

BGC Vacuum and Synchrotron Light considerations

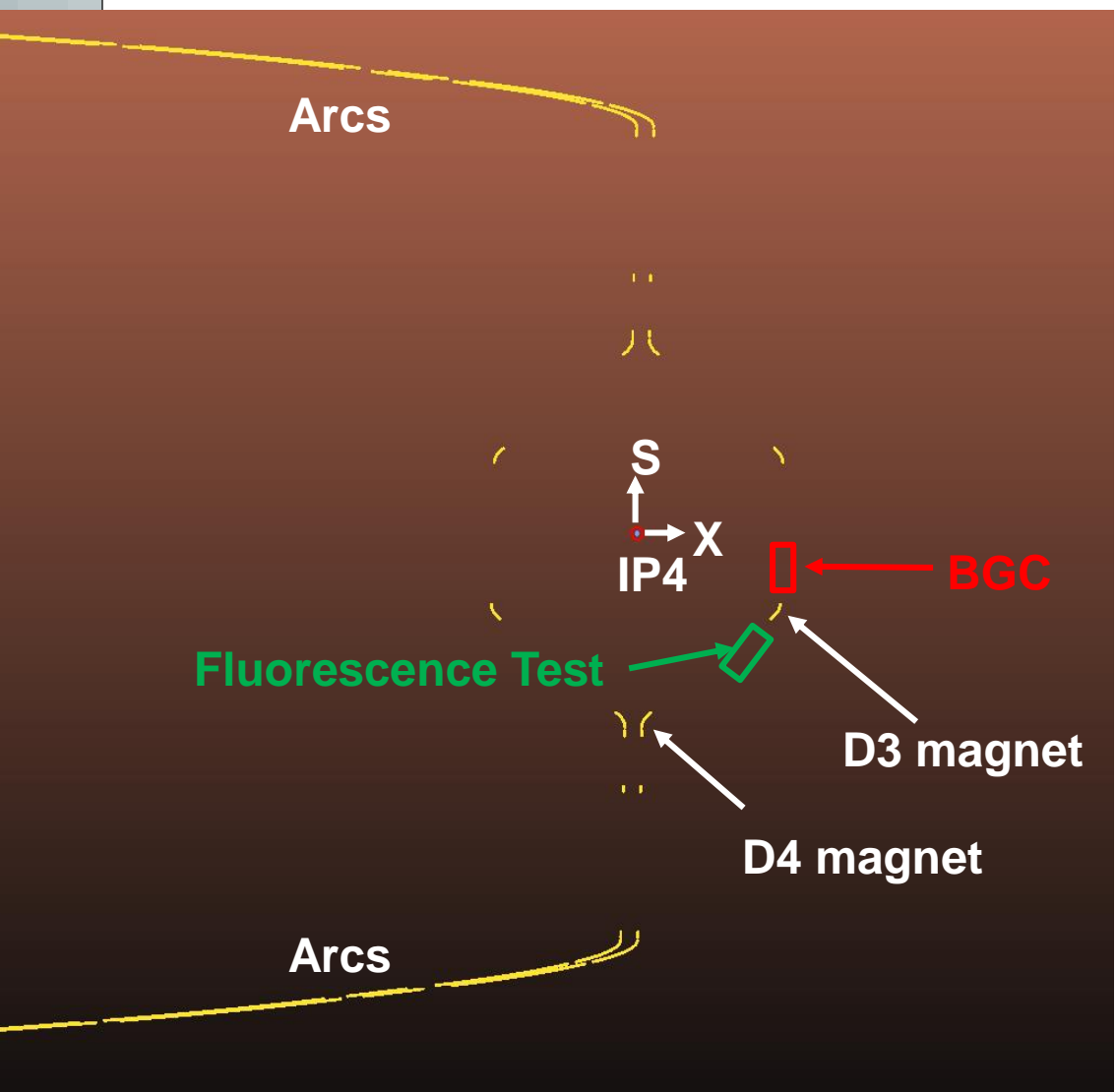
➤ **Synchrotron Light**

➤ **Vacuum system**

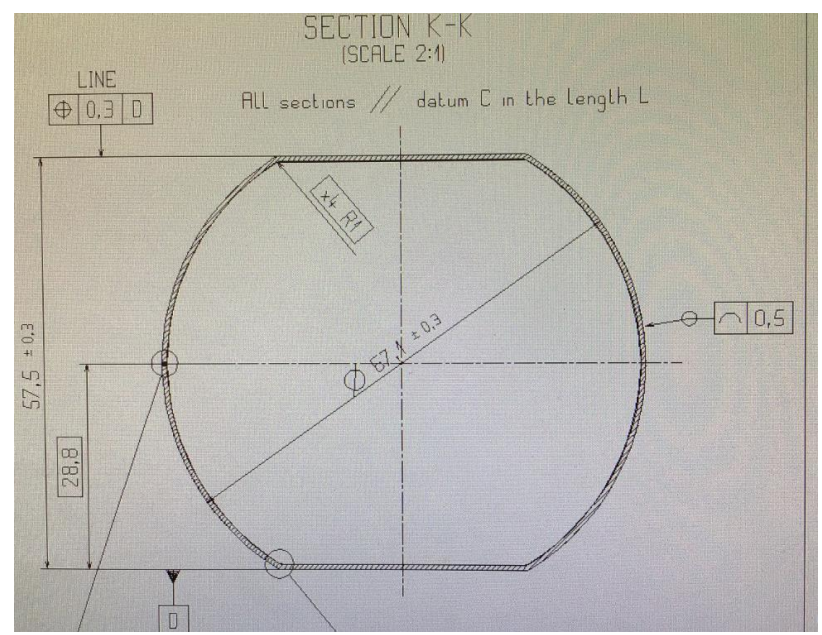
**G. Schneider, M. Ady, R. Kersevan, E. Page, J. Finelle, G. Bregliozzi;
H. Zhang, A. Salehilashkajani**

Synchrotron Radiation at Fluorescence Test and BGC

Synchrotron Radiation



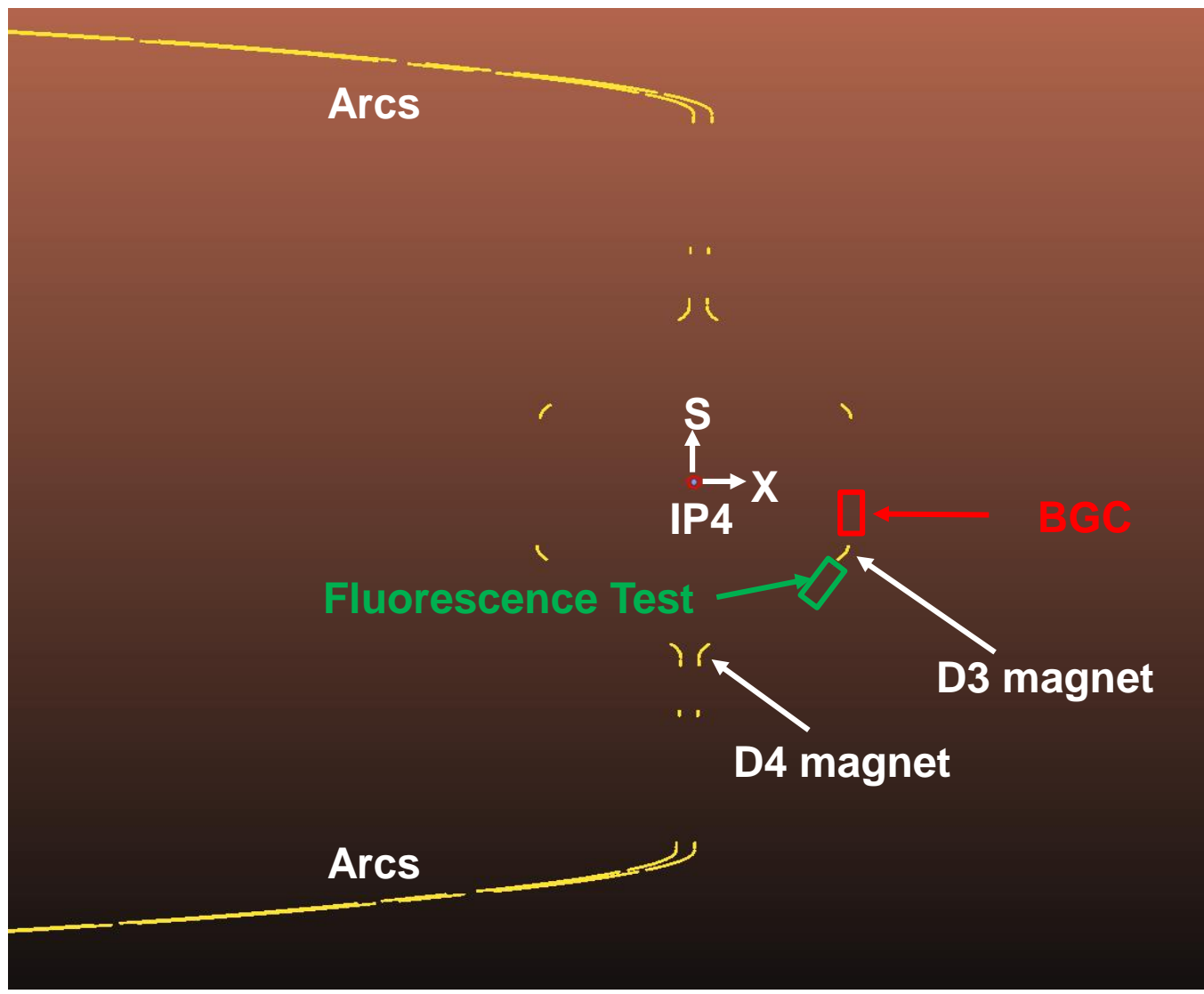
**Beam Screen for
D3 and D4 magnets
as per LHCVSSJ_0021;
Thickness: 0.6 mm**



Else: Drift tubes diameter 80 mm

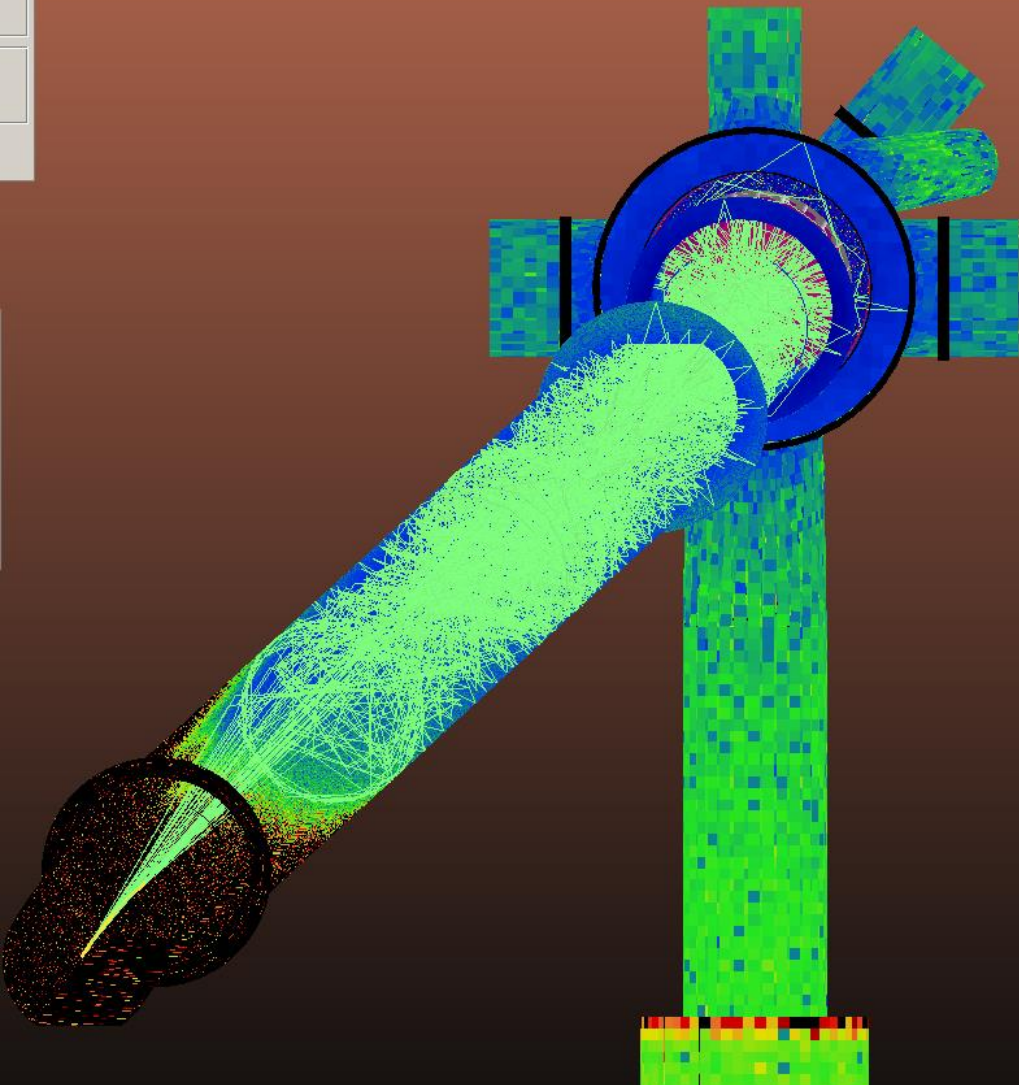
Courtesy: M. Ady

Synchrotron Radiation



Fluorescence Test D4

D4 to Fluorescence Test: about 60 m

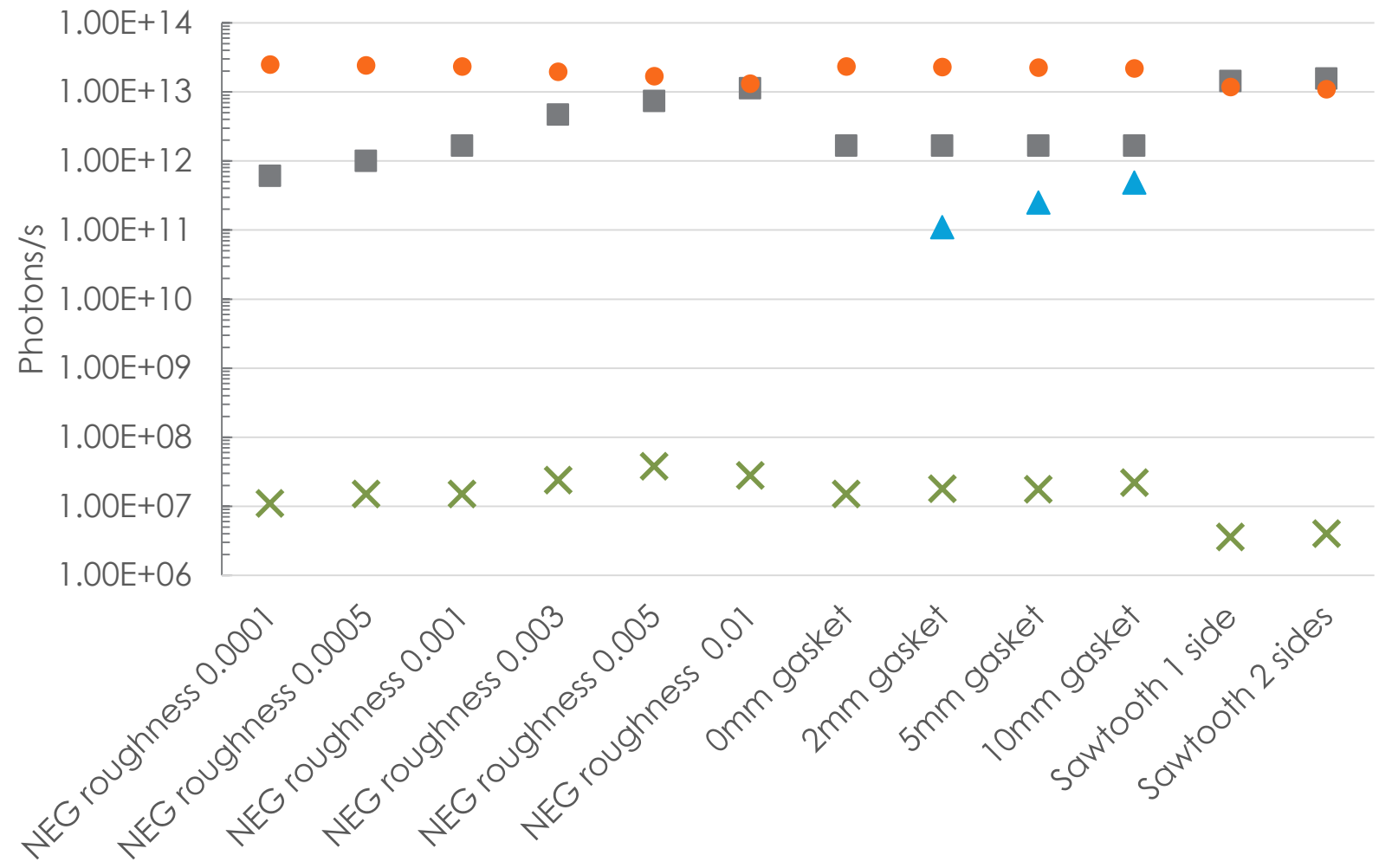


| | | | | | | | | | |
|------------|--------------------------------|--------------|---------|-----------|--------|----------------|----------------|---------------|------------------|
| 9861.2842 | | 102791 | 101801 | -135.797 | 6.663 | 9861.2842 | 9867.9472 | LQYBB.5L4 | QSL4 |
| 9867.9472 | | 102792 | 101648 | -129.134 | 11.42 | 9867.9472 | 9879.3672 | LBRBA.5L4 | D4L4 |
| 9879.3672 | VACSEC.F5L4.B VACSEC.F5L4.R | 272086 | 571161 | -117.714 | 0.655 | 9879.3672 | 9880.0222 | VAFHB.5L4.C | VAFHB.1174.5L4.C |
| 9880.0222 | VACSEC.E5L4.B | 637477 | 271757 | -117.059 | 7 | 9880.0222 | 9887.0222 | VCDA.G5L4.B | VCDA.1136.5L4.B |
| 9887.0222 | VACSEC.E5L4.B | 637476 | 271848 | -110.059 | 0.3 | 9887.0222 | 9887.3222 | VMAAB.C5L4.B | VMAAB.1099.5L4.B |
| 9887.3222 | VACSEC.E5L4.B | 637475 | 271757 | -109.759 | 7 | 9887.3222 | 9894.3222 | VCDA.F5L4.B | VCDA.1063.5L4.B |
| 9894.3222 | VACSEC.E5L4.B | 637474 | 2208114 | -102.759 | 0.3 | 9894.3222 | 9894.6222 | VAMWD.D.5L4.B | VAMWD.1026.5L4.B |
| 9894.6222 | VACSEC.E5L4.B | 637473 | 271757 | -102.459 | 7 | 9894.6222 | 9901.6222 | VCDA.E5L4.B | VCDA.990.5L4.B |
| 9901.6222 | VACSEC.E5L4.B | 637472 | 271848 | -95.459 | 0.3 | 9901.6222 | 9901.9222 | VMAAB.B5L4.B | VMAAB.953.5L4.B |
| 9901.9222 | VACSEC.E5L4.B | 637471 | 271757 | -95.159 | 7 | 9901.9222 | 9908.9222 | VCDA.D5L4.B | VCDA.917.5L4.B |
| 9908.9222 | VACSEC.E5L4.B | 637470 | 606708 | -88.159 | 0.3 | 9908.9222 | 9909.2222 | VAMFA.F5L4.B | VAMFA.880.5L4.B |
| 9909.2222 | VACSEC.E5L4.B | 637404 | 625093 | -87.859 | 6.648 | 9909.2222 | 9915.8702 | VDFE.F5L4.B | VDFE.845.5L4.B |
| 9915.8702 | VACSEC.E5L4.B | 637469 | 1660215 | -81.211 | 0.645 | 9915.8702 | 9916.5152 | VAEHK.5L4.B | VAEHK.809.5L4.B |
| 9916.5152 | VACSEC.D5L4.B | 637468 | 271757 | -80.566 | 7 | 9916.5152 | 9923.5152 | VCDA.C5L4.B | VCDA.771.5L4.B |
| 9923.5152 | VACSEC.D5L4.B | 637467 | 615849 | -73.566 | 0.2 | 9923.5152 | 9923.7152 | VMAAA.D5L4.B | VMAAA.735.5L4.B |
| 9923.7152 | VACSEC.D5L4.B | 637462 | 271757 | -73.366 | 7 | 9923.7152 | 9930.7152 | VCDA.B5L4.B | VCDA.699.5L4.B |
| 9930.7152 | VACSEC.D5L4.B | 637464 | 279448 | -66.366 | 0.2 | 9930.7152 | 9930.9152 | VCDDS.B5L4.B | VCDDS.663.5L4.B |
| 9930.9152 | VACSEC.D5L4.B | 637461 | 799281 | -66.166 | 0.3 | 9930.9152 | 9931.2152 | VAMFR.5L4.B | VAMFR.660.5L4.B |
| 9931.2152 | | 642434 | 642431 | -65.866 | 0.85 | 9931.2152 | 9932.0652 | MGMWH.A5L4.B1 | |
| 9932.0652 | VACSEC.D5L4.B | 4633320 6 | 5730801 | -65.016 | 0.2 | 9932.0652 | 9932.2652 | VCDNA.B5L4.B | VCDNA.649.5L4.B |
| 9932.2652 | VACSEC.D5L4.B | 637465 | 615849 | -64.816 | 0.2 | 9932.2652 | 9932.4652 | VMAAA.C5L4.B | VMAAA.649.5L4.B |
| 9932.4652 | VACSEC.D5L4.B | 4009011 1 | 625163 | -64.616 | 1.4 | 9932.4652 | 9933.8652 | VCDFJ.B5L4.B | VCDFJ.640.5L4.B |
| 9932.63205 | | 2057442 | 2057333 | -64.44915 | 0.85 | 9932.6320 5 | 9933.4820 5 | MGMWH.C5L4.B1 | |
| 9933.8652 | VACSEC.D5L4.B | 637466 | 615849 | -63.216 | 0.2 | 9933.8652 | 9934.0652 | VMAAA.B5L4.B | VMAAA.631.5L4.B |
| 9934.0652 | VACSEC.D5L4.B | 4633320 5 | 5730801 | -63.016 | 0.2 | 9934.0652 | 9934.2652 | VCDNA.A5L4.B | VCDNA.629.5L4.B |
| 9934.2652 | VACSEC.D5L4.B | 4009011 5 | 625163 | -62.816 | 1.4 | 9934.2652 | 9935.6652 | VCDFJ.A5L4.B | VCDFJ.622.5L4.B |
| 9934.43205 | | 2057445 | 2057429 | -62.64915 | 0.85 | 9934.4320 5 | 9935.2820 5 | MGMWH.V5L4.B1 | |
| 9935.6652 | VACSEC.D5L4.B | 637463 | 615849 | -61.416 | 0.2 | 9935.6652 | 9935.8652 | VMAAA.F5L4.B | VMAAA.613.5L4.B |
| 9935.8652 | | 642436 | 642433 | -61.216 | 0.85 | 9935.8652 | 9936.7152 | MGMWH.V5L4.B1 | |
| 9936.7152 | VACSEC.D5L4.B | 637460 | 799267 | -60.366 | 0.3 | 9936.7152 | 9937.0152 | VAMFQ.5L4.B | VAMFQ.602.5L4.B |
| 9937.0152 | VACSEC.D5L4.B | 637459 | 850922 | -60.066 | 0.945 | 9937.0152 | 9937.9602 | VCDFR.A5L4.B | VCDFR.600.5L4.B |
| 9937.9602 | VACSEC.D5L4.B | 637458 | 597985 | -59.121 | 0.205 | 9937.9602 | 9938.1652 | VMAAA.E5L4.B | VMAAA.592.5L4.B |
| 9938.1652 | | 6729055 | 1722304 | -58.916 | 0.285 | 9938.1652 | 9938.4502 | BPMWI.A5L4.B1 | |
| 9938.4602 | VACSEC.D5L4.R VACSEC.D5L4.B | 272117 | 3980193 | -58.621 | 0.655 | 9938.4602 | 9939.1152 | VAHHA.5L4.C | VAHHA.583.5L4.C |
| 9939.1152 | | 102793 | 101654 | -57.966 | 11.556 | 9939.1152 | 9950.6712 | LBRSA.5L4 | D3L4 |
| 9950.6712 | | 102794 | 101810 | -46.41 | 1.691 | 9950.6712 | 9952.3622 | LU.5L4 | |
| 9952.3622 | VACSEC.C5L4.B VACSEC.C5L4.R | 272118 | 571164 | -44.719 | 0.665 | 9952.3622 | 9953.0272 | VAHB.5L4.C | VAHB.444.5L4.C |
| 9953.0272 | VACSEC.B5L4.B | 637505 | 271757 | -44.054 | 7 | 9953.0272 | 9960.0272 | VCDA.A5L4.B | VCDA.406.5L4.B |
| 9960.0272 | VACSEC.B5L4.B | 637504 | 1502597 | -37.054 | 0.29 | 9960.0272 | 9960.3172 | VMAAB.A5L4.B | VMAAB.369.5L4.B |

Fluorescence test sees reflected synchrotron light from D4 magnet

Courtesy: M. Ady

Sr absorption flux (photons/sec)



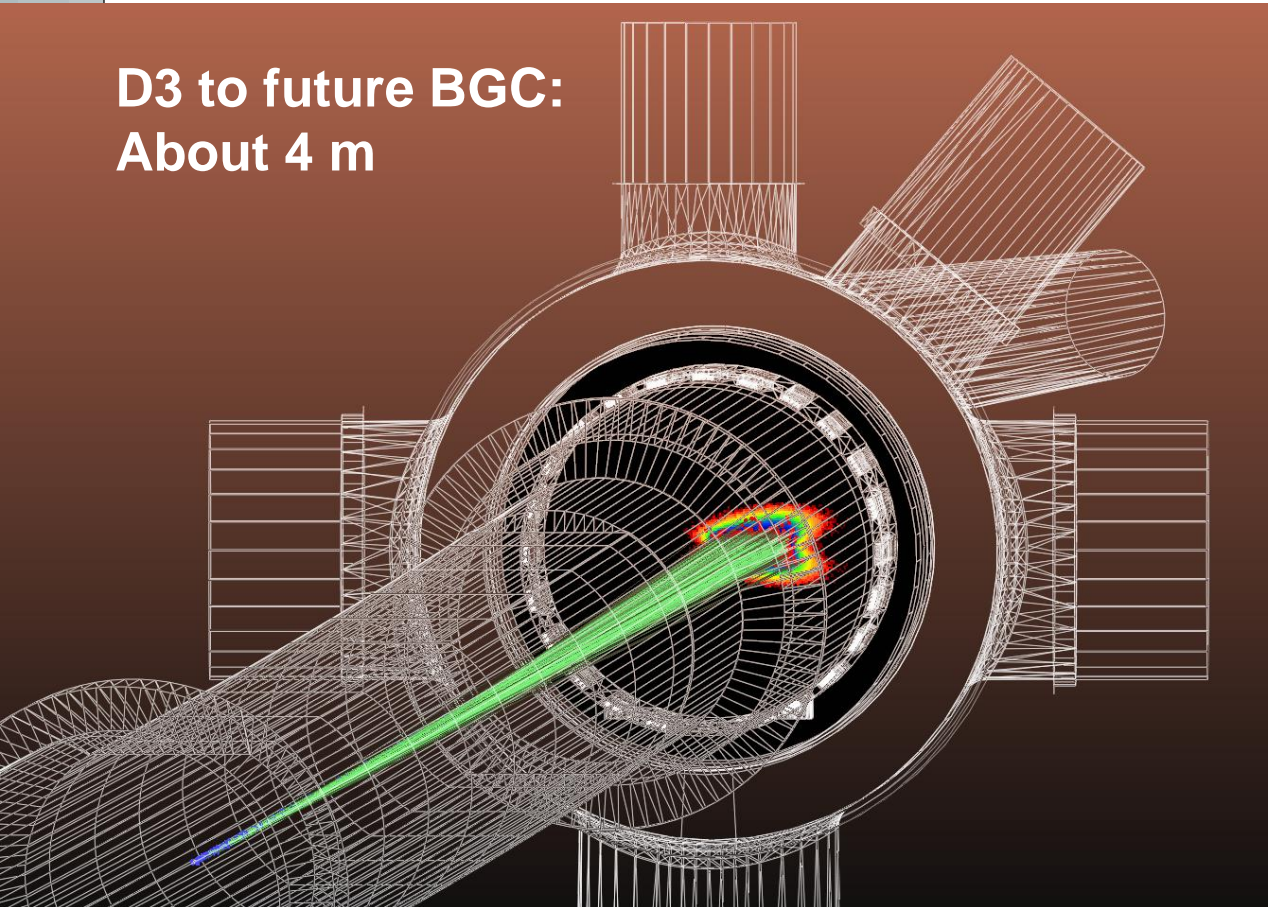
Flexible Parameters

■ NEG ● Target ▲ Gasket × Camera

Courtesy: M. Ady

BGC location

D3 to future BGC:
About 4 m



| | | | | | | | | | |
|------------|--------------------------------|-----------|----------|-----------|--------|------------|------------|------------------|------------------|
| 9861.2842 | | 102791 | 101801 | -135.797 | 6.663 | 9861.2842 | 9867.9472 | LQYBB.5L4 | QSL4 |
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| 9887.0222 | VACSEC.E5L4.B | 637476 | 271848 | -110.059 | 0.3 | 9887.0222 | 9887.3222 | VMAAB.C5L4.B | VMAAB.1099.5L4.B |
| 9887.3222 | VACSEC.E5L4.B | 637475 | 271757 | -109.759 | 7 | 9887.3222 | 9894.3222 | VCDA.F5L4.B | VCDA.1063.5L4.B |
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| 9894.6222 | VACSEC.E5L4.B | 637473 | 271757 | -102.459 | 7 | 9894.6222 | 9901.6222 | VCDA.E5L4.B | VCDA.990.5L4.B |
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| 9930.7152 | VACSEC.D5L4.B | 637464 | 279448 | -66.366 | 0.2 | 9930.7152 | 9930.9152 | VCDDB.B5L4.B | VCDDB.663.5L4.B |
| 9930.9152 | VACSEC.D5L4.B | 637461 | 799281 | -66.166 | 0.3 | 9930.9152 | 9931.2152 | VAMFR.5L4.B | VAMFR.660.5L4.B |
| 9931.2152 | | 642434 | 642431 | -65.866 | 0.85 | 9931.2152 | 9932.0652 | MGMWH.A5L4.B1 | |
| 9932.0652 | VACSEC.D5L4.B | 4633320.6 | 5730801 | -65.016 | 0.2 | 9932.0652 | 9932.2652 | VCDNA.B5L4.B | VCDNA.649.5L4.B |
| 9932.2652 | VACSEC.D5L4.B | 637465 | 615849 | -64.816 | 0.2 | 9932.2652 | 9932.4652 | VMAAA.C5L4.B | VMAAA.649.5L4.B |
| 9932.4652 | VACSEC.D5L4.B | 4009011.1 | 625163 | -64.616 | 1.4 | 9932.4652 | 9933.8652 | VCDFJ.B5L4.B | VCDFJ.640.5L4.B |
| 9932.63205 | | 2057442 | 2057333 | -64.4915 | 0.85 | 9932.63205 | 9933.48205 | MGMWH.C5L4.B1 | |
| 9933.8652 | VACSEC.D5L4.B | 637466 | 615849 | -63.216 | 0.2 | 9933.8652 | 9934.0652 | VMAAA.B5L4.B | VMAAA.631.5L4.B |
| 9934.0652 | VACSEC.D5L4.B | 4633320.5 | 5730801 | -63.016 | 0.2 | 9934.0652 | 9934.2652 | VCDNA.A5L4.B | VCDNA.629.5L4.B |
| 9934.2652 | VACSEC.D5L4.B | 4009011.5 | 625163 | -62.816 | 1.4 | 9934.2652 | 9935.6652 | VCDFJ.A5L4.B | VCDFJ.622.5L4.B |
| 9934.43205 | | 2057445 | 2057429 | -62.64915 | 0.85 | 9934.43205 | 9935.28205 | MGMWH.D5L4.B1 | |
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| 9935.8652 | | 642436 | 642433 | -61.216 | 0.85 | 9935.8652 | 9936.7152 | MGMWH.A5L4.B1 | |
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| 9938.1652 | | 6729055 | 1722304 | -58.916 | 0.285 | 9938.1652 | 9938.4502 | BPMWI.A5L4.B1 | |
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| 9950.6712 | | 102794 | 101810 | -46.41 | 1.691 | 9950.6712 | 9952.3622 | LU.5L4 | |
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| 9960.0272 | VACSEC.B5L4.B | 637504 | 1502597 | -37.054 | 0.29 | 9960.0272 | 9960.3172 | VMAAB.A5L4.B | VMAAB.369.5L4.B |

D3 synchrotron light not toughing BGC, only multiscattered and backscattered photons

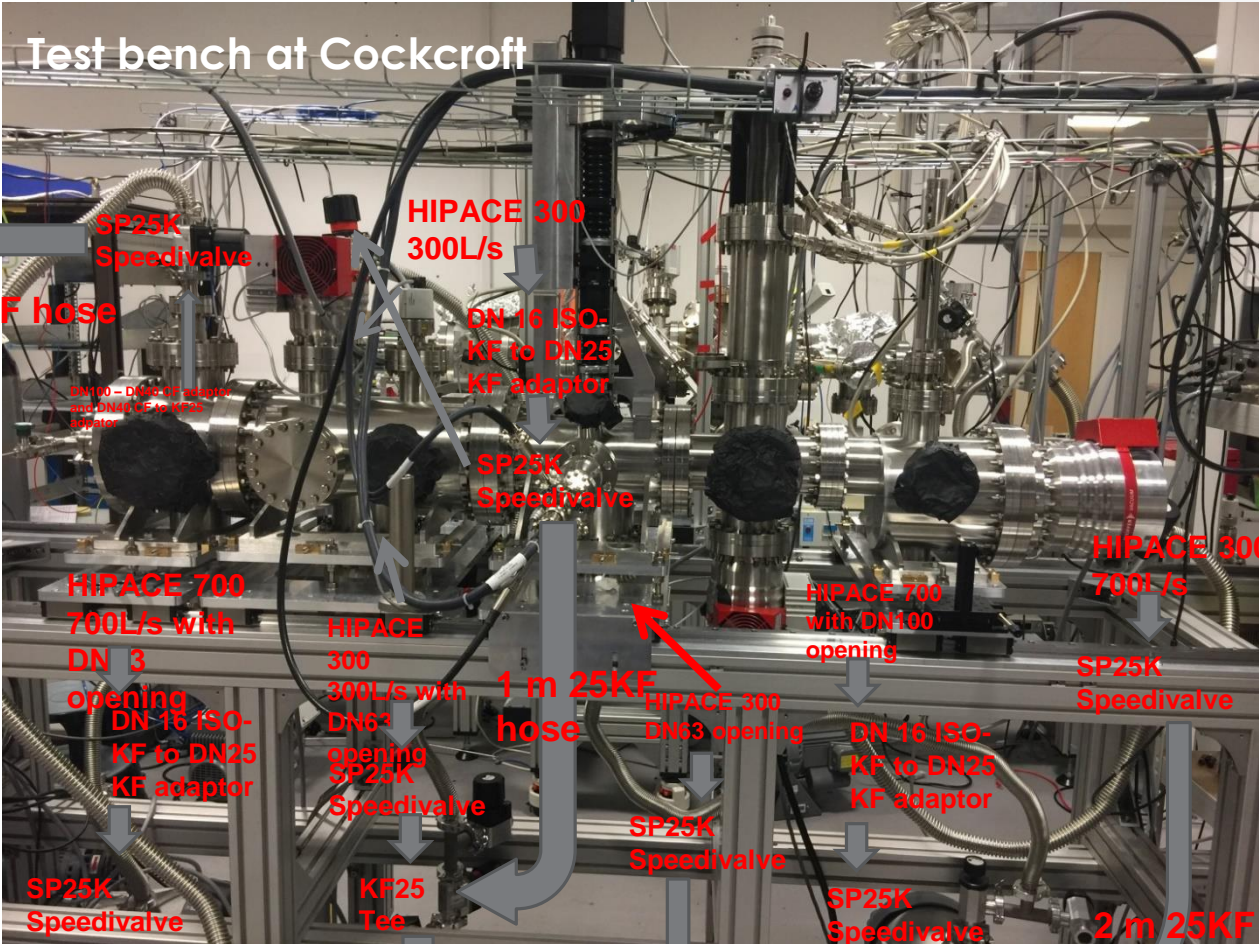
Courtesy: M. Ady

Summary Synchrotron Radiation

- **D3 dipole basically no contribution, only backscattered light**
- **D4 dipole (60m upstream) scatters light downstream- important for fluorescence test, much reduced at the level of the BGC**
- **NEG coating is still quite shiny**
- **Simulation not sensitive to roughness**
- **Gasket with diameter restriction doesn't help much**
- **Sawtooth would be beneficial**

Vacuum Considerations

- **V2 Layout**
- **V3 Layout**
- **Tests performed**
- **Requirements for control system**
- **Status of vacuum installation**
- **Open issues**



Test bench at Cockcroft

nXDS10i scroll pump from Edwards
 2 m 25KF hose

This Channel is used for initial pumping, will be turned off when Turbo turns on.

2 m 25KF hose

HIPACE 300 300L/s

DN 16 ISO-KF to DN25 KF adaptor

SP25K Speedivalve

HIPACE 700 700L/s with DN 3 opening

DN 16 ISO-KF to DN25 KF adaptor

SP25K Speedivalve

HIPACE 300 300L/s with DN6³ opening

SP25K Speedivalve

0.5 m 25KF hose

1 m 25KF hose

0.75 m 25KF hose

HIPACE 700 with DN100 opening

HIPACE 300 DN63 opening

SP25K Speedivalve

SP25K Speedivalve

HIPACE 300 700L/s

DN 16 ISO-KF to DN25 KF adaptor

SP25K Speedivalve

SP25K Speedivalve

2 m 25KF hose

1 m 25KF hose

nXDS15i scroll pump from Edwards

nXDS15i scroll pump from Edwards

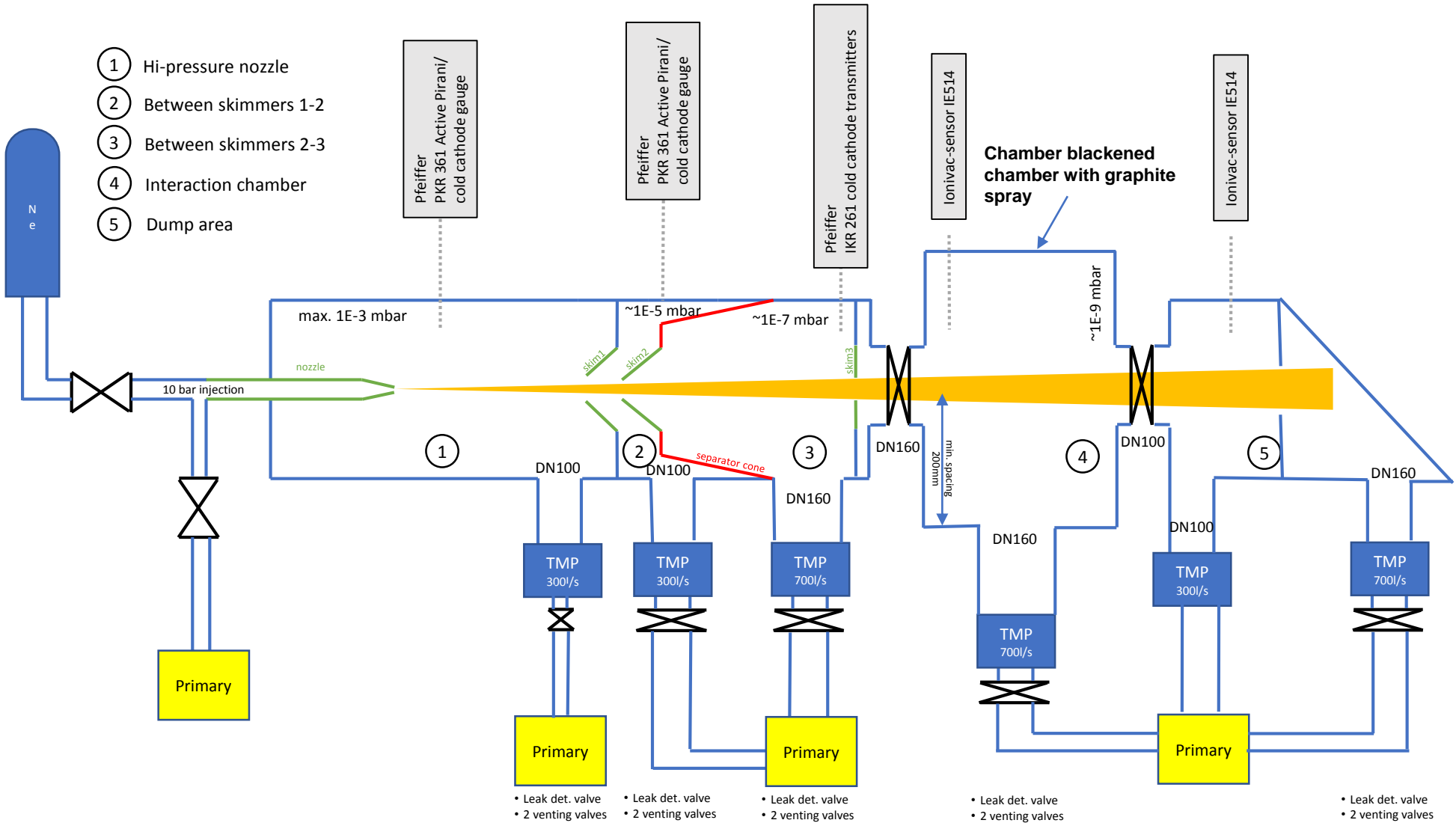
2* KF25 Tee

1 m 25KF hose

nXDS15i scroll pump from Edwards

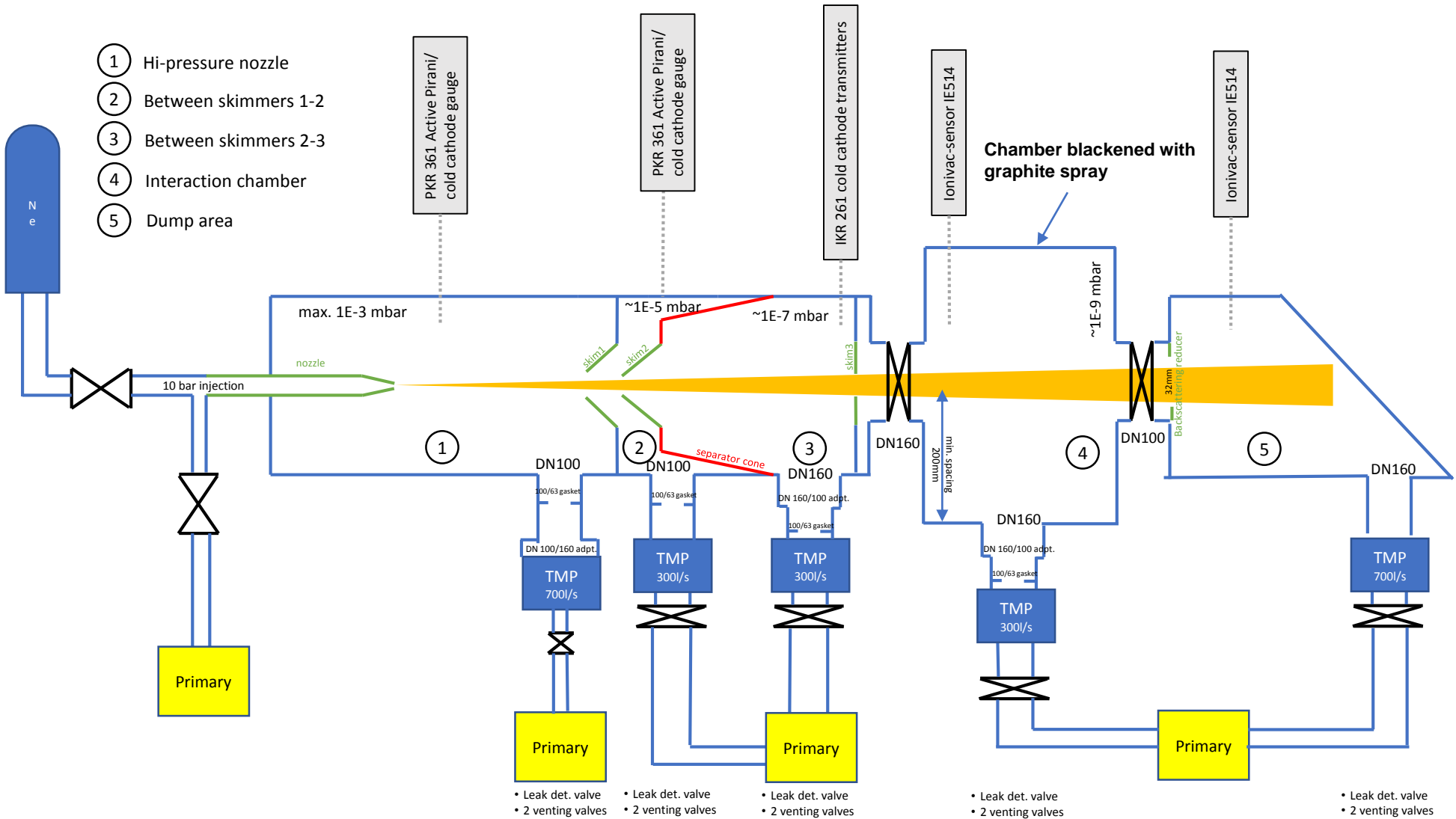
Cockcroft V2 Installation

- ① Hi-pressure nozzle
- ② Between skimmers 1-2
- ③ Between skimmers 2-3
- ④ Interaction chamber
- ⑤ Dump area

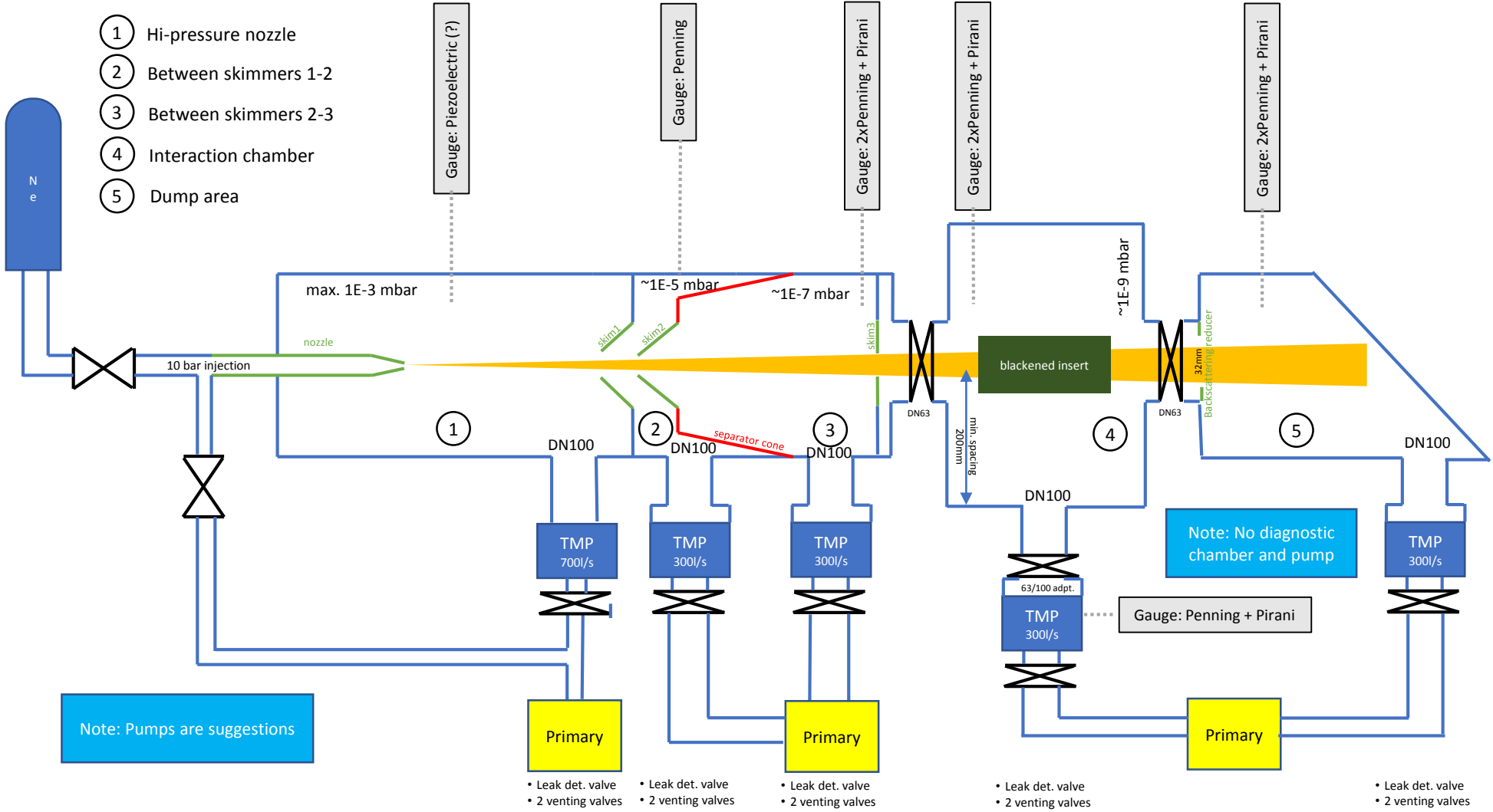


Cockcroft V2 modification for pump and pressure tests

- ① Hi-pressure nozzle
- ② Between skimmers 1-2
- ③ Between skimmers 2-3
- ④ Interaction chamber
- ⑤ Dump area



CERN V3 Installation



Pumping Test Performed on Nozzle chamber

➤ Issue: TMP on Nozzle chamber overheats.

Tests made with TMP rotation speeds and alternative primary pumps EBARA 250 and ACP28 during visit VSC E. Page and J. Finelle to Cockcroft

➤ Results: Pressure in Nozzle chamber with primary backed TMP Pfeiffer 700, Nozzle 30 microns and 5 bar

- P Nozzle chamber= 4.0^{E-3} mbar
- Photon number: 7400 to 7600 for all combinations of primary pumps to TMP
- Temperature at 820 Hz (100%) and 1.3 A of TMP: up to 46°C
- Temperature when reducing TMP speed to 546 Hz and 0.8 A: up to 40°C – no significant pressure increase or photon reduction compared to 820 Hz

➤ Results: Only primary pumps on Nozzle chamber

- P Nozzle chamber= 1.5^{E-1} mbar
- No gas jet

Conclusion on Nozzle chamber pumping tests:

- **Turbo Molecular Pump on Nozzle chamber needed**
- **Reduction of rotation speed seems a solution to avoid overheating the pump without losing significant performance loss.**
- **Alternatives:**
 - **water cooling**
 - **lower gas load (20 μm nozzle?)**
 - **multiple pumps**
 - **investigation in high pressure TMP**

Requirements for Vacuum Controls

- **Fool-proof safe system for LHC operation**
- **Allow for progressive installation in phases – important for valves**
- **Vacuum controls system to be fully tested before LHC tunnel installation (on HEL test stand?)**

Status of the Vacuum Installation

- **Cables for BGC about to be pulled – both for the vacuum system and for the BGC part**
- **Vacuum valves about to be purchased**
- **All vacuum installation parts on the beam vacuum including supports about to be ordered**
- **Installation agreement of the modified BGC is ongoing, CERN internal presentation on 21 June**
- **Not on order: Pumps, gauges, other vacuum chambers, skimmers**