THE HOR NUCLEAR INSTRUMENT CHANNEL REFIT

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International Conference on Research Reactors:
Safe Management and Effective Utilization

Rabat, Morocco
14-18 November 2011

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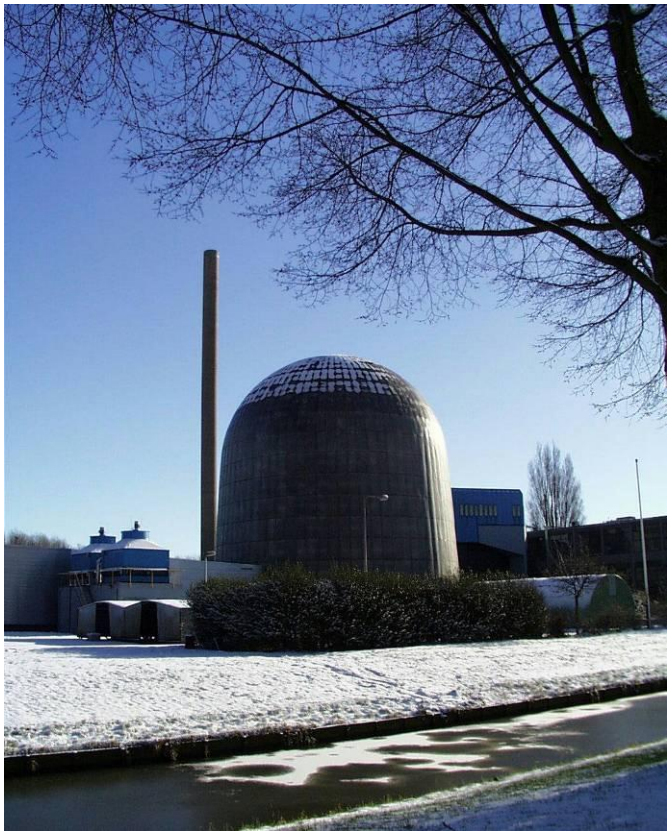
Introduction

RID: Reactor Institute Delft

Neutrons & Positrons for Science & Society

facilities

- 2 MW research reactor (pool type)
- neutron beams
- neutron scattering instruments
- neutron activation facilities
- positron beams
- radiochemical laboratories



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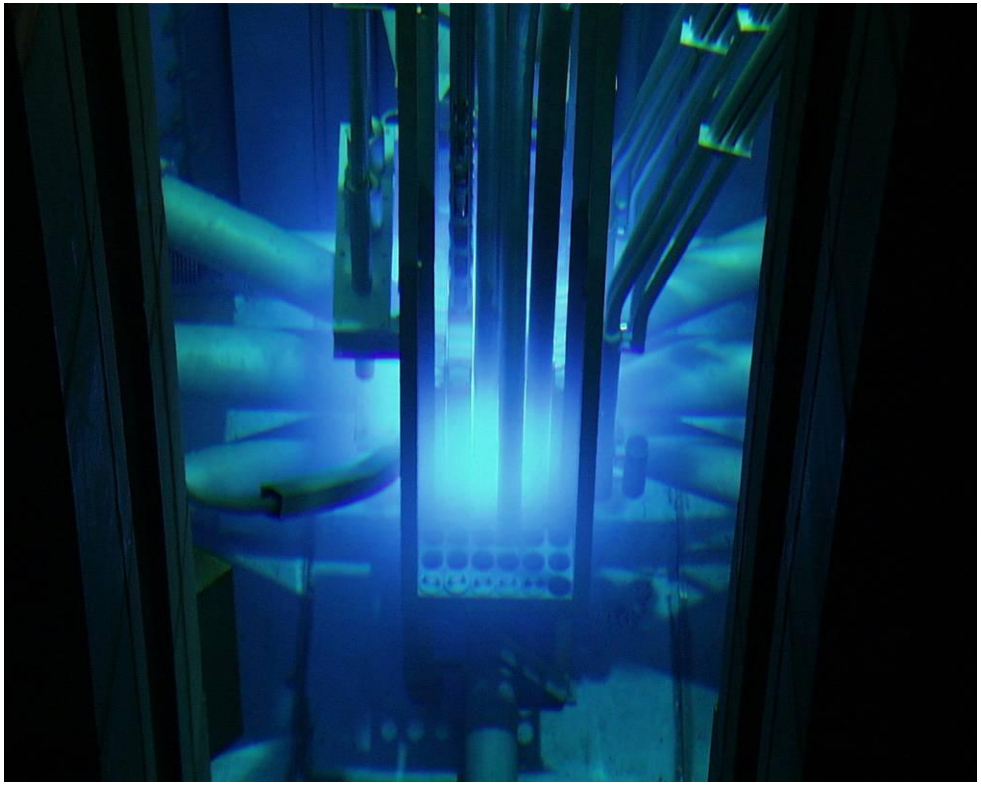
Our armory

- neutrons (thermal, fast)
- positrons
- γ-radiation



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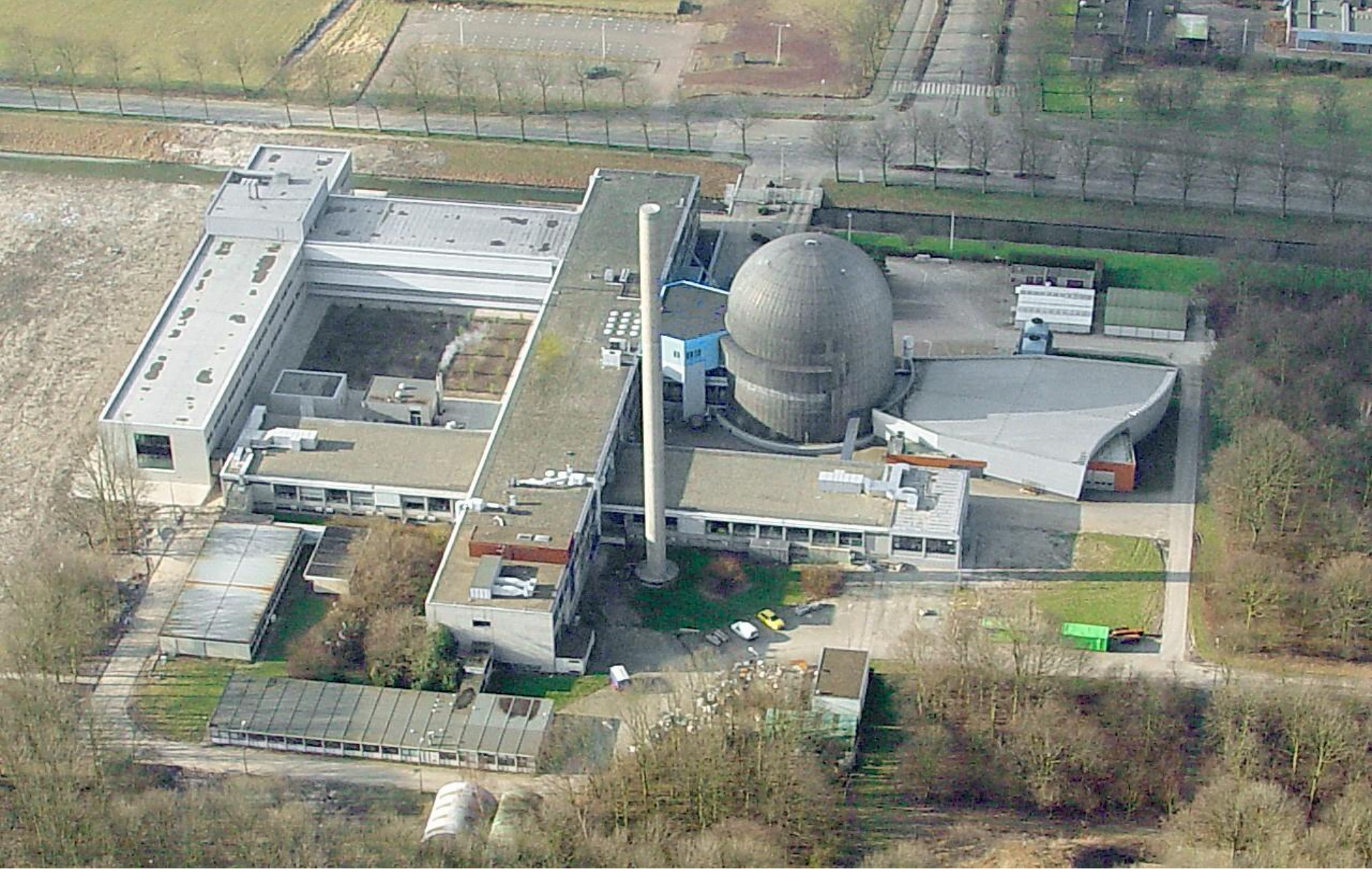

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Project: HOR nuclear channel refit

- Old channels from 1980
- Aged: Components not available anymore
- Became difficult to calibrate the channels
- Started preparations in 2008
- European Tender

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Control room
Before refit

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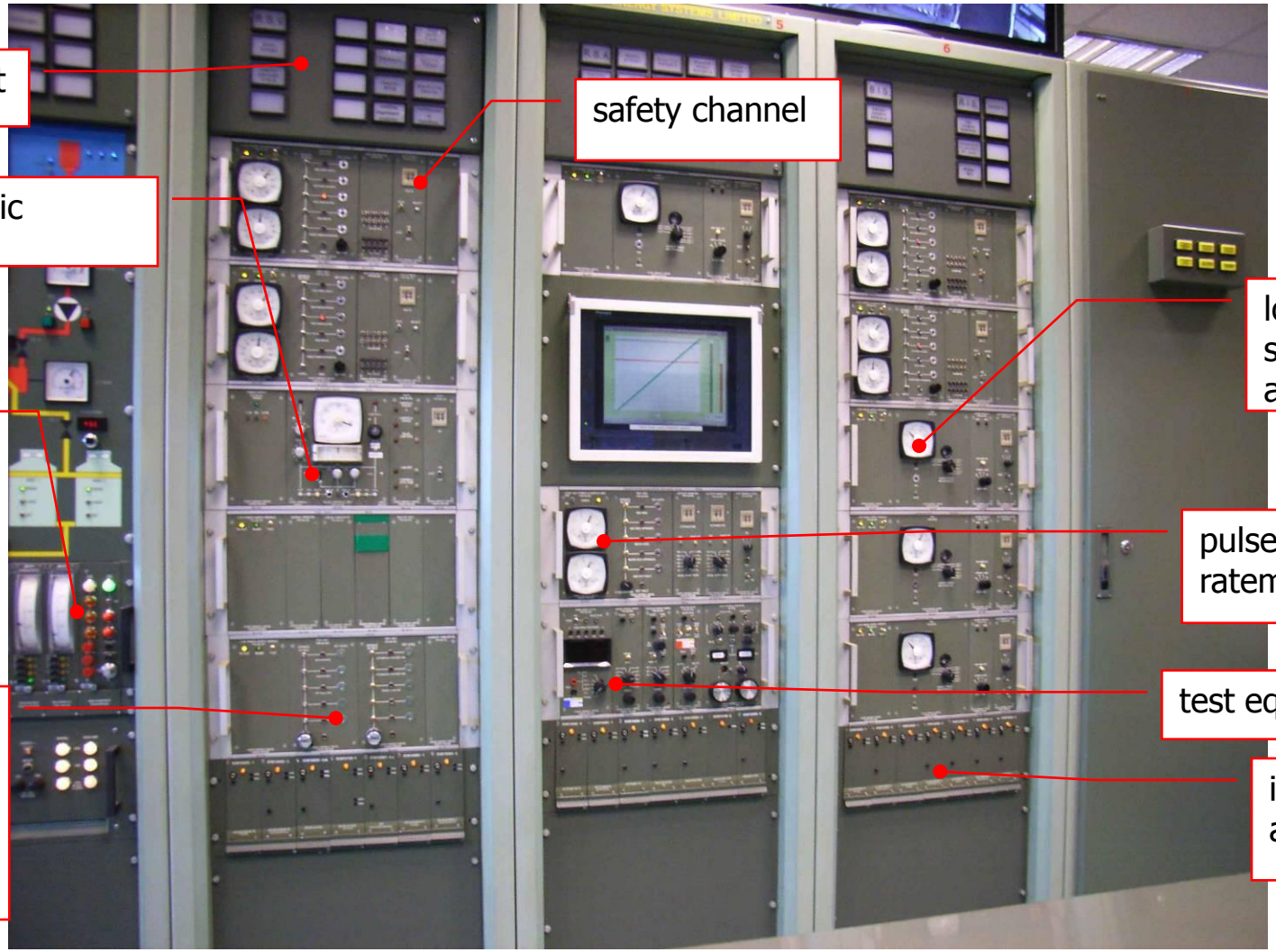

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Nuclear instrumentation to be replaced

Name	Amount	Safety function	Instrument principle
Linear / Logarithmic channel	1	No	Wide range pulse / Campbell channel with fission chamber
16N reactor power	1	No	Low Current Shut-down Amplifier with gamma detector
Pool fission product activity forced cooling	1	No	Pulse counting / ratemeter
Safety channel neutron flux level	4	Yes	Auto-Reset Shut down Amplifier with an uncompensated ion chamber
Pool gamma monitor	1	Yes	Low current shut-down amplifier with gamma detector
Pool outlet gamma monitor	1	Yes	Low current shut-down amplifier with gamma detector
Bridge gamma monitor	1	Yes	Low current shut-down amplifier with gamma detector
Stack off gas activity channel	1	Yes	Pulse counting / ratemeter

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Scope

- Design safety system is not changed
- Only electronics in the control room and preamplifiers in the field are renewed
- Cables and detectors are reused.
- A no-break installation implemented for data registration purposes.

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Requirements

- Channel should have the same functionality as old one
- Functional interface to plant should be the same
- Equipment should be used before in other RR
- Standards: KTA 3501/3505 or equivalent
- Installation in maintenance period summer 2010

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Safety Study

Our authority had two concerns:

1. Response of new channels on Postulated Initiating Events (PIEs)?
   - The list of PIEs published in IAEA Safety Standards Series No. NS-R-4 is used to investigate the influence of the new channels on PIEs.
   - As the new channels still full fill the requirements of the 'old' safety analysis the response of the new channels will be equal to the response of the old channels.
2. Common Cause Failures in the software.
   - The software was compared with the IAEA requirements published in IAEA Nuclear Energy Series No. NP-T-1.5.
   - All IAEA requirements to minimize Common Cause Failures are fulfilled

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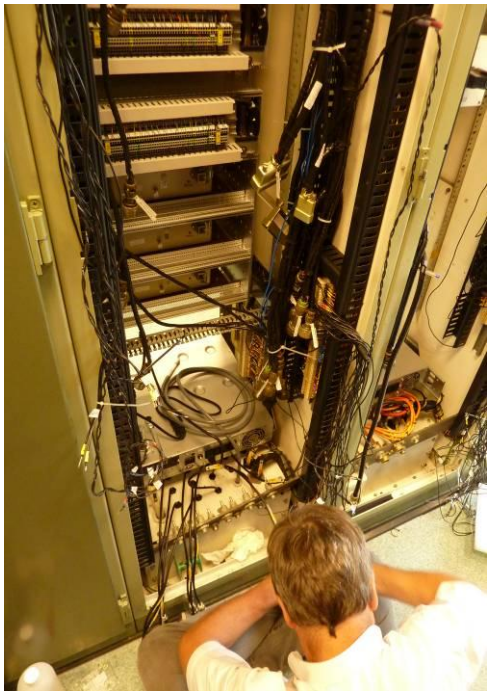
Time schedule

- Mid 2008
  - approval of project proposal by the dean
  - start of preparation European tender
  - Start of discussions with the authorities
  - Specifications are written
- 2009
  - Selection of manufacturer
  - Start of design phase
  - Detailed proposal send to the authorities
  - Software approved by independent software department TUV-Nord
- Mid 2010
  - Factory Acceptance Test, witnessed by TUV-Nord
  - Commissioning in the summer maintenance period
  - Site Acceptance Test, witnessed by the authorities
  - Start-up (2 weeks) with cold and warm tests

Commissioning phase



Start
Removing
Old equipment

4 weeks

Site Acceptance
Test

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Old versus new [1]

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Old versus new [2]

- Digital with 2 microcontrollers
- Built in test generators
- All analogue outputs are 4-20 mA
- Parameters instead of potentiometers
- Automatic ranging

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Flow blockage protection [1]

- Open pool with possibility to drop something into the pool
- If a coolant channel is voided the neutron flux will decrease
- This can be detected with a special function in the neutron flux instrumentation
- In the previous instrumentation this was done with analogue electronics
- In the new channel this function is implemented in the software of the microcontroller

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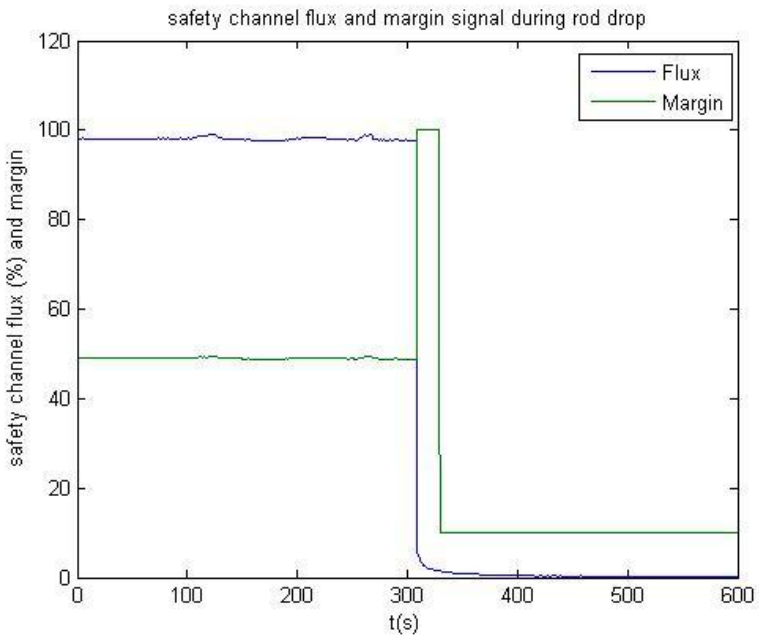
Flow blockage protection [2]

- At steady state margin = ½ flux
- The reference signal can only follow the flux signal within the limits of the tracking rate.
- Margin is the difference between reference and flux signal.
- If the flux signal decreases faster the margin signal will increase until a trip condition is reached



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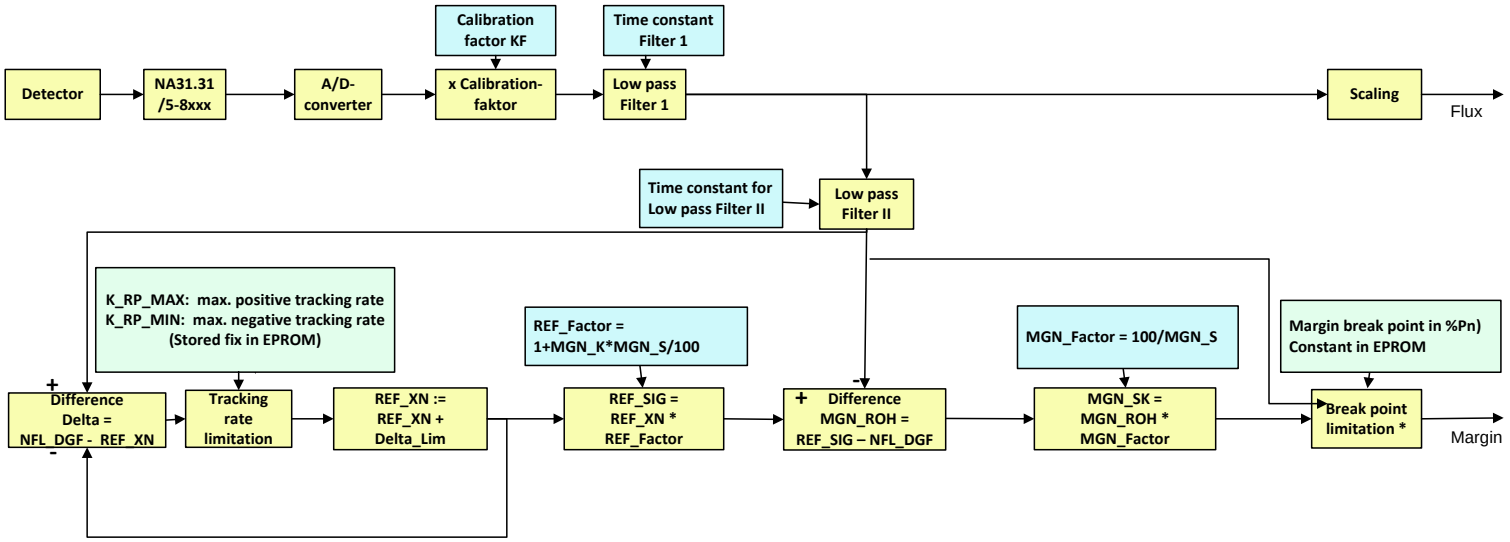
Flow blockage protection [3]
The digital implementation



By courtesy of MGPI

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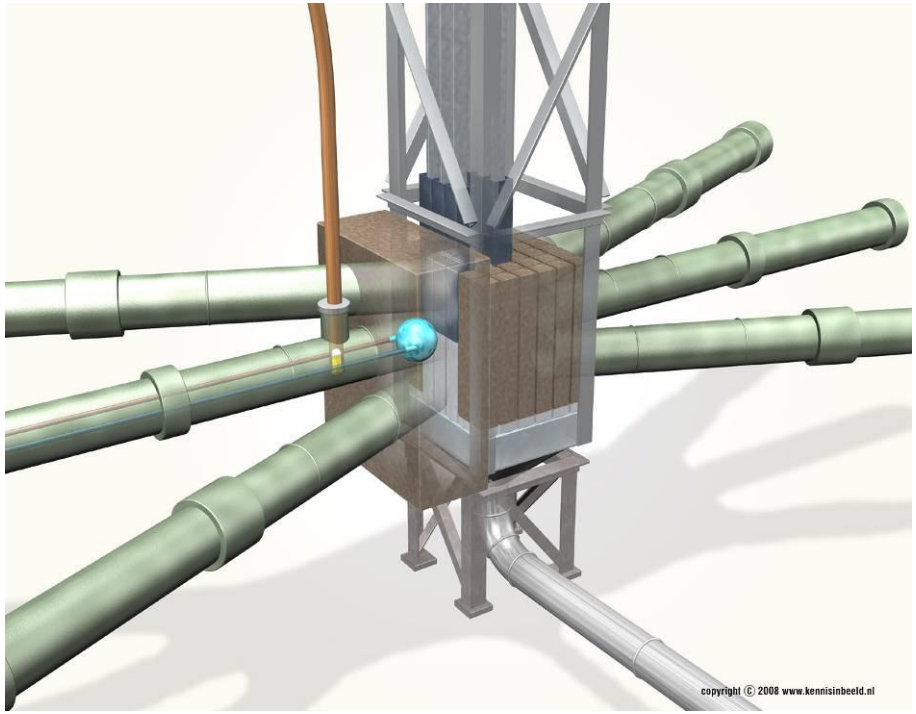
Flexibility for future needs: Oyster project

- Power increase to 3MW
- Ultra Compact Core (3x3)
- Implementation of Cold Neutron Source



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Conclusions

- Project done within budget en scheduled time
- Look en feel of new instrumentation is similar to old
- Testing is user friendly by using the built in signal sources
- Until now the equipment showed good performance without errors in the channels
- Next project will be the renewal of the voting logic and guard line system

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Thank You

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