CLIC workshop
” Technical Issues, Integration & Cost ” working group

Progress on Study of Module Cooling

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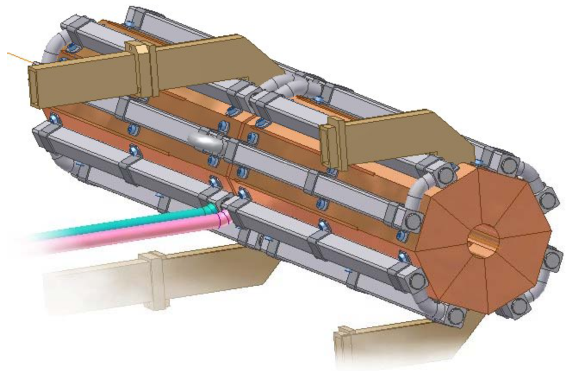
16.10.2008

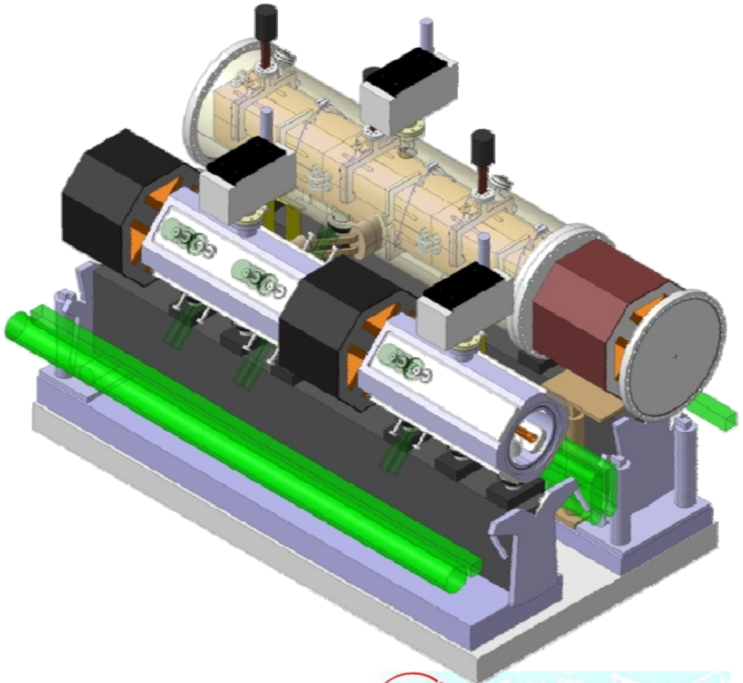
Outlook

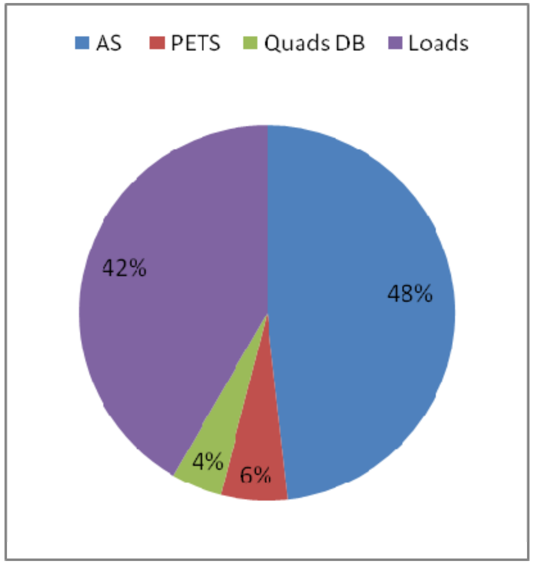
- Introduction
- Current layout for module cooling
- Cooling specifications for the AS and the PETS
- WUT Collaboration
- Accelerating structure cooling
- PETS cooling
- Challenges
- “Bigger picture”
- Future work



Introduction

- Reserved Dissipations
  - AS ~ 412 W
  - PETS ~ 110 W
  - Load ~ 712 W
  - DB Quad ~ 148 W
  - Module ~ 7.7 kW
  - Linac ~ 70172 kW





- Cooling circuits
  - Circuit A – Module components
  - Circuit B – General cooling
  - ...

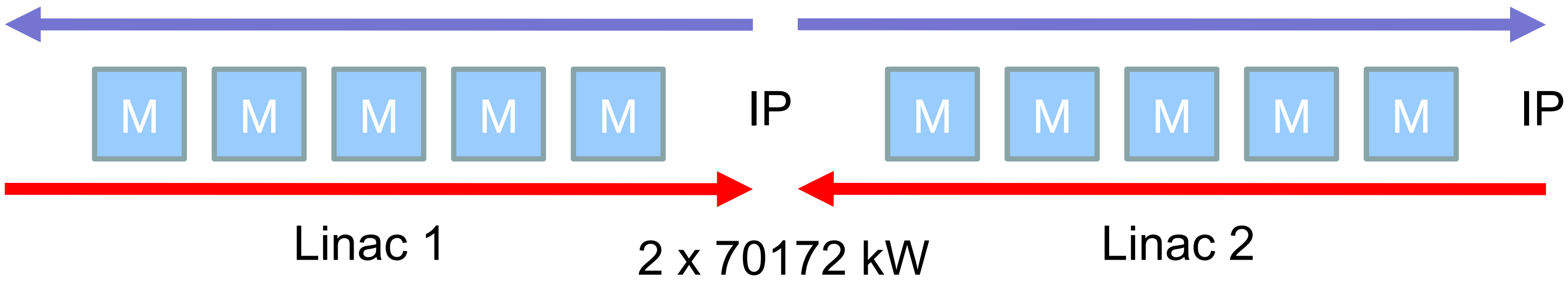
Cooling layout

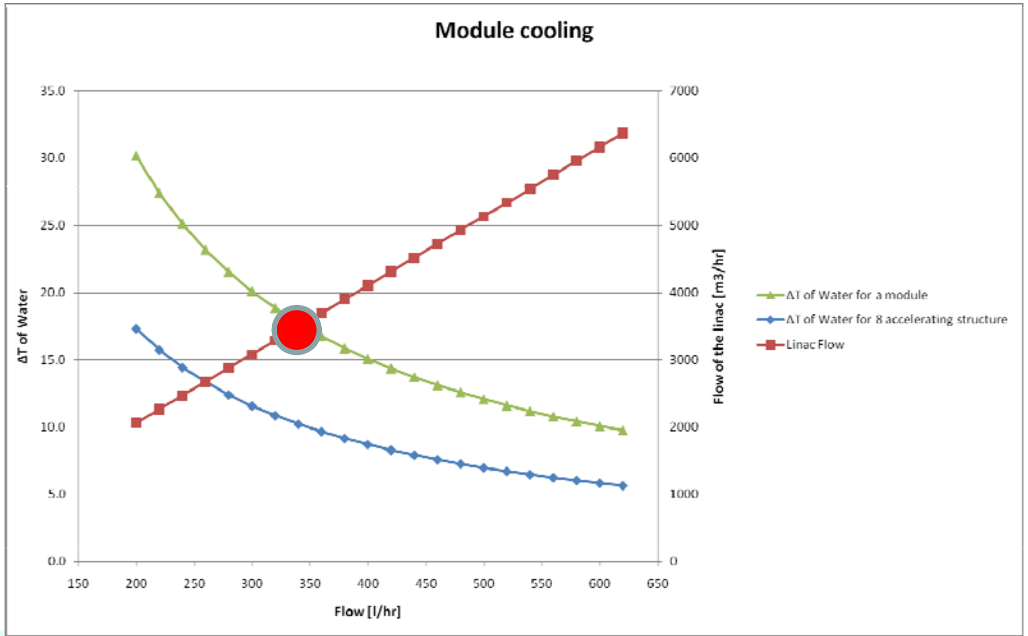
Circuit A

Uniform duct over a full length of a linac.

Demineralised water

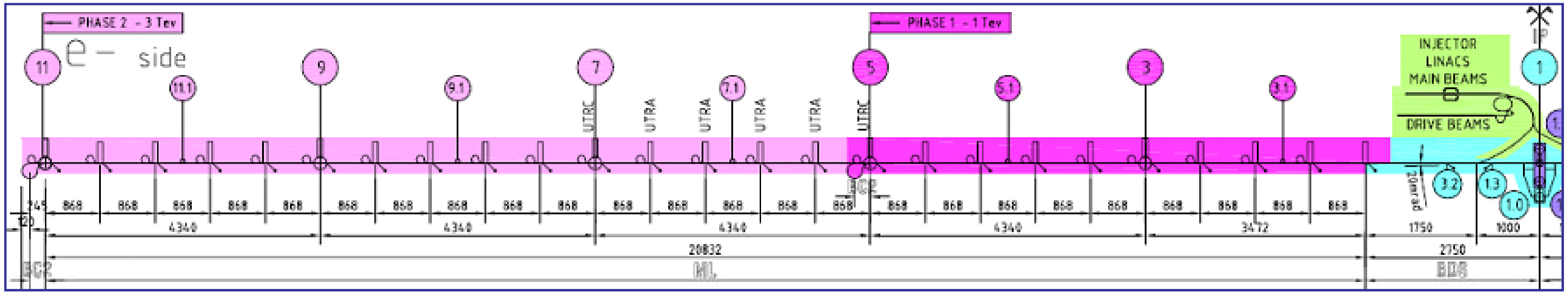
Unique inlet/outlet point close to IP





● Baseline configuration

Cooling layout



Baseline configuration

Flow / Linac: 3490 m^^{3}/hr

Flow / Module: 340 m^^{3}/hr

$\Delta T_{linac} = \Delta T_{module} = 17.5$ K

$\Delta T_{AS} = 10.2$ K

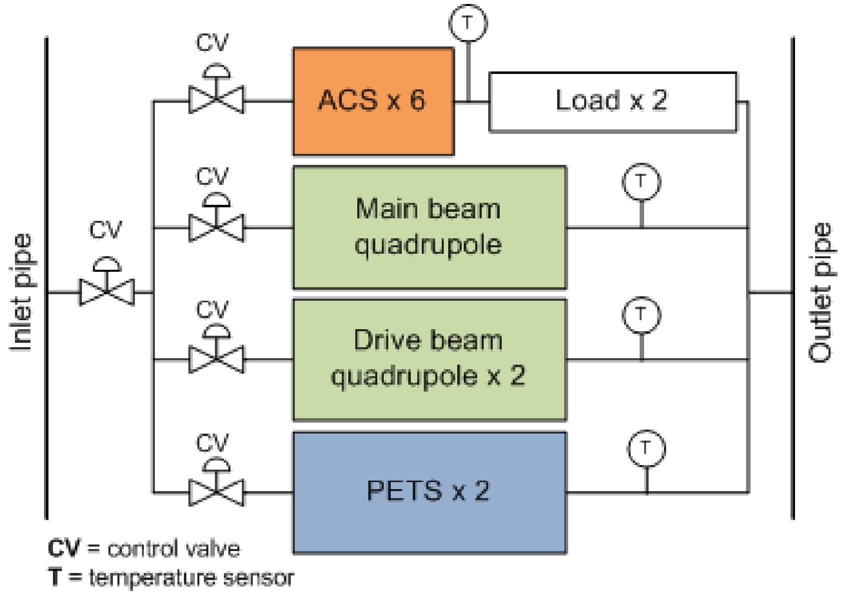
$\Delta T_{PETS} = 10.2$ K

$\Delta T_{DB\_Q} = 10.2$ K

$\Delta T_{Load} = 8.9$ K

$\Delta T_{MB\_Q} = 6.3$ K

$T_{In} = 25$ ºC



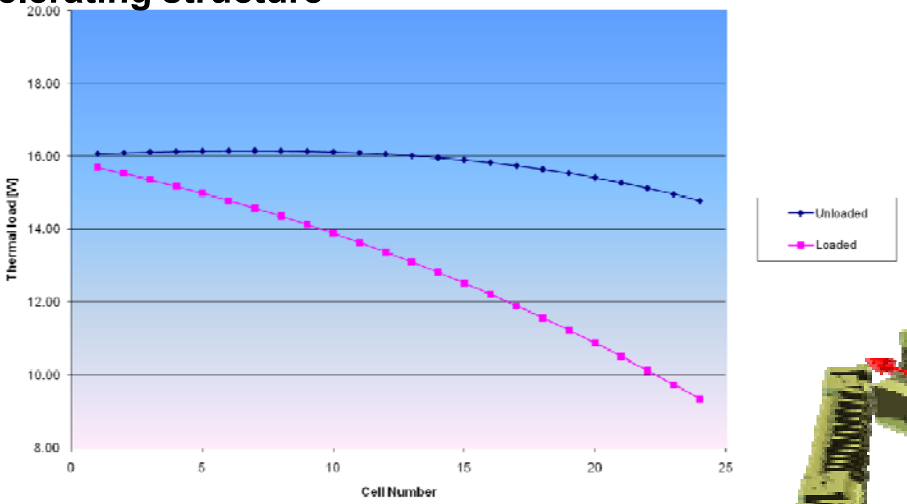
Cooling specification

- AS **EDMS 964717**
  - Is well advanced

<u>Some key points:</u>

- – Sustain alignment of few microns
- – Design the operation temperature in parallel to RF-design
- – Consider unloaded condition and loaded condition
- – Consider RF-power variation in AS

Thermal cell-by-cell dissipation distribution in an accelerating structure

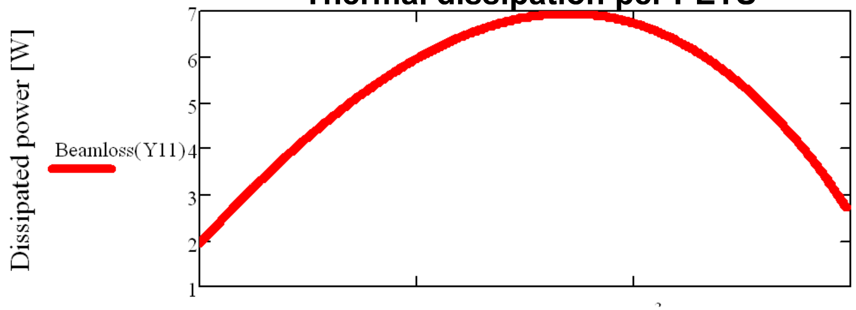


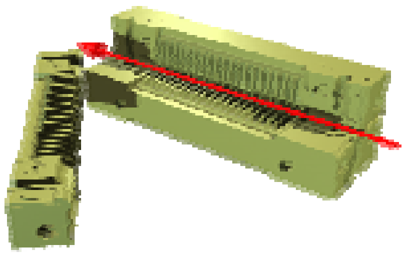
- PETS **EDMS 964715**
  - Is well advanced

<u>Some key points:</u>

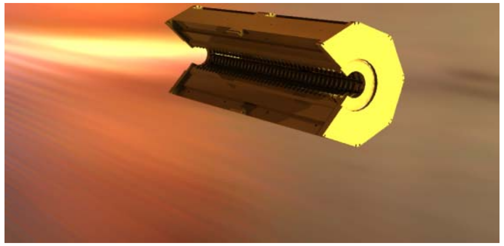
- – Sustain alignment of ~20 microns
- – Consider steady state beam losses (0.5 %) and surface currents
- – Consider higher beam losses
- – Consider bar to bar losses in one PETS

Thermal dissipation per PETS





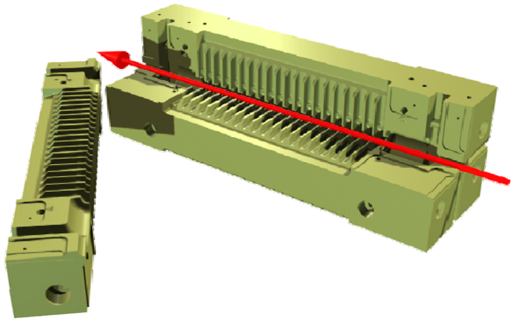
Over DB sector

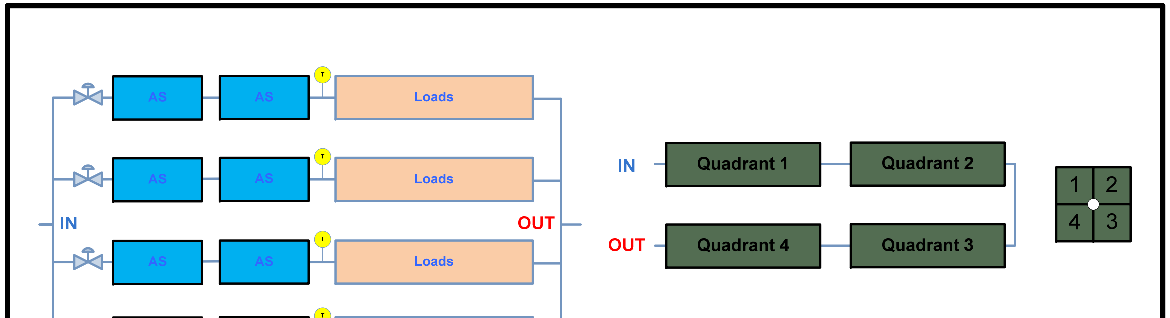


Nb. Thanks to R. Zennaro, A. Grudiev and I. Syratchev for their contribution

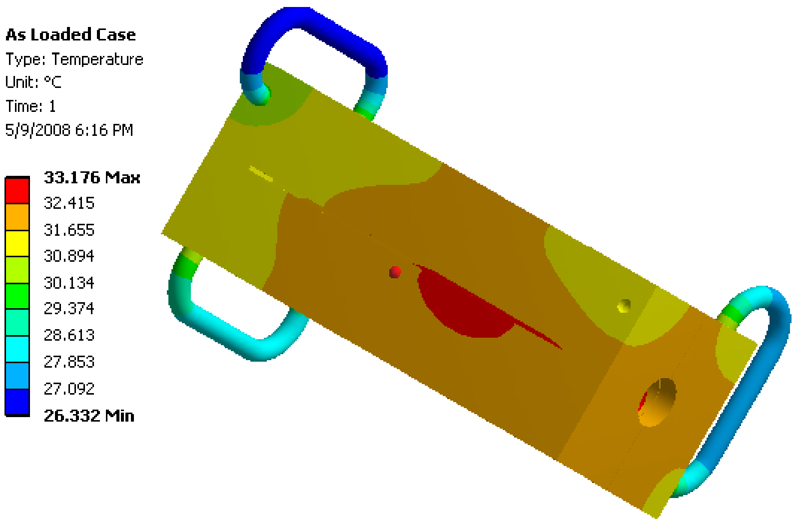
Good basis to start more detailed design!

First results for AS Cooling





Baseline of the routing



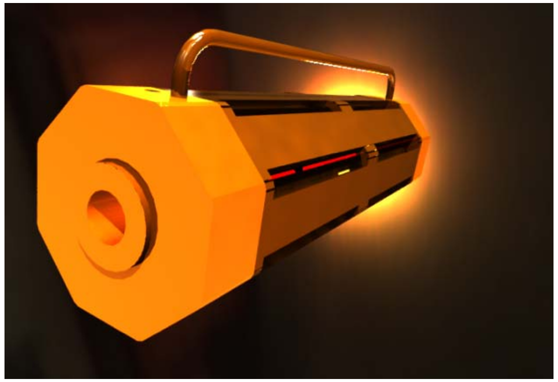
CFD – analysis

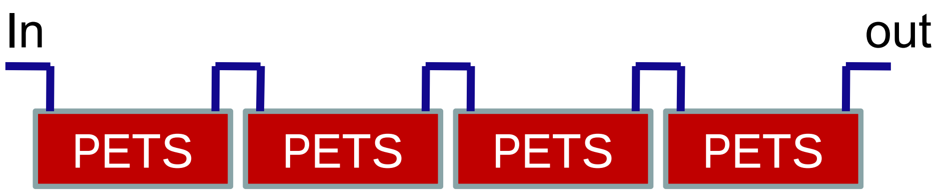
Cell to Cell power dissipations
P_{in} = 412 W (nominal power)

ΔT_{AS} = 6.8 K
ΔT_{Water} = 5 K (by definition with requirements)

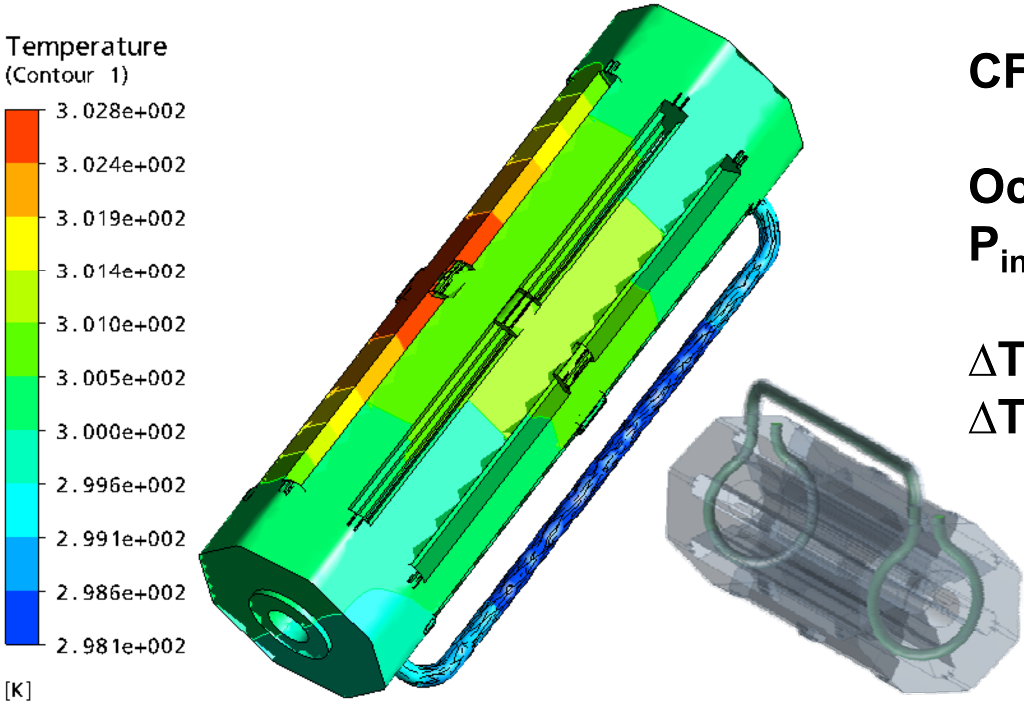
Total ΔT_{Water} = 10 K

First results for PETS Cooling





Baseline of the routing

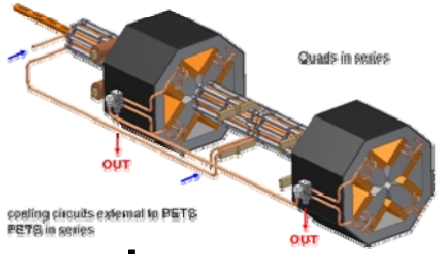


CFD – analysis

Octant to octant power dissipations
P_{in} = 39 W (safety is 2 for beam loss)

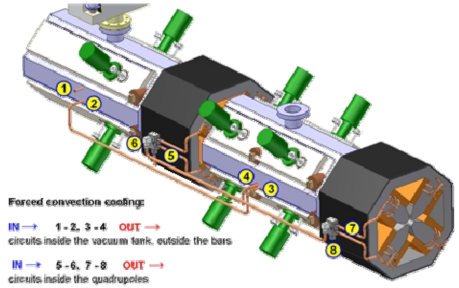
ΔT_{PETS} = 4.7 K
ΔT_{Water} = 0.9 K (by definition with requirements)

Challenges



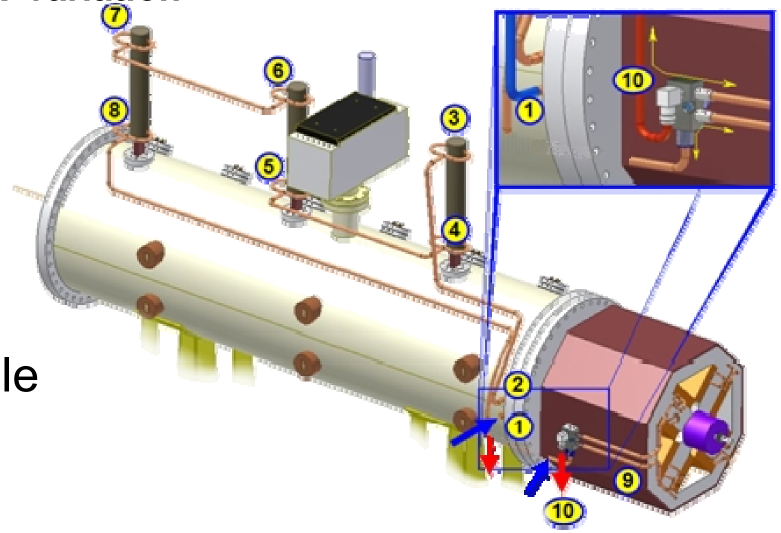
Cooling design that sustains alignment

Thermal stability — Performance is strongly coupled with temperature



Thermal effects

- **Predictable: operational temperature, longitudinal elongation, transverse elongation**
- **Unpredictable: water temperature instability, RF power variation**



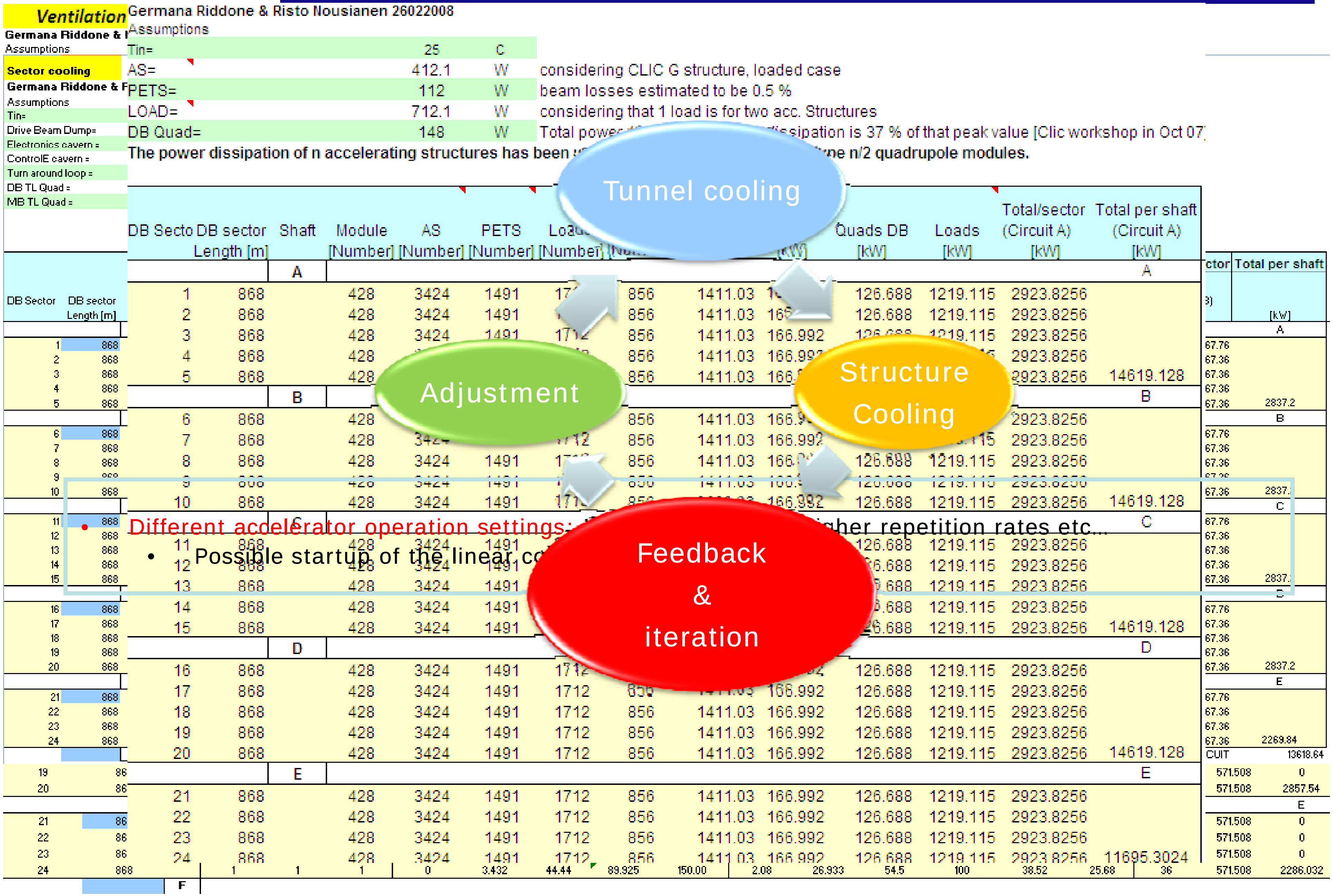
Big overall dissipation

System Integration

Risk of high pressure drops through a module

Risto Nousiainen,
16.10.2008

“Bigger picture”



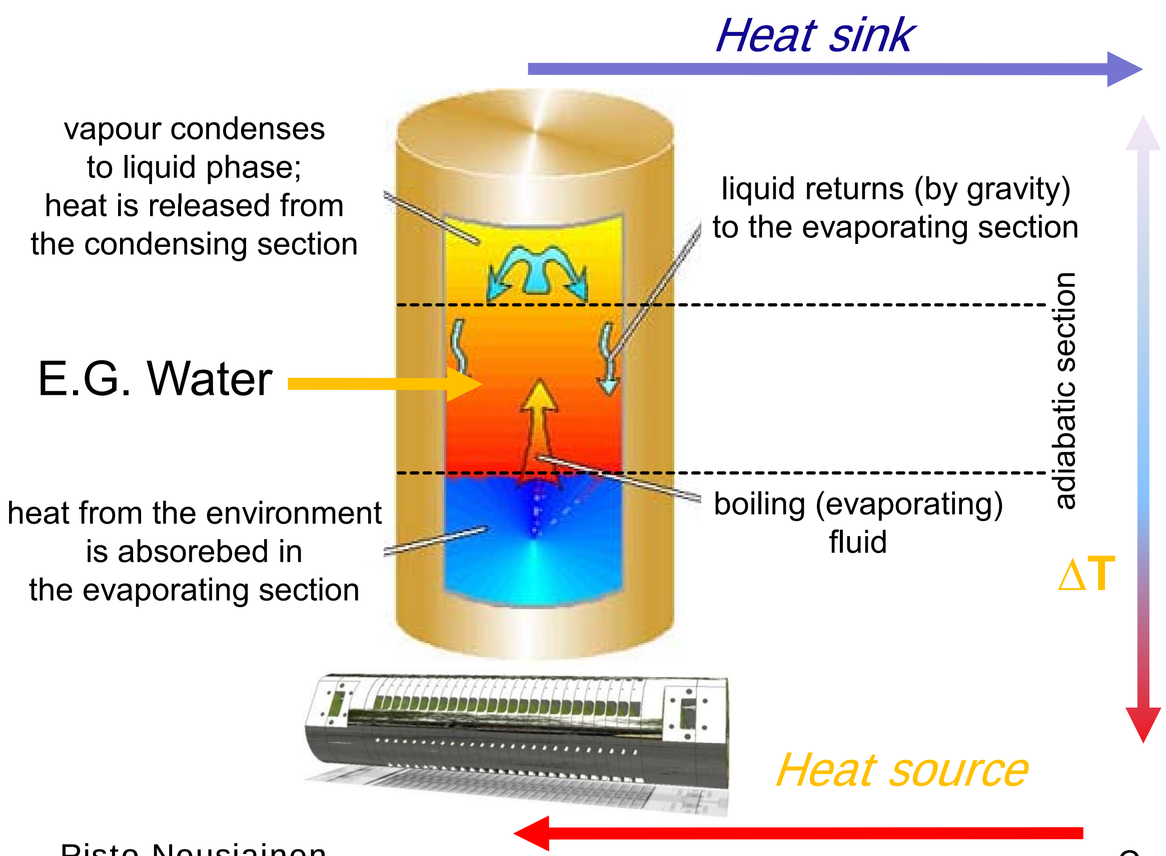
Collaborations

Wroclaw University of Technology (WUT)

- Proposition of WUT cryogenic and refrigeration group for structure cooling

HEAT PIPE CONCEPT

The concept of a heat pipe is explained in Figure 1. A heat pipe is a simple device that can quickly transfer heat from one point to another. It is often referred to as a "superconductor" of heat as it possesses an extraordinary heat transfer capacity & rate with almost no heat losses (quasi isothermal process).



In a nutshell: Pressure controlled vessel that is adjusted to work on certain temperature, intensity of medium evaporation is a function of heat input

-Stabile temperature!

Advantages:

Self control,

Minimum vibrations – no flow

Simplicity

Safety

Conclusions and Future work

- Means to start detailed structure cooling design are available
- Well defined subtasks for collaborators
- Previous study:
  - Thermal dissipations of linac:
    - Modules
    - General components
    - Ventilation requirements
- Future work
  - 2nd iteration for the dissipations of the overall cooling system
  - Detailed design of component cooling

Thank you!