CLIC Module Acquisition and Control

A Brief Summary of the controls challenges and milestones

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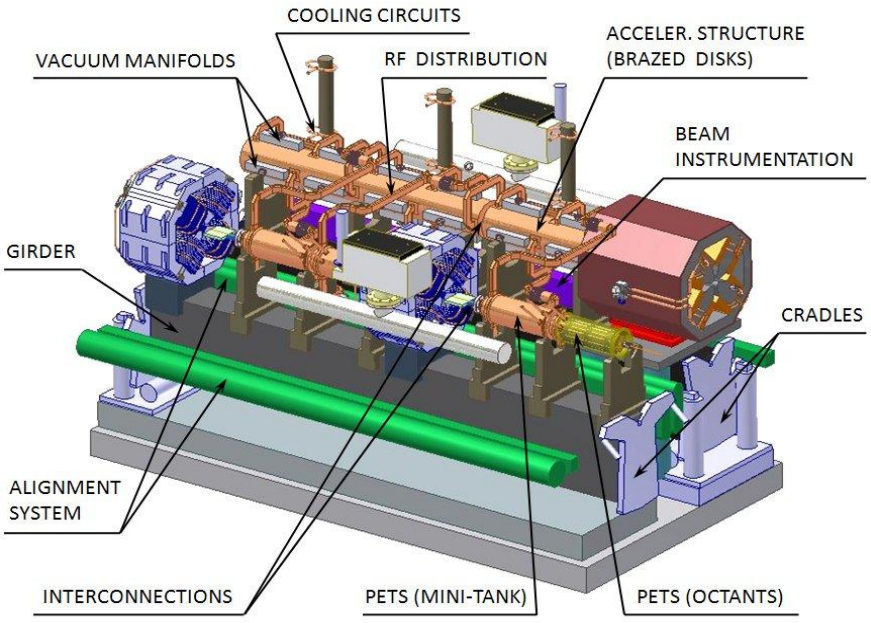
AGENDA

- What are the NEW Challenges?
- Key Requirements and Constraints
- Basic Concepts
- Current Status and Outlook
- Conclusions



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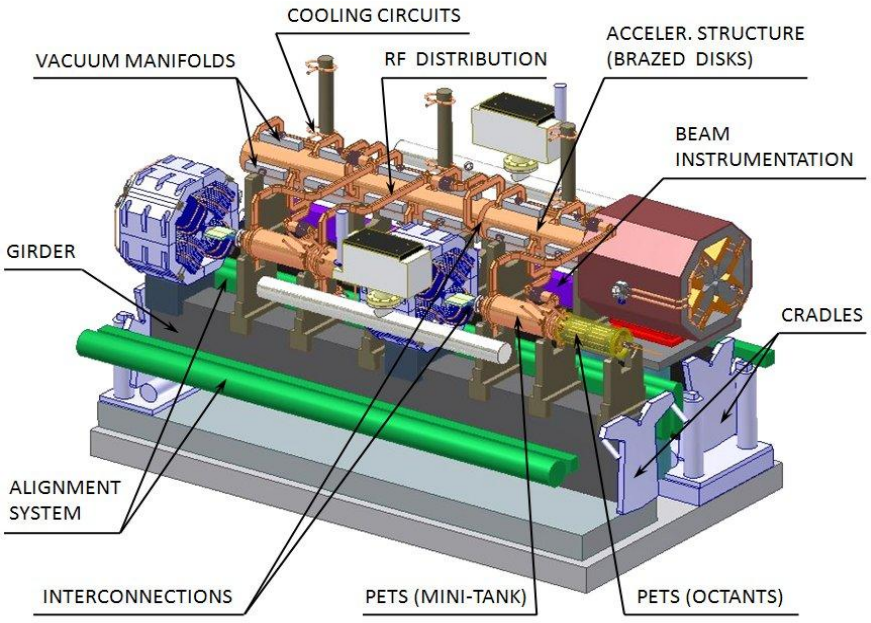
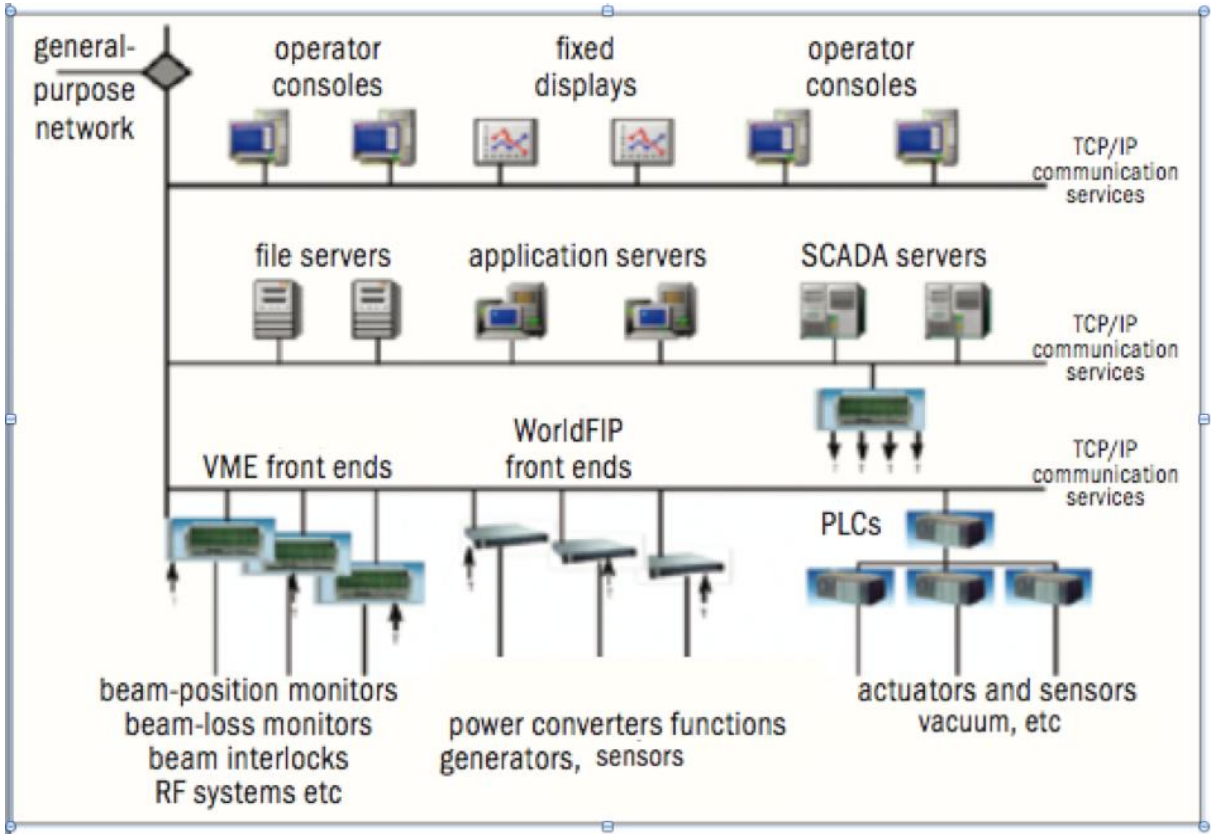


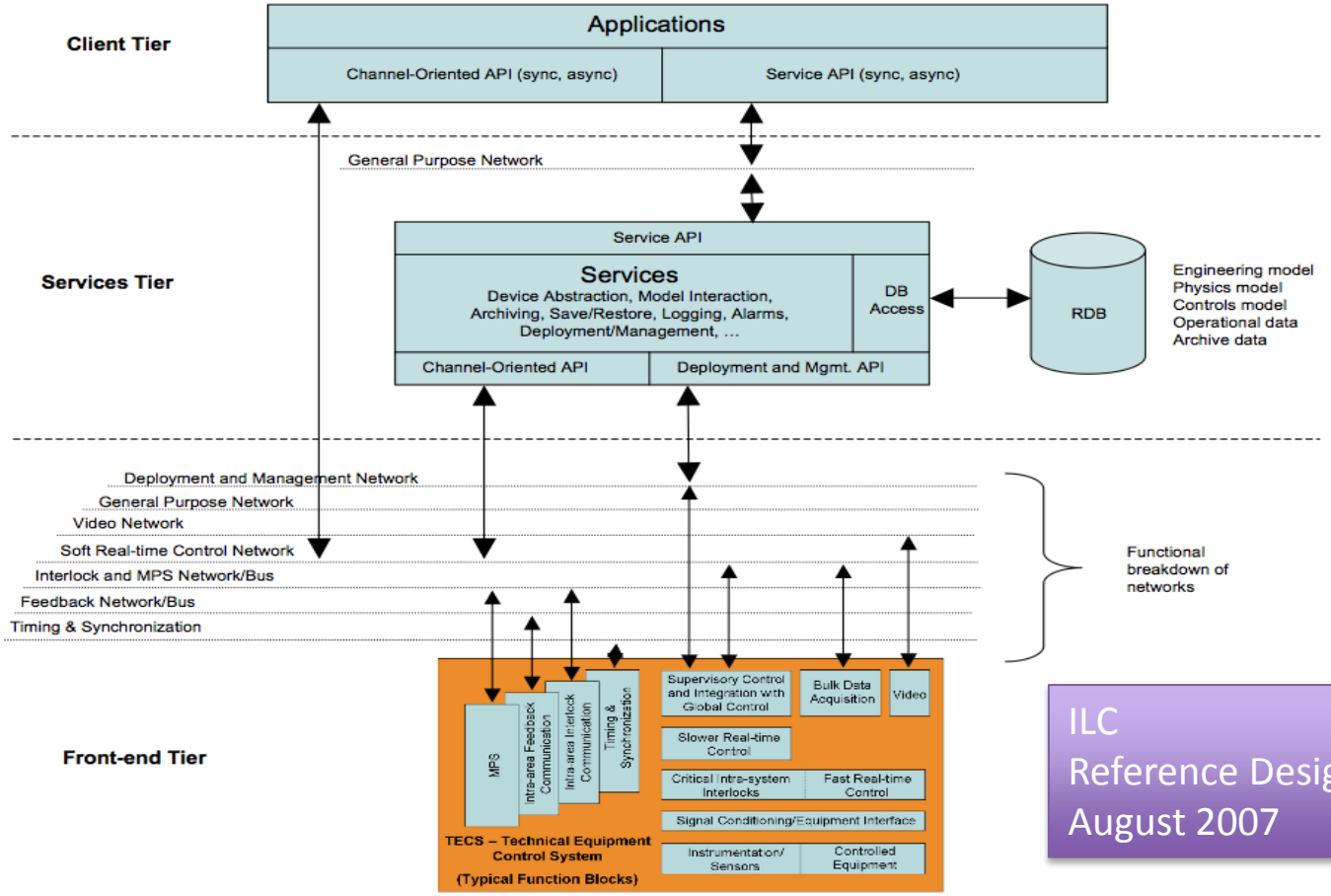
What are the NEW Challenges?

- 3-Tier Accelerator Control System Model - LHC



What are the NEW Challenges?

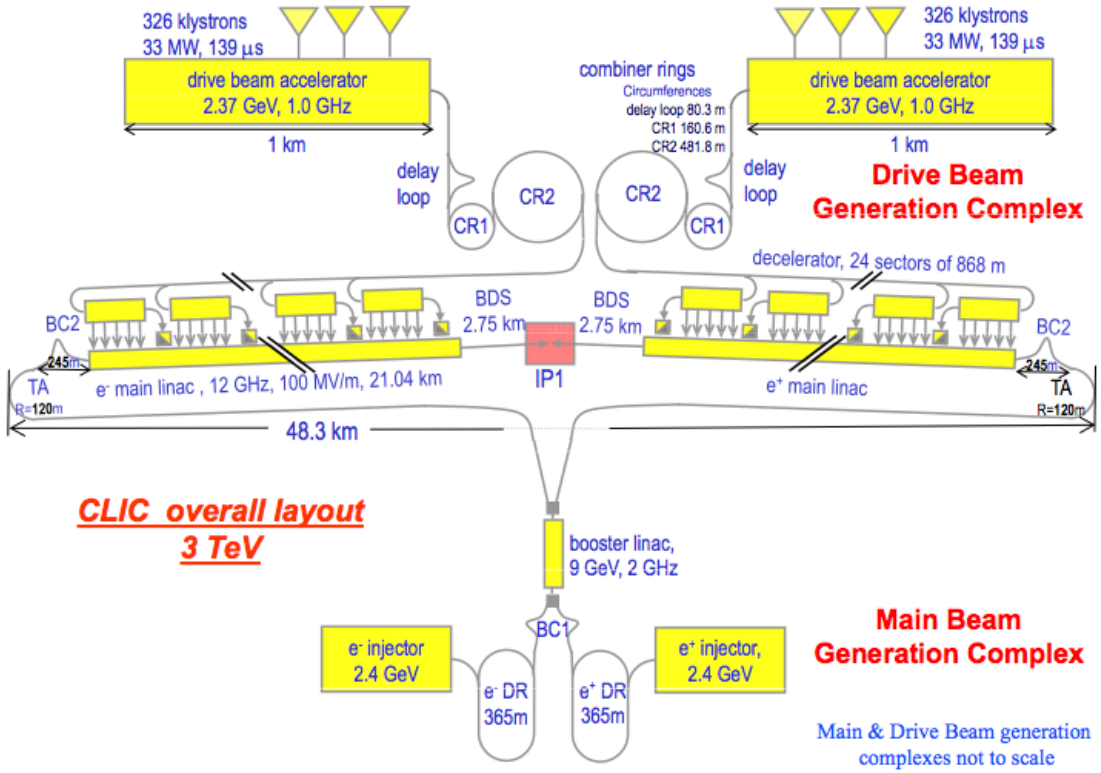
- 3-Tier Accelerator Control System Model - ILC



ILC
Reference Design Report
August 2007

What are the NEW Challenges?

- Does the 3-Tier model fit with the CLIC Architecture?

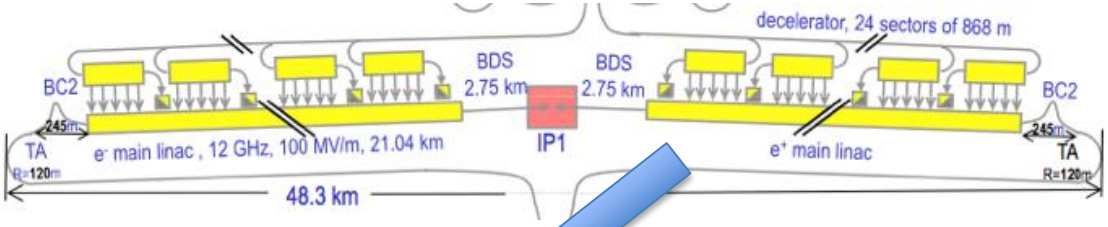


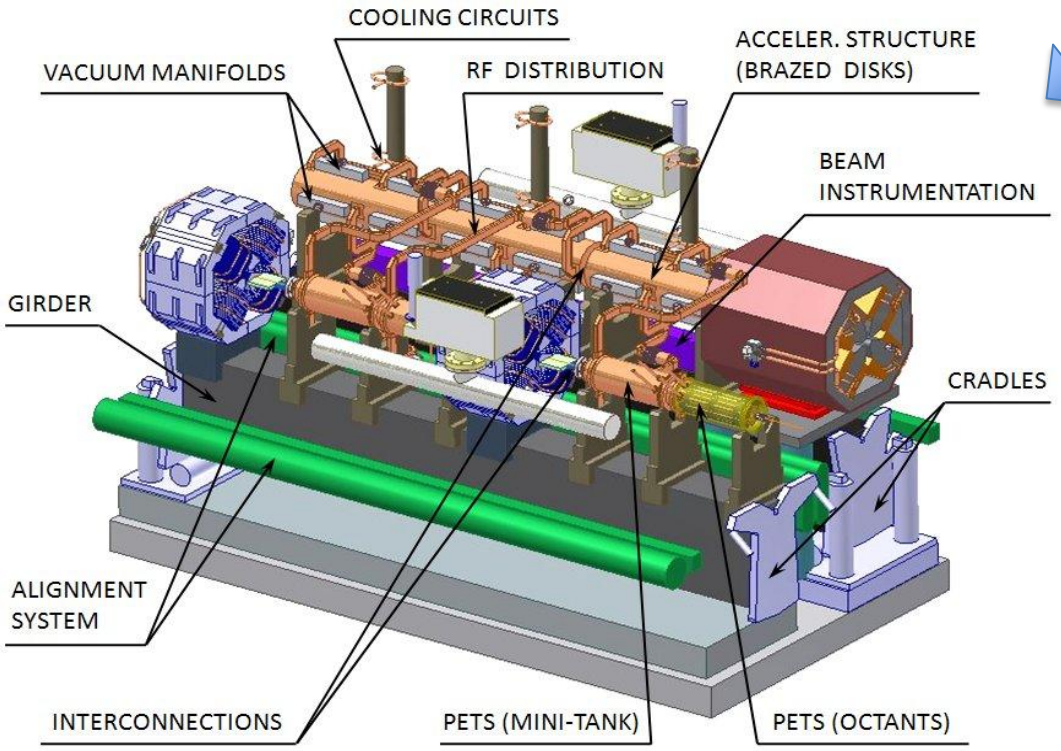
Courtesy H.Schmickler

YES but … Main Linac structure raises new challenges for the Front-End Tier

What are the NEW Challenges?

- CLIC Main Linacs





More than 20.000 “Modules”

Courtesy
H.Schmickler

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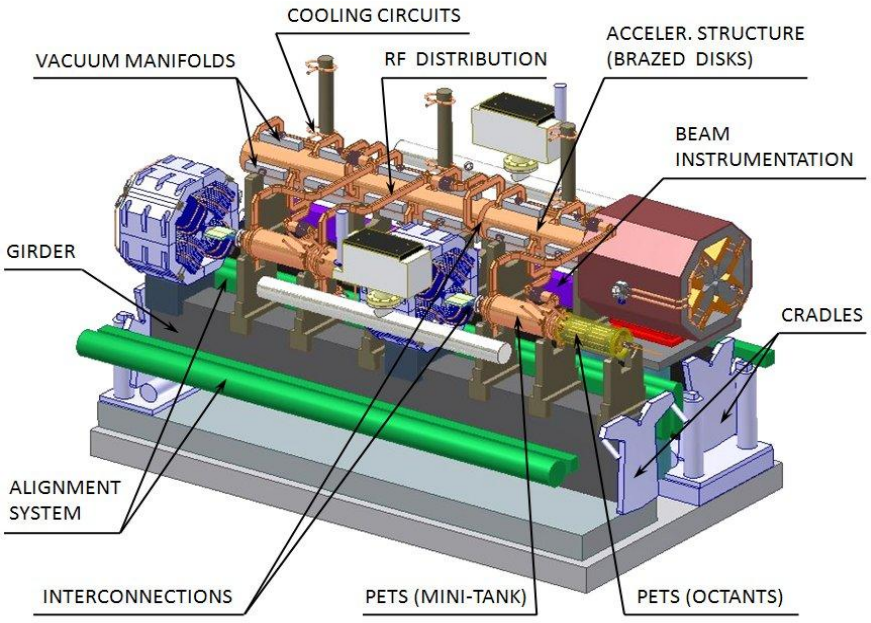


Key Requirements and Constraints

- CLIC MODULE Signals
  - +/- 200 signals per MODULE
  - Fast Wakefield monitors, DC temperature sensors, flow meters, etc
  - Need for Real-Time feedback loops (Beam trajectory, …)
  - Acquisitions and Controls Synchronized with Machine Timing System

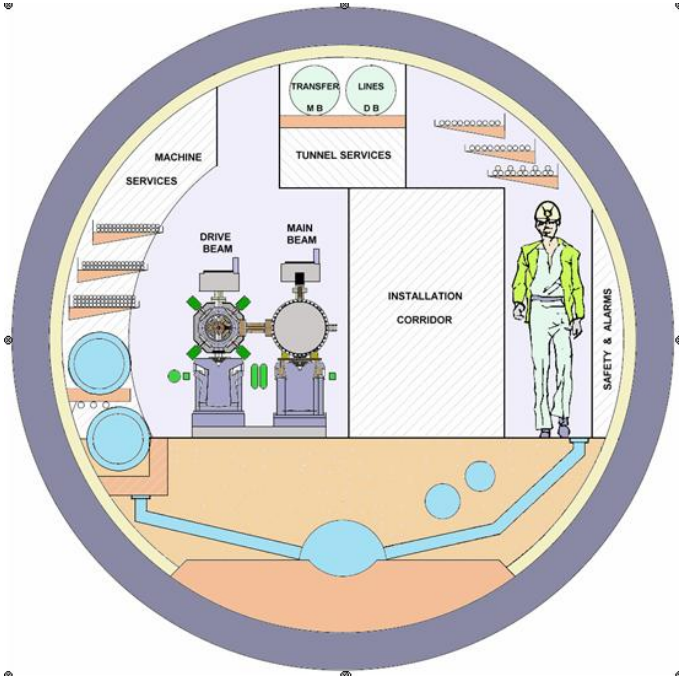
	Number of signals	Signal frequency	Sampling frequency	Resolution	Frequency of readout
Beam instrumentation	17	50MHz	100MS	16 bit	50Hz
RF instrumentation	8	50MHz	100MS	8 bit	50Hz
Cooling	72	DC	1kS	4 bit	0.1-1Hz
Alignment	35	10-100Hz	1kS	24 bit	1Hz
Stabilisation	89	1kHz	10kS	18 bit	1kHz
Vacuum	12	10-100Hz	?		1Hz
Power	4	100Hz	1kS	18 bit	100Hz

Courtesy L.Soby, CERN

Key Requirements and Constraints

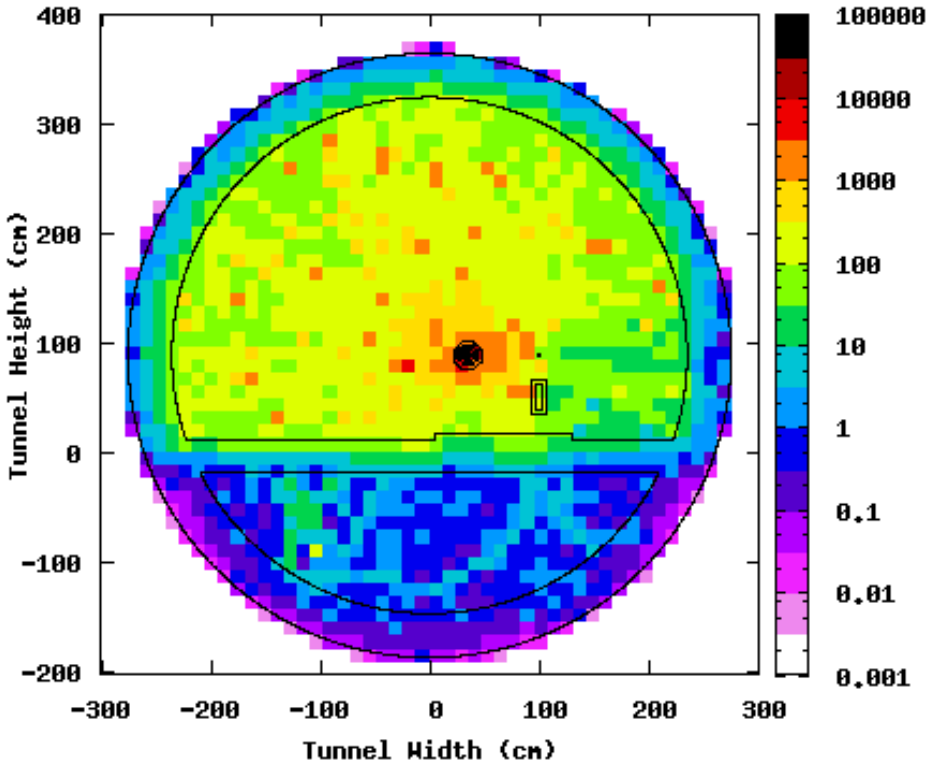
- Tunnel Space Constraints
  - Remote installation of the Low Level Front-end electronics is not possible (space and cabling issues)

- Limited Power dissipation
  - Total power dissipation to air = 150 W/meter
  - Power budget for all Front-End electronics in the order of MAX 30 to 50 W/meter



Key Requirements and Constraints

- Radiation Aspects
  - Average absorbed dose in main Tunnel @ 1.5 TeV : 1KGy/year



High

Medium

Low

Courtesy
S.Mallows, T.Otto

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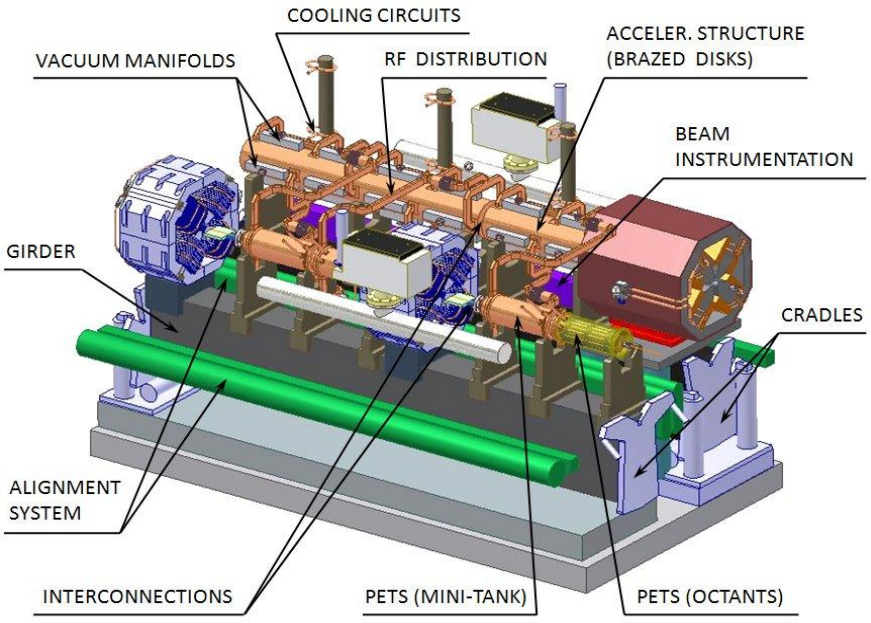

Basic Concepts

- Traditional Front-end Tier approach will not scale (1/2)
  - Usage of **heterogeneous solutions** (PLCs, VMEBus, PICMG 1.3, etc) for the Front-End Tier **will NOT be possible** anymore due to space and power consumption constraints
  - Need to **federate** the acquisition and controls requirements for all MODULE sub-systems (RF, Beam instrumentation, vacuum, etc)
  - Need for an **open and modular architecture**
    - offering the basic (pulsed) powering, communication and synchronization features common to all systems
    - Allowing the plug-in of system specific front-end electronics (ADCs, DACs, etc)

Basic Concepts

- Traditional Front-end Tier approach will not scale (2/2)
  - Front-end Tier split in **2 parts**:

Front-End Task	Location
Synchronized low level acquisition and control of equipment (DACs, ADCs, sensors and actuators)	Main Linac Tunnel
Real-time Software Framework, data processing and communication with Services Tier (middleware, archiving, etc)	Surface Buildings

  - **Fast data link between tunnel and surface** Tiers
    - Acquisitions, control and feedback loops synchronized with Machine pulse
    - Configuration and diagnostic commands

Basic Concepts

- Power Consumption and Radiation
  - Front-end electronics design must be **rationalized** whenever possible (common power supplies)
  - CLIC will be pulsed @ 50 Hz
    - Front-end electronics will be **switched off** between two consecutive pulses (driven by Machine Timing System)
  - Radiation-hard design and shielding required to avoid single-event upsets and latch-ups (expected life-time of 15 years for the front-end electronics)

Basic Concepts

- The absolute Need for Quality Assurance
  - We talk about another scale factor …
    - CERN Accelerator Control System = **1200** Front-end embedded systems, LHC included
    - CLIC Main Linac only (48km long) = **22.000** Front-end embedded systems
  - State-of-the art procedures shall be used during the design phase in order to
    - Accommodate with the evolution of the requirements and constraints
    - Decouple requirements from design and technology evolution
    - Validate the radiation-hard design
    - Provide stable and documented baseline for the mass production
      - > 22.000 items
      - 15 years life-time (operations and maintenance)
  - Asset Management will be mandatory for maintaining infrastructure under operational conditions
    - Components life-cycle, serial numbers, repairs, etc

Basic Concepts

- Remote Configuration and Diagnostics
  - Efficient operation and high availability of more than 22.000 front-end systems will require full remote capabilities such as:
    - Possibility to upgrade any “configurable” part of the system remotely
    - Possibility to automatically monitor the Real-Time status of each module (power supply failure, ADC failure, temperature drifts, …)
    - Possibility, if needed, to run the CLIC module in degraded mode

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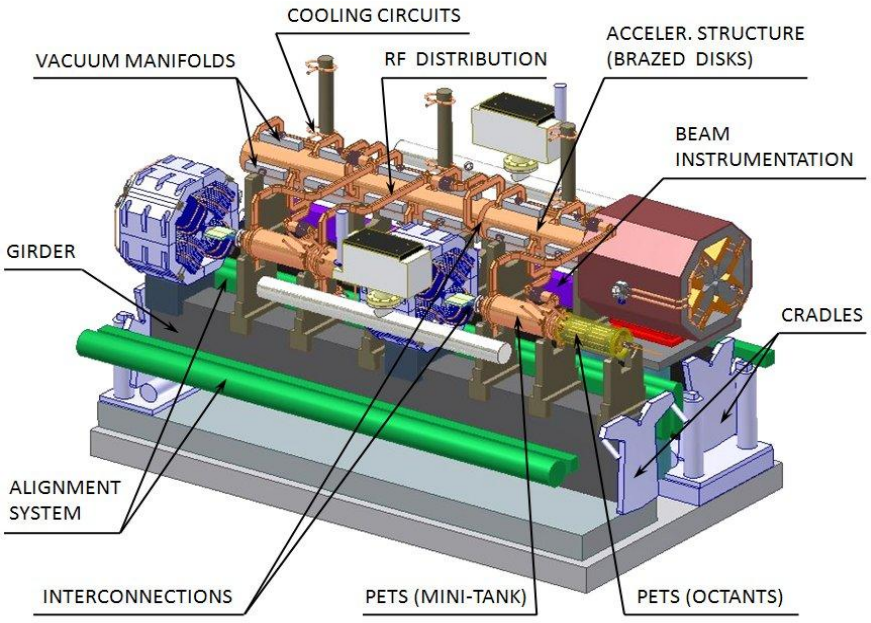

Current Status and Outlook

- Build agreement on the key requirements and constraints (CDR due October 2010)
- Launch In-house prototyping work
  - Development in collaboration with LAPP (Annecy-France) and BE-BI group under the steering of the BE-CO-FE unit
  - First prototype (subset) in 2012 for installation on CTF3
- In parallel, off-the-shelf procurement by one of the major market leaders in embedded systems - steered by EN-ICE-MTA unit
- Formal design proposal by end 2013

Conclusions

- The **classical 3-Tier control system architecture** (CERN, ILC) can address most of CLIC controls requirements
- Several **new constraints** apply to the design of the Front-end Tier for the main LINAC (space, power consumption, radiation)
- All key requirements and constraints will be described in the **CLIC CDR**
- Home-made prototyping work (CERN, LAPP) and collaborations with industry have started and will lead to a **formal design** proposal by **end 2013**
- The cost, volume and complexity of the CLIC front-end tier electronics imposes the usage of **strict Quality Assurance principles** for the specification, design, production and maintenance of all components