The Beam Safety System of the PSI UCN Source

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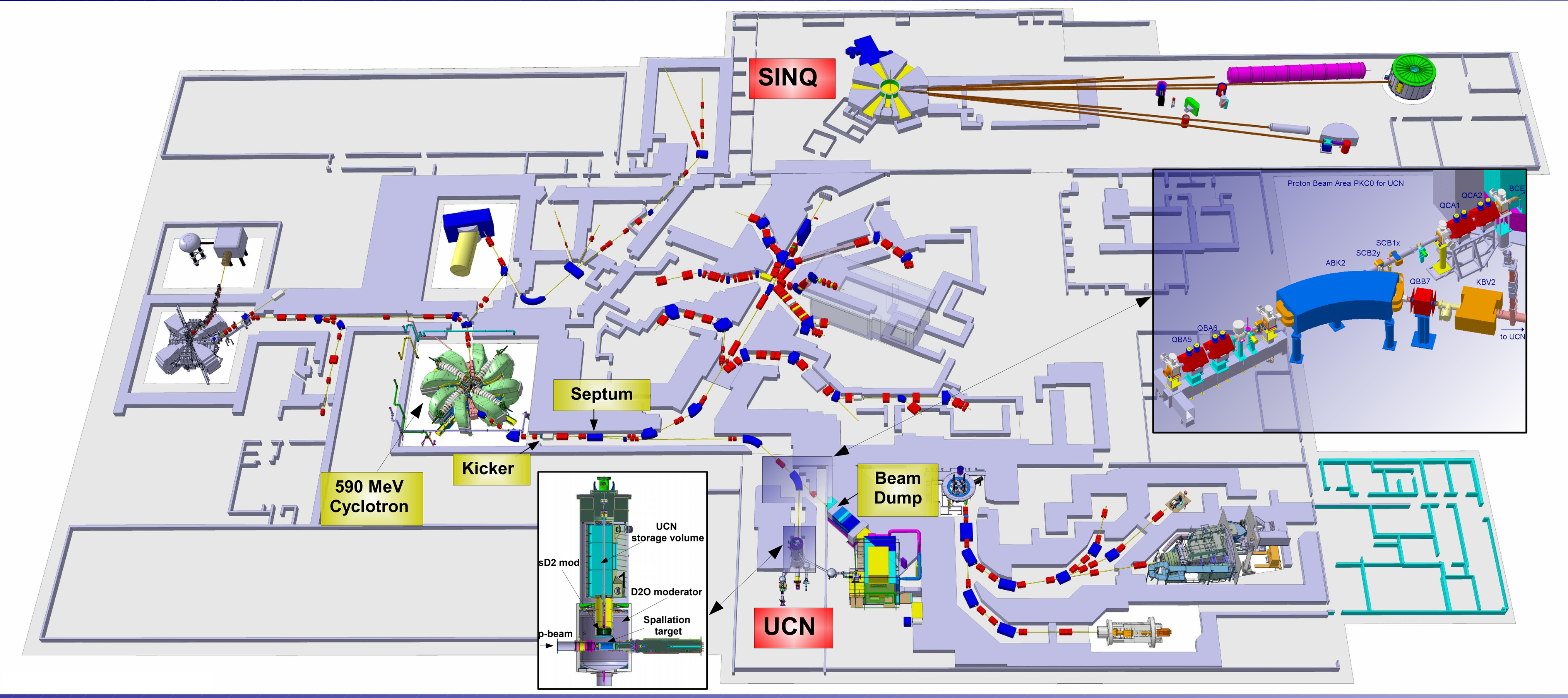
The new Ultra Cold Neutron Source at PSI



Features

• **At PSI, a new Ultra-Cold Neutron spallation source will start operation in 2011**. Its design intensity is ~100 times larger than the currently strongest source.

• **Two neutron spallation sources** - the continous wave SINQ and the macro-pulsed UCN source will be **concurrently driven by the same accelerator facility**.

• The 590 MeV, 1.3 MW proton beam delivered by the ring cyclotron will be switched towards the UCN source for about **8 s every 800 s (1 % duty cycle)**.

• The switching system is based on a **fast kicker magnet with a rise-time of 1 ms**.

• UCN employs a **solid state target** made of lead-filled zircaloy tubes **based on the SINQ design**.

• Typical UCN experiments are **nEDM** and **neutron lifetime**.

The UNC-SAS Beam Safety System

Motivations

• **The PSI machine protection system guarantees safe operation of the accelerator facility** preserving the installation from instantaneous beam losses and from activation generated by large integrated losses.

• **The PSI machine protection system is not conceived to protect an experimental setup**.

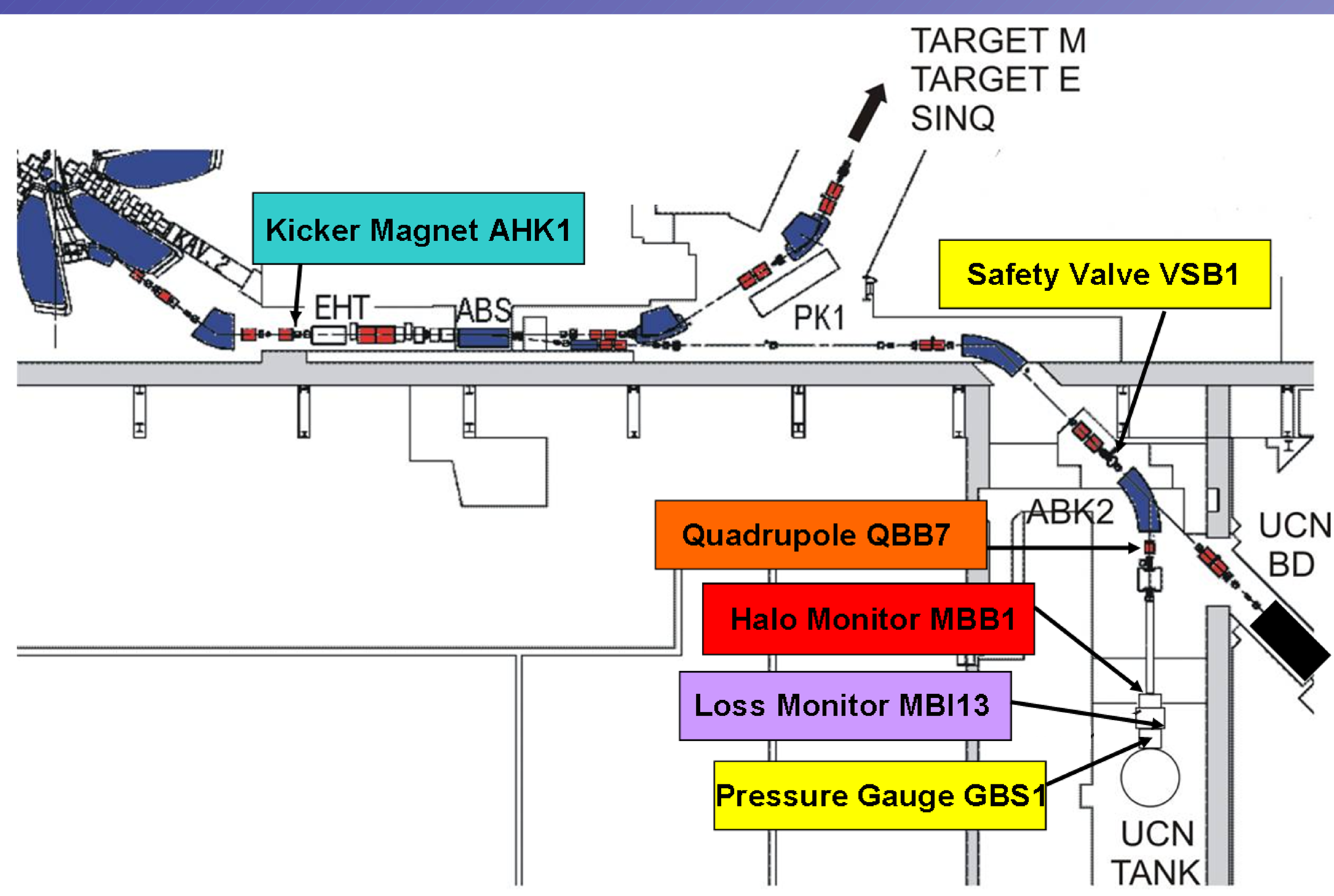
• A SINQ-SAS beam safety system was built in 2005 to protect the MEGAPIE target experiment.

• **The UCN-SAS beam safety system was designed based on the MEGAPIE experience**.

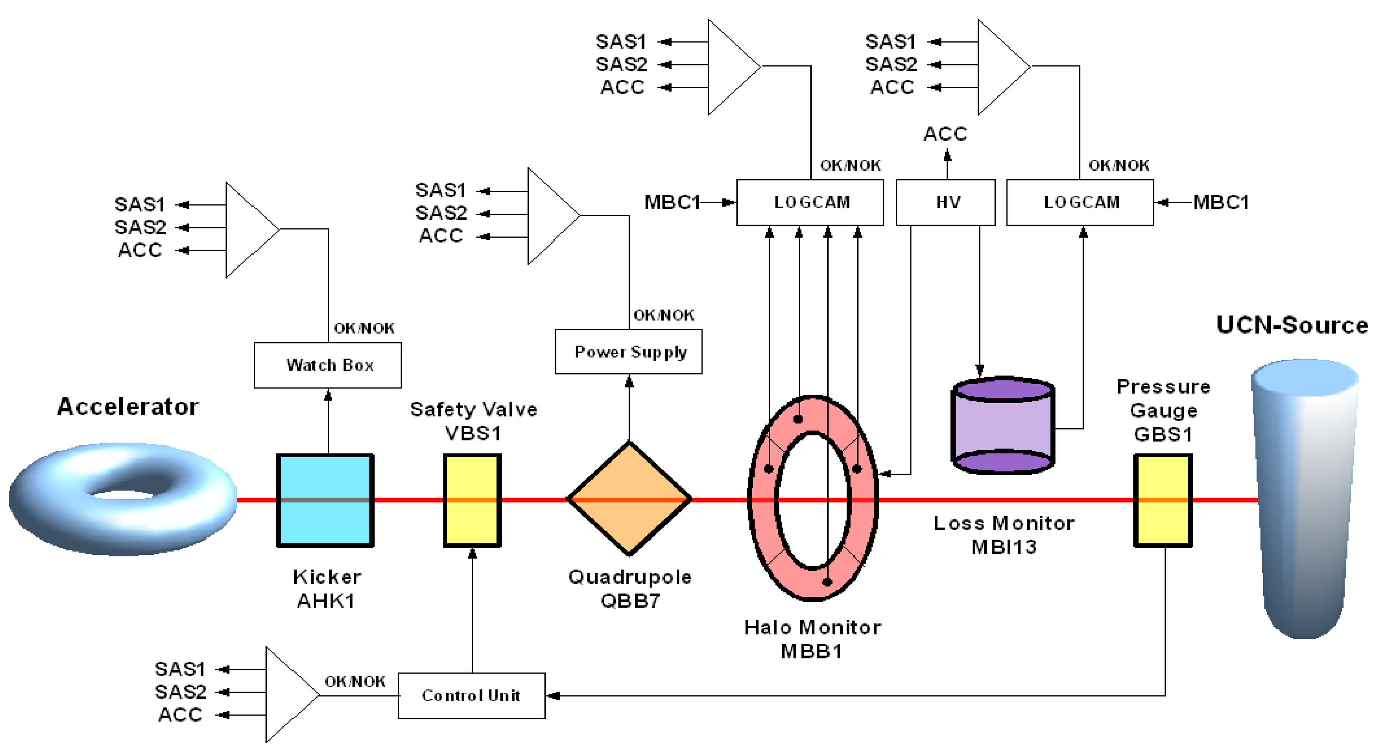
• The UCN-SAS protects:

- The UCN target from an incorrect beam optics and trajectory (nominal peak current density: 22 μA/cm^2, **maximum allowed peak current density: 50 μA/cm^2 during 100 ms**);
- The beam-line and the accelerator facility from potential release of radioactive material by the UCN source;
- The UCN kicker magnet from overheating.

• The UCN-SAS is a **highly redundant system**.



Design



• The **beam spot** at the UCN target is monitored thanks to signals provided by **three beam-line elements**:

- The **halo monitor MBB1**, divided into 4 sectors and receiving about 5 % of beam, measures the beam size and position;
- The **beam loss monitor MBI13** giving hints about the beam setting;
- The **quadrupole QBB7** defining the UCN beam spot size (current > 90 % of its nominal value).

• In case of rupture of the UCN target window, the contamination of the accelerator facility is prevented by the **pressure gauge GBS1 shutting the safety valve VBS1 and triggering a beam interlock**.

• The duration of the UCN pulse is monitored by a counter in order to **prevent overheating of the UCN kicker magnet AHK1.**

• **All UCN-SAS signals are duplicated (SAS1 and SAS2)**. Each SAS signal goes also to the accelerator protection system **(ACC)**.

Connection with Other Systems

• The **UCN-LAS (slow interlock system)** monitors several UCN-Source parameters (heavy water, cryogenic, vacuum, D2 and N2 gas, ventilation and radiation monitoring systems). UCN-LAS provides a OK/NOK input to the UCN-SAS.

• The UCN-SAS provides an enable signals for the **UCN kicker AHK1** and for **the Run Permit System.**

• The OK/NOK interlock signal from the UCN-SAS is put in coincidence with the corresponding signal from the **SINQ-SAS**.

• The beam-off actuators controlled by the UCN-SAS are the **kicker AWK1** and the **beam blocker BW2** (870 keV transfer line). The interlock reaction time is less than 5 ms.

• Should the AWK1 power supply fail, then the accelerator **ion source IQ** is switched off within 10 ms.