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MYRRHA

Beam Diagnostics for ADS

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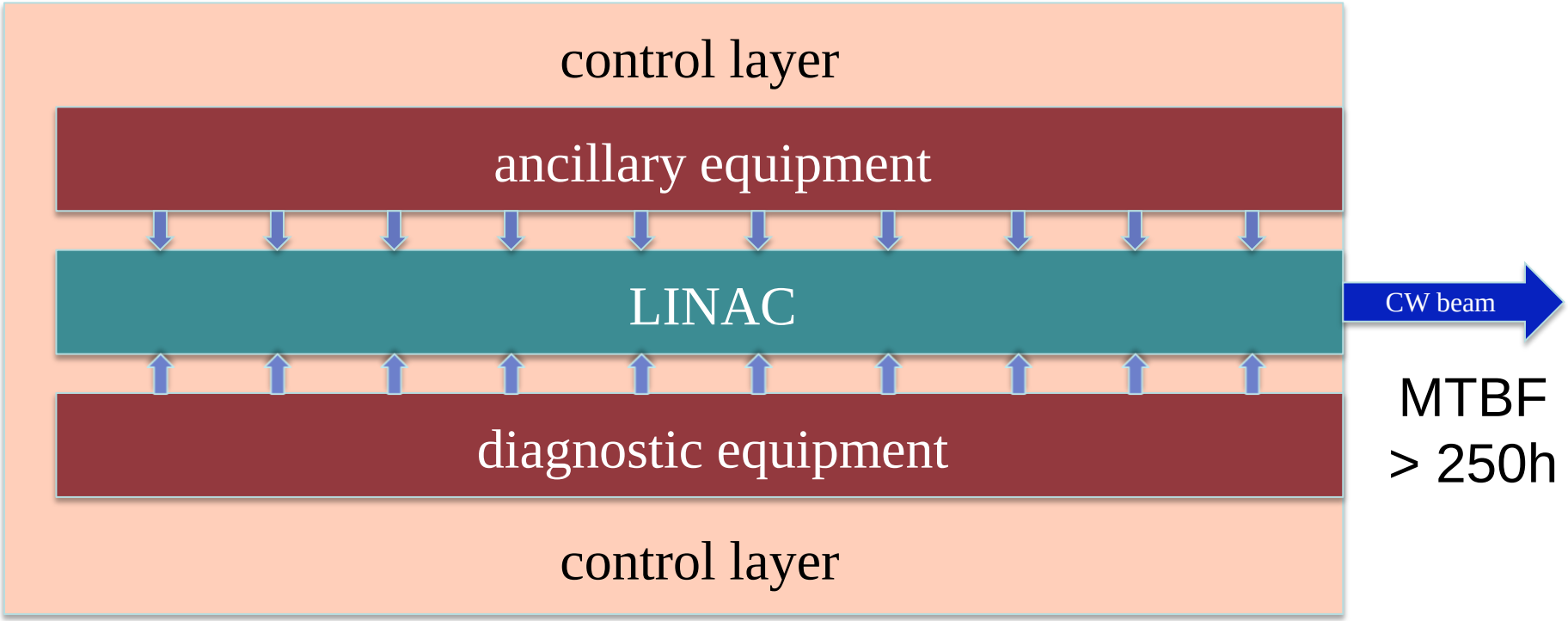
Introduction: framework

MAX
MYRRHA Accelerator eXperiment
Research & development programme

- Accelerator for ADS:
  - modest in terms of beam energy and current performances
  - challenging for CW and beam-MTBF
- practical exploitation of a *real* machine:
  - ancillary equipment
  - diagnostic equipment
  - control system

framework


control layer
ancillary equipment
LINAC
CW beam
diagnostic equipment
control layer
MTBF
> 250h

framework: present

system	subsystem	design study	realization
ancillary	classic	FEED	industry
	cryo	ACS [MAX]	industry
	RF	Thales [MAX]	industry
controls	LL slow	-	PLC-based
	LL fast, RT	Cosylab +	tbd
	HL, integration	Cosylab	industry
diagnostics	beam	acc. team	-
	others	acc. team	-

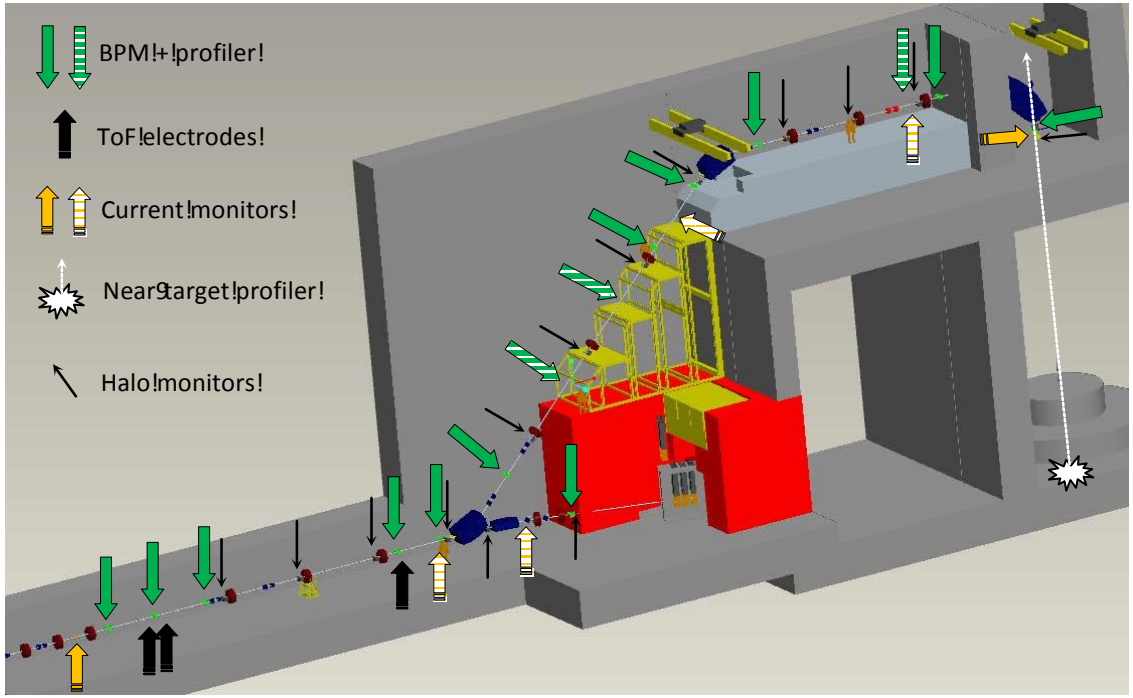
grey: small scale studies only

acknowledged issues:

- industry standards
- some form of redundancy

Introduction

- The R&D need for new diagnostic devices is very small



see: CDT Deliverable D2.4 "Accelerator design related issues", Chapter 5

- 2 main global questions regarding diagnostics:
  1. consequences of ADS operation
  2. consequences of the reliability goal

Global concepts: ADS operation

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1. Consequences of the ADS operation of the accelerator onto the diagnostic system ?

item	accelerator design issue	diagnostic role	diagnostic system	request, action
HP CW	min. beam loss	Machine Protection	Beam Loss Monitors	µs-level response, shut off
stability	(specifications)	transverse ctrl longitudinal ctrl	BPM bunch length meas.	"slow" feedback "fast" feedback
current	varying duty cycle	requested current on target, averaged at 0.1s level	N/A on target! upstream current meas., beam centering device	"medium" feedback to cycle definition (TS)
energy		constant beam energy	TOF	

Global concepts: reliability

2. Consequences of the accelerator reliability goal onto the diagnostic system ?

mission:

avoid beam trips — fast recovery from beam trips — foresee beam trips

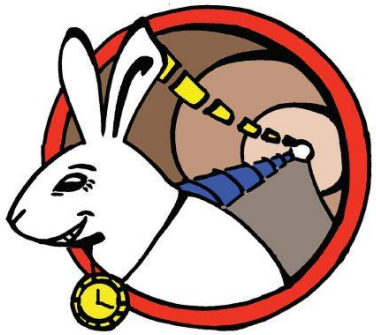
accelerator design issues	role of diagnostic system	request
fault tolerance (redundancy) automatic recovery	fault detection automatic feedback	Confidence
maximize MTTF • all subsystems • all components	(follow the rule)	
minimize MTTR	(follow the rule)	
avoid the occurrence of interlocks • automated tuning • advanced supervision • increase interlock confidence level • evaluate interlock confidence level	high quality analog acquisitions be predictive be highly reliable generate statistics	

reliability

- How ?
  - at level of individual diagnostic device
    - MTTF (obvious)
    - include provisions for
      - self-diagnostics
      - self-evaluation
      - self-calibration
      - self-repair
    - powerful low level controller (FPGA)
  - at the global level of a given diagnostic *system* :
    - make the system overdetermined (redundant)
      - statistics
      - coherence checks
      - numerical confidence level
    - generate enough data for predictive algorithms to be applied
    - powerful high level controller

reliability

- based on :
  - highest quality hardware
  - highest quality timing system (WR to be evaluated)
  - models !!
    - behaviour of individual components
    - global: "virtual accelerator"
  - matched Control System



foreseeable R&D

- R&D issues :
  - availability of experimental platforms is limited
  - presently envisaged in MYRRHA context: IS + LEBT + RFQ
    - not extensive enough for coherence checks with beam induced signals
    - useful for individual devices: MTTF, self-checks
    - high power SS RF amplifier
    - small scale tests on feedback systems (e.g. beam current regulation)
    - small scale tests on "virtual accelerator"
  - conceptual developments
    - global models
    - statistical tools

R&D

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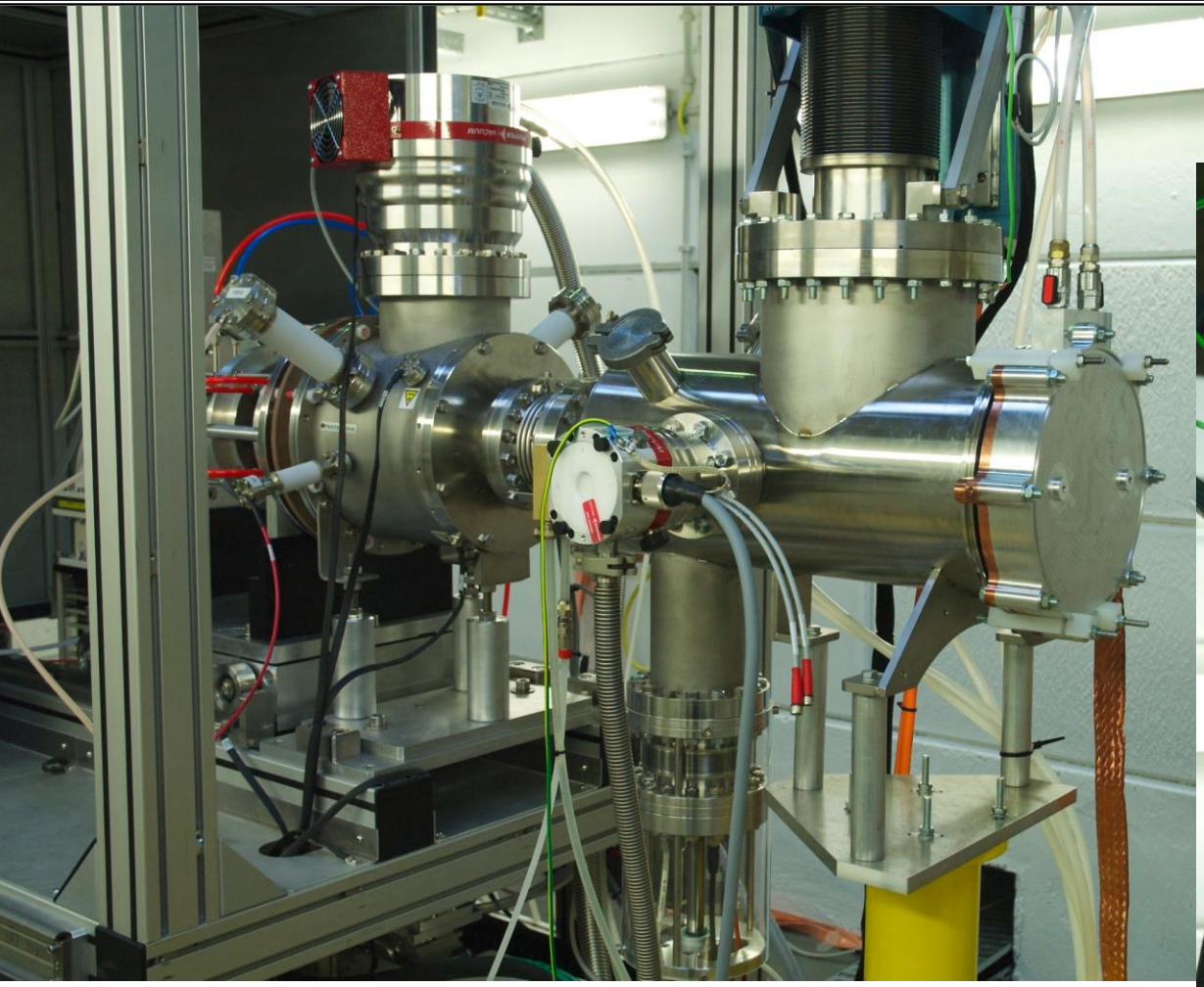

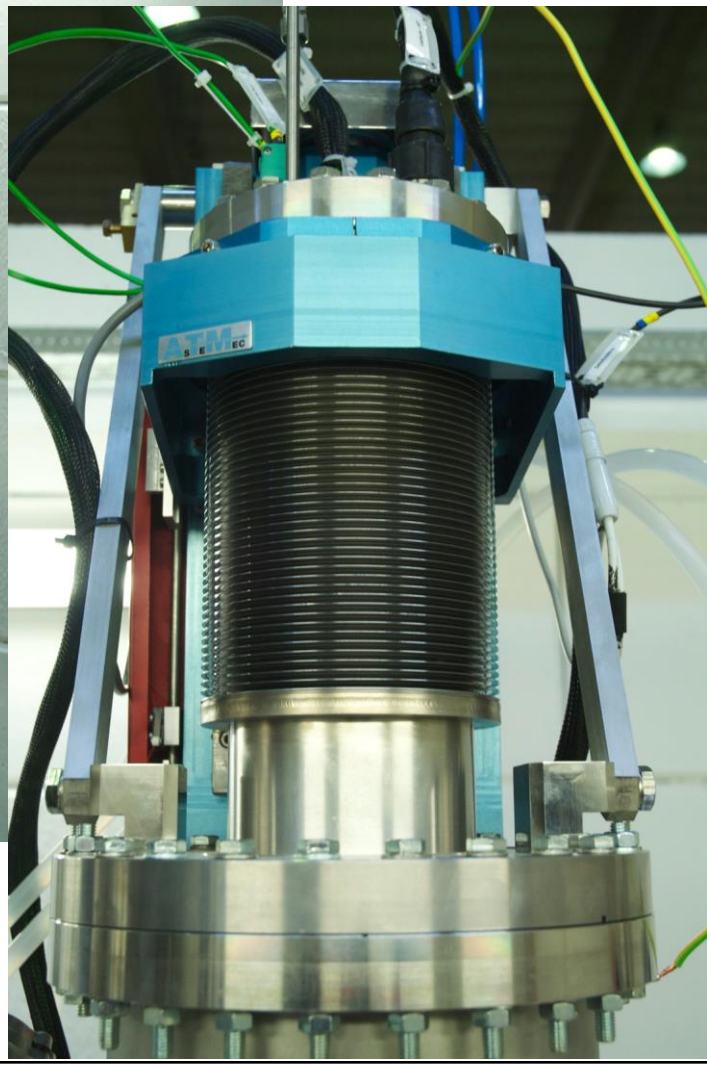

Conclusion and outlook

- ADS: diagnostics are facing contradictory requirements
  - full protection
  - perfect stability
  - 0 false interlocks
- keyword: confidence = reliability + coherence
- border between device and control becomes very fuzzy
- diagnostic system as a whole to go into the reliability model
- main message: it is time to consider the diagnostics within the ADS accelerator R&D program. The subject (or items of it) may be of broader interest and profit from possible synergies with other programs.