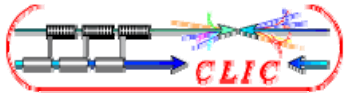
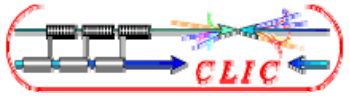


CLIC workshop ”Two beam hardware and integration” working group

Main requirement for module cooling

Risto Nousiainen

17.10.2007



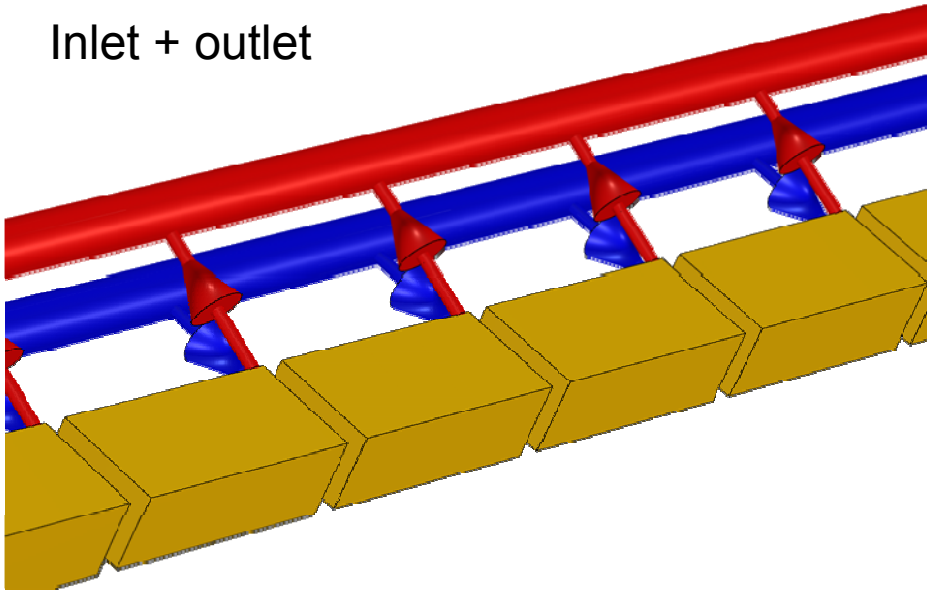
Introduction

- Baseline for the cooling
- Main components
- Boundaries / objectives for cooling
- Possible layouts for module cooling
- Cooling concepts for accelerating structure
- Discussion
- Future work

Baseline

- 10275 modules in a one linac
- Modules cooled in parallel
- One cooling sector 4.8 km
- Water cooling

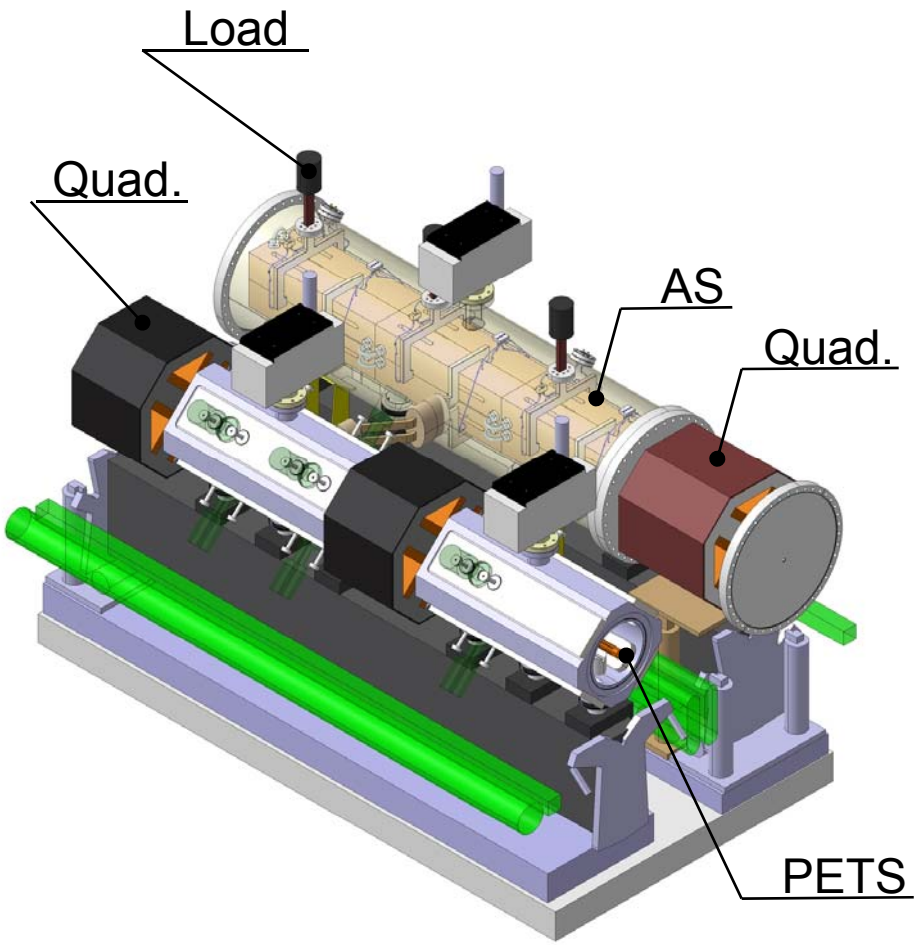
Inlet + outlet



Modules

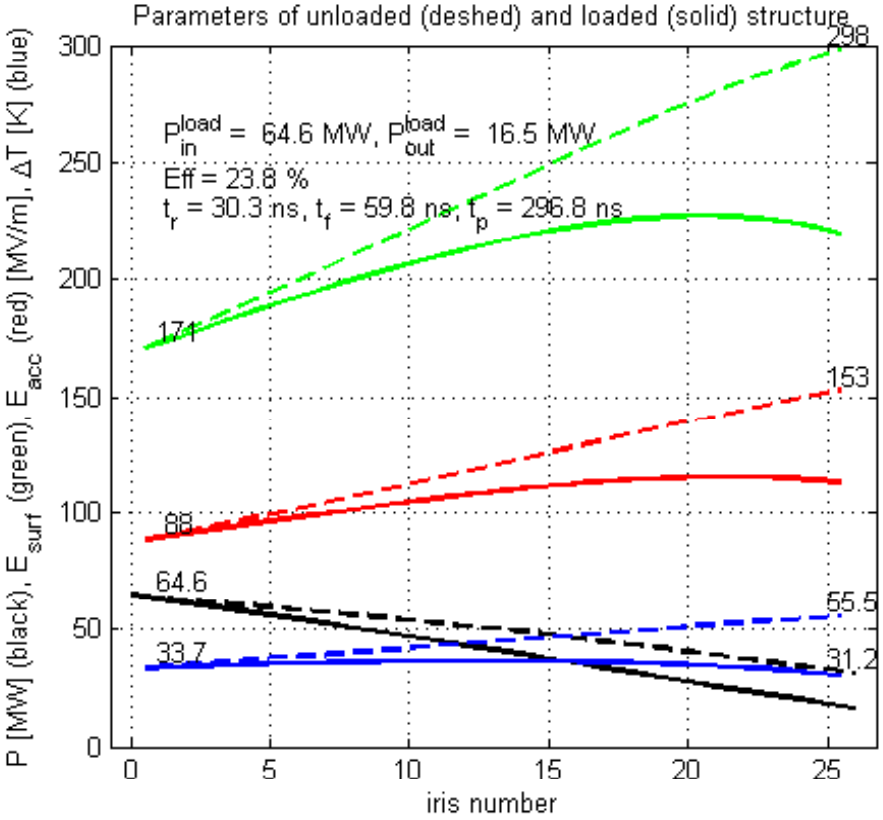
Main components

- Order of magnitudes:
- Thermal load of a one structure
  - AS ~ 550 W
  - PETS ~ 110 W
- Thermal load of a standard module
  - ~ 7.7 kW
- Thermally sensitive components:
  - AS
  - (PETS)
- Conventional cooling:
  - Loads
  - Quadrupoles



Boundaries / objectives

- Tight alignment tolerances
  - Micron level requirement for AS
- Tight thermal requirements
  - +/- 0.1 K (1σ) stability
- Beam energy levels
  - From 0.5 TeV to 3 TeV
  - Affects on thermal load
- Loaded and Unloaded case
  - Different thermal load



Cooling induced effects

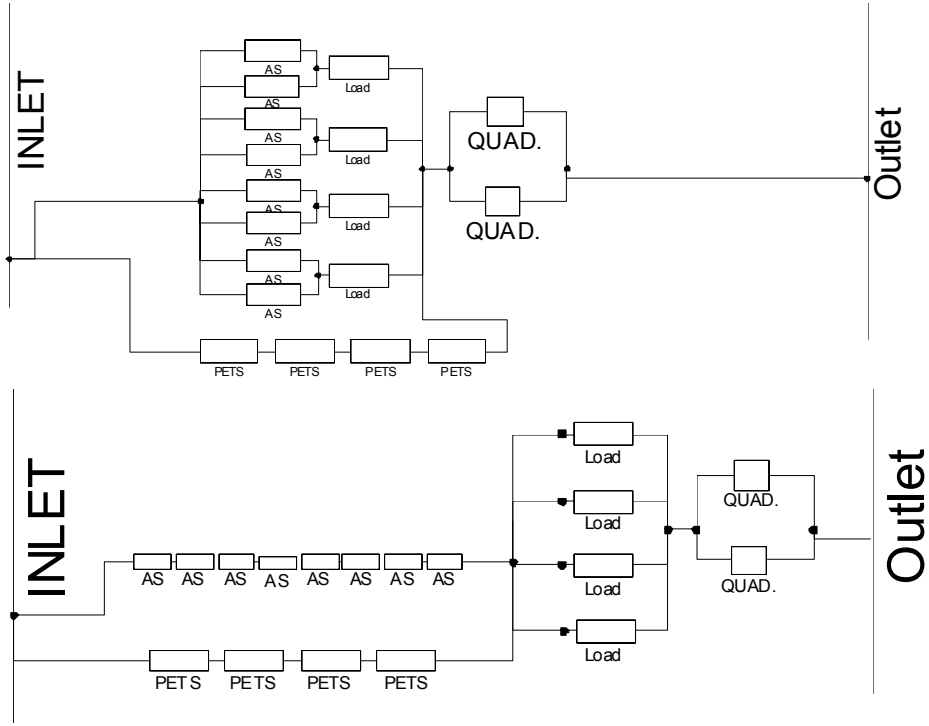
- Thermal:
  - Alignment errors due to thermal expansion
    - Static → **Predictable: operational temperature, longitudinal elongation, transverse elongation**
    - Dynamic → **Unpredictable: water temperature instability, RF power variation**
  - Temperature dependent RF behavior
    - Phase error (mainly for AS)
- Mechanical
  - Fluid induced vibrations

Layouts for module cooling

Configuration	-	+	$V_{flow\ module}$	$V_{flow\ sector}$
AS Parallel	Additional volumetric flow	Thermal stability Temperature gradient	3 m^3/hr	7500 m^3/hr
AS Series	8 different structures Thermal stability	Smal volumetric flow High ΔT of water	0,5 m^3/hr	1200 m^3/hr

- Two extreme cases
- Other options:
  - Two AS in series

ΔT over one AS 1.5 K

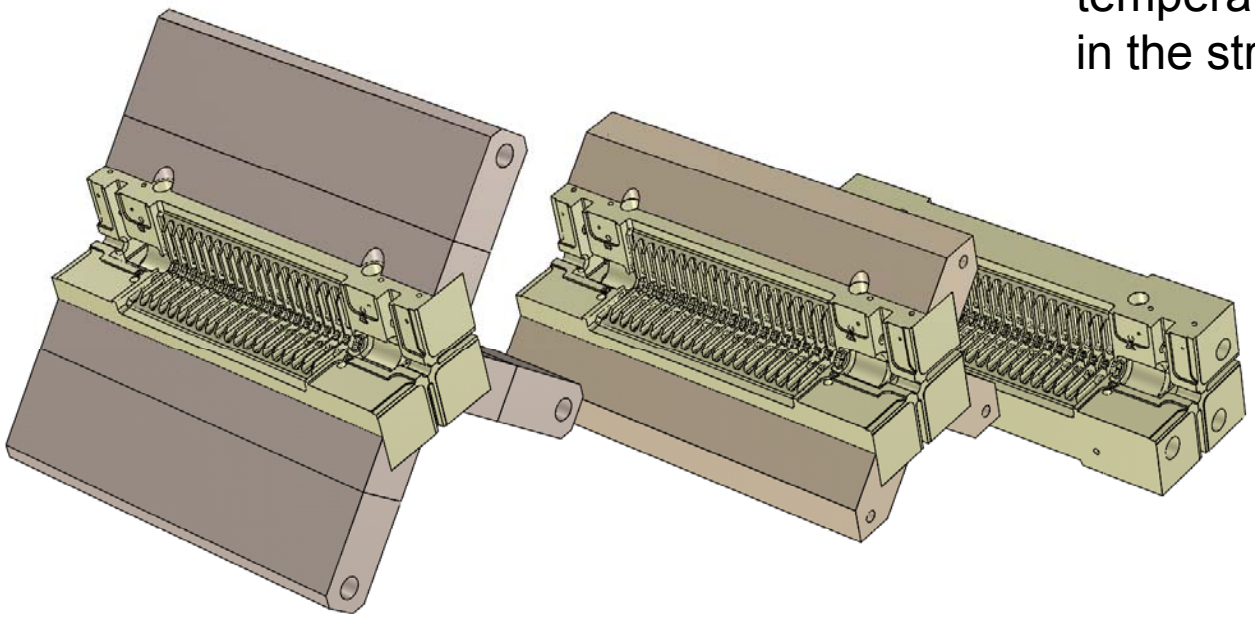


NB: For a standard module.

Cooling concepts for AS

1. Convection cooling
2. Conduction cooling

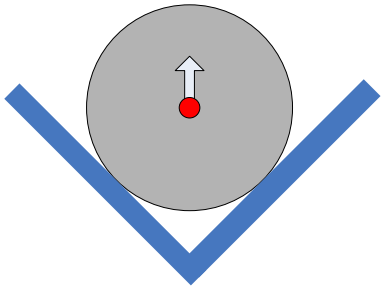
Objective: Minimize the temperature gradient in the structure



2 2 1

Discussion

- Main issues:
  - 1. Tolerances
    - Static
    - Dynamic
  - 2. Vibrations
    - Water induced
    - Balance between sufficient cooling and acceptable flow parameters
  - 3. Temperature stabilization
  - 4. Volumetric flow



1 Kelvin causes an misalignment of 7 microns with the current support

Future work

- Previous study:
  - Water induced Quadrupole vibrations
- Future work
  - How to compensate dynamic effects?
  - How to predict water induced vibrations?
  - System design for cooling