airpointer® O_3 module

UV Absorption

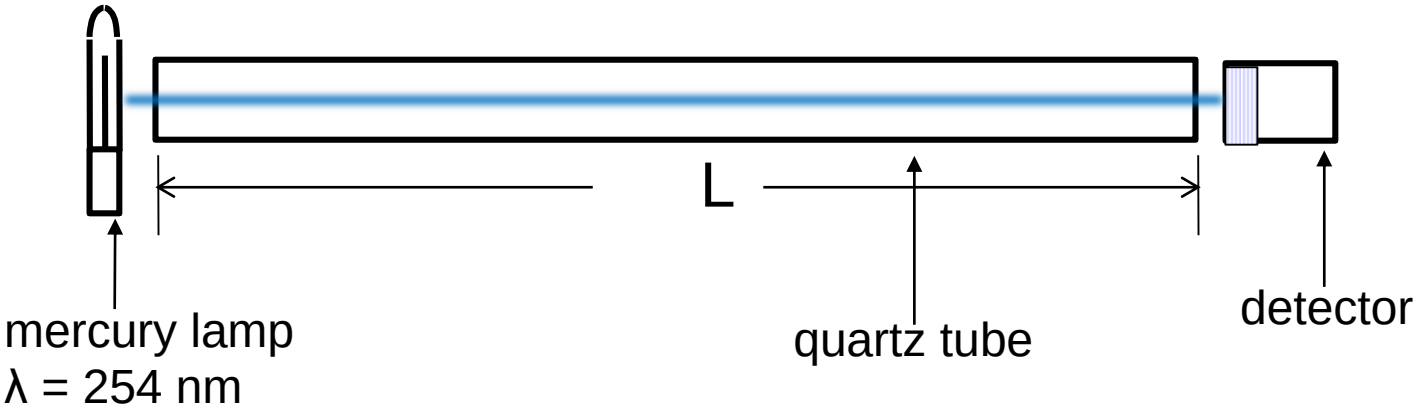
Lambert-Beer's Law:

$$I = I_o \, e^{-\alpha L c}$$

$$c = \ln (I_o/I) \, (1/\alpha L)$$

I:	Intensity of the light transmitted (after absorption)
I_o:	Intensity of the light emitted
α:	absorption coefficient of the gas (here: ozone)
L:	absorption path length
c:	concentration of the absorbing gas (here: ozone)

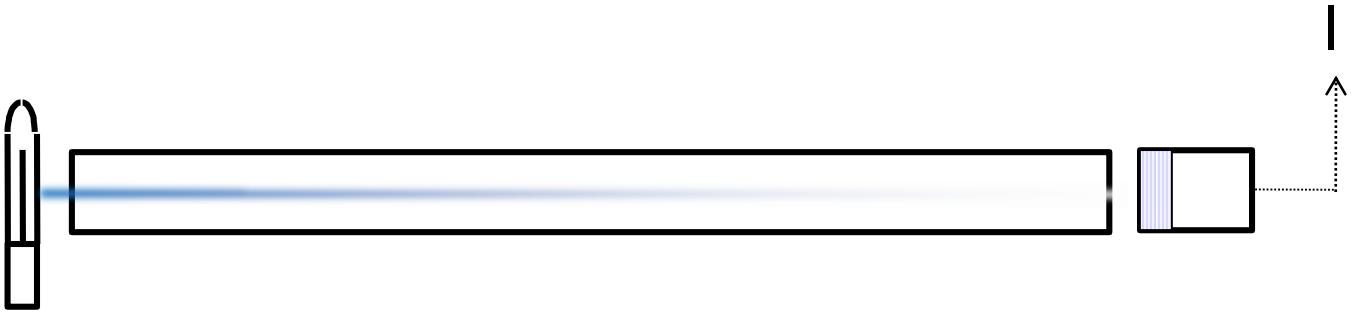
03 Module



We know the distance (L) that the light has to travel through the tube. This distance is "L" in the Lambert-Beer equation (α is a known constant):

$$c = \ln (I_o/I) (1/\alpha L)$$

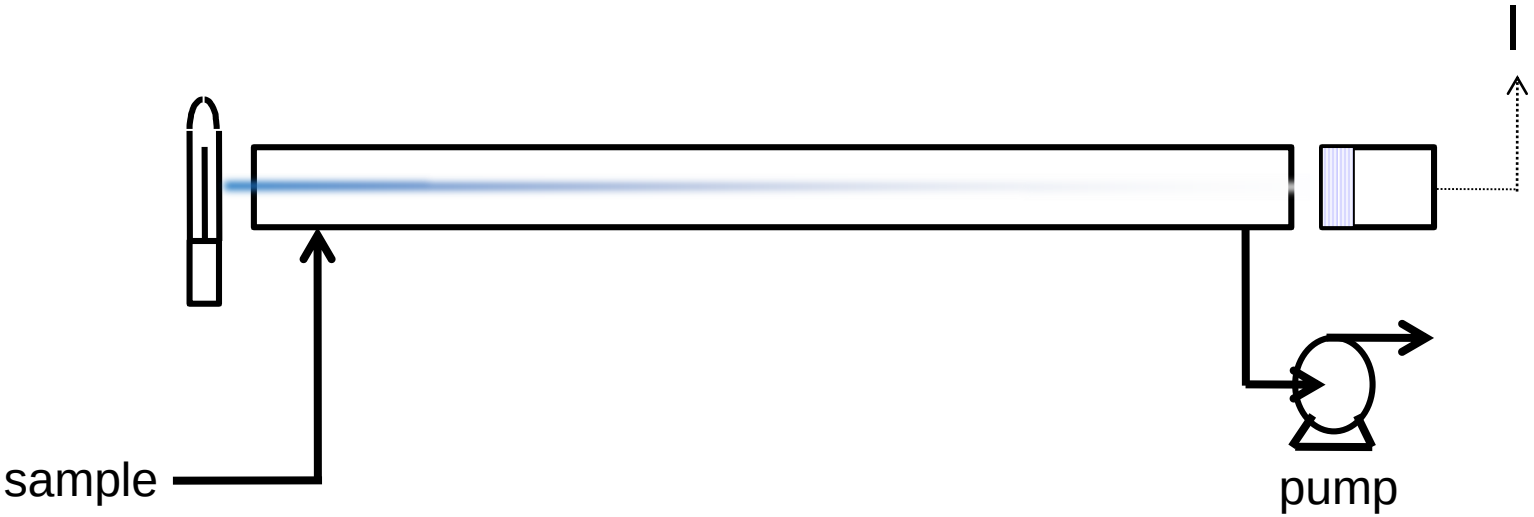
03 Module



If the sample contains ozone, some of the light will be absorbed. The output of the detector then corresponds to "I" in the Lambert-Beer equation.

$$c = \ln (I_o/I) (1/\alpha L)$$

03 Module



If the sample contains ozone, some of the light will be absorbed. The output of the detector then corresponds to "I" in the Lambert-Beer equation.

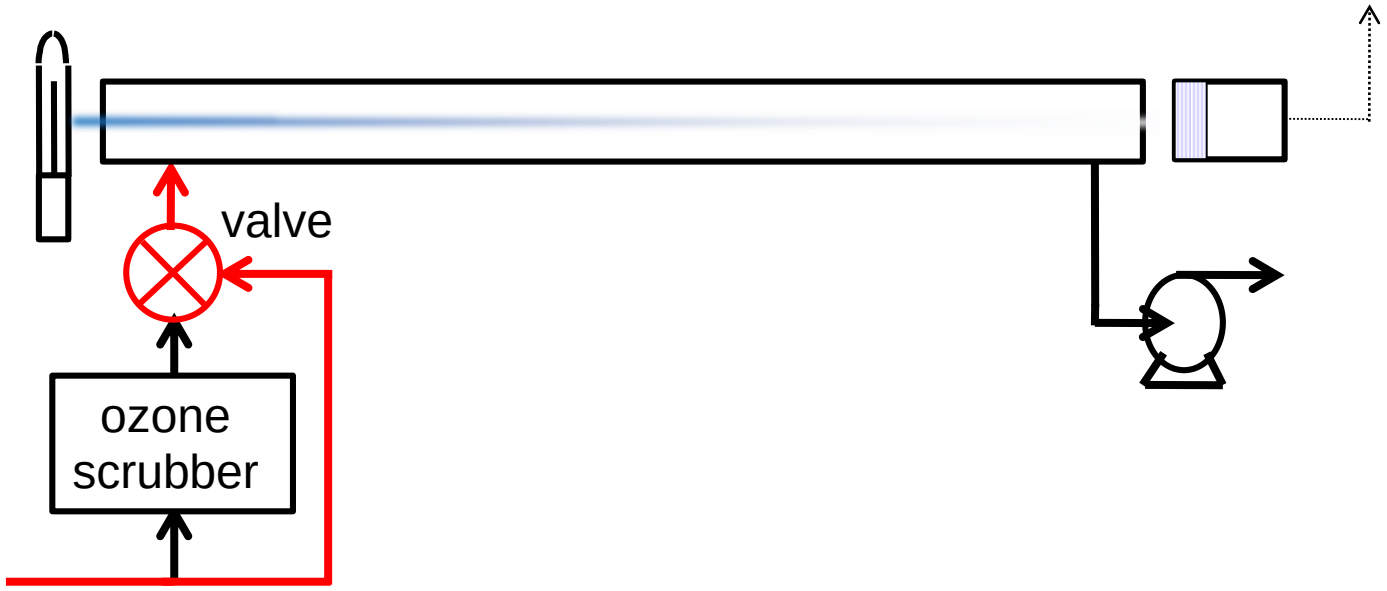
$$c = \ln (I_o/I) (1/\alpha L)$$

03 Module

At the ozone scrubber, all ozone is destroyed. No other influence on the measuring gas occurs. The output of the detector is the I_0 in the Lambert-Beer equation:

$$c = \ln (I_o/I) (1/\alpha L)$$

03 Module



In our module the valve switches every six seconds. This enables us nearly continuous measurements of the ozone concentration.

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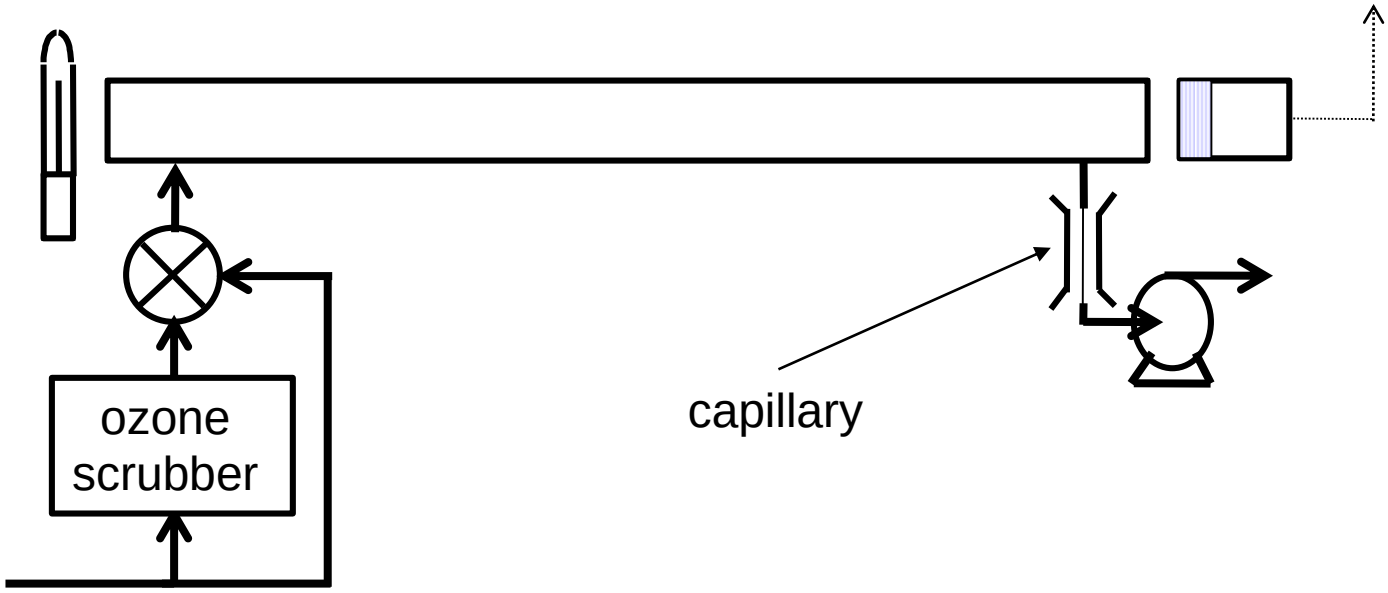


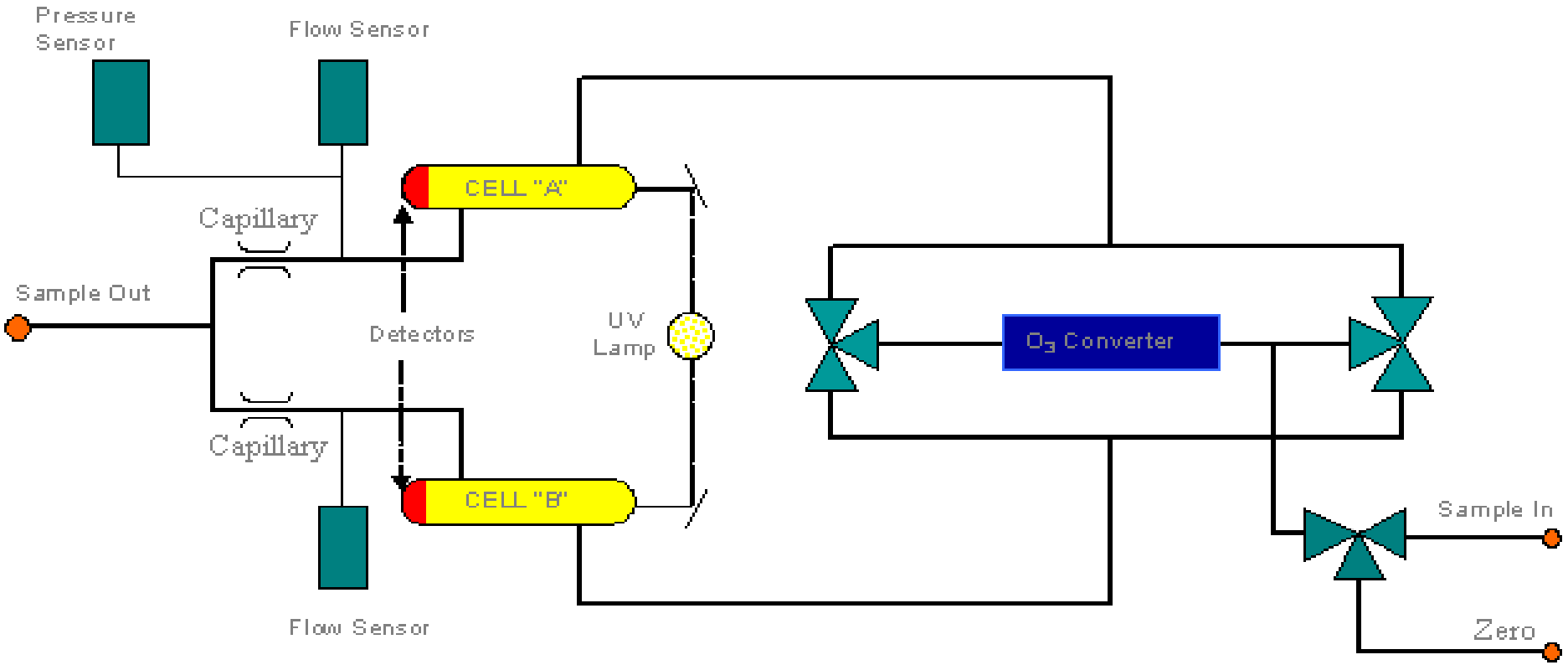
Adding a capillary before the pump gives the analyzer a stable flow rate.

03 Module

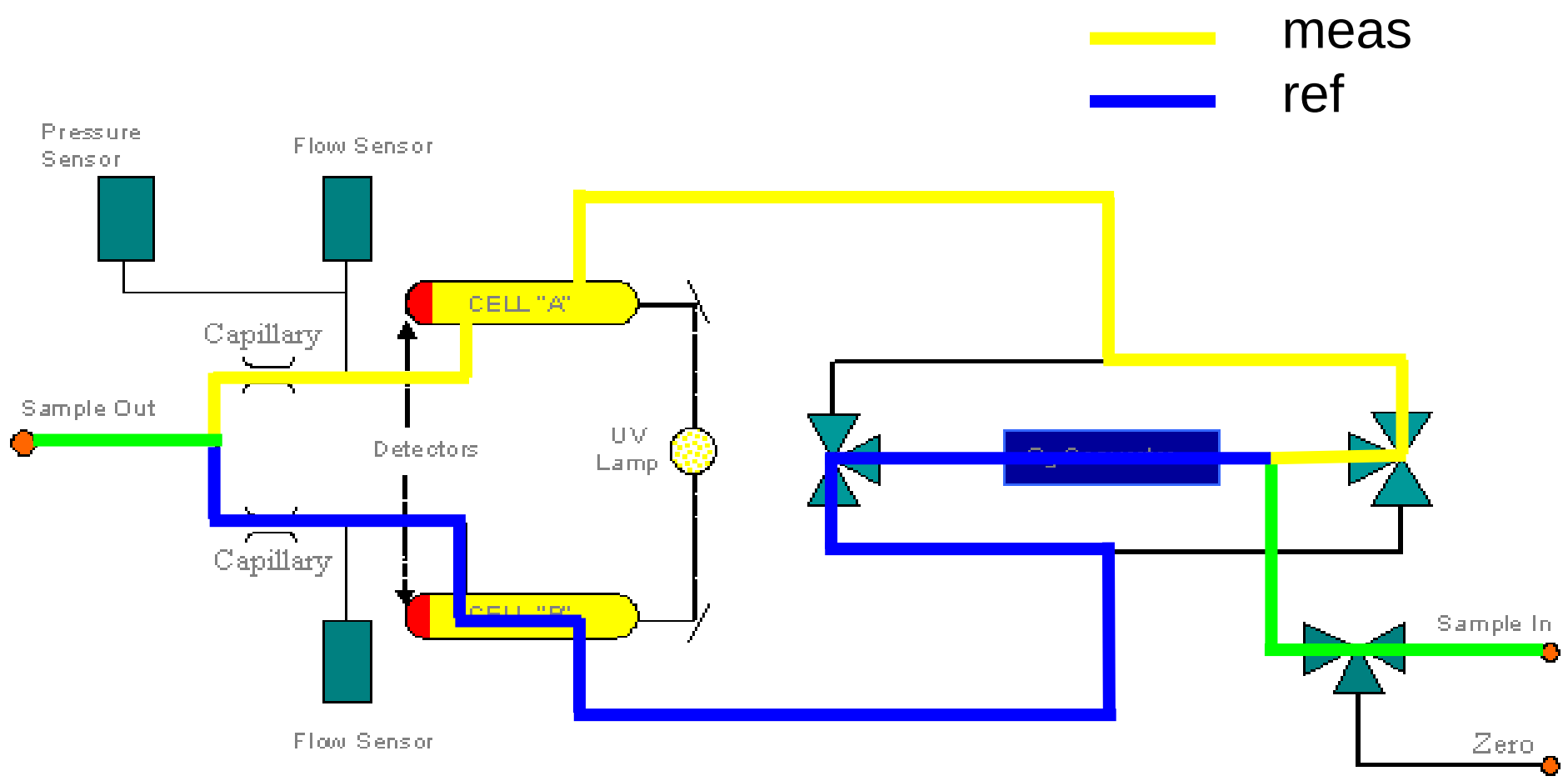
To compensate the fluctuations of the UV lamp, we use a dual bench, dual detector and a single lamp

If one bench is in the reference (I_0) – mode, the other is in the measuring (I)-mode.

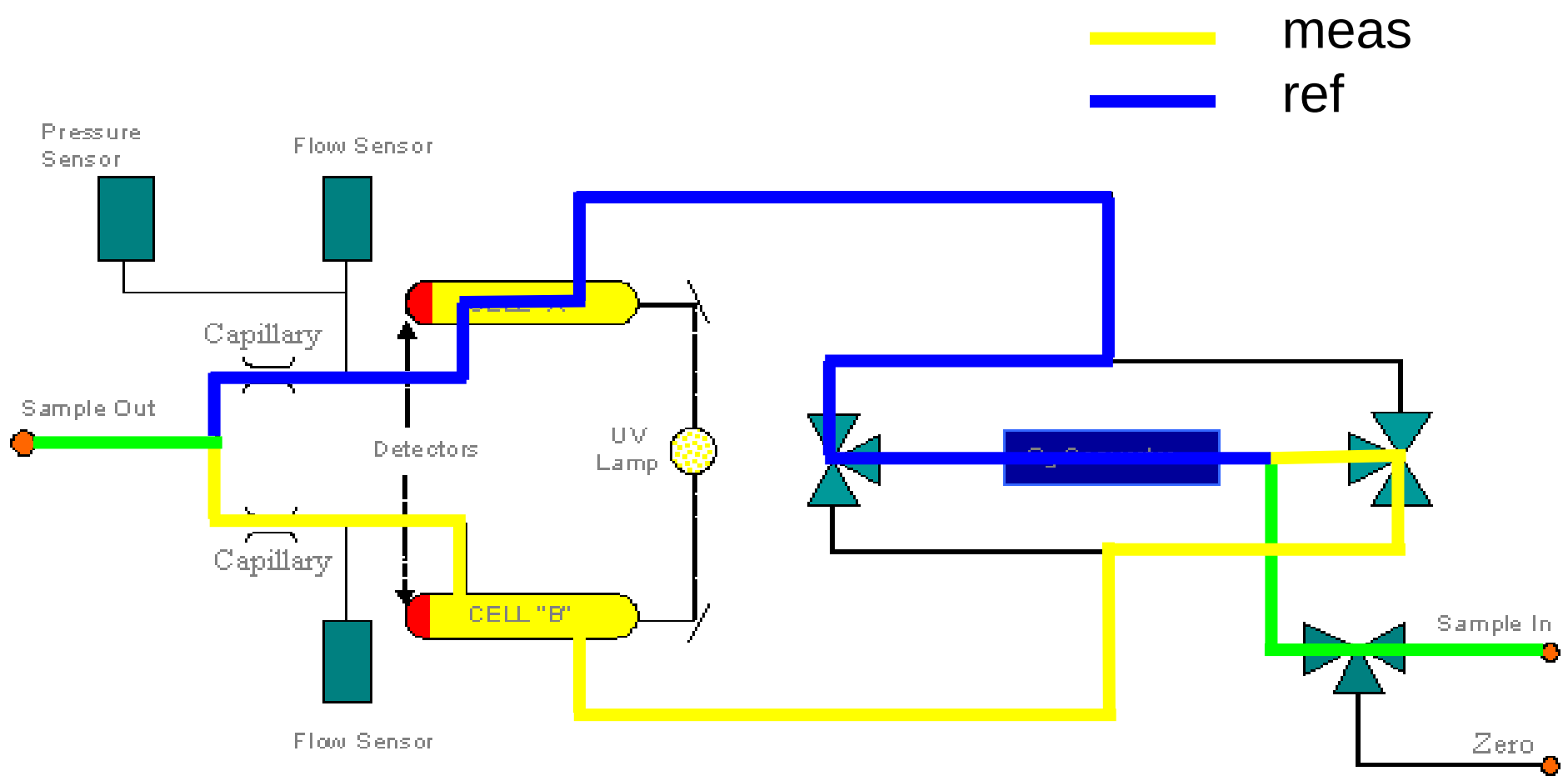
Flow diagram



Flow diagram



Flow diagram



Parameters

O3Sensor

G/P	Status	Parameter	Actual	Average	Unit	lower limit fail	lower limit warn	upper limit warn	upper limit fail	Board Adr
G3P1	OK	O3	49.3	49.1	ppb	-	-	-	-	-
G3P2	OK	PressO3	876.2	872.4	mbar	300.0	500.0	1200.0	1300.0	083
G3P3	OK	BenchTO3	50.0	50.0	°C	46.0	48.0	65.0	68.0	099
G3P5	OK	SampleTempO3	29.2	29.2	°C	0.0	10.0	60.0	75.0	083
G3P11	OK	PowerToBenchO3	9.4	9.4	%	-	-	-	-	099
G3P13	OK	LampPower	32.0	32.0	%	-	-	-	-	-
G3P14	OK	O3_all	49.3	49.1	ppb	-	-	-	-	-
G3P15	OK	O3StdDev	1.12	1.44	ppb	-	-	-	-	-
G3P16	OK	PhotoOutMeas_A	118059	118030	Hz	20000	30000	190000	200000	083
G3P17	OK	PhotoOutMeas_B	84552	84528	Hz	20000	30000	190000	200000	083
G3P18	OK	PhotoOutRef_A	118107	118072	Hz	20000	30000	190000	200000	083
G3P19	OK	PhotoOutRef_B	84586	84566	Hz	20000	30000	190000	200000	083
G3P20	OK	O3_A_raw	49	51	ppb	-5000	-1000	-	-	-
G3P21	OK	O3_B_raw	50	52	ppb	-5000	-1000	-	-	-
G3P22	OK	LampCurrO3	6.64	2.45	mA	0.00	0.40	22.00	24.00	083
G3P23	OK	Flow_A	536	538	ml/min	300	350	850	950	083
G3P24	OK	Flow_B	551	551	ml/min	300	350	850	950	083
G3P25	OK	O3GenPress	991.6	991.7	mbar	300.0	500.0	1200.0	1300.0	099
G3P26	OK	O3GenTemp	49.8	49.8	°C	46.0	48.0	65.0	68.0	099
G3P27	OK	O3GenTPower	48.3	47.5	%	-	-	-	-	099
G3P28	OK	O3GenLampCurr	0.3	0.3	mA	-	-	22.0	24.0	099
G3P29	OK	O3GenIntensity	42.3	42.3	mV	-	10.0	4950.0	-	099
G3P31	OK	O3GenPower	0.0	0.0	%	-	-	-	-	-
G3P34	OK	O3_raw	49.1	51.1	ppb	-	-	-	-	-

Parameters

O3Sensor

G/P	Status	Parameter	Actual	Average	Unit			upper limit warn	upper limit fail	Board Adr
G3P1	OK	O3	49.3	49.1	ppb			-	-	-
G3P2	OK	PressO3	876.2	872.4	mbar			1200.0	1300.0	083
G3P3	OK	BenchTO3	50.0	50.0	°C	46.0	48.0	65.0	68.0	099
G3P5	OK	SampleTempO3	29.2	29.2	°C			0	75.0	083
G3P11	OK	PowerToBenchO3	9.4	9.4	%				-	099
G3P13	OK	LampPower	32.0	32.0	%				-	-
G3P14	OK	O3_all	49.3	49.1	ppb	-	-	-	-	-
G3P15	OK	O3StdDev	1.12	1.44	ppb	-	-	-	-	-
G3P16	OK	PhotoOutMeas_A	118059	118030	Hz	20000	30000	190000	200000	083
G3P17	OK	PhotoOutMeas_B	84552	84528	Hz	20000	30000	190000	200000	083
G3P18	OK	PhotoOutRef_A	118107	118072	Hz	20000	30000	190000	200000	083
G3P19	OK	PhotoOutRef_B	84586	84566	Hz	20000	30000	190000	200000	083
G3P20	OK	O3_A_raw	49	51	ppb	-5000	-1000	-	-	-
G3P21	OK	O3_B_raw	50	52	ppb	-5000	-1000	-	-	-
G3P22	OK	LampCurrO3	6.64	2.45	mA	0.00	0.40	22.00	24.00	083
G3P23	OK	Flow_A	536	538	ml/min		50	850	950	083
G3P24	OK	Flow_B	551	551	ml/min		50	850	950	083
G3P25	OK	O3GenPress	991.6	991.7	mbar	300.0	500.0	1200.0	1300.0	099
G3P26	OK	O3GenTemp	49.8	49.8	°C	46.0	48.0	65.0	68.0	099
G3P27	OK	O3GenTPower	48.3	47.5	%	-	-	-	-	099
G3P28	OK	O3GenLampCurr	0.3	0.3	mA	-	-	22.0	24.0	099
G3P29	OK	O3GenIntensity	42.3	42.3	mV	-	10.0	4950.0	-	099
G3P31	OK	O3GenPower	0.0	0.0	%	-	-	-	-	-
G3P34	OK	O3_raw	49.1	51.1	ppb	-	-	-	-	-

1 to 2 pressure sensor

2 to 3 temperature probes

2 flow sensors

Parameters

O3Sensor

G/P	Status	Parameter	Actual	Average	Unit	lower limit fail	lower limit warn	upper limit warn	upper limit fail	Board Adr
G3P1	OK	O3	49.3	49.1	ppb	-	-	-	-	-
G3P2	OK	PressO3	876.2	872.4	mbar	300.0	500.0	1200.0	1300.0	083
G3P3	OK	BenchTO3	50.0	50.0	°C	46.0	48.0	65.0	68.0	099
G3P5	OK	SampleTempO3	29.2	29.2	°C	0.0	10.0	60.0	75.0	083
G3P11	OK	PowerToBenchO3	9.4	9.4	%	-	-	-	-	099
G3P13	OK	LampPower	32.0	32.0	%	-	-	-	-	-
G3P14	OK	O3_all	49.3	49.1	ppb	-	-	-	-	-
G3P15	OK	O3StdDev	1.12	1.44	ppb	-	-	-	-	-
G3P16	OK	PhotoOutMeas_A	118059	118030	Hz	20000	30000	190000	200000	083
G3P17	OK	PhotoOutMeas_B	84552	84528	Hz	20000	30000	190000	200000	083
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G3P20	OK	O3_A_raw	49	51	ppb	-5000	-1000	-	-	-
G3P21	OK	O3_B_raw	50	52	ppb	-5000	-1000	-	-	-
G3P22	OK	LampCurrO3	6.64	2.45	mA	0.00	0.40	22.00	24.00	083
G3P23	OK	Flow_A	536	538	ml/min	300	350	850	950	083
G3P24	OK	Flow_B	551	551	ml/min	300	350	850	950	083
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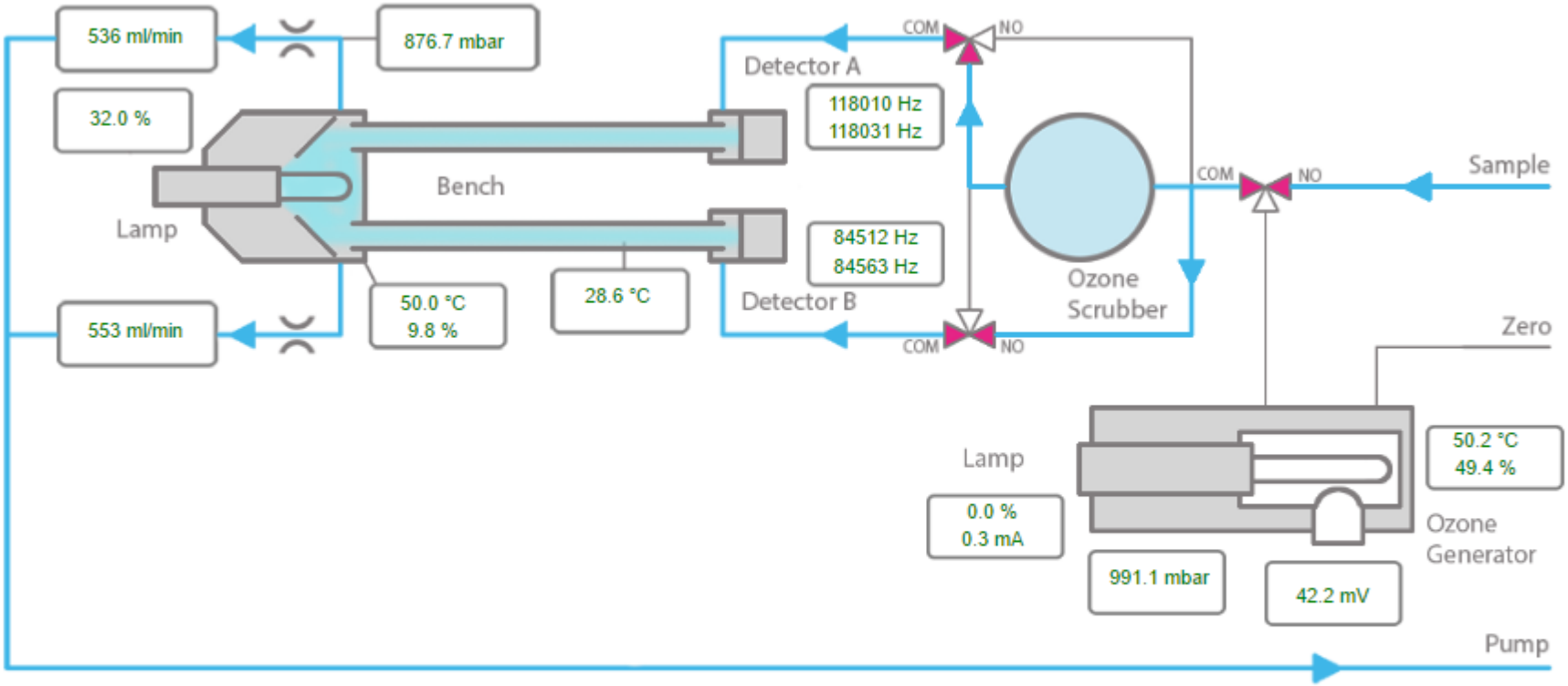
G3P26	OK	O3GenTemp	49.8	49.8	°C	46.0	48.0	65.0	68.0	099
G3P27	OK	O3GenTPower	48.3	47.5	%	-	-	-	-	099
G3P28	OK	O3GenLampCurr	0.3	0.3	mA	-	-	22.0	24.0	099
G3P29	OK	O3GenIntensity	42.3	42.3	mV	-	10.0	4950.0	-	099
G3P31	OK	O3GenPower	0.0	0.0	%	-	-	-	-	-
G3P34	OK	O3_raw	49.1	51.1	ppb	-	-	-	-	-

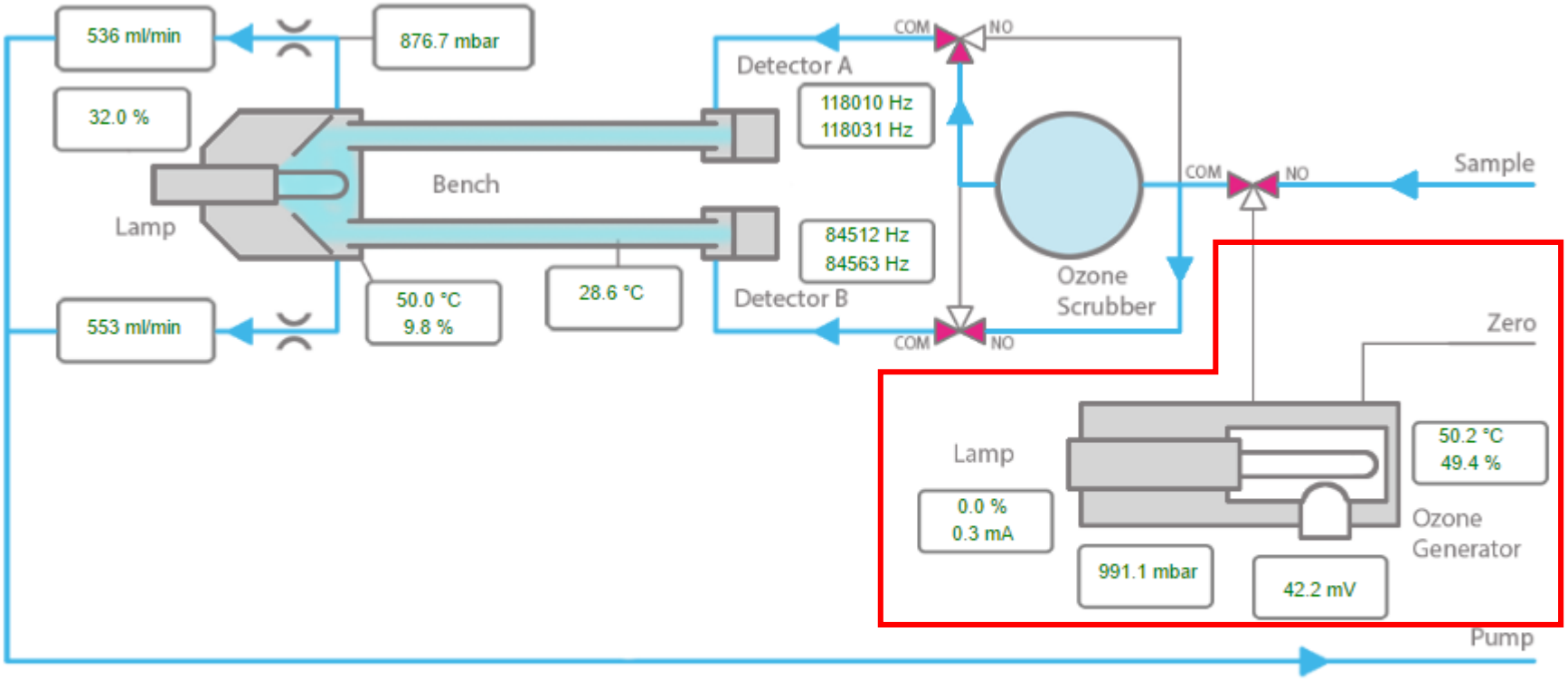
Parameters



O3 49.9 ppb

Note: '-9999' is displayed for a missing value.

Span check



O3 49.9 ppb

Note: '-9999' is displayed for a missing value.

Calibration

- Using external zero air and external ozone generator (O_3 generated by oxidation of O_2 by UV light)

Preventive maintenance

Every year:
- Cleaning absorption tubes

Every 3-4 years:
- UV Lamp
- O_3 scrubber

Full schedule available here:
https://www.airpointer.tech/maintenance-schedule/

Troubleshooting O_3

PhotoOutRef and PhotoOutMeas unstable

→ dirty tubings, unstable temperature, or not optimum control loops

Thank you for your attention!