Report on Sessions B1 and B2

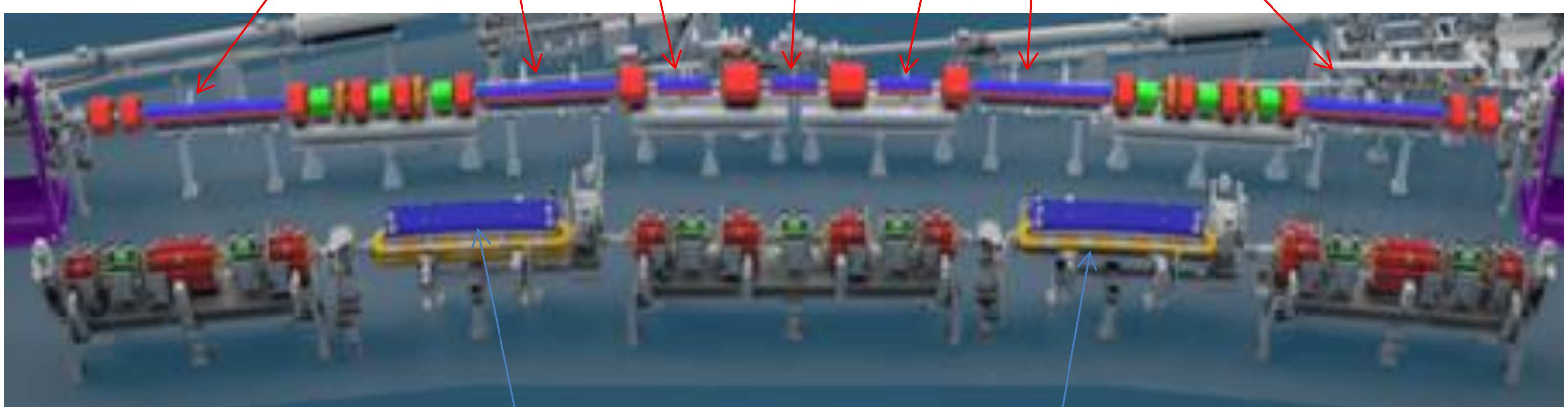
Erica Lindström

Boosting accelerator electrical efficiency at the ESFR

Presented by Mr. Jean François Bouteille

- The new proposed lattice

New lattice with 7 dipoles



Old lattice with 2 dipoles

New low emittance lattice ring

- 33% reduction on needed magnet power
- At least a 30% reduction on RF losses per turn
- 30% reduction on accelerator cooling need
- 28% reduced peak power demand for the storage ring

They have foreseen two technologies to choose from:

- Electromagnets
- Permanent magnets

If the more power consuming electromagnetic solution would be chosen, it would still lead to a 25% power decrease in magnet power compared to current solution.

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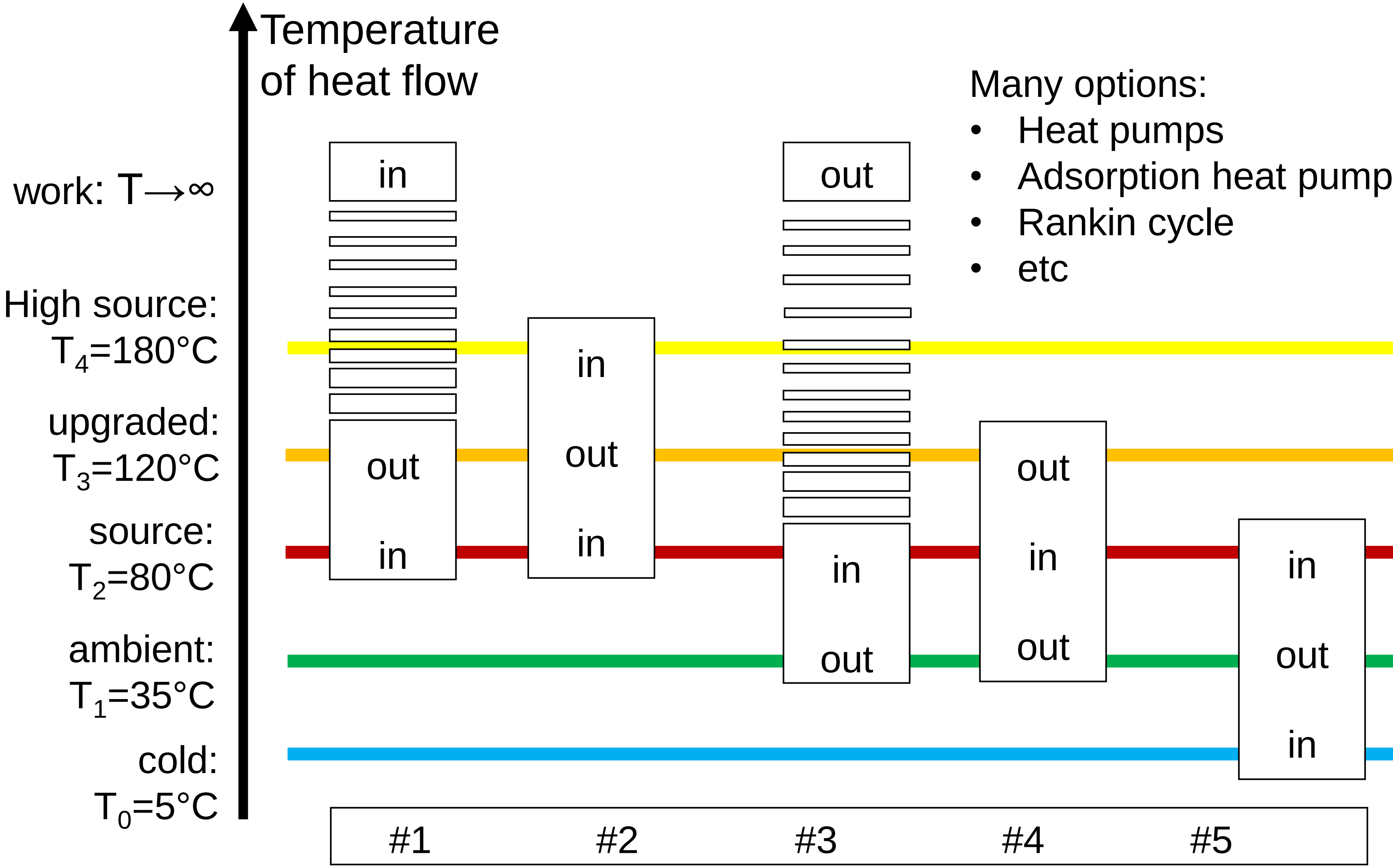
Valorization of low-grade waste heat

Presented by Prof. Felix Ziegler



Many options:

- Heat pumps
- Adsorption heat pumps
- Rankin cycle
- etc

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It is possible to double the Seasonal Energy Efficiency Ratio (SEER) when combining heat sink and drive

$$SEER_{el} = \frac{Q_{cold}}{\sum W} > 10$$

Control strategy	$SEER_{el}$
#1: Classic drive (Temperature)	13
#2: Heat sink (Temperature and flow rate)	19
#3: Drive (Temperature and flow rate)	14
#4: Combination (#2+#3)	22

Efficient heat transfer is the key to implementation

From eV to TeV: the Green ILC

Presented by Mr. Denis Perret-Gallix

ILC Sustainable energy institute missions

- Get involved in the most advanced and promising researches:
  - Basic research is the most needed and least funded
  - Technology and engineering (devices and systems)

- How to power ILC:
  - Identify locations with low environmental impacts.
  - Design and build pilot power plants from various energy sources
  - Connect to ILC, to the GRID

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ILC site has potential for many different renewable energy sources

- Photovoltaic and thermal sun energies
- Wind and marine power, many possible spots on sea shore and off-shore
- Local hot springs, geothermal
- Biomass/biofuel energy

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Green ILC energy issues

- Energy saving and efficiency
- Developing sustainable energies for ILC
- Smart (local) grid

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Energy efficiency of particle accelerators – a network in the European program EuCARD-2

Presented by Dr. Mike Seidel

Management and Communication

- WP1: Management and Communication (MANCOM)

Networking Activities

- WP2: Catalysing Innovation (INNovation)
- WP3: Energy Efficiency (EnEfficient)
- WP4: Accelerator Applications (AccApplic)
- WP5: Extreme Beams (XBEAM)
- WP6: Low Emittance Rings (LOW-e-RING)
- WP7: Novel Accelerators (EuroNNAc2)

Transnational Access

- WP8: ICTF@STFC
- WP9: HiRadMat@SPS and MagNet@CERN

Joint Research Activities

- WP10: Future Magnets (MAG)
- WP11: Collimator Materials for fast High Density Energy Deposition (COMA-HDED)
- WP12: Innovative Radio Frequency Technologies (RF)
- WP13: Novel Acceleration Techniques (ANAC2)

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EnEfficient is a **new networking activity** related to efficient utilization of electrical power in accelerator based facilities

The aim is to hold workshops, evaluate present technology, identify areas with promising potential and to initiate development projects

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task 1: energy recovery from cooling circuits

task 2: higher electronic efficiency RF power generation

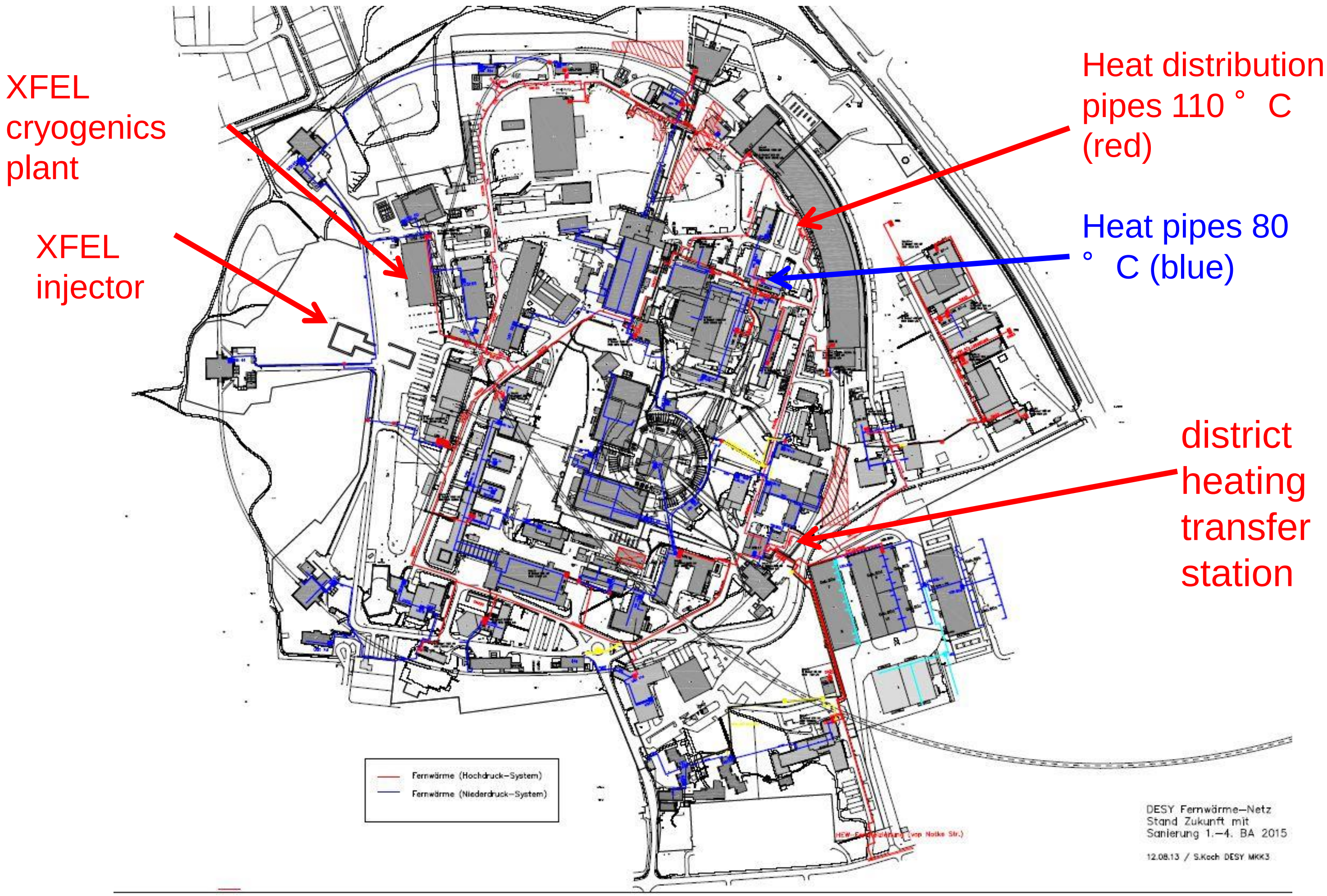
task 3: short term energy storage systems

task 4: virtual power plant

task 5: beam transfer channels with low power consumption

Cryogenic waste heat utilization for DESY and European XFEL

Presented by Mr. Jens-Peter Jensen



Cooling water waste heat utilization with heat pump

- The most waste heat goes into the cooling water
- The cooling water temperatures are to low for direct transfer into the heat distribution pipes
- heat pump needed to boost the temperature
- The savings does not pay back the invest and service costs

Heat pump utilization to boost low temperatures does not pay

XFEL Cryogenic oil waste heat utilization

The utilization of the oil waste heat pays back after 2 – 3 years

	1 street	2 streets
heat extraction	4,6 GWh/a	7,0 GWh/a
cost savings[1)]	228.450 €/a	350.600 €/a
payback period [2)]	2,6 a	1,7 a
cash value after 10 years [3)]	807.740 €	1.558.298 €
CO_2-Emission [4)]	1.087 t-CO_2/a	1.669 t-CO_2/a

Development of high-power IOTs as an efficient alternative to klystrons

Presented by Dr. Morten Jensen

IOT advantages:

Significantly smaller than a klystron

High efficiency at operation point

Cost typically does not scale strongly with output power

Low power consumption in standby or for reduced output power

No need to pulse HV for pulsed operation

Broadcast Industry has promoted IOT development
Klystrons have almost been replaced

Power levels limited to kW range

ESS to push the technology to MW levels

High Development Cost

High requirement justifies R&D for ESS

Successful development will reduce risk for other accelerators

High Efficiency and Minimal Energy Consumption is Mandatory for ESS

What would IOTs mean for ESS?

- Higher modulator efficiency
- Higher RF efficiency
- Power saving from High Beta section
- Lower voltage, no oil tanks
- Heat can still be recovered from collectors
- Lower capital cost for modulator
- Smaller size lowers building cost

Energy reduction:

example of a test facility upgrade with pulsed magnets instead of DC magnets, saving 90% of energy consumption
Presented by Mr. Jean-Paul Burnet

The East Area of CERN consumes energy continuously whereas it is used only during 7.5% of the “duty cycle”

Pulsed operation will raise the project costs BUT will also result in recurring savings and a much smaller carbon footprint from the East Experimental Area

pay back of the project costs would occur in **5 years**

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- **Energy Audits are a useful tool for identifying potential for saving**
- **The PS East Area is a prime candidate**
  - Old components needs to be exchanged
  - Continuously energised BUT use only a fraction of physics operations time
  - DC powering of magnets ➧ unnecessary cooling requirements
- **Pulsing the magnets drastically reduces consumption**
  - Energy requirement from 11GWh to 0.6GWh per year
  - Saving of 600kCHF per year
- **Great example of a self-funded project**
  - Extra cost of approximately 3MCHF but,
  - Short payback time - approximately **5 years**
- **East Area is a model for other projects** (e.g. North area in CERN)