Reliability of accelerators for ADS systems

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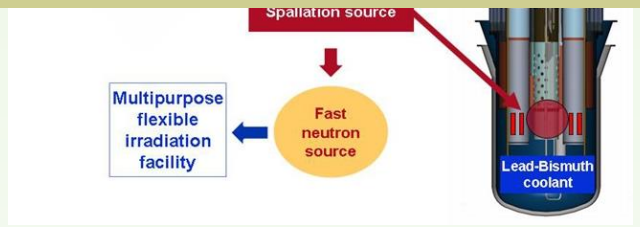
From EuCard2- MAX workshop on Accelerators for Accelerator Driven Systems, March 2014

➤ *Coupling : Accelerator + spallation source + subcritical reactor*



High power proton beam (up to 2.4 MW)

Proton energy	600 MeV
Peak beam current	0.1 to 4.0 mA
Repetition rate	1 to 250 Hz
Beam duty cycle	10^{-4} to 1
Beam power stability	< ± 2% on a time scale of 100ms
Beam footprint on reactor window	Circular Ø85mm
Beam footprint stability	< ± 10% on a time scale of 1
# of allowed beam trips on reactor longer than 3 sec	10 maximum per 3-month operation period
# of allowed beam trips on reactor longer than 0.1 sec	100 maximum per day
# of allowed beam trips on reactor shorter than 0.1 sec	unlimited

Extreme reliability level

◆ **Avoid beam trips longer than 3 seconds to minimise thermal stresses and fatigue on target, reactor & fuel assemblies and to ensure 80 % availability.**

➤ Actual *Specification : Less than 10 trips per 3 months operation cycle.*

◆ **Reliability guidelines are needed for the ADS accelerator design:**

➤ **Strong design** i.e. robust optics, simplicity, low thermal/mechanical stress, operation margins…

➤ **Redundancy** (serial where possible, or parallel) to be able to tolerate failures

➤ **Repairability** (on-line where possible) and efficient maintenance schemes

F Bouly

Reliability needs to be built in from scratch

1) Design phase:

solidity/simplicity vs complexity/dependability?

redundancy

modularity, standardisation of components

built-in flexibility and acceptance

Failure Modes and Effects Analysis to prioritize and understand impacts

2) Construction & installation:

quality assurance plans for production and installation follow-up

test procedures

review against technical specifications
drawings validation

equipment selection

information reporting

3) Operation:

build in system diagnostics & checks
automatic control systems vs checklists?

interlock systems (but don't overload…)

automatized recovery and compensation procedures

Work/people management, staff training

gather system information: logbooks, post-mortem etc
general monitoring, failure data study

asset management
preventive or corrective maintenance? Which balance?

4) Repairs :

efficient trouble-shooting→ skills, experience

strategy planning for intervention

procedures and traceability
inventory of spares, traceability, databases

5) Human factor:

improve communication, accountability, ownership
→ personal engagement & participation

improve collaboration and information sharing
→ avoid single-point weaknesses

staff training & schedules , skills availability

information selection, how do you choose your data?