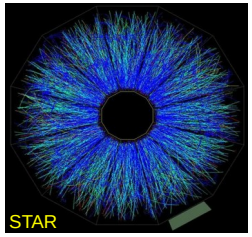
M5. First prototype of next generation FEC produced.



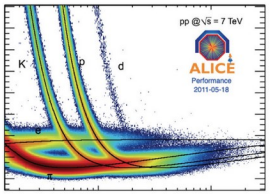
Participating Institutes



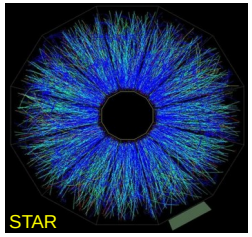
Universidade de São Paulo (USP)
Carleton University (U Carleton)
Institute of High Energy Physics (IHEP/CAS)
Tsinghua University (U Tsinghua)
Helsinki Institute of Physics (HIP)
University of Jyväskylä (U Jyväskylä)
IRFU, CEA, University Paris-Saclay (IRFU/CEA)
University of Bonn (U Bonn)
Technische Universität Darmstadt, Institut für Kernphysik (TUDa)
GSI Helmholtzzentrum für Schwerionenforschung (GSI)
Wigner Research Centre for Physics (RCP)
INFN Sezione di Bari (INFN-Bari)
INFN Sezione di Roma (INFN-Roma1)
Iwate University (IU)
European Organisation for Nuclear Research (CERN)
Paul Scherrer Institut (PSI)



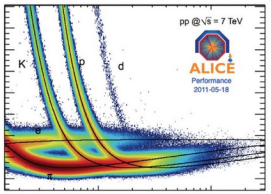
Interest of Participants in Tasks



Institute	T1	T2	T3	T4	T5
USP				x	
U Carleton	x	x			
IHEP/CAS	x	x		x	x
U Tsinghua				x	
HIP	x		x		x
U Jyväskylä	x				
IRFU/CEA	x			x	
U Bonn	x	x		x	x
TUDa	x		x		
GSI	x			x	x
RCP	x				
INFN-Bari			x		x
INFN-Roma1	x	x			
IU	x		x		
CERN		x			
PSI	x	x			



MoU



Annex 10.2.4 Work Package 4 - Inner and central tracking with PID (Tracking TPCs)

Work Package Leaders:…
Proposal Date:…
Annual Scientific Endorsement Date & Minutes:….
Annual Resource Endorsement Date & Minutes:…
Annual Collaboration Board Endorsement Date & Minutes:…

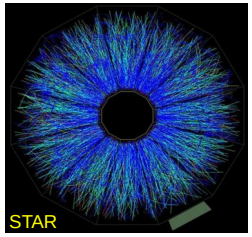
Time Projection Chambers (TPCs) have been extensively studied and used in many fields especially in particle, nuclear and neutrino physics experiments. Also smaller size TPCs are a good choice for beam diagnostics operating in high particle rate environments.

Web Link: https://drd1.web.cern.ch/wp/wp4

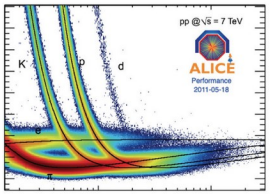
Table 10 Institutes

Table 11: Milestones and Deliverables

Table 12 Funding Agencies and Resources



Other Things



Some WP have created projects, which concentrate on particular tasks, e.g. WP8

WP8 Project A - High Pressure TPCs for precision studies of neutrino interactions.
WP8 Project B - TPCs for low-energy nuclear physics.
WP8 Project C - Electroluminescence-based TPCs for Rare-Event Searches and other R&D on pure noble-gas amplification.
WP8 Project D - Radiopure and/or low-energy TPCs for precise track imaging and/or calorimetry with avalanche-based readouts.

Web-page: https://drd1.web.cern.ch/wp/wp4
Currently only the text discussed before is on the web page.

We should prepare a discussion, of how the interface to the working groups should look like, what we expect and how we would like to contribute.