CAMPBELL SCIENTIFIC®

WHEN MEASUREMENTS MATTER

涡动通量系统的野外维护:

数据采集器, 三维超声风速仪, 红外气体分析仪

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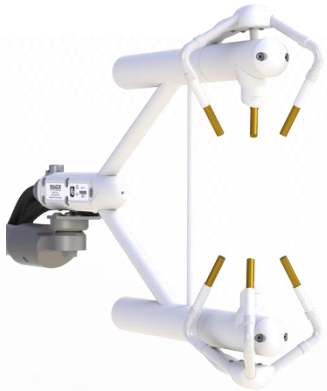
2021年8月，北京

目录:

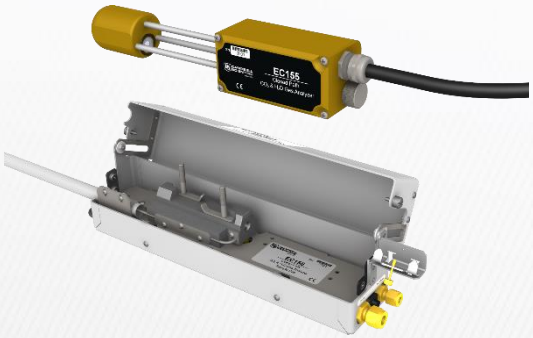
李晗

问题：

工程师好，想咨询一下，开路和闭路系统如何检验所测的水汽和二氧化碳通量是准确的？安装一段时间后，如何校准，谢谢



- 怎样定义准确性 (平均和脉动)
- Zero vs Span 误差贡献
- 清洁光路
- 横向对比 （零气、相对湿度）
- CO2标气溯源



- 闭路设备通常变化更平缓
- 腔室温度和腔室压力平稳
- 直接输出 混合比
- 在线校准
- CO2标气溯源

1. 涡度通量系统的野外维护

数据采集器及其它电子设备

定期更换机箱内部的干燥剂

无凝结条件是保证电子设备长期安全可靠运行的重要保证!

远程或现场访问数据采集器的状态信息

Status Summary
2019/7/10 8:25:36

Datalogger Information
Reported Station Name: 5601
OS Version: CR3000.Std.32.03
OS Date: 08/03/2018
OS Signature: 64273
Panel Temperature: NAN °C
Memory: 4194304 bytes
Watchdog Errors: 17685 - Reset this value. If errors continue, contact Campbell Scientific.

Program Information
Current Program:
Start Time: 2009/5/27 21:16:27
Run Signature: 43690
Program Signature: 0
Results for Last Program Compiled: Warning: Default Settings might have been restored.
No Program
Low Battery, unable to calibrate!
Memory Free: 3848364 bytes

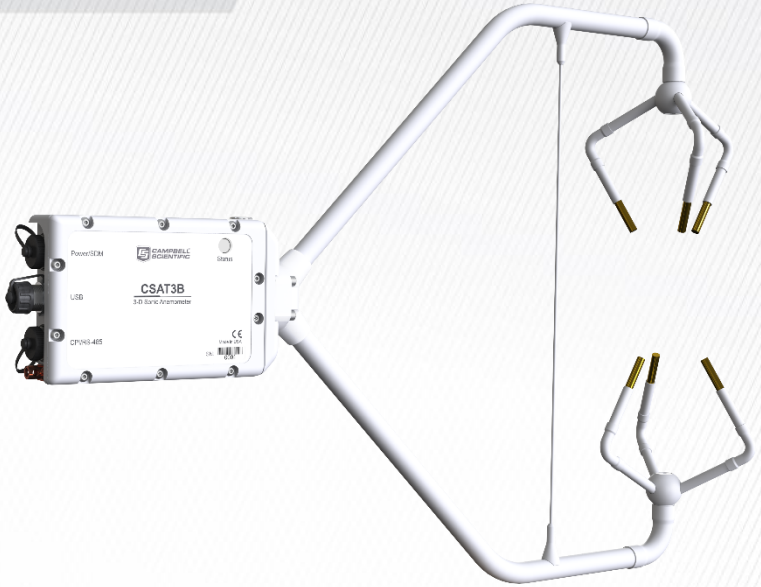
Program Errors
Program Errors: 2
Skipped Scans: 0
Skipped System Scans: 0
Skipped Records in :
Variable Out of Bounds: 0

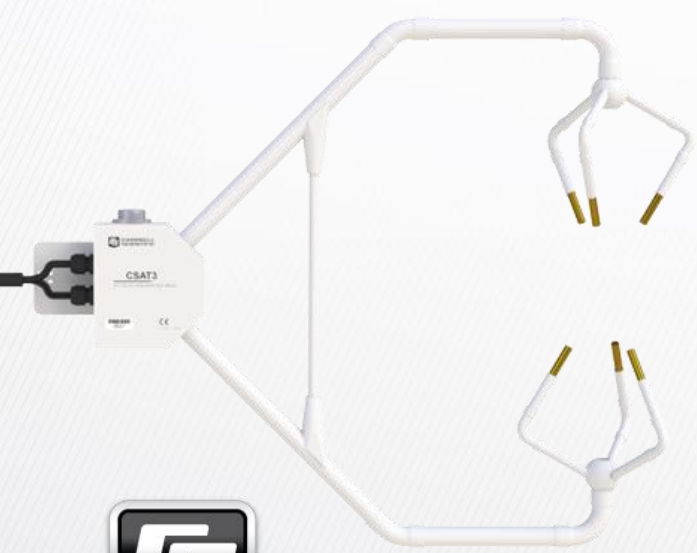
Battery Information
Battery Voltage: 0.00 - The battery voltage is low.
Lithium Battery: 3.45
Number of times the datalogger's 12V supply has dropped below operating threshold: 37118 - Check your battery
Number of times voltage has dropped below 5V: 0

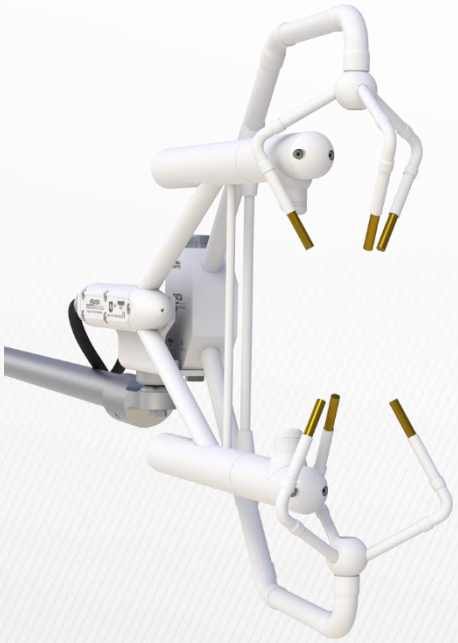
Card Information
Card Status: No Card Present.

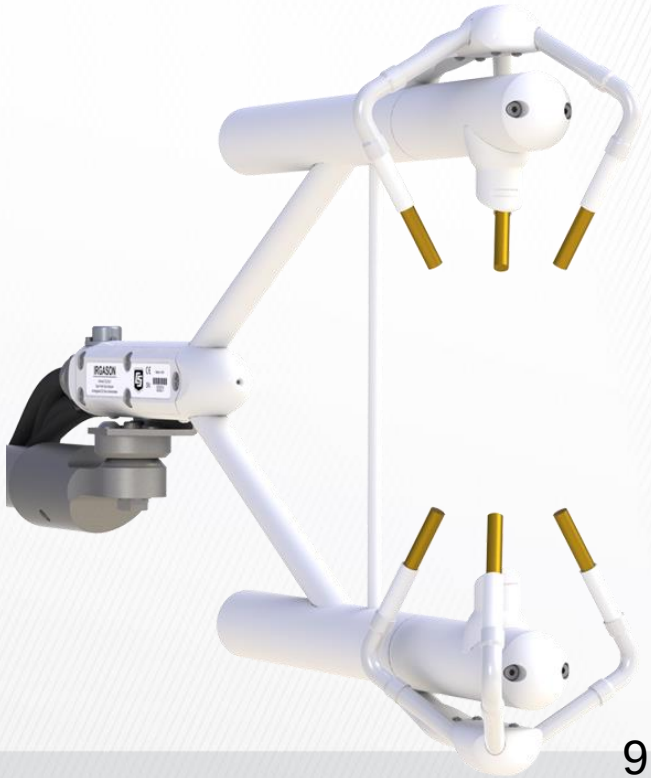
部分极端情况

三维超声风速仪





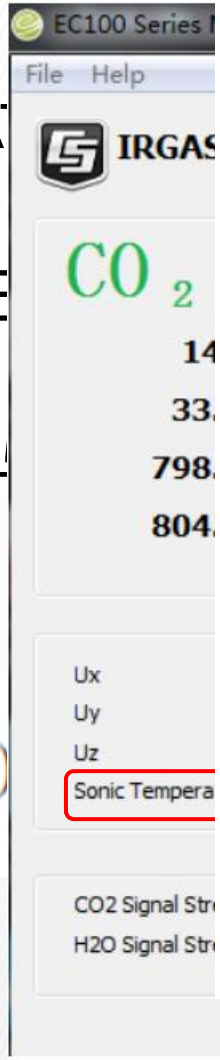




判断三维超声读数的合理范围

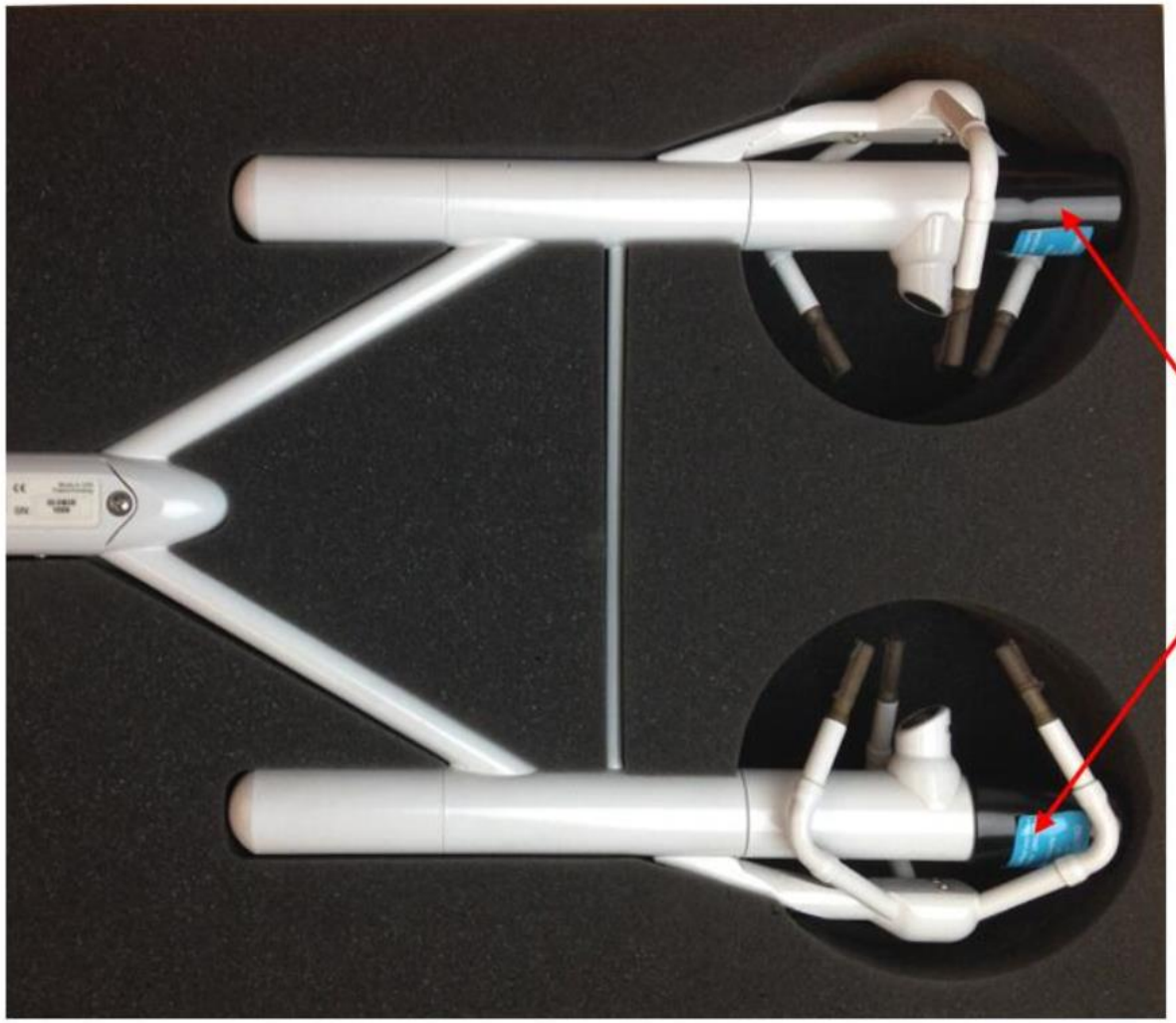
- CSI对每一台CSA
  准
- 对于Ux, Uy, Uz 三
  符合指标
- 对于Ts, 可以通过
  Ts值是否合理

$$T_S = T(1 + 0.51q)$$



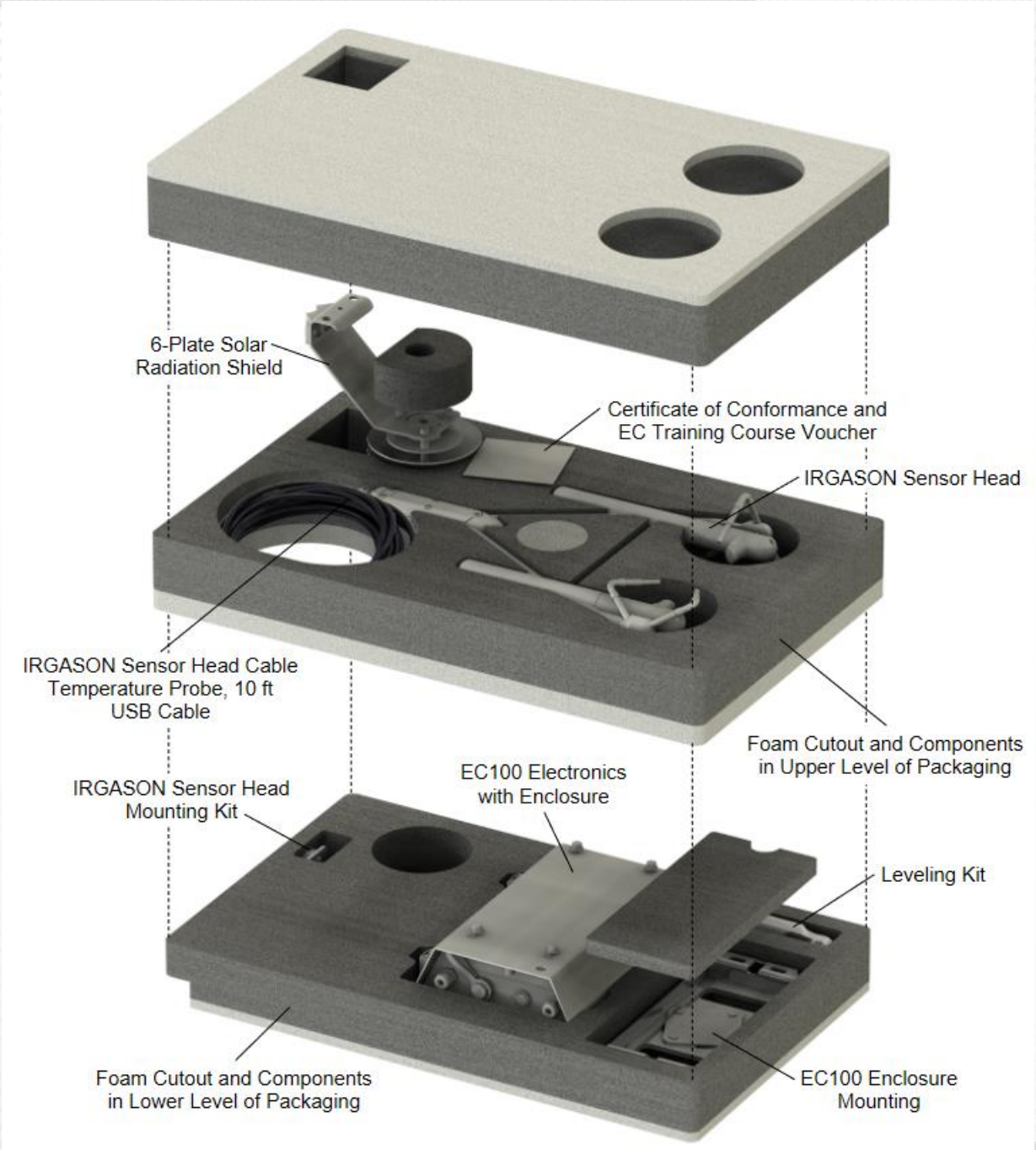
-0.1751	-0.1740	0.0584	36.6339	19.3166	20.2479	000	0
-0.1729	-0.1665	0.0513	36.6973	19.3081	20.0976	000	0
-0.1734	-0.1533	0.0561	36.6069	19.2545	20.0465	000	0
-0.1646	-0.1568	0.0609	36.5616	19.1610	20.1010	000	0
-0.1791	-0.1593	0.0610	36.5444	19.1091	20.0328	000	0
-0.1686	-0.1726	0.0548	36.5878	19.1419	20.0664	000	0
-0.1494	-0.1794	0.0652	36.6001	19.1143	19.9889	000	0
-0.1385	-0.1924	0.0611	36.4764	19.0321	19.8076	000	0
-0.1035	-0.1581	0.0902	36.5865	19.2117	19.9689	000	0
-0.1315	-0.1841	0.1013	36.4243	18.9577	19.7309	000	0
-0.1289	-0.1659	0.1009	36.3701	18.9806	19.7878	000	0
-0.1281	-0.1570	0.0815	36.3643	18.9607	19.7129	000	0
-0.1500	-0.1690	0.0869	36.3755	18.9131	19.7733	000	0
-0.1583	-0.1687	0.0856	36.4629	18.9198	19.6508	000	0
-0.1223	-0.1716	0.0835	36.1544	18.9792	19.6570	000	0
-0.1295	-0.1626	0.0960	36.0214	18.7476	19.6760	000	0
-0.1252	-0.2007	0.0902	36.2178	18.9097	19.5441	000	0
-0.1105	-0.1805	0.1093	36.0469	18.5384	19.5846	000	0
-0.0855	-0.2075	0.0660	36.4911	18.9955	20.1023	000	0
-0.1012	-0.1756	0.0765	36.7148	18.9912	20.0228	000	0
-0.1155	-0.1710	0.0628	36.2566	19.0000	19.8123	000	0
-0.1220	-0.1854	0.0780	36.3317	18.8116	19.6682	000	0
-0.1473	-0.1867	0.0662	36.2504	18.8062	19.6915	000	0
-0.1268	-0.1814	0.0663	36.6652	18.9019	20.1731	000	0

运输安全 (老版)



Protective shipping bumpers

运输安全(新版)


6-Plate Solar
Radiation Shield
Certificate of Conformance and
EC Training Course Voucher
IRGASON Sensor Head
IRGASON Sensor Head Cable
Temperature Probe, 10 ft
USB Cable
Foam Cutout and Components
in Upper Level of Packaging
IRGASON Sensor Head
Mounting Kit
EC100 Electronics
with Enclosure
Leveling Kit
Foam Cutout and Components
in Lower Level of Packaging
EC100 Enclosure
Mounting

运输安全

三维超声诊断值

Sonic anemometer diagnostic flags -- not connected

Flag Status	Description
N/A	Low amplitude ok
N/A	High amplitude ok
N/A	Signal lock ok
N/A	Delta temperature ok
N/A	Sonic is running
N/A	Sonic head calibration signature ok

三维超声防雨网

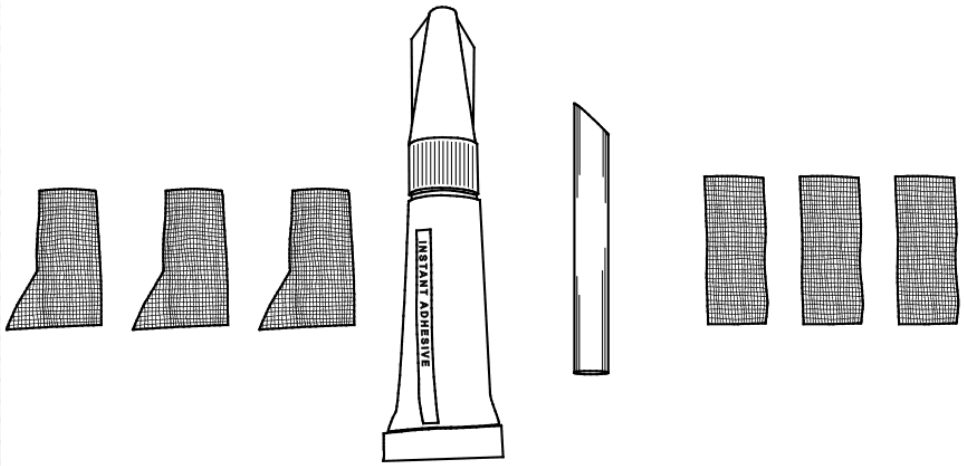


FIGURE 9-2. PN 28902 CSAT3 Sonic Wick Spares Kit contents

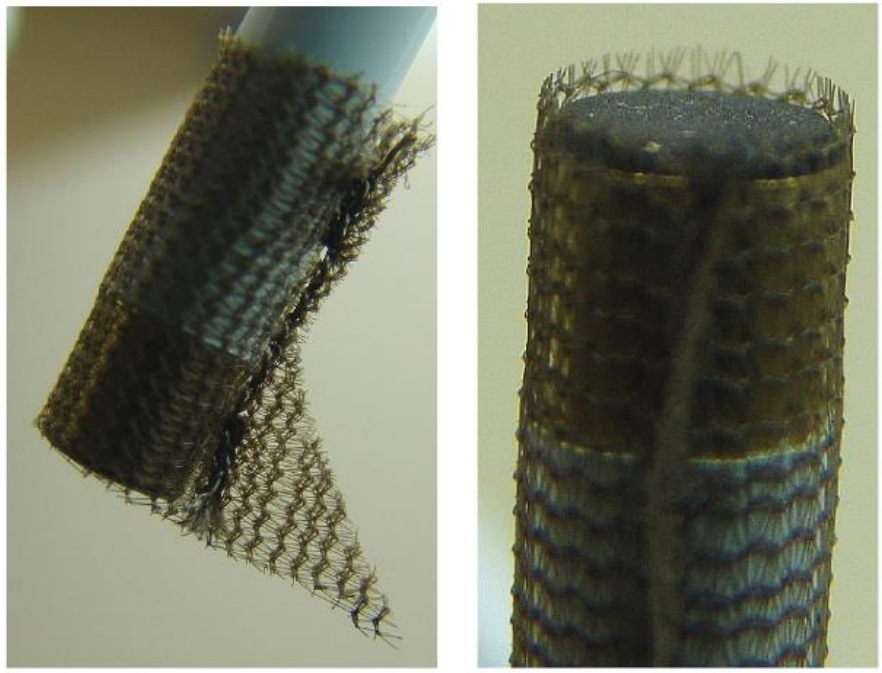
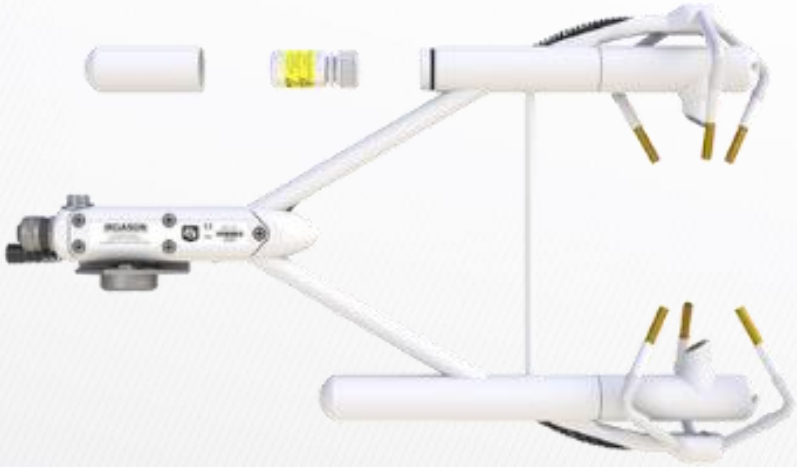
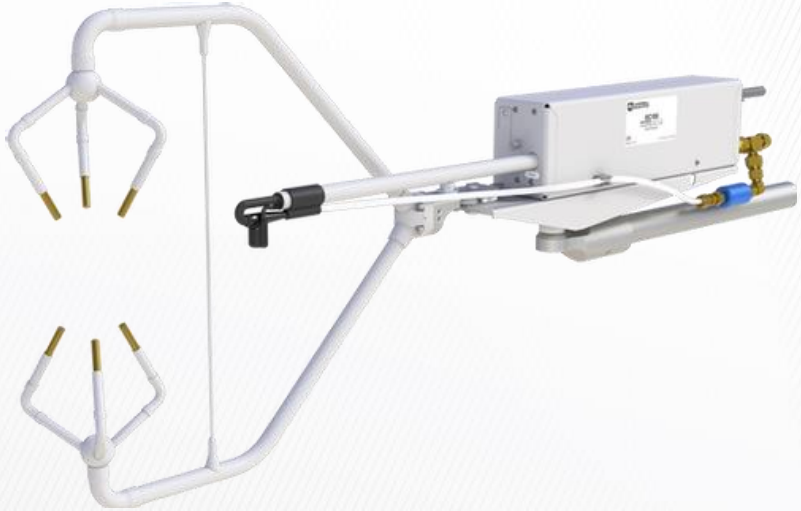


FIGURE 9-1. Proper location of the sonic top wick (left) and bottom wick (right)

红外气体分析仪

- EC150/IRGASon/EC155





分析仪诊断值

Gas analyzer diagnostic flags -- not connected

Flag Status	Description
N/A	No diagnostic flags are set
N/A	No general system fault
N/A	Gas analyzer is running
N/A	Motor speed within limits
N/A	TEC temperature within limits
N/A	Source power within limits
N/A	Valid source temperature
N/A	Source current within limits
N/A	Gas head powered
N/A	Gas input data in sync with home pulse
N/A	Valid ambient temperature
N/A	Valid ambient pressure
N/A	CO2 I within limits
N/A	CO2 Io within limits
N/A	H2O I within limits
N/A	H2O Io within limits
N/A	Moving variation in CO2 Io within limits
N/A	Moving variation in H2O Io within limits
N/A	CO2 signal level ok
N/A	H2O signal level ok
N/A	Gas head calibration signature ok
N/A	Heater control within limits
N/A	Differential pressure within limits

Gas head lifetime hours not connected

分析仪信号强度 vs 窗口清洁

- 分析仪信号强度，实时动态补偿窗口变脏程度
- 随着时间推移，分析仪窗口上的灰尘累积越来越多
- 如果信号强度过低，分析仪读数可能不准确

- 每次访问站点时，最好清洁一次分析仪窗口

分析仪防雨网

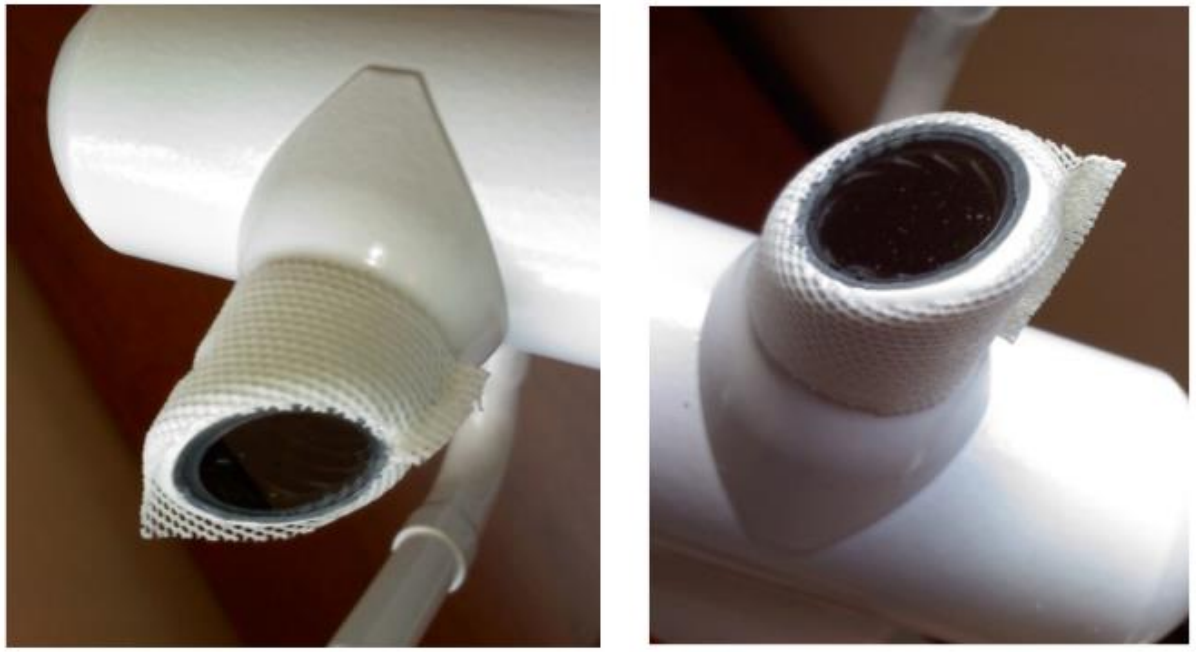
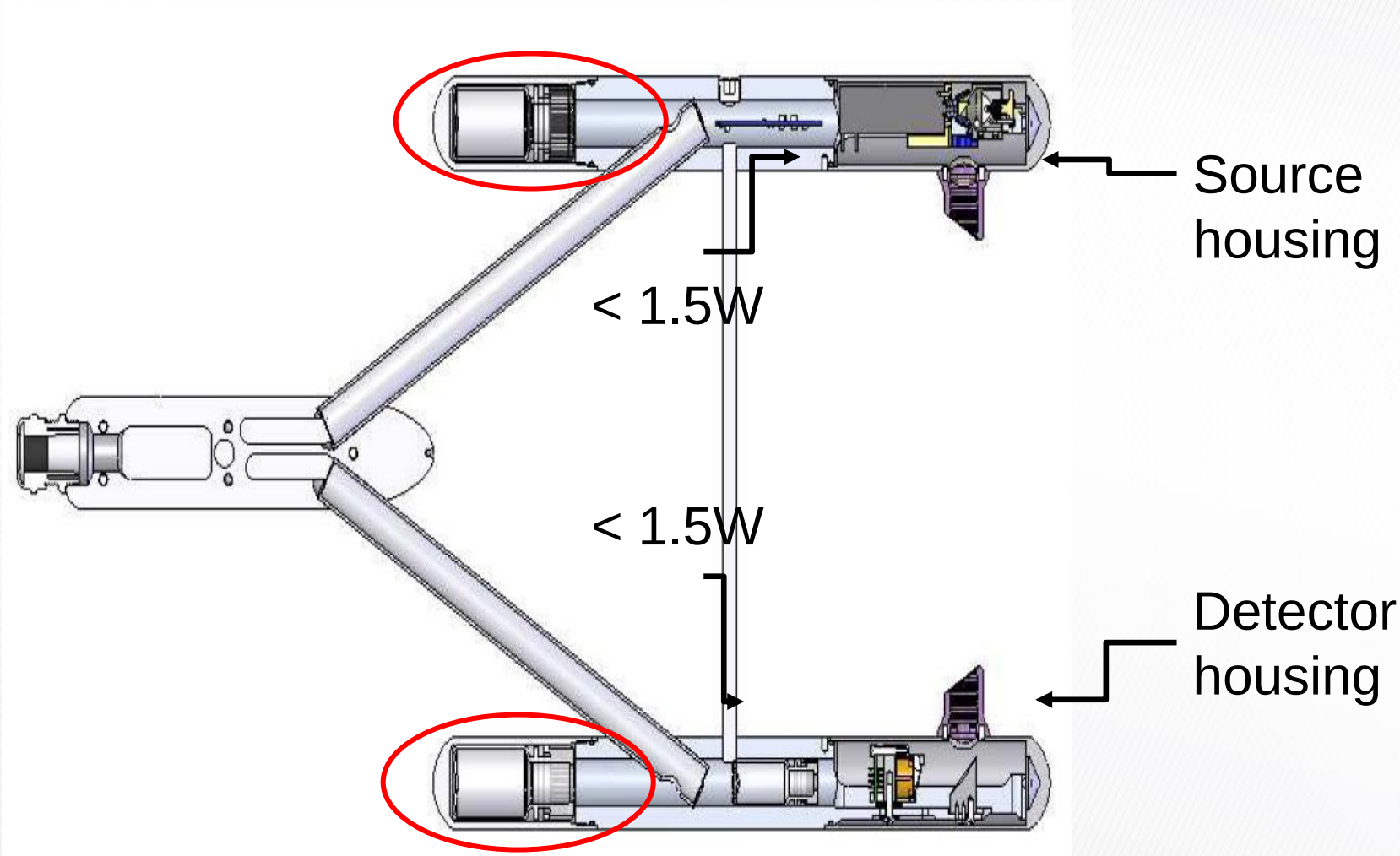


FIGURE 8-1. Proper location of the gas analyzer top wick (left) and bottom wick (right)

- 定期更换
- 低温冰冻区域，可不使用
- 多风沙地区，可不使用

更换CO2/H2O吸收剂

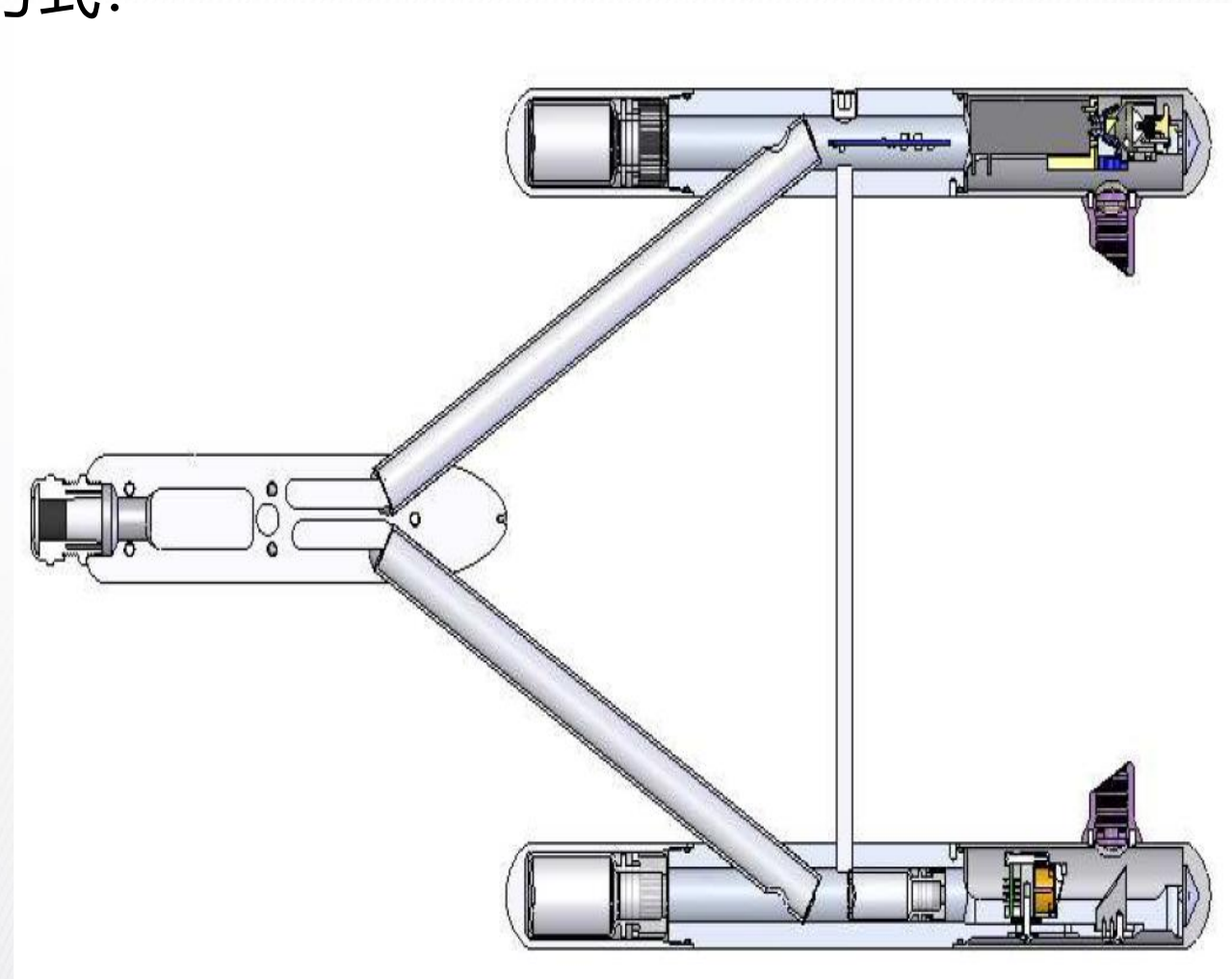


多长时间更换一次CO2/H2O吸收剂?

- Campbell Scientific 建议每年更换一次
- 不过，如果zero 和span 系数发生较大漂移，则应该及时的更换CO2/H2O吸收剂
- 新的吸收剂成分是分子筛，**<u>无毒无害</u>**

  - 更换吸收剂后，等待3天，再实施Zero/Span

- 在更换吸收剂之前使用高纯N2 吹扫 分析仪是否是一种好的方式?

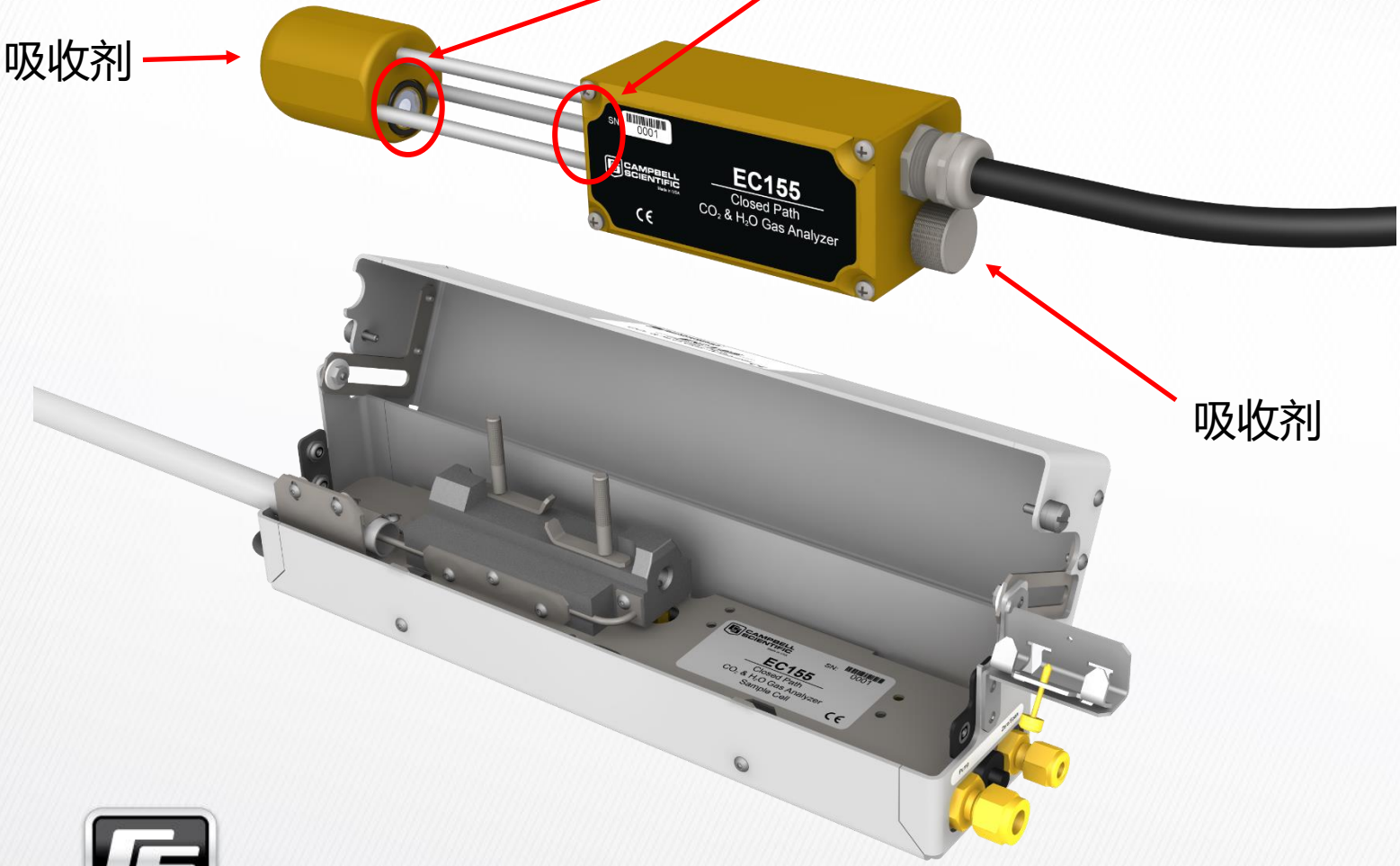


CPEC310 闭路系统

CPEC310, w/ Vortex Filter

EC155 - 2011

- 如果信号强度明显下降，清洁窗口
- 每3年或以上，更换O形圈

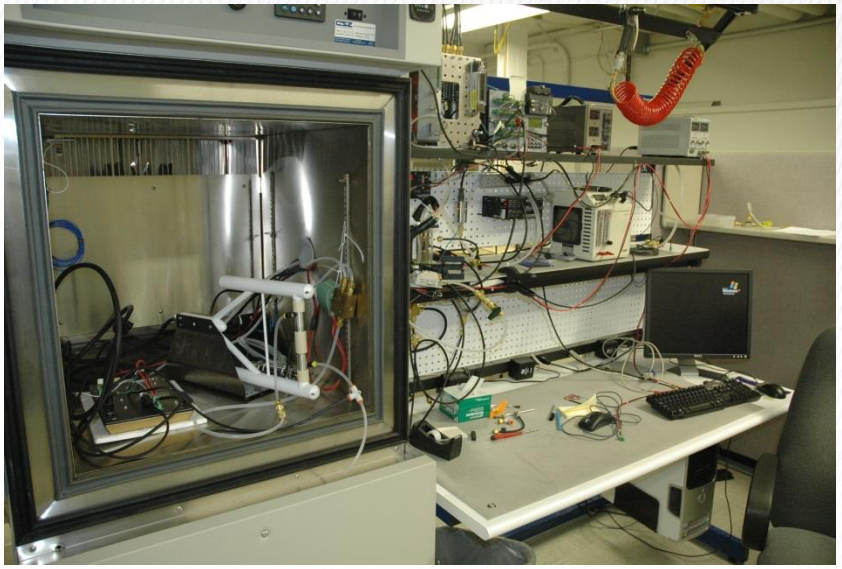


2. 为什么要对分析仪实施Zero/Span

为什么要校准

- **验证**仪器测量的准确性、可重复性
- 分析仪校准包括两部分：
  - 工厂校准
  - Zero/Span

气体分析仪工厂校准 —— 寻找分析仪的工作曲线

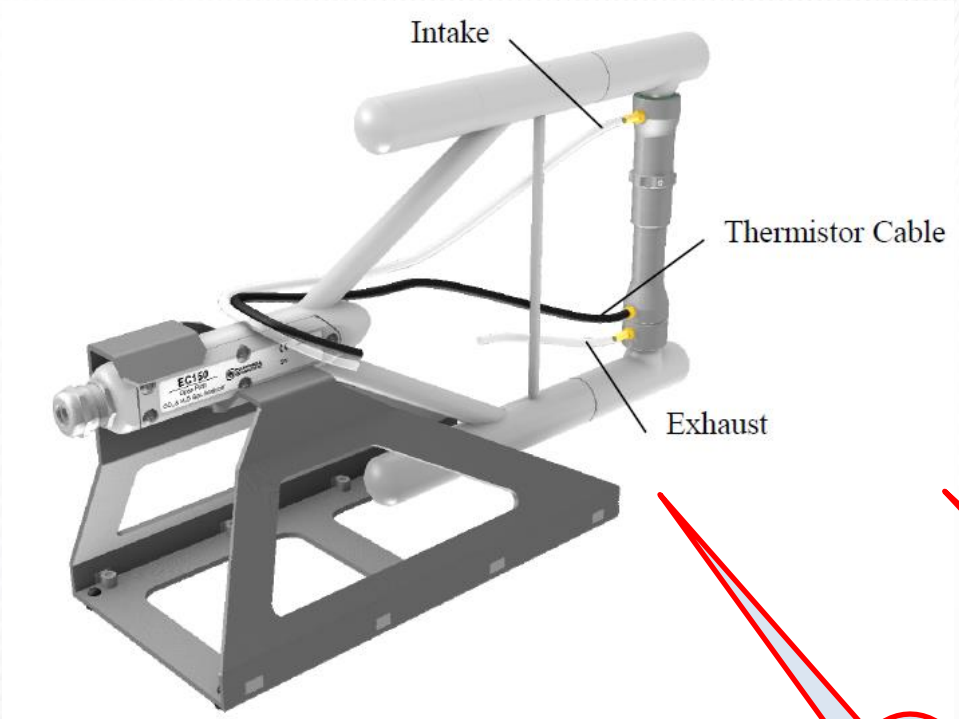


- factory calibration (CO2 concentrations, pressures, temperatures and dew points in combinations encountered in practice)

$$CO_2 = S_{CO_2} * f_{CO_2 cal} \left\{ Z_{CO_2} * \left(\frac{CO_2 I}{CO_2 I_O} \right) \right\}$$

$$H_2O = S_{H_2O} * f_{H_2 O cal} \left\{ Z_{H_2O} * \left(\frac{H_2 OI}{H_2 OI_O} \right) \right\}$$

ZERO 和 SPAN —— 进一步调整零点和跨度系数



$$CO_2 = S_{CO_2} * f_{CO_2cal}\left\{Z_{CO_2} * \left(\frac{CO_2I}{CO_2I_O}\right)\right\}$$

- 2点校准（零气 和 跨度标气）

$$H_2O = S_{H_2O} * f_{H_2Ocal}\left\{Z_{H_2O} * \left(\frac{H_2OI}{H_2OI_O}\right)\right\}$$

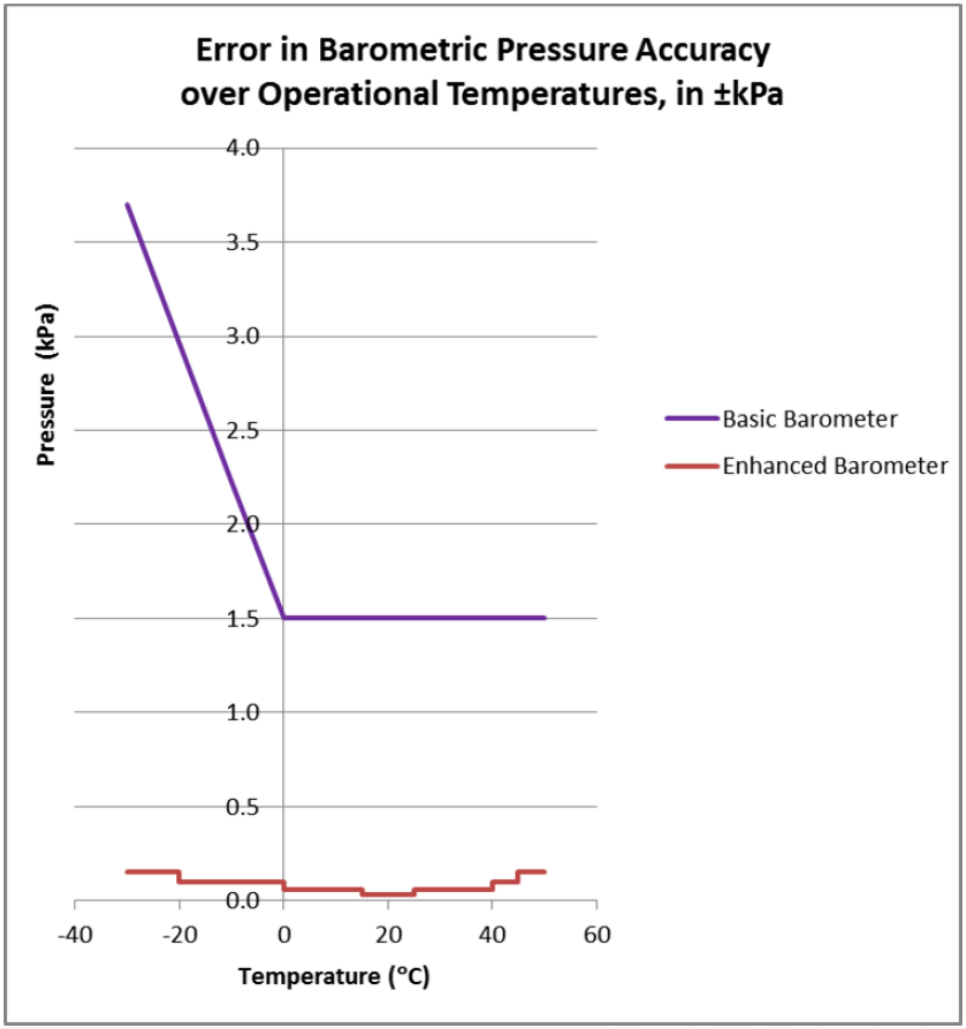
很多因素都会影响分析仪的测量准确度 Accuracy

- 温度变化 （环境温度和分析仪温度）
- 交叉干扰度 (CO2/H2O)
- 环境压力
- 光路的清洁程度
- 湿度
- 内部化学吸收剂的有效性
- 电子元件的老化

选择什么气压传感器?

- 基本型BB 或 增强型EB?
  - 大气压P 用于计算空气密度，1% 的气压误差会导致 1% 的显热通量误差。
  - 尽管CO2 跨度校准是以浓度单位输入，但是需要大气压用于计算CO2/H2O的密度， 因此 1% 的气压误差会导致 1% 的CO2通量误差。
  - 问题：在标况下（20℃和100kPa），1℃ 温度误差和1kPa气压误差，哪一个导致CO2/H2O的密度读数误差更大?

两种类型气压计的准确度Accuracy指标：

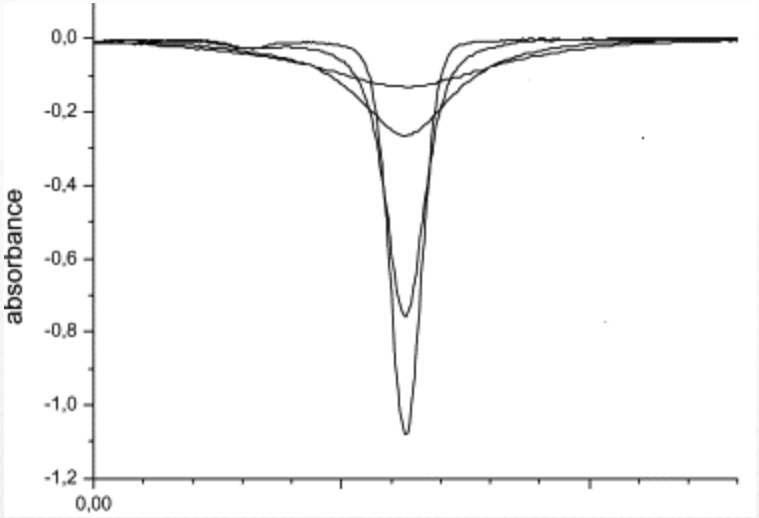


校准备件:

- 分析仪支架 —— PN 27278
- 光路气室 ——　　PN 26390
- 高压钢瓶减压器 和 流量计
- 铝塑管，带Swagelok接头，最好带三通　——　21823-L20
- 零气发生器或高压零气，CO2 Span 标气，H_2O Span (露点仪)
- 其它 ——　　30厘米长活动扳手、BEV管、直流电源

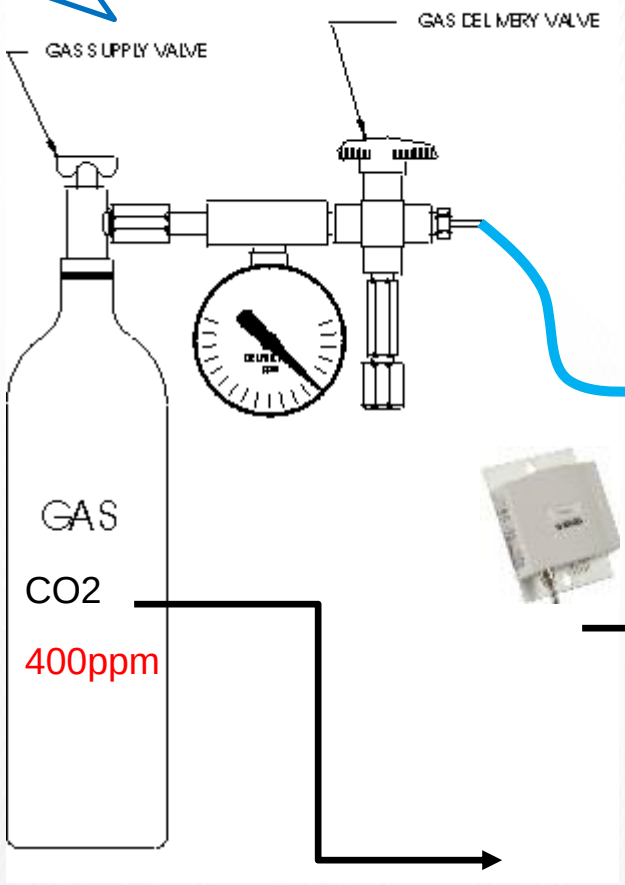
ZERO 和 CO2 SPAN

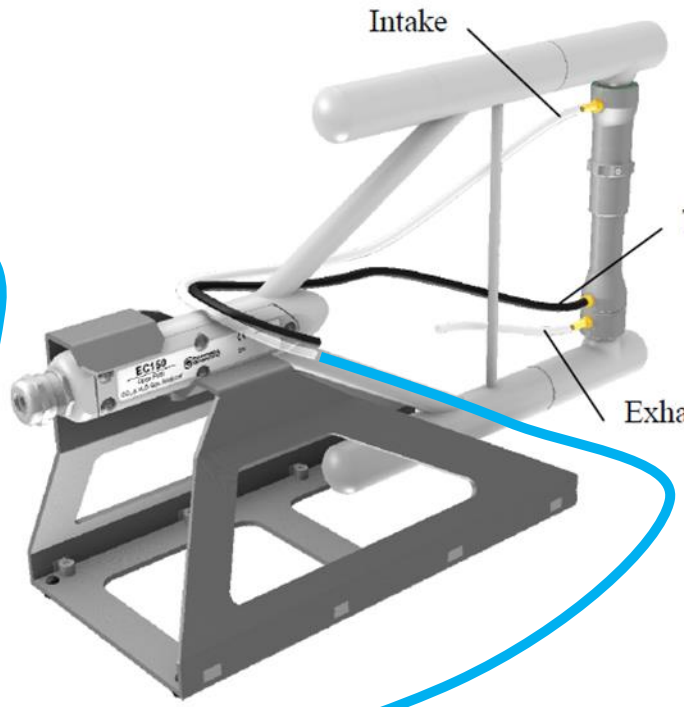
- 零气：不含CO2的干空气 或 高纯N2
- Span 标气：以**干空气**为平衡气的CO2标气
  不含 其它杂质气体



正确的操作顺序，避免污染标气。

CO2 SPAN





$$\rho_c = \frac{X_c M_c}{10^6}\left(\frac{P}{R(T+273.15)}\right)$$

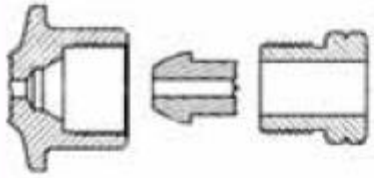
高质量的气瓶减压器

CYLINDER VALVE CONNECTIONS

CGA Connections

Connection 590

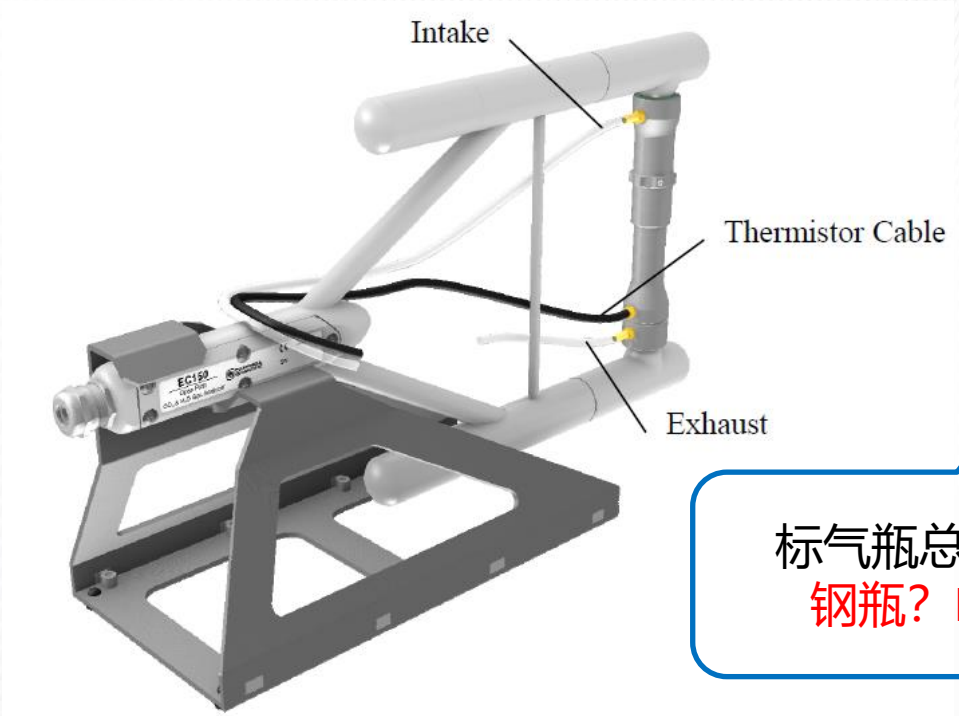
.965-14NGO LH Int.



Air (Industrial)	
Nut	830 1215
Gland	830 4128 (2 ½)
	830 4123 (3)
	830 3274 (3 ½)
	830 4122 (4)

- Designed for use with ultra high purity gasses
- Clean
- Corrosion resistant materials
- Low internal volumes

ZERO 和 SPAN



标气瓶总开关
钢瓶？No!

- 2点校准（零气 和 跨度标气）

$$CO_2 = S_{CO_2} * f_{CO_2cal}\left\{Z_{CO_2} * \left(\frac{CO_2I}{CO_2I_O}\right)\right\}$$

$$H_2O = S_{H_2O} * f_{H_2Ocal}\left\{Z_{H_2O} * \left(\frac{H_2OI}{H_2OI_O}\right)\right\}$$

CO2标气中的平衡气应该与大气成分比接近

$A=\log(I/Io)=\varepsilon cL$

$\varepsilon = f(\text{gas composition})$

gas composition = 20.94% O2 + 78.08% N2 + 0.0004% CO2

- Use air as a balance gas, NOT nitrogen. The presence of oxygen changes the absorption coefficient
- Low levels of other contaminants (CH4, N2O, etc.)
- Check with NIST standards

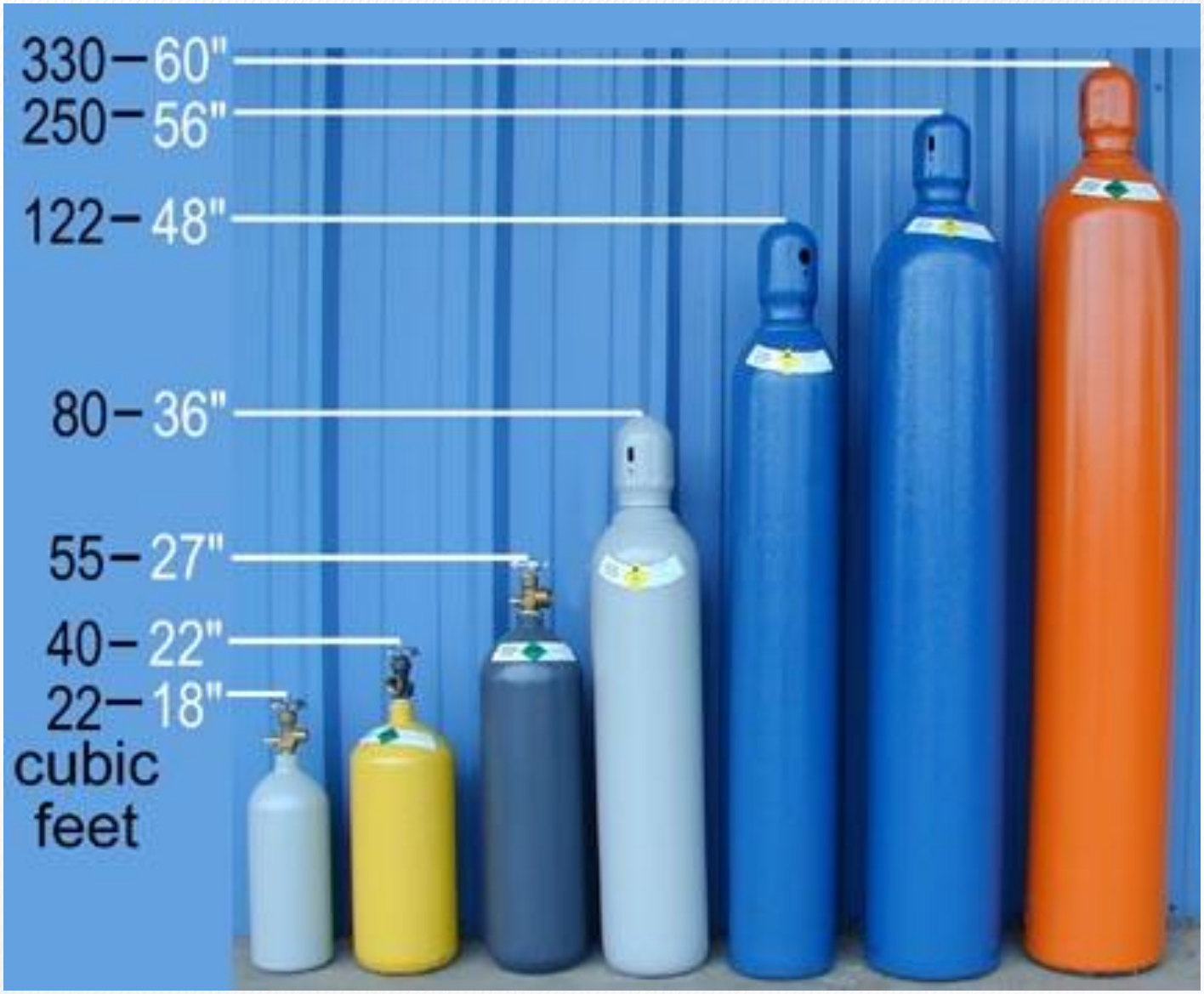
TYPES OF GAS MIXTURES

Air Liquide supplies a number of different grades of mixtures both in the gas and liquid phase. These different grades meet the requirements for most applications that standards are used for in laboratory and analytical applications.

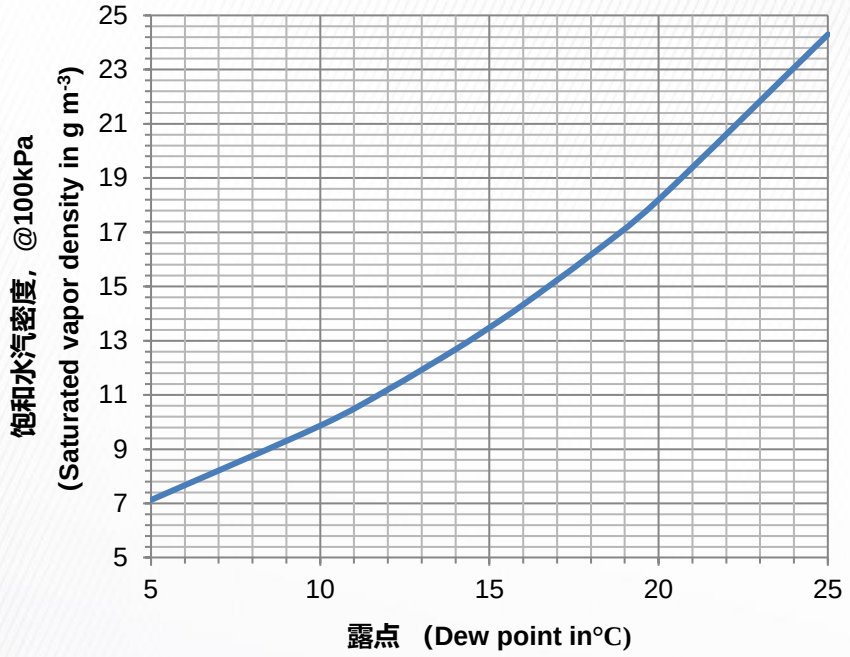
Dual Certified Primary Standards are recommended where the greatest accuracy is required. These mixtures are prepared gravimetrically to close tolerances and analyzed against NIST traceable standards. The reported concentrations are tied to both the gravimetric numbers and the analytical results to determine the reported uncertainty. Both numbers should fall within 1% of the reported value. Such dual analysis ensures the greatest accuracy.

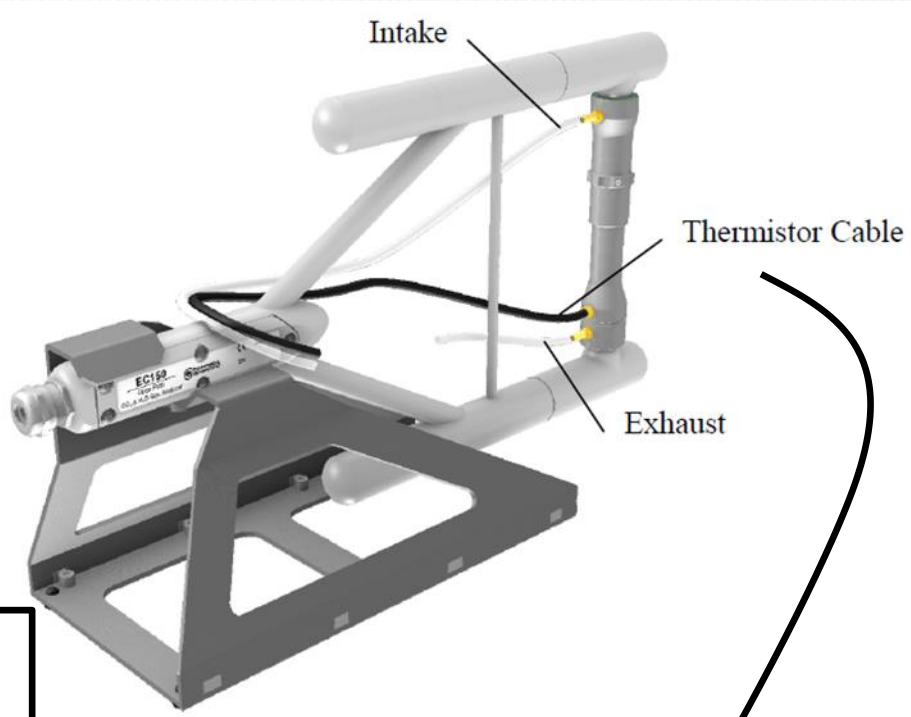
Primary Standards are prepared gravimetrically to close tolerances. They are analyzed against reference standards if available to confirm the gravimetric numbers. The methodology used to determine each concentration and the uncertainty is reported on the Certificate of Analysis.

Custom Certified Standards are prepared gravimetrically but must be certified against traceable reference standards. Gravimetric numbers may be used in place of analytical numbers but only if they are determined to have less uncertainty. The method of determination of the reported number is stated on the Certificate of Analysis.


330 – 60"
250 – 56"
122 – 48"
80 – 36"
55 – 27"
40 – 22"
22 – 18"
cubic feet

H2O 的 ZERO 和 SPAN

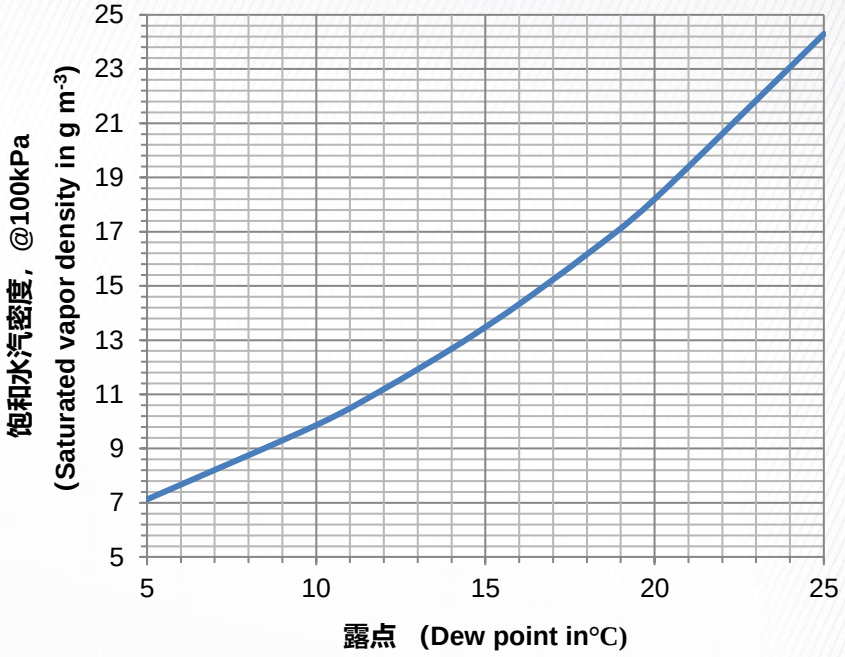




$$\rho_v = \frac{(0.018)(0.61121)f}{R(T+273.15)} EXP\left(\frac{17.502T_d}{240.97+T_d}\right)$$

提升露点精度

- 流量不要过大
- 订正露点发生器内部泵压产生的露点偏差

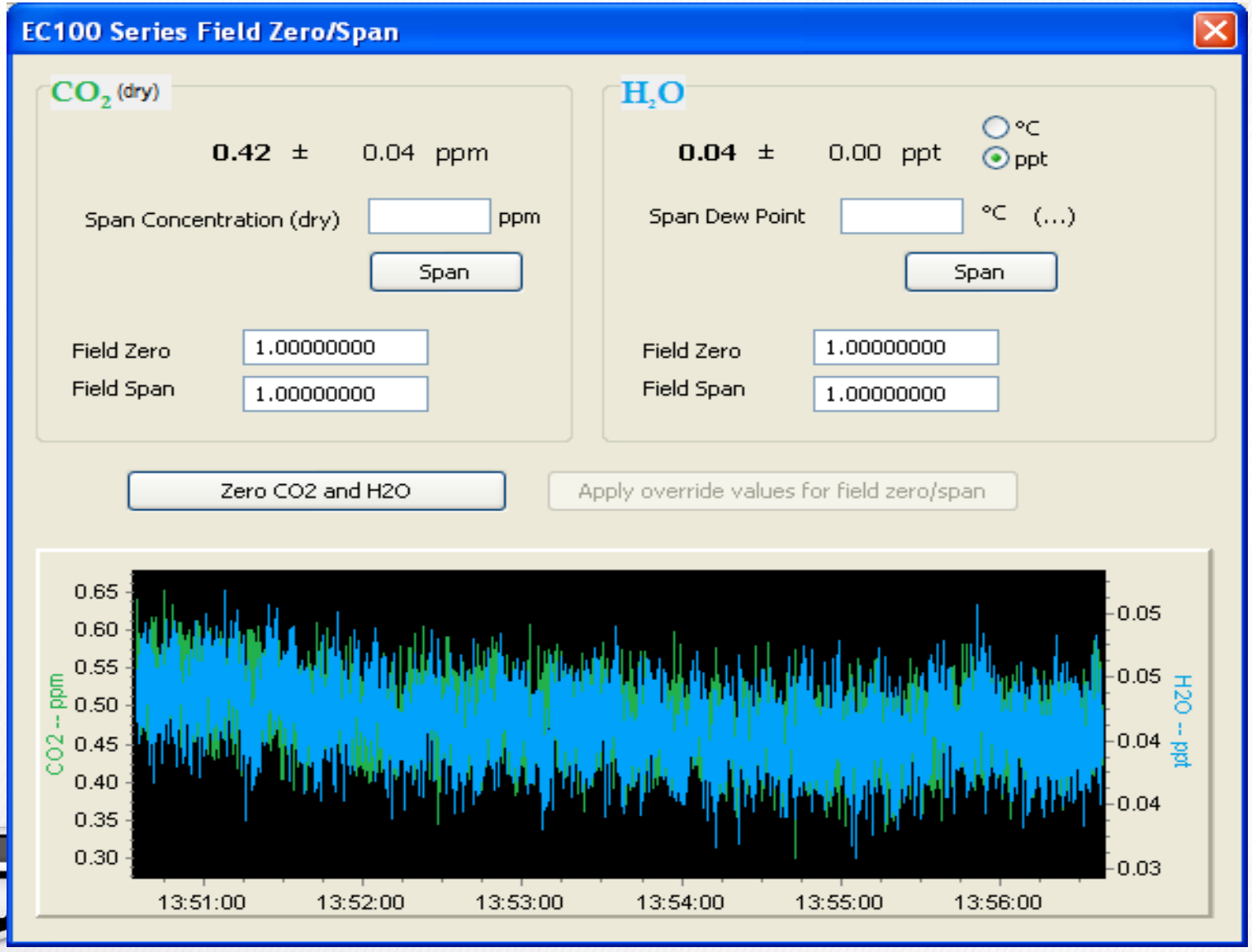


$$T_{d\_GA} = \frac{240.97\left(\ln\frac{P_{GA}}{P_{GA}+0.097h}+\frac{17.502T_d}{240.97+T_d}\right)}{17.502-\left(\ln\frac{P_{GA}}{P_{GA}+0.097h}+\frac{17.502T_d}{240.97+T_d}\right)}$$

工作环境：

- 远离日光直射、加热器、电风扇、空调出风口等不利于仪器稳定工作的环境。
- 分析仪 和 露点发生器需要充分预热
- 在校准之前，先用无水乙醇或医用酒精(75% vol/vol)清洁分析仪窗口；在操作中始终监视信号强度变化

监视读数是否稳定：


EC100 Series Field Zero/Span
CO2 (dry)
0.42 ± 0.04 ppm
Span Concentration (dry)
ppm
Span
Field Zero
1.00000000
Field Span
1.00000000
H2O
0.04 ± 0.00 ppt
°C
ppt
Span Dew Point
°C (...)
Span
Field Zero
1.00000000
Field Span
1.00000000
Zero CO2 and H2O
Apply override values for field zero/span
CO2 -- ppm
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
H2O -- ppt
0.05
0.05
0.04
0.04
0.03
13:51:00
13:52:00
13:53:00
13:54:00
13:55:00
13:56:00

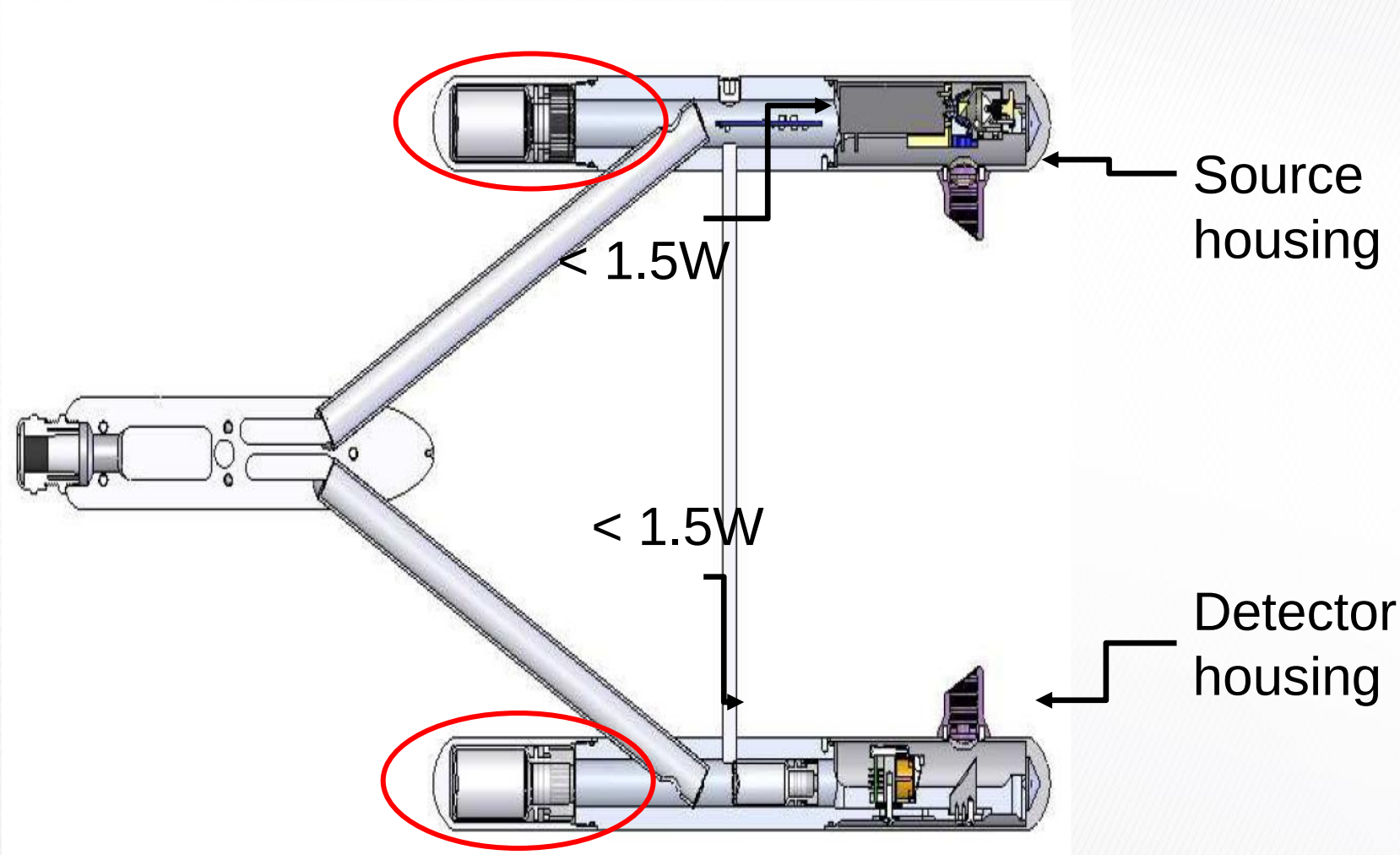
检查分析仪增益（Gain）：

$$Gain = \frac{\text{标准CO2浓度}}{\text{标准CO2测定值} - \text{无CO2测定值}}$$

- 如Gain=1，且无CO_2时气体分析的CO_2测定值为0，则无需进行CO_2的零点和跨度重置。

- 如Gain < 0.95 或Gain > 1.05，应检查CO_2吸收剂，并跟据吸收剂的已工作时间考虑更换。（若更换，等待3天）

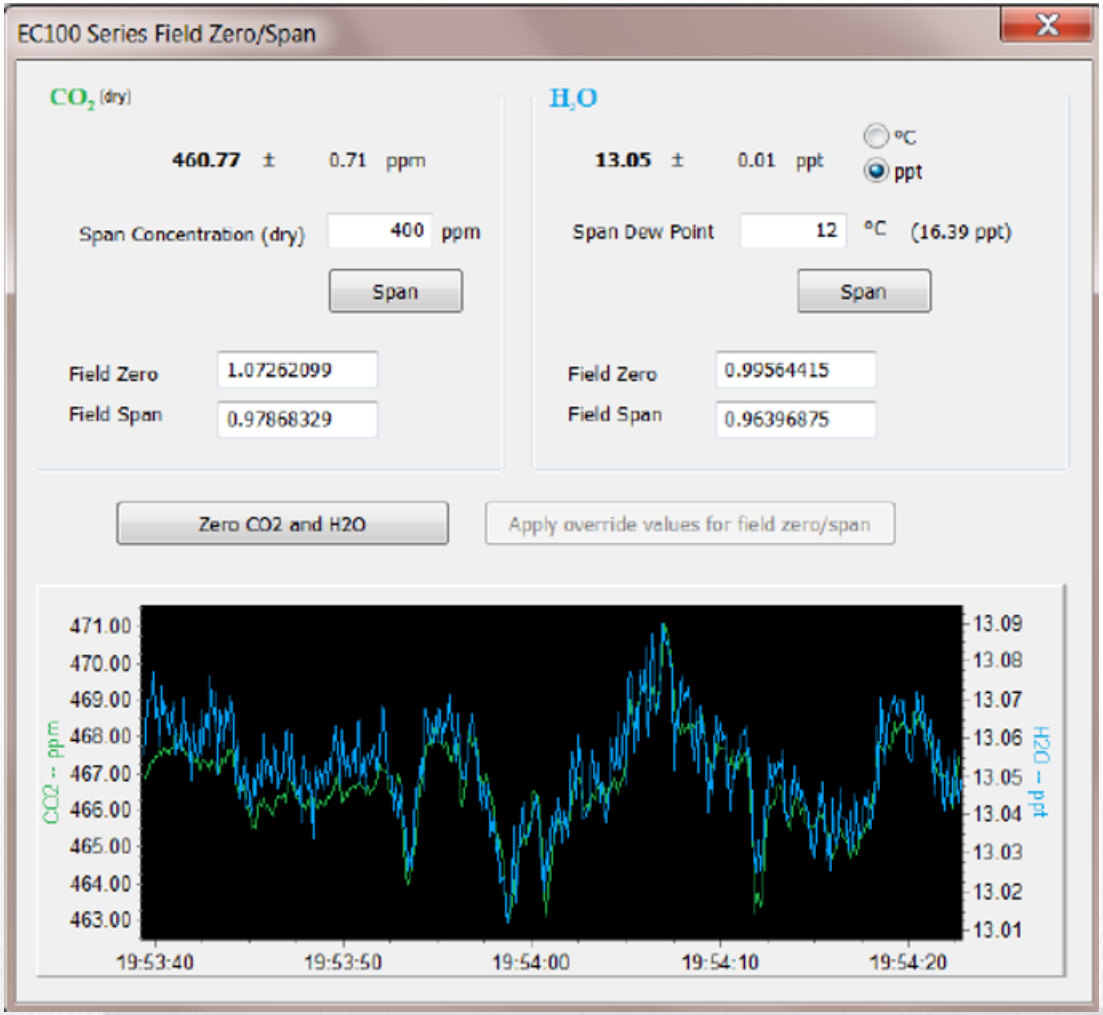
为什么要更换CO2/H2O吸收剂?



多长时间更换一次吸收剂?

- Campbell Scientific 建议每年更换一次
- 不过，如果zero 和span 系数发生较大漂移，则应该及时更换CO2/H2O吸收剂
- 新的吸收剂成分是分子筛，**<u>无毒无害</u>**
  - 更换吸收剂后，等待3天，再实施Zero/Span

- 在条件允许的情况下，Campbell Scientific 推荐用户在站点现场对分析仪进行Zero/Span校准。但站点现场的校准操作一般需要等待更长的时间让读数达到稳定。

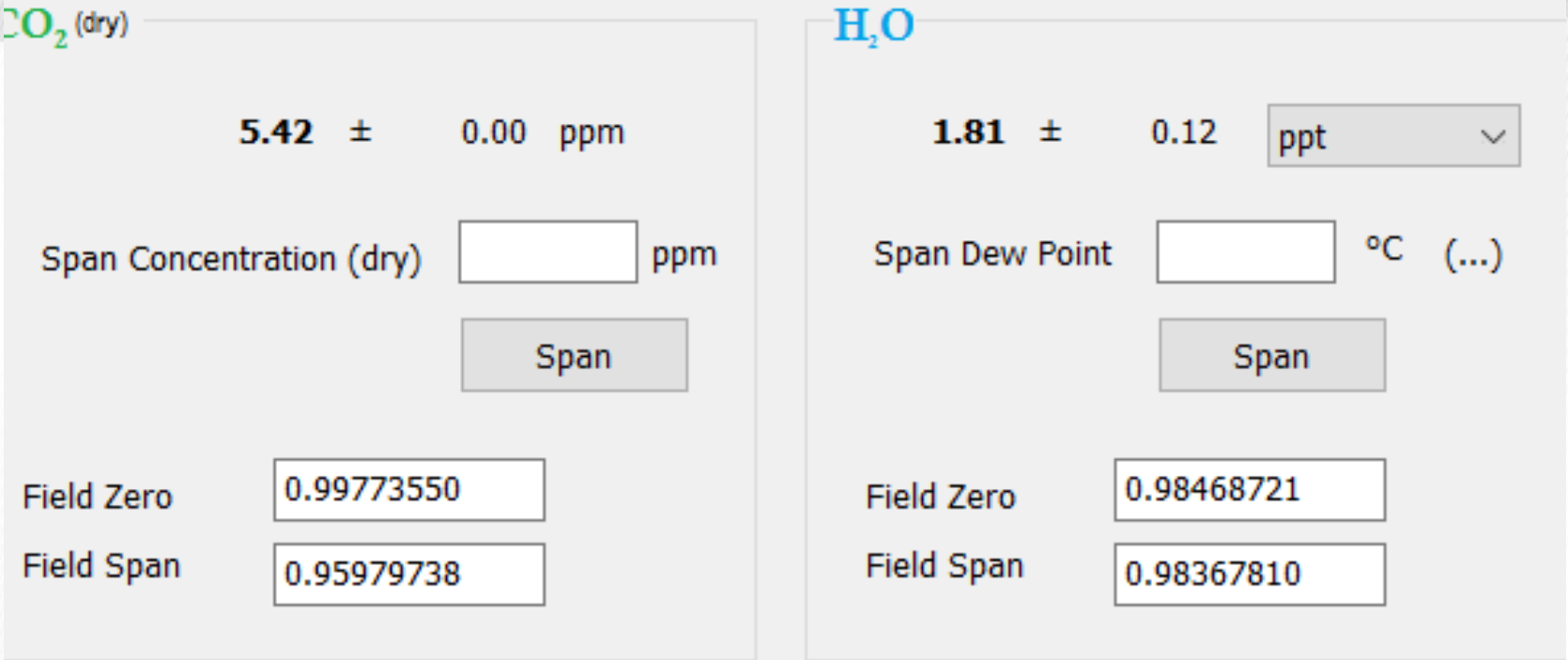


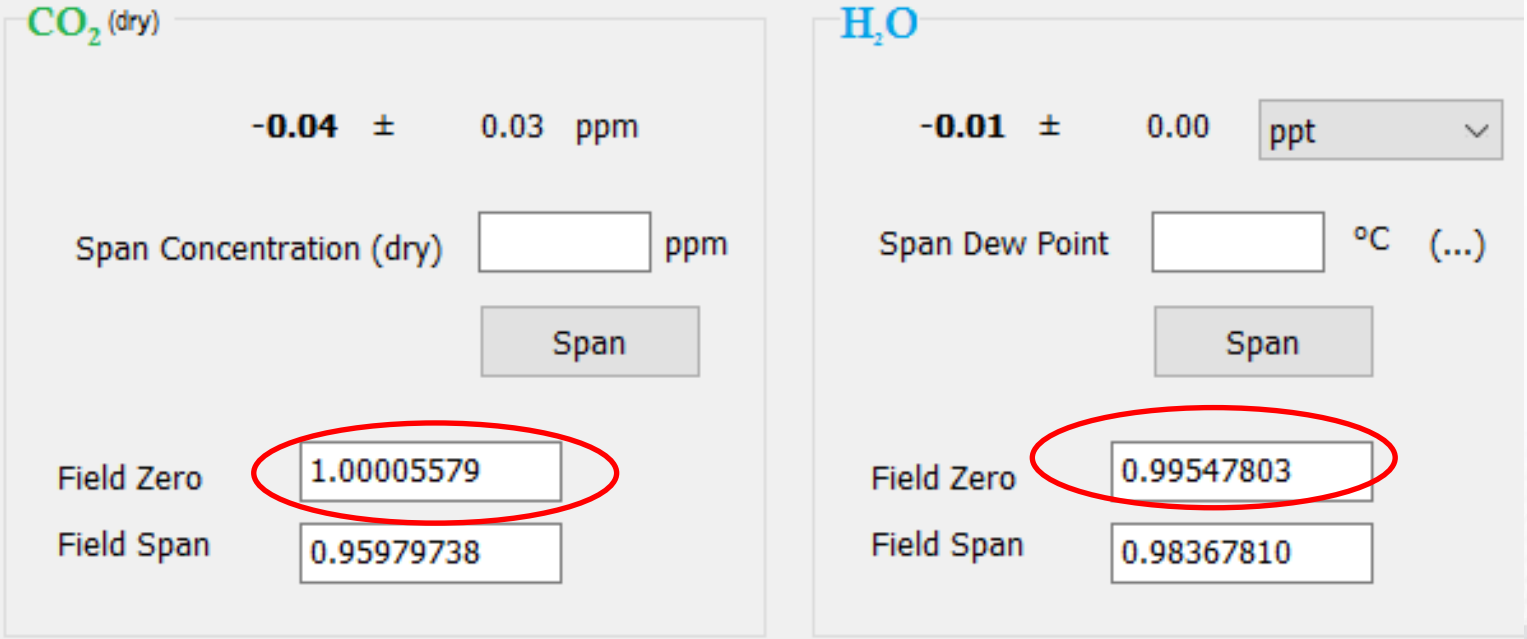
零气发生器

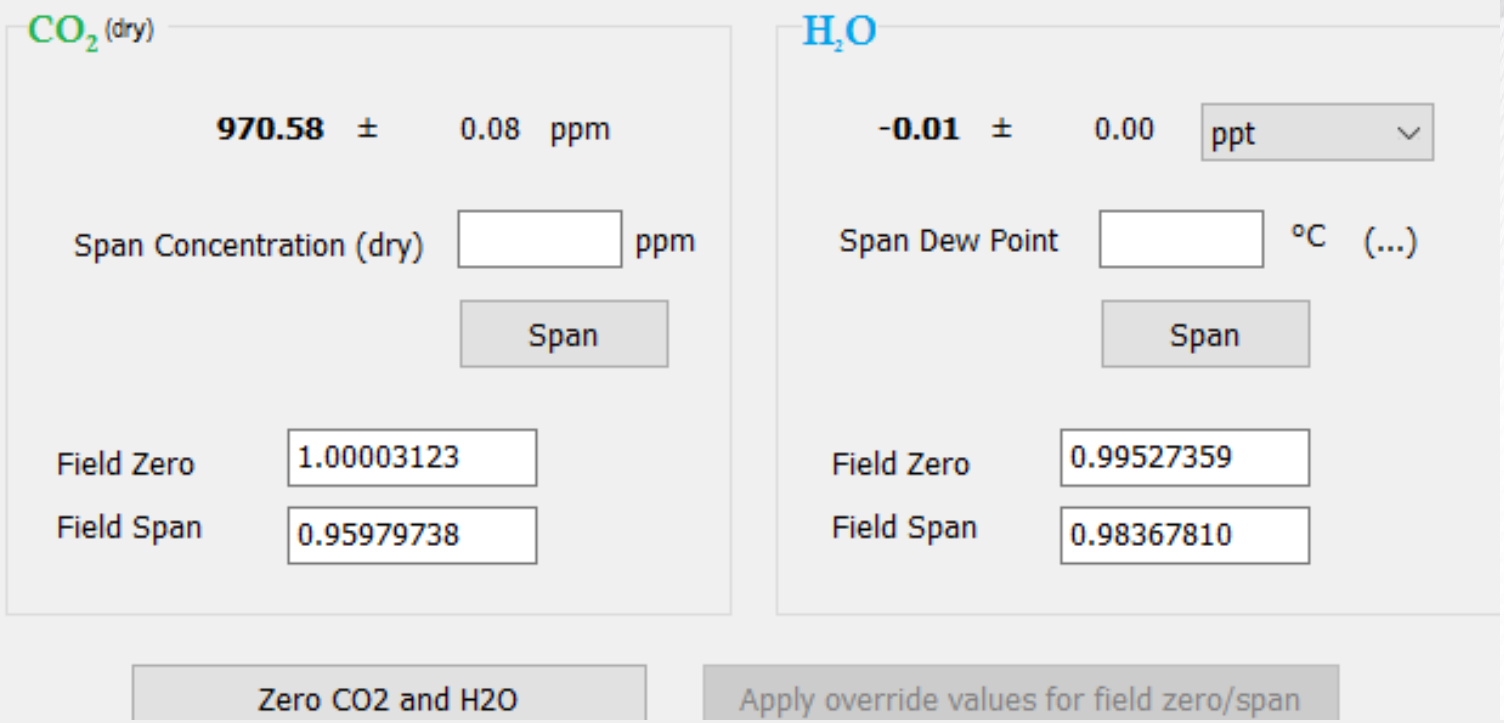
- 非常有用的一个工具
  - 用于对分析仪作零点校准
  - 方便携带

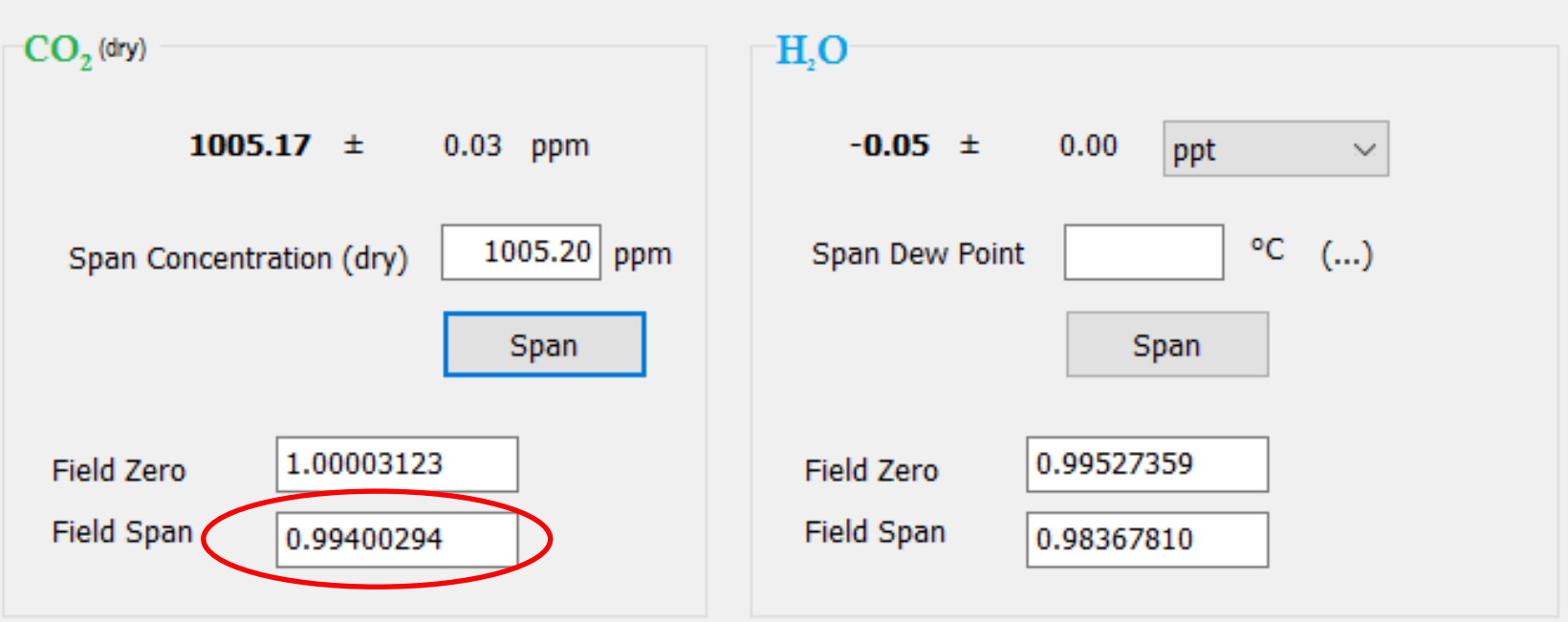
校准顺序：

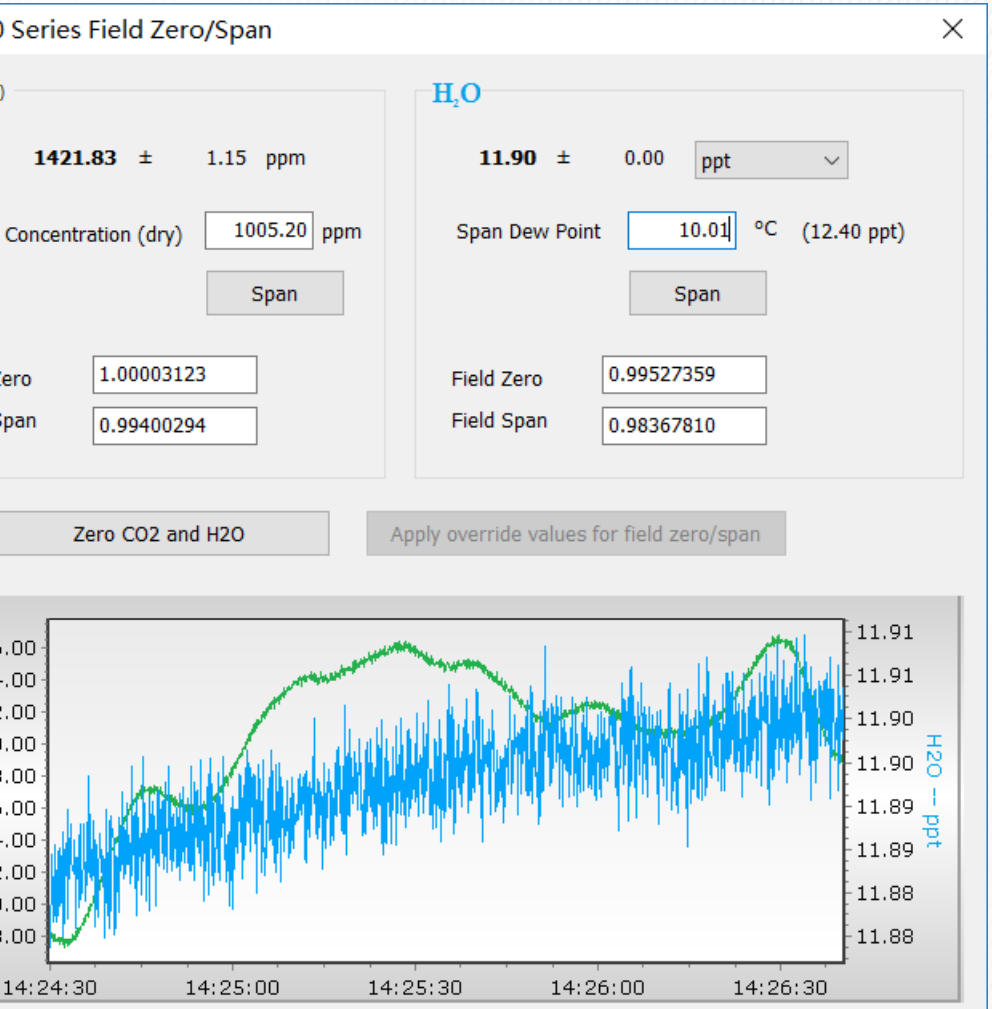
- CO2/H2O Zero
- CO2 Span
- H2O Span

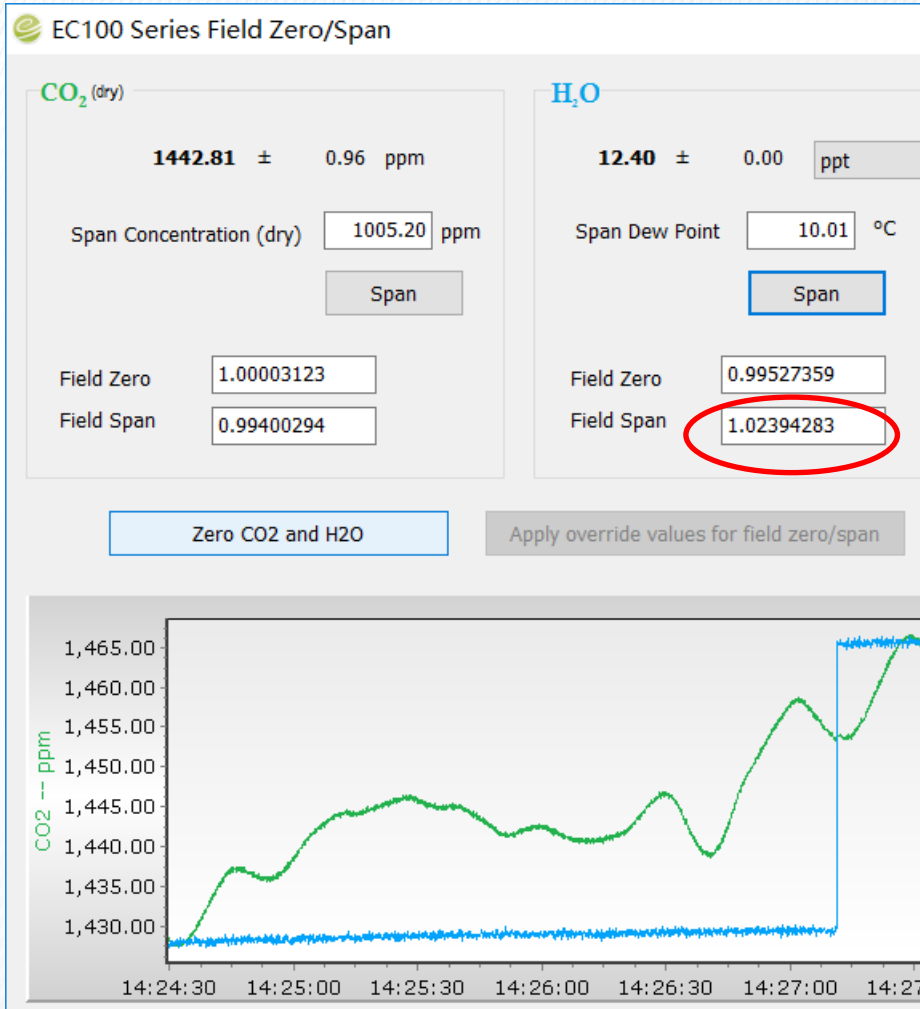

CO2 (dry)
5.42 ± 0.00 ppm
Span Concentration (dry)
ppm
Span
Field Zero
0.99773550
Field Span
0.95979738
H2O
1.81 ± 0.12
ppt
Span Dew Point
°C
(...)
Span
Field Zero
0.98468721
Field Span
0.98367810


CO2 (dry)
-0.04 ± 0.03 ppm
Span Concentration (dry)
ppm
Span
Field Zero
1.00005579
Field Span
0.95979738
H2O
-0.01 ± 0.00
ppt
Span Dew Point
°C
(...)
Span
Field Zero
0.99547803
Field Span
0.98367810


CO_2 (dry)
970.58 ± 0.08 ppm
Span Concentration (dry)
ppm
Span
Field Zero 1.00003123
Field Span 0.95979738
H_2O
-0.01 ± 0.00 ppt
Span Dew Point
°C (...)
Span
Field Zero 0.99527359
Field Span 0.98367810
Zero CO2 and H2O
Apply override values for field zero/span


CO_2 (dry)
1005.17 ± 0.03 ppm
Span Concentration (dry) 1005.20 ppm
Span
Field Zero 1.00003123
Field Span 0.99400294
H_2O
-0.05 ± 0.00 ppt
Span Dew Point
°C (...)
Span
Field Zero 0.99527359
Field Span 0.98367810


Series Field Zero/Span
H2O
1421.83 ± 1.15 ppm
Concentration (dry) 1005.20 ppm
Span
Zero 1.00003123
Span 0.99400294
11.90 ± 0.00 ppt
Span Dew Point 10.01 °C (12.40 ppt)
Span
Field Zero 0.99527359
Field Span 0.98367810
Zero CO2 and H2O
Apply override values for field zero/span
11.91
11.91
11.90
11.90
11.89
11.89
11.88
11.88
H2O -- ppt
14:24:30
14:25:00
14:25:30
14:26:00
14:26:30


EC100 Series Field Zero/Span
CO2 (dry)
H2O
1442.81 ± 0.96 ppm
Span Concentration (dry) 1005.20 ppm
Span
Field Zero 1.00003123
Field Span 0.99400294
12.40 ± 0.00 ppt
Span Dew Point 10.01 °C
Span
Field Zero 0.99527359
Field Span 1.02394283
Zero CO2 and H2O
Apply override values for field zero/span
1,465.00
1,460.00
1,455.00
1,450.00
1,445.00
1,440.00
1,435.00
1,430.00
CO2 -- ppm
14:24:30
14:25:00
14:25:30
14:26:00
14:26:30
14:27:00

小结：Zero/Span 操作中可能会碰到的一些问题

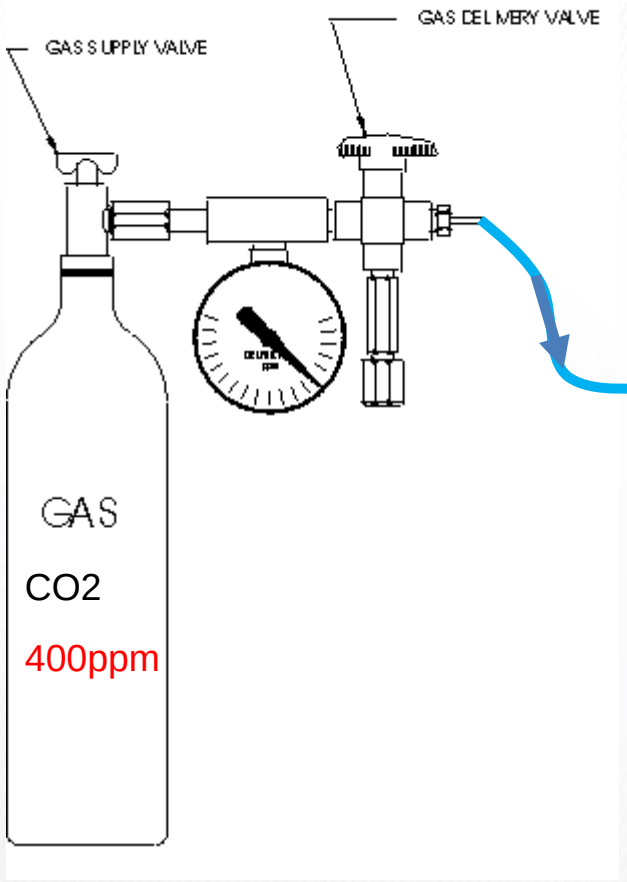
- Zero/Span的操作顺序
- 温度的影响因素
- 压力的影响因素
- 校准中读数大小对Zero/Span系数的影响
- 水汽露点值大小的选取
- 冬季的Zero/Span 校准
- EC15x 分析仪在高原上的应用

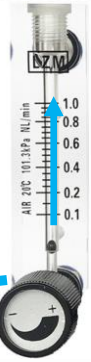
3. 开路分析仪 Zero/Span 操作演示

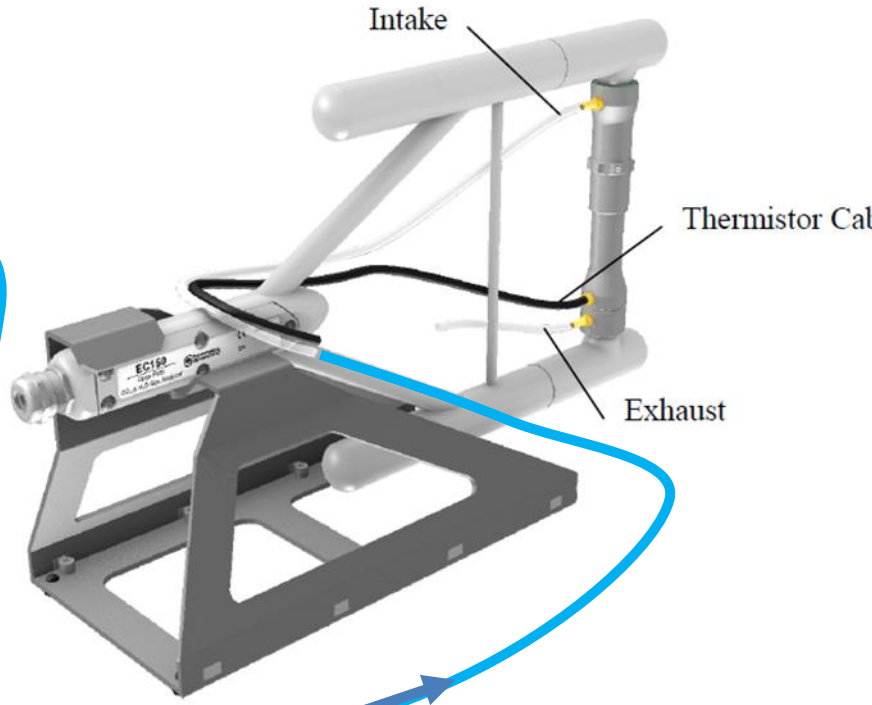
注意事项

- 正确安装校准管 (IRGASon ***)
- 露点仪充分预热
- 正确的气路结构
- 避免多余的动作（触碰、敲击等）

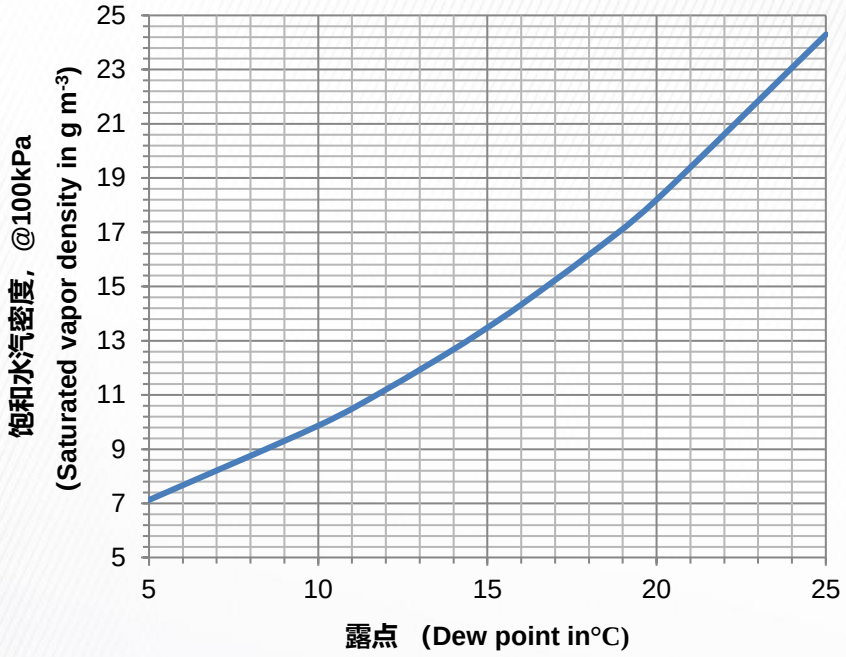
Zero 或 CO2 SPAN

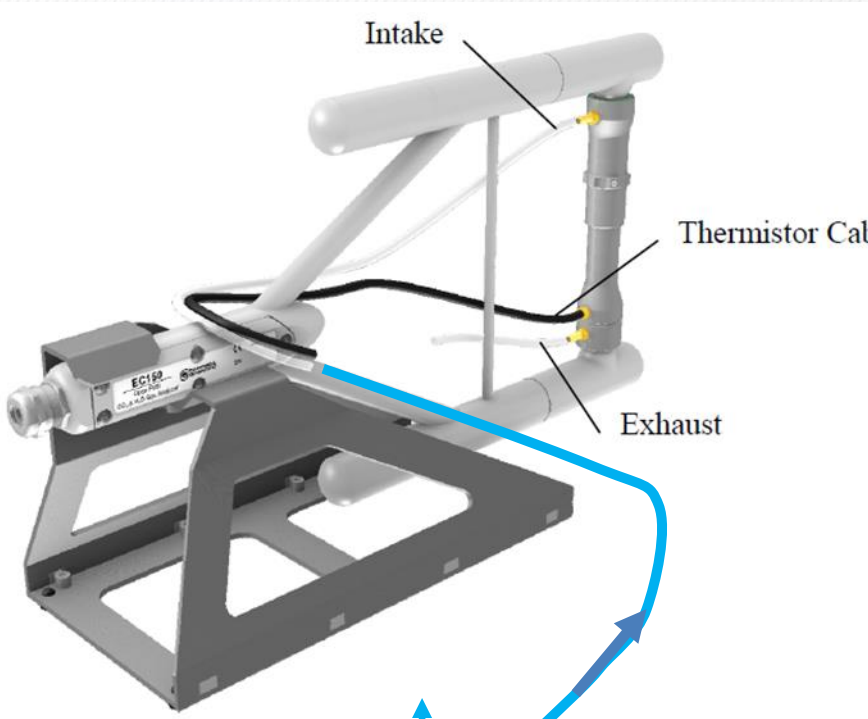






H2O SPAN


饱和水汽密度，@100kPa
(Saturated vapor density in g m-3)
25
23
21
19
17
15
13
11
9
7
5
5
10
15
20
25
露点 (Dew point in°C)


Intake
Thermistor Cal
Exhaust

露点仪

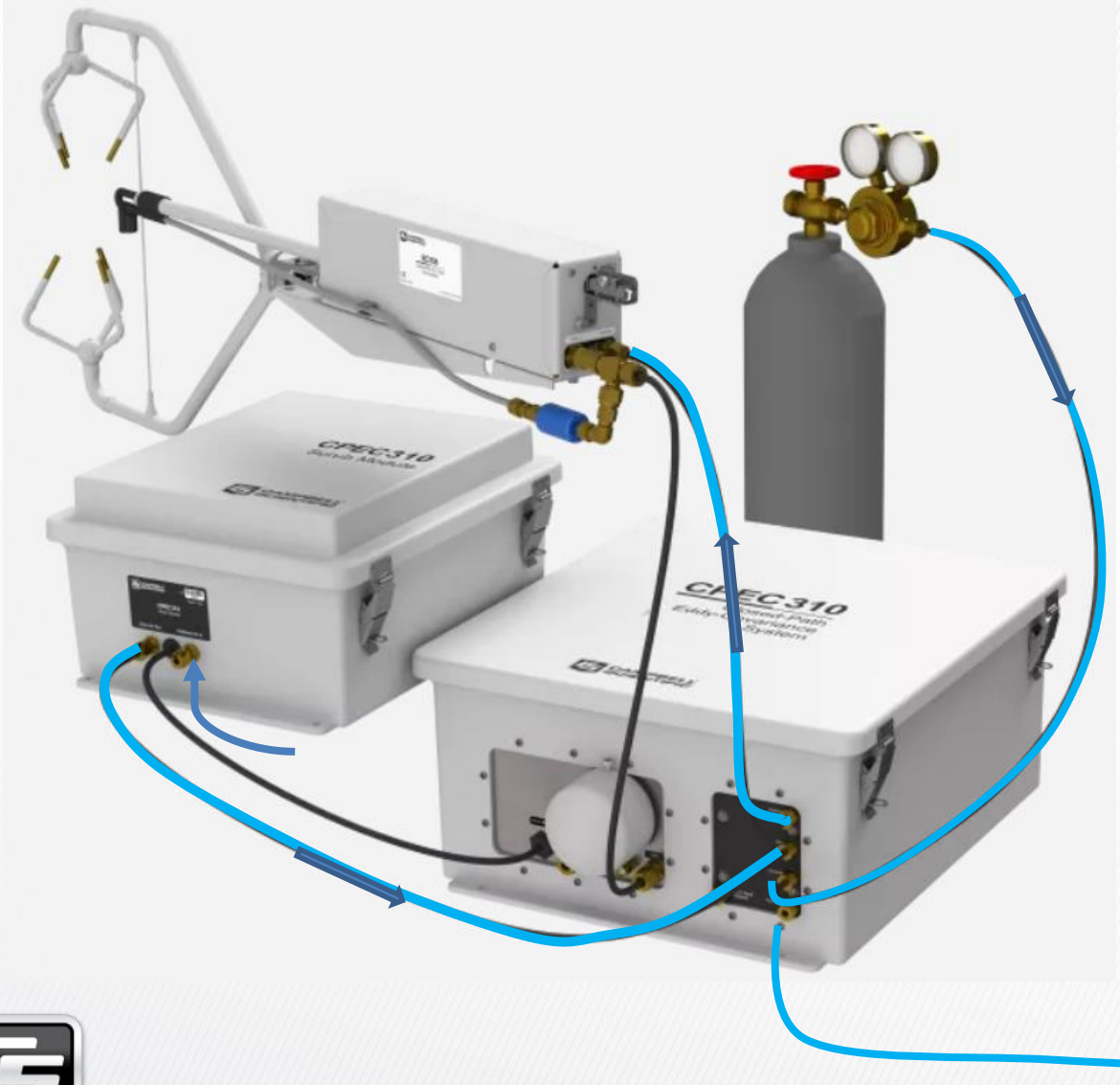
4. 闭路系统 Zero/Span 操作演示

CPEC310 自动在线校准

校准前注意事项

- 防止过高压力危害系统安全
- 正确安装
- 漏气检测
- 管路吹扫 (Purge)
- 标气压力（流速）调节
- 备份 Zero/Span 系数

CPEC310 自动在线校准气路示意图



Valve Module

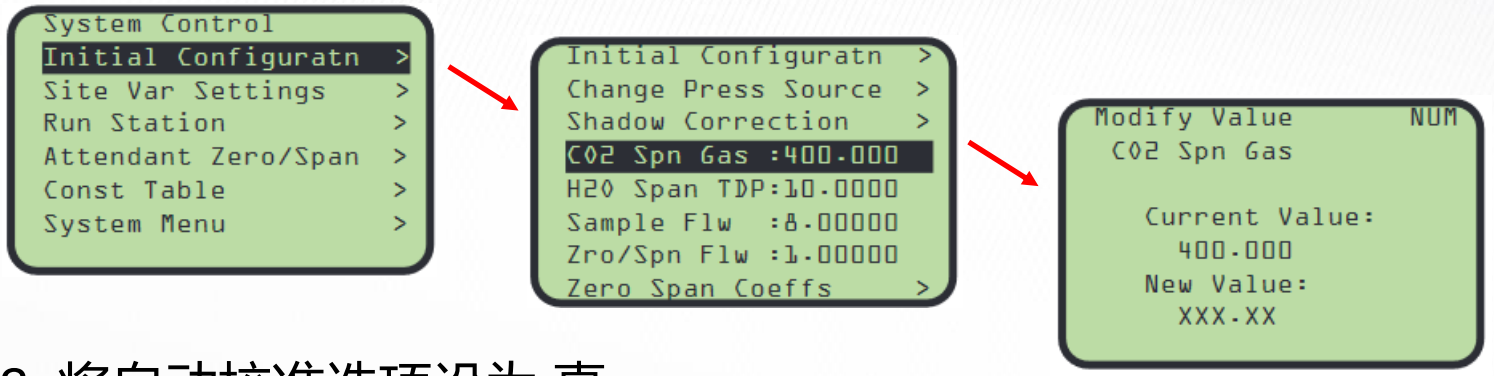
问题：在开路H2O Span中，气路中需要加一个三通，而闭路H2O Span的气路中没有三通，为什么？

CPEC310 自动在线校准

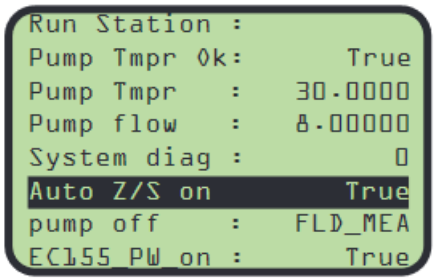
- 程序自动控制
- 含 Valve Module
- Scrub Module （默认）提供零气，CO2 标气瓶提供CO2 Span 标气
- 自动在线校准可实现 Zero All 和 Span CO2，理论上也可以把Span H2O 包含在自动校准序列里

自动在线校准参数预设置

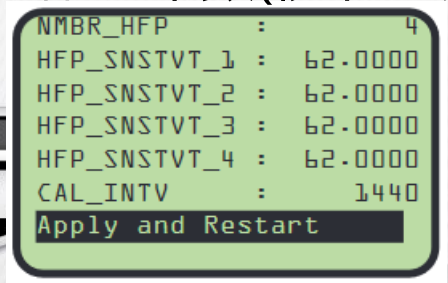
1. 配置初始化参数



2. 将自动校准选项设为 真



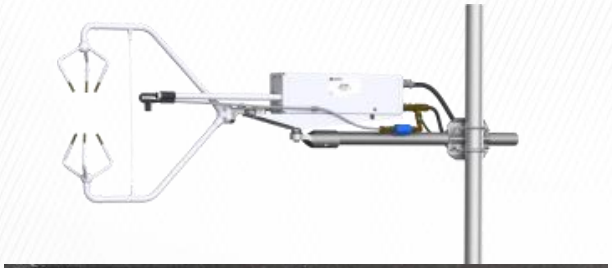
3. 配置常数(校准时长、校准间隔等)，并启动程序



自动在线校准典型动作序列 (Check 和 Set)

Site	Description	Duration	
SITE_1	fld smp		测量
SITE_2	offst P	10 sec	泵停止
SITE_3	chk CO2	65 sec	检查CO2
SITE_4	chk zro	85 sec	检查 Zero
SITE_5	set zro	10 sec	设定 Zero
SITE_6	set CO2	90 sec	设定 CO2
SITE_7	chk H2O	185 sec	检查 H2O
SITE_8	set H2O	10 sec	设定 H2O
SITE_9	Equilib	30 sec	平衡，泵启动
SITE_1	fld smp		测量

CPEC310 现场校准



- 操作者控制 数采菜单
- 可实现：
  - Auto Zero/Span Cycle
  - Field Zero All
  - Field CO2 Span
  - Field H2O Span
- 阀控动作系列与自动在线校准类似 （Check 和 Set）

通过LoggerNet 操作现场校准

Mode	Abbreviation	Description
1	FLD_MEA	测量模式
2	PMP_OFF	泵停止
3	ZRO_ALL	零点校准
4	SPN_CO2	CO2 跨度校准
5	SPN_H2O	H2O 跨度校准
6	IRG_SLP	分析仪休眠
7	AUTO_ZS	零点/跨度 校准

5. 廓线系统 Zero/Span 操作演示

注意事项

- 根据系统要求，需要安装4到8套Sample Intake
- 负压工作
- 露点仪充分预热
- Zero 和 CO2 Span 可实现自动在线校准
- H2O Span 需要手动操作，需要准备三通，需要知道AmbientPressure 和 CellPressure
- 管路吹扫 (Purge)

AP200 廓线系统管路连接

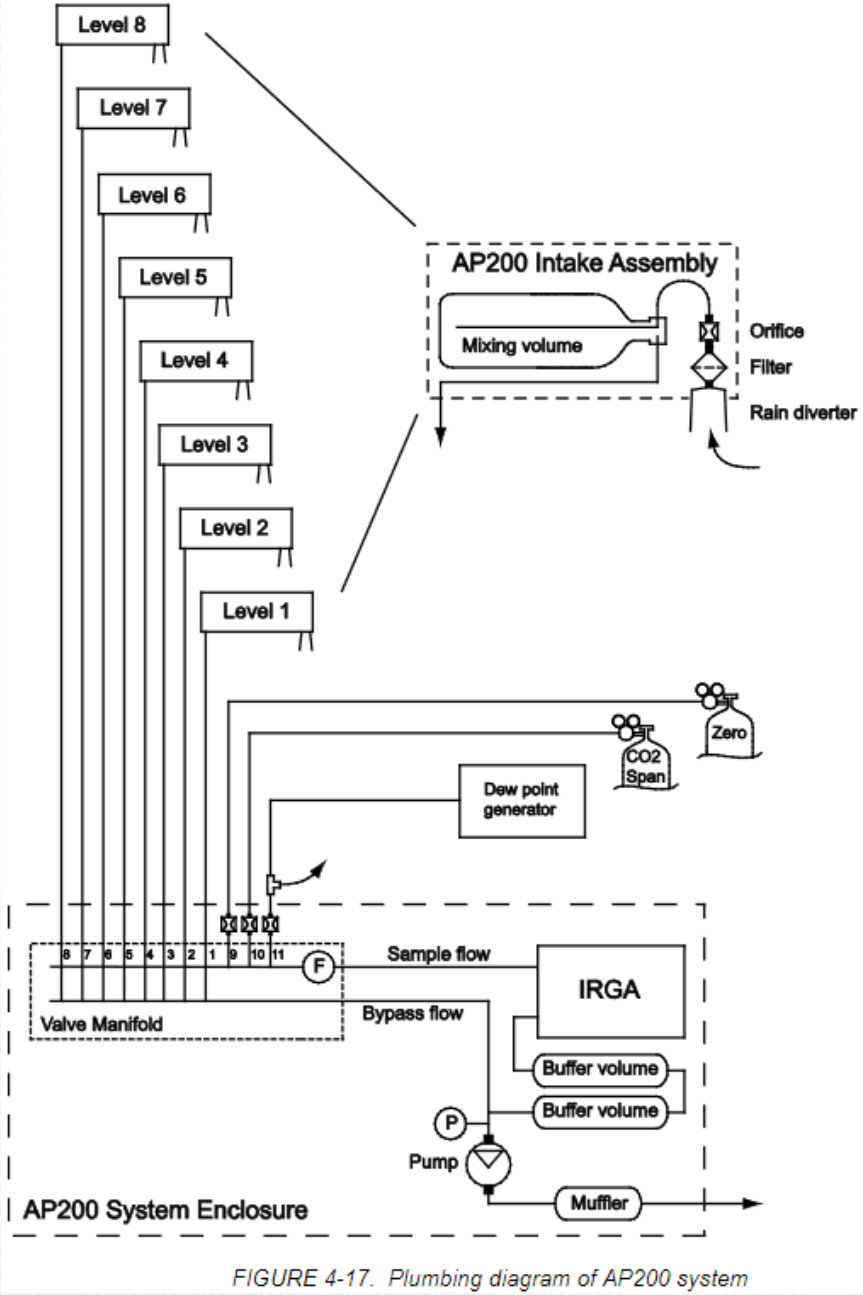


FIGURE 4-17. Plumbing diagram of AP200 system

系统初始化

主菜单

AP200 Menu
Check Status >
Manual ValveControl >
Manual Zero/Span >
Configure System >
System Menu >

Configure System
PRESS_AMBIEN |
PUMP_P_SETPT |
LEVELS_USED |
MEASURE_TANK |
AUTO_ZEROSPA |
CAL_INTERVAL |
CAL_TIMEOFFS |
CO2_SPAN_PPM |
BATT_LOWLIMI |
BATT_DEADBAN |

设置校准参数

Check Status:
diag_AP200 |
CO2 |
H2O |
seq_ACTIVE |
valve_number |
sample_flow |
cell_press |

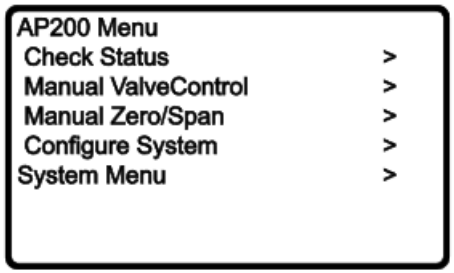
检查状态

Manual ValveControl:
STOPsequence |
STARTsequenc |
seq_ACTIVE |
valve_number |
sample_flow |
CO2 |
H2O |

管路吹扫，流速调节

手动 Zero 或 手动 CO2 Span

主菜单



手动 Zero/Span

Zero/Span 预检查

手动 Zero

手动
CO2 Span

H2O Span

主菜单

AP200 Menu
Check Status >
Manual ValveControl >
Manual Zero/Span >
Configure System >
System Menu >

手动 Zero/Span

Manual Zero/Span:
Check Span, Zero >
Do Zero (CO2&H2O) >
Do CO2 Span >
Do H2O Span >
seq_ACTIVE |
valve_number |
STARTsequenc |

Zero/Span 预检查

Check Span, Zero:
seq_ACTIVE |
STOPsequence |
valve_number |
CO2_SPAN_PPM |
diag_AP200 |
CO2 |
H2O |

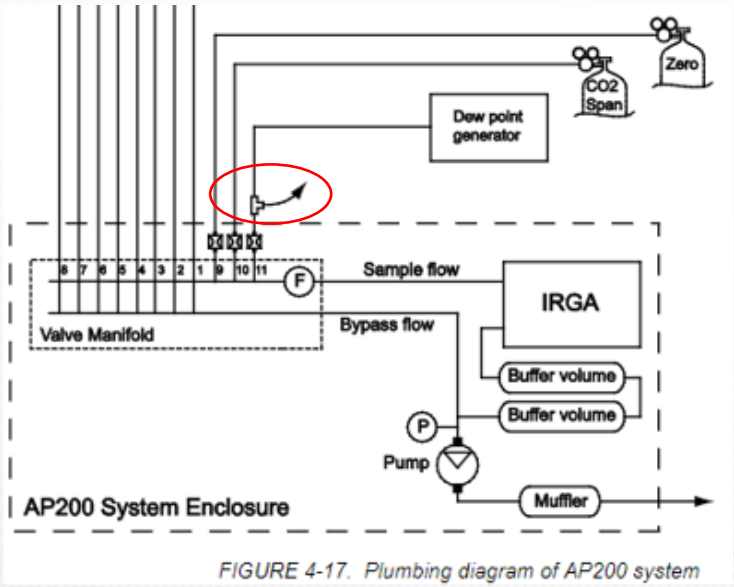


FIGURE 4-17. Plumbing diagram of AP200 system

Do H2O Span
seq_ACTIVE |
STOPsequence |
cell_press |
pump_ON |
H2OSpanDewPt |
PRESS_AMBIEN |
SETpressAmbi |
Td_cell |
Td_ambient |
cell_press |
pump_ON |
SpanCellP |
SETspanCellP |
valve_number |
diag_AP200 |
Td_ambient |
DO_H2O_span |

H2O Span

谢谢！