AIDA WG9.2

GASEOUS DETECTOR INFRASTRUCTURE

I: TPC INFRASTRUCTURE: MAGNET, INTEGRATION, COOLING

U. Bonn, CERN, DESY, Lund, Nikhef, Saclay

INTRODUCTION

- In EUDET, a magnet was offered by KEK, Japan and installed at DESY. But required weekly He supplies interrupting the operation for O(1day).
- A field cage, an endplate and a trigger were built
- ALTRO electronics was purchased and adapted to TPC readout. However with insufficient packing.
- A new chip (Timepix) was designed (from Medipix 2) and a digital TPC was operated
- This DESY TPC test beam facility was operated from 2008 on
- In AIDA, task 9.2.1 was to improve this facility, task 9.2.2 was to provide manpower to make MPGD prototypes available from the CERN workshop (Rui de Olivera's talk) and task 9.2.3 aimed at reading out an arbitrary number of Timepix and Timepix3 chips (M. Lupberger's talk).

PCMAG MAGNET UPGRADE

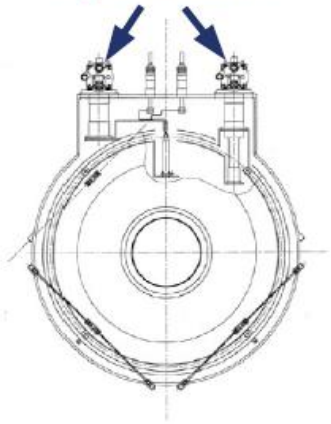
Ralf Diener, AIDA meetings 2013, 2014

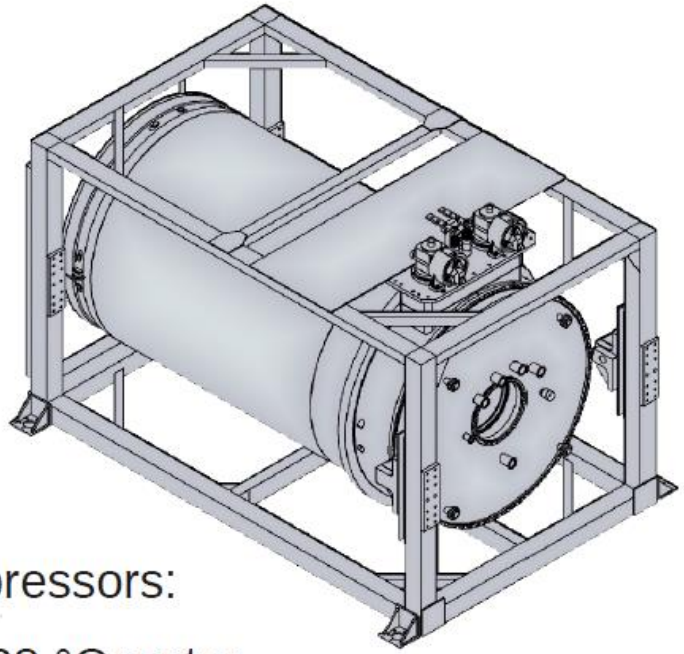
Improvement needed for the 1-6 GeV beam facility
Moved to KEK and Toshiba in 2011, back in 2012.
Received mechanics for moving in all degrees of freedom

PCMAG Upgrade Details

- Two cryo coolers *(Gifford McMahon cycle)* have been added to vacuum vessel:
  - One two-stage cooler for the coil and the radiation shield (4 resp. 50 K)
  - One one-stage cooler for the current leads (50 K)

cryo coolers





- 2 Helium gas compressors:
  - Water cooled: 7-28 °C water, minimum 7 l/min @ 28°C
  - Power: 6.5-7.2 W (380 V, 13 A)

Screenshots from http://www.shicryogenics.com

SRDK-408D2 Specification Chart

Model		SRDK-408D2-A71A SRDK-408D2-F50L SRDK-408D2-F50H SRDK-40
1st Stage Capacity	Watts @ 50 Hz	34 W @ 40 K
	Watts @ 60 Hz	44 W @ 40 K
2nd Stage Capacity	Watts @ 50 Hz	1.0 W @ 4.2 K
	Watts @ 60 Hz	1.0 W @ 4.2 K
Lowest Temperature 2nd Stage †		<3.5 K
Cooldown Time 2nd Stage †		<60 Min. (4.2 K)
Coldhead	Ambient Temperature	5~35 °C ‡
	Weight	18.0 kg (39.7 lbs.)
	Maintenance Interval	10,000 Hours

F-50 Indoor Water-Cooled Compressor

	F-50
Electrical Power†	3 Phase 200 V, 50/60 Hz [Low Volt] 380, 400, 415 V, 50 Hz or 460-480 V, 60 Hz [High Volt]
Ambient Temperature‡	5-35 °C (41-95 °F)
Minimum Cooling Water Requirement and Temperature Range*	4-28 °C (39-82 °F)‡ Min. 7 L/min (1.9 gal/min) at 28 °C
Weight and Dimensions	120 kg (265 lbs.) 551 mm x 450 mm x 585 mm (23.3" x 17.7" x 23.2") HxWxD
Maintenance Interval/ Adsorber Exchange	30,000 Hours

YEAR	MONTH	DURATION	COLLABORATION/EXPERIMENT	DESCRIPTION
2012	Jul	2 weeks	LCTPC	Test with 6 Micromegas TPC modules with integrated electronics
	Sep	3 weeks	LCTPC	Test with 3 GridGEM TPC modules
	Nov-Dec	3 weeks	LCTPC	Test of 3 SciEnergy GEM TPC modules
2013	Jan-Feb	2 weeks	LCTPC	Test with 7 Micromegas TPC modules with integrated electronics
	Feb	2 weeks	ATLAS	Measurement of Lorentz angle and charge collection efficiency of Si microstrip detectors
	Feb-Mar	4 weeks	LCTPC	Test with 3 GridGEM TPC modules
	Mar-Apr	2 weeks	LCTPC	Test with 2 TimePix TPC modules (GEM + Ingrid)
	Apr	1 week	ATLAS	Measurement of Lorentz angle and charge collection efficiency of Si microstrip detectors
	Apr	2 weeks	SBS	GEM Tracker Chambers
	May	1 week	ATLAS	Measurement of Lorentz angle and charge collection efficiency of Si microstrip detectors
	Jun	1 week	LCTPC	Micromegas TPC module with ALTRO readout electronics
	Jun	2 weeks	ATLAS	Micromegas chambers for ATLAS New Small Wheel (NSW)
	Aug	2 weeks	ATLAS	Measurement of Lorentz angle and charge collection efficiency of Si microstrip detectors
	Oct-Nov	5 weeks	ATLAS	Measurement of Lorentz angle and charge collection efficiency of Si microstrip detectors
	Nov	1 week	LCTPC	Laser calibration studies with GEM TPC modules
	Nov-Dec	6 weeks	BELLE II	Installation
2014	Jan	4 weeks	BELLE II	BELLE II: pixel and strip sensors vertex detector integration test including DAQ, slow control and cooling
	Feb	2 weeks	ATLAS	Measurement of Lorentz angle and charge collection efficiency of Si microstrip detectors
	Feb	2 weeks	LCTPC	Test with 7 Micromegas TPC modules with CO_2 cooling including laser calibration measurements and a combined run with 2 TimePix/Ingrid TPC modules

This upgrade improved safety and reliability of operation.

The use of the facility goes far beyond LCTPC (Belle, ATLAS, etc…)

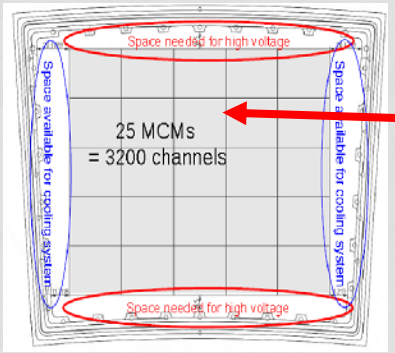
First part of 2015 already fully booked

ELECTRONICS INTEGRATION

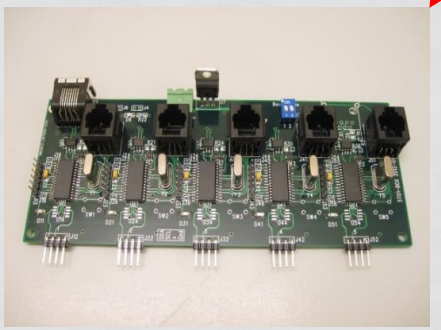
- The EUDET electronics (ALTRO and S-ALTRO) and the Micromegas test electronics (AFTER from T2K TPC) needed better packing to increase the number of channels that can be read out
- This forced to develop hardware and tools for a better integration (5 to 20 mm^2 by chanel)

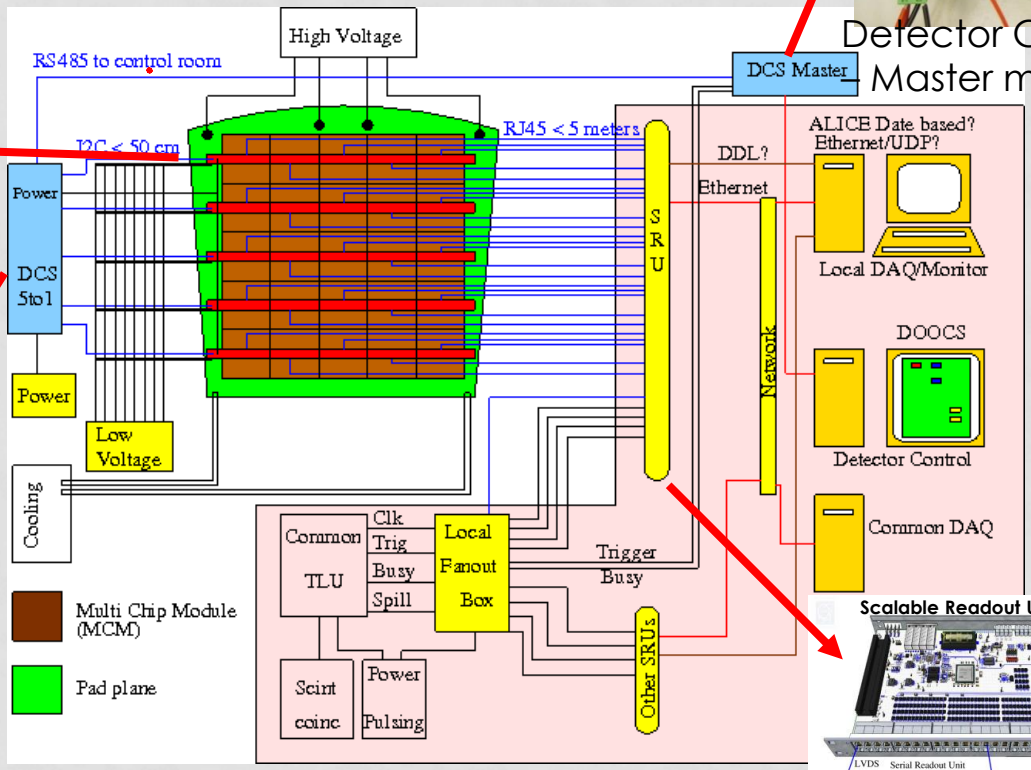
S-ALTRO ELECTRONICS

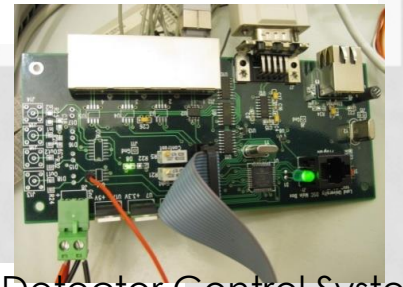
LowVoltage boards attached to one pad module



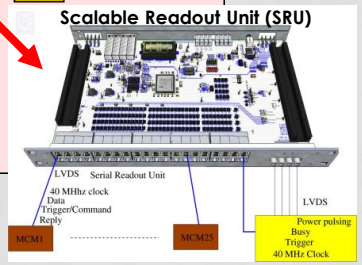
MultiChipModules on a pad module







Detector Control System – Master module



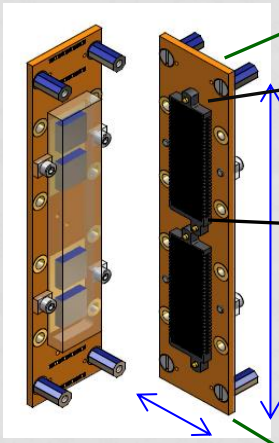
INTEGRATED AFTER- BASED ELECTRONICS

- Remove packaging and protection diodes
- Wire-bond AFTER chips
- Use two 300-point connectors

Front-End Card (FEC)

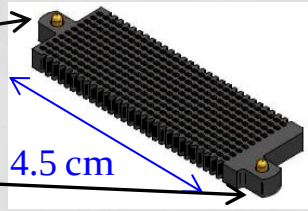
14 cm

25 cm

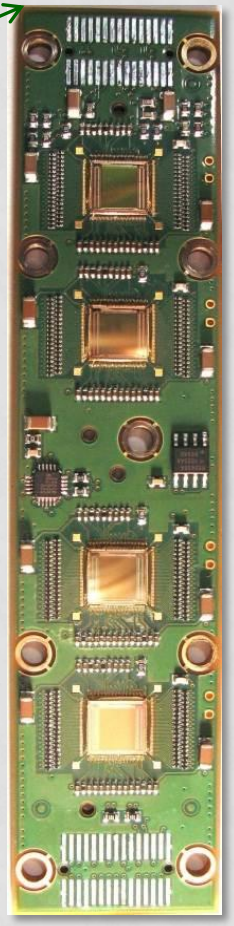


12.5 cm

2.8 cm



4.5 cm

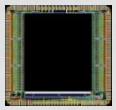


AFTER Chip

3.5 cm

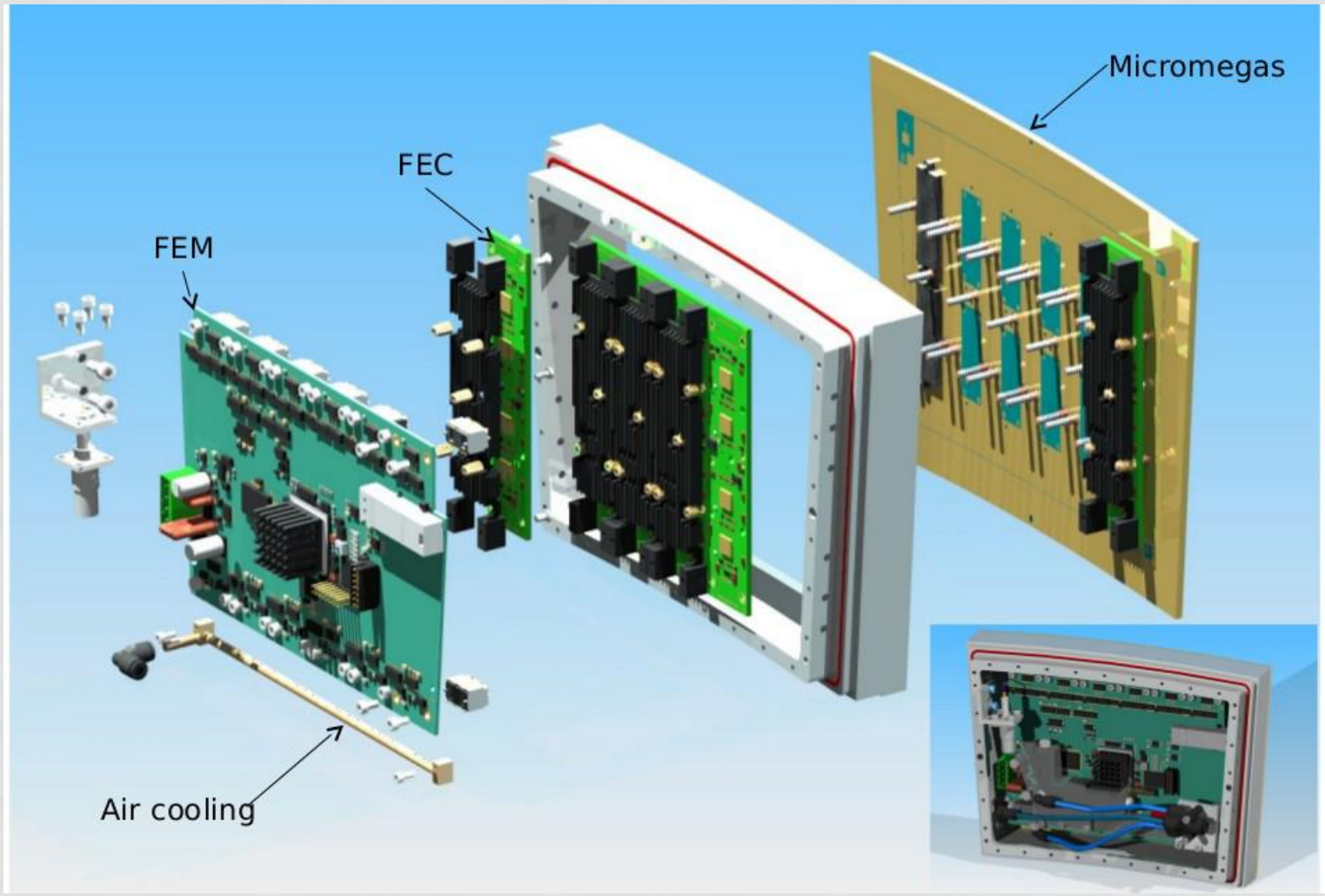
3.5 cm

0.78 cm



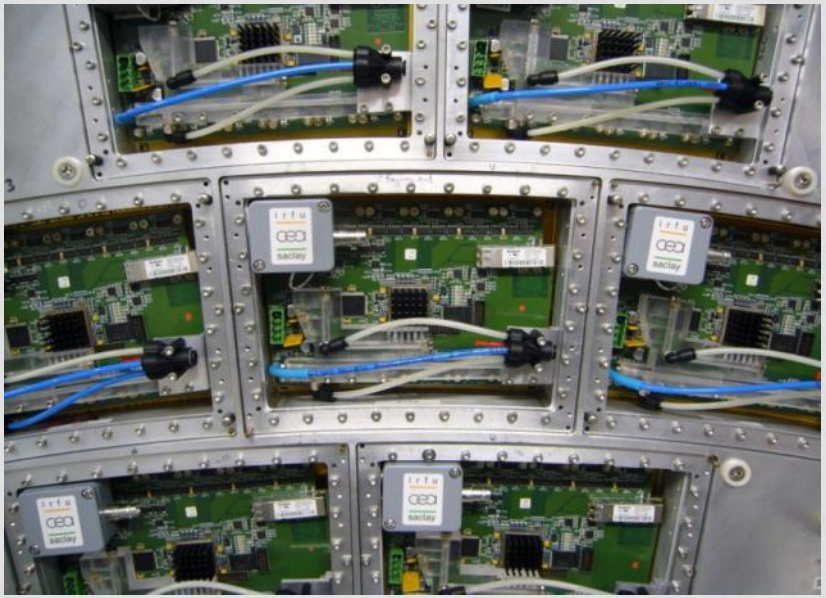
0.74 cm

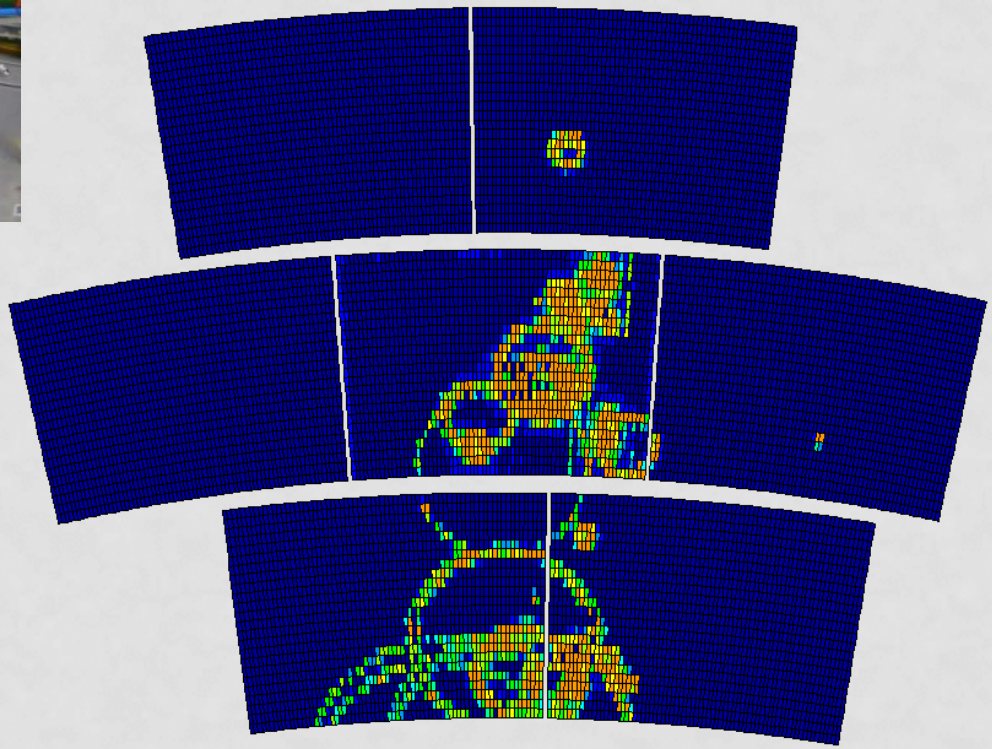
The resistive foil protects against sparks



Each module has 1728 pads and is connected by 3 cables :
HV, LV, optical fiber for DAC/signals. Total < 25% X°

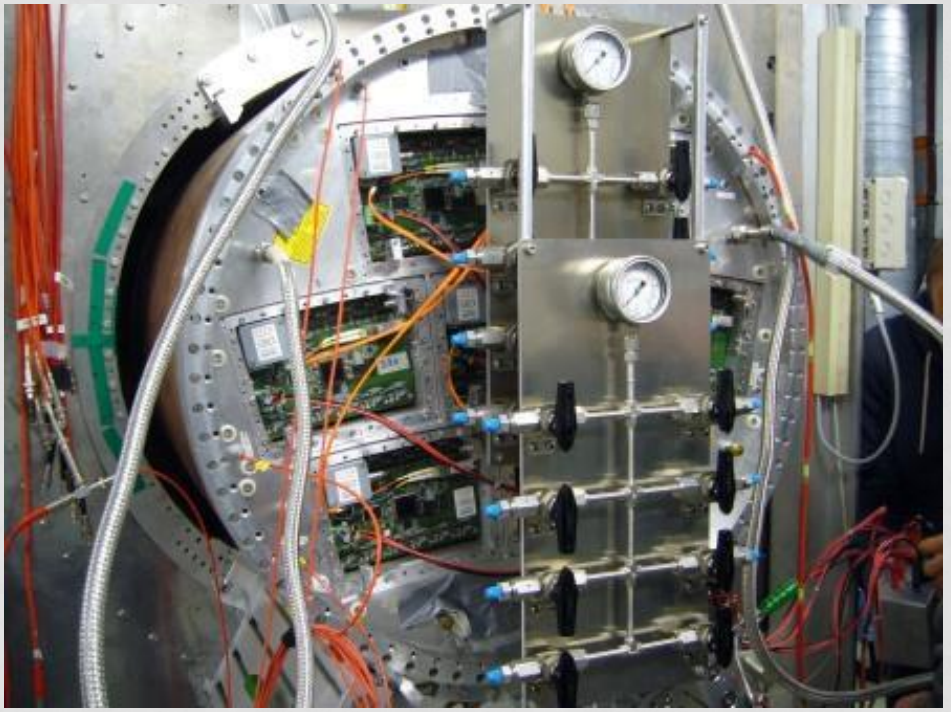
DATA TAKEN IN 2013 AND 2014 WITH 7 MODULES





2 PHASE CO2 COOLING

CO2 cooling allows efficient removal of heat at room temperature, with O(1mm pipes)



A TRACI system (AIDA development) was bought by KEK at Nikhef and adapted to the Micromegas fully equipped TPC (dec.6, 2013 at Nikhef and test at DESY in March 2014

CONCLUSIONS

- All the AIDA funds have been spent (568.5 k€), plus about twice as much from various sources (Toshiba in-kind contribution, KEK, DESY, CEA, Bonn, etc… own funds)
- The SALTRO project is not fully finished (it expanded a lot in the course of the development) but got very positive results (development of integration techniques, contact with industry)
- All the initial goals have been reached (plus the CO2 cooling), and a lot has been done for the integration of electronics (contact with industry).
- All milestones have been reached and deliverables sent

(D9.2, D9.3, D9.6)