MOPV044

LESSONS LEARNED MOVING FROM PHARLAP TO LINUX RT

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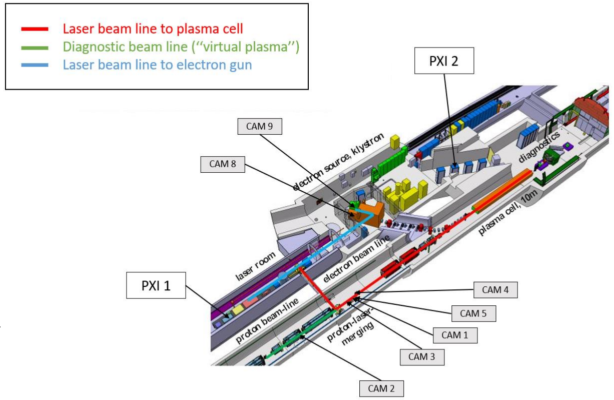
MOTIVATION

- Diagnose and profile the plasma propelled proton beams at AWAKE
- Physicists need live streaming of the images acquired along the beam line at 10Hz
- Due to performance issue the system was upgraded from PharLap to NI Linux RT

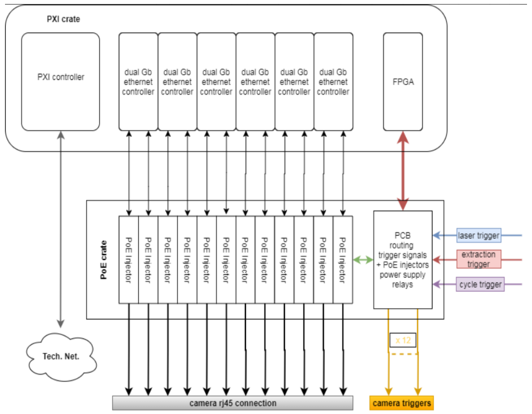


OPERATING SYSTEM

- Support for 10Gbps card.
- PharLap is that it's a lightweight
- PharLap timing synchronization issue
- CERN accelerator complex infrastructure is UNIX based
- built-in NTP timing service on NI Linux RT

INTEGRATION

- AWAKE timing system using a CTRp card manufactured at CERN
- PharLap being obsolete
- NI Linux RT all the standard GCC and UNIX tool chains available

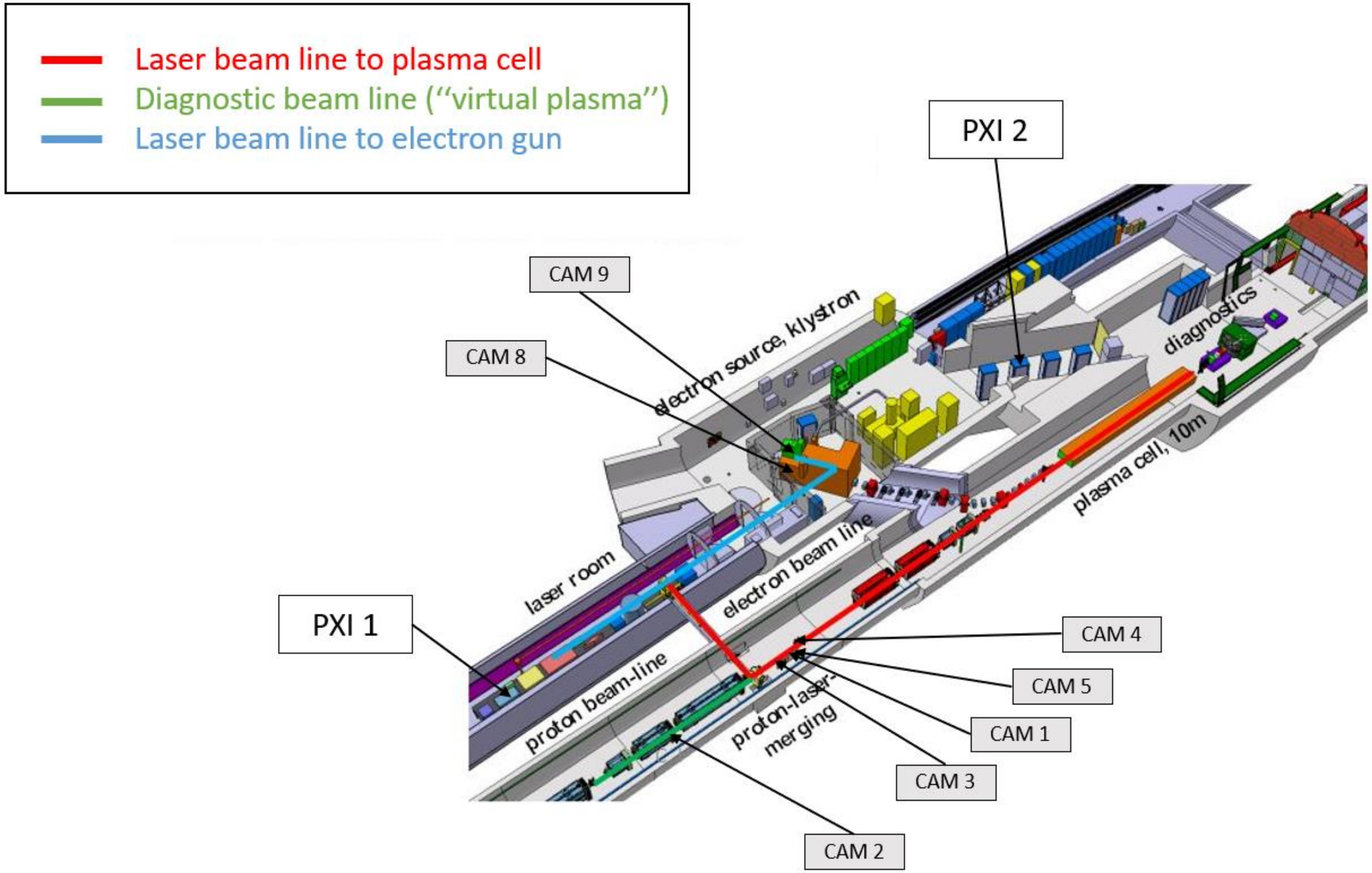


CONCLUSION

- Switching from PharLap to NI Linux RT brought performance improvements, reducing both the general resource and CPU usage.
- The UNIX environment simplified library and system administration

MOTIVATION

The cameras are positioned along the beam line for several purposes (Fig. 1). The cameras that are on the virtual laser diagnostic line are used to measure the characteristics of the laser used to initiate the plasma. Other cameras are used to image the path of the laser and proton beams to align them in the plasma cell. Finally, some cameras are positioned to visualize the low energy electron beam at different points of its path before it is accelerated by the proton generated wakefield in the plasma cell.



OPERATING SYSTEM

PharLap

The main advantage of PharLap is that it is a lightweight RTOS (Real Time Operating System) with few software layers, which makes it robust and stable while maintaining determinism. This advantage is also a weak point in terms of debugging because when a RT application crashes, the whole OS stops responding, and a reboot of the device is required. In addition, because it does not implement memory virtualization, very little can be fixed at runtime without rebooting, requiring careful memory management. National Instruments will stop its support of PharLap in 2025 with some new modules already not supported on this platform, forcing the community to stop using it for new projects or major upgrades.

Another issue is the timing synchronization daemon, SNTP 1.2, based on SNTP (Simple Network Time Protocol), that does not work properly on PharLap. When SNTP is synched, we measure a continuous oscillation of about +/- 0.02 seconds around the correct time. After a few hours (2 to 20+), we measure an abrupt offset of about 4 minutes, followed by oscillations of +/- 0.2 seconds.

Linux RT

As the CERN accelerator complex infrastructure is UNIX based, having an acquisition system based on a NI Linux RT distribution makes its integration into existing services and databases easier. Contrary to PharLap, NI Linux RT (based on the OpenEmbedded platform) ships with built in tools for compiling, debugging, administrating and monitoring our device by default. The behaviour of the built-in NTP timing service works, and debugging via ssh (secure shell) is more convenient since this can be done while the system is running.

INTEGRATION

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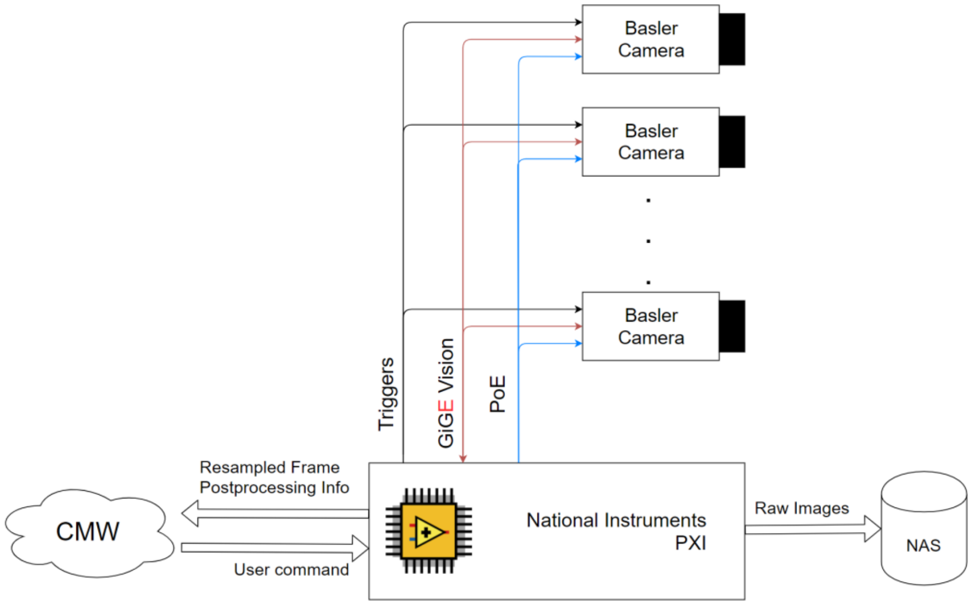

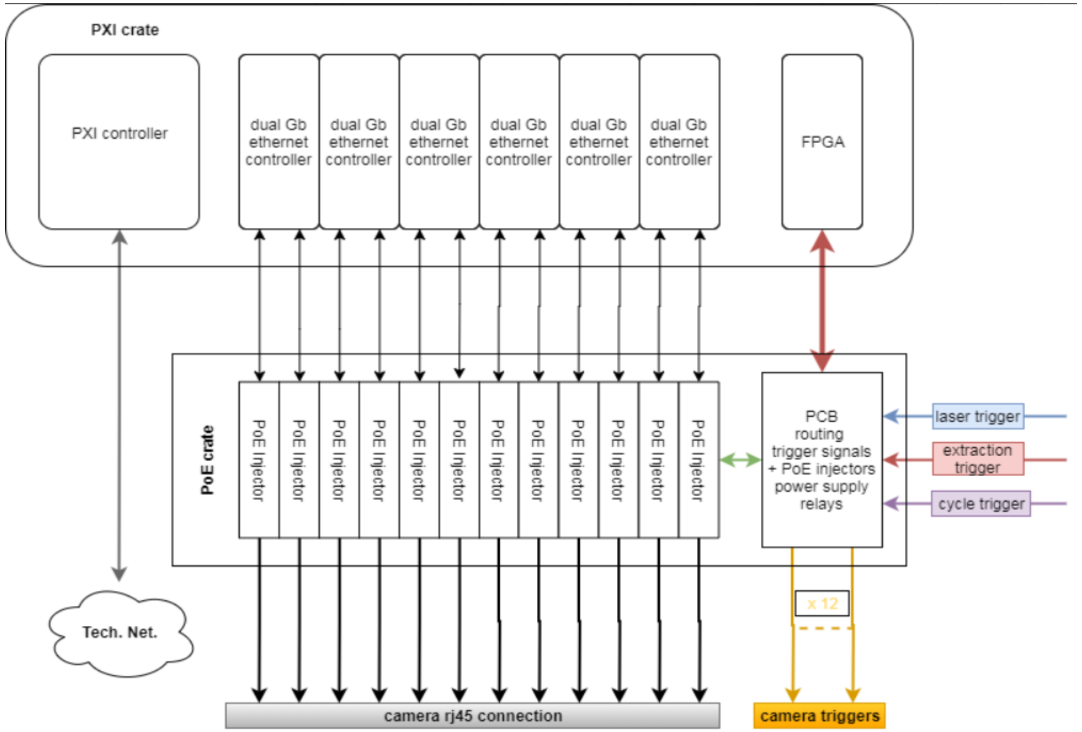

Each camera is connected to the PXI system and powered by a PoE (Power over Ethernet) module. The triggering is handled through the FPGA as shown in the hardware architecture

CONCLUSION

Switching from PharLap to NI Linux RT brought performance improvements, reducing both the general resource and CPU usage. The UNIX environment simplified library and system administration. It also allowed features that were missing from PharLap such as the 10 Gbps network drivers and the NAS.

The next challenges will be to increase the image post-processing speed in order to increase the resolution of the cameras. As a result of the operating system change, we can now benefit from newer FPGA cards dedicated to vision analysis, allowing us to offload some calculations from the CPU.