Autonomous mobility with ropeways – the next generation of modern transportation

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AURO ropeways operate without station attendants. Equipped with state-of-the-art and networked technology, they bring passengers safely and reliably to their destination in tourist areas or in cities.

Agenda

1. AURO System
2. AURO MGD
   - technical features
   - operational experience
3. AURO CLD
   - technical features
   - operational experience

Doppelmayr

Silvretta® Montafon

AURO System

AUtonomous **R**opeway **O**peration

AURO SYSTEM

AURO

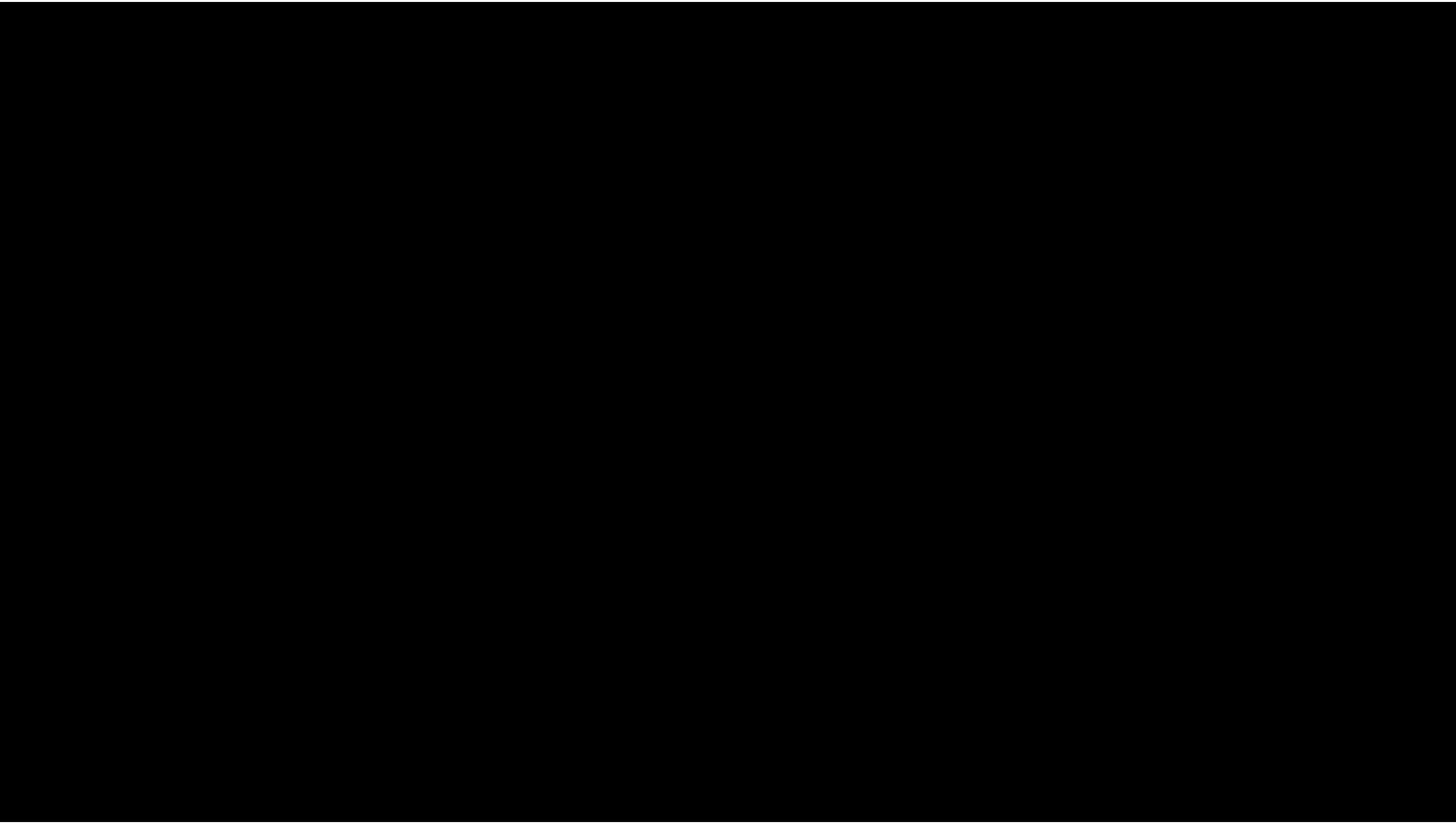
- personnel-efficient operation
- passenger operation without station personnel during public transportation
- unmanned stations are monitored by technical systems
- operators from the ROC do not have to permanently supervise the unmanned stations
- one or more ropeways with unmanned stations are operated and monitored from a central location, the so-called "Ropeway Operation Center" (ROC)

AURO SYSTEM

Ropeway Operation Center

- ROC is the central manned control center for operation
- ROC must not be located directly at the ropeway
- control room of a manned station can be used as ROC
- ROC equipment:
  - control panel for ropeway controls
  - intercom to the unmanned loading/unloading area
  - video surveillance system


AURO MGD
Doppelmayr



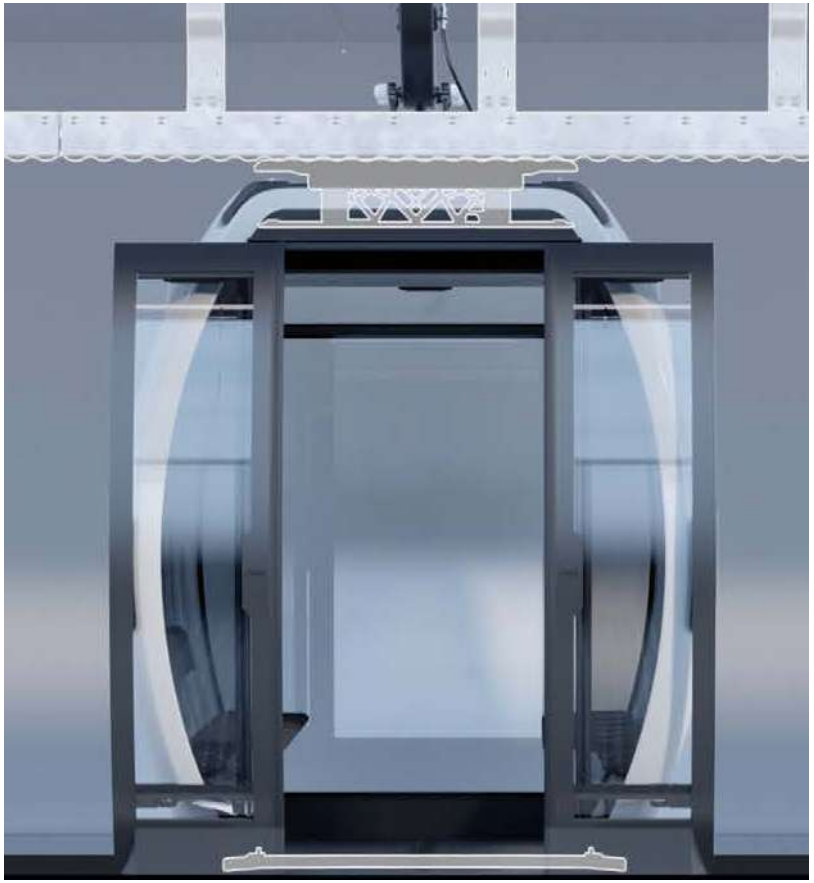

Ropeway Operation Center (ROC)
Cabins
Cabin stabilization
Information banner
CCTV system in the stations
Outline detection with shutdown function
Emergency stop button and intercom system
Platform gate with shutdown function
Cabin step designed to align with platform
Presence recognition in pit with shutdown function
Platform gate with warning function
Emergency stop button and intercom system

AURO MGD, Technical requirements

Technical measures station:

Cabin stabilization

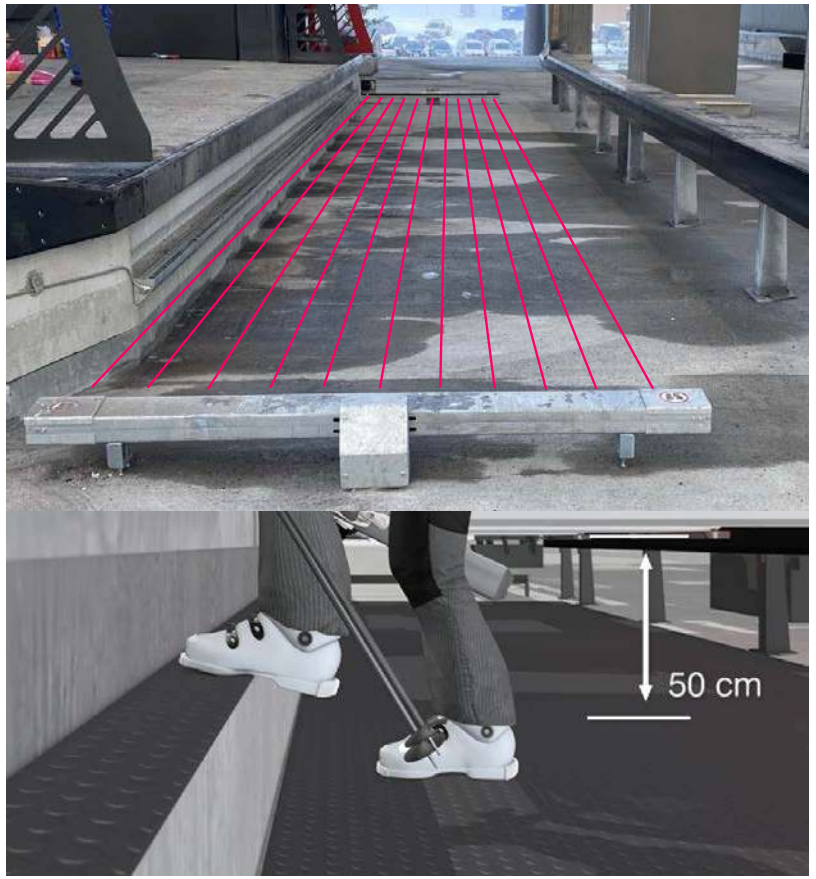
- minimization of the longitudinal swaying of the cabins in the loading and unloading area
- minimization of the vertical movement between empty and full cabins in the loading and unloading area



AURO MGD, Technical requirements

Technical measures station:
Presence monitoring pit

- light barrier reacts to object size and length of stay
- automated stop of installation
- separate step to get out
- distance between cabin and floor min. 50cm



Technical measures station:

Cabin step geometry

- adjusted to the platform outline
- minimum gap between cabin step and platform
- object or body part can not get stuck between cabin step and platform
- no ski rack on outside of door

AURO MGD, Technical requirements

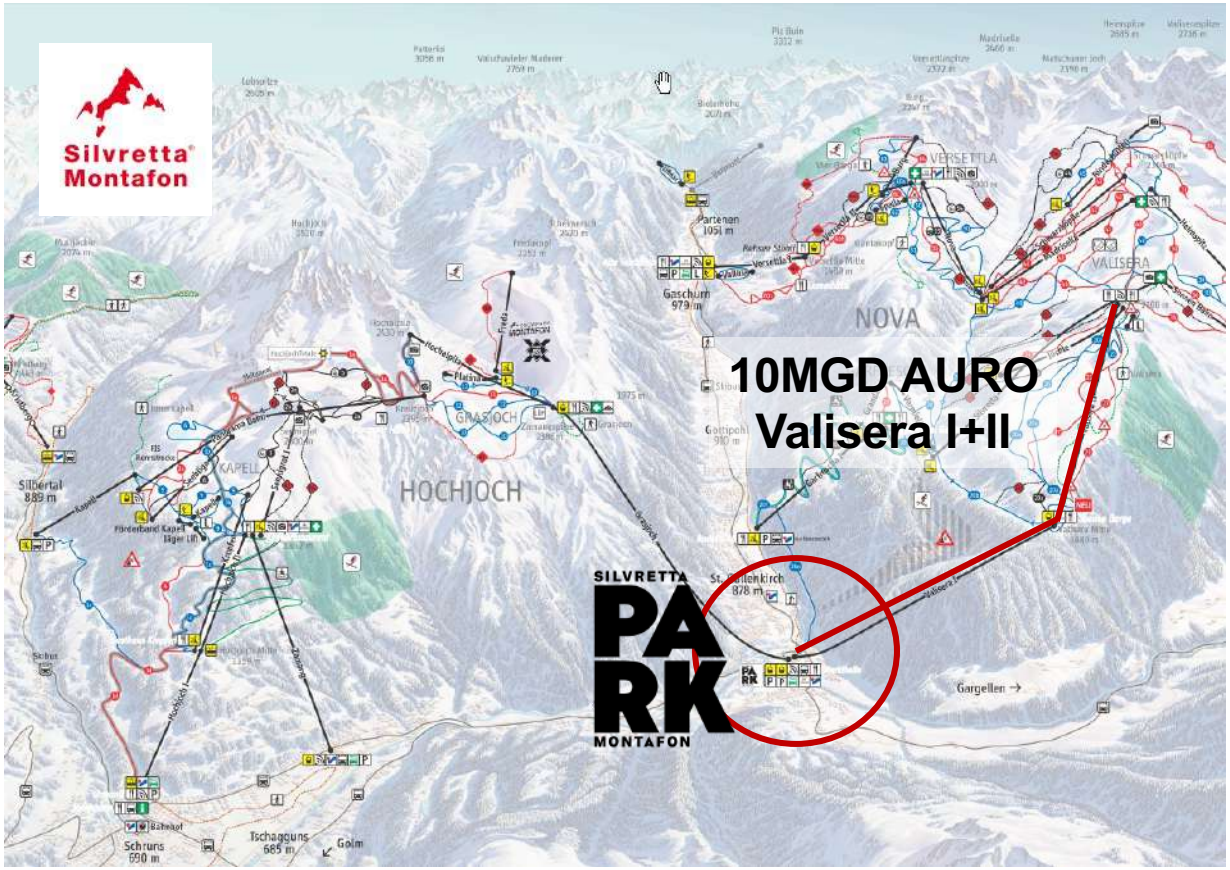
Technical measures station:
Stop button and intercom system

- transporting an injured person
- communication: ski patrol – ROC

Same procedure for

- wheelchair loading
- communication: passenger – ROC

AURO MGD, Operational Experience



Ski resort Silvretta Montafon

- 36 ropeways and lifts
- transport capacity of ~ 66.000 P/h
- 6 entry points to the ski area
- Silvretta Park - main terminal & most important entry point

10MGD AURO Valisera I+II

- replacement of the former 6MGD in the year 2021
- first AURO ropeway in Austria

AURO MGD, Operational Experience

10MGD AURO Valisera I+II

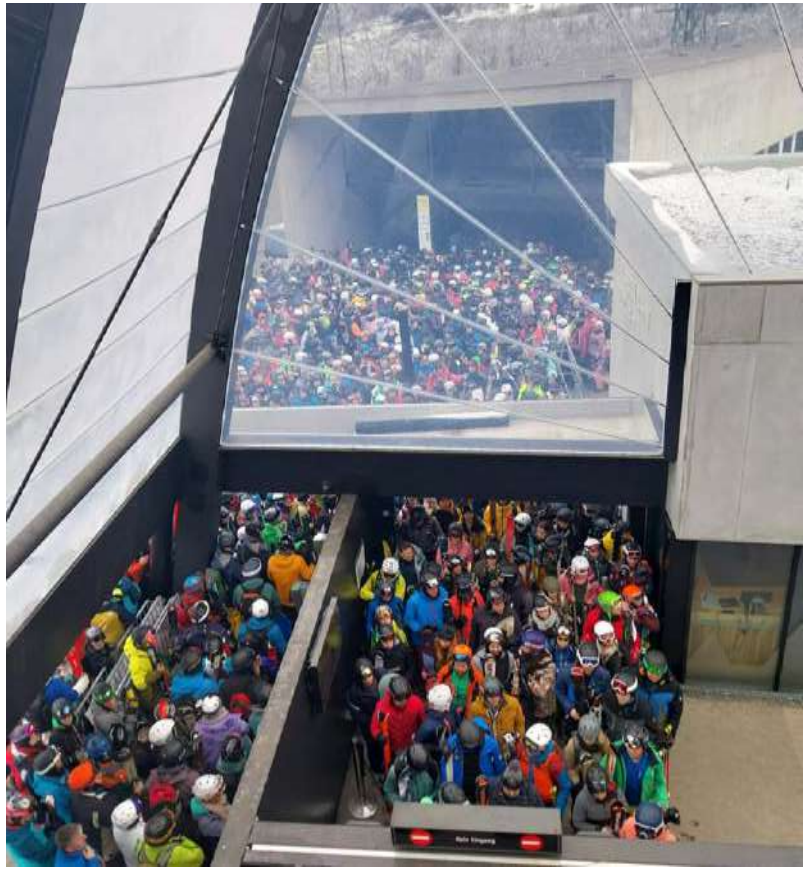
Doppelmayr D-Line (YOC 2021), technical data:

- 2800 P/h, upgrade to 3600 P/h for season 2024/25
- rope speed 6,5 m/s; loading speed 0,26 m/s
- inclined lenght: 4.015m; difference in elevation: 1.286m
- DDD with 1.191 kW (section I) and 941 kW (section II)

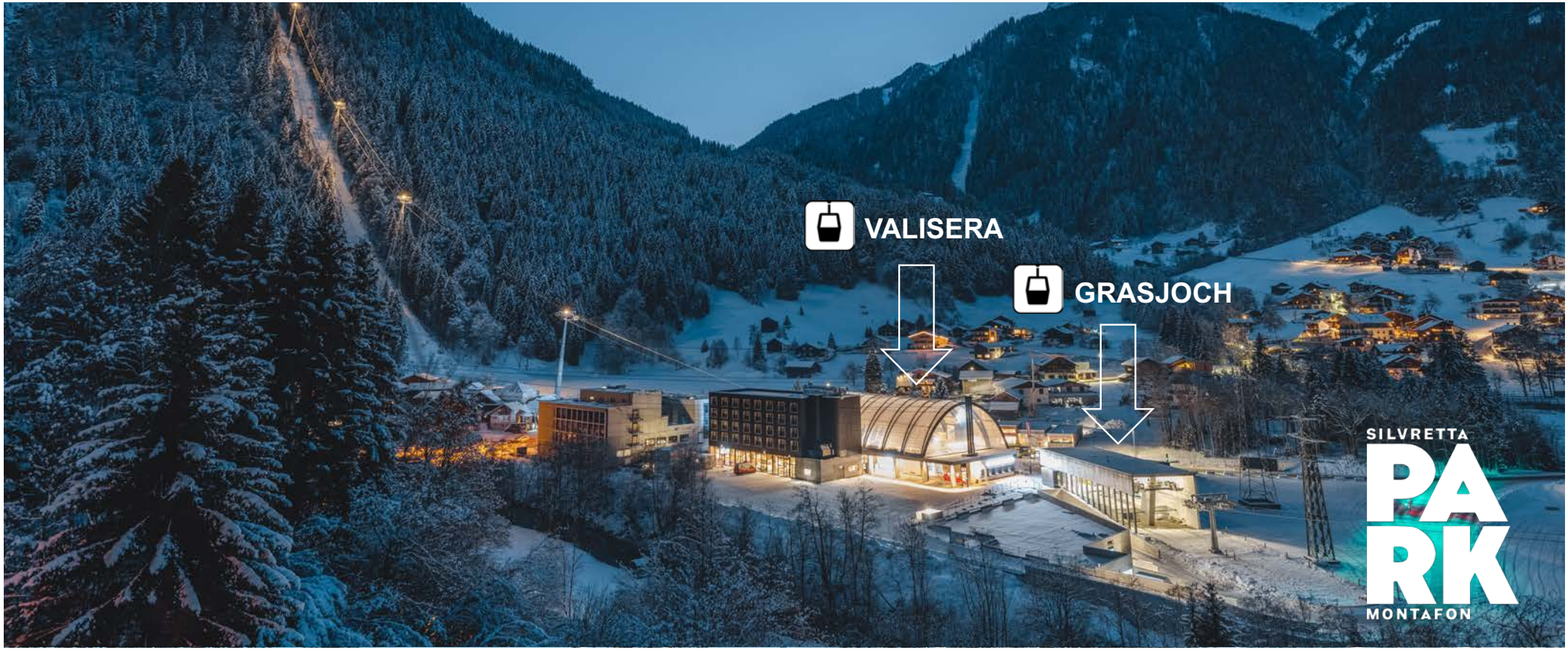
10MGD AURO Valisera I+II - # passengers

Number of passengers per winter season:

- 850.000 to 900.000 passengers (on each section)
- 17.000 passengers on peak days (on each section)
- ⅓ of the skiers use this ropeway to enter the ski area



AURO MGD, Operational Experience

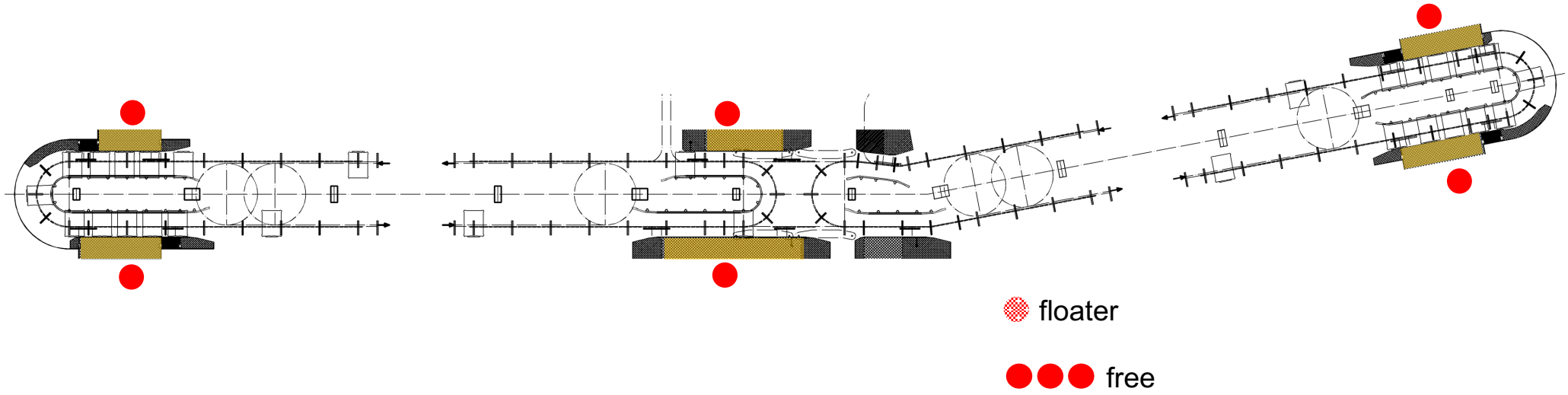


AURO MGD, Operational Experience

AURO MGD, Operational Experience

10-MGD AURO Valisera I+II - required personnel

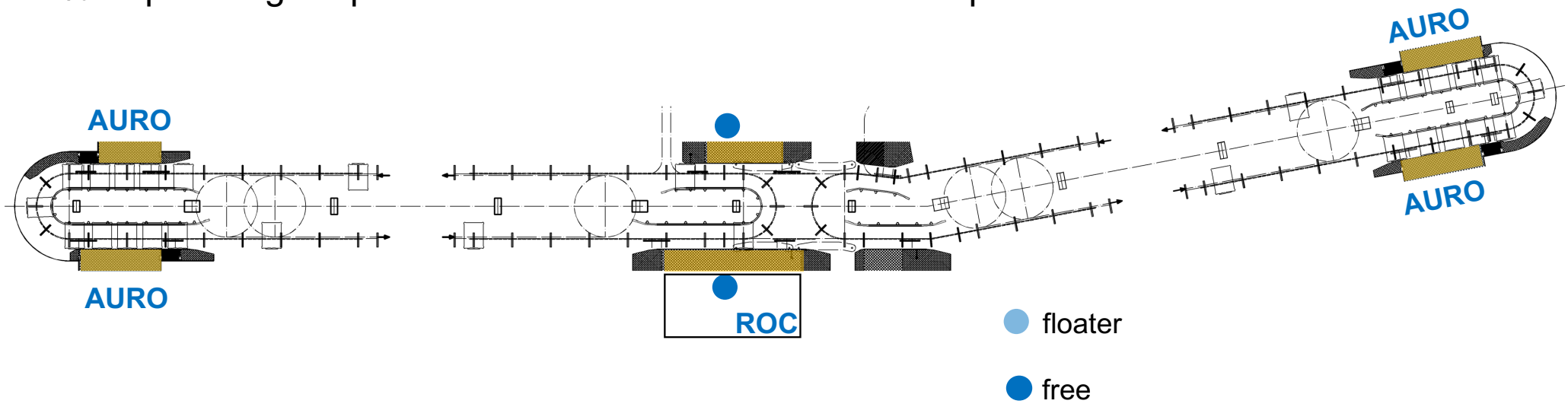
– without AURO system: 9 employees



AURO MGD, Operational Experience

10-MGD AURO Valisera I+II - required personnel

- without AURO system: 9 employees
- with AURO system in bottom & top station: 3 employees
- 99% of passenger operations with unmanned bottom & top station



AURO MGD, Operational Experience

10MGD AURO Valisera I+II - stops & availability

Number of stops through the AURO system during passenger operation in section I and II (winter 2023/24):

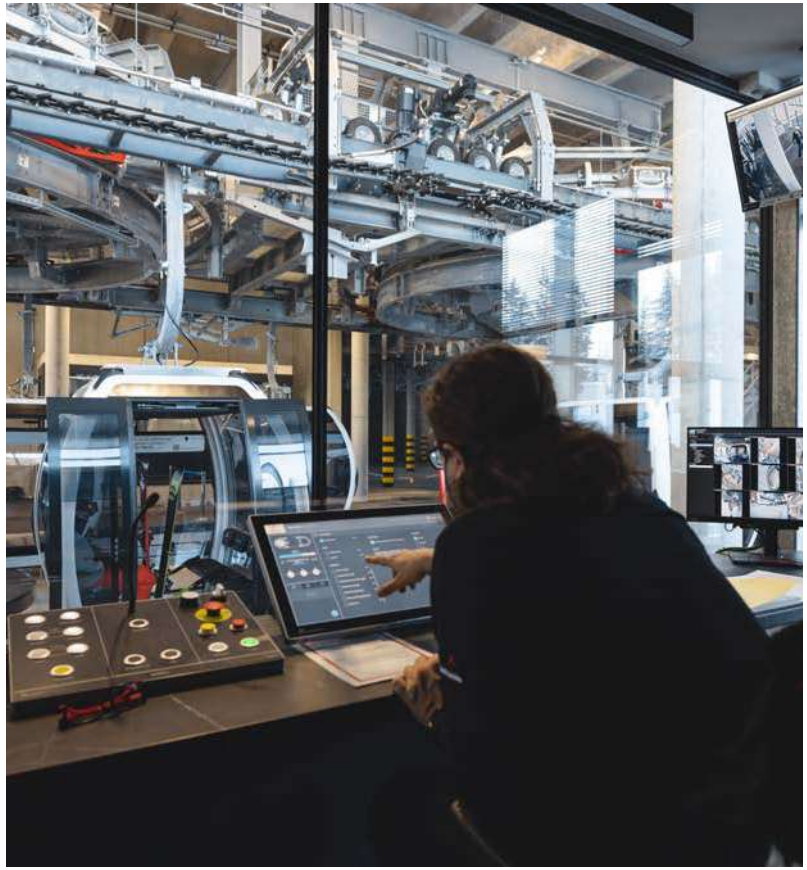
- ø 1,5 - 2 stops/day (min. 0, max. 5 stops/day)
- ø 1 stop per ~ 7.600 passengers (in each station)
- in total ~ 25 false stops since 2021 (~ 3% false stops)

Restart after stops during AURO operation (2023/24):

- 85% - 90% remote from ROC
- 10% - 15% with staff member in AURO station

Availability of the AURO system (since 2021):

- 100% system availability of the AURO system



AURO MGD, Operational Experience

10-MGD AURO Valisera I+II - guest behavior

Occupancy rate of the gondolas:

- section 1: 75% - 80% during peak time
- section 2: up to 95% during peak time

Help requests from guests through the intercom system:

- number of help requests per day: ~ 5 - 10

Guest complaints in the winter season 2023/24:

- total complaints ski resort: # 137
- complaints depending AURO MGD: # 0

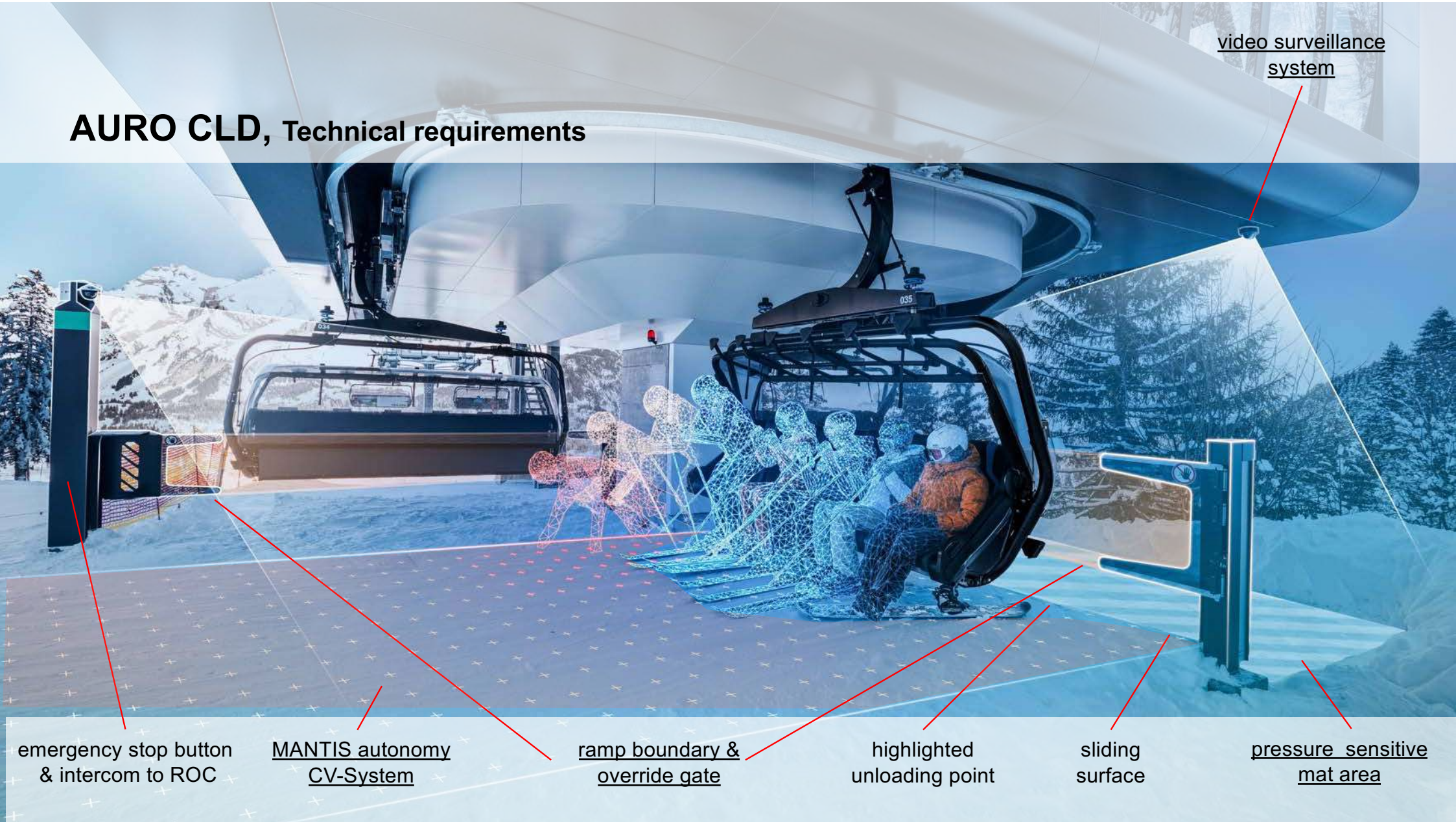
10-MGD AURO Valisera I+II - conclusion

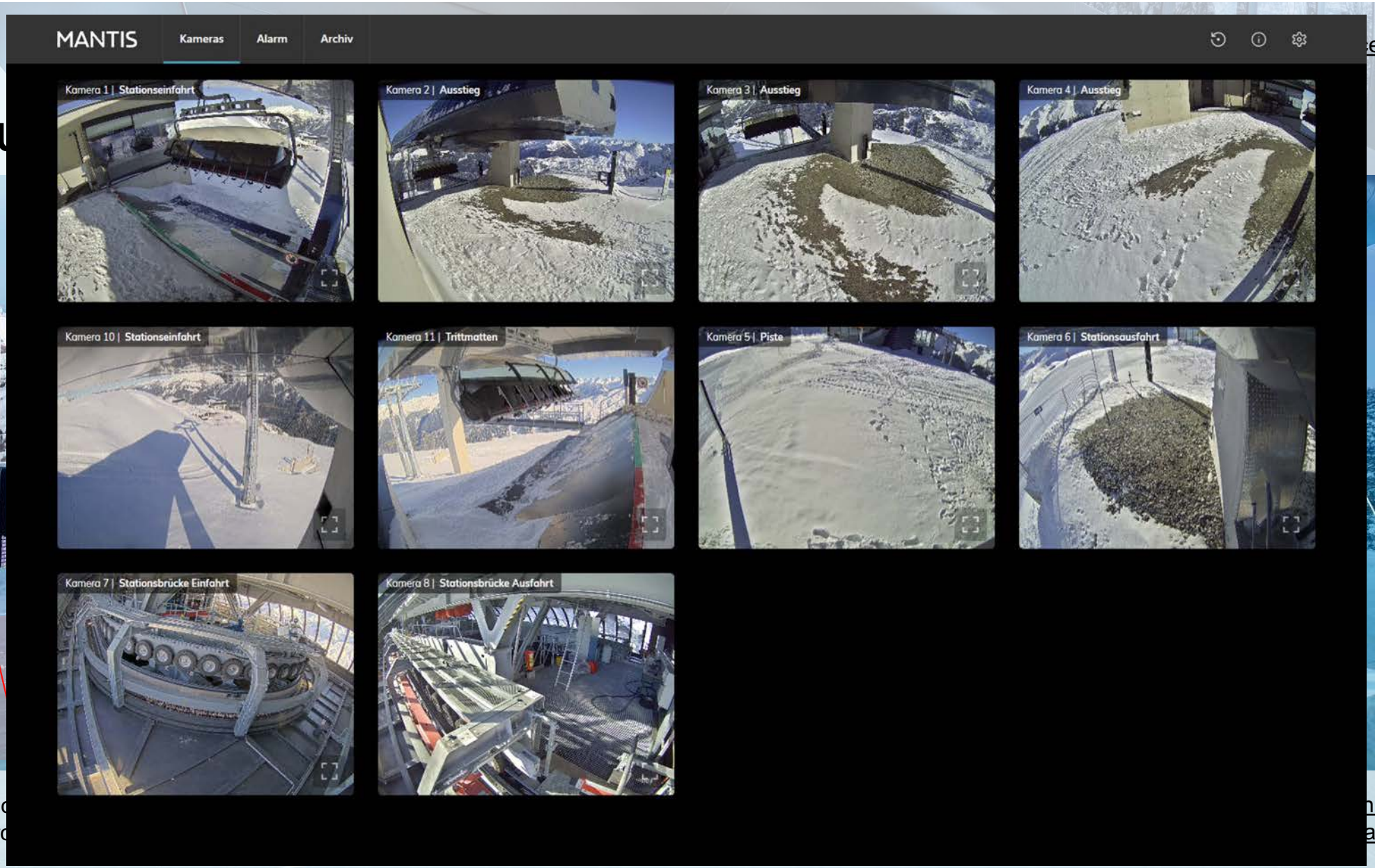
- Reducing personal requirement from 9 to 3 employees.
- Savings in operational costs.
- High accuracy - approx. 97% of correct AURO stops.
- 100% availability of the AURO system.

➔ Future MGD projects in the ski resort Silvretta Montafon will all be equipped with the AURO.

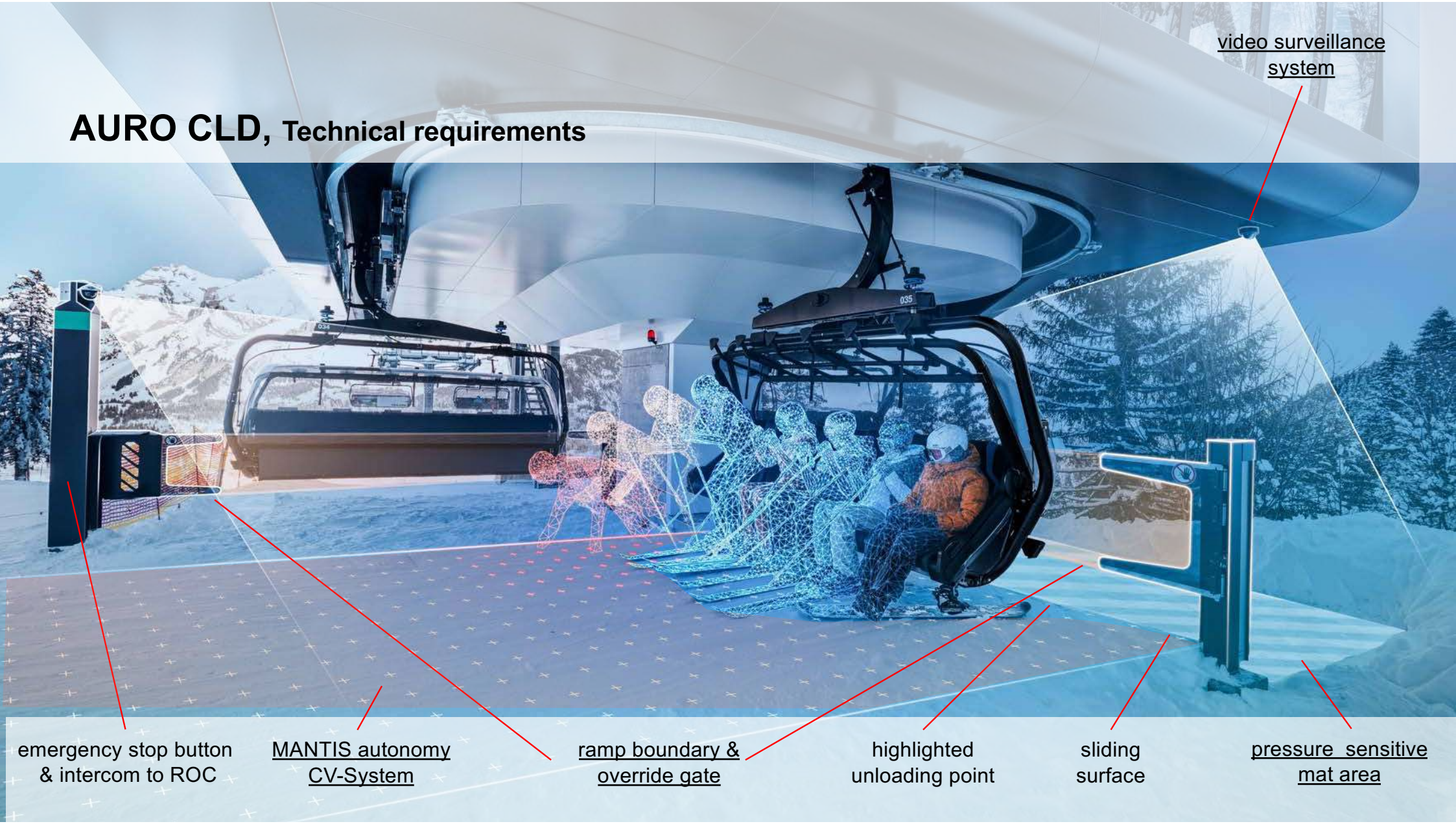
AURO CLD

AURO CLD, Technical requirements

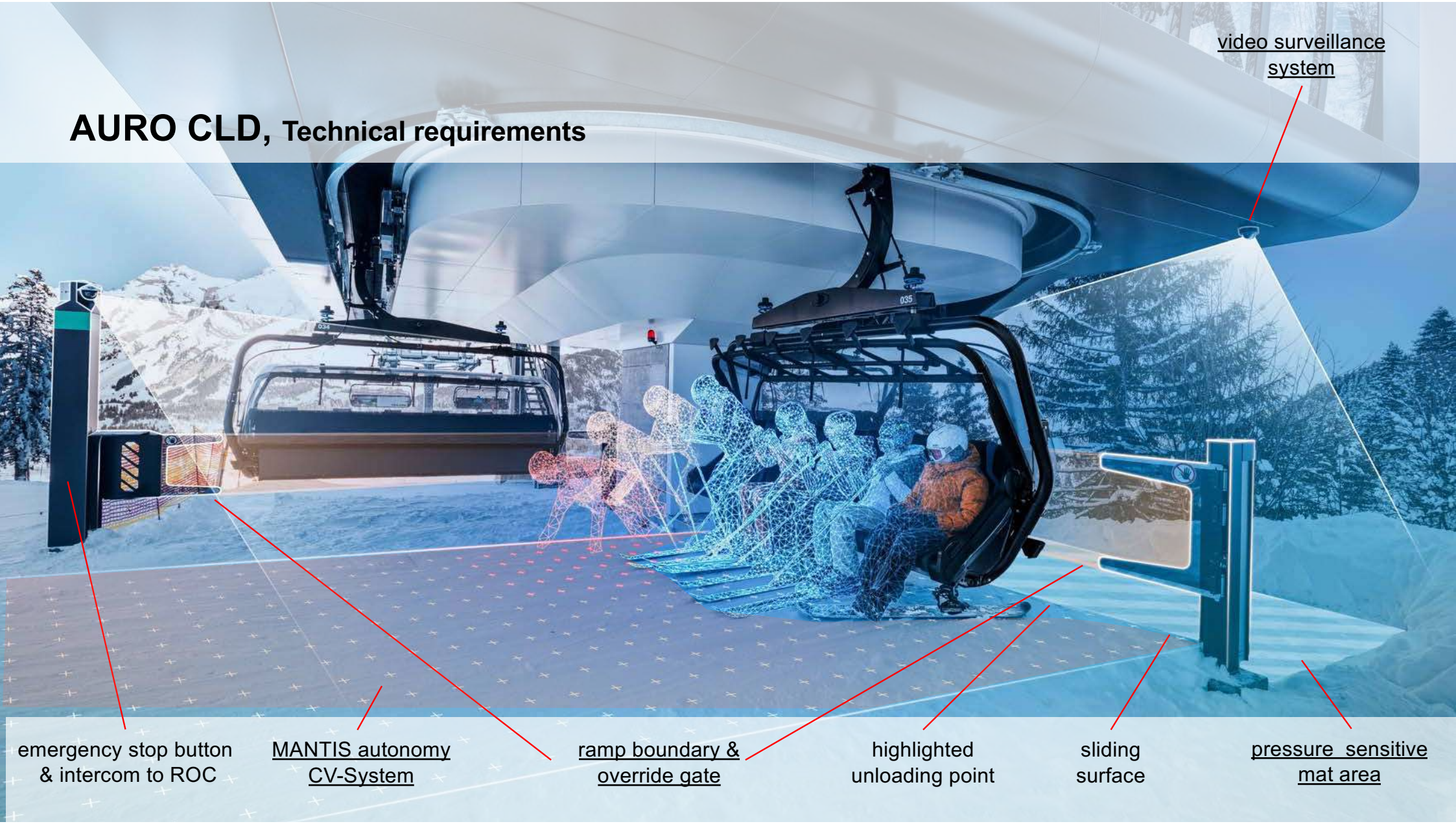



MANTIS
Kameras
Alarm
Archiv
Kamera 1 | Stationseinfahrt
Kamera 2 | Ausstieg
Kamera 3 | Ausstieg
Kamera 4 | Ausstieg
Kamera 10 | Stationseinfahrt
Kamera 11 | Trittmatten
Kamera 5 | Piste
Kamera 6 | Stationsausfahrt
Kamera 7 | Stationsbrücke Einfahrt
Kamera 8 | Stationsbrücke Ausfahrt

AURO CLD, Technical requirements



AURO CLD, Technical requirements

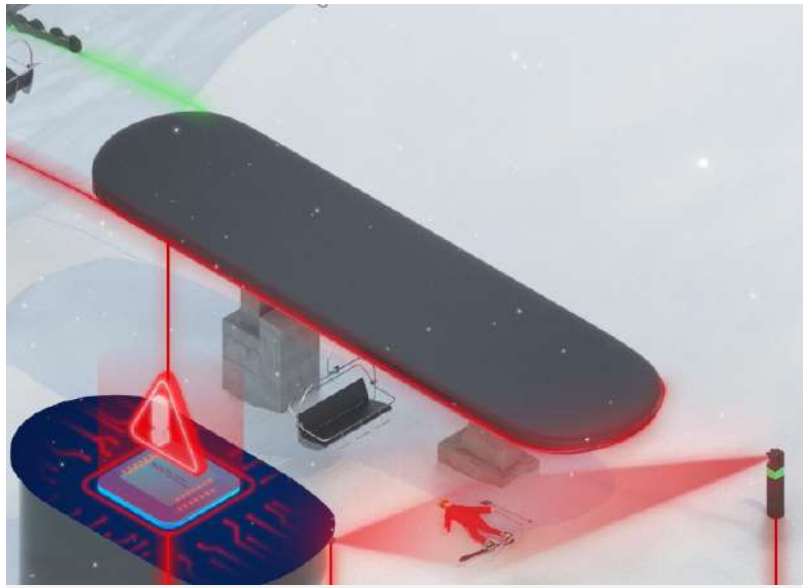



2023-02-16T14:26:10+01:00
chairlift 0.95
16451
chairlift 0.92
16467
person 0.84
16471
person 0.80
16456
zone_person_collision_exitright
zone_person_noncollision_exitright

AURO CLD, Technical requirements

CV-System

- AI-powered incident detection for unattended upper terminals
- learned from more than 3 million passengers at 10 stations
- first computer vision solution in the ropeway industry
- takes a decision 15 times per second using cameras from all angles
- automatically stops or slows down the lift depending on the situation



AURO CLD, Operational Experience

8CLD/B AURO Alptobel (Silvretta)

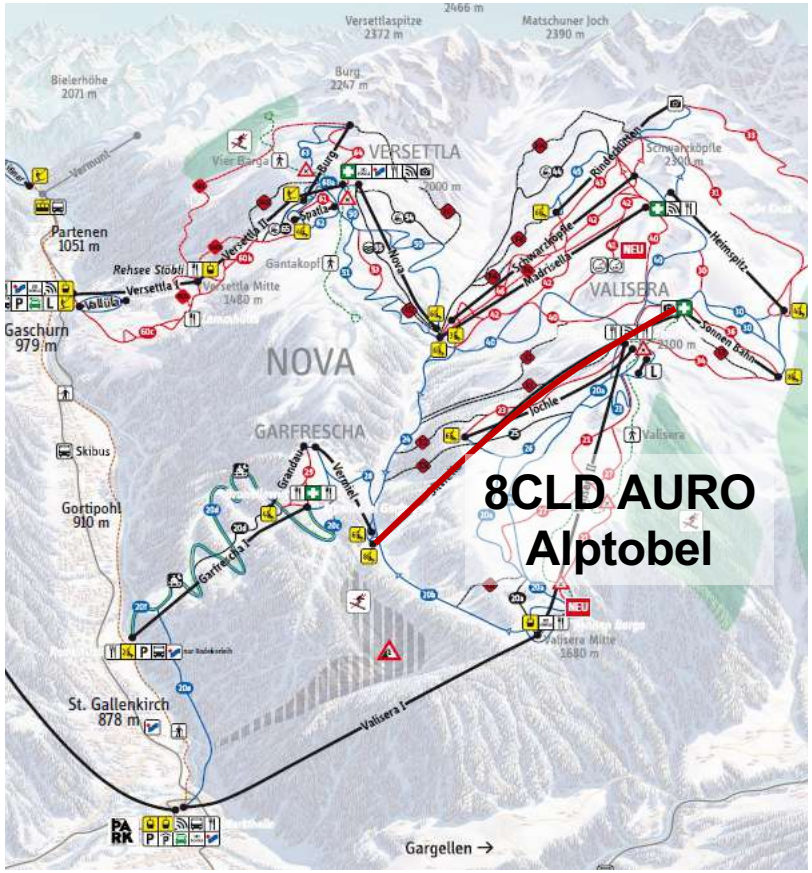
Doppelmayr UNI-G (YOC 2016), technical data:

- AURO: 2021 pilot operation; operation licence 12/2023
- transport capacity: 3200 P/h; interval of chairs: 9 sec
- rope speed 5,5 m/s; un-/loading speed 0,8/0,4 m/s
- inclined lenght: 2.093m; difference in elevation: 685m
- drive power: 1.118 kW

8CLD/B AURO Alptobel - # passengers

Number of passengers per winter season:

- 750.000 passengers in total
- 12.500 passengers on peak days



AURO CLD, Operational Experience

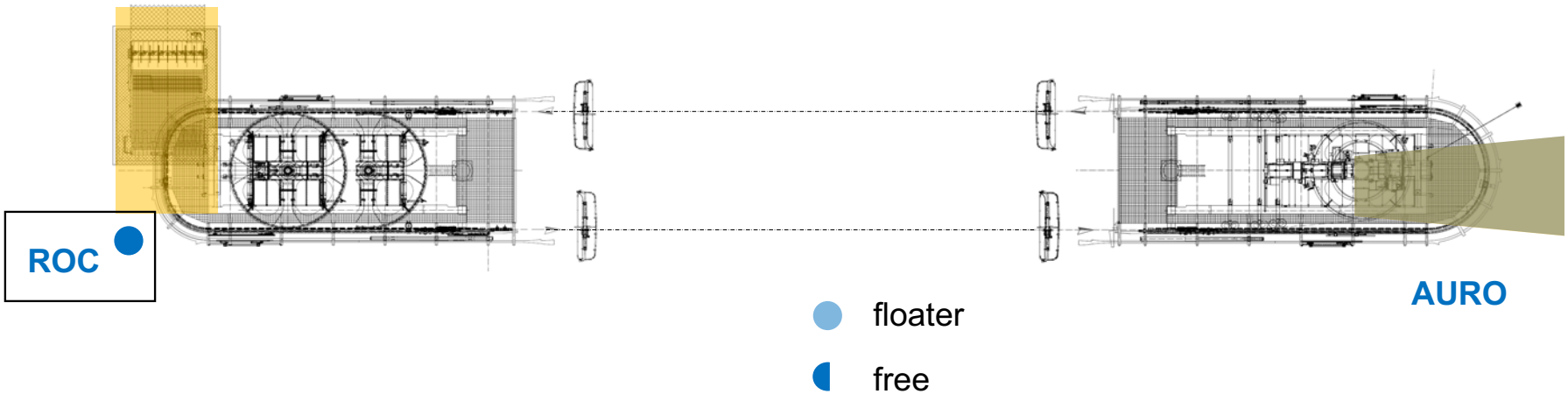
AURO CLD, Operational Experience

8-CLD/B AURO Alptobel - required personnel

– without AURO system: 3 employees

8-CLD/B AURO Alptobel - required personnel

- without AURO system: 3 employees
- with AURO system in bottom and top station: 1,5 employees
- ~ 95% of the operating days with AURO system



8CLD/B AURO Alptobel - stops & availability

Number of interventions through the AURO system during passenger operation in winter season 2023/24:

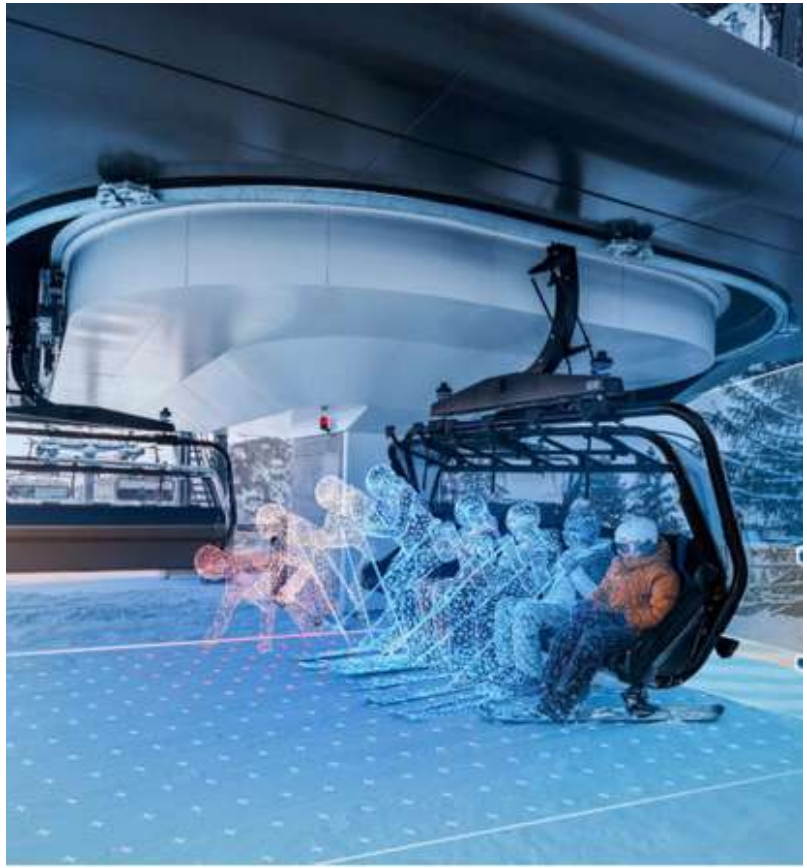
- ø 10,2 interventions/day; 56% slows, 44% stops
- ø 1 intervention per ~ 650 passengers

Detection accuracy of the AURO system (2023/24):

- 92% correctly detected critical situations
- 8% false (overcautious) interventions

Availability of the AURO system (2023/24):

- self monitoring system causes 1 stop every 2nd day
- in total 6 stops through handling error during season



AURO CLD, Operational Experience

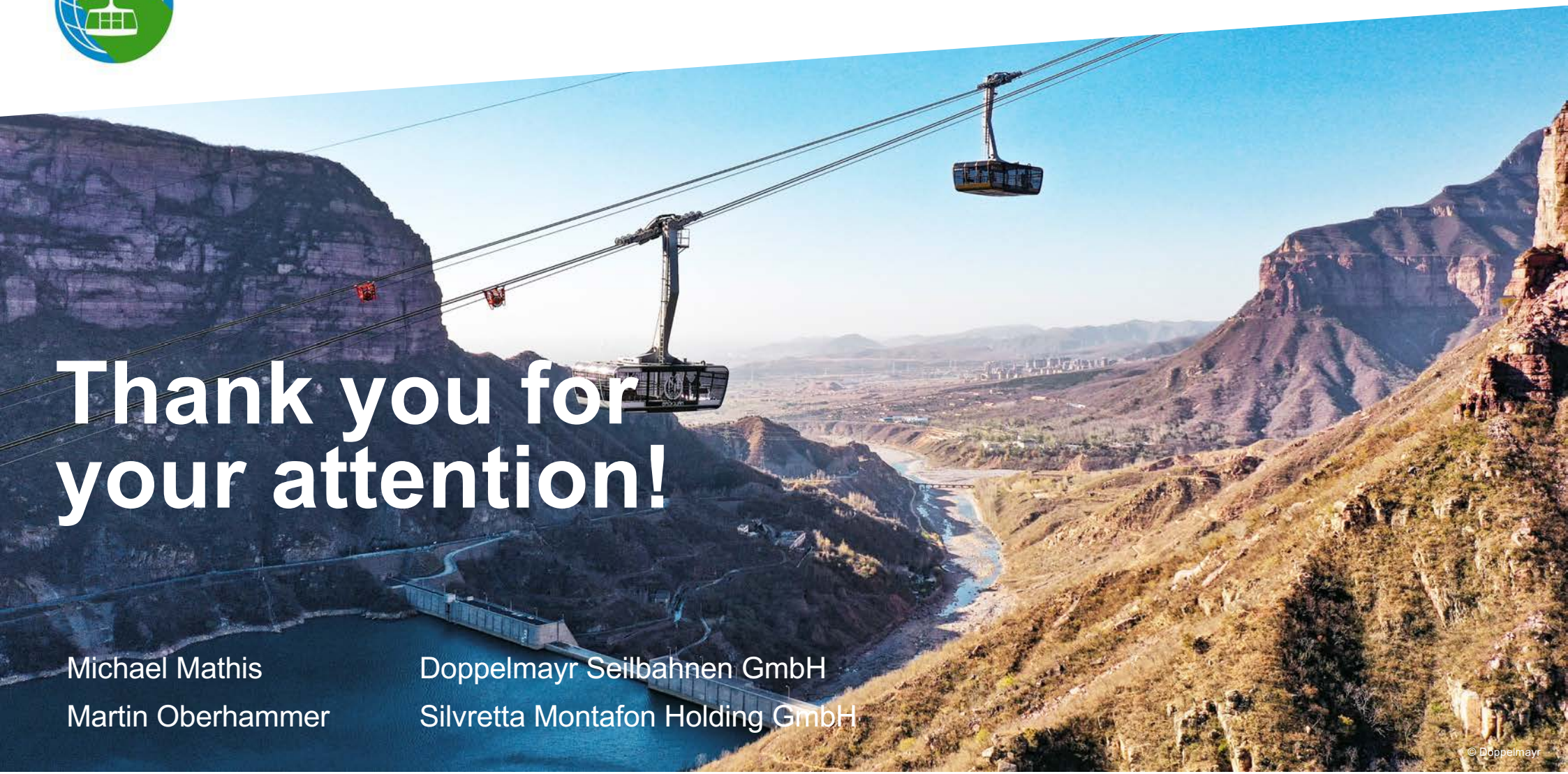
8CLD/B AURO Alptobel - Safety gain through AURO?

- relevant critical positions covered by cameras and sensors
- fast reaction in case of critical situations
- constant altertness, no tiring
- legal assessement - confirms increase in safety

8CLD/B AURO Alptobel - conclusion

- Reducing personal requirement from 3 to 1,5 employees.
- Savings in operational costs.
- Safety gain - more than one pair of eyes.
- High accuracy - 92% correct AURO interventions.
- Good availability - few interruptions through self monitoring system.

➔ AURO upgrade for several existing CLDs in the ski resort Silvretta Montafon within the next 3 years in planning.



Thank you for your attention!

Michael Mathis — Doppelmayr Seilbahnen GmbH
Martin Oberhammer — Silvretta Montafon Holding GmbH