Drift Chamber Safety System

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UBC
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BaBar Drift Chamber

- 29k wires located in a 5000l volume of flammable gas (He:iso 80:20);
  » 7100 sense wires at 2000V
  » feedthroughs glued into endplates of 24mm/12mm aluminum;
  » outer cylinder is 9mm CF/nomex; epoxy & 80µ aluminum foil for seal.
  » inner cylinder is 1mm coated beryllium; O-ring seal.
- Secondary gas seals with bulkheads.
  - readout electronics at rear end only

- Emphasis will be on safety of gas system, but not completely.
  - integration of gas hut / gas system / confined space / electronics safety.
Major Components

- Gas Hut located above IR near road.
  - gas cylinders stored on pad outside
  - 3 gas racks + electronics rack inside
- Gas lines run from hut to rack 10 on top of detector and then to DC.
  - also static pressure lines from DC and bulkheads to sensors in rack 10.
- HV supplies and SIAMS in electronics house
Gas System

- **Running mode** recirculates 15 l/min
  - 10% fresh gas.
  - He security line to ensure >2 mbar in DC; 3.5 mbar nominal
  - CO2 flow through cover regions
  - N2 flow through exhaust line

- **Safe/Rest mode**
  - VVPC_1 open, VVPC_2 – VVPC_9 closed, pump off (safety trip; power failure, pneumatic pressure loss).
- Purging with Helium (non-recirc).
  - Additional intermediate modes available via EPICS
- Procedures/checklists for all transitions.
- Failure analysis for all components
- Lengthy testing of system in France
  - meet tomorrow with O’Neill to establish testing program at SLAC.
Safety Issues

- Explosion/Flammable gas
- Confined space (O2 deficiency)
- HV
- Gas system failure
  - underpressure; overpressure; leaks;
    → equipment or performance danger.
- Electronics protection (cooling)
Safety System

- HV (CAEN SY527)
  - supply current limited to <40µA; <2µA under normal operating conditions
  - stored energy < 0.1 Joule

- Confined Space
  - awkward 3.5m long DIRC tube.
  - CO2 switched to air (lock and tag);
  - Portable O2 monitor used before entry
  - forced air ventilation ensures < LEL for any plausible leak (currently .08 l/min).
Flammable Gas Safety

- Gas hut reviewed by HEEC
  - flow restrictions; ventilation; HAD sensors
- Leak prevention
  - feedthrough leaks contained by bulkheads
    - currently .08 l/min
  - outer cylinder wrapped with mylar; open at front end only (gas cannot accumulate).
    - currently no measurable leaks
  - bubblers & interlocks ensure DC pressure is 2–15 mbar; static relief valves elsewhere
» pressure-tested stainless welded lines; swagelock for valves, monitors.

» gas gain chamber sealed in box.

● Prevention of explosive mixtures

» purge/ventilate locations where gas accumulation is possible:
  – bulkheads: CO2 flow at >4 l/min ⇒ <25% LEL; up to 30 l/min possible.
  – flush gain chamber box with CO2
  – exhaust line flushed with N2

» inhibit isobutane flow with O2 sensor
Restrict ignition sources

- class 2 explosion-proof pneumatic valves in gas hut; 3 feet from electronics rack.
  - ventilation ensures that explosion-proof is not required.
- HV disabled if > 2500 ppm O2 in chamber; DC electronics disabled by alarms.
Sensors and Interlocks

- Interlocks ensure safe response regardless of EPICS
  - EPICS monitors system and provides early warning or diagnosis of problems.
  - additional sensors for data quality.

- SIAMS in gas hut and electronics house; nano-automate in gas hut
  - industrial/CERN safety controller; EPICS readable
Verify the functionality of safety systems described above:

» ventilation/purging functioning
» leaks (O2 into gas; over/under pressure)

Isobutane sensors

» top/bottom of rack 10 (as per gas hut)
» inline detectors on CO2 exhaust.

Gas system failures

» isobutane temp; recirc failure; He flow.
Alarms and Lights

- gas hut alarm
  - disables isobutane and HV;
  - alarm lights in hut and annunciator panel;
  - signal to EPICS
  - signal to IR2.

- gas system alarm
  - put system into safe and disable HV;
  - alarm light on nanoautomate and annunciator panel.
  - signal to EPICS
### Interlock Summary

<table>
<thead>
<tr>
<th>Sensor</th>
<th>Trigger if...</th>
<th>Gas Hut Alarm disable ISO</th>
<th>Gas System Alarm—go to Safe</th>
<th>disable HV</th>
<th>disable LV</th>
</tr>
</thead>
<tbody>
<tr>
<td>IR2 alarm</td>
<td>(contact)</td>
<td>x</td>
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<tr>
<td>HADs in gas hut</td>
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<td>x</td>
<td></td>
<td>x</td>
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<tr>
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<tr>
<td>HAD on front CO2</td>
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<td></td>
<td>x</td>
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<tr>
<td>HAD on rear CO2</td>
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<td>x</td>
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<tr>
<td>HAD rack 10 top</td>
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<tr>
<td>HAD rack 10 bottom</td>
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<tr>
<td>isobutane in mix</td>
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<tr>
<td>O2 in gas circuit</td>
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<td>O2 in gas circuit with Iso</td>
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<tr>
<td>DC pressure</td>
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<tr>
<td>DC inlet pressure</td>
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<td>Recirculation pressure</td>
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<td>humidity in forward bulkhead</td>
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</tbody>
</table>

*O2 inhibits isobutane, no alarm*

*O2 inhibits isobutane, no alarm when recirculating*

*bypass during access when recirculating*