SoLID Heavy Gas Cherenkov Update

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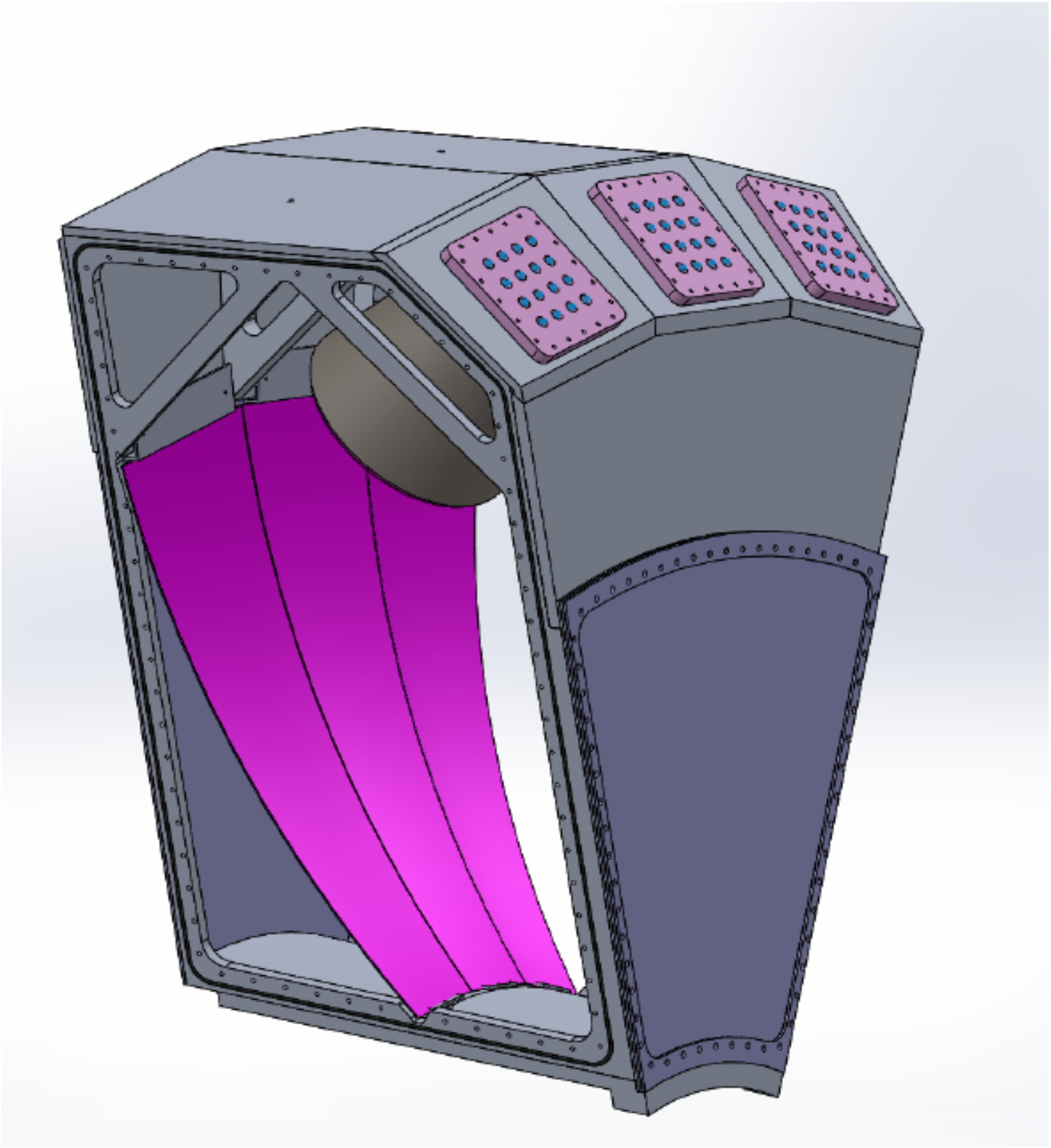
HGC Prototyping Update

C$100k grants allow the U.Regina group to construct one SoLID HGC module for testing.

Questions to be addressed:

- Enclosure deformation at 1.5 atm operating pressure (investigate design and metal alloy options).
- Performance of the O-ring seals against adjacent units.
- Performance of thin entrance window in terms of light and gas tightness (test several options).



Conceptual design by Gary Swift, Duke U.

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Progress since December 2016 meeting

HGC Entrance Window Pressure Tests

- **We purchased rolls of 5mil mylar and 12mil kevlar from Challenge Sailcloth, recommended to us by Dave Meekins.**
- The materials are marketed for sailcloth repair of high performance racing sailboats.
- The mylar is crosshatched with strands of carbon fiber and fiberglass. The kevlar comes with an adhesive backing which is used to bind the layers.
- **Air was slowly pumped in, until window failure, and the window bulge measured vs. pressure.**
- **Two tests were performed:**
  1. **Manufacturer's adhesive backing used to bond the mylar-kevlar layers.**
  2. **Epoxy added around the window circumference to increase the tensile strength at the clamped edges.**

Photo of 2nd test setup with epoxy around circumference, which gave better performance.

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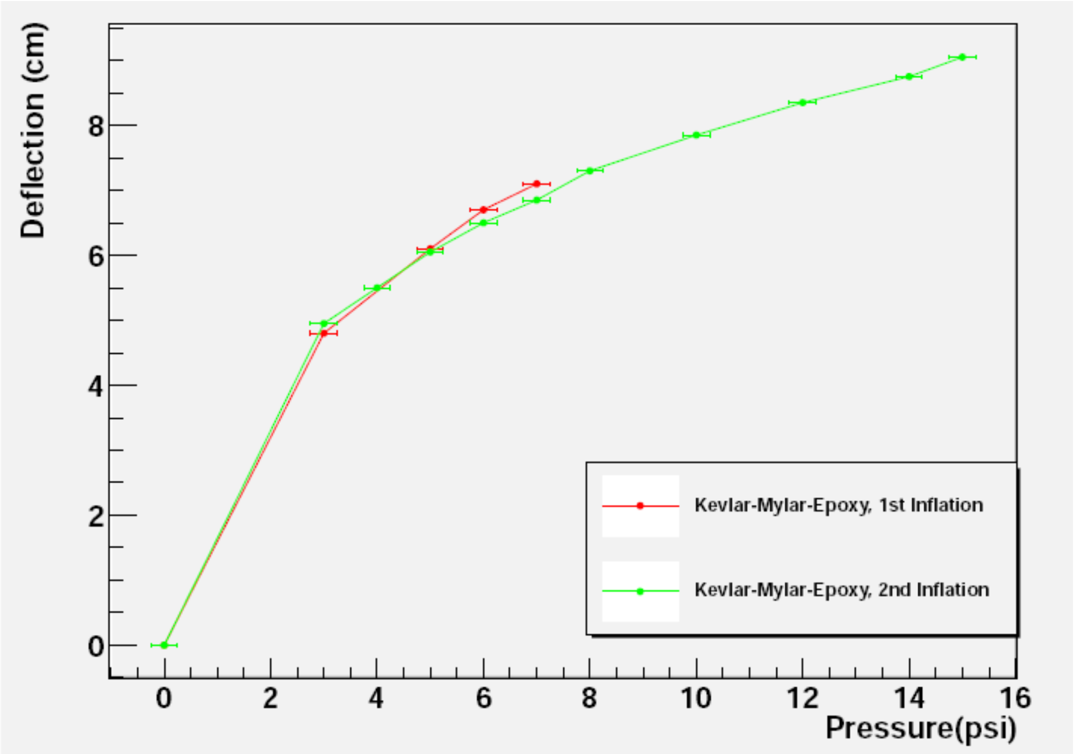
HGC Entrance Window Test

Photo showing how window material failed in 2nd test.

Deflection vs. pressure in 2nd test.



- In comparison to our previous CLAS-LTCC window material test (1.5mil tedlar-3mil PET-1.5mil tedlar), this window performed much better.
- Dramatically less window deflection, about 7.5cm at the operating 0.5atm overpressure (1.5atm absolute).
- Window failure occurred at 1atm, which is close to our design goal.
- Based on these results, we requested 10cm for HGC front window bulging and clearance from LGC at the Feb 20 meeting.
- We are planning additional tests to see if performance can be increased further, including epoxy over the whole window, and/or a double layer of kevlar.
- Copies of full reports available upon request.

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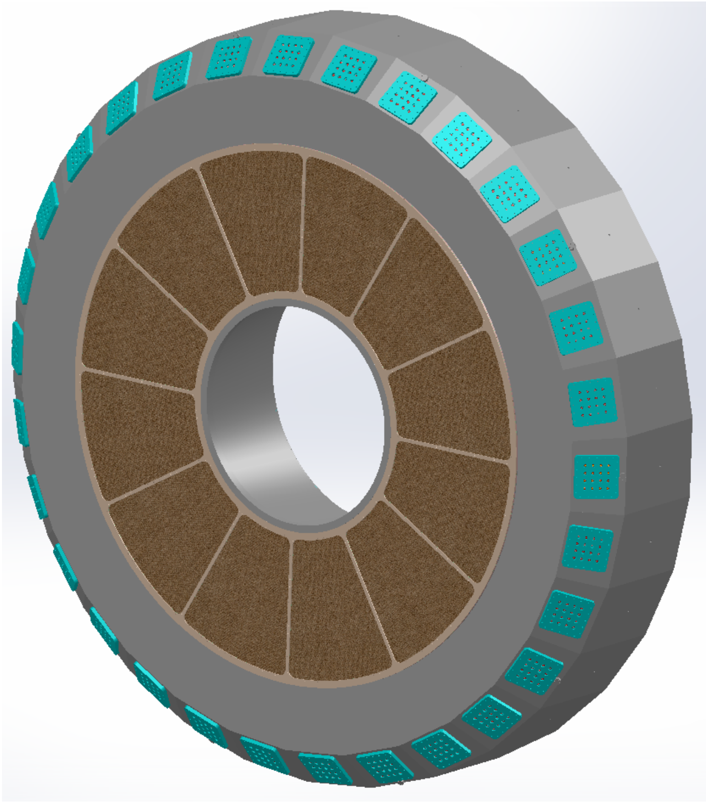
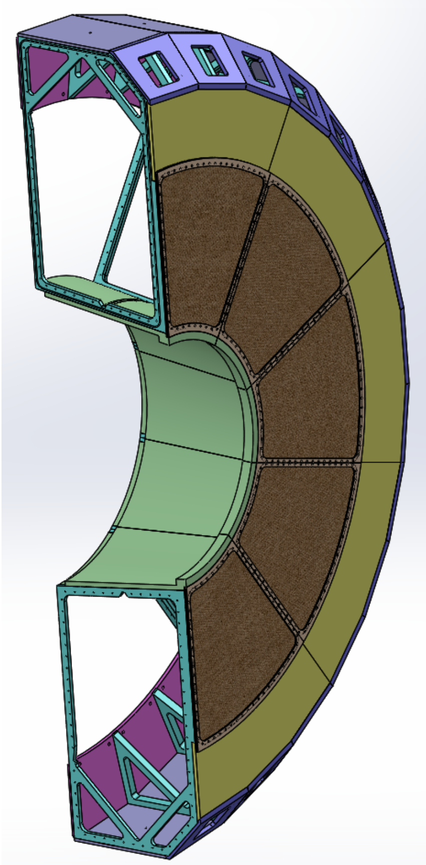
HGC Design Considerations

- HGC needs to stay in half vertically before final installation, mainly due to beamline in the middle, thus the HGC will be divided into two independent L,R sections
- Can we leave the HGC as two independent sections during the operation or we need to remove the separations and combine the two sections as a whole?
  - It will simplify the design
  - If we leave the separations, it will cause some dead area in the detector
  - This will influence the Gas System design a bit



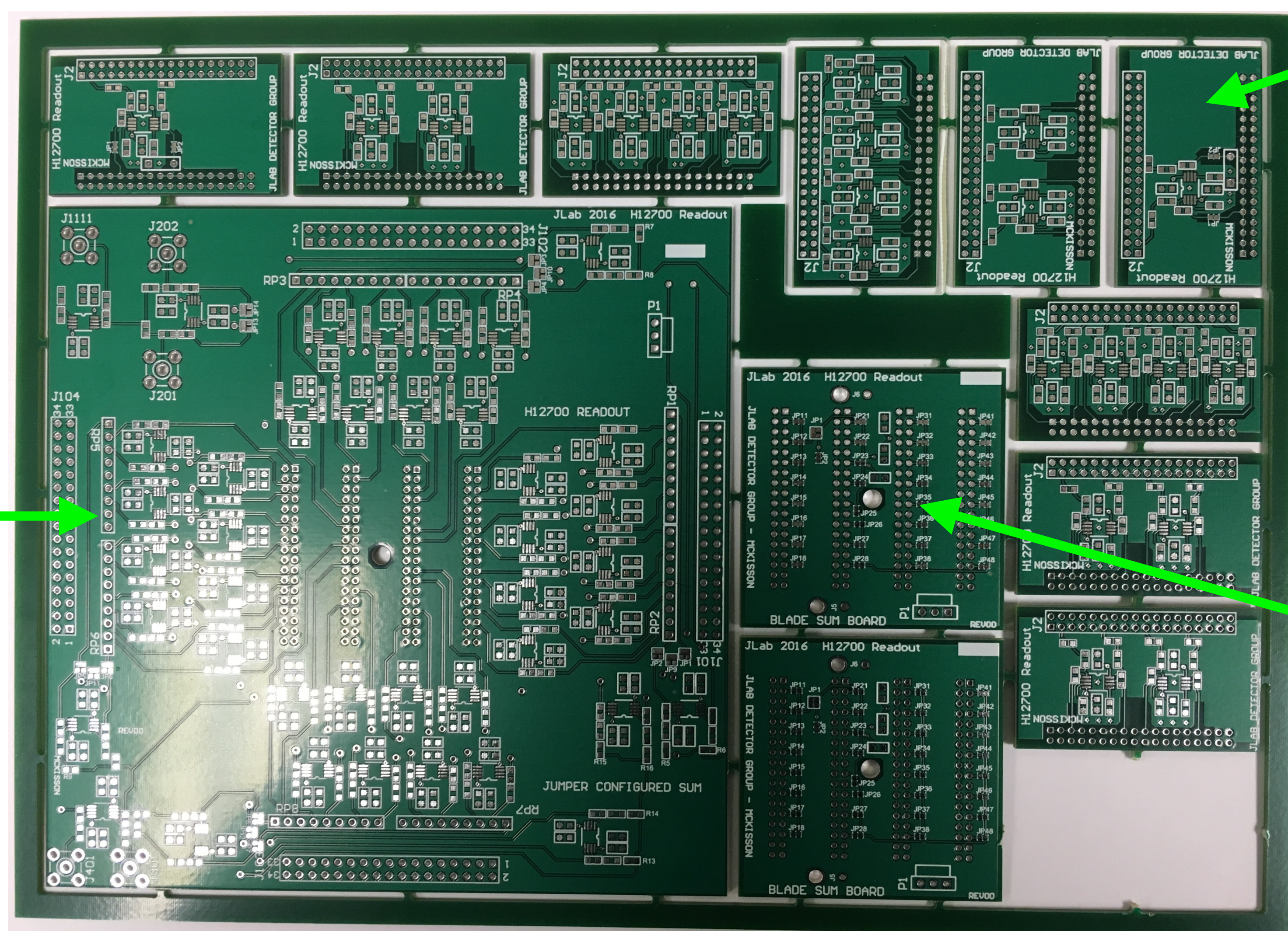


Readout System

- Summing board designed by Jack McKisson
  - We have received some prototypes
  - Plan to do a test with this test board with our MAPMTs once Jack finishes the soldering

Perpendicular board prototype with 3 different sum configuration (sum of 2, 4, 8 channels)

Test board for one MAPMT test (one amplifier for each channel, sum configuration set by jumpers)



Parallel backboard prototype

Readout System

- Hole area estimation for HGC
  - BNC cable: 1/PMT = 16/module = 480 (total)
  - HV cable: 1/PMT = 16/module = 480 (total)
  - Gas lines: depend on the layout of the detector (number of sections)
  - Estimation for the space taken by the cables
    - 16 BNC cables and 16 HV cables per module (assume 3mm dia for each cable, so each cable has ~7 mm^2
    - Assume 0.75 packing factor and 50% tolerance, thus the total cross area required by the cables is 450 mm^2 per module

Gas System

- Brief info for HGC gas system
  - The volume of the detector is 20 m^3 filled with 300kg heavy gas (C4F10) at 1.5 atm (0.5 atm pressure difference)
  - Two options: recirculating system and fill-and-seal system
- Recirculation system:
  - A system used in Hall B LTCC (thin window, 1 atm). The major reason for this design is to carefully control the pressure to prevent damage to their detector window
  - Gas is recovered, filtered, and distilled during the operation in order to reuse (3 times per week to recover the gas from return tank to supply tank)
  - 1.5kg/day gas loss rate, it will be higher in our operation pressure
- Focus on a fill-and-seal system for the SoLID HGC (suggestion by George Jacobs and Jack Segal)

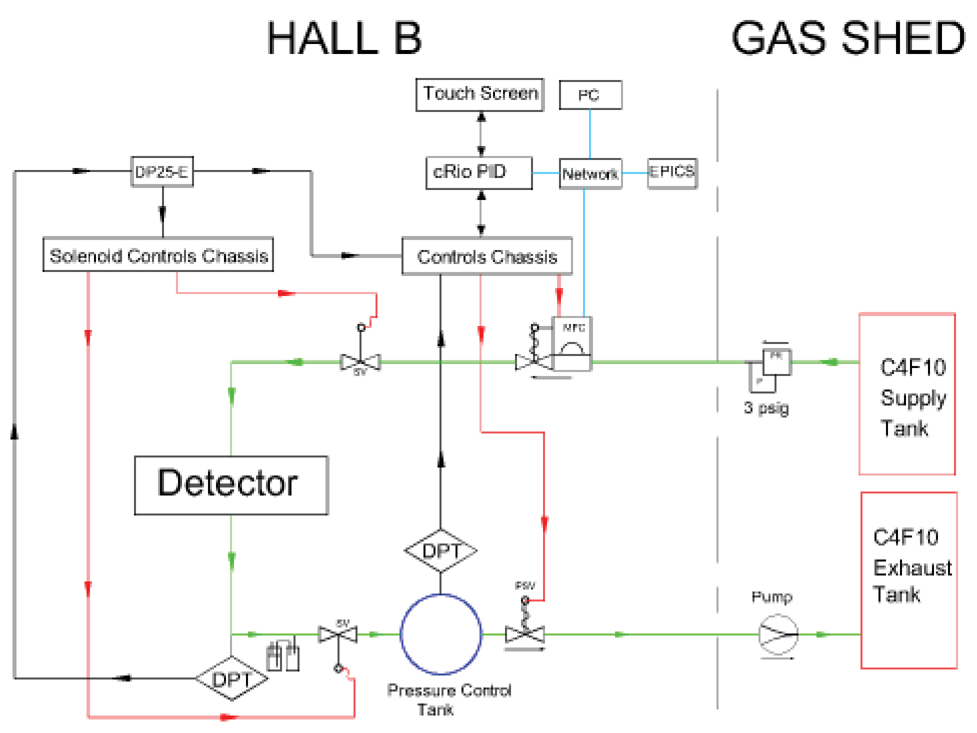
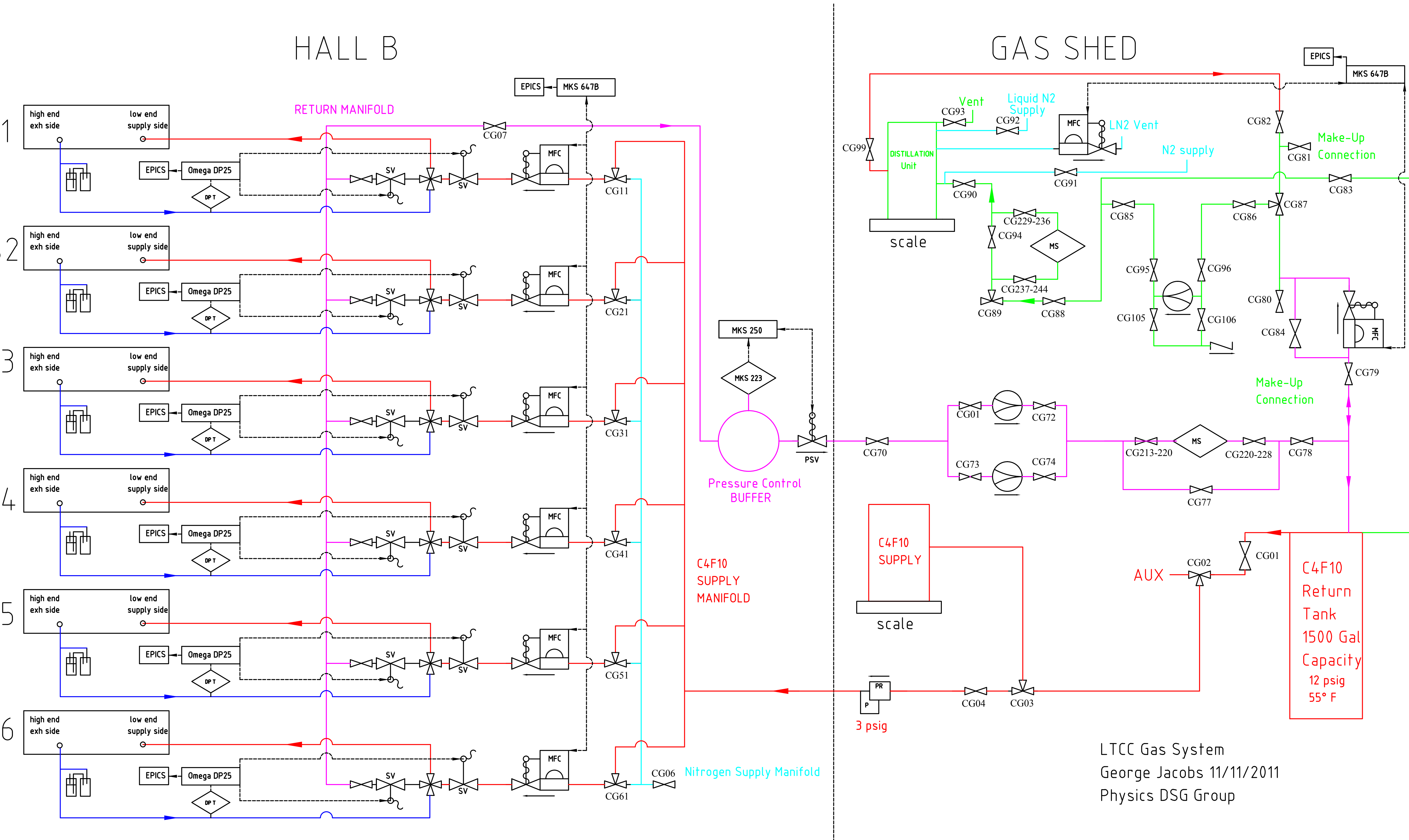


FIG. 1. LTCC gas controls diagram. Red lines are power, blue are network, black are signal, and green are gas flow.

Gas System

- Fill-and-seal system
    - Simpler system, mostly the supply part (C4F10 and N2) of the recirculation system
    - The pressure will not be dynamically controlled like the Hall B LTCC system, it is monitored by meters
    - The major gas leak is at the recirculation process according to Jack, so a fill-and-seal system will have less leaking rate
    - It is still possible to recover much of the C4F10 in the event of a refill situation, the gas will be collected in the tank and purified (a separate purify system is required)
    - The whole system is planned to be placed in the hall to prevent adding pipe line into hall
- Cost estimation for a fill-and-seal system
    - The cost of components estimated by Jack for a fill-and-seal system is ~70K? (purify system not included)
    - Still working on a more detailed (itemized) cost estimation

Backups


HALL B
GAS SHED
RETURN MANIFOLD
EPICS
MKS 647B
CG07
1
2
3
4
5
6
high end
exh side
low end
supply side
Omega DP25
DP T
SV
MFC
CG11
CG21
CG31
CG41
CG51
CG61
CG06
Nitrogen Supply Manifold
C4F10
SUPPLY
MANIFOLD
MKS 250
MKS 223
PSV
Pressure Control
BUFFER
CG70
CG01
CG72
CG73
CG74
CG213-220
MS
CG220-228
CG78
CG77
CG99
CG93
Vent
Liquid N2
Supply
CG92
LN2 Vent
DISTILLATION
Unit
N2 supply
CG91
CG90
scale
CG229-236
CG94
CG237-244
CG89
CG88
CG85
CG95
CG105
CG96
CG106
CG86
CG87
CG82
CG81
Make-Up
Connection
CG83
CG80
CG84
CG79
C4F10
SUPPLY
scale
AUX
CG02
CG01
C4F10
Return
Tank
1500 Gal
Capacity
12 psig
55° F
PR
P
3 psig
CG04
CG03
LTCC Gas System
George Jacobs 11/11/2011
Physics DSG Group

Gas System

- Concern:
    - The design contains a lot of joints and O-rings, so how well we can seal it will be a question. We will try to make it as small as possible, but probably the gas pressure will have to be topped-up periodically due to leakage. Notice this problem does not depend on the type of gas system we used.
    - The pressure will not be as stable as the recirculation system, some study need to be done to decide the tolerance of the pressure which will not affect of our physics.
    - The cost of the separated purify system, plan to contact George Jacobs to learn something about their purify system.