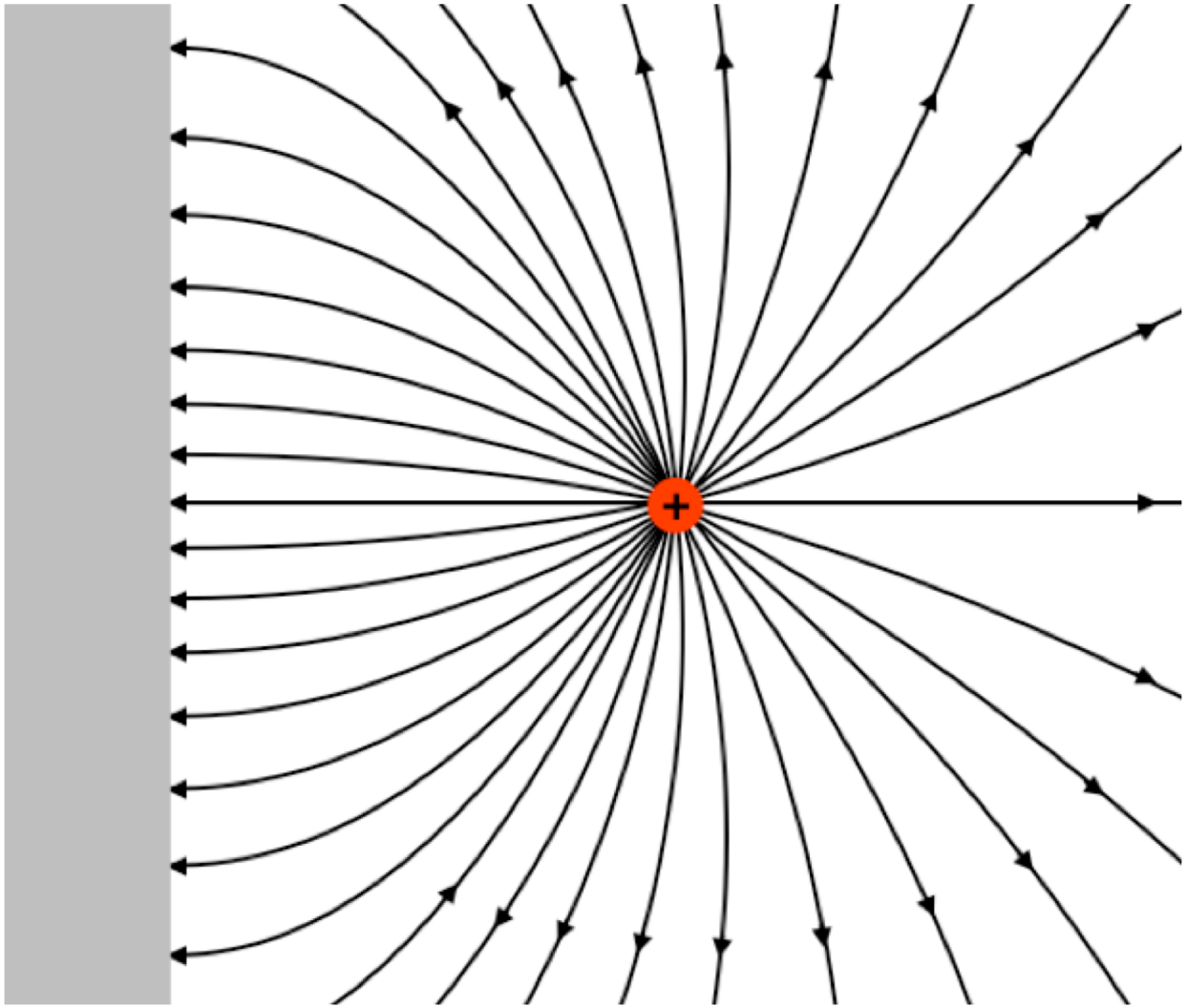
Small-Strip Thin Gap Chamber (sTGC)

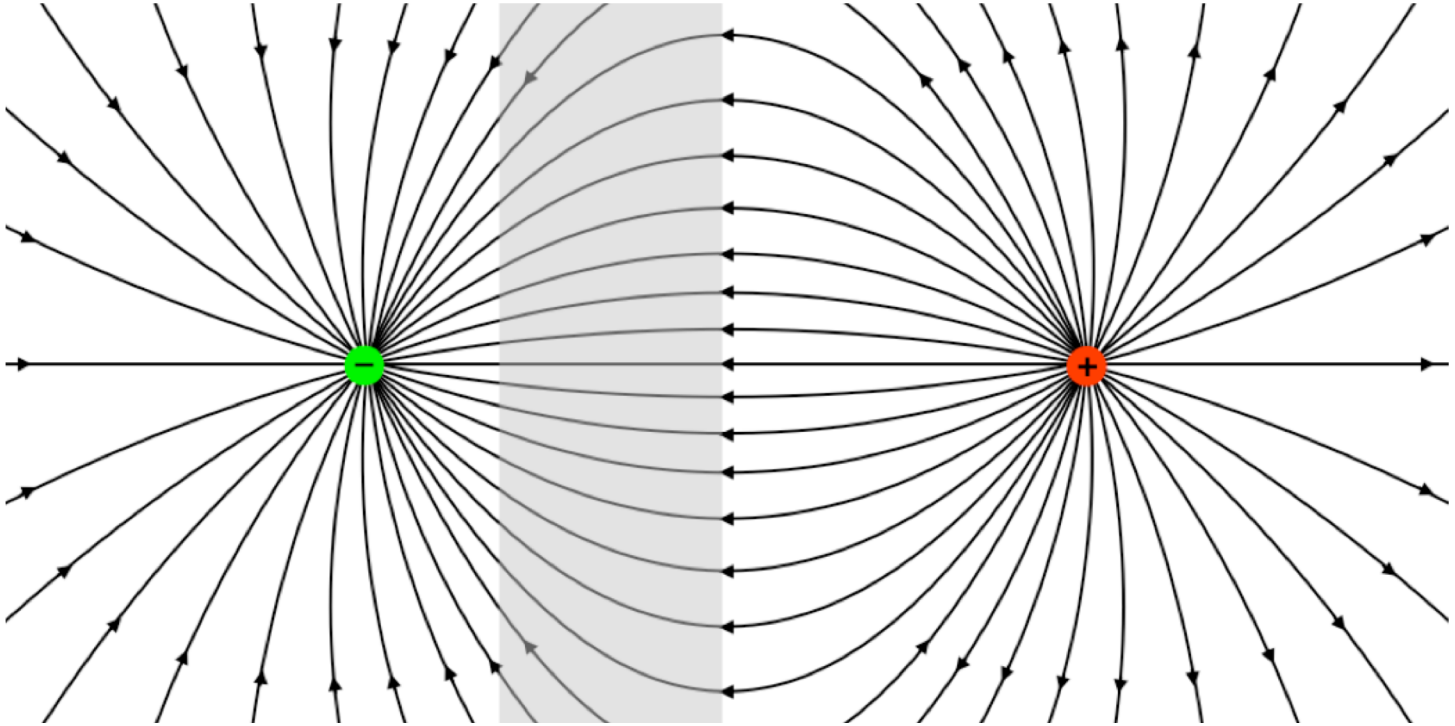
Prashanth Shanmuganathan

Image Charge



https://phys.libretexts.org/Courses/University_of_California_Davis/UCD%3A_Physics_9C__Electricity_and_Magnetism/1%3A_Electrostatic_Fields/1.8%3A_Method_of_Images

Image Charge

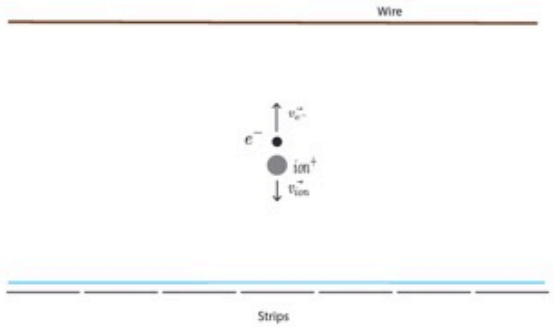


A Clever Trick

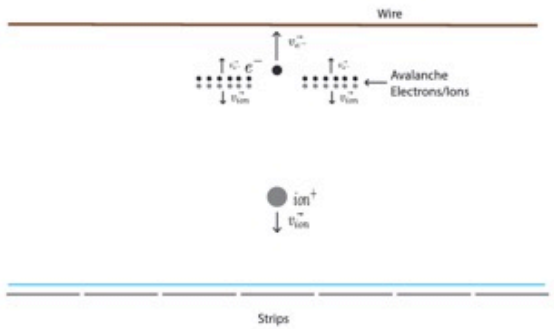
The equivalence of these two fields provides us with an opportunity to use a clever trick for analyzing physical situations involving electric charges near flat conductors. For a point charge, this trick involves introducing an imaginary *image charge* reflected across the conducting surface, and using that charge to derive the actual field outside the conductor surface.

Alert

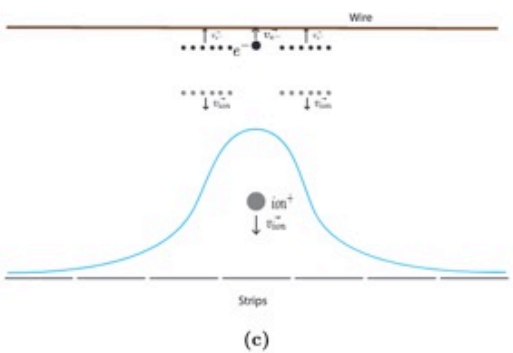
It can't be stressed enough that this trick does not involve introducing an actual physical charge, any more than constructing a gaussian surface involved constructing an actual physical surface. These are techniques for performing calculations, and one should always keep in mind what the actual physical circumstances are.



(a)

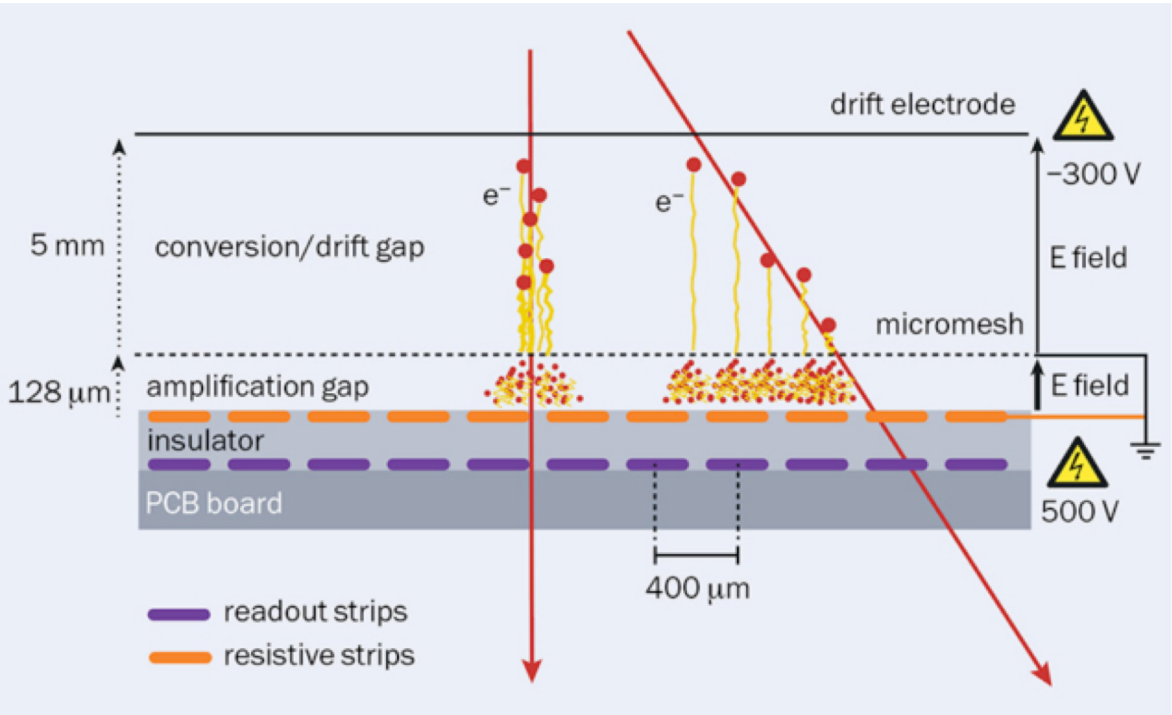


(b)

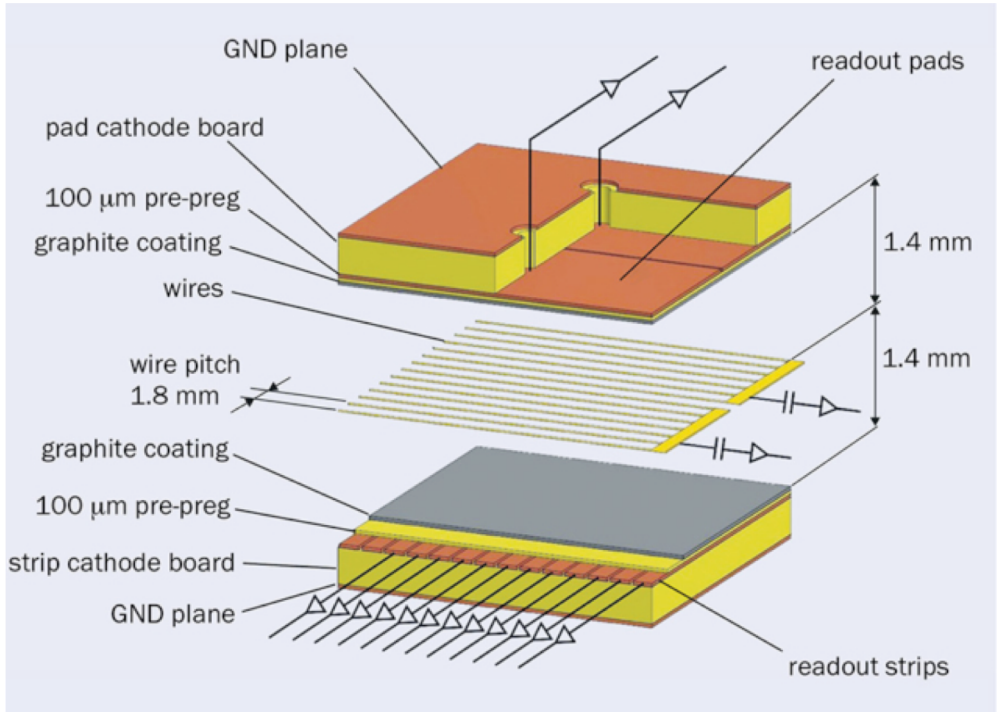


(c)

https://curve.carleton.ca/system/files/etd/814bd173-bafd-4040-a118-f1f5878b5ccd/etd_pdf/7411adb2a23f372a5ba42298c211cfba/pizzi-simulationofgasdetectorsusingramostheorem.pdf



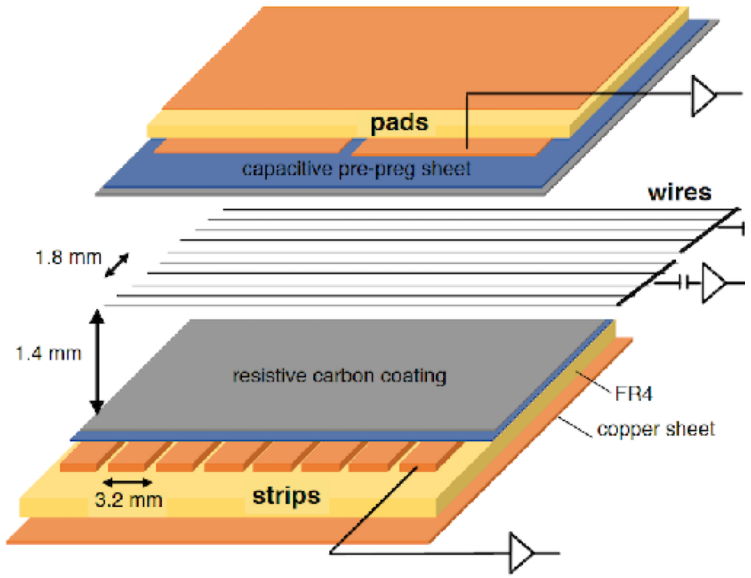
Micro-Mega

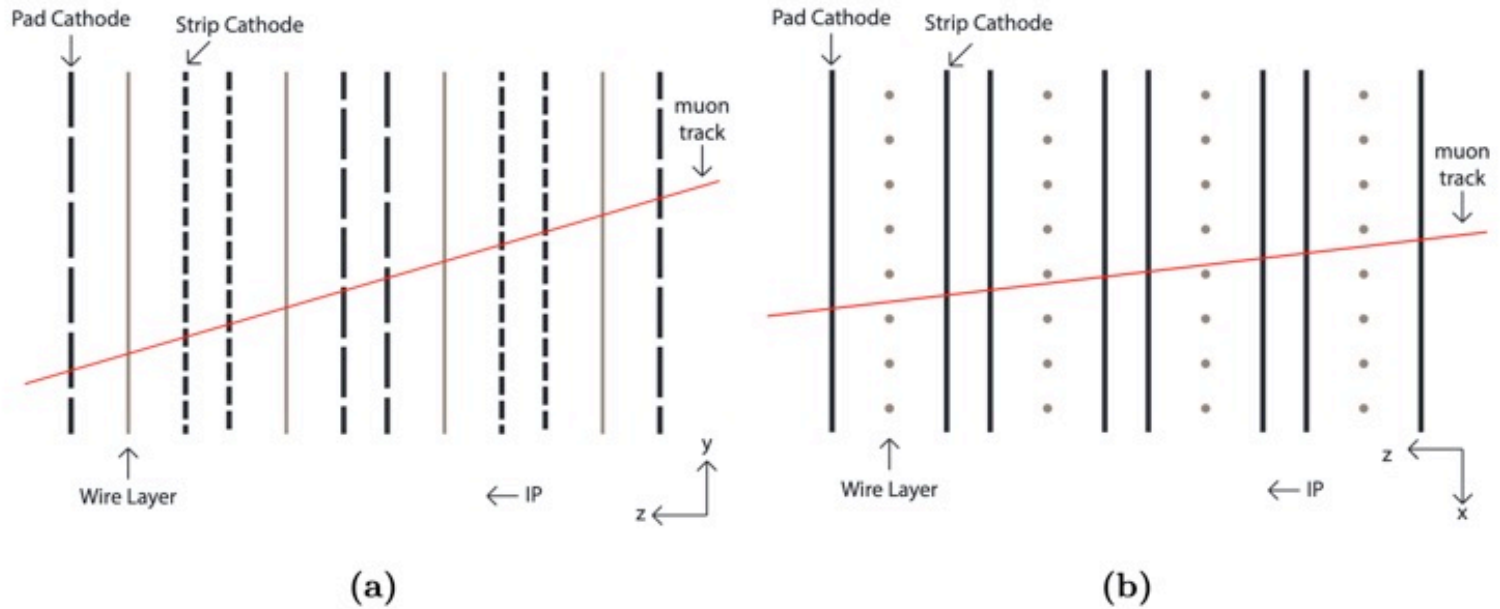


sTGC

https://cerncourier.com/a/wheels-in-motion-for-atlas-upgrade/

sTGC

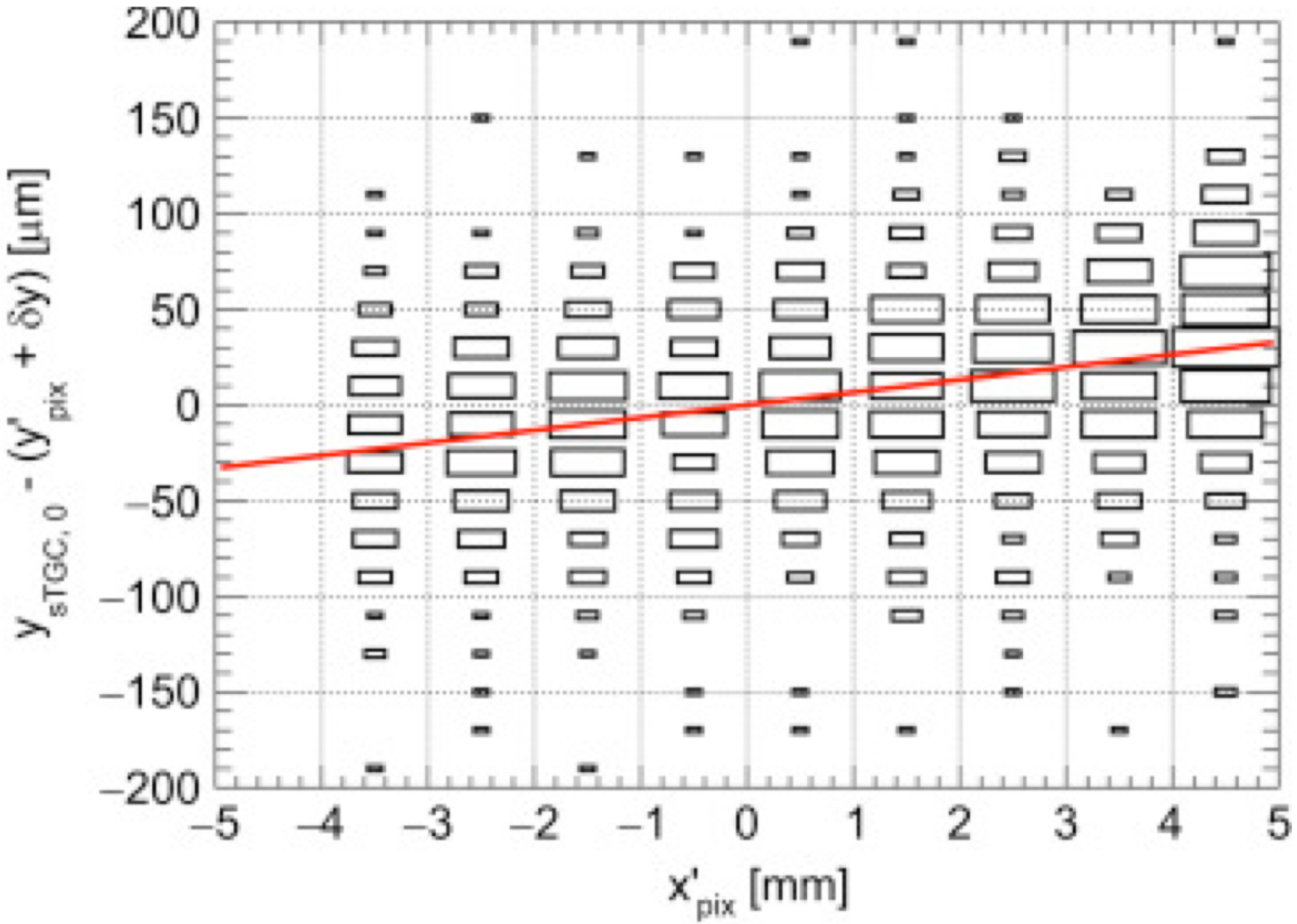




(a) (b)

Figure 4.1: **(a)** Side view through an sTGC quadruplet. Shown is a muon passing through the four layers, from left to right. In reality cathodes are continuous with pad/strip segmentation occurring in the cathode board, segmentation in picture is for illustrative purpose only and is not to scale. **(b)** Top-down view of sTGC quadruplet with muon originating from IP. Shown are the individual wires that make up the wire layer, not to scale.

Track reconstruction



Gas

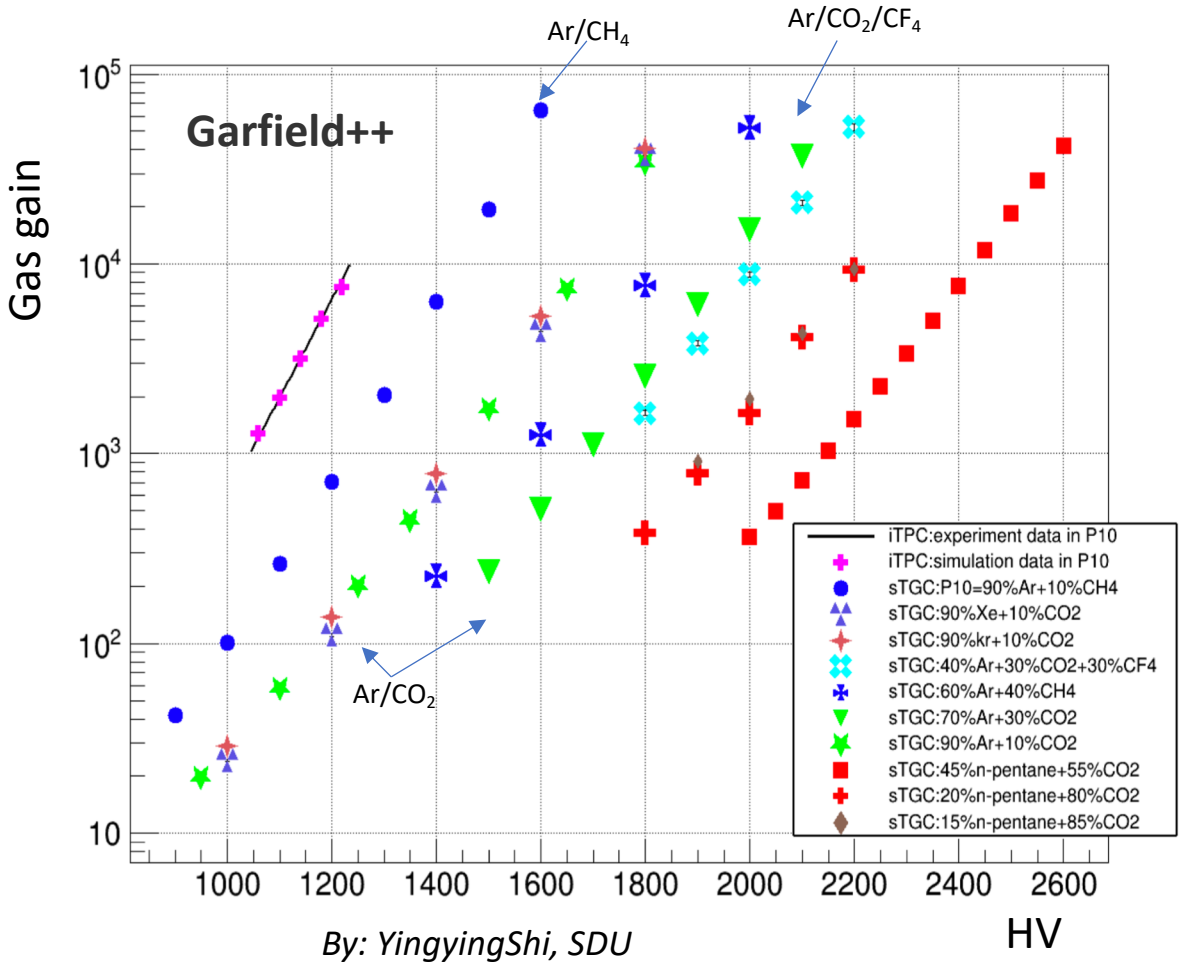
Table 1

Properties of several gases used in proportional counters (from different sources, see the bibliography for this section). Energy loss and ion pairs per unit length are given at atmospheric pressure for minimum ionizing particles

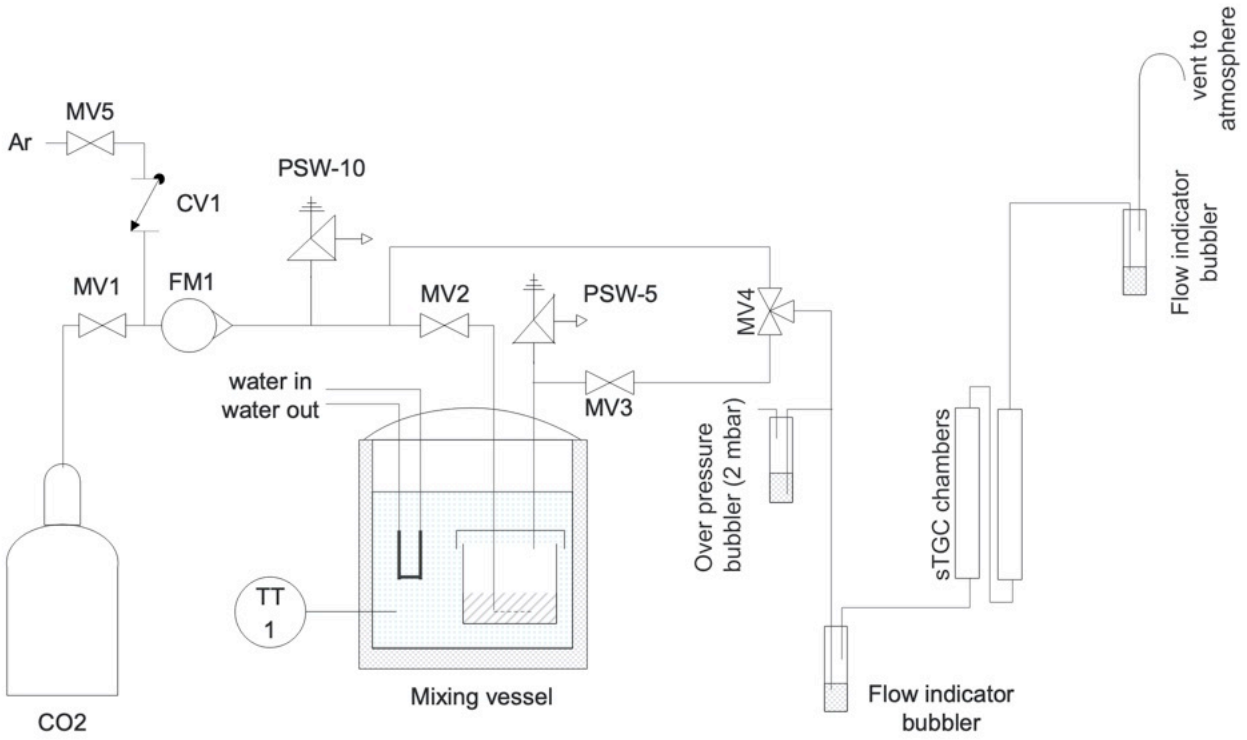
Gas	Z	A	δ (g/cm^3)	E_{ex}	E_i (eV)	I_o (eV)	W_i	dE/dx ($MeV/g\ cm^{-2}$)	dE/dx (keV/cm)	n_p (i.p./cm) a)	n_T (i.p./cm) a)
H_2	2	2	8.38×10^{-5}	10.8	15.9	15.4	37	4.03	0.34	5.2	9.2
He	2	4	1.66×10^{-4}	19.8	24.5	24.6	41	1.94	0.32	5.9	7.8
N_2	14	28	1.17×10^{-3}	8.1	16.7	15.5	35	1.68	1.96	(10)	56
O_2	16	32	1.33×10^{-3}	7.9	12.8	12.2	31	1.69	2.26	22	73
Ne	10	20.2	8.39×10^{-4}	16.6	21.5	21.6	36	1.68	1.41	12	39
Ar	18	39.9	1.66×10^{-3}	11.6	15.7	15.8	26	1.47	2.44	29.4	94
Kr	36	83.8	3.49×10^{-3}	10.0	13.9	14.0	24	1.32	4.60	(22)	192
Xe	54	131.3	5.49×10^{-3}	8.4	12.1	12.1	22	1.23	6.76	44	307
CO_2	22	44	1.86×10^{-3}	5.2	13.7	13.7	33	1.62	3.01	(34)	91
CH_4	10	16	6.70×10^{-4}		15.2	13.1	28	2.21	1.48	16	53
C_4H_{10}	34	58	2.42×10^{-3}		10.6	10.8	23	1.86	4.50	(46)	195

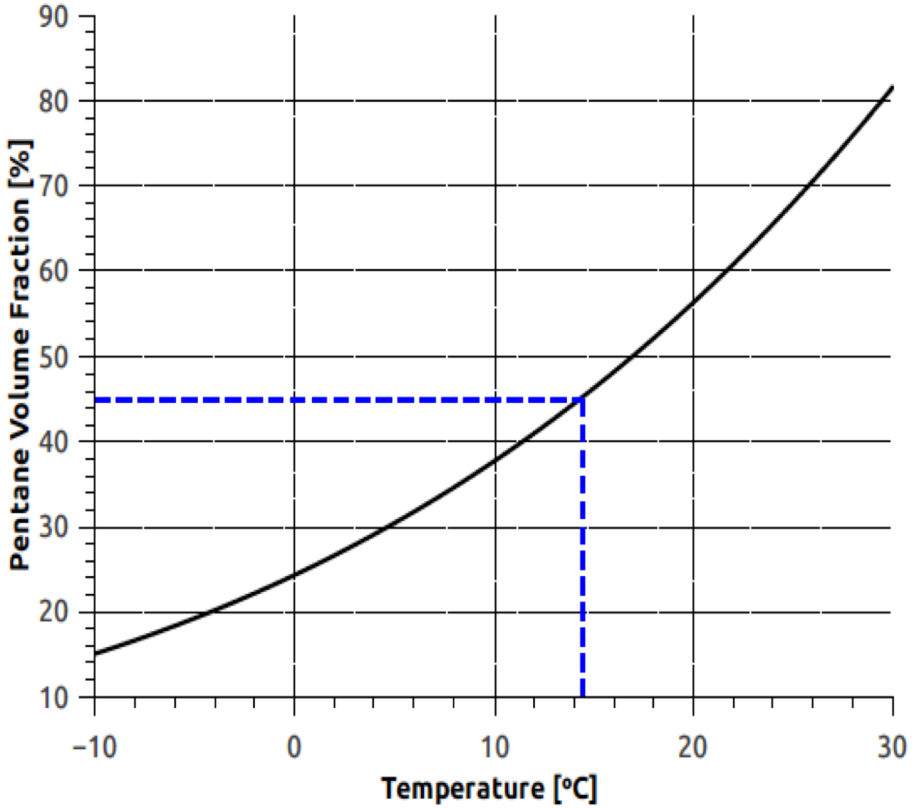
a) i.p. = ion pairs

Gas Choices


Ar/CH4
Ar/CO2/CF4
Garfield++
Gas gain
Ar/CO2
HV
By: YingyingShi, SDU
iTPC:experiment data in P10
iTPC:simulation data in P10
sTGC:P10=90%Ar+10%CH4
sTGC:90%Xe+10%CO2
sTGC:90%kr+10%CO2
sTGC:40%Ar+30%CO2+30%CF4
sTGC:60%Ar+40%CH4
sTGC:70%Ar+30%CO2
sTGC:90%Ar+10%CO2
sTGC:45%n-pentane+55%CO2
sTGC:20%n-pentane+80%CO2
sTGC:15%n-pentane+85%CO2

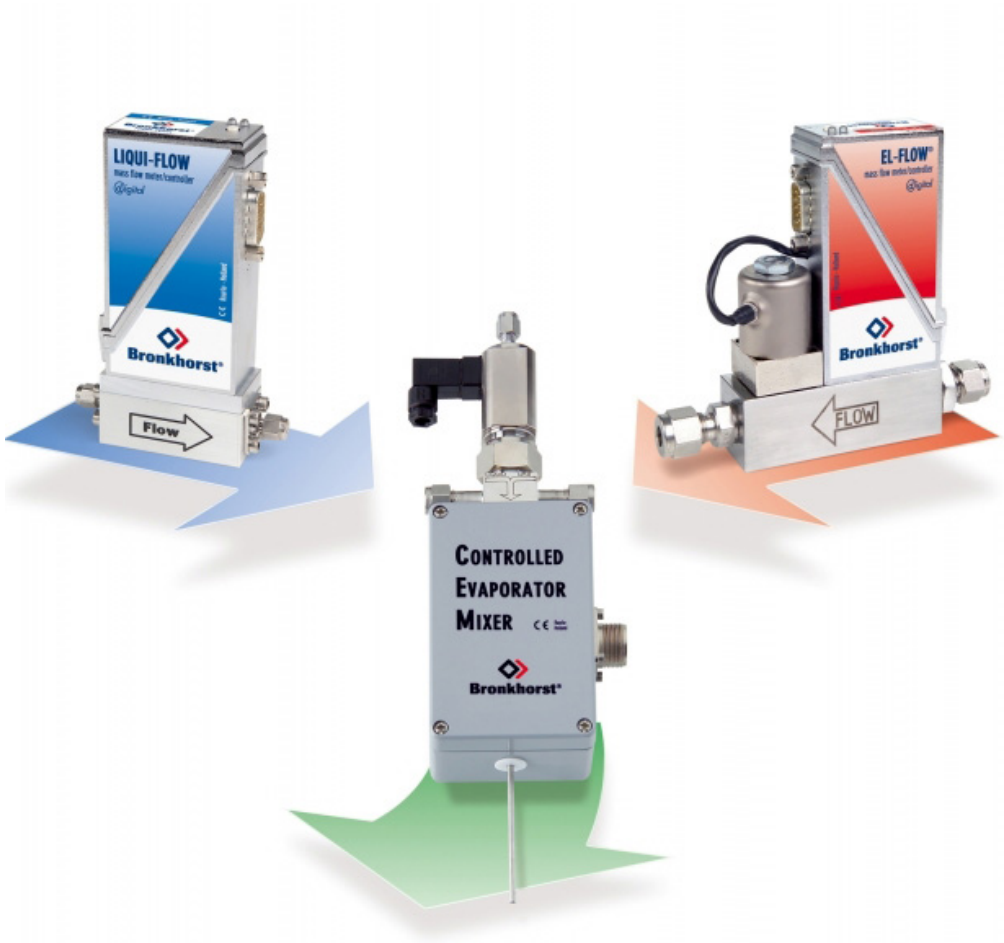
Getting the right mixture





arXiv:1702.01240v3 [physics.ins-det]

Getting the right mixture

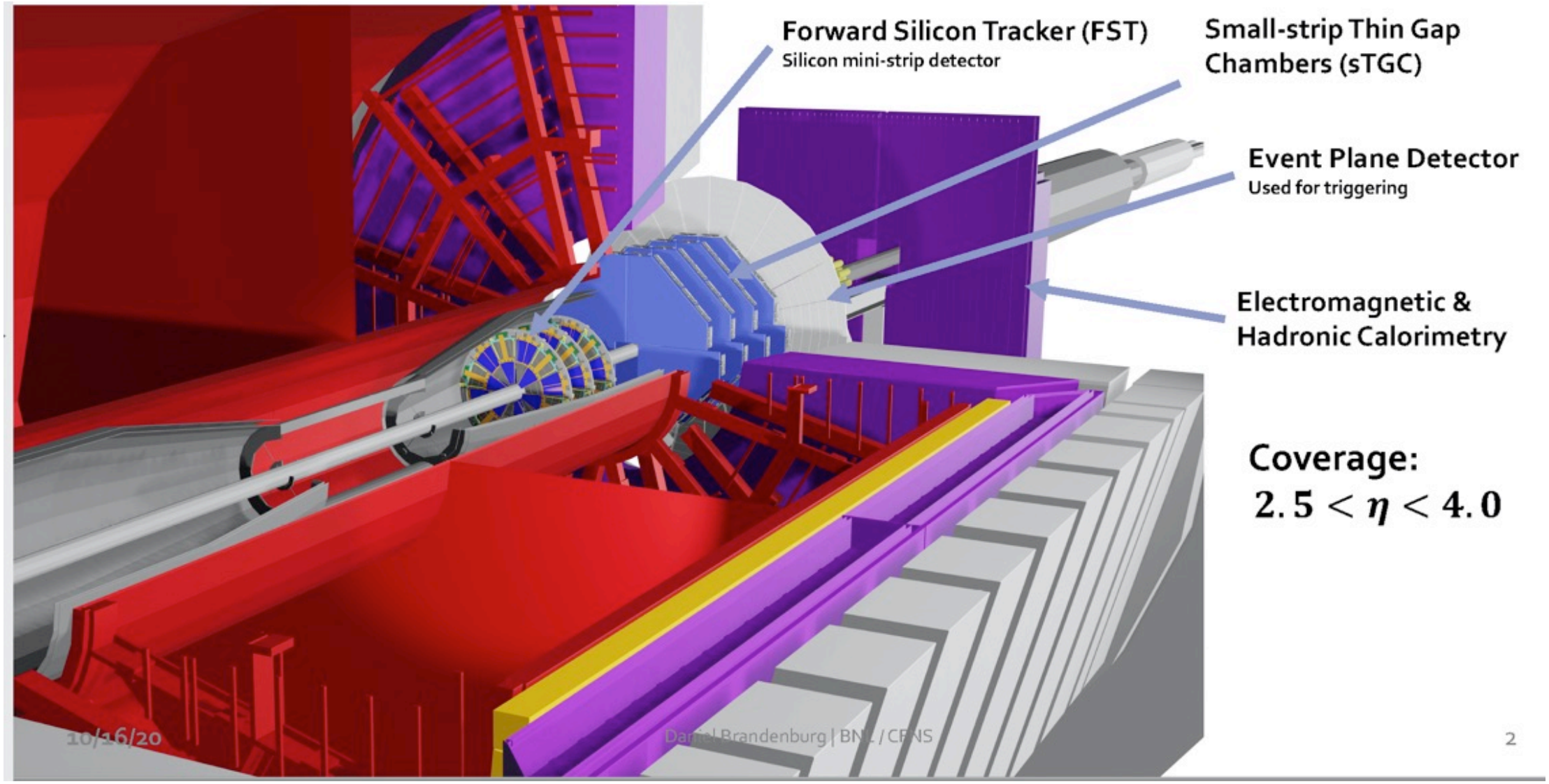


Bronkhorst components assembled in the gas cabinet

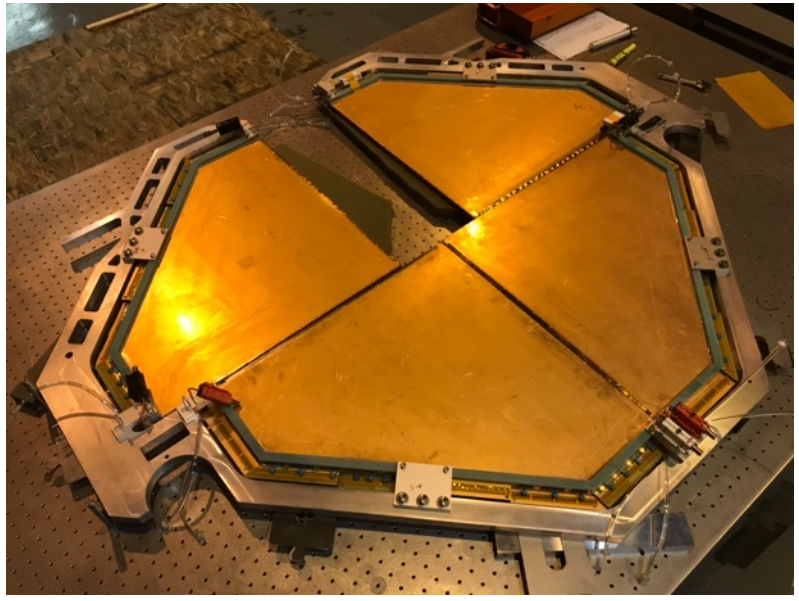
sTGC Operations Reequipments

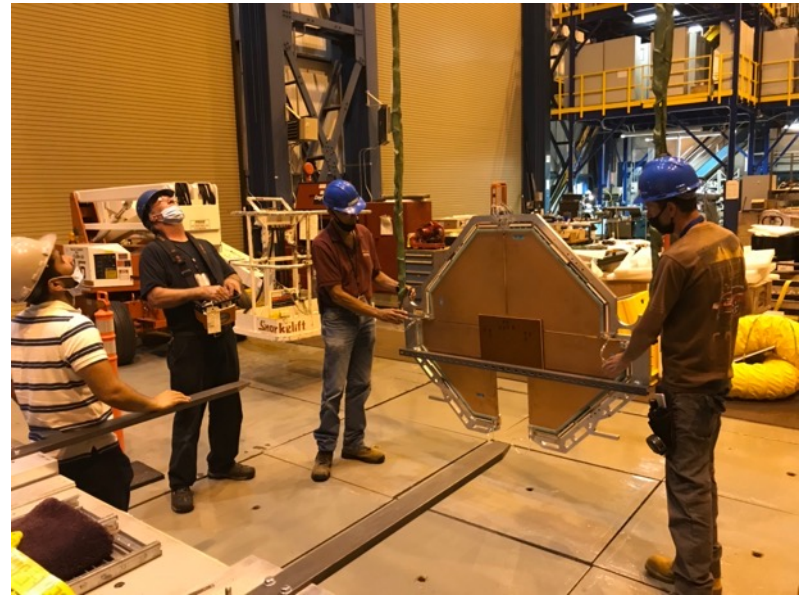
- Anode (HV): 50 µm gold-plated tungsten wires held at a potential of ~2900 V
- Working gas: n-Pentane+CO2= 45:55% by volume
- Supply pressure 2 mbar above atm
- Flow about 50 cc/min

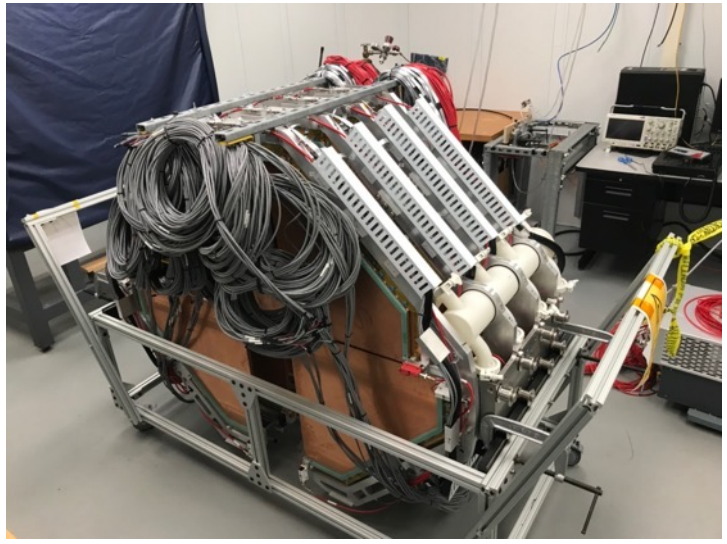
STAR Forward Upgrade

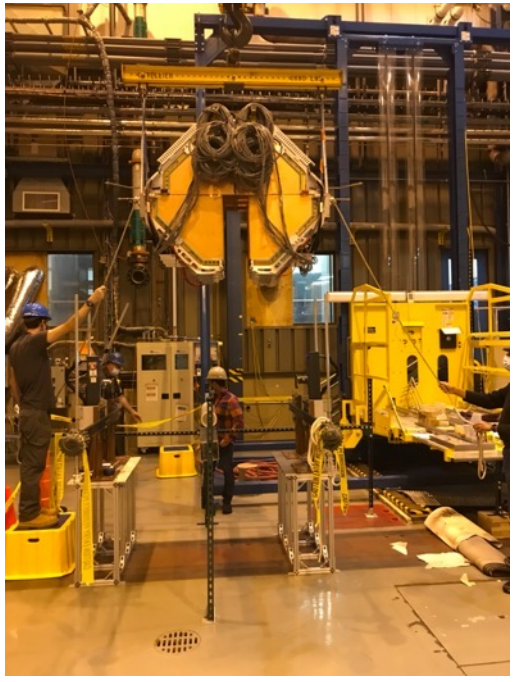


sTGC Detector Assembly

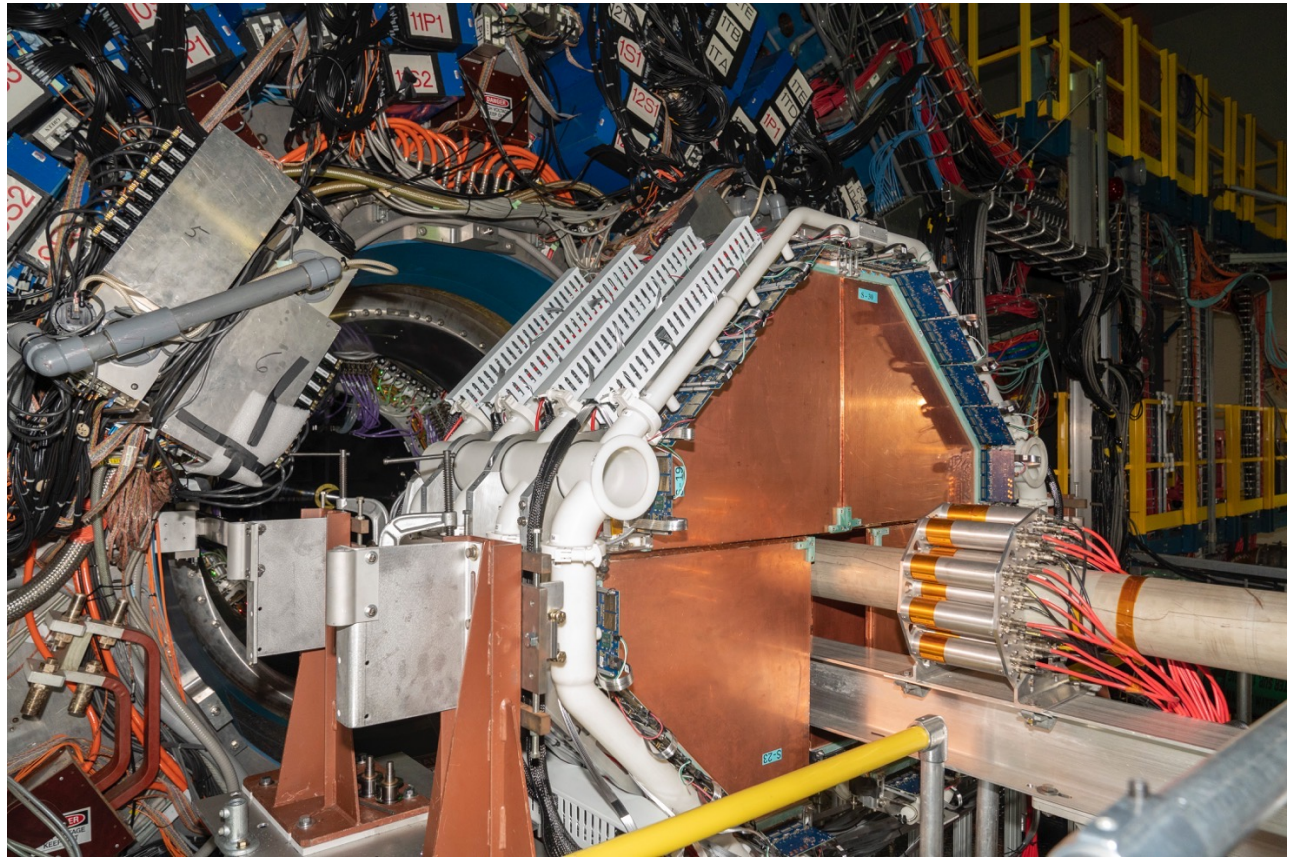


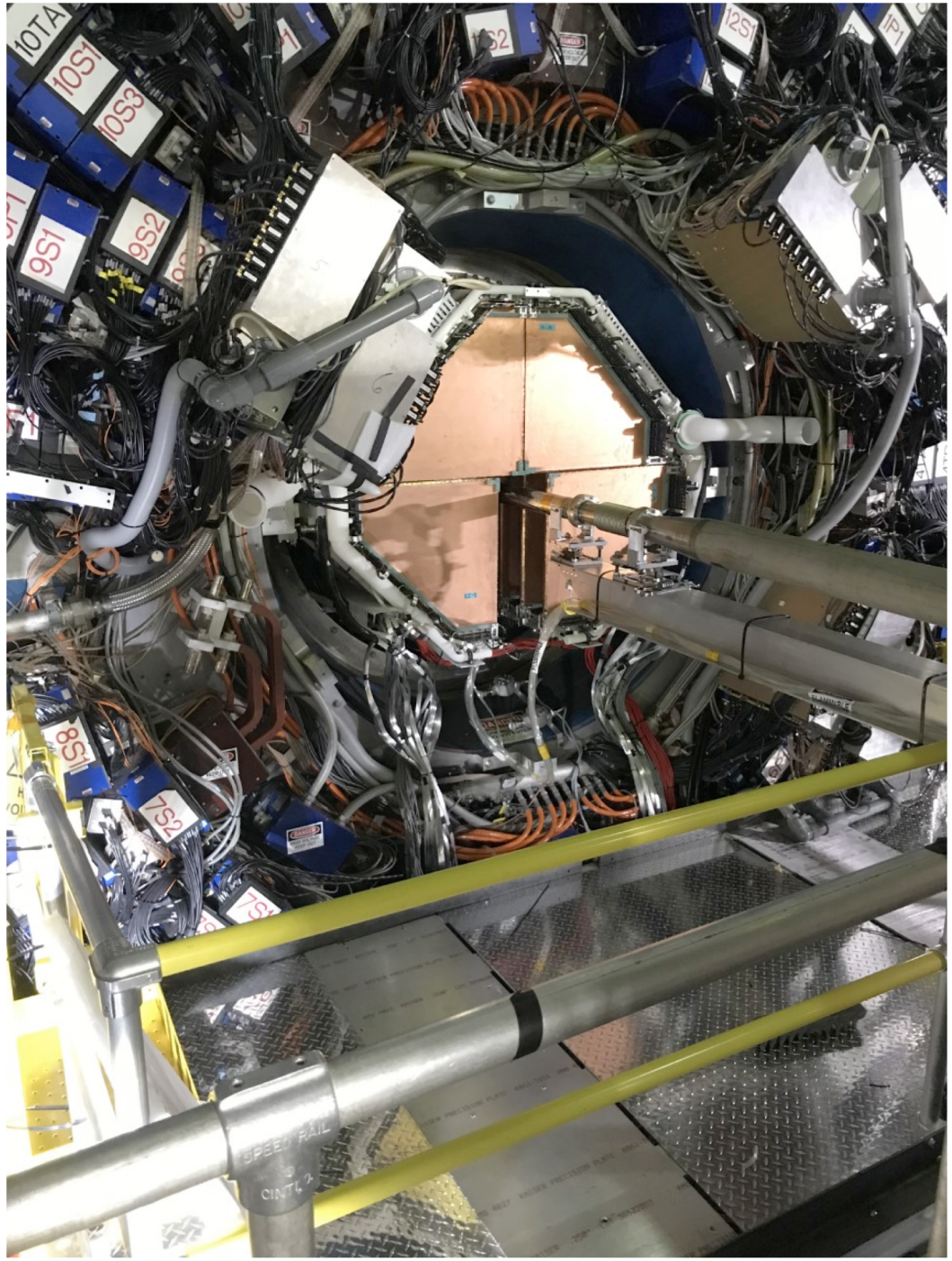




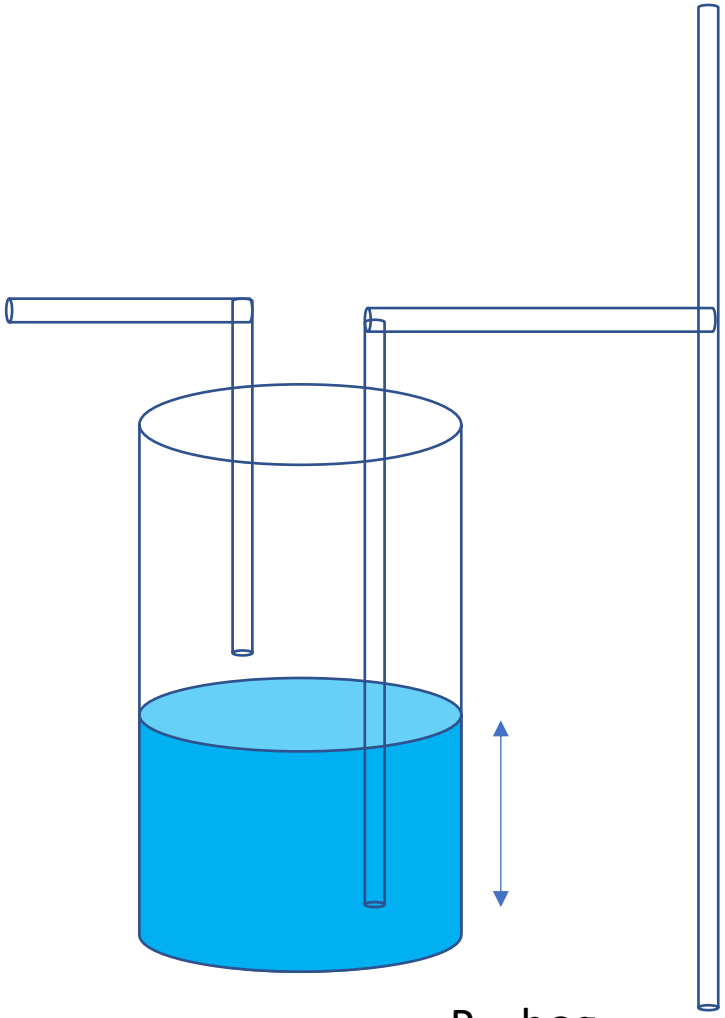


sTGC Detector Assembly



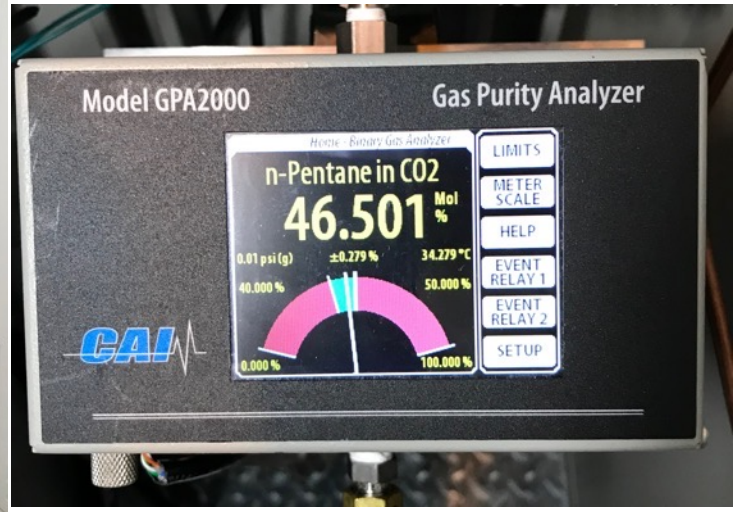


Protecting the chambers form over pressure



$P = h\rho g$

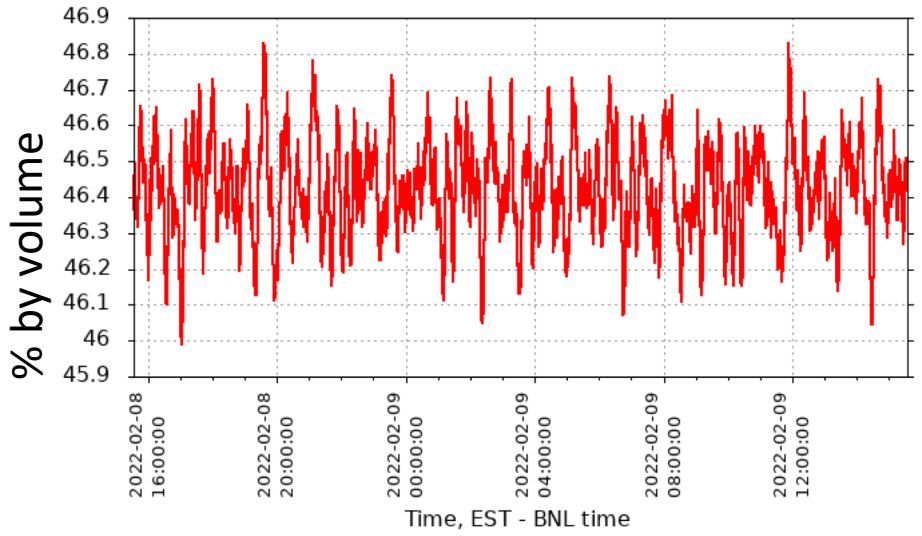
Gas System



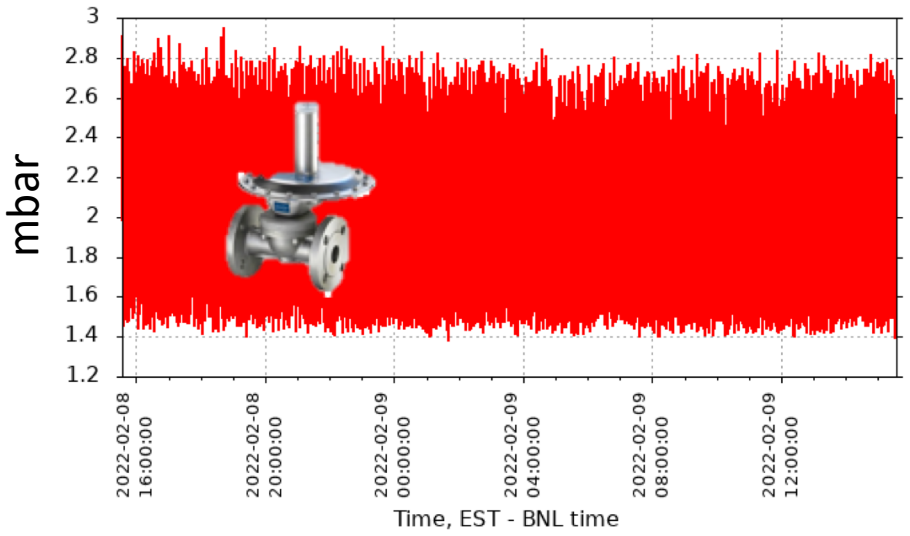
n-Pentane

- n-pentane isomer formula C_5H_{12}
- Is a highly flammable liquid and vapor
- Boiling point of pentane is 97^0F (36^0C)
- Density of pentane is 0.626 g/ml
- The pentane vapor is heavier than air
  - It sinks if released to atmosphere
- Explosive limits of pentane by volume in air: 1.4-7.8%

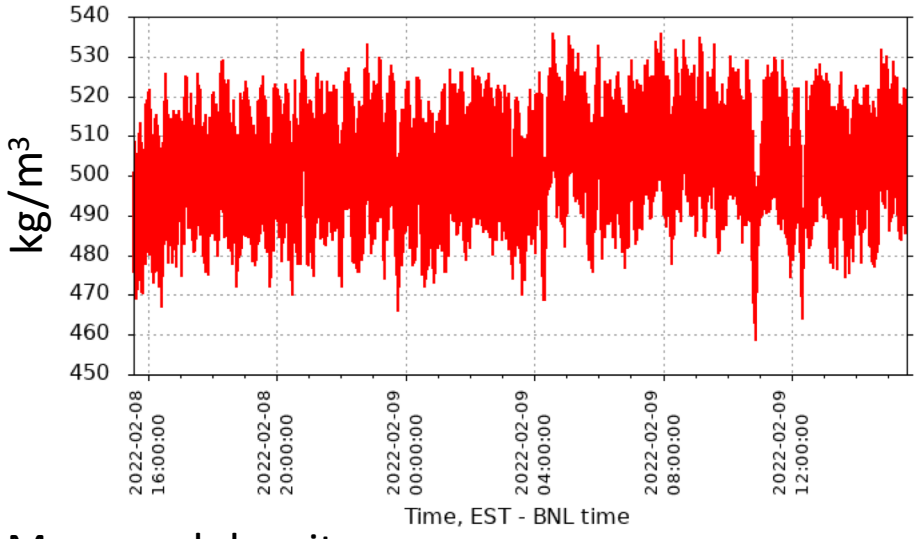
sTGC Gas System



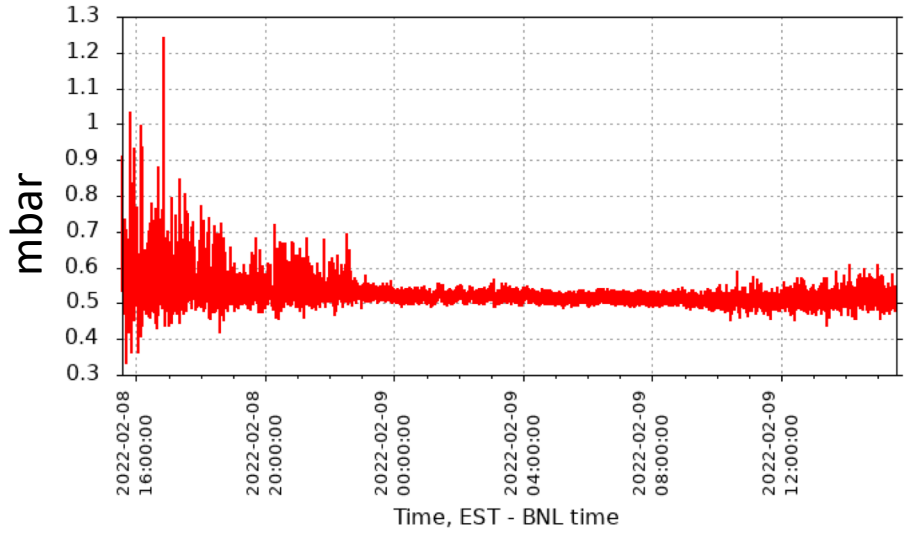
n-Pentane/CO2 Ratio sTGC:Gas:GPA:ratio, %



Chamber input pressure sTGC:ADAM:PT-6:pressure, mbar



Measured density of n-Pentane sTGC:Gas:Pentane:Density, kg/m3



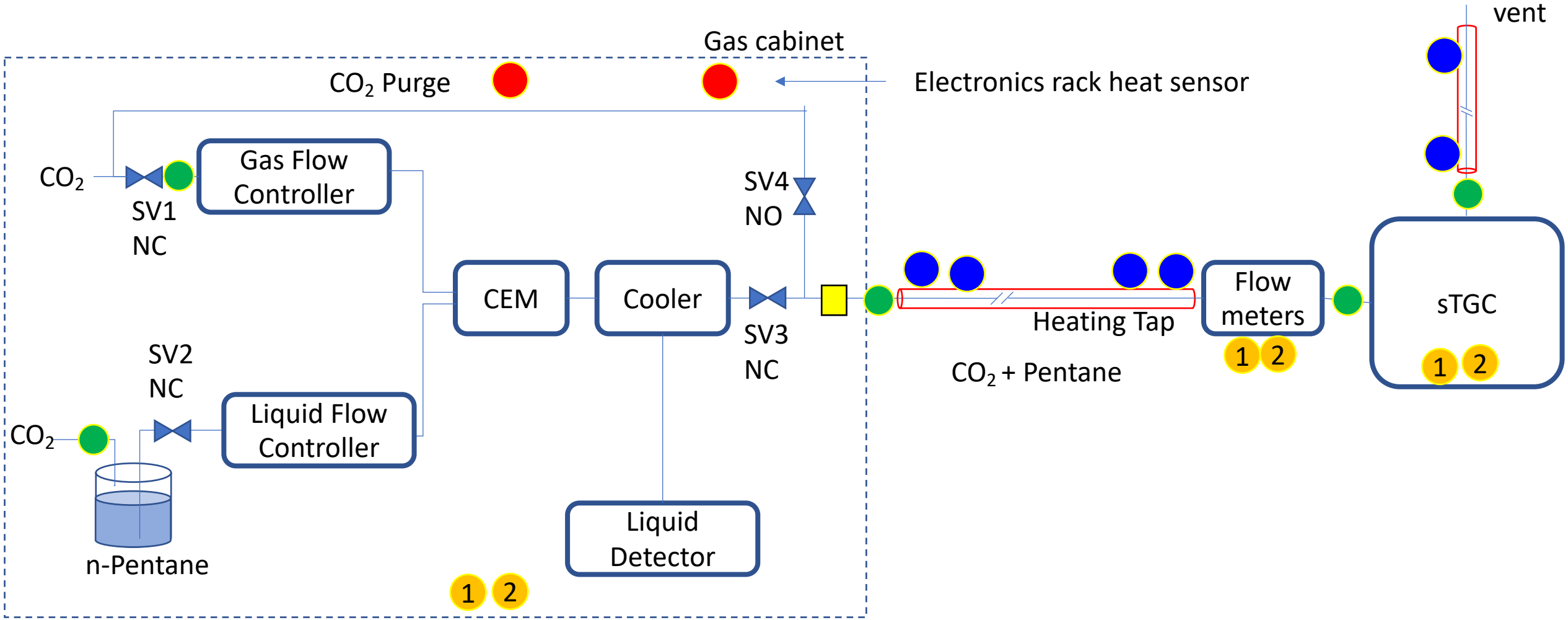
Chamber vent pressure sTGC:ADAM:PT-5:pressure, mbar

Safety System

	Status During Interlock	sTGC Purge	sTGC No Flow	sTGC LV Permissive	sTGC HV Permissive	UPS Power for Control Cabinet	Audible & Visible Alarm
1	**Normal status**	Mixing	Mixing	Enable	Enable	On	Off
	Interlocks						
	Fire/Heat Detection						
2	Heat in gas cabinet	X		X	X		X
3	Heat in electronic cabinet	X		X	X	X	
	Pentane Gas Leak Detection						
4	15% of LEL in pentane sniffer **1** - Gas cabinet	X		X	X		X
5	15% of LEL in pentane sniffer **1** - Flow meters	X		X	X		X
6	15% of LEL in pentane sniffer **1**- sTGC chambers	X		X	X		X
7	15% of LEL in pentane sniffer **2** - Gas cabinet	X		X	X		X
8	15% of LEL in pentane sniffer **2** - Flow meters	X		X	X		X
9	15% of LEL in pentane sniffer **2** - sTGC chambers	X		X	X		X
10	Pentane sniffer **1** malfunction w/5 min delay	X		X	X		X
11	Pentane sniffer **2** malfunction w/5 min delay	X		X	X		X
	Gas mixing and Delivery						
12	Liquid pentane present after mixing	X		X	X		X
13	Supply line heat tap -LOW/HIGH	X		X	X		X
14	Vent line heat tap -LOW/HIGH	X		X	X		X
	Pressure						
15	sTGC Supply over pressure (PT5)		X	X	X		X
	STAR global interlock (SGIS)						
16	From SGIS	Appropriate action to be determined, not implemented for Run21					
17	To SGIS	Appropriate action to be determined, not implemented for Run21					

State Table

Safety Sensors



SV – Solenoid valves
NC – Normally closed
NO – Normally open

Pentane Sniffer,
1 & 2 are independent monitoring

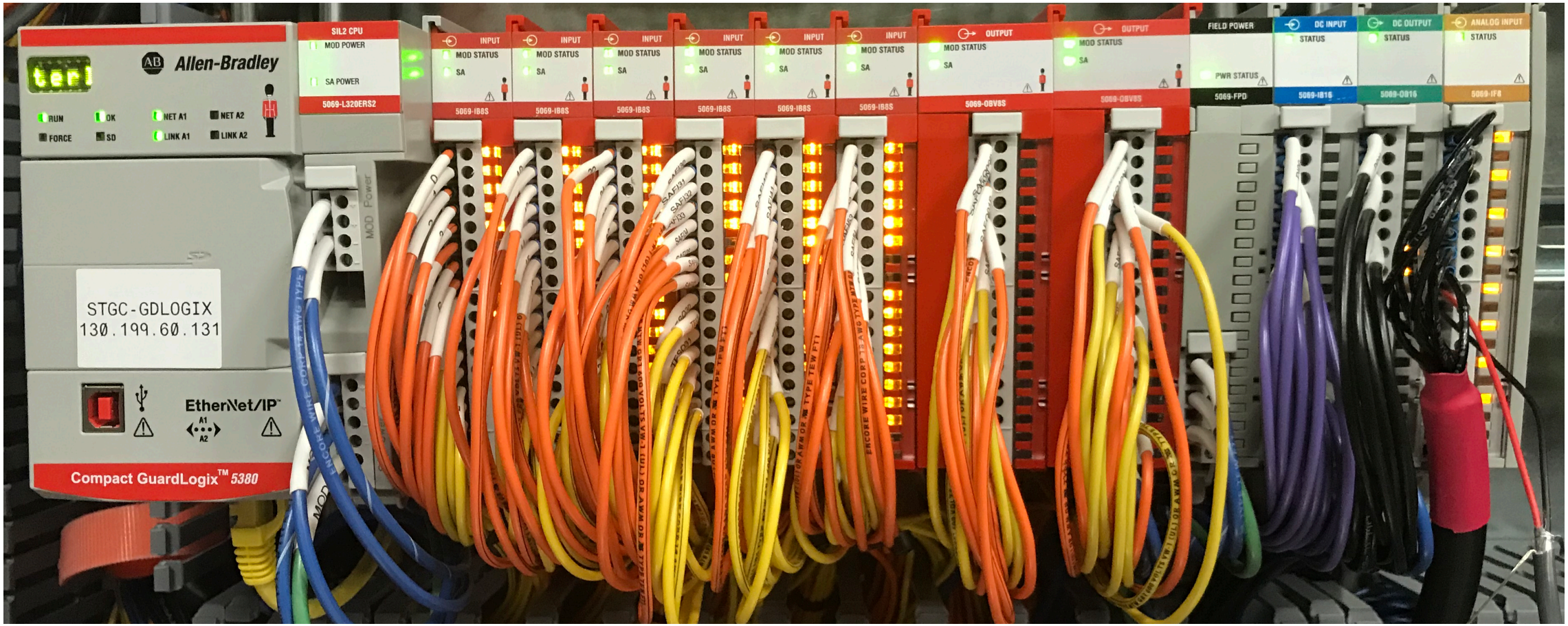
Heat sensor

Thermocouple

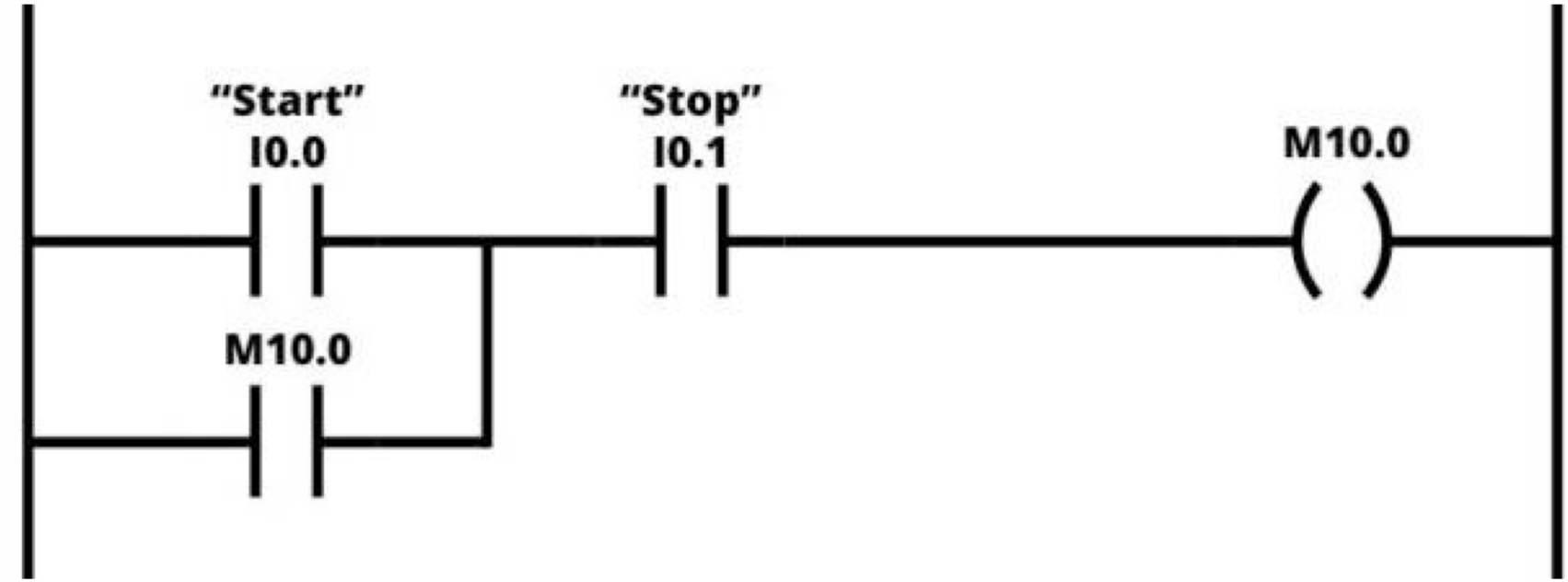
Pressure transmitter

Liquid detector

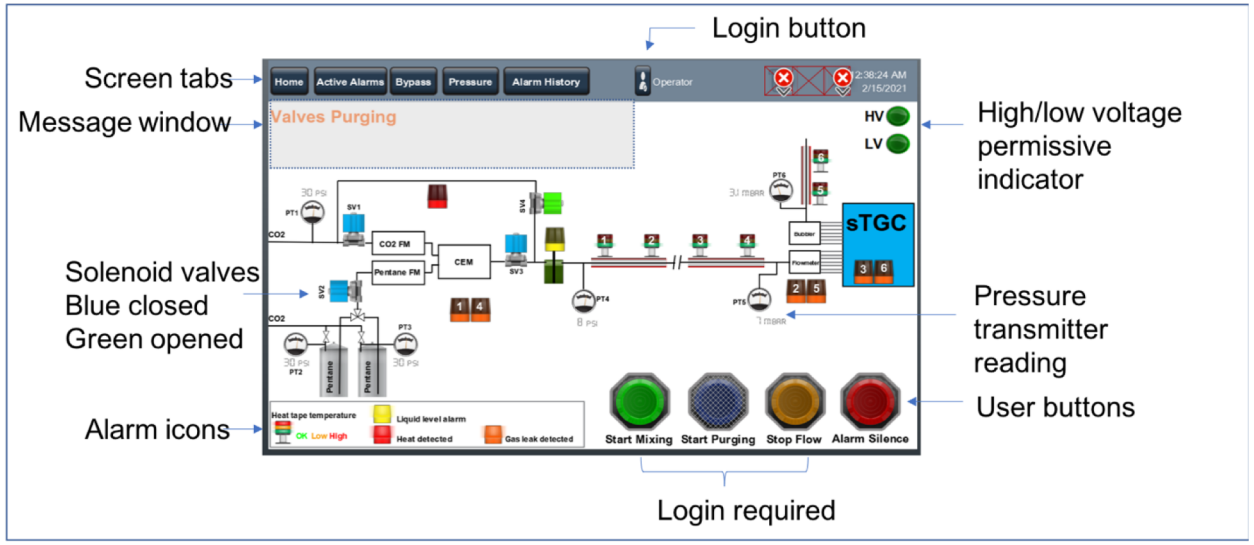
PLC

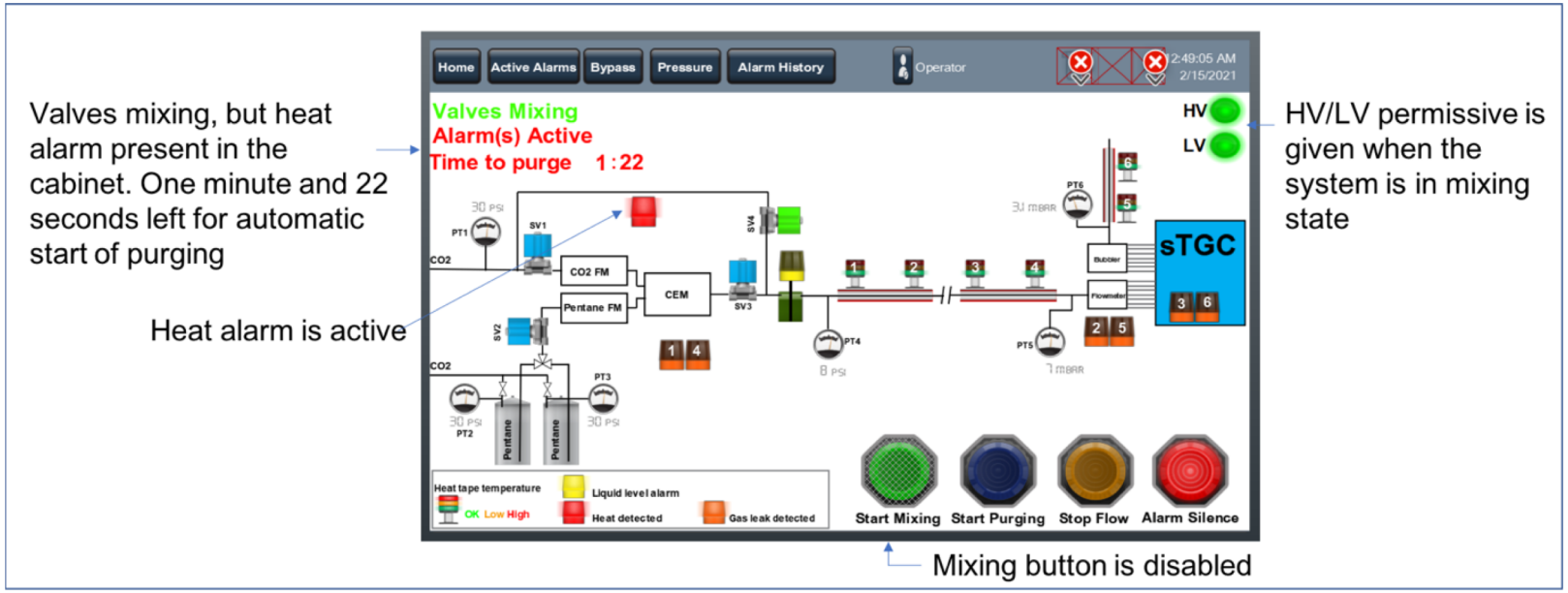

Allen-Bradley
RUN
FORCE
OK
SD
NET A1
LINK A1
NET A2
LINK A2
SIL2 CPU
MOD POWER
SA POWER
5069-L320ERS2
STGC-GDLOGIX
130.199.60.131
EtherNet/IP
Compact GuardLogix™ 5380
INPUT
MOD STATUS
SA
5069-IB8S
OUTPUT
5069-OBV8S
FIELD POWER
PWR STATUS
5069-FPD
DC INPUT
STATUS
5069-IB16
DC OUTPUT
5069-OB16
ANALOG INPUT
5069-IF8

PLC – Ladder Diagram

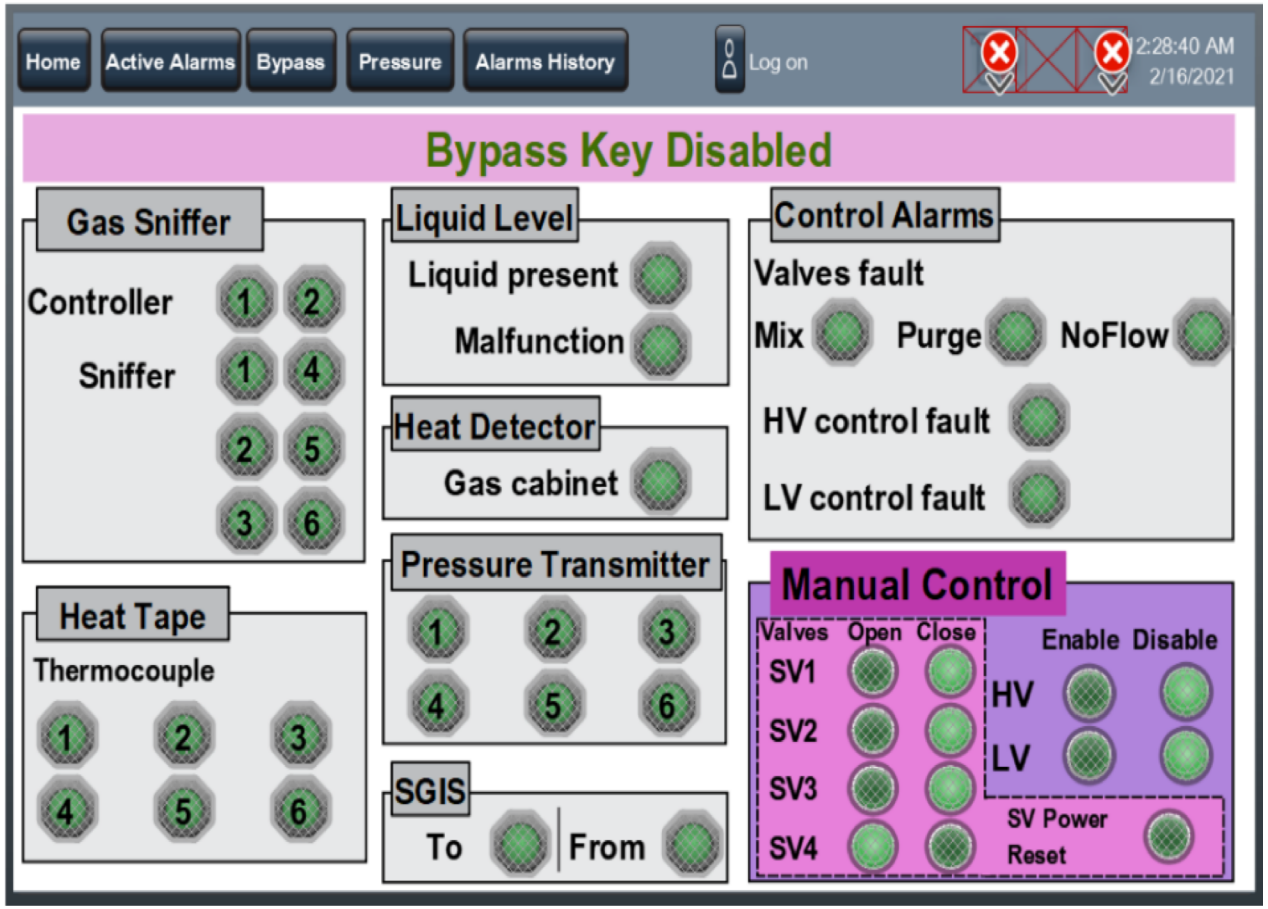


PLC - Controls





PLC - Controls



HW

- Sketch a diagram for 10 mbar overpressure protector?
- A point charge q located near infinite grounded conducting plate, what are the
  - E(r)
  - V(r)