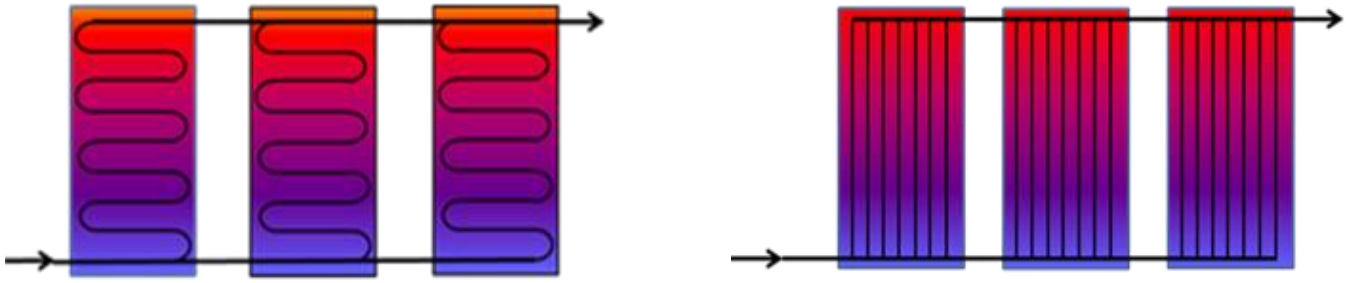
SHIP Egypt

Collector Hydraulics

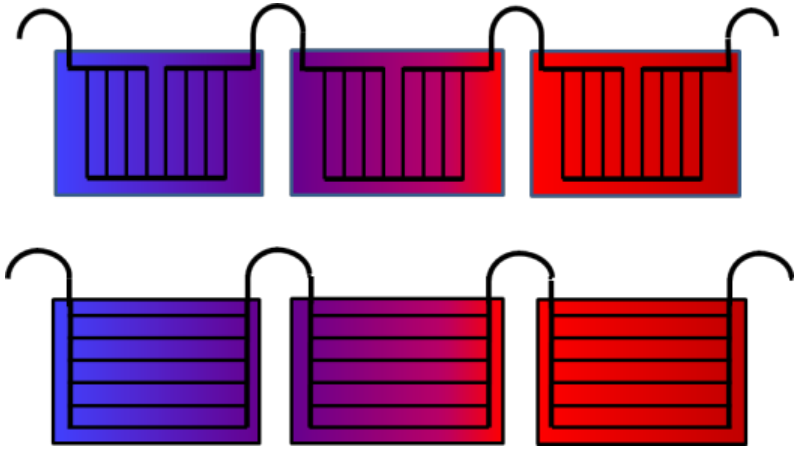
Wolfgang Glatzl & Josef Buchinger

AEE INTEC & ConPlusUltra

Parallel and serial collector connections



Parallel connection of meander (left) and a harp collectors (right)



Serial connection of collectors. This is often used for large collector fields

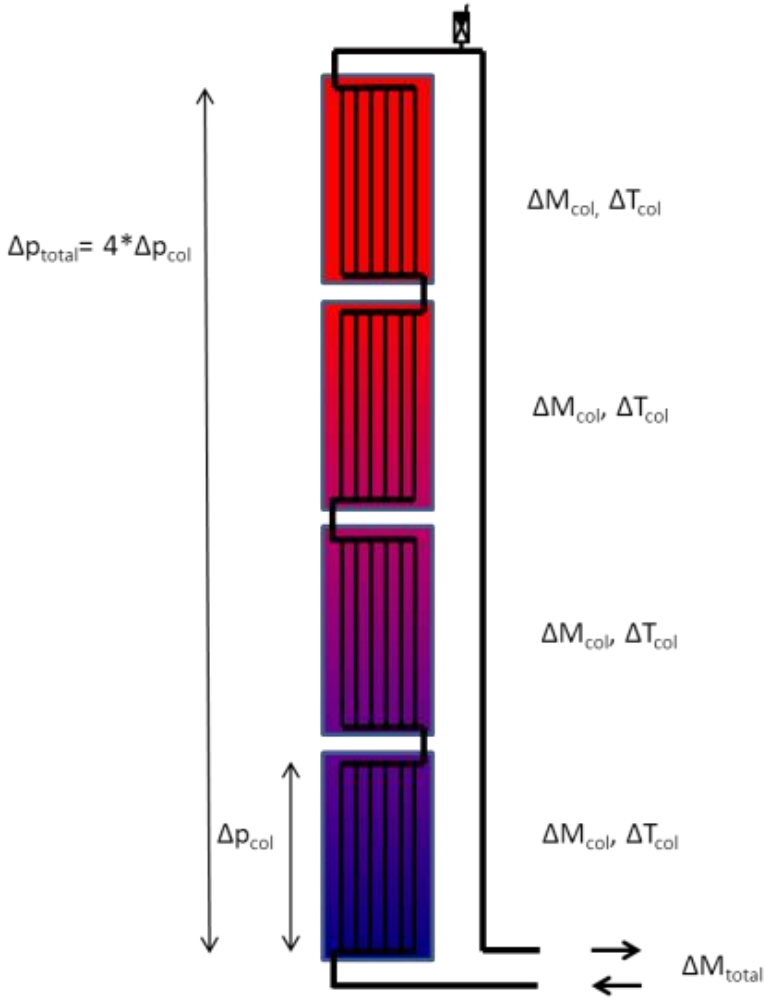
Serial connection of collectors at Ulstedt, Denmark

Source: SDH, ee 2011-2

Serial connection “Low-Flow”

$\Delta M_{total} = \Delta M_{col} = 10\text{-}15\ l/m^2h$

$\Delta T_{total} = 4 * \Delta T_{col} = 40°C$

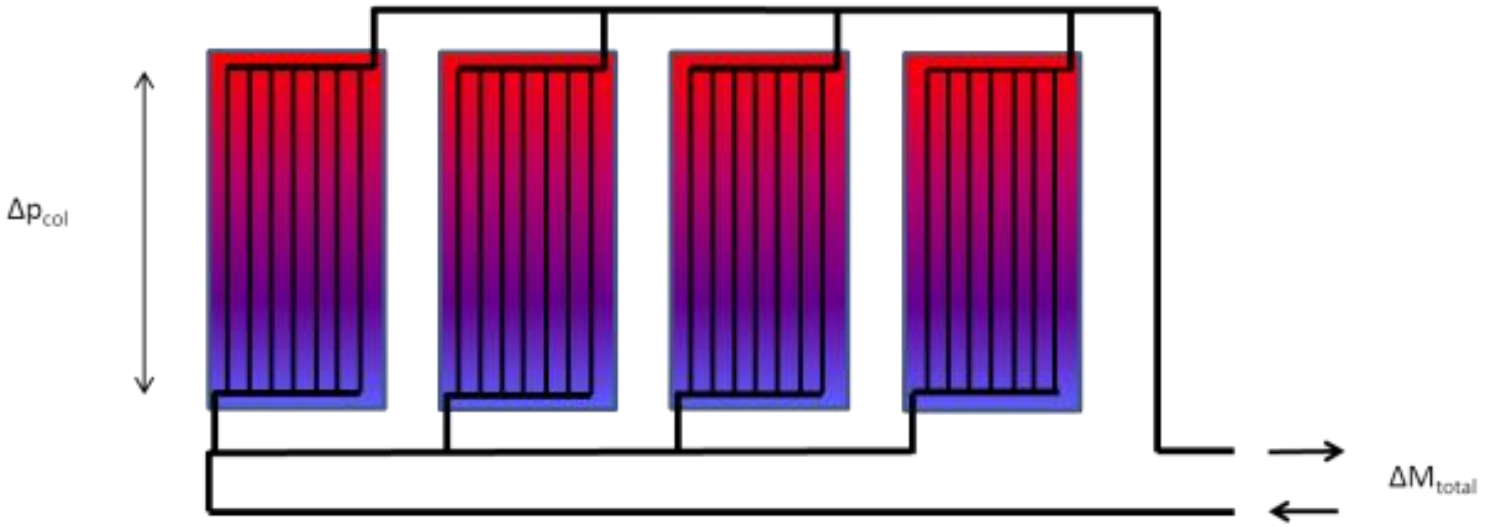


Parallel Connection "High-Flow"

$\Delta M_{total} = 4 * \Delta M_{col} = 50\ l/m^2h$

$\Delta p_{total} = \Delta p_{col}$

$\Delta T_{total} = \Delta T_{col} = 10°C$



Parameters defining the most favourable connection type for collector fields

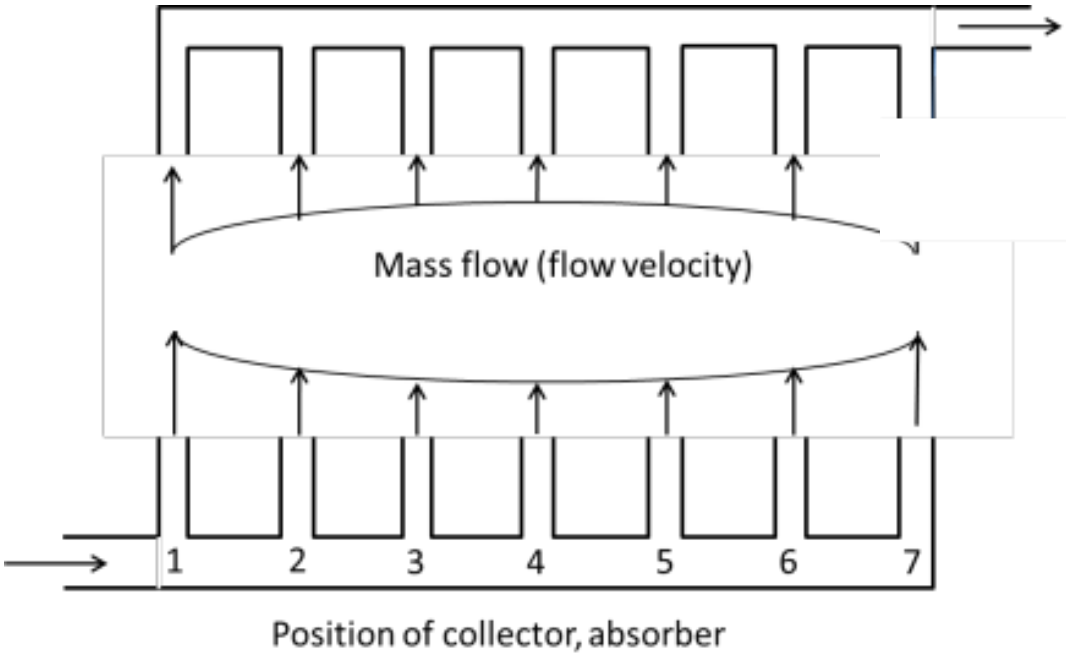
specific producer recommended volume flow rate $\dot{V}_{col}$ for one square metre collector area [l/m²h]; typical volume flow rates lie between 40 – 70 l/m²h, turbulent flow in the absorber tubes is the physical criterion

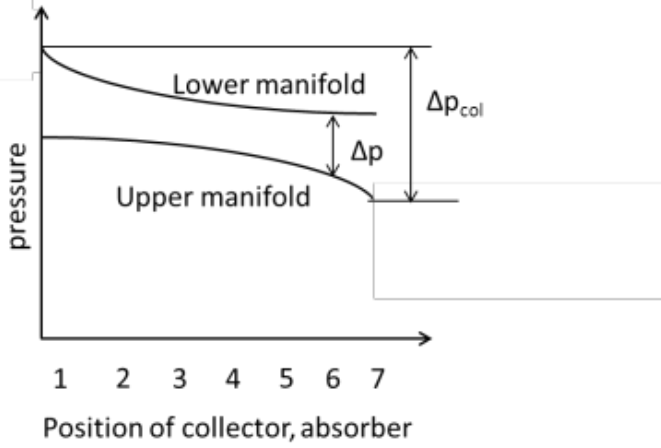
- The requested operating mode (“classical”, “Low-Flow”)
- The collector design
- The installation mode on the roof

The available pump output

For designing the pump system it is necessary to consider that the pressure drop for e.g. three serially connected collectors is three times as high as for one collector with the same flow rate. In contrast the pressure drop in collector fields with parallel connection does not increase (compare Figure 107) for the relevant volume flow.

Flow distribution and pressure drop in parallel connected absorber strips or collectors





$$\Delta p = \sum \zeta \cdot \frac{\rho \cdot u^2}{2} = \sum \zeta \cdot \frac{\dot{m}^2}{2 \cdot \rho} = \sum \zeta \cdot \frac{\rho \cdot \dot{v}^2}{2} = \sum \zeta \cdot \frac{\rho \cdot \dot{V}^2}{2 \cdot A^2_{tube}}$$

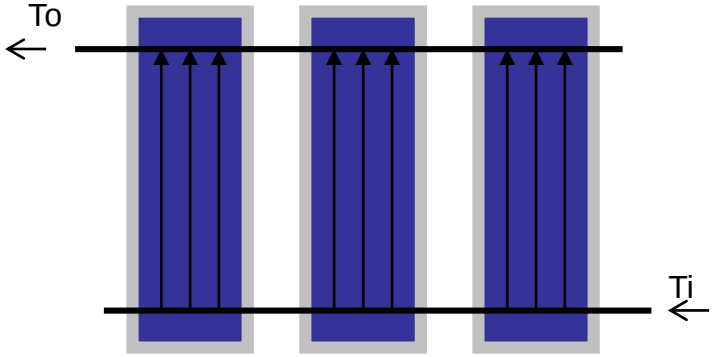
Collector hydraulics: serial - parallel

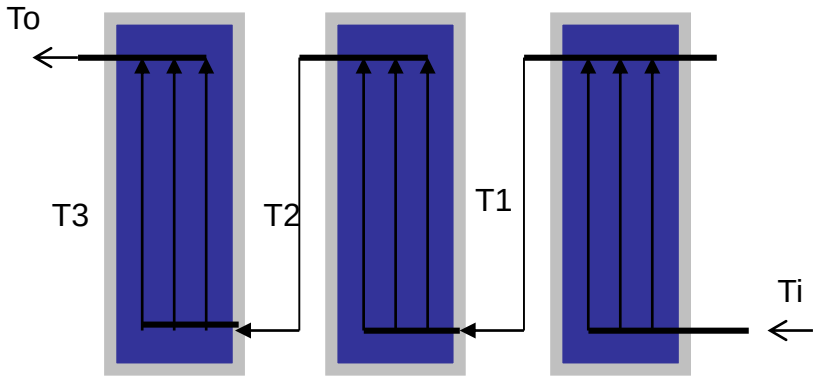
⇨**Parallel connection**

⇨All collectors work on the <u>same temperature level</u>

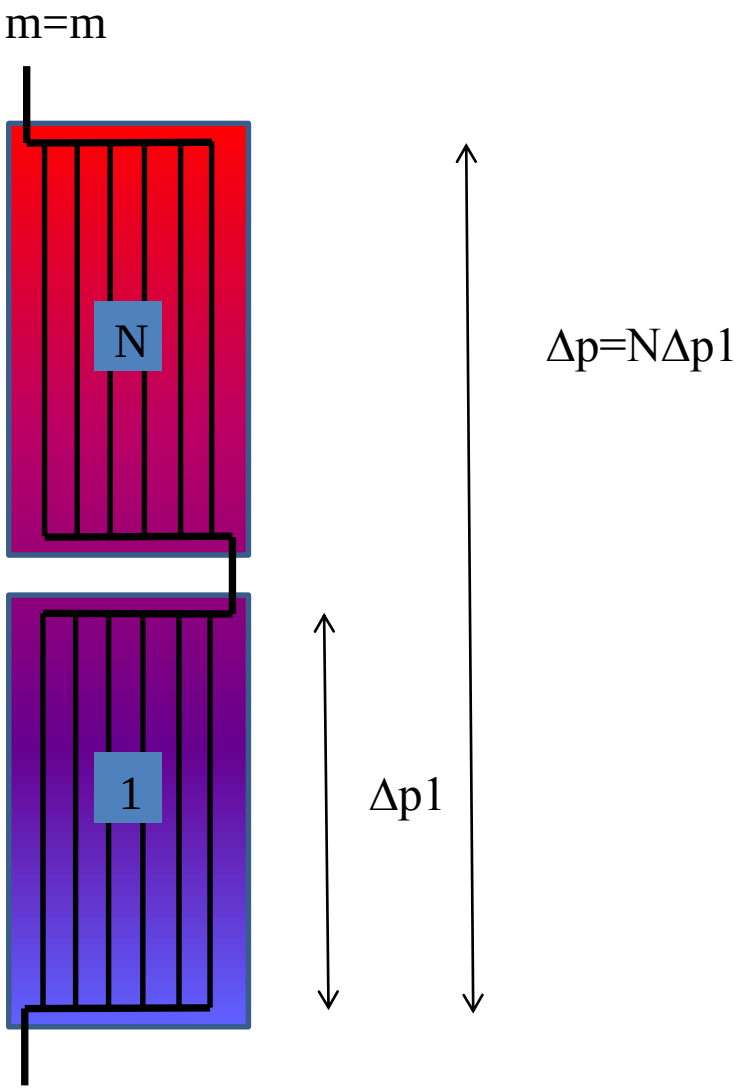
➢**Serial connection**

⇨All collectors work on <u>different temperature levels</u>

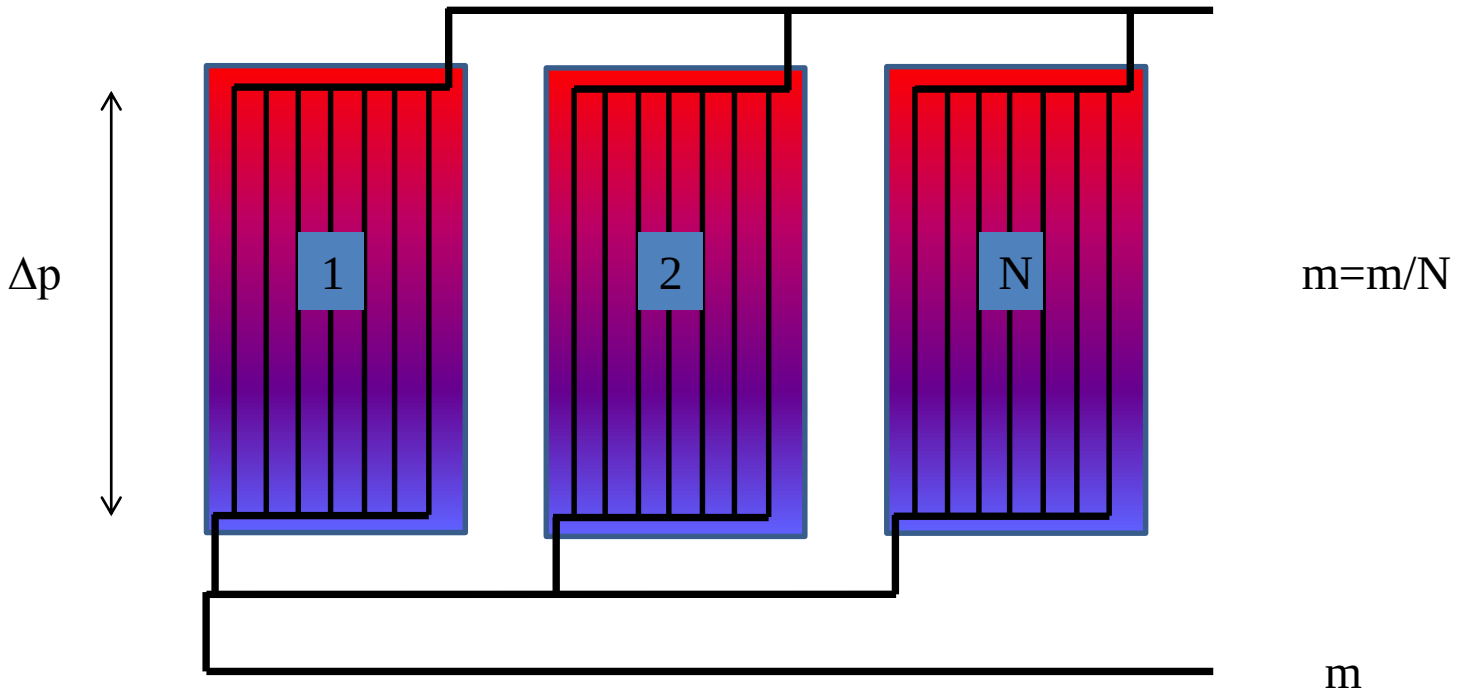




Pressure drop



Pressure drop



Mass flow in parallel connected collectors

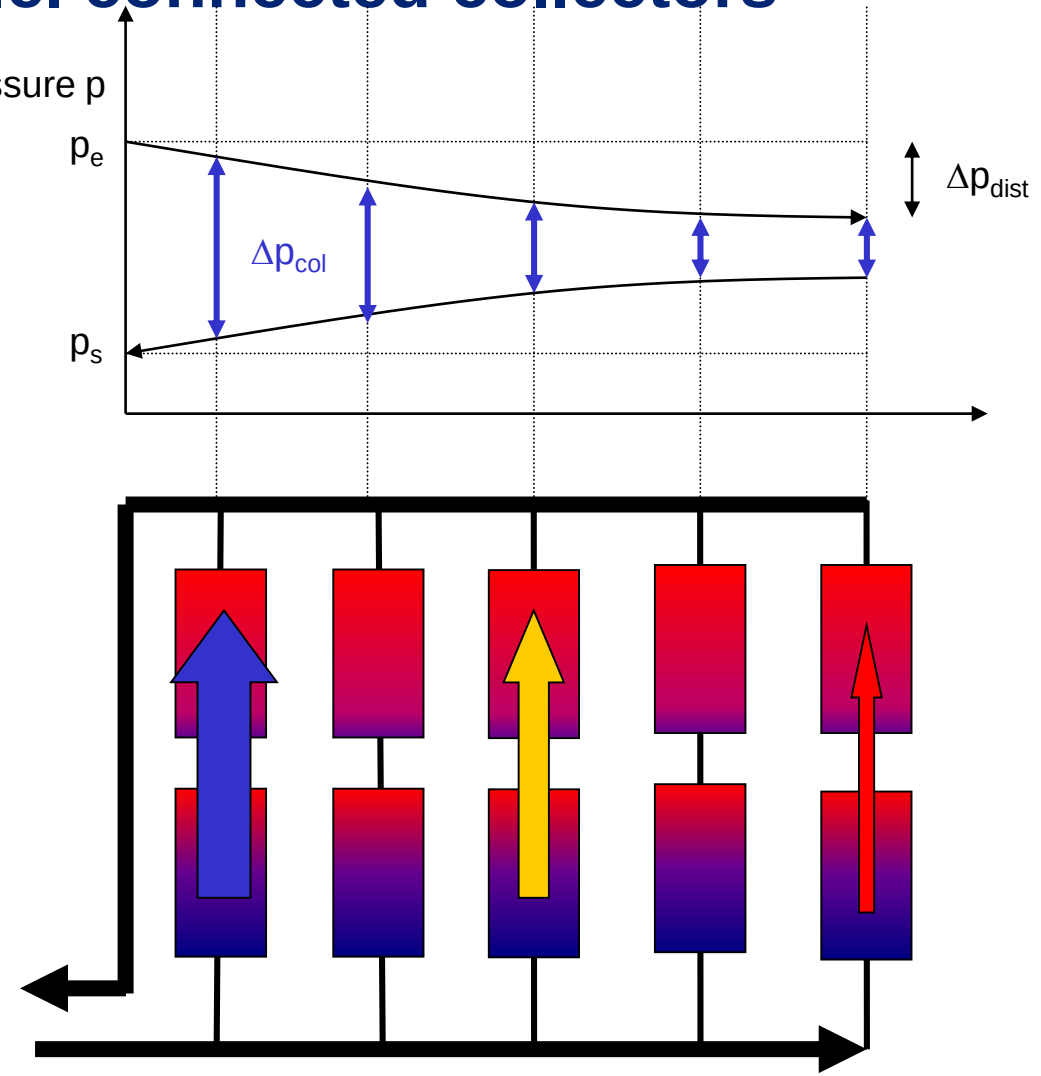
1. Connection which causes different mass flows

High mass flow in the first collector, low mass flow in the last collector of the field

$$\dot{m}_{col} = f\left(\Delta\, p_{col}\right)$$

The higher the pressure drop (mass flow) in the collector – the lower the pressure drop in the distribution pipes

$$\Delta p_{dist} << \Delta p_{col}$$

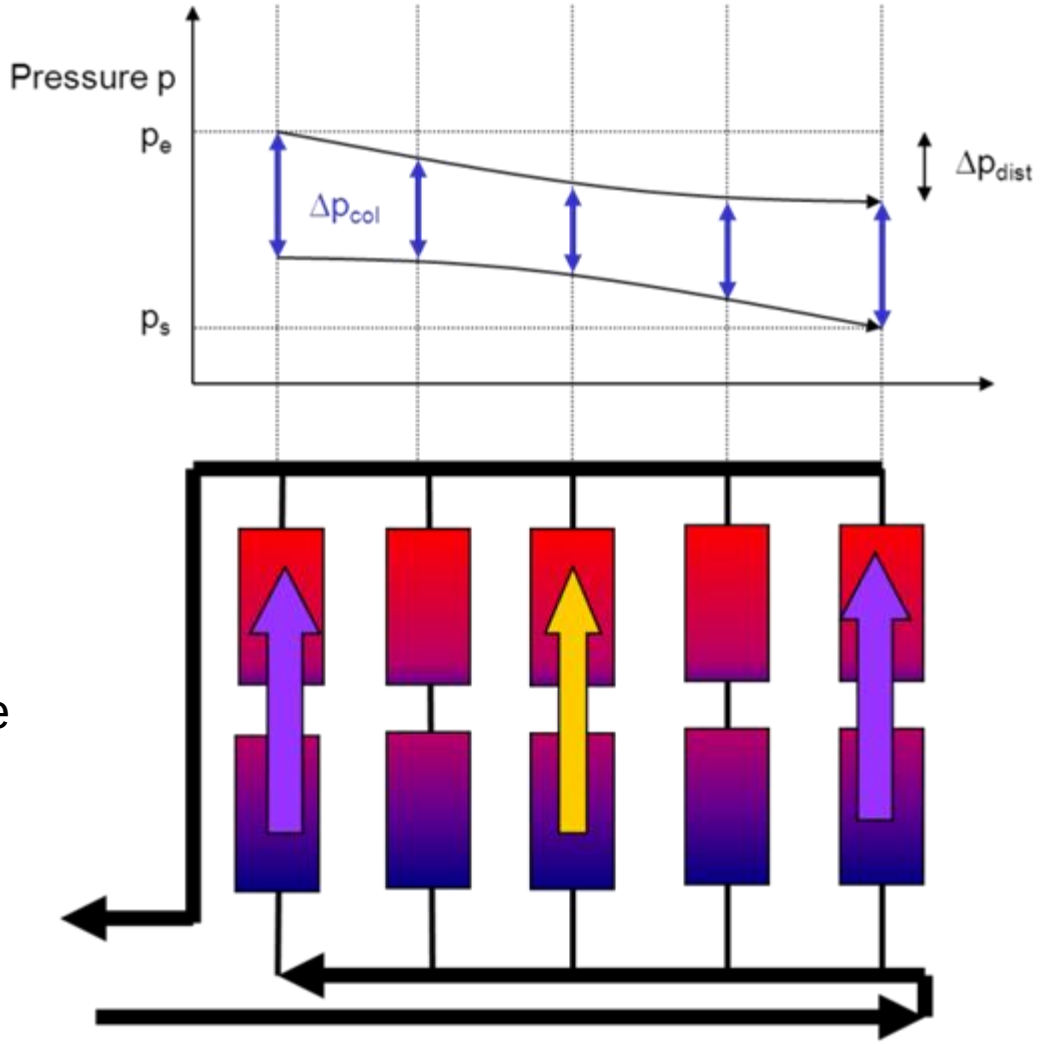


Mass flow in parallel connected collectors

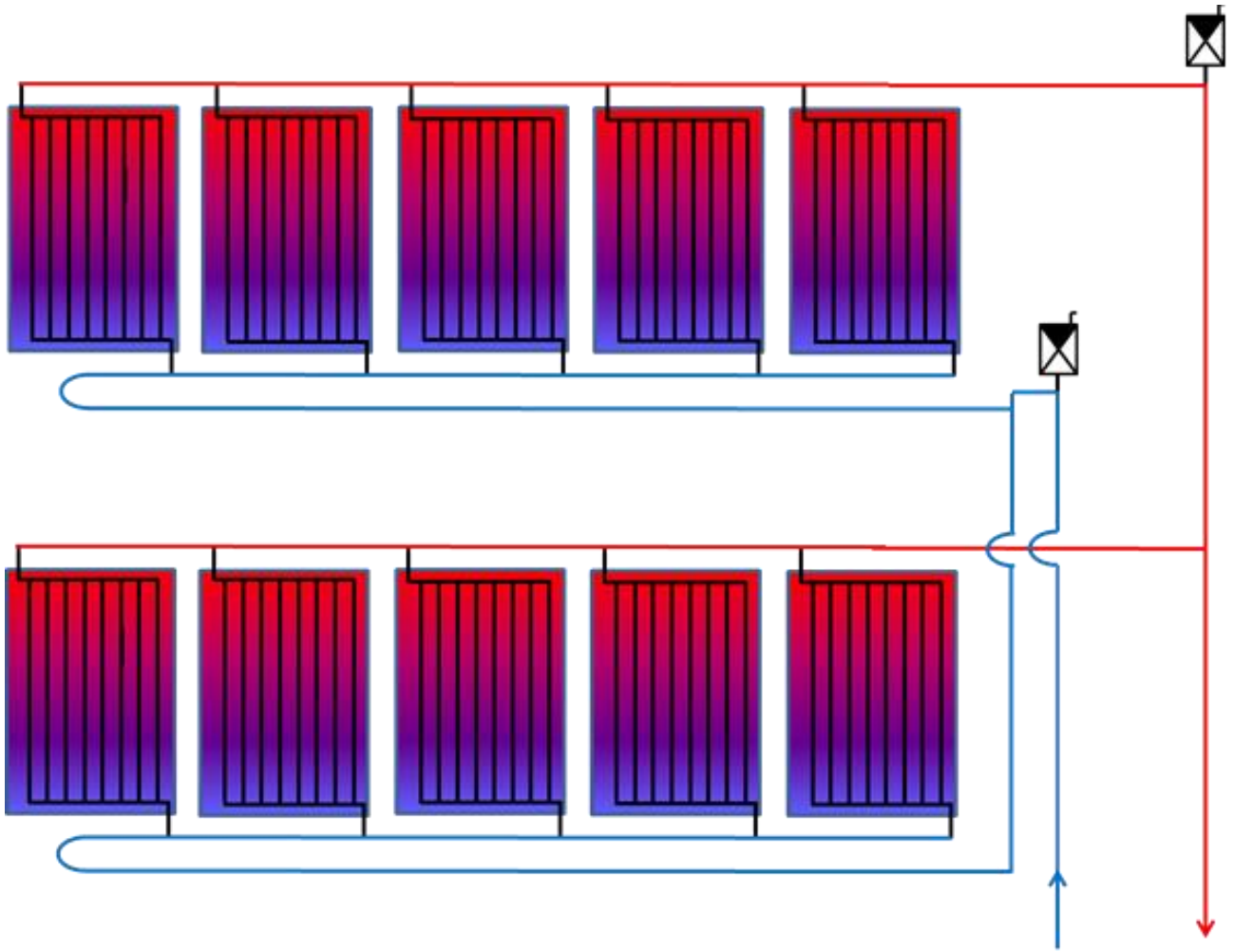
2. Connection via return pipe (Tichelmann)

Different mass flows in the centre and at the end of the collector field

-> non-linear pressure in the distribution pipes



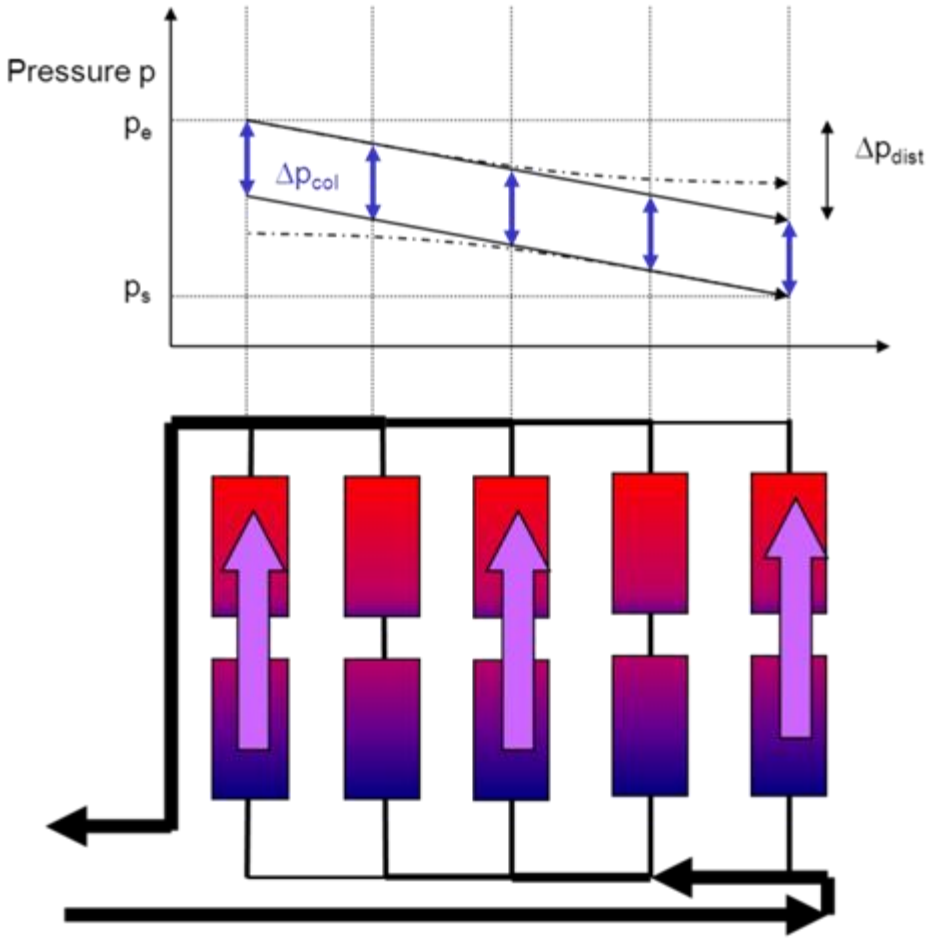
Large collector arrays connected in parallel with Tichelmann connection



Mass flow in parallel connected collectors

3. Connection via return pipe and reduced pipe diameter in the distribution pipes

Equal mass flow in all collectors of the field

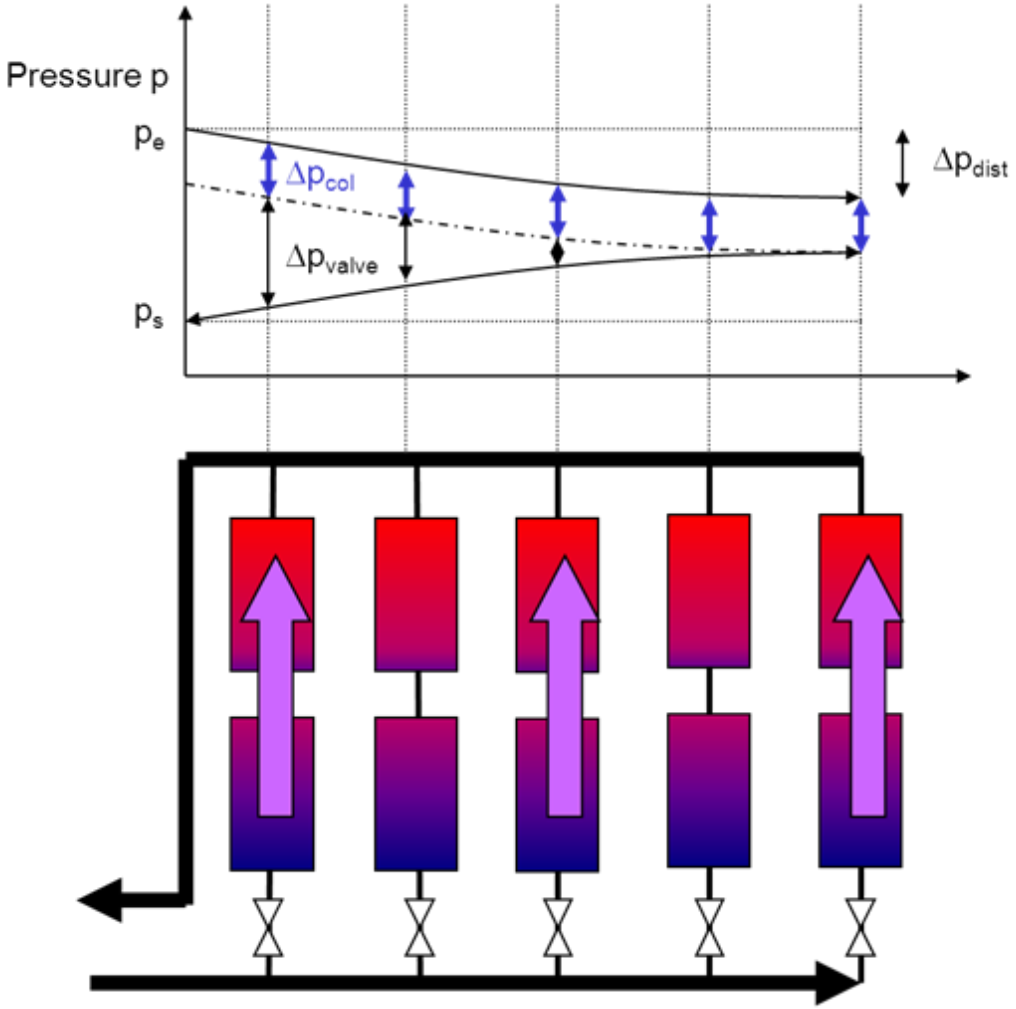


Mass flow in parallel connected collectors

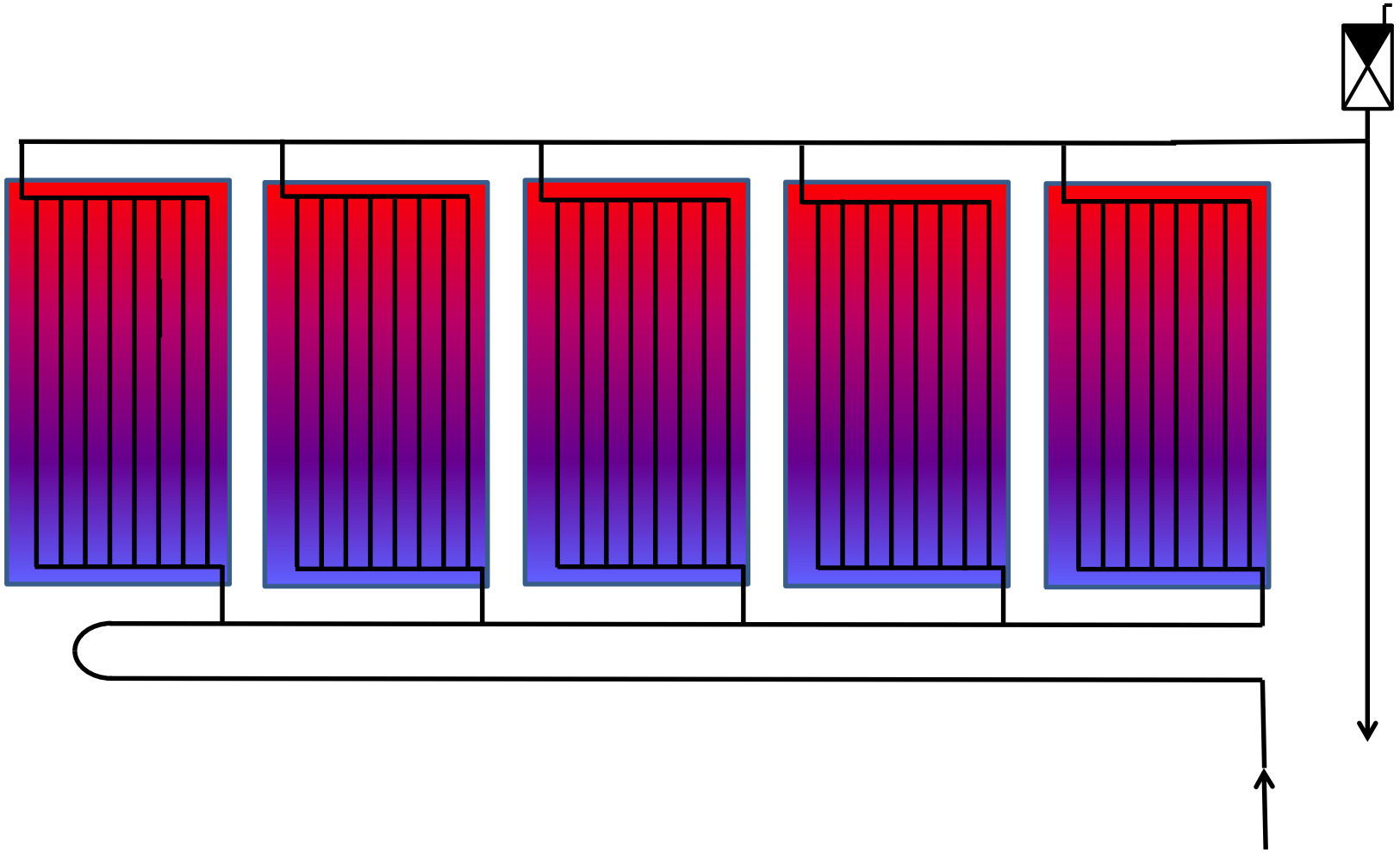
4. Connections with valves for each string

Equal mass flow in all collectors of the field

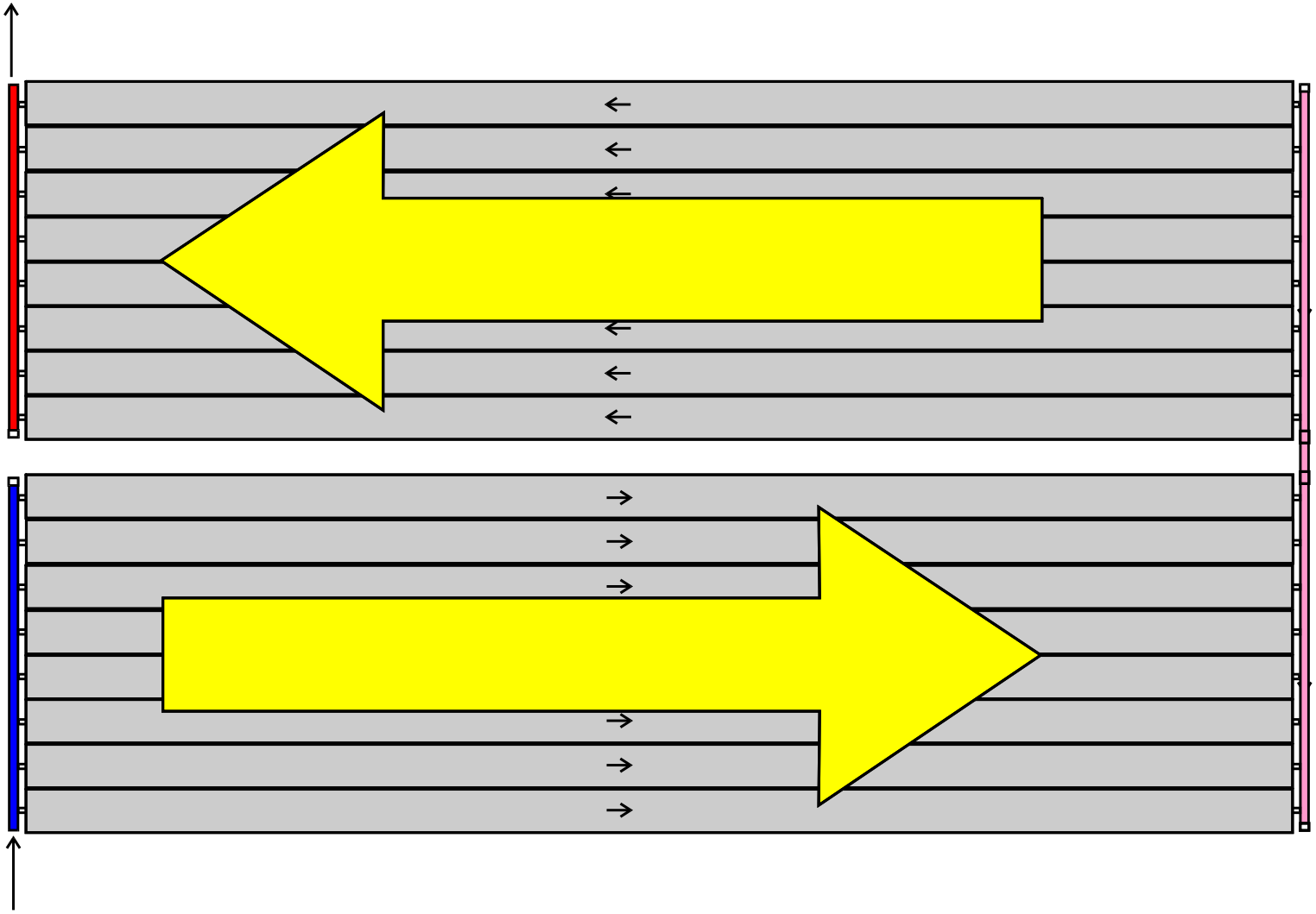
Different pressure is compensated via ajustable valves



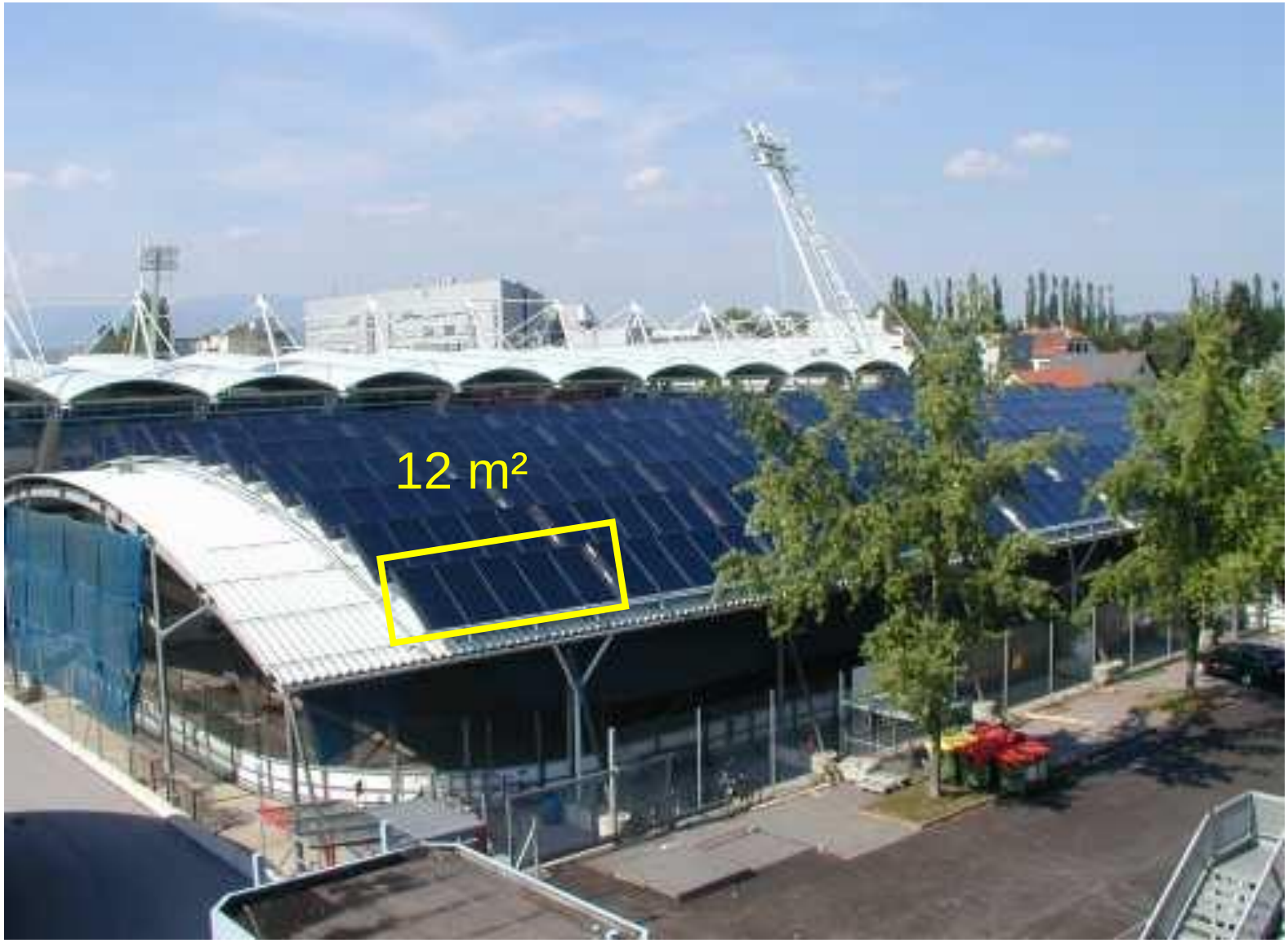
Hydraulic connection of collectors



Hydraulic connection of large-scale collectors



Flat plate collectors



SHIP Egypt

Collector Hydraulics

Wolfgang Glatzl & Josef Buchinger

AEE INTEC & ConPlusUltra