

Deployment of GAP Instruments

<i>Instrument</i>	<i>ID</i>	<i>Est. weight (kg)</i>	<i>Power (W)</i>	<i>Data acquisition</i>
Condensation Particle Counter **	CPC	0.75	15.0	RS-232
Optical Particle Counter **	OPC	0.30	5.4	RS-232
Cloud Droplet Probe	CDP	1.6	14.0	RS-232
Pyranometer **	CM22- A	0.40	NA	datalogger
Multi-Channel Airborne Radiometer (405, 550, 875, PAR)	MCAR	0.30	0.1	RS-232
Cloud Condensation Nucleus Counter	CCN	3.00	25.0	RS-232
digital video camera	DC	0.5	0.1	Flash card
data acquisition system **	DAQ	0.5	10	--
aerosol inlet **	AI	0.3	NA	--
<i>Estimated payload for each platform</i>		<i>Payload (kg)</i>	<i>Power (W)</i>	<i>Instrumentation</i>
above-cloud		3.75	30.7	AI, DAQ, CPC, 2*CM22, OPC, 2*MCAR, DC
in-cloud		3.85	45.4	AI, DAQ, CPC, CDP, OPC
below-cloud		4.85	50.1	AI, DAQ, CPC, CCN, MCAR, OPC

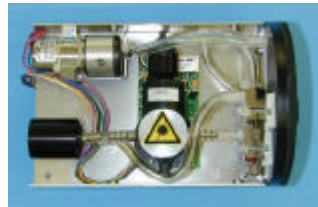
** GAP-PT deployment: Total estimated weight = 2.7 kg; power = 30 W

GAP-PT Instruments (fuselage)



Condensation Particle Counter (CPC)

Weight: 0.75 kg
Dimensions: 250 x 120 x 70 mm
Power consumption: 15 W (9 VDC)
Data output: RS-232
Deployment: fuselage



Optical Particle Counter (OPC)

Weight: 0.30 kg
Dimensions: 96 x 60 x 34 mm
Power consumption: 5.4 W (12 V DC)
Data output: RS-232
Deployment: fuselage



Data Acquisition (DAQ)

Weight: 0.08 kg
Dimensions: ca 100 x 100 x 15 mm
Power consumption: 5 W (5 V DC)
Data output: RS-232
Deployment: fuselage

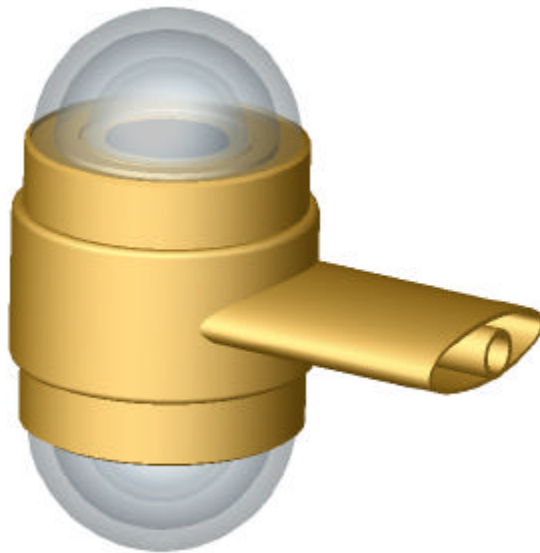


Flow Splitter / Inlet (AI)

Weight: 0.03 kg
Dimensions: 23 Ø x 112 mm
Power consumption: NA
Data output: NA
Deployment: fuselage

NOTE: fuselage part of aerosol inlet

GAP-PT Instruments (external)



Pyranometer (CM21-A)

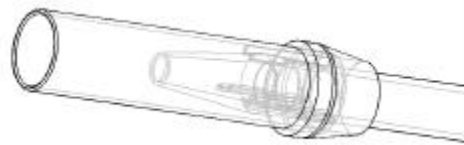
Weight: 0.25 kg

Dimensions: 56 Ø x 102 mm (cylinder: 57 mm height)

Power consumption: NA

Data output: RS-232

Deployment: extend from wing



Aerosol Inlet (AI)

Weight: 10 g

Dimensions: 10 Ø x 200 mm

Power consumption: NA

Data output: NA

Deployment: nose

NOTE: splitter in fuselage

GAP-PT Instrumentation



Condensation Particle Counter (CPC)

Weight: 0.75 kg
Dimensions: 250 x 120 x 70 mm
Power consumption: 15 W (9 VDC)
Data output: RS-232
Deployment: fuselage



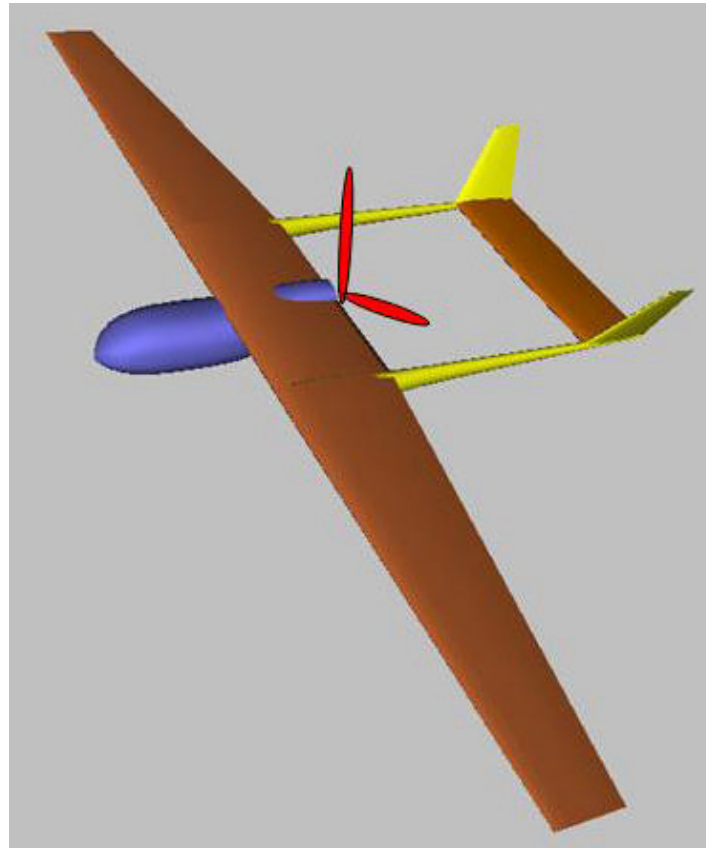
Optical Particle Counter (OPC)

Weight: 0.30 kg
Dimensions: 96 x 60 x 34 mm
Power consumption: 5.4 W (12 V DC)
Data output: RS-232
Deployment: fuselage



Data Acquisition (DAQ)

Weight: 0.08 kg
Dimensions: ca 100 x 100 x 15 mm
Power consumption: 5 W (5 V DC)
Data output: RS-232
Deployment: fuselage



Aerosol Inlet (AI)

Weight: 10 g
Dimensions: 10 Ø x 200 mm
Power consumption: NA
Data output: NA
Deployment: nose
NOTE: splitter in fuselage



Flow Splitter / Inlet (AI)

Weight: 0.03 kg
Dimensions: 23 Ø x 112 mm
Power consumption: NA
Data output: NA
Deployment: fuselage
NOTE: fuselage part of aerosol inlet

Venturi?

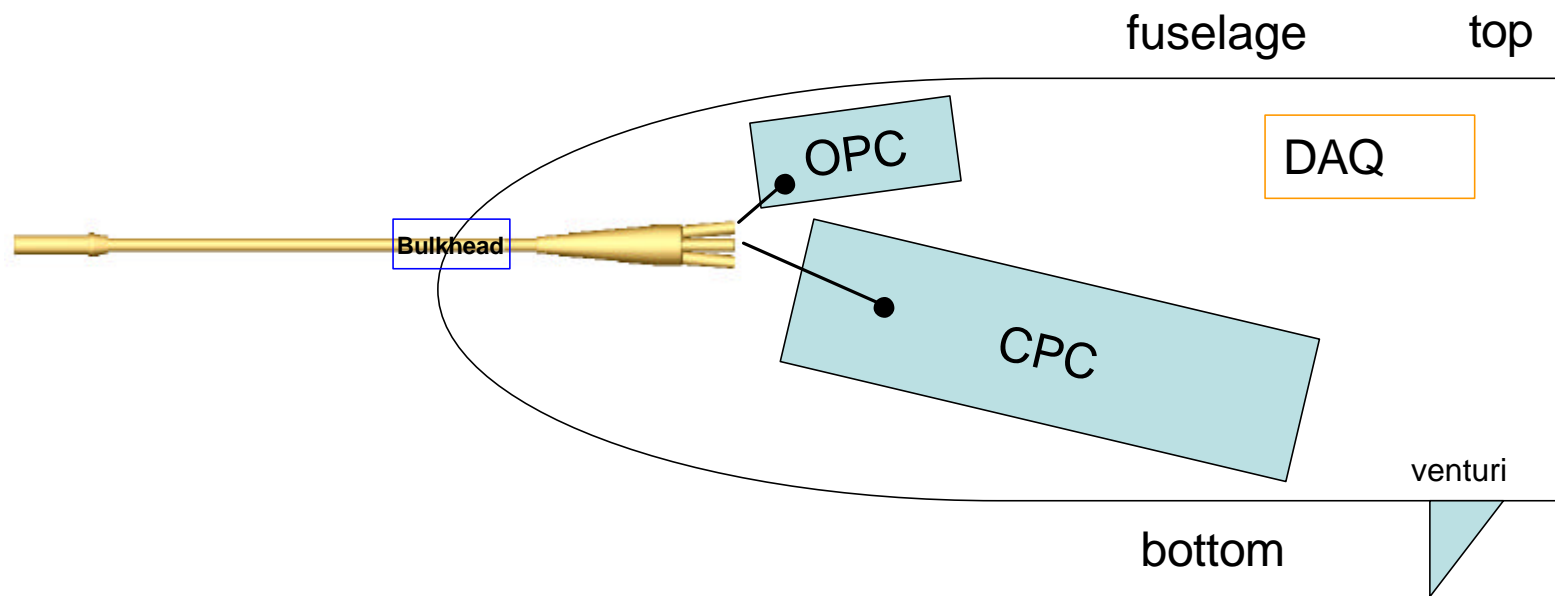
Platform specific instruments



Pyranometer (CM21-A)

Weight: 0.25 kg
Dimensions: 56 Ø x 102 mm
Power consumption: NA
Data output: RS-232
Deployment: wing

GAP-PT Fuselage Assembly



Pyranometer wing

General questions

- Sample outside of boundary layer and bending of streamlines (Baron & Willeke, 2001)
 - Below the center of each wing
 - lower aircraft fuselage
 - Upper aircraft fuselage ahead of trailing edge of wings but well behind cockpit
 - Extending into the air stream ahead of aircraft nose
- Payload weight distribution (weight/balance relationship) – CG vs. position relationship will be given – Jose is working on this now.
- Instrument rack – and mounting points directly onto fuselage mold
- Vibration / inlet motion -- staking electronics
- Temperature and sealing of fuselage – inlet ports to keep instruments cool
- DC power supply (output voltages and power) – 28 VDC @ 50 W generator for instruments
- Grounding of plane and instruments – separate strips for onboard computer and instruments
- Propeller will not effect aerosol measurements in front of fuselage
- Angle of attack: pitch ($< 1.5^\circ$) and yaw angles (less than a couple of degrees); take off at 12° ; max at 16°
- Velocity of aircraft (cruise 36 m s^{-1} ; min 6.5 m s^{-1} ; max 47 m s^{-1})
- Dimensions of fuselage (ca. 20 cm diameter)

Stream lines around fuselage

Sampling of aerosols

1. Centerline on nose
2. Offset from centerline
3. Above fuselage

Note: 1 & 2 extend at least r_{fuselage} into air stream

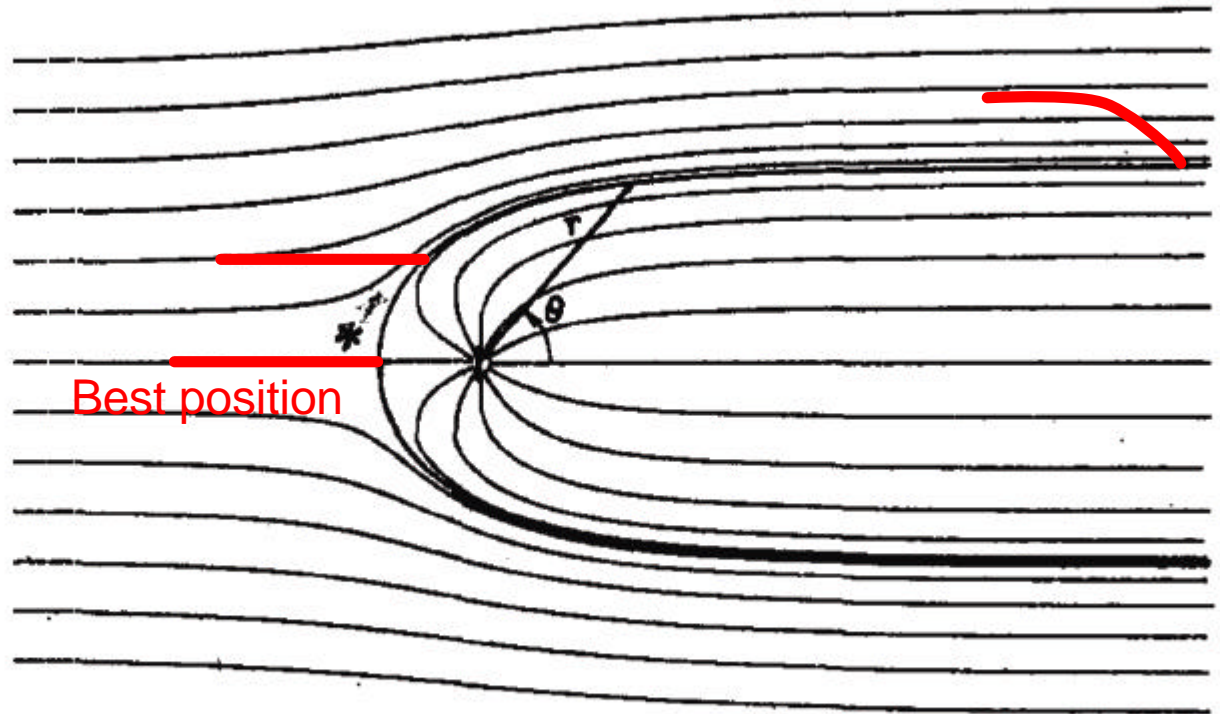
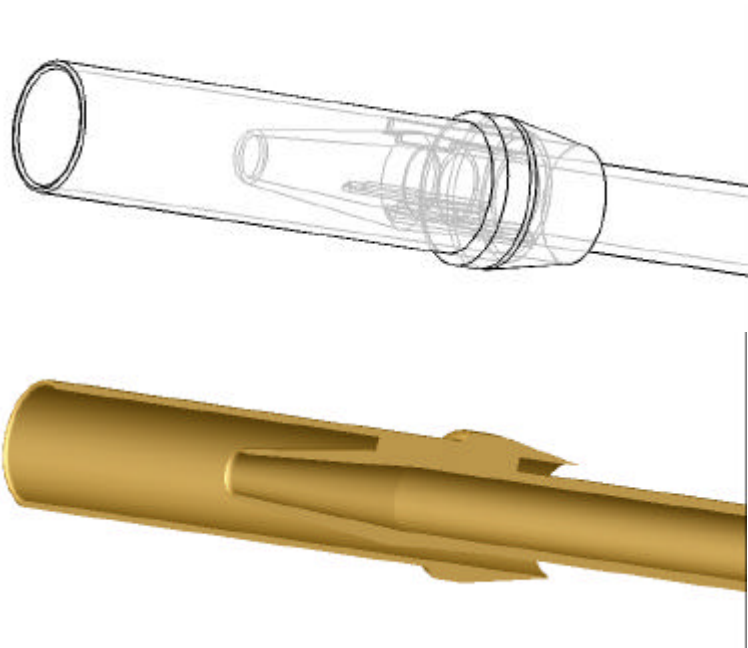


FIG. 1. Streamlines around a single source embedded in a uniform flow.

Shrouded Aerosol Inlet



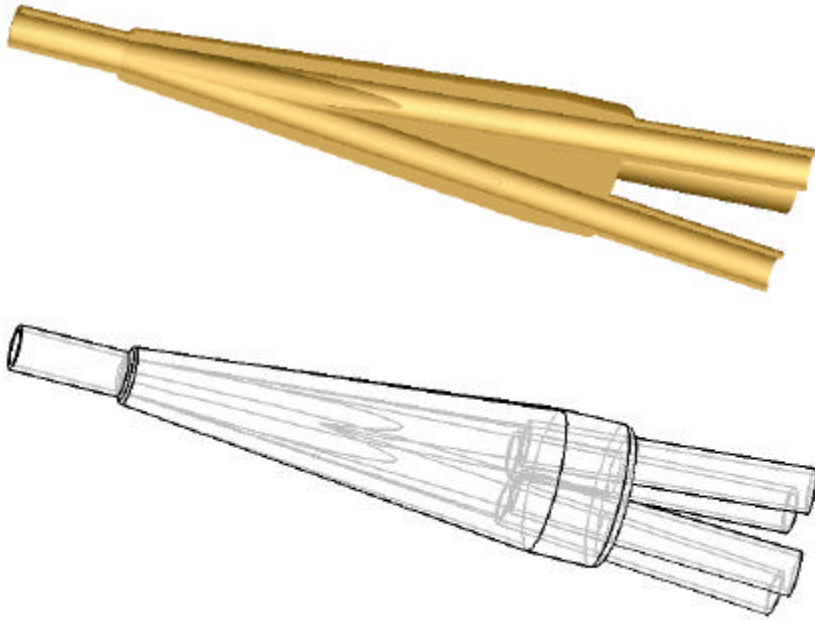
Technical information

- ID_{inlet} : 3.05 mm (0.120")
- OD_{tube} : 6.35 mm (0.250")
- OD_{shroud} : 9.53 mm (0.375")
- weight: 10 g
- $A_{pr} / A_{sh} = 0.7$
- flow rate: 4.5 to 6.5 lpm

Requirements:

- sample outside influence of aircraft
 - extend from nose ca. $r_{fuselage}$ (10-15 cm)
 - top of fuselage (propeller effects)
- oriented into the air stream at the center of the nose
- calibration (modelling / wind tunnel)
 - shroud reduction velocity
 - aerosol aspiration efficiency (at various speeds and attack angles)
- design for 36 m s^{-1}
- accommodate for 1.5 degree pitch during flight
- possible anti-vibration cone at nose

Flow Splitter



Requirements:

- attach directly to aerosol inlet (inside fuselage)
- shortest connection to OPC and CPC
- attach to venturi to measure flow
- grounded

Technical information

- OD: 6.35 mm (0.250")
- ID: 4.83 mm (0.190")
- dimensions: 23 Ø x 112 mm
- weight: 30 g
- 10° included angle
- flow rate: 4.5 to 6.5 lpm

Condensation Particle Counter



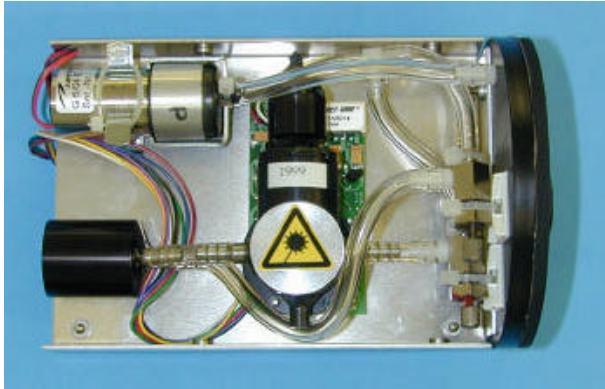
Technical information

- TSI Model 3007
- Weight: 0.75 kg
- Dimensions: 250 x 120 x 70 mm
- Power consumption: 15 W (9 VDC)
- Data output: RS-232
- Deployment: fuselage

Requirements:

- deploy with optical block slightly raised and toward the nose
- fuselage mount in carbon fiber cage
- staking of electronics
- power supply (9 VDC)

Optical Particle Counter



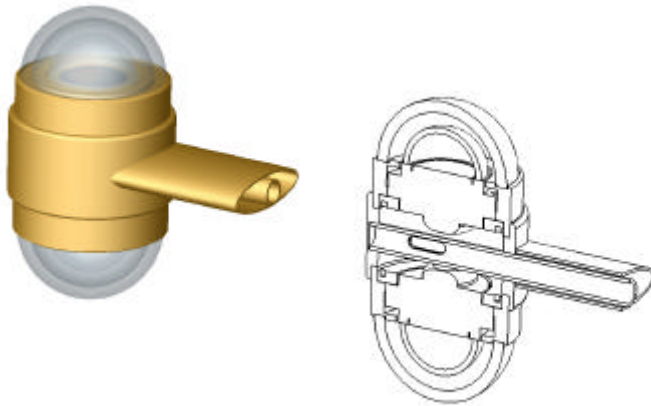
Requirements:

- attach as close as possible to flow splitter
- fuselage mount in carbon fiber cage
- staking of electronic components
- power supply (12 VDC)

Technical information

- Weight: 0.30 kg
- Dimensions: 96 x 60 x 34 mm
- Power consumption: 5.4 W (12 V DC)
- Data output: RS-232
- Deployment: fuselage

Pyranometer



Requirements:

- no obstruction of hemispherical view
- upward and downward mounted sensors
- dome and sensor housing exposed to air stream
- extend from end of wing
- staking of electronic parts

Technical information

- Modified CM-21
- Weight: 0.15 kg
- Dimensions: 56 Ø x 102 mm
(cylinder: 57 mm height)
- Power consumption: NA
- Data output: datalogger
- Deployment: wing

Data Acquisition



Technical information

- Advantech PCM-3350
- Weight: 0.08 kg
- Dimensions: ca 100 x 100 x 15 mm
- Power consumption: 5 W (5 V DC)
- Deployment: fuselage

Requirements:

- mounted in carbon fiber cage
- fuselage mount
- shielded from RF and EMI
- grounded
- power supply (5 VDC)
- staking of electronic parts (vibration)
- maintain temperature in fuselage
- communication with flight computer (time, GPS coordinates, data transmission, storage)

GAP-PT development

- mold of fuselage to mount instruments
 - integration of inlet and pyranometer
 - cage for fuselage mounted instruments
- wind tunnel testing
- calibration/performance and modelling efforts
- probe comparisons

AUAV design

