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1st MSA-Trough Webinar, 17-09-2024



Deutsches Zentrum
für Luft- und Raumfahrt
German Aerospace Center

Martin Eickhoff

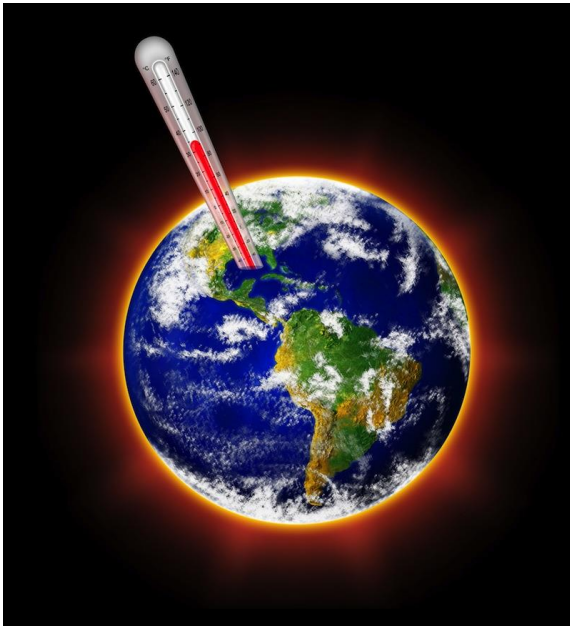
MSA-Trough concept and expected contribution beyond state-of-the art

- 1. Why do we need MSA-Trough technology?**
- 2. MSA-Trough Concept**
- 3. Advantages of the MSA-Trough system**

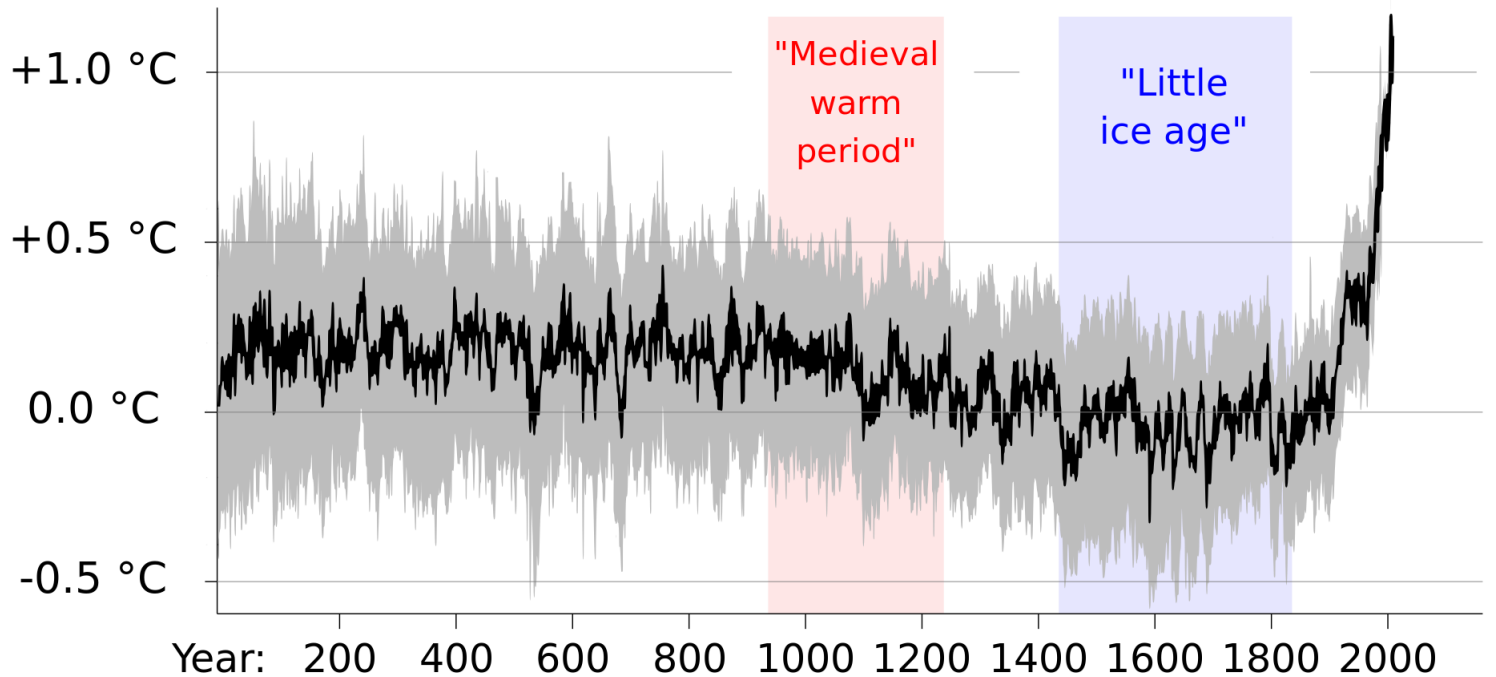
Why do we need MSA-Trough technology?

Global warming

Our planet is getting hotter and hotter

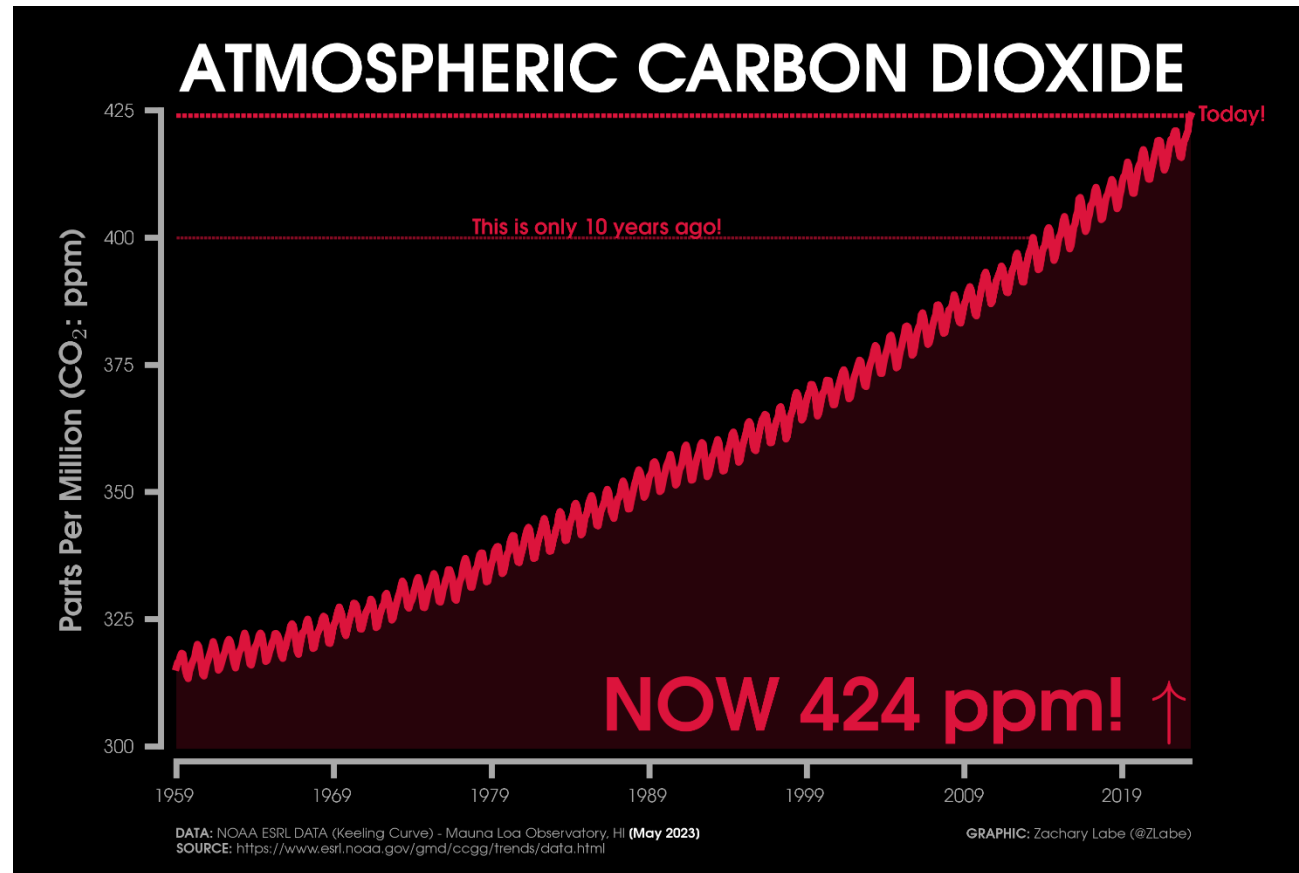


Global Average Temperature Change



From graphic by Ed Hawkins. Data: from PAGES2k (and HadCRUT 4.6 for 2001-). Reference period: 1850-1900.

Why do we need MSA-Trough technology?



“Keeling curve”

Why do we need MSA-Trough technology?

Use of renewable energy
to substitute fossil fuels

Wind energy
PV-Solar energy



- Electricity production only when wind blows or sun is shining
- Batteries to store electricity are expensive
- Raw material for batteries are limited and not enough for a global energy transition

Why do we need MSA-Trough technology?

CSP can generate electricity 24hours every day using thermal storage systems (molten salt)

- **Very low storage cost**
(when operating at 550°C)
- **No raw material problem**

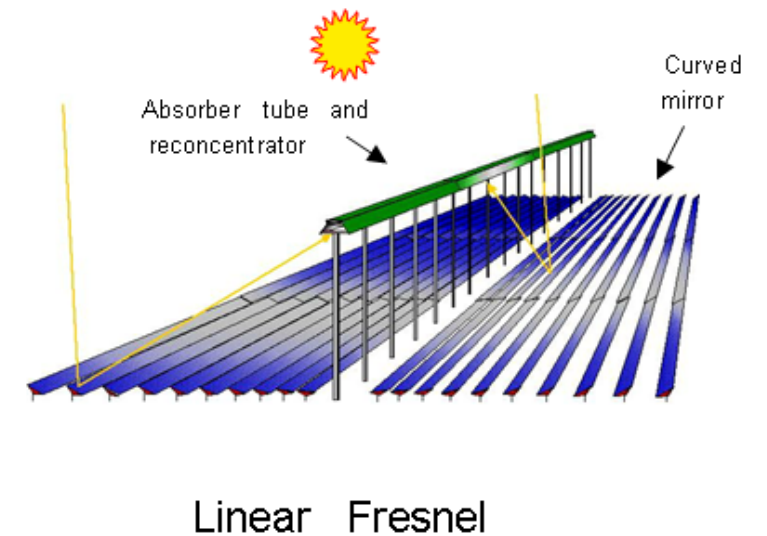
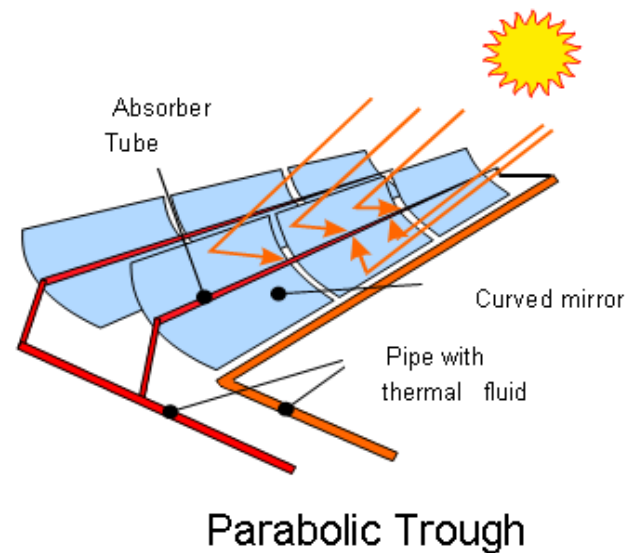
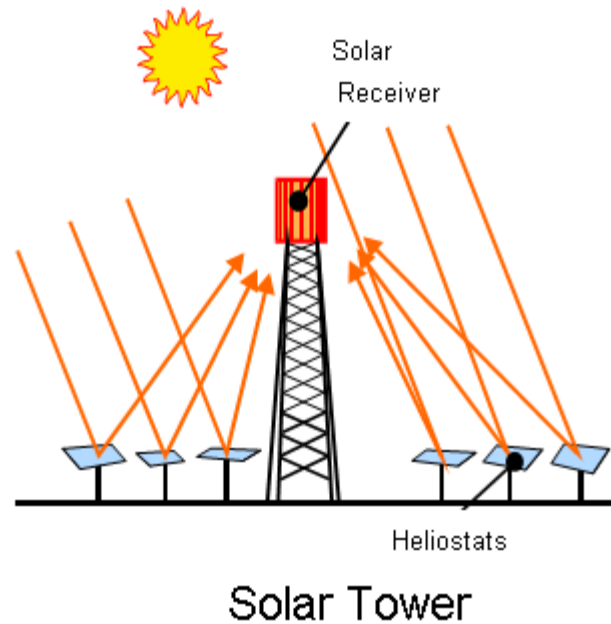
Problem:

- CSP power plant costs are still high
- Handling of molten salt is complicated because of freezing risk

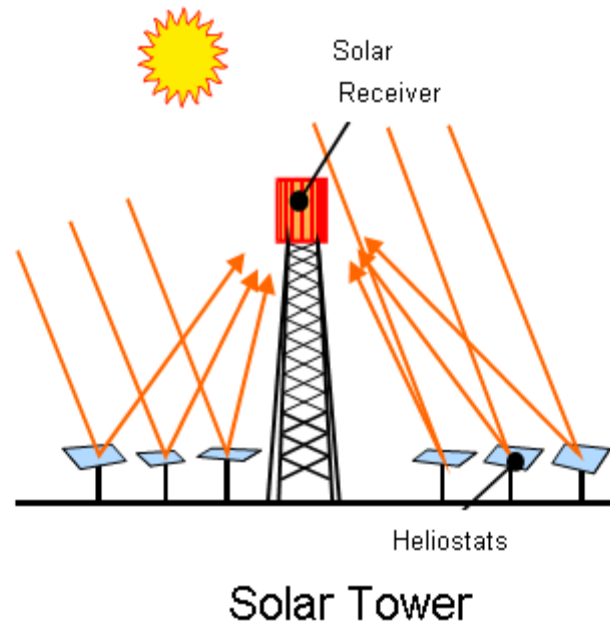


Why do we need MSA-Trough technology?

suitable CSP systems to integrate thermal storages with molten salt:



Why do we need MSA-Trough technology?



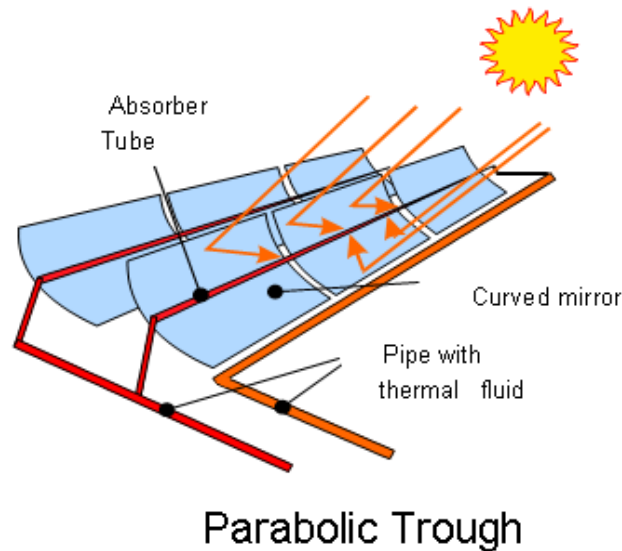
Advantages:

- Technology is already state-of-the-art for molten salt at 550°C
- No freeze protection at night necessary (drained receiver)

Disadvantages:

- High solar field costs (many tracking units with two tracking axis necessary)
- Significant solar tower costs

Why do we need MSA-Trough technology?



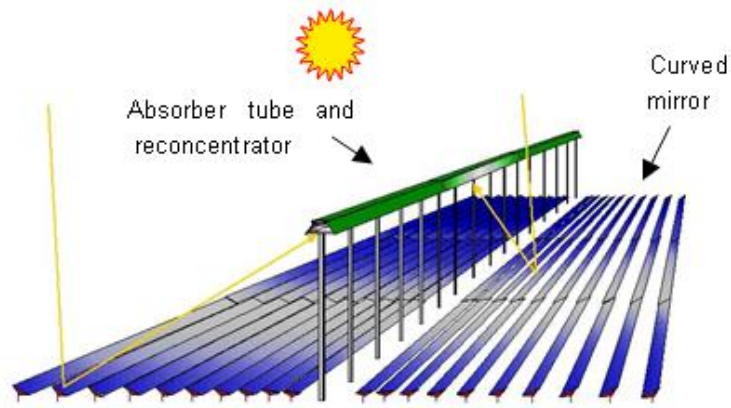
Advantages:

- Proven and cost efficient technology
- High optical efficiency because of short focal length

Disadvantages:

- Absorber tube is moved with concentrator => flexible hoses necessary
- Freeze protection during night
- Impedance heating (absorber tubes) and trace heating (passive tubes, flexible hoses) necessary

Why do we need MSA-Trough technology?



Linear Fresnel

Advantages:

- Cost efficient technology
- Fixed absorber => no need of flexible joints

Disadvantages:

- Low optical efficiency (long focal distance, shading between mirrors)
- Freeze protection during night
- Impedance heating (absorber tubes) and trace heating (passive tubes) necessary

Why do we need MSA-Trough technology?

- ✓ **MSA-Trough combines all advantages of the existing CSP systems**
- ✓ **MSA-Trough eliminates all disadvantages of the existing CSP systems**
- ✓ **MSA-Trough offers additional efficiency improves**
- ✓ **MSA-Trough offers additional cost reductions**

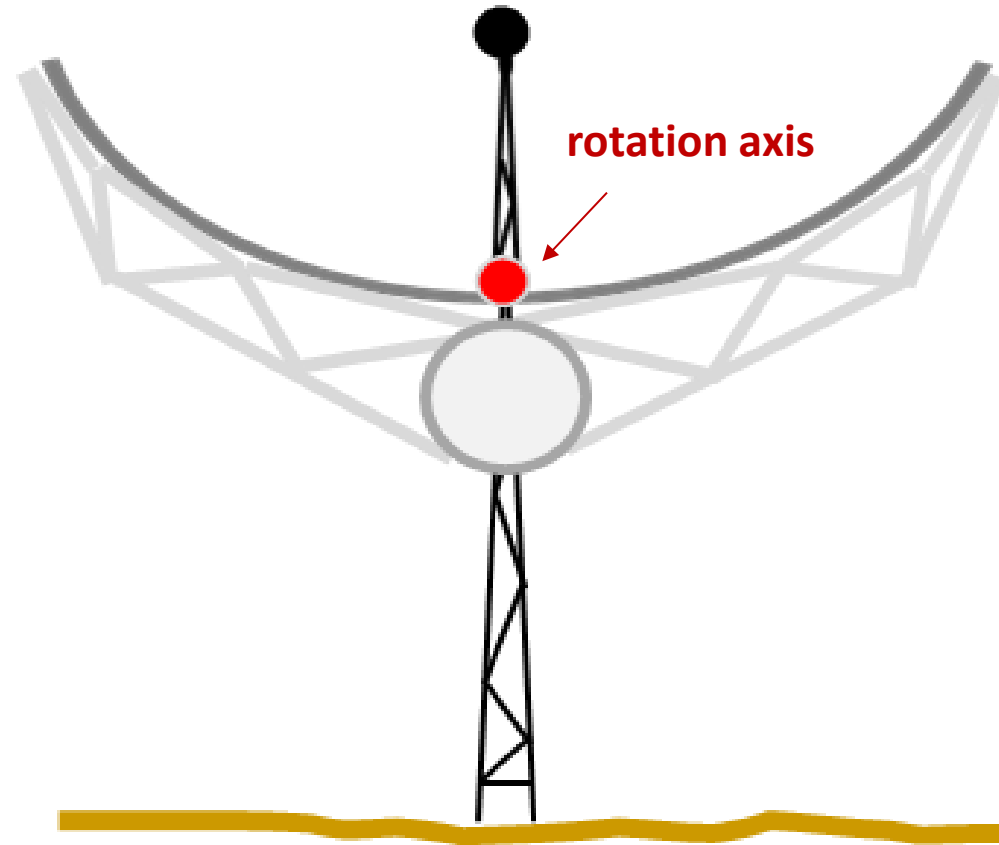
MSA-Trough concept

Main differences to state-of-the-art:

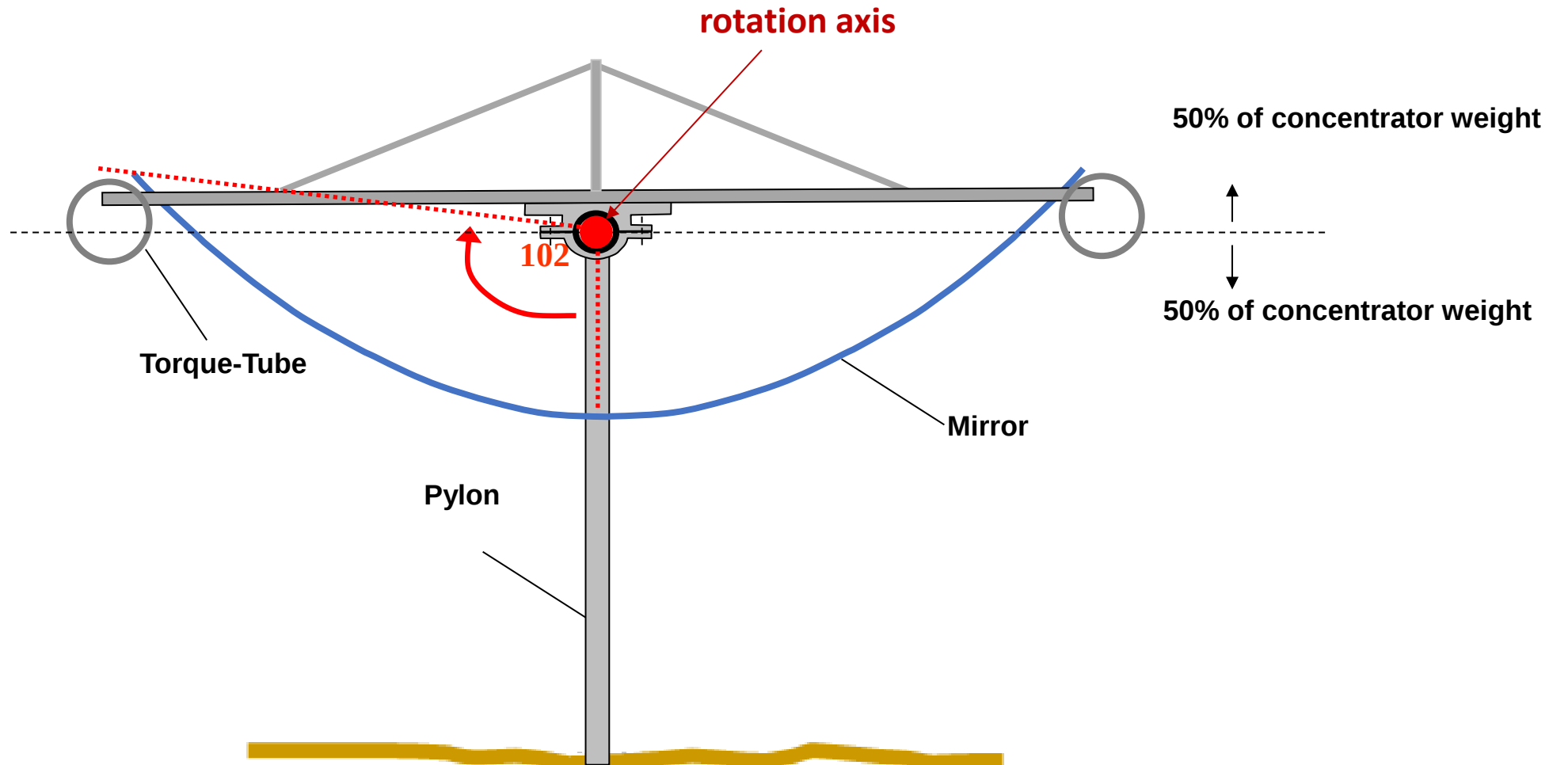
1. Fixed focus (absorber tube is not moved with the concentrator)
2. New storm position (reduction of wind loads)
3. Use of torsion compensators
4. Thin glass mirrors
5. Use of automatic washing system with water recycling
6. Use of “overnight draining strategy”

MSA-Trough concept

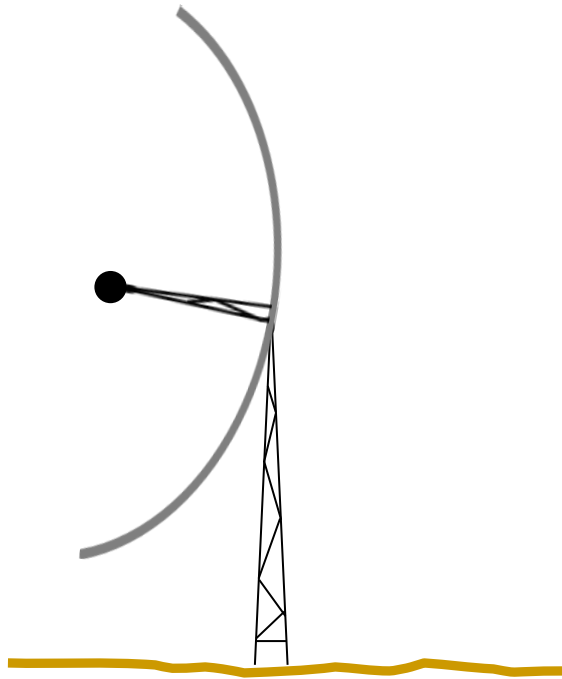
Conventional trough collector:



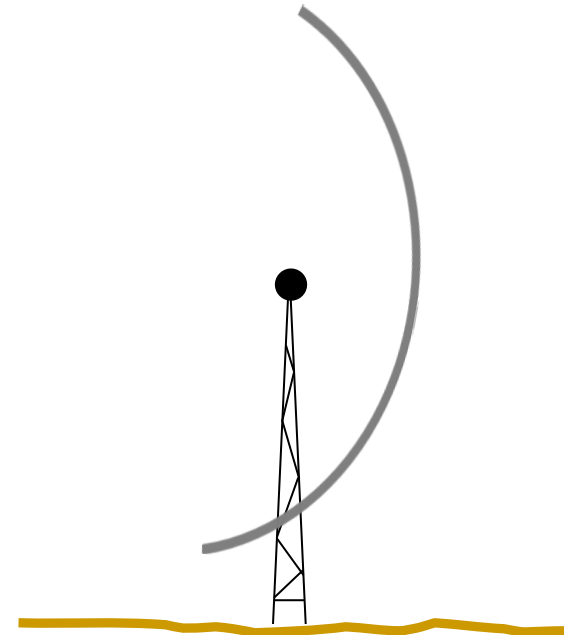
MSA-Trough concept



MSA-Trough concept

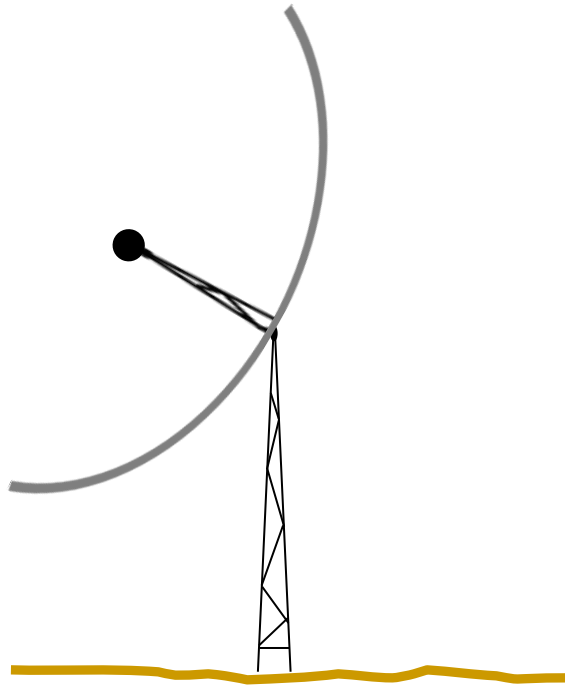


conventional collector

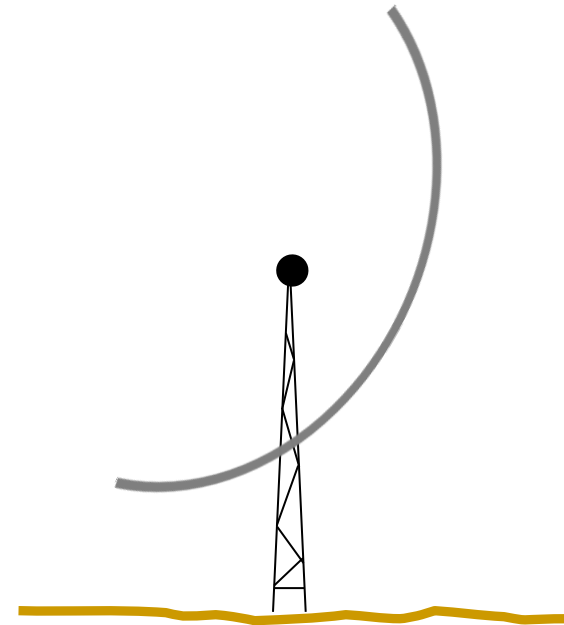


MSA-Trough

MSA-Trough concept

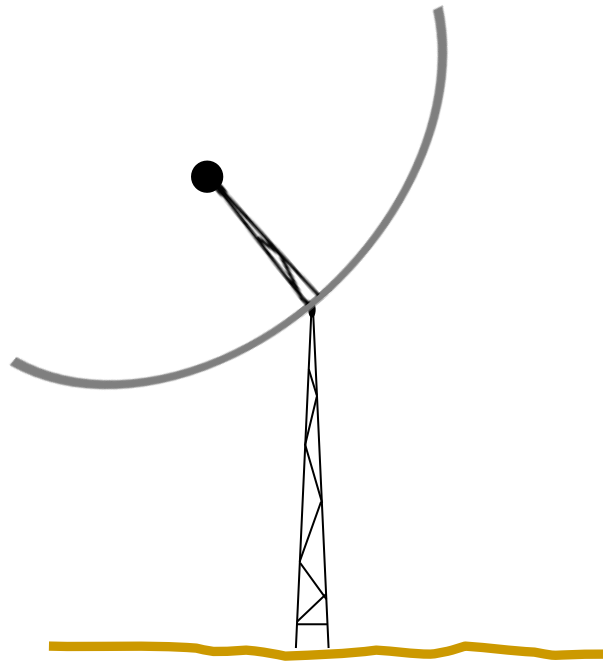


conventional collector

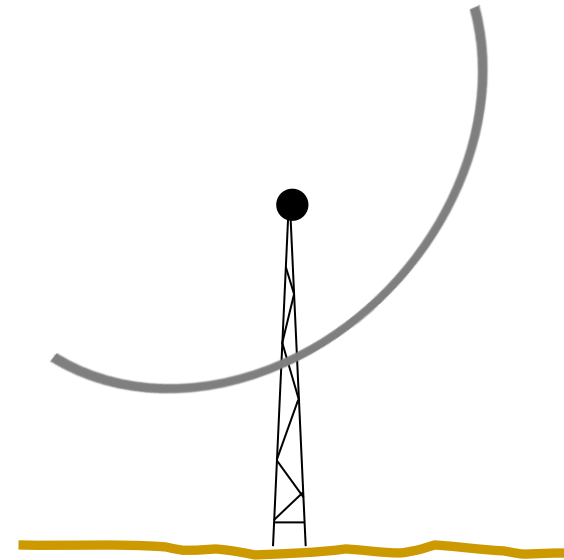


MSA-Trough

MSA-Trough concept

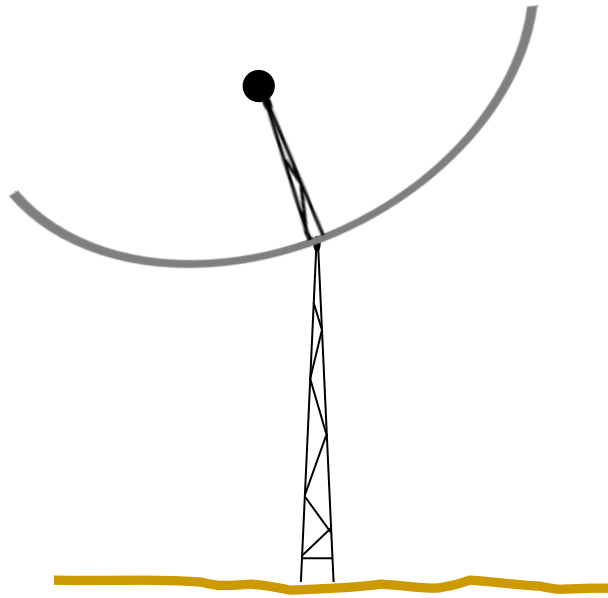


conventional collector

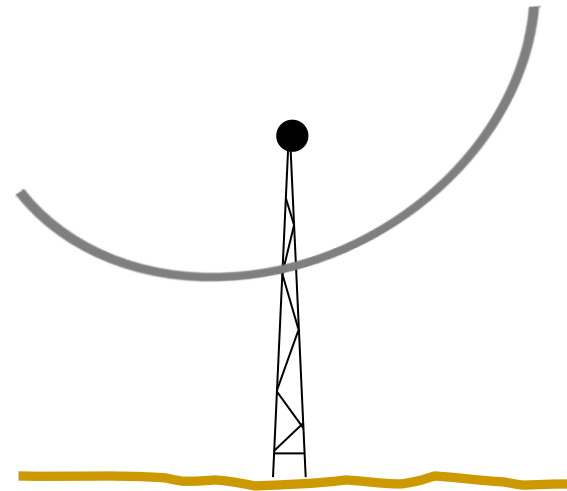


MSA-Trough

MSA-Trough concept

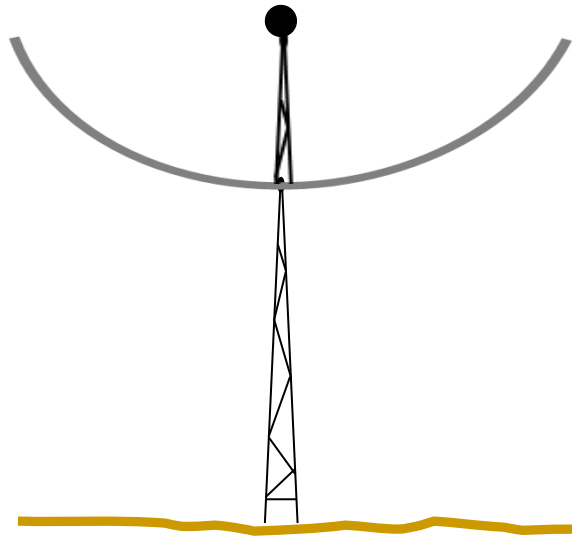


conventional collector

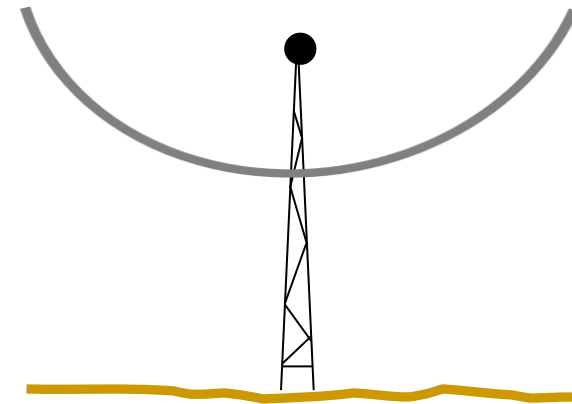


MSA-Trough

MSA-Trough concept

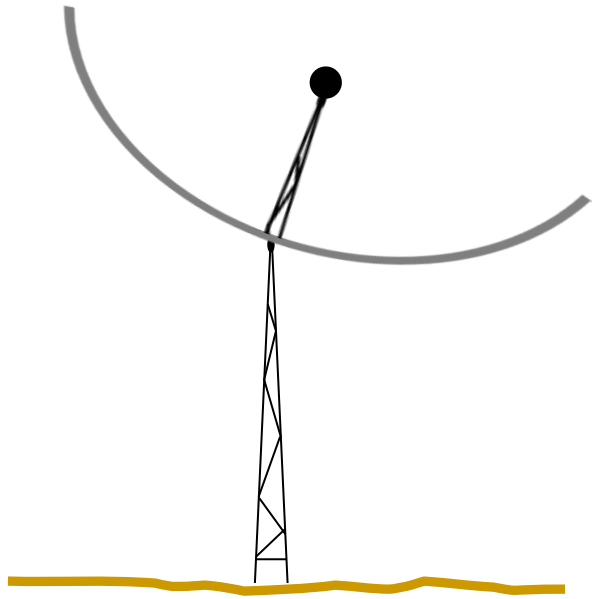


conventional collector

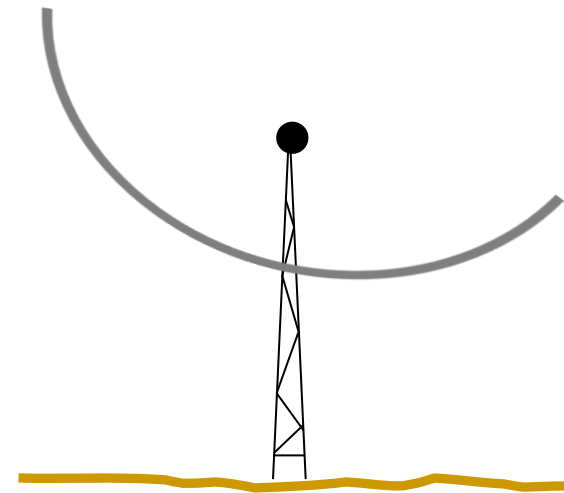


MSA-Trough

MSA-Trough concept

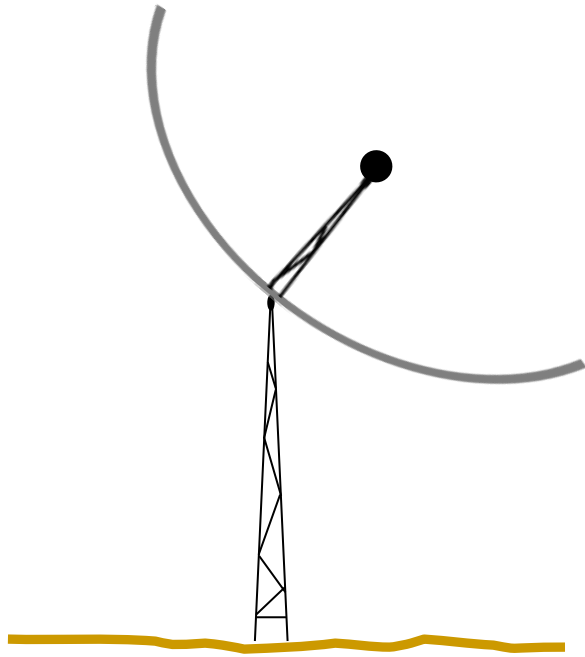


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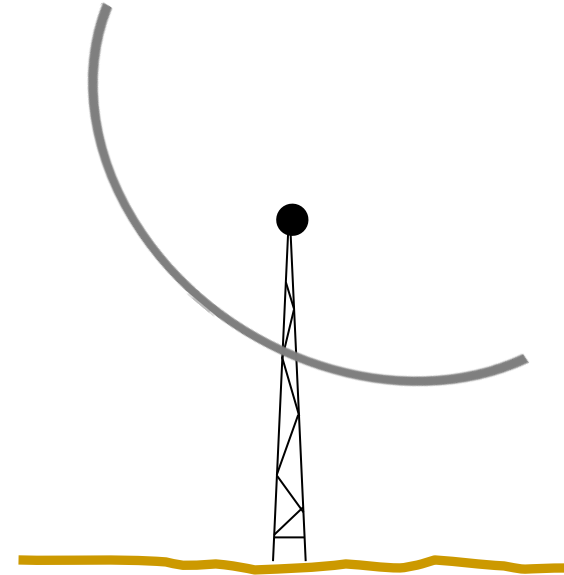


MSA-Trough

MSA-Trough concept

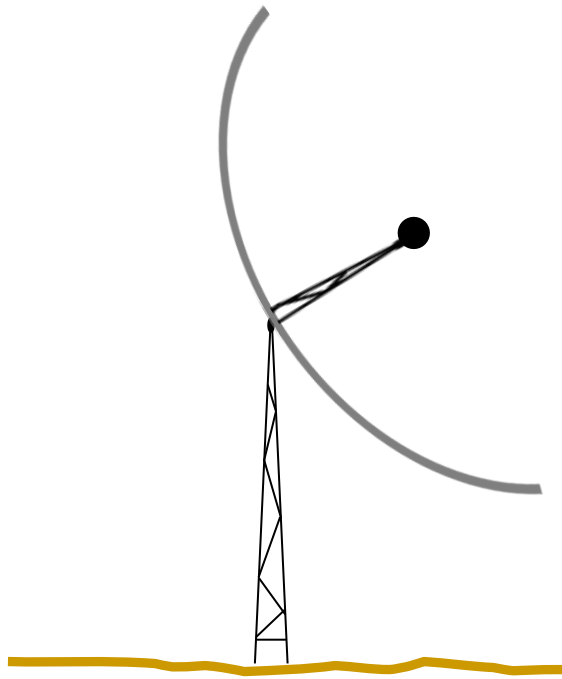


conventional collector

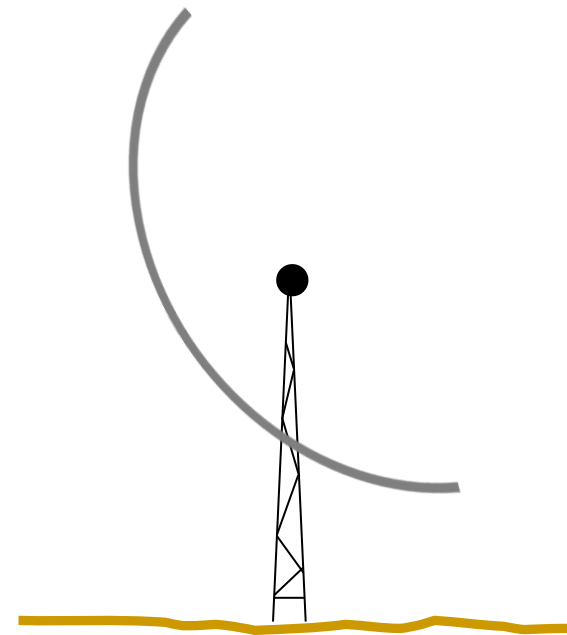


MSA-Trough

MSA-Trough concept

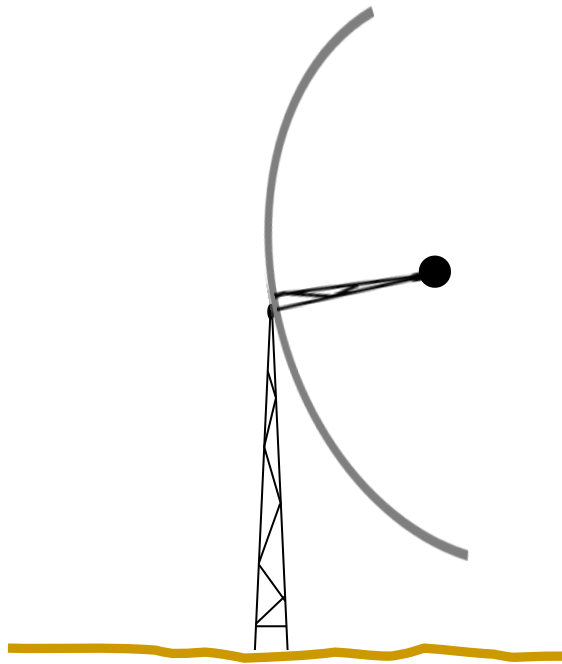


conventional collector

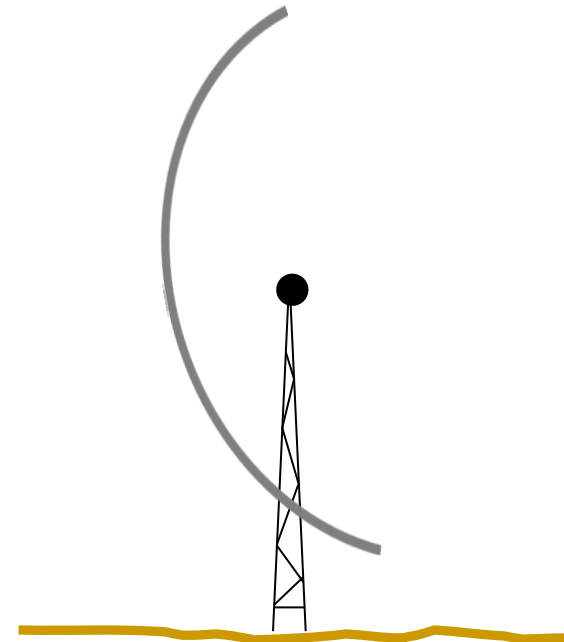


MSA-Trough

MSA-Trough concept



conventional collector

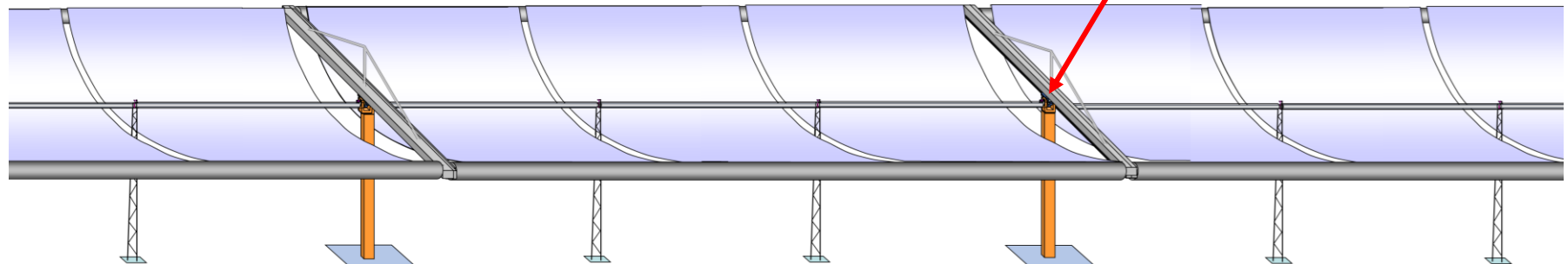
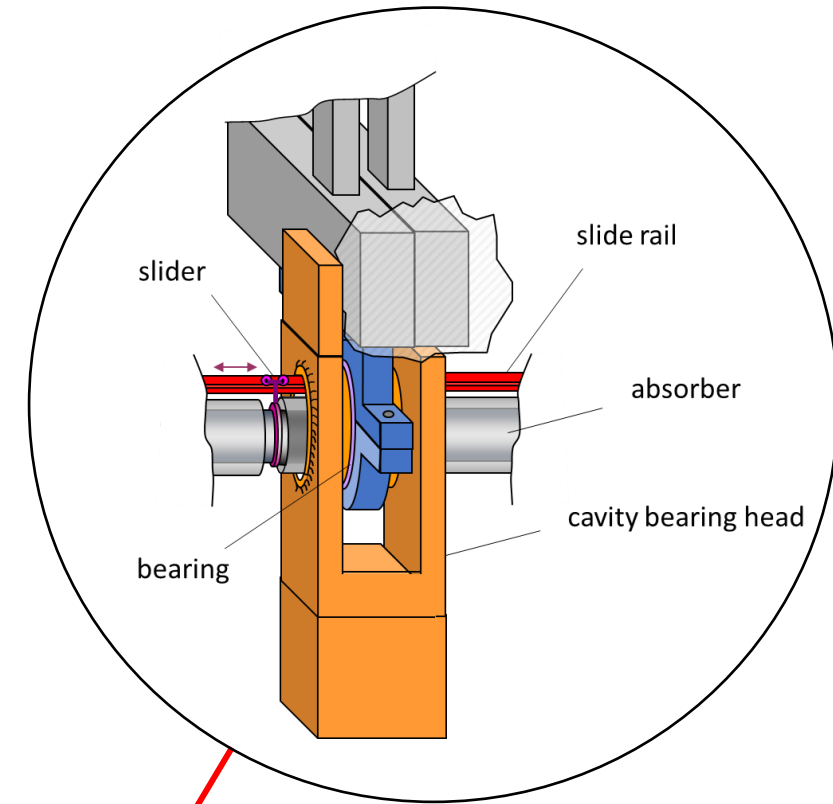


MSA-Trough

Advantages of the MSA-Trough (1. Fixed focus)

Independence between absorber tube and concentrator

- ✓ 1km continuous absorber tube (easy drainage)
- ✓ No collector middle losses
- ✓ No collector connecting losses
- ✓ Less collector end losses

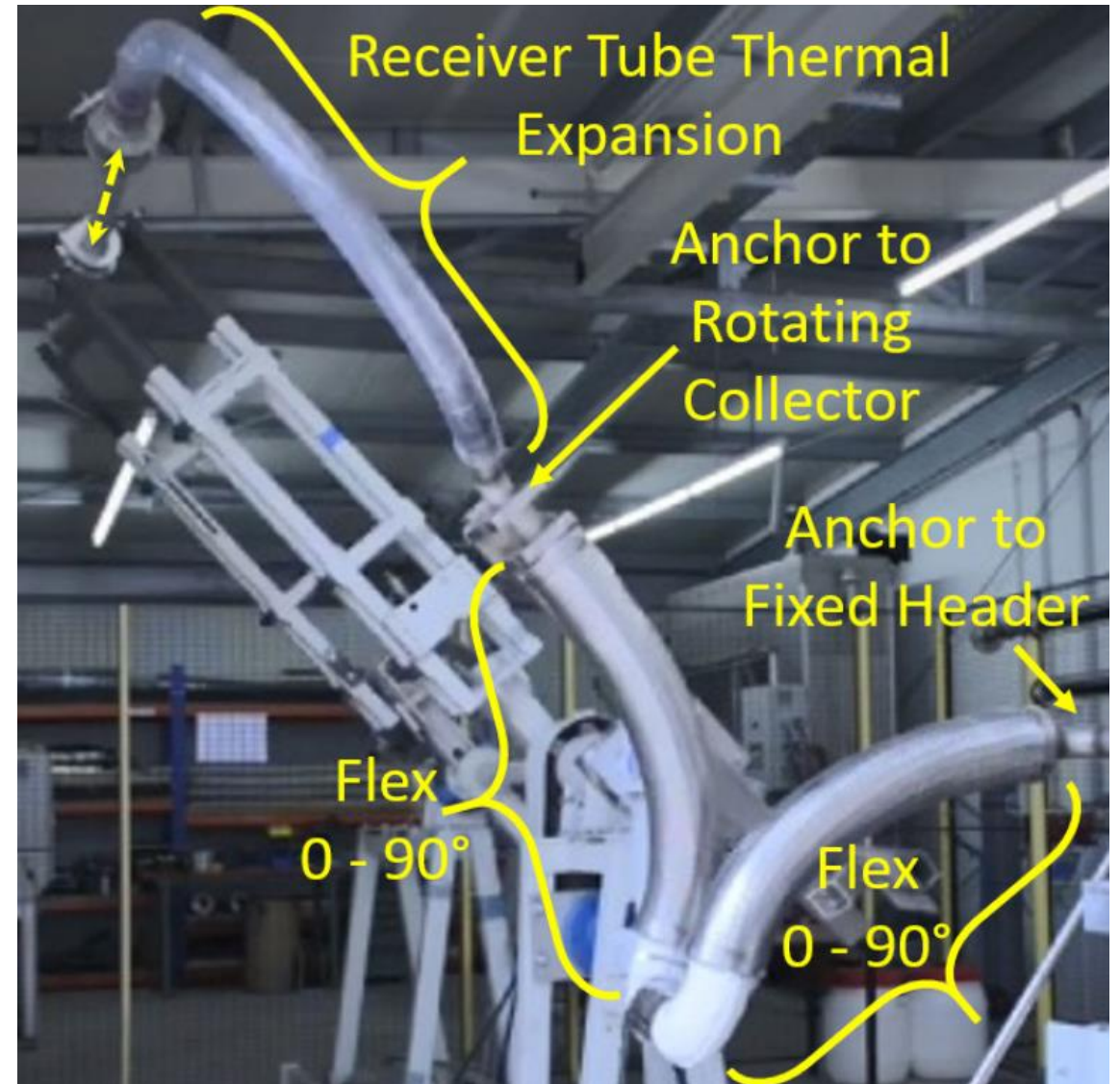


Advantages of the MSA-Trough

(1. Fixed focus)

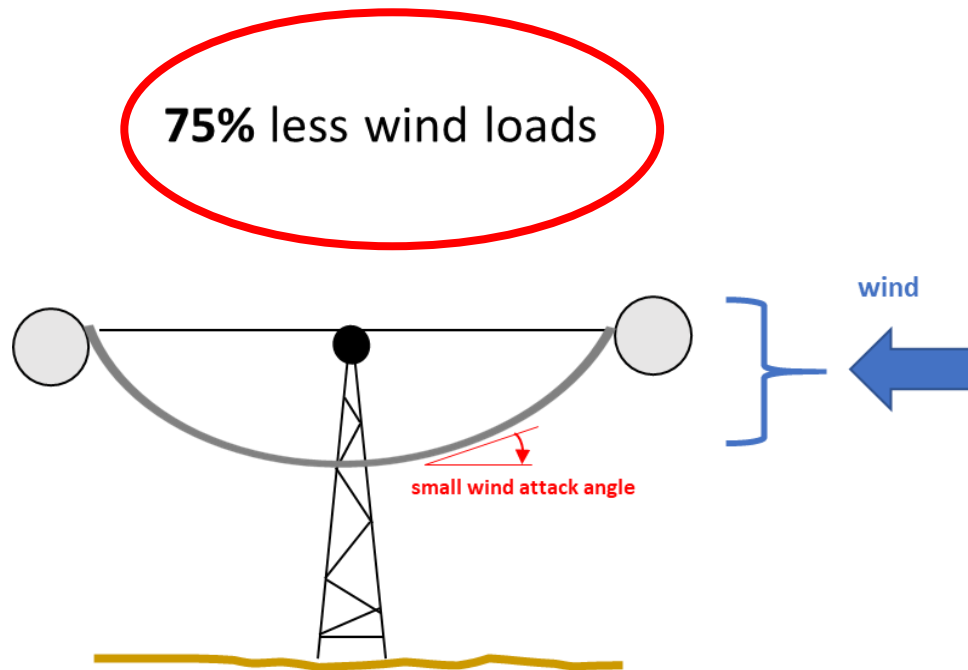
No need of flexible hoses

- ✓ Save investment costs
- ✓ No heat tracing
- ✓ Complete loop drainage (no salt rests)
- ✓ Less pressure losses
- ✓ Less heat losses
- ✓ Less maintenance

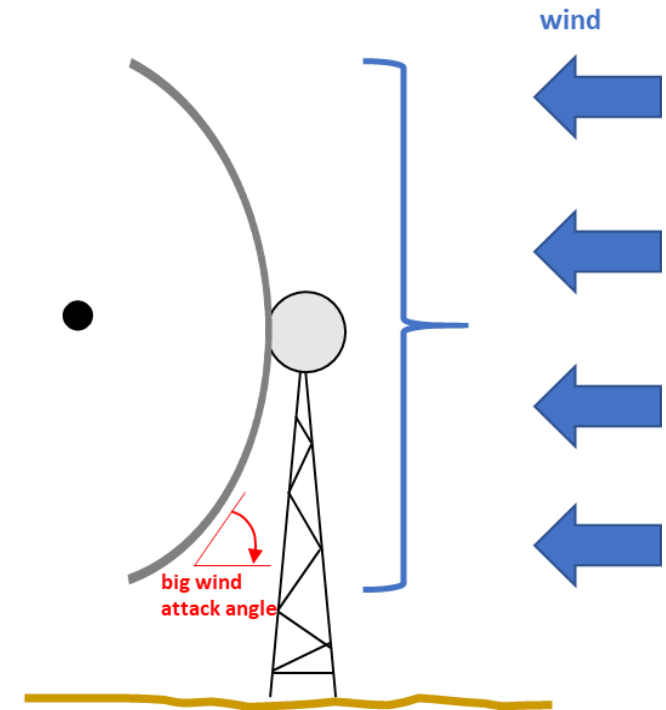


Advantages of the MSA-Trough (2. New storm position)

New storm position:



MSA-Trough

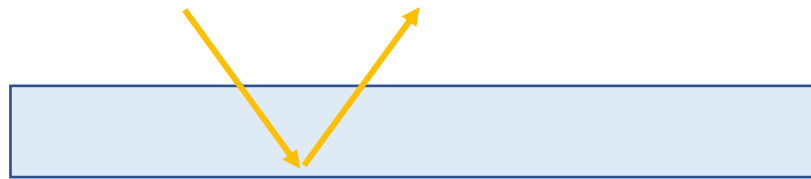


state-of-the-art collector

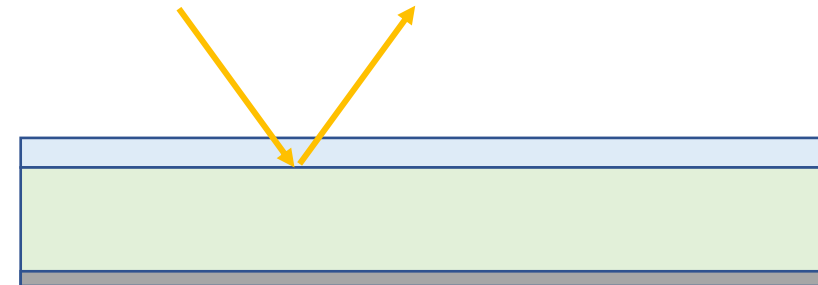
Advantages of the MSA-Trough (3. Thin glass mirrors)

Thin glass sandwich mirrors

Improvement of the collector efficiency through better reflectivity of the thin glass mirror
2% efficiency increase



conventional thick glass mirror

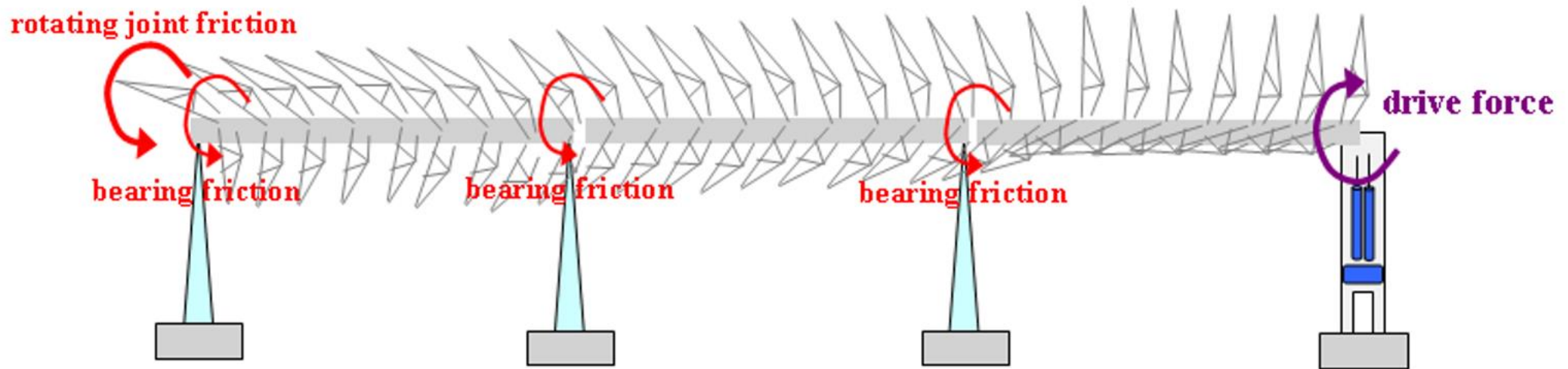


sandwich mirror

Advantages of the MSA-Trough (4. Torsion compensators)

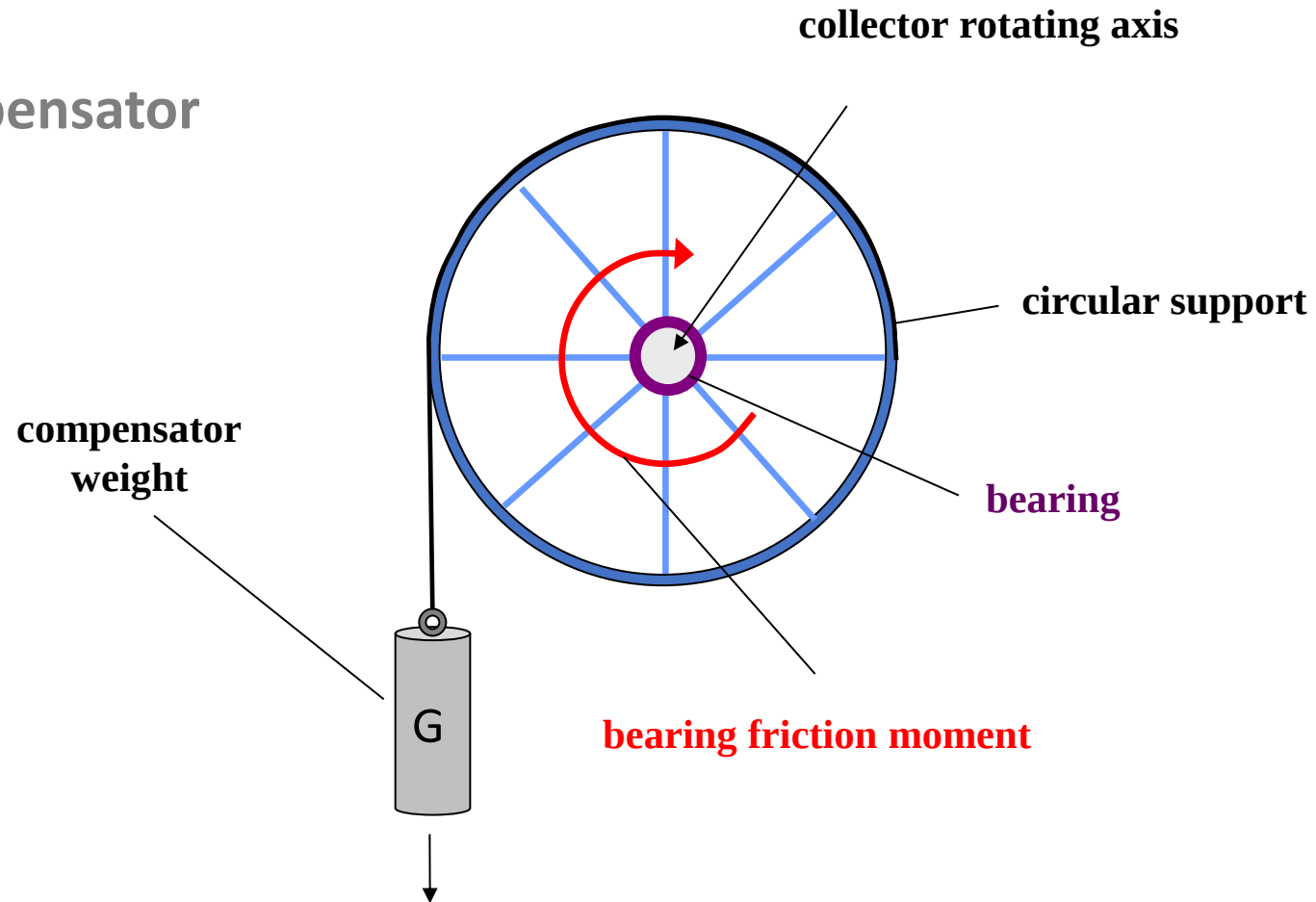
Integration of torsion compensators

- ✓ Improved optical collector efficiency due to elimination of collector torsion

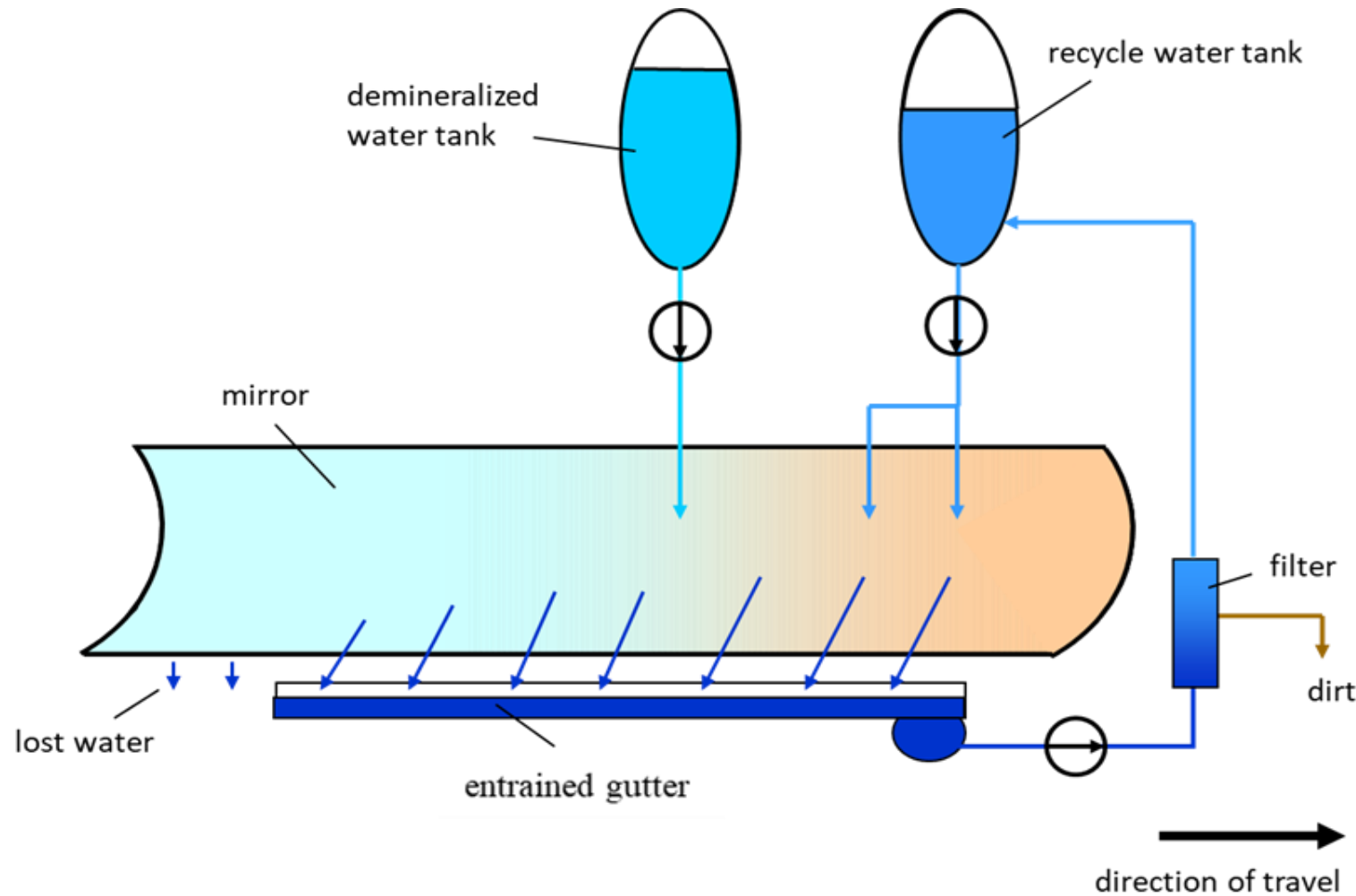


Advantages of the MSA-Trough (4. Torsion compensators)

torsion compensator



Advantages of the MSA-Trough (5. Automatic mirror washing device)



Automatic mirror washing device

- ✓ Improved solar field efficiency by daily cleaning
- ✓ Water saving by water recovering and filtering

Advantages of the MSA-Trough (6. Overnight drainage strategy)

“Overnight drainage strategy”

1. **Step: Drainage** of MSA-Trough loop in the evening after normal operation
(by gravity and pressurized air)
 2. **Step: Solar preheating** of absorber tube to 280-300°C in the next morning
(driving the absorber shortly through the focus several times)
(waiting some minutes after every drive through)
 3. **Step: Filling** of MSA-Trough loop after “solar preheating” with molten salt from the cold tank
- ✓ avoids heat losses during nights
 - ✓ avoids freeze protection during nights
 - ✓ no need of impedance heating



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Thank You !