

# Cryogenics

Erstellt von Moritz Büdenbender

# Agenda

- Was bedeutet Cryogenics?
- Cryogenics am CERN
- Anlagen
  - Kompressor
  - Wärmetauscher
  - Turbinen
- Meine Arbeit: Bypassvermessung

# Was bedeutet Cryogenics?

- Erzeugung von Temperaturen unter  $123^{\circ}\text{K}$
- Verhalten von Materialien
- $\text{H}_2$ , He,  $\text{N}_2$ ,  $\text{O}_2$ , Ne
  - Siedepunkte unter  $123^{\circ}\text{K}$
- Anwendungsgebiete:
  - Supraleitfähigkeit
  - Konservierung
  - Raketentreibstoff

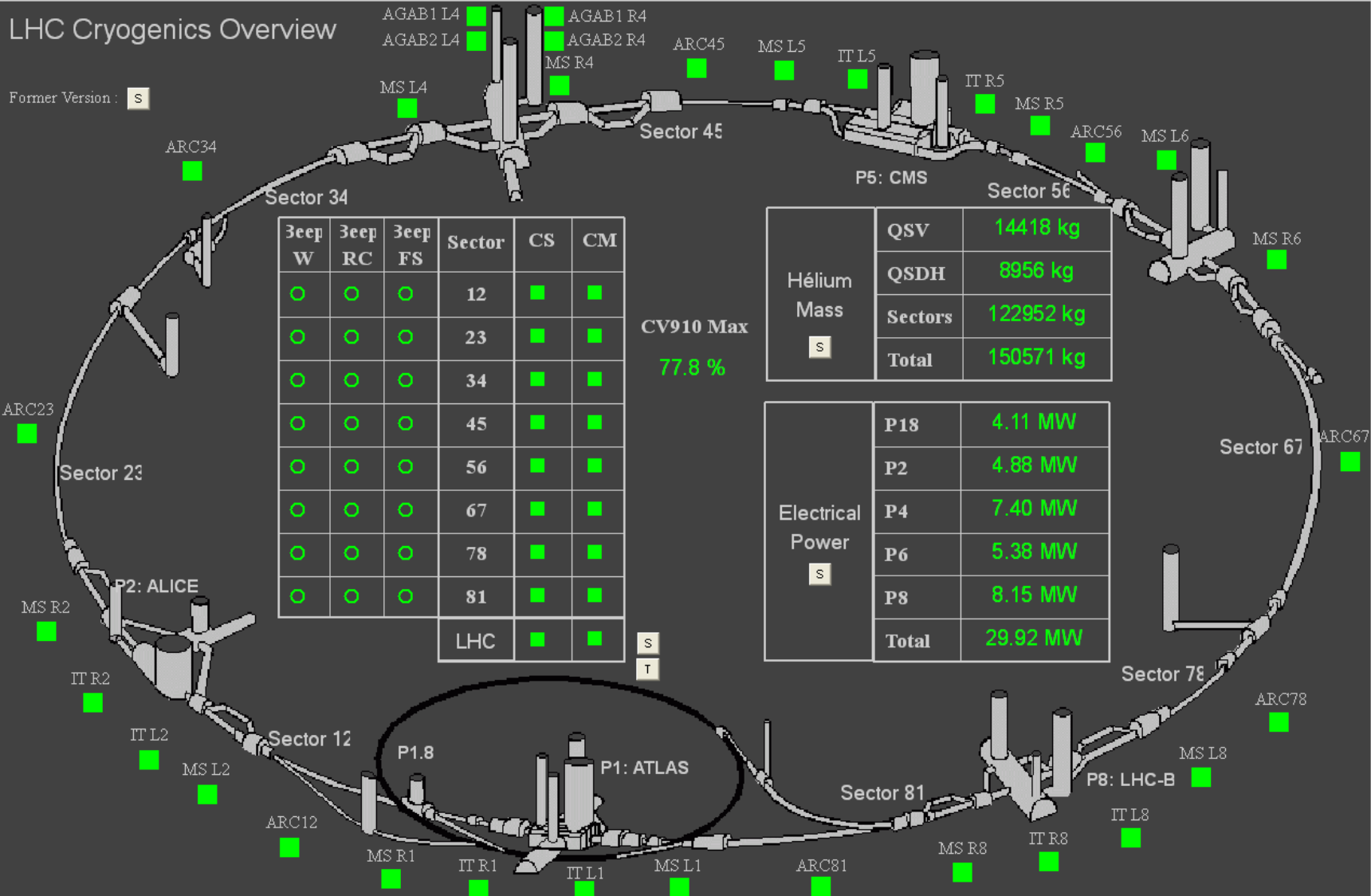
# Cryogenics am CERN

- Gewährleistung der Supraleitfähigkeit
  - $\rightarrow 1,9^\circ \text{K}$
- 123 t Helium im LHC
- Eng mit Vakuumtechnik verknüpft  $\rightarrow$  Isolation



# LHC Cryogenics Overview

Former Version:  S



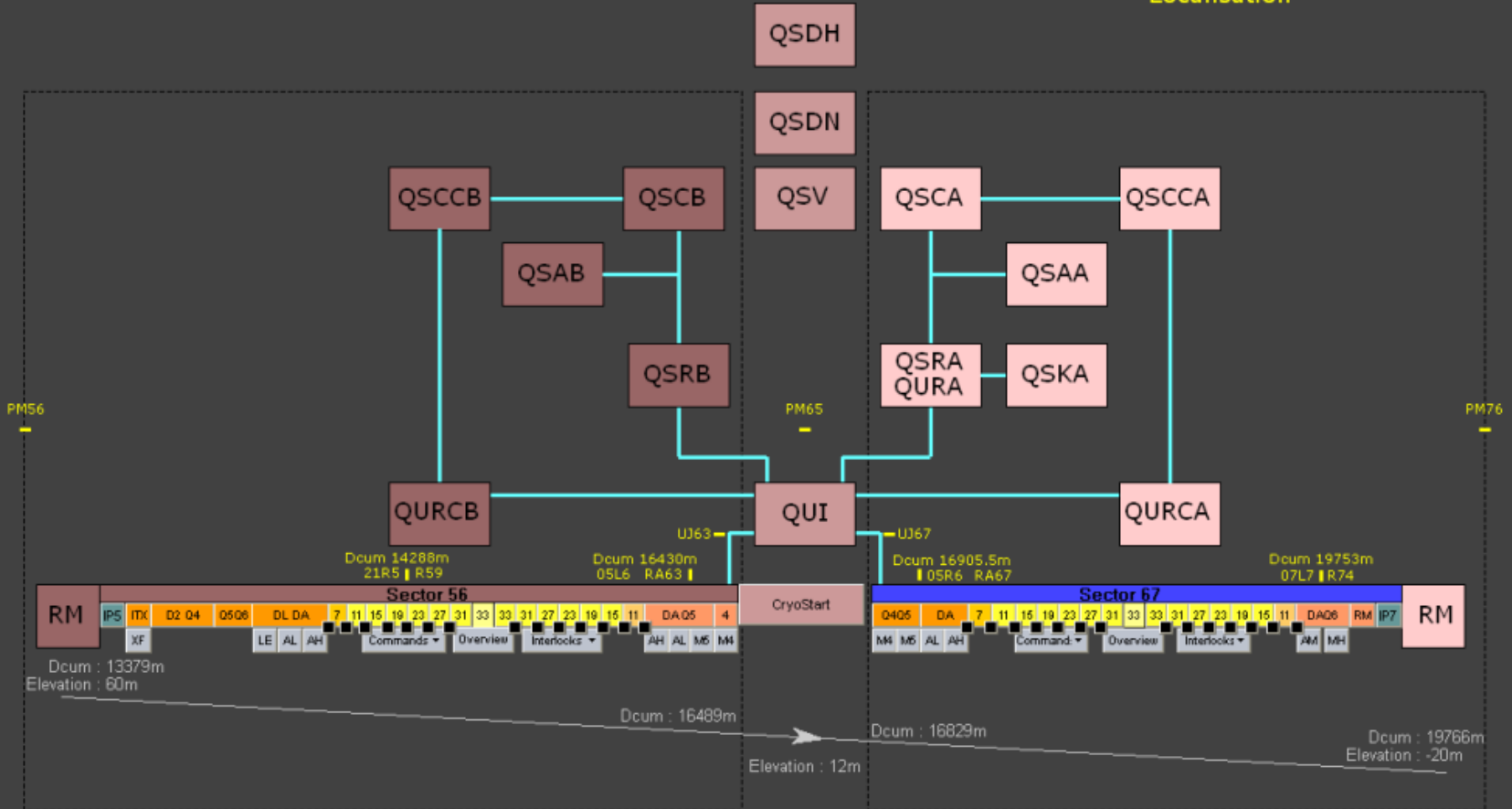
3εep W	3εep RC	3εep FS	Sector	CS	CM
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	12	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	23	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	34	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	45	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	56	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	67	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	78	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	81	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
			LHC	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

CV910 Max  
77.8 %

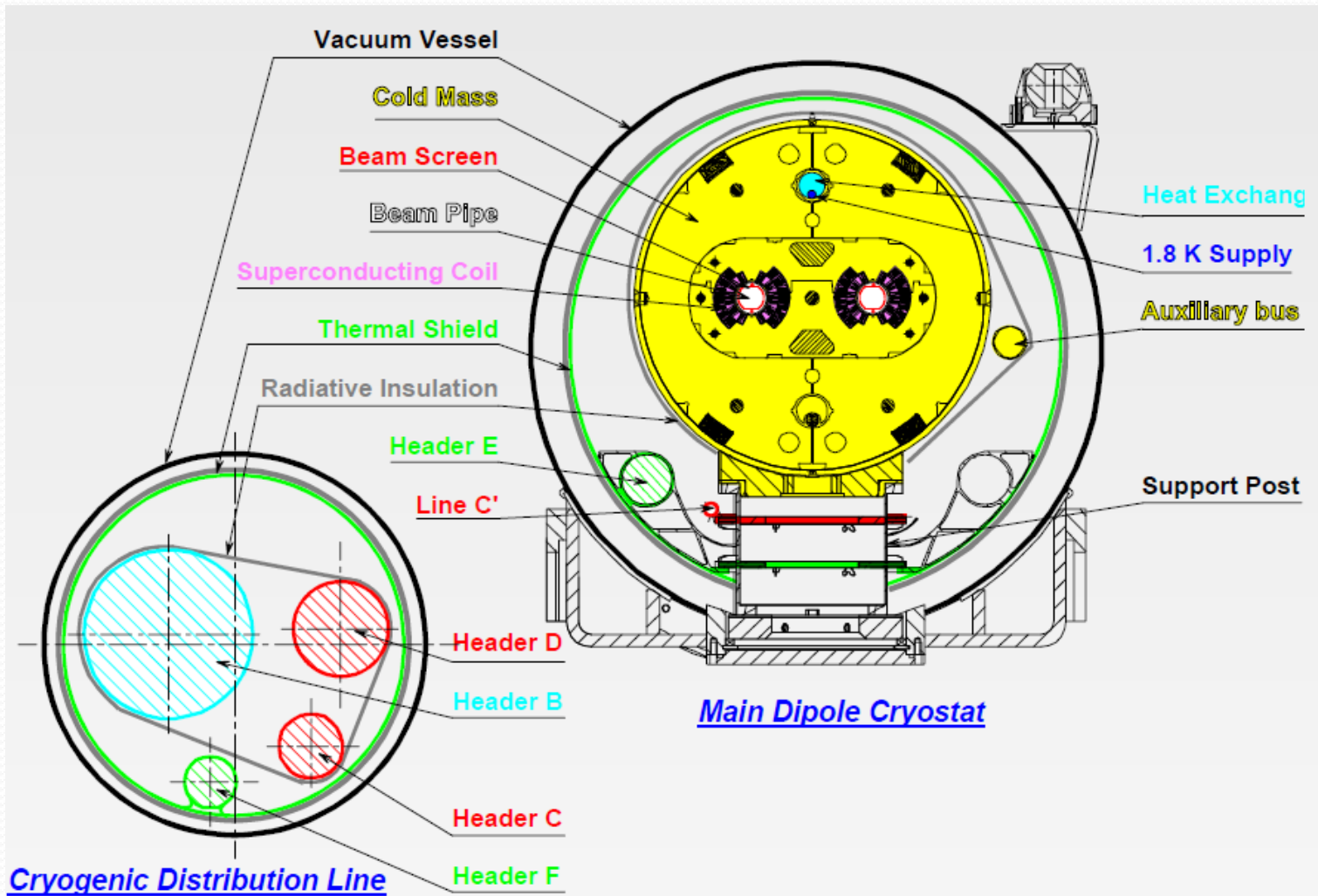
Hélium Mass <input type="checkbox"/> S	QSV	14418 kg
	QSDH	8956 kg
	Sectors	122952 kg
	Total	150571 kg

Electrical Power <input type="checkbox"/> S	P18	4.11 MW
	P2	4.88 MW
	P4	7.40 MW
	P6	5.38 MW
	P8	8.15 MW
	Total	29.92 MW

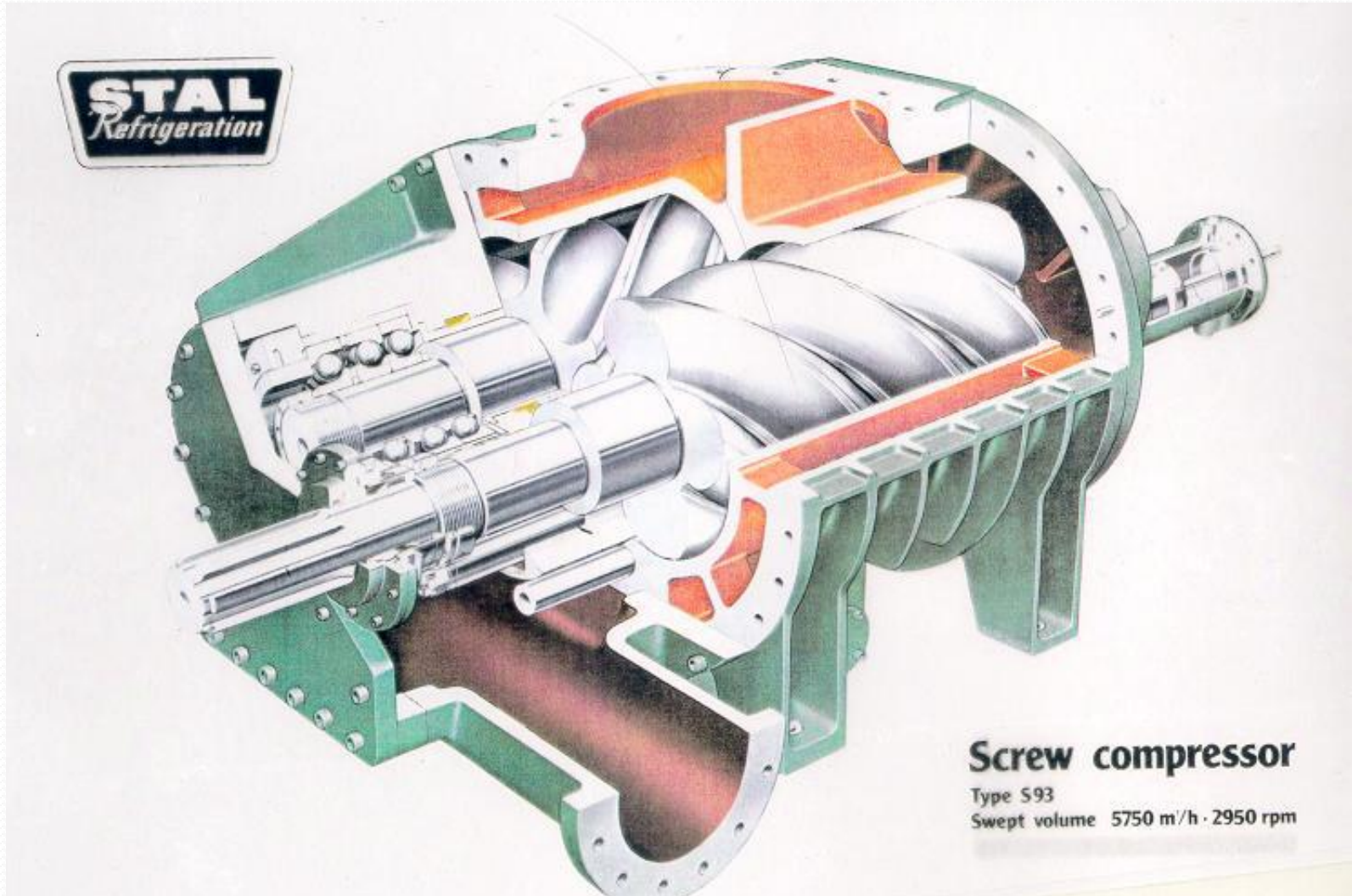
### Electrical Localisation



# Kühlsystem im Magneten

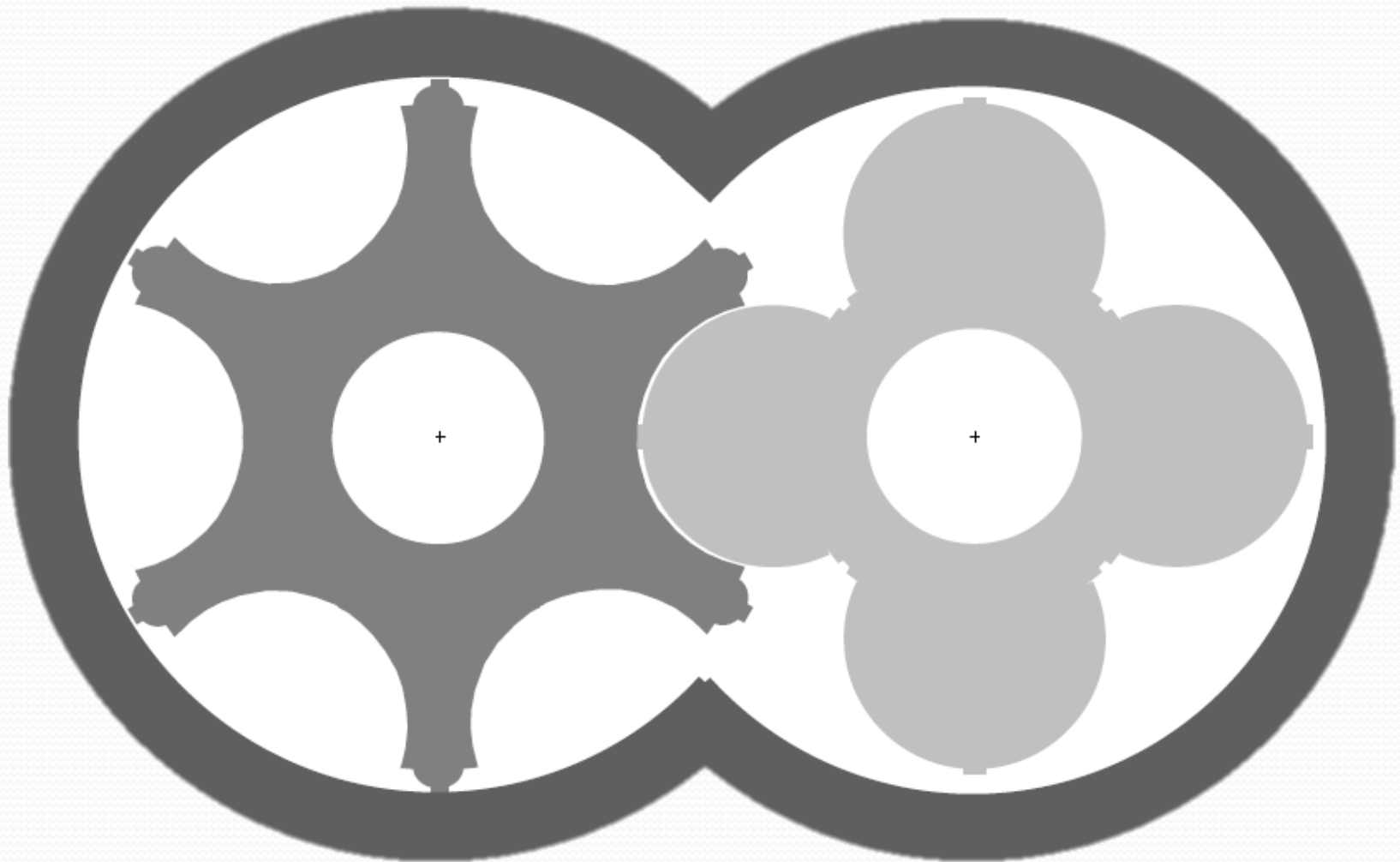


# Anlagen – Kompressor

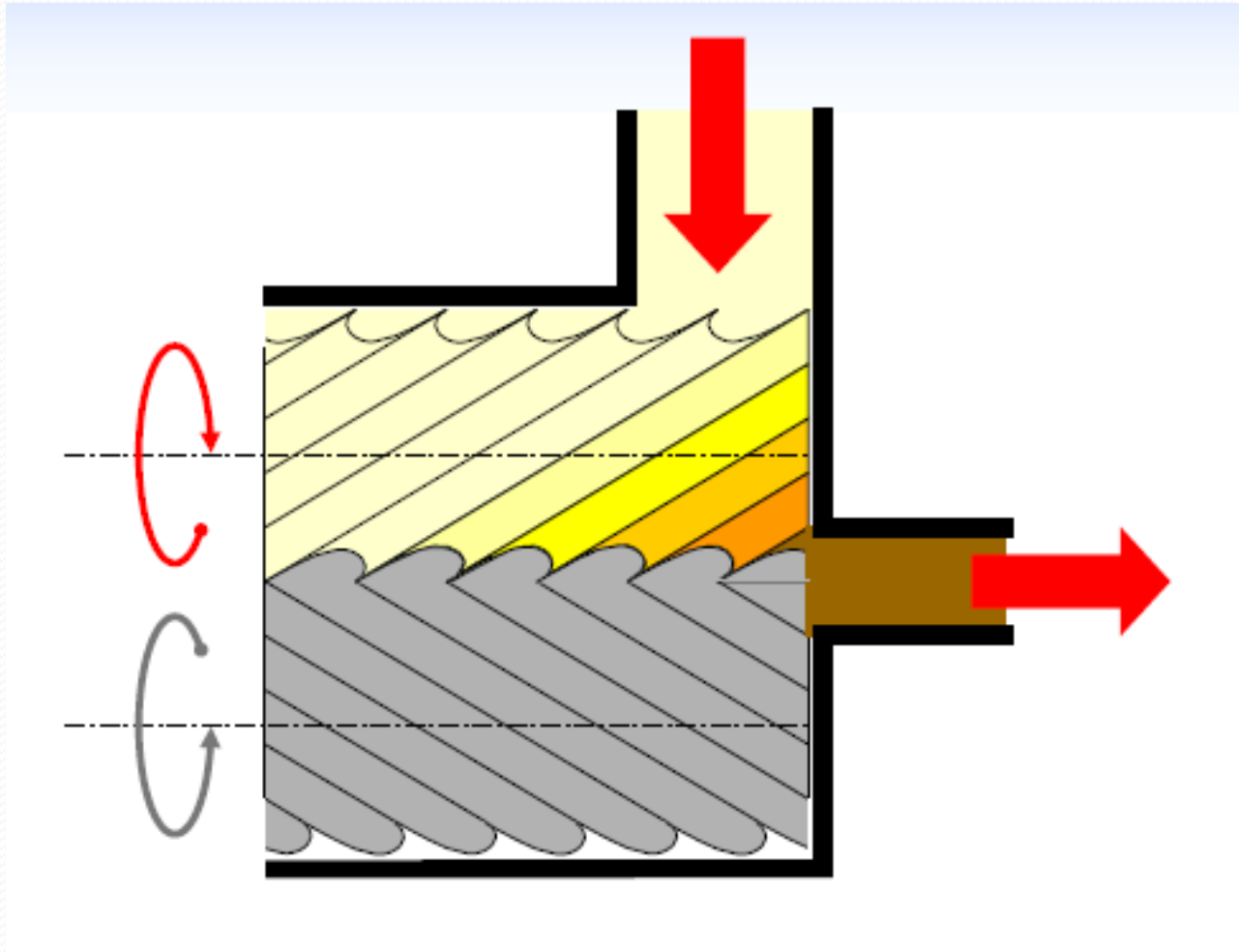




# Anlagen – Kompressor

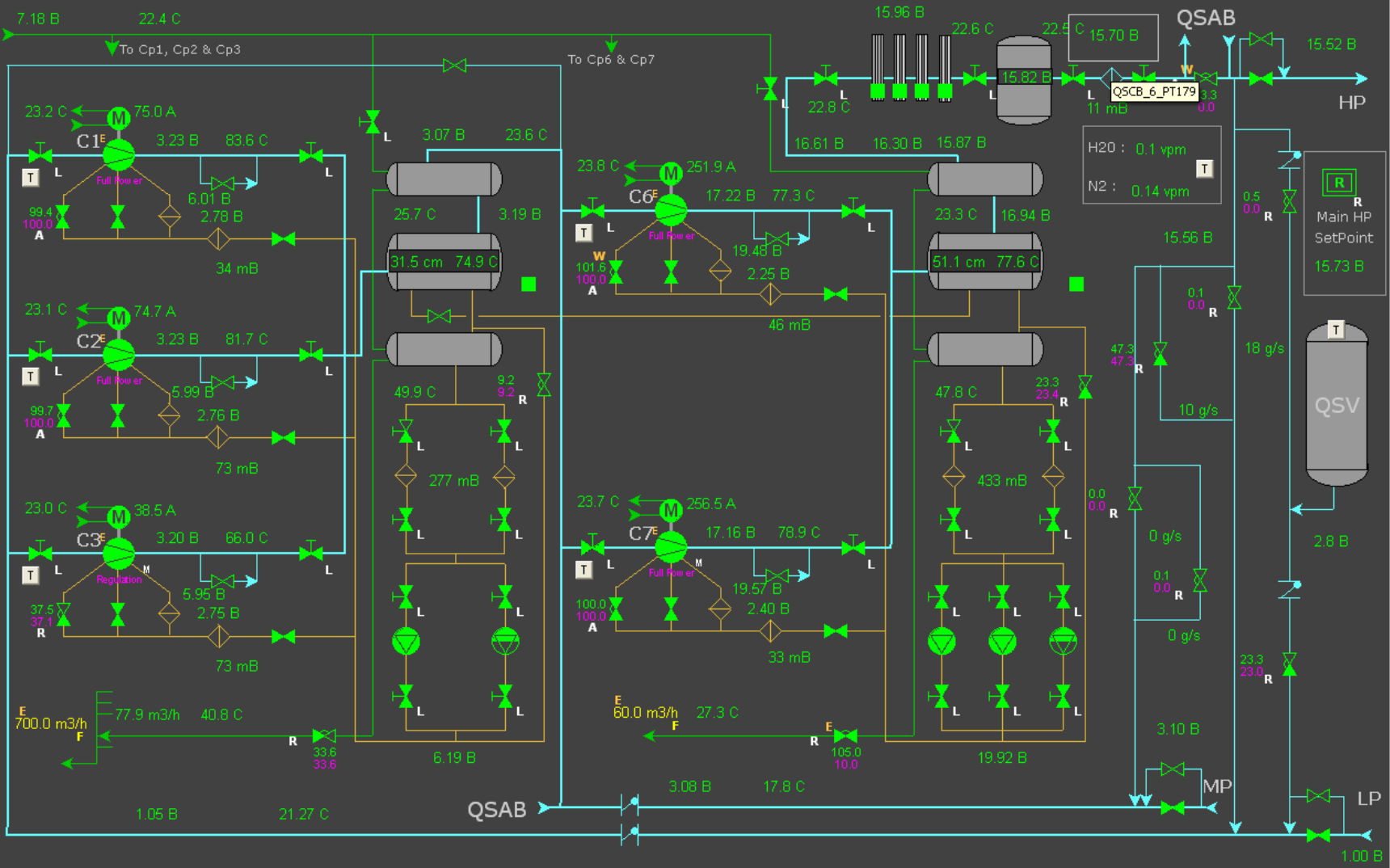


# Anlagen – Kompressor



# P6 QSCB - OVERVIEW

11:30:06 AM 4/20/2012 1 [X] [X] [X]



Cmd LHCB	Analysis
QSCB	Comps Values
	Hand Valves
	Utilities

Remaining time  Device P6\_62:QURA\_6\_CV296

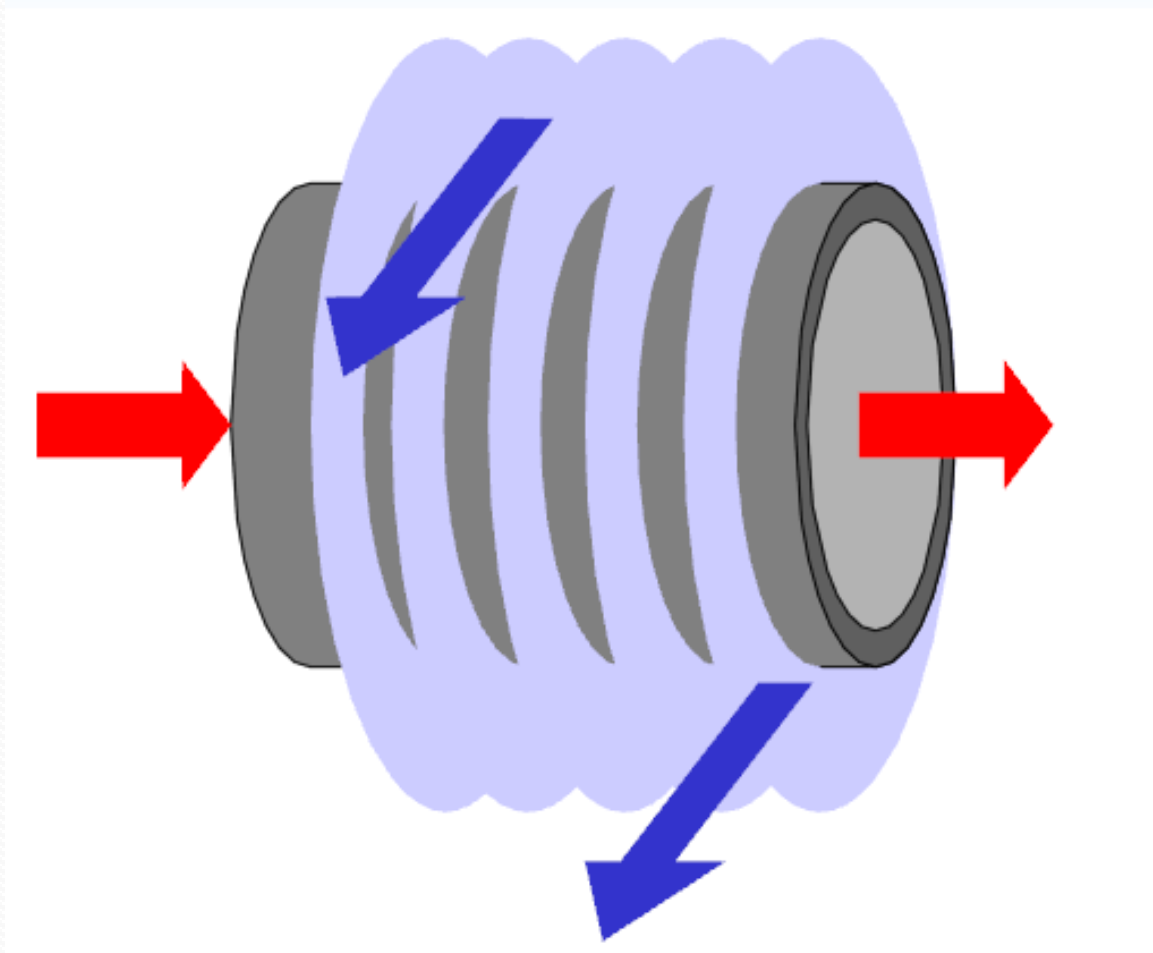
L 2012.04.20 11:29:47.005 INFO Select QSCA\_6\_1PT134

T 2012.04.20 11:30:03.571 INFO Select QURA\_6\_PC230\_9PT216

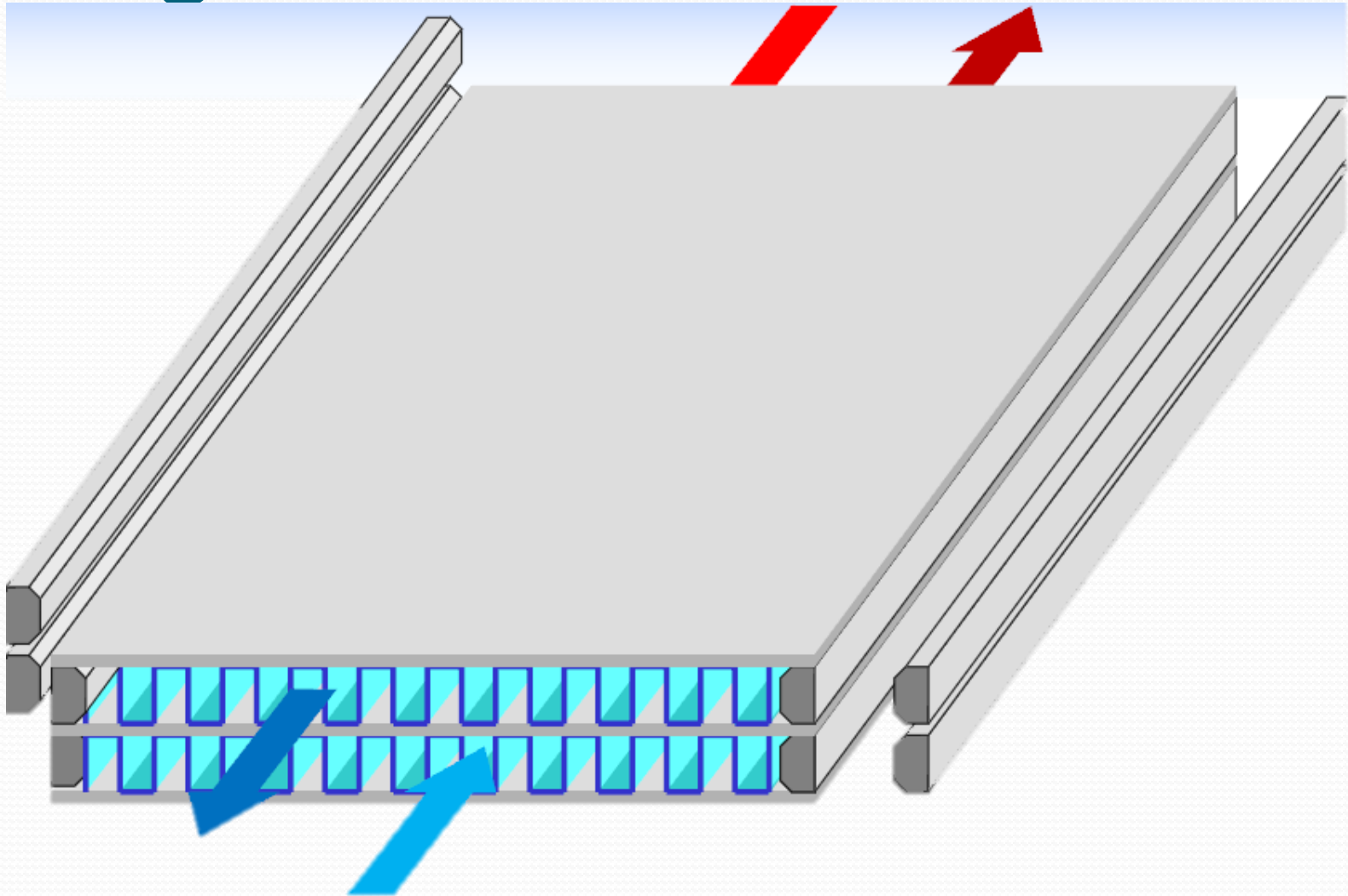
# Anlagen - Kompressor



# Anlagen – Wärmetauscher



# Anlagen – Wärmetauscher

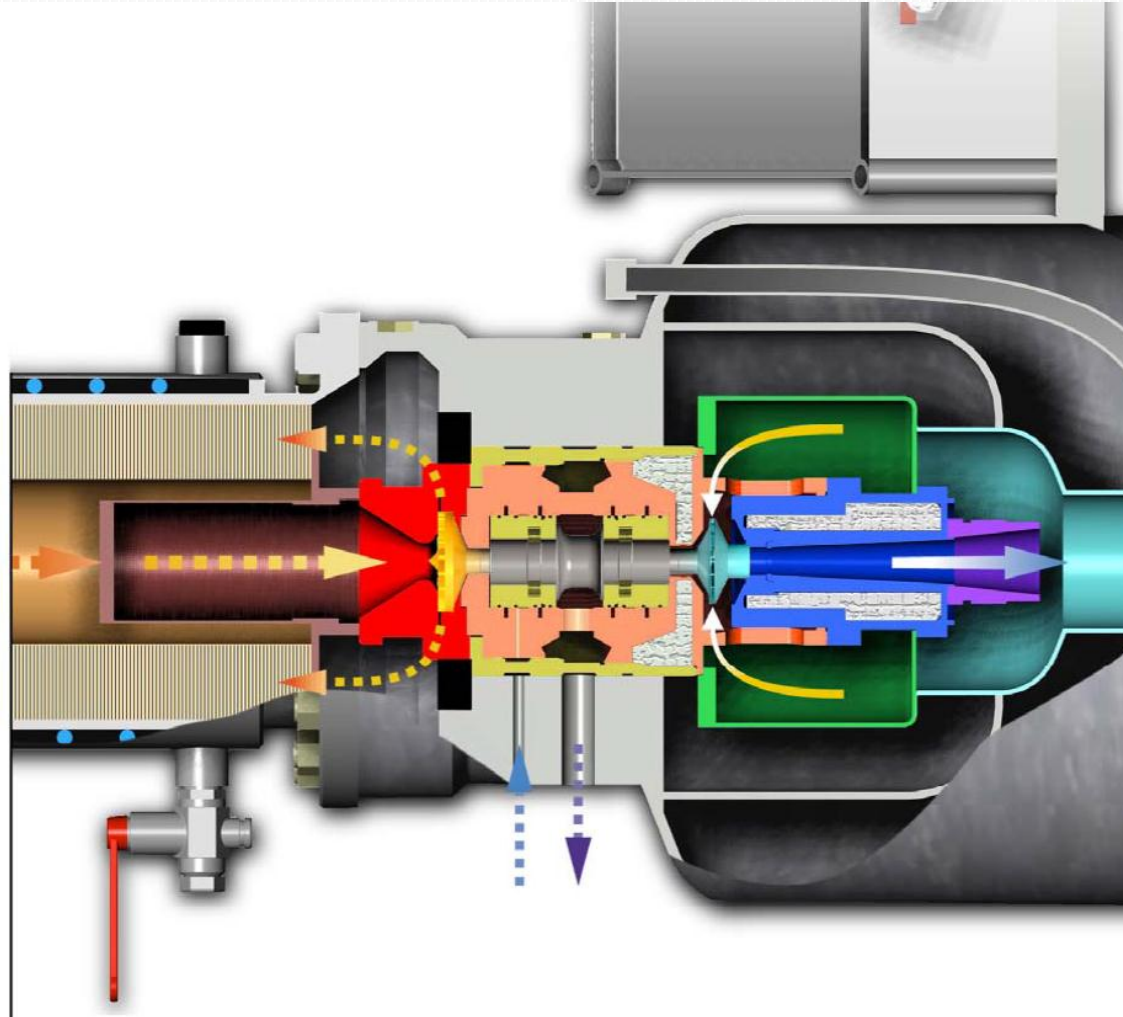




# Anlagen - Wärmetauscher

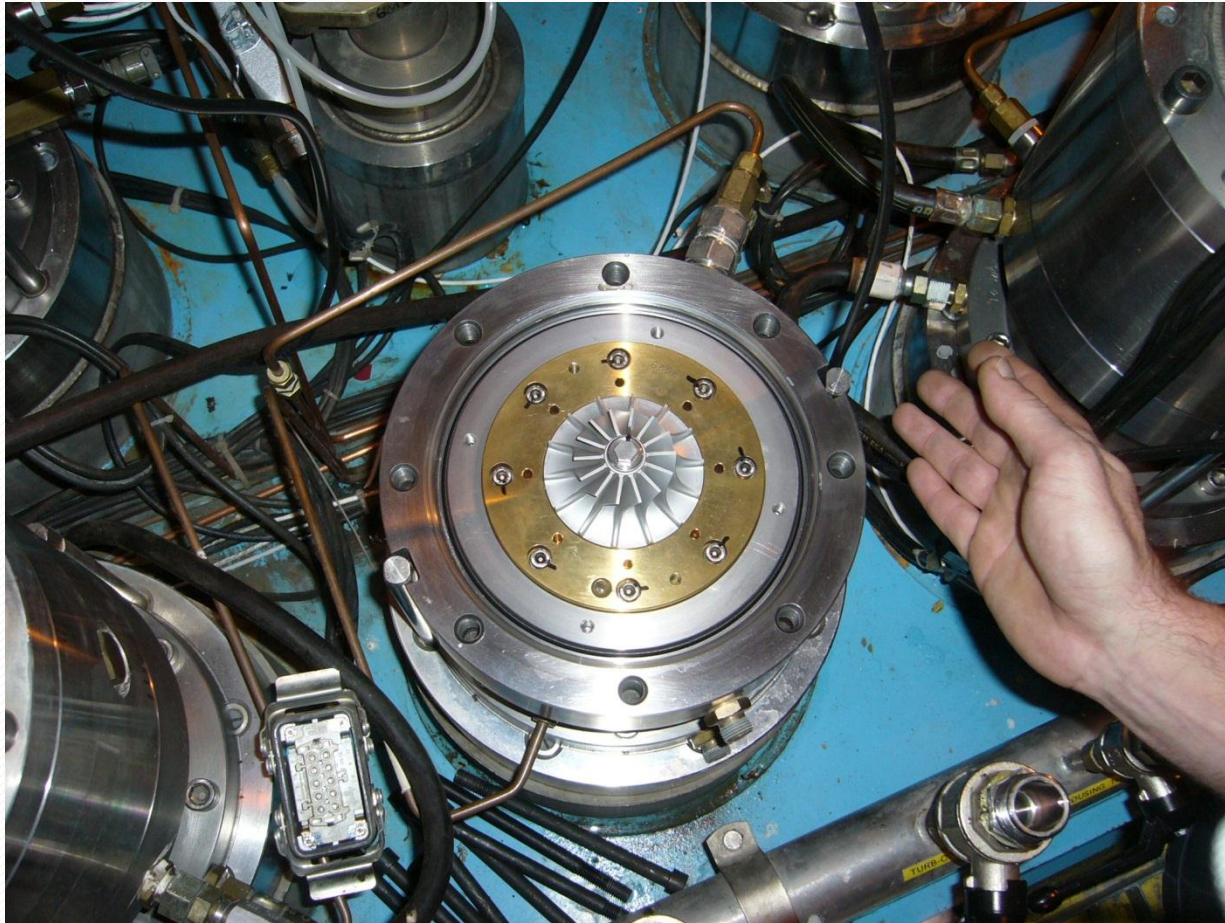


# Anlagen - Turbinen

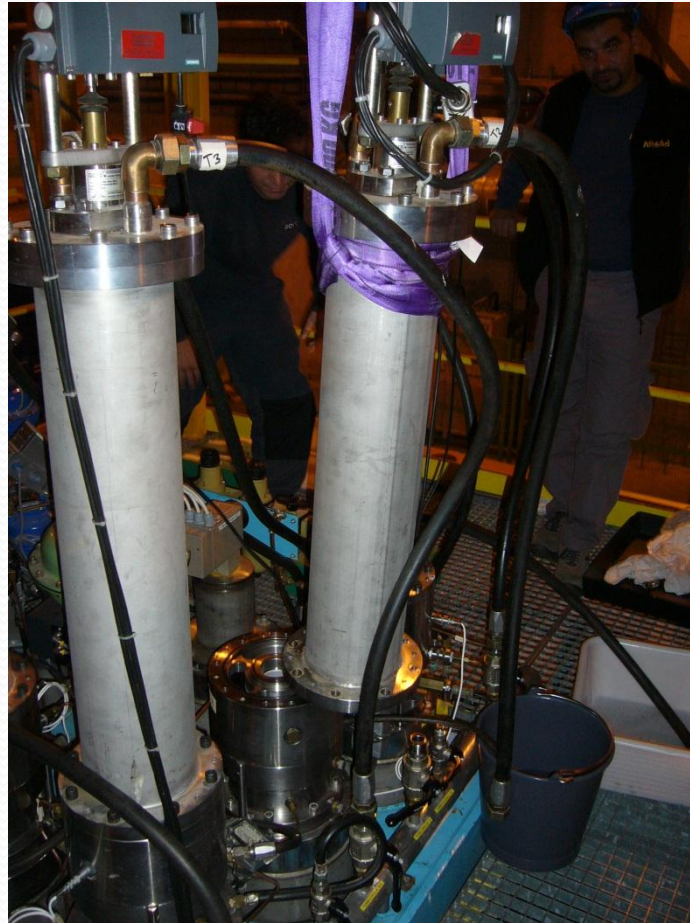




# Anlagen - Turbinen



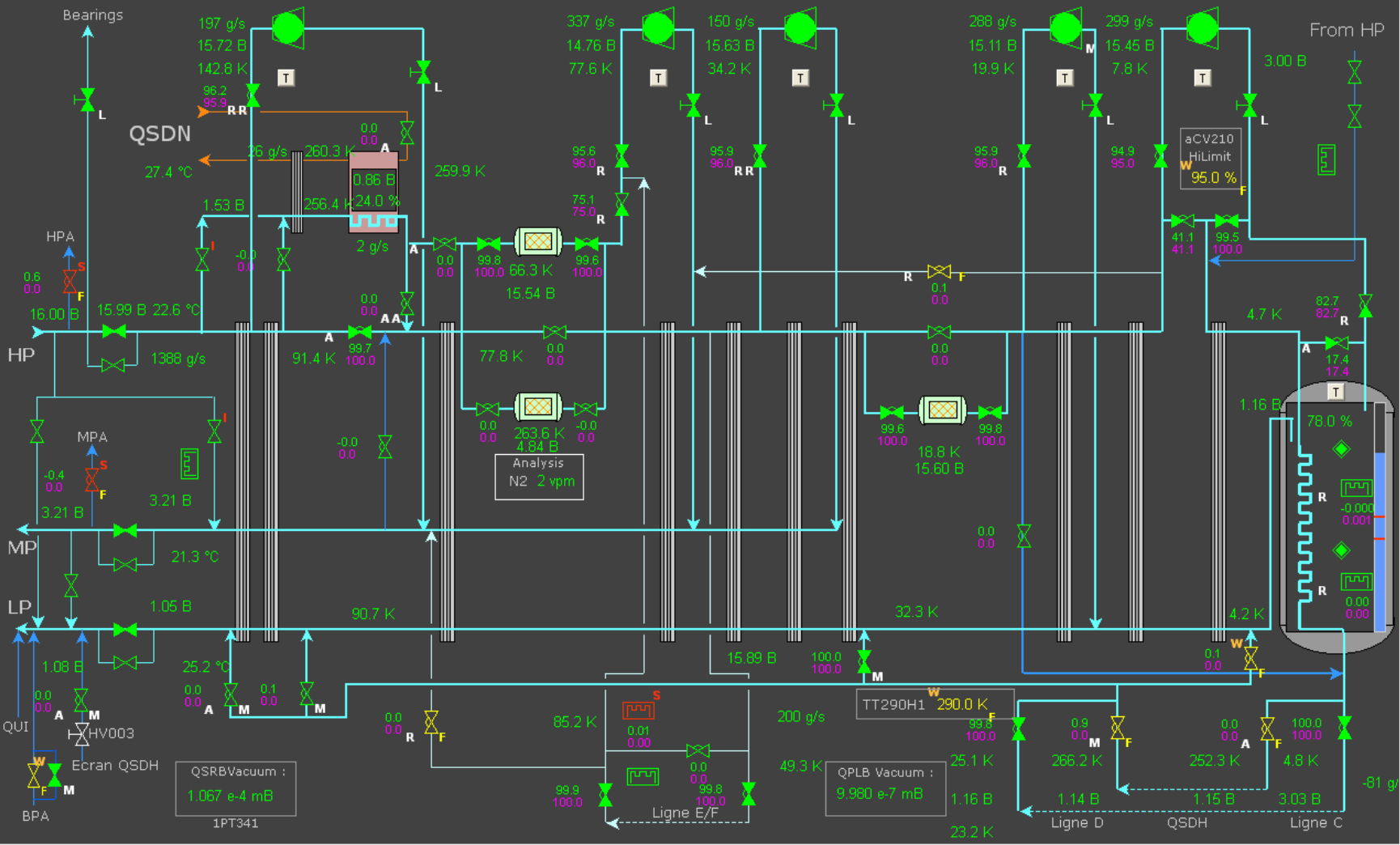
# Anlagen - Turbinen



# P6 QSRB - OVERVIEW

11:26:24 AM 4/19/2012 1 2 X X

TU Output Temperature	TU1	TU2	TU3	TU4	TU5	TU6	TU7	TU8	TU9	TUA
	125.3 K	109.9 K	89.3 K	65.7 K	48.3 K	29.9 K	22.3 K	15.0 K	9.4 K	5.4 K



Cmd LHCB	Regeneration	Vacuum
QSRB	Hand Valves	Utilities

Device: P6\_62:QSRB\_6\_4CV210



# Anlagen – „Kühlschrank“

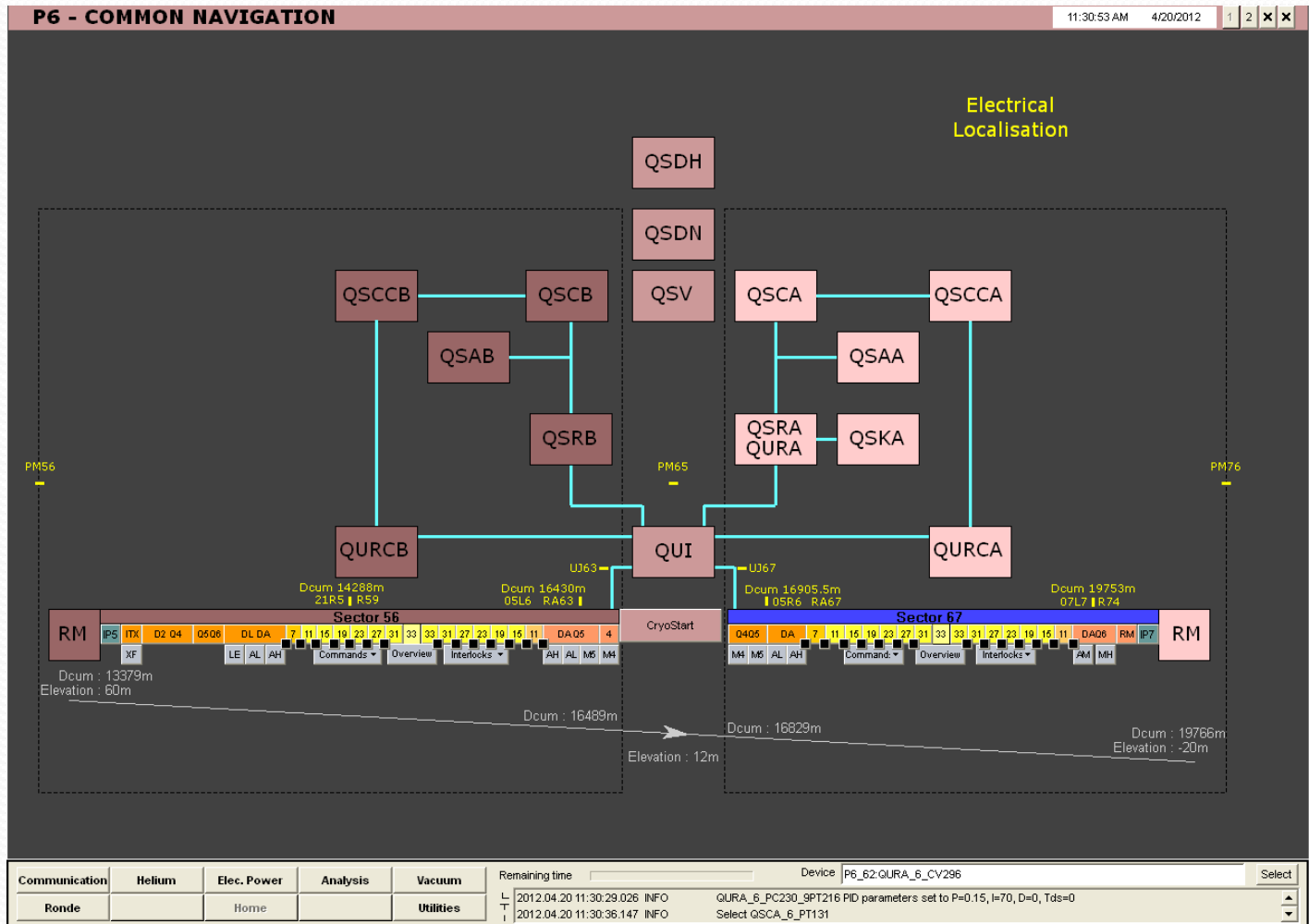


# Anlagen – „Kühlschrank“





# Unsere Arbeit

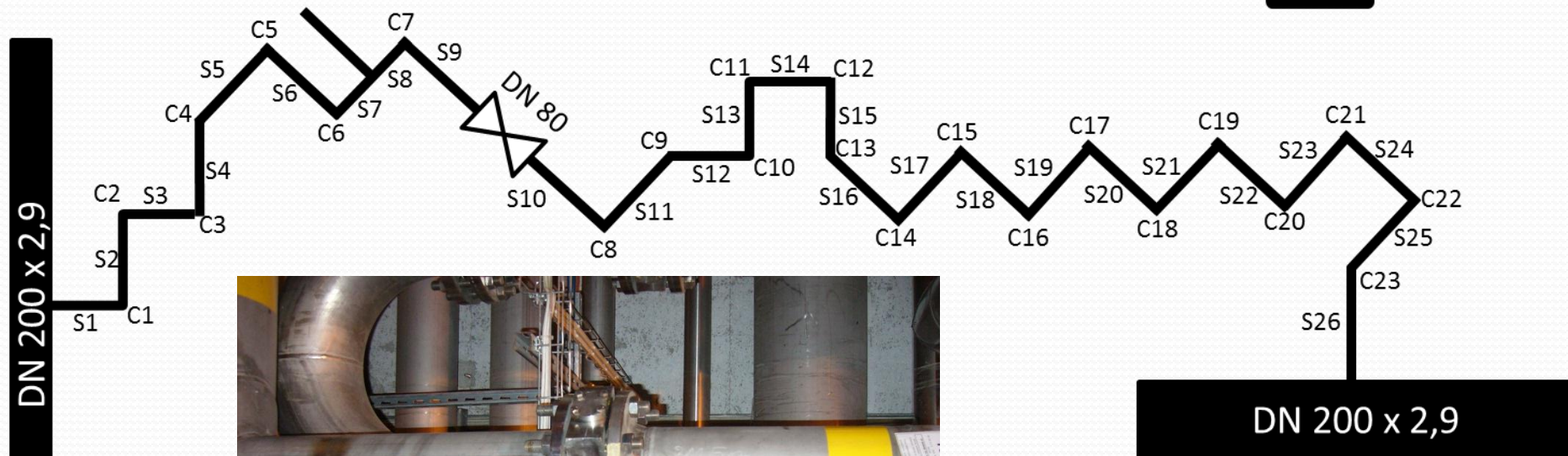


# Unsere Arbeit

- Vermutung: Rohre des Bypasssystems zu klein
  - Hoher Druckverlust
  - Druckverlust bestimmen
  - Rohre vermessen
  - Austausch während Stopp 2013

# Unsere Arbeit

P 4  
HP





# Unsere Arbeit

## HP – P8

SP					Curves			
Nr.	Length [mm]	Diameter [mm]	Crossing Valves	Nr.	Angle [°]	Radius [mm]	Diameter [mm]	
1	320	DN 80 x 2,0	DIN 2635 DN 80	1	45	65	DN 80	
2	2935	DN 80 x 2,0		2	90	65	DN 80	
3	950	DN 80 x 2,0		3	90	65	DN 80	
4	250	DN 80 x 2,0		4	90	65	DN 80	
5	3310	DN 80 x 2,0		5	45	65	DN 80	
6	2390	DN 80 x 2,0		6	90	65	DN 80	
7	700	DN 80 x 2,0		7	90	65	DN 80	
8	740	DN 80 x 2,0		8	45	65	DN 80	
9	330	DN 80 x 2,0						
					Sum of parts	r/d	Pressure Drop/Part	
	Sum of lengths	Pressure Drop [mbar]						
DN 80	11925	0,617122908		DN 80 90°	5	1,3	0,617	
				DN 80 45°	3	1,3	0,705	
					Sum:		5,201	

# Vielen Dank Steffen!!



# Vielen Dank für Ihre Aufmerksamkeit

