Join Institute for Nuclear Research
Laboratory of High Energy Physics

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Benefits of a Microkernel Architecture for Slow Control Systems Software in Research Activities

Case Studies from LHEP, JINR

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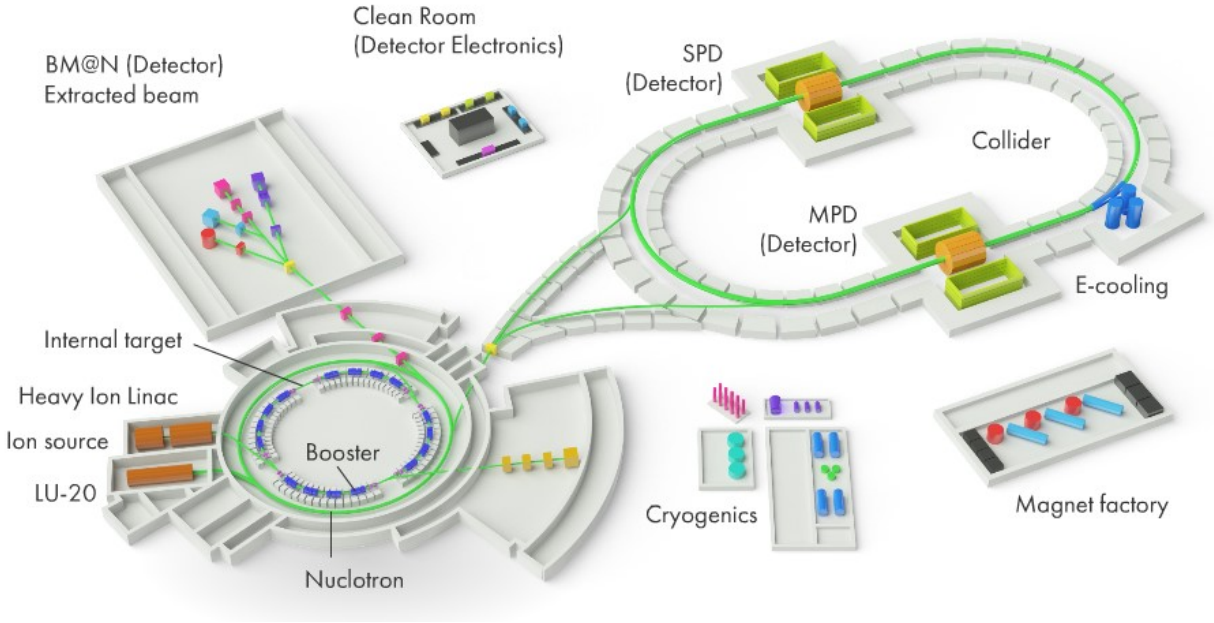
AYSS-2025

Context

Our team is developing and maintaining hardware and software for various systems at LHEP JINR



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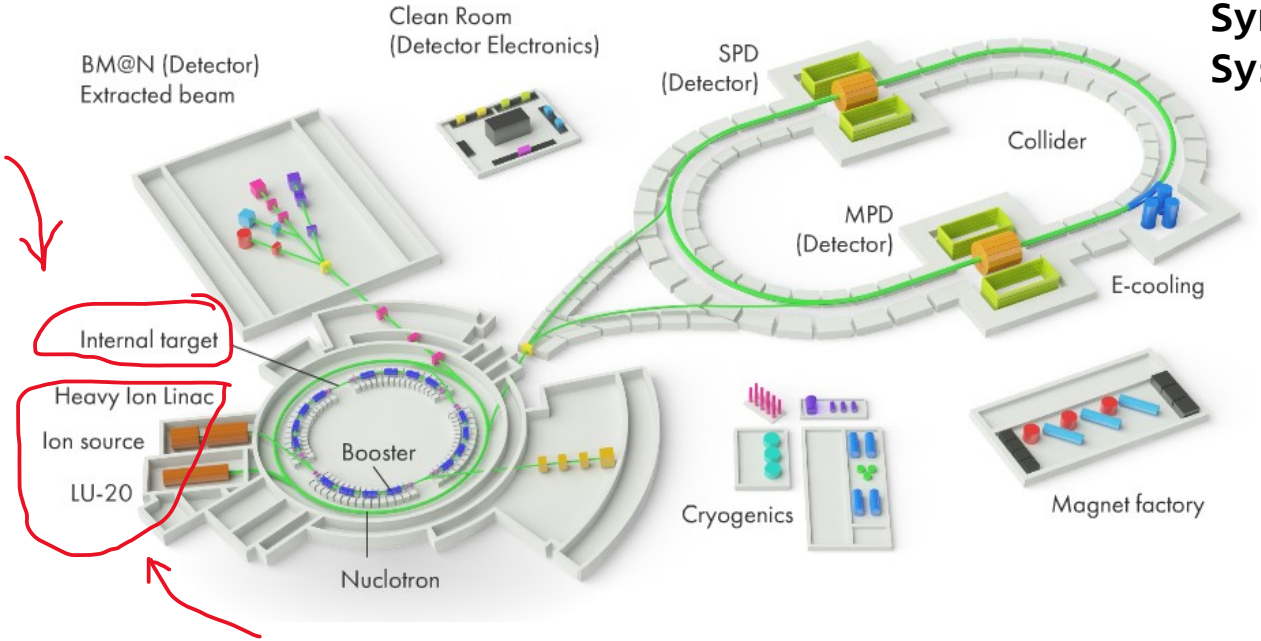

Synchronization Systems

- KRION
- Heavy Ion Linac
- Source of Polarized Ions
- Internal Nuclotron Target

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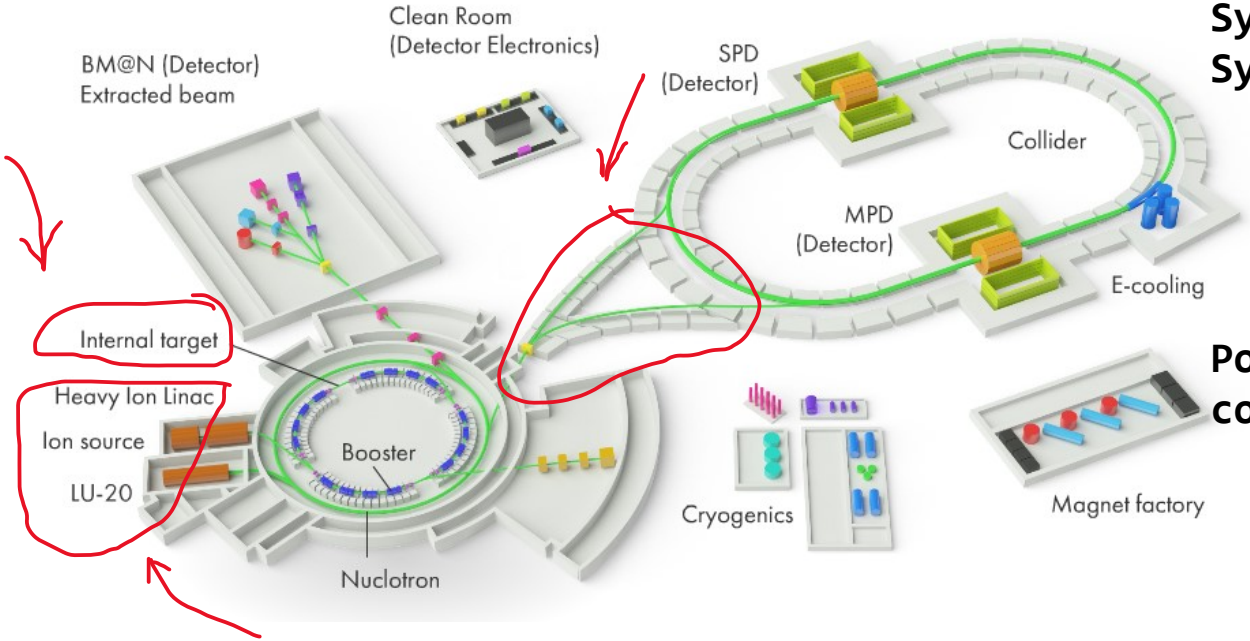

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Power supply controllers

- Beam Transport Channel
- Nuclotron-Collider

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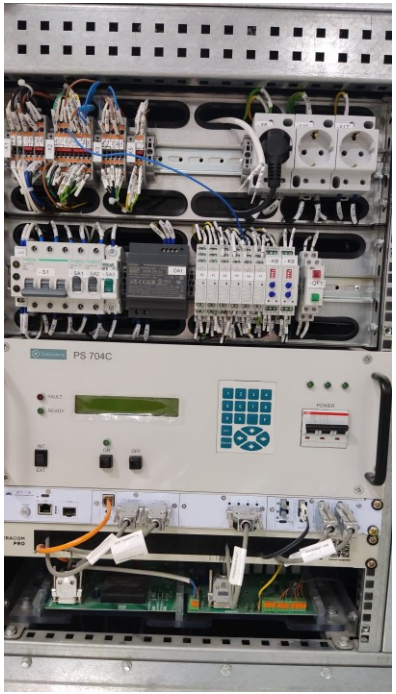

The **hardware** is **various** according to the aim, **but** a majority of modules are built on the **unified** platform

Software should be unified as well

Problem

Research activities **require specific hardware** maintained by staff hardware developers

The **complexity** of modern systems arouses the question of the need for the **bespoke software**

Both software and **hardware** need to be **flexible** to adapt to various constantly-changing requirements from end-users: **physicists**

Slow control systems

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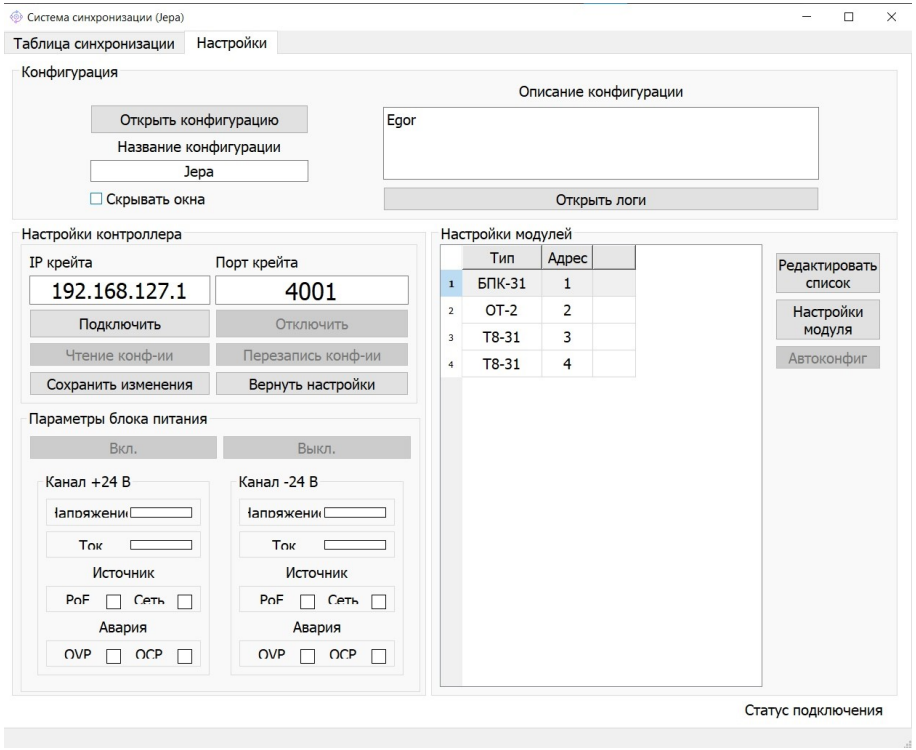
Often we used to build the standalone software for such kind of systems from scratch

But can we unify the software developing process in such context?

Our past experience



We have started with the maintaining of **KRION** synchronization system software in 2021

But it was not scalable enough

The idea of unifying the software and implementing it into other systems came to mind

Solution

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We decide to build our own platform

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1. Integration

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According to Neal Ford and Mark Richards, Microkernel Architecture would satisfy our quality attribute requirements

1. **Integration**
2. **Evolutionary**
3. **Simplicity**

Architecture characteristic	Star rating
Partitioning type	Domain and technical
Number of quanta	1
Deployability	★★★
Elasticity	★
Evolutionary	★★★
Fault tolerance	★
Modularity	★★★
Overall cost	★★★★★
Performance	★★★
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Microkernel Architecture == Plugin Architecture

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Microkernel Architecture == Plugin Architecture

Software module for controlling hardware device == Plugin

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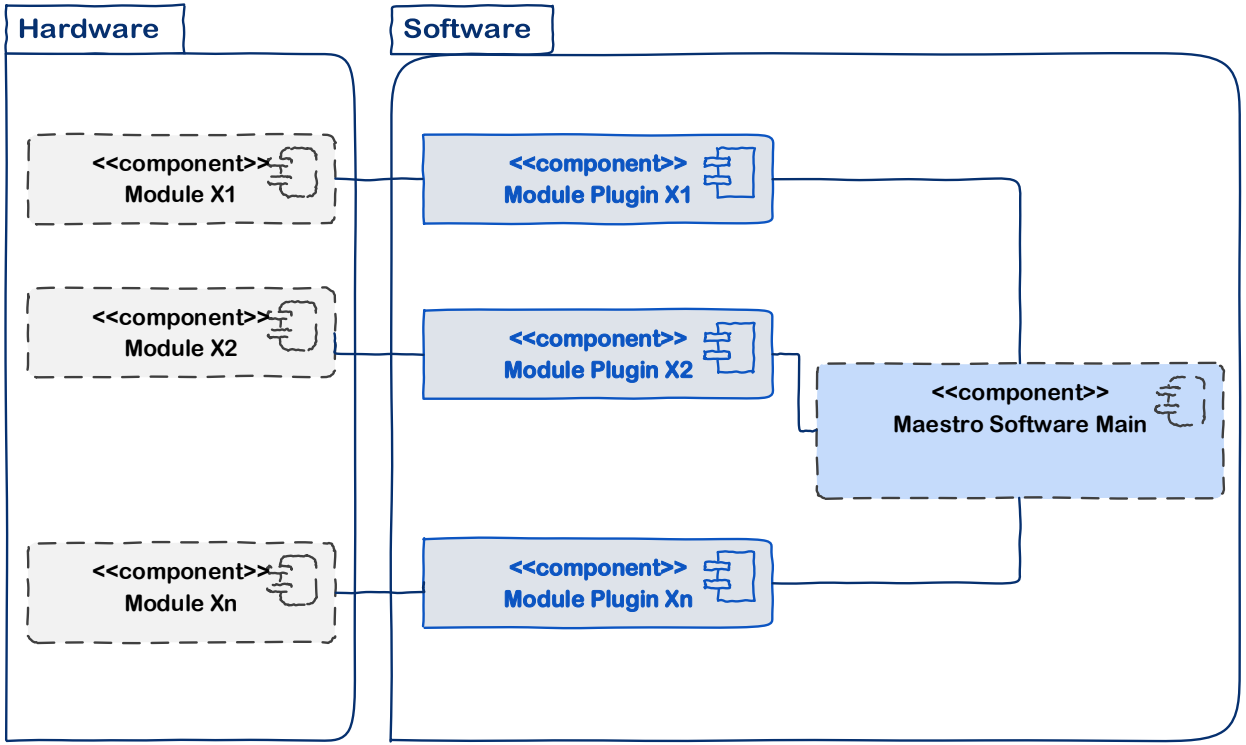
Implementation – Maestro Software



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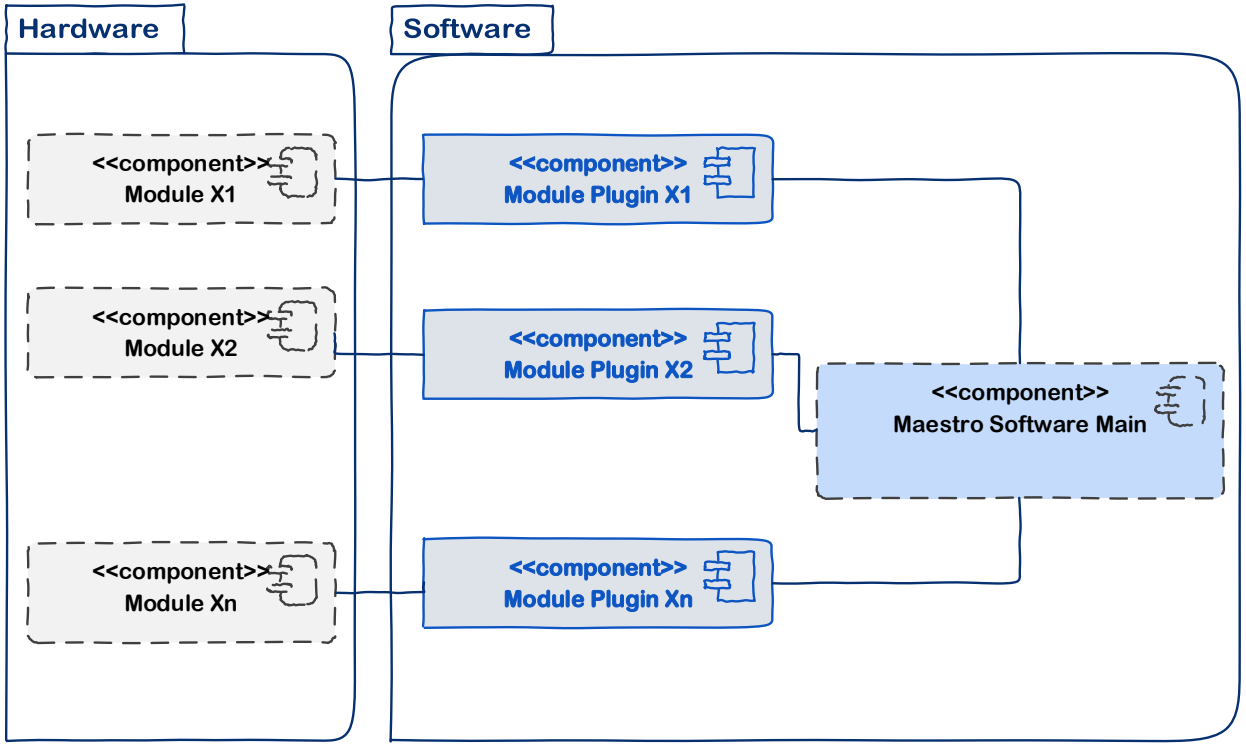

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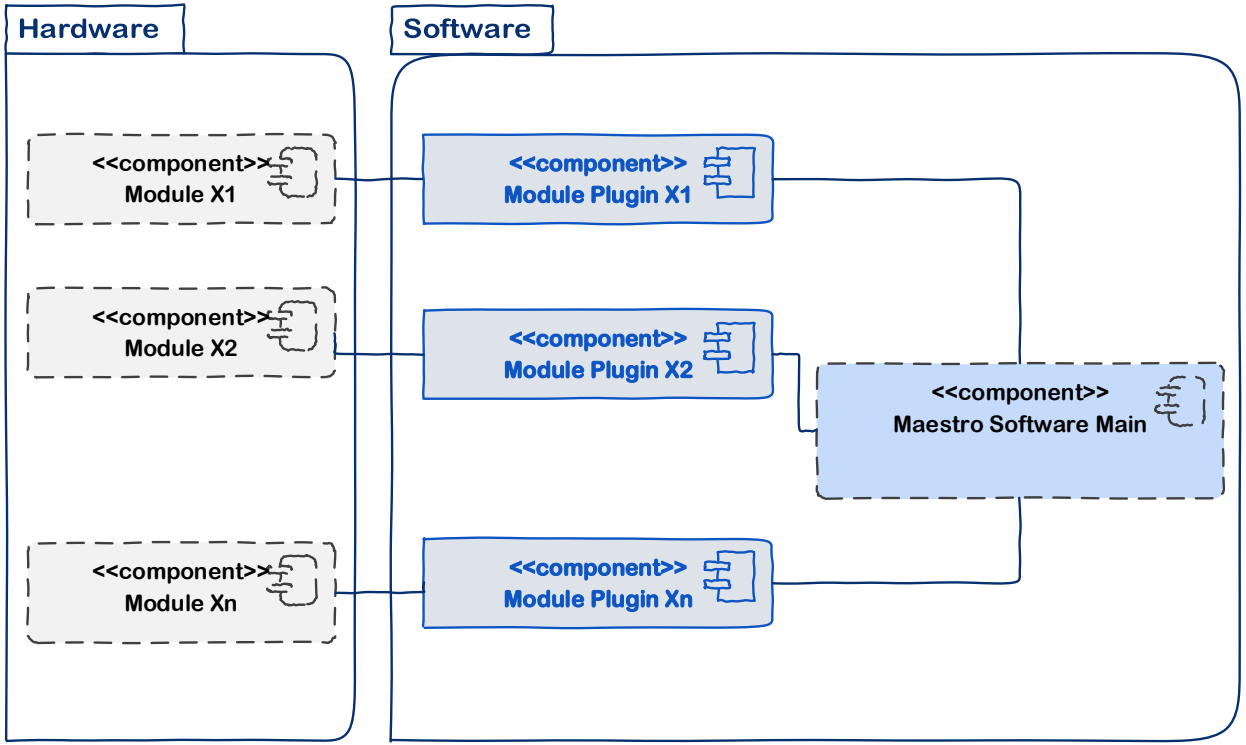

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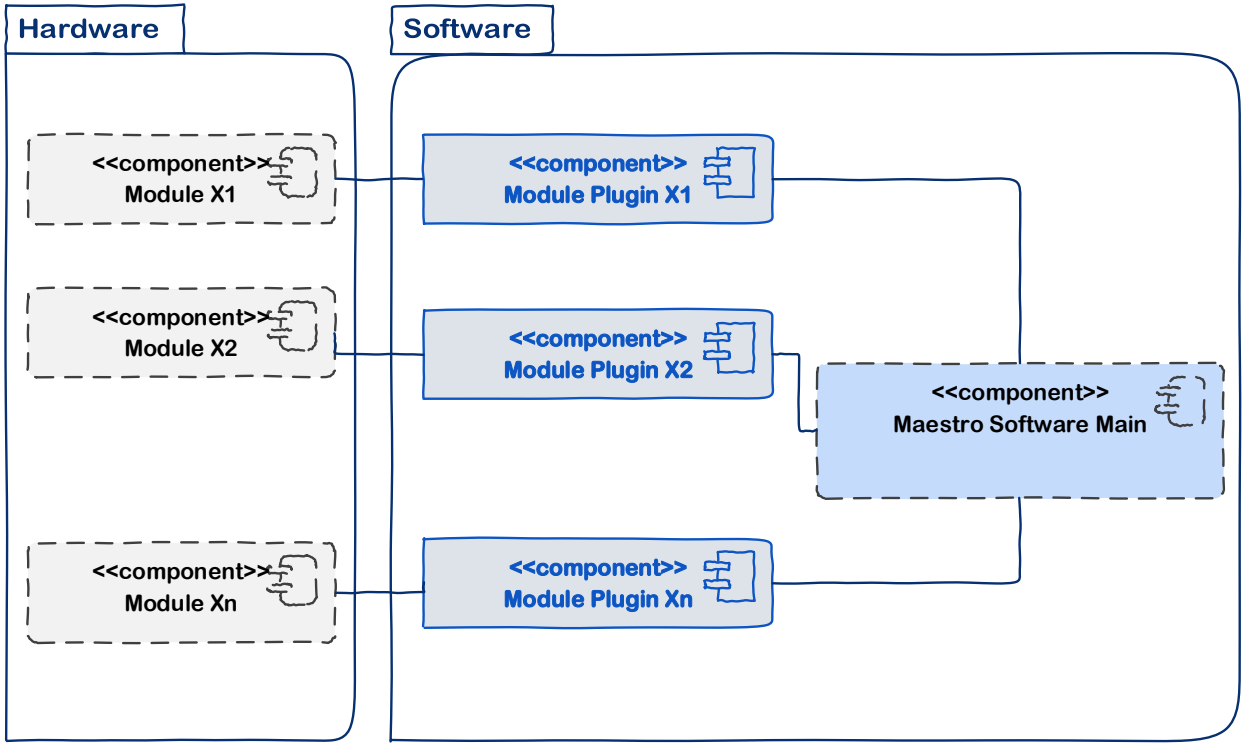

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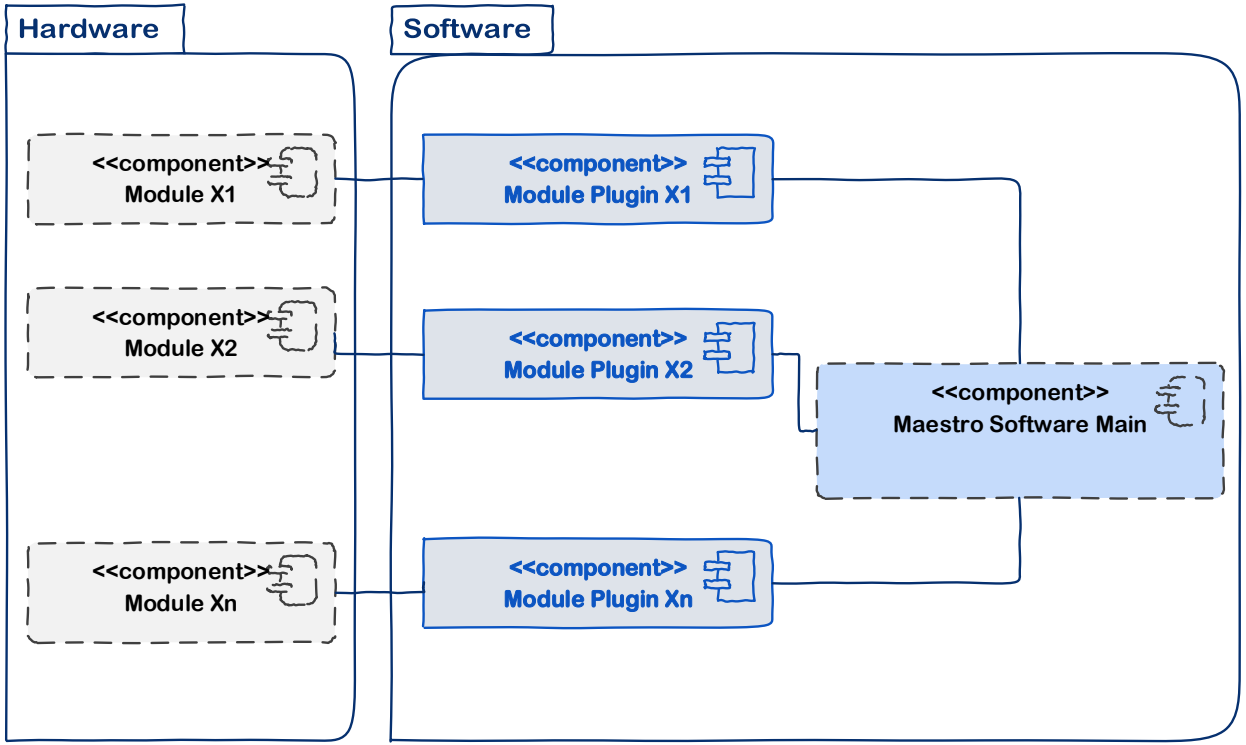

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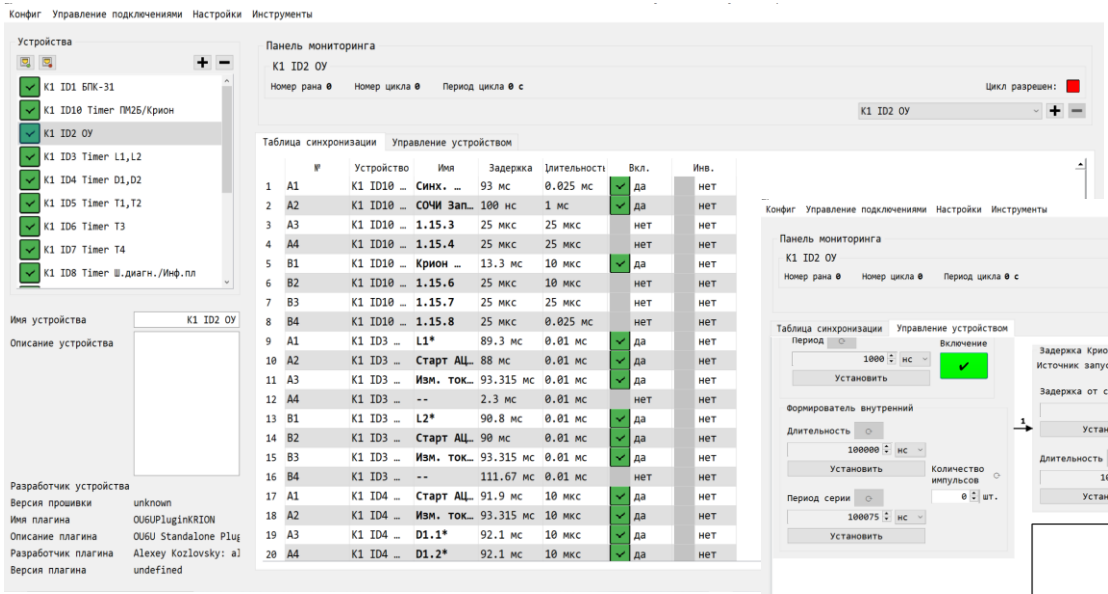
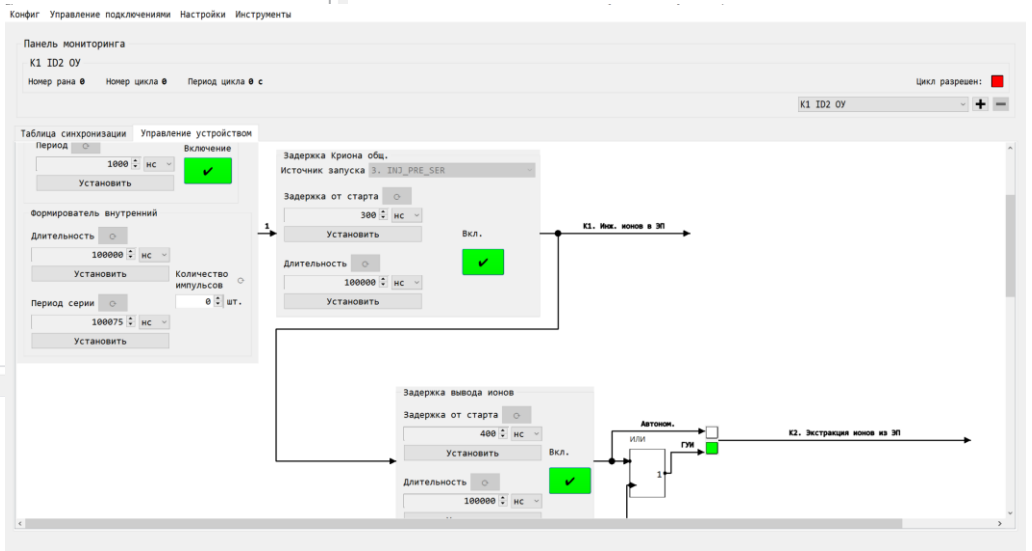


Software examples from KRION and HILAC Synchronization Systems

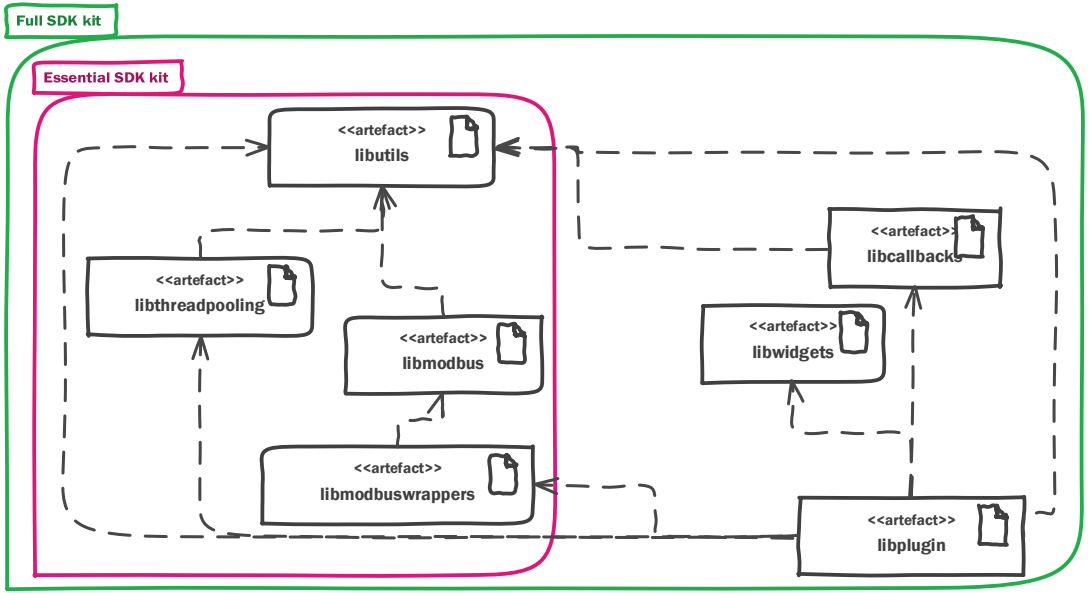


Challenges

As we built **our SDK** with **7** libraries there were an issue with the complexity of maintaining which consumes a lot of time resources

For solving this problem we implemented our **own** self-hosted conan **package manager***

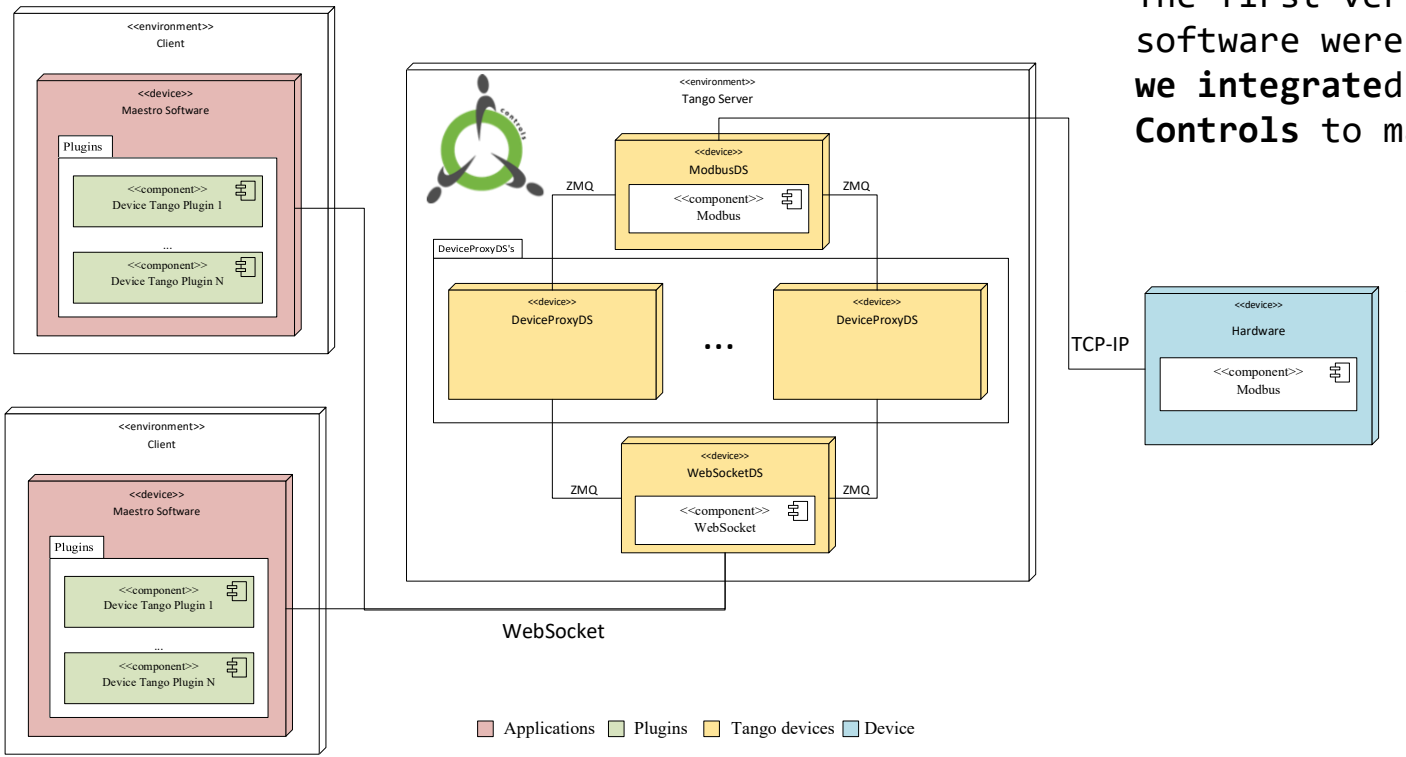
* See the talk of Denis Ivliev



JFrog

CONAN 2.0
C/C++ Package Manager

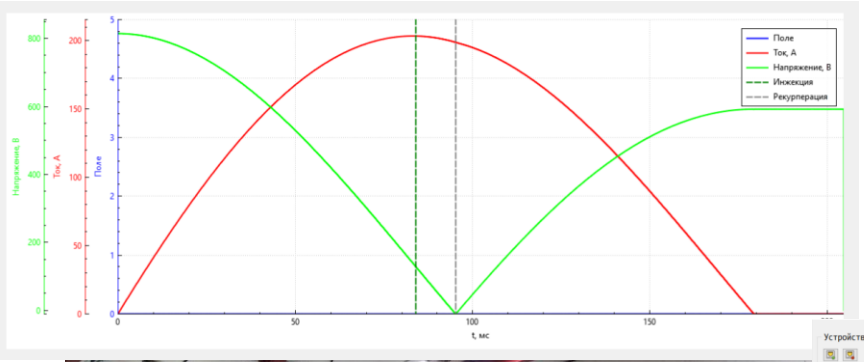
Challenges



The first versions of our software were standalone, but **we integrated** it **with Tango Controls** to make it **distribute**

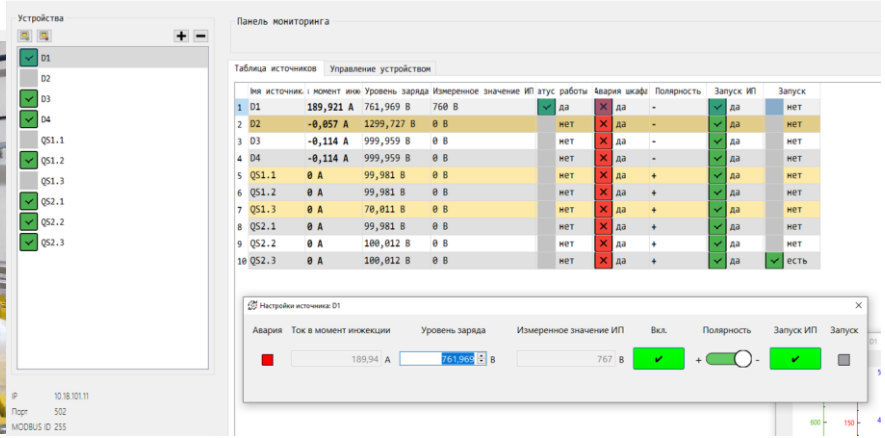
* See the talk of Alexey Bukharin

What about other systems?



Despite the initial orientation towards the synchronization system, our unified platform can be customized to fit the aims of controlling the power supplies of the **Nuclotron-Collider Beam Transport Channel**

* See the talk of Artyom Noskov



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What about SIMPLICITY?

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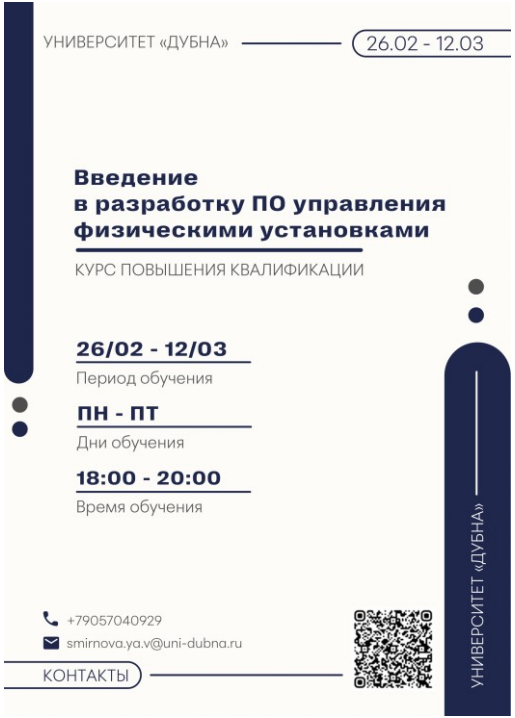

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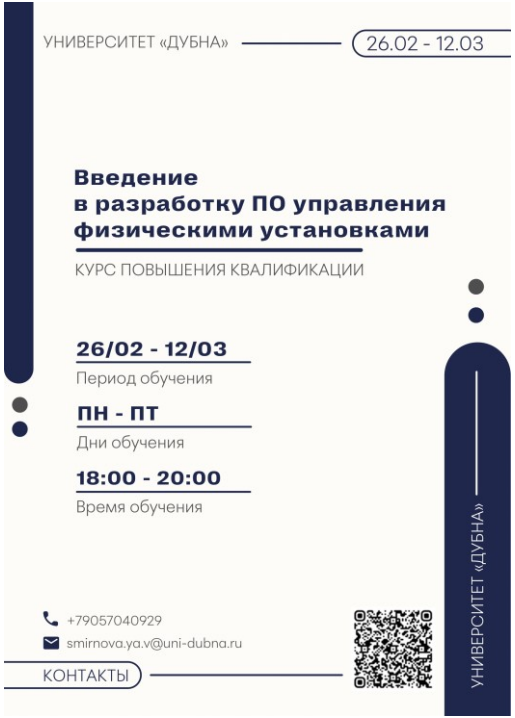

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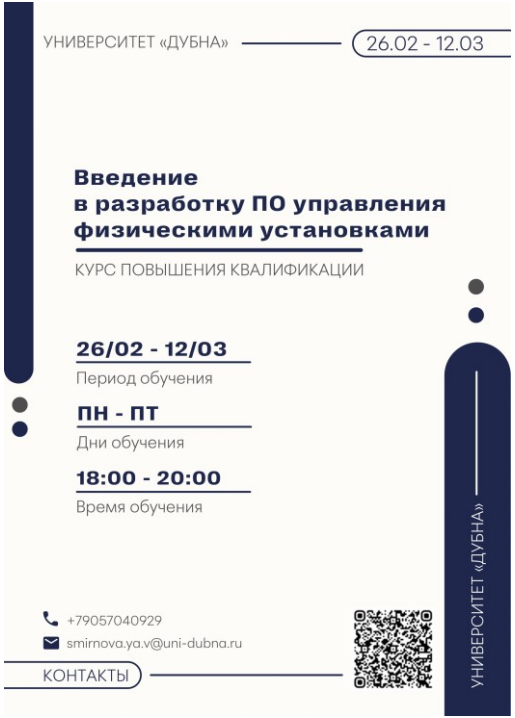

It has become possible to delegate certain tasks of developing software for hardware module control to a student!

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The new generation of SoE students now is working on the software for Measure Unit Hardware control

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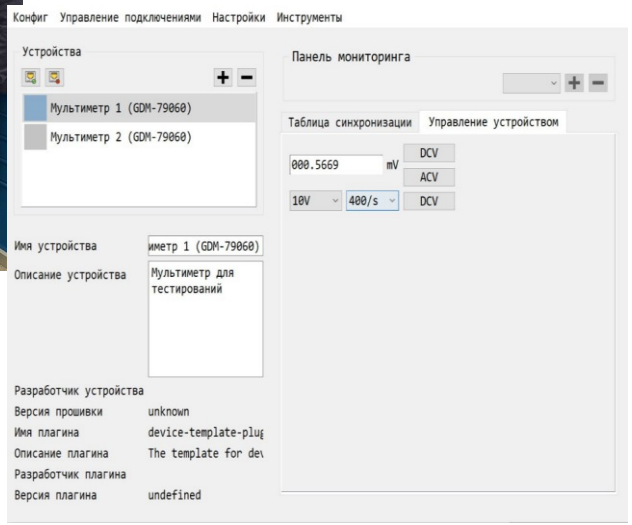

The new generation of SoE students now is working on the software for Measure Unit Hardware control

They are developing the **Maestro Software plugins** with **SCPI** commands support by **themselves**

Results

The unified platform for client or standalone software for slow control system management has been developed and implemented in different parts of NICA Complex

The software has been integrated with Tango Controls

The system of Maestro Software Plugins **description** has been composed and successfully tested within the framework of the **School of Engineering**

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Thank you for your attention

Alexey Kozlovsky kozlovsky@jinr.ru