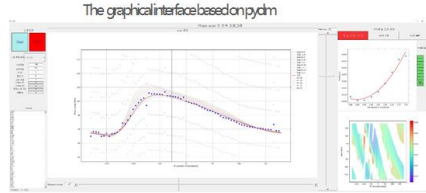


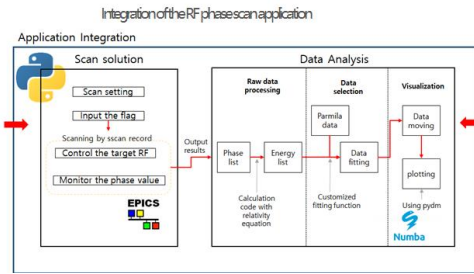
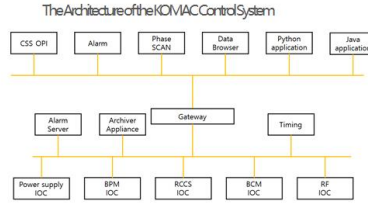
DEVELOPMENT OF THE RF PHASE SCAN APPLICATION FOR THE BEAM ENERGY MEASUREMENT AT KOMAC

SungYun Cho†, Jeong-Jeung Dang, Jae-Ha Kim, Young-Gi Song
 Korea Multi-purpose Accelerator Complex, Korea Atomic Energy Research Institute, Gyeongju, Korea

• The purpose of the development

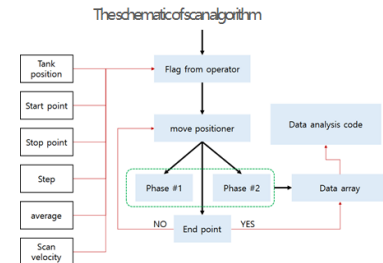


- The KOMAC has been operating the 100MeV proton linear accelerator
- The output beam energy from each drift tube linac (DTL) can be changed by the operation RF phase
- The original phase scan application was developed on the Java eclipse and the analysis application was developed on the Matlab
- The integration application has been developed based on Pydm and EPICS
- The interface has been implemented using pydm which works with the Signal & Slot
- The goal of development is high implementation and rapid data analysis speed similar to the original

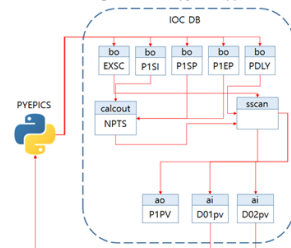


• The phase scan using sscan record

- The EPICS sscan record has a function to move positioners and record detector data at each of the positions
- The sscan record is similar to the original algorithm based on Java
- The positioner is the moving parameter for the phase setting
- When the moving of the positioner is finished, the data analysis code will be started
- The EXSC field is a flag signal for sscan record processing
- Because the NPTS is the number of points in a range of between the PISP and P1EP fields, the step can be changed by the custom function from the NPTS using calcout record
- The detector record such as D01pv can monitor the RF phase it can be outputted the array or scalar data

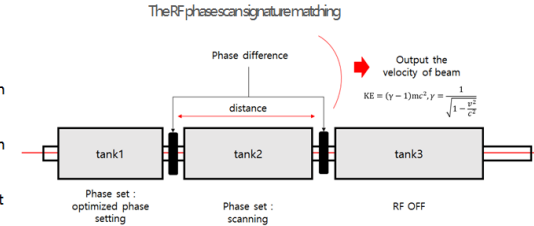


The EPICS record and I/O signals from the python application

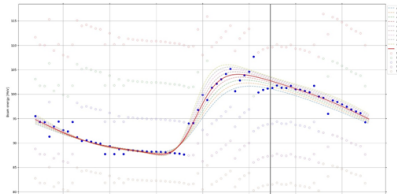


• How can the beam energy measure from the RF phase?

- The beam energy can be calculated by the phase scan signature matching
- The selected tanks are the target tank and downstream tank
- A scan experiment is conducted to change the phase set value from the setting range
- The BPM offset value is considered between -180 and 180 degree
- The velocity of the beam can be calculated from the phase difference
- The energy of the beam can be calculated according to Einstein's equation



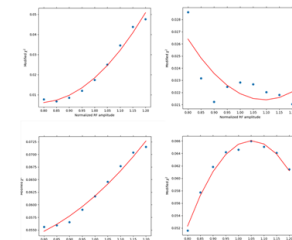
The beam energy from the measured RF phase



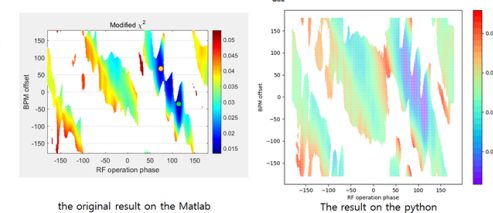
• The data analysis

- The measured results need to compare with the calculated results which are from the PARMILA calculation in order to determine the proper RF operating point
- The optimized RF operation phase can be determined from the minimum chi-square result that is calculated from each amplitude of parmila data
- If the scipy library is used in order to curve fitting, the calculation speed is slow remarkably
- The numba library is selected in order to rapid calculation processing similar to Matlab code
- Since the scipy library can't be used in the environment of numba, the custom fitting function needs to be built
- The quadratic gradient of the fitting function can determine whether it is concave or convex
- The key of time reduction is just to do discrimination action in the loop except set up an equation
- The determining of the optimized point isn't problem on the new calculation code whether the data fitting function was accurate

The fitting results of the measured results

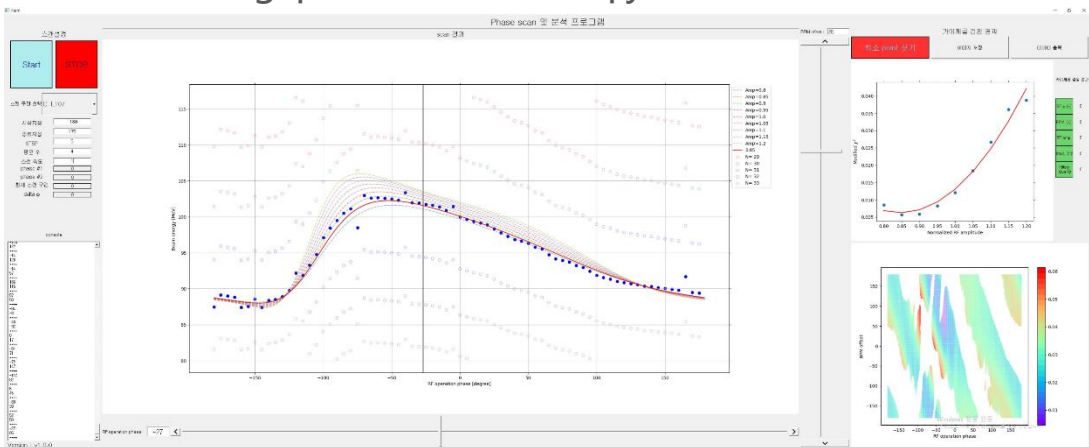


The result of the chi-square for finding the optimized RF operation phase compared with original result

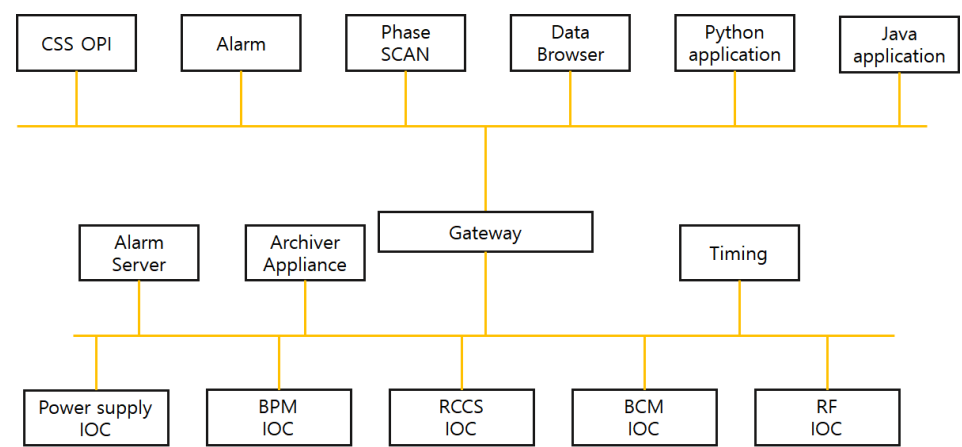


The purpose of the development

The graphical interface based on pydm



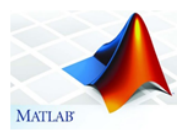
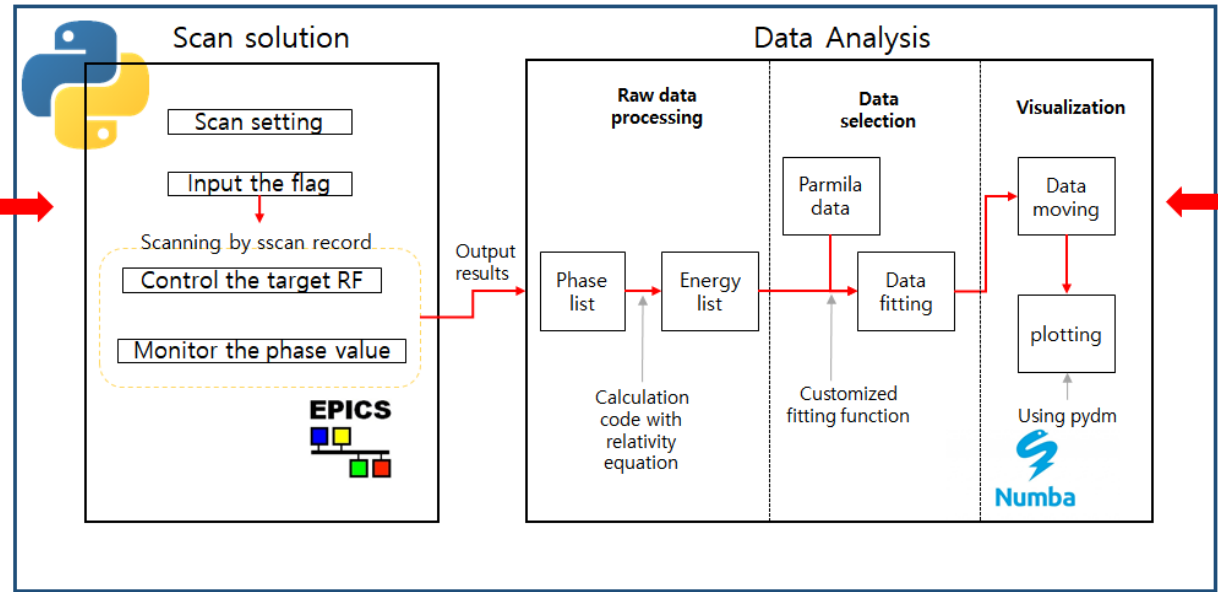
The Architecture of the KOMAC Control System



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Integration of the RF phase scan application

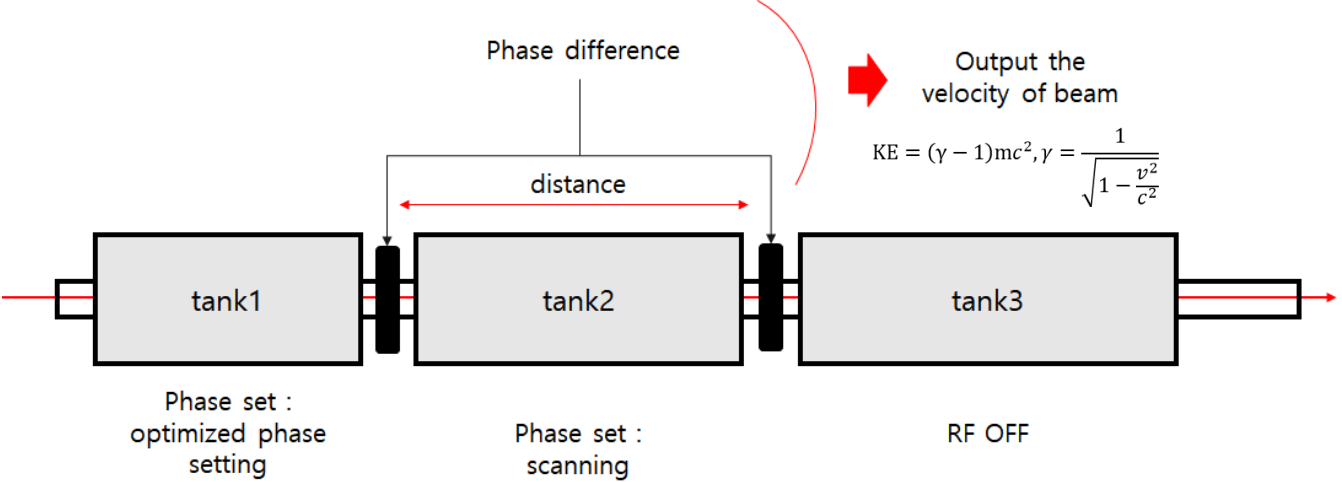
Application Integration



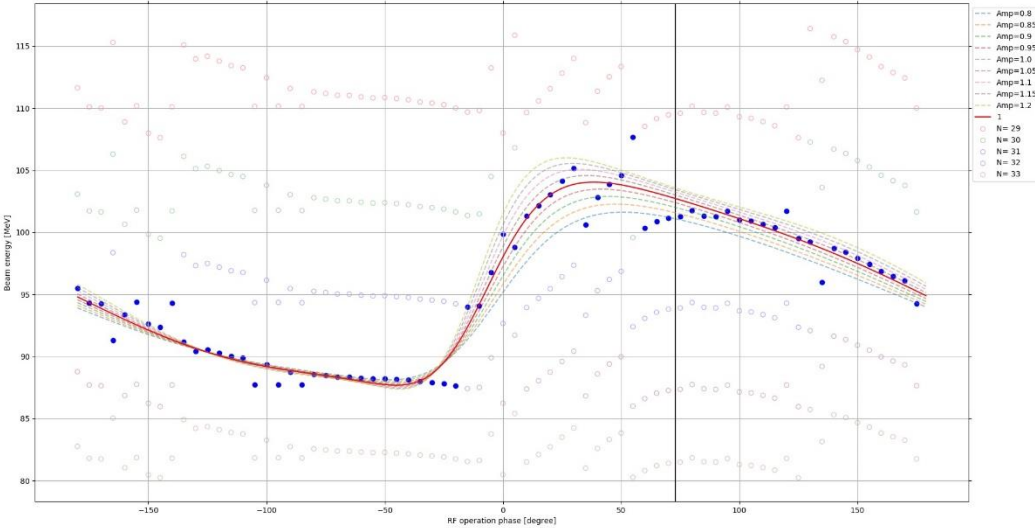
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The RF phase scan signature matching



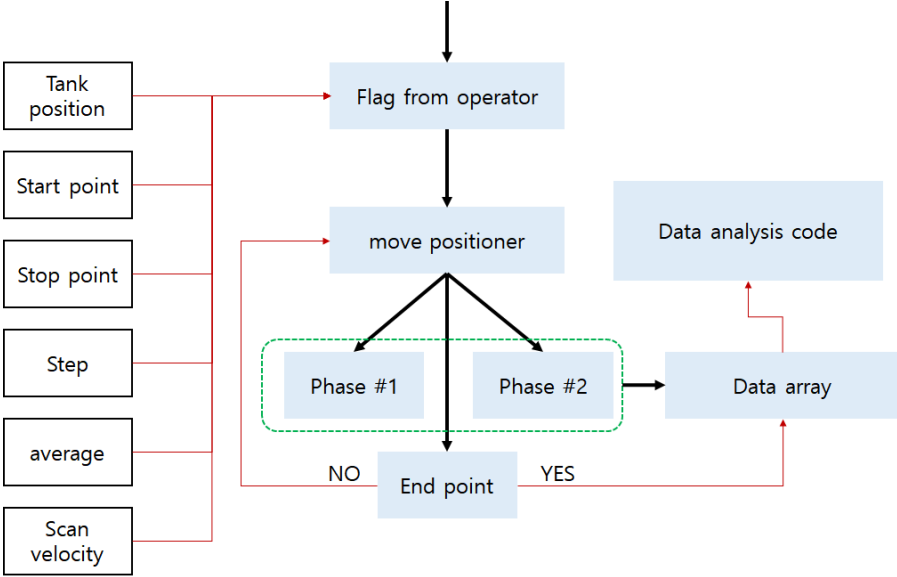
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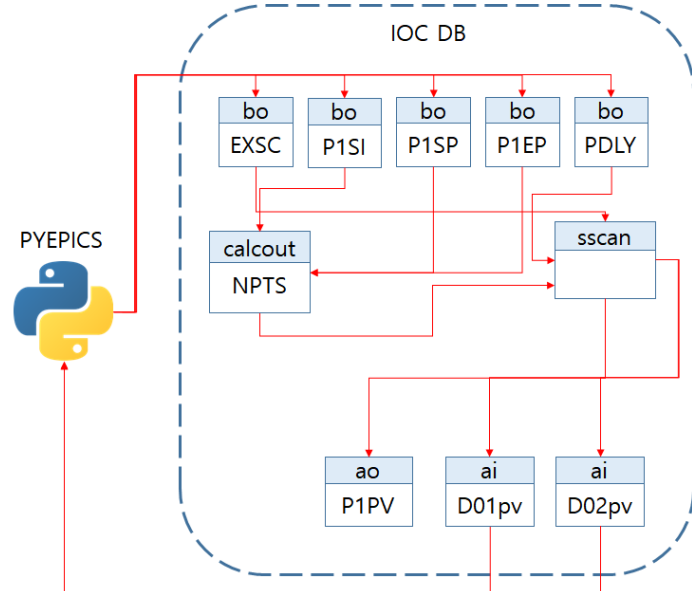
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The schematic of scan algorithm



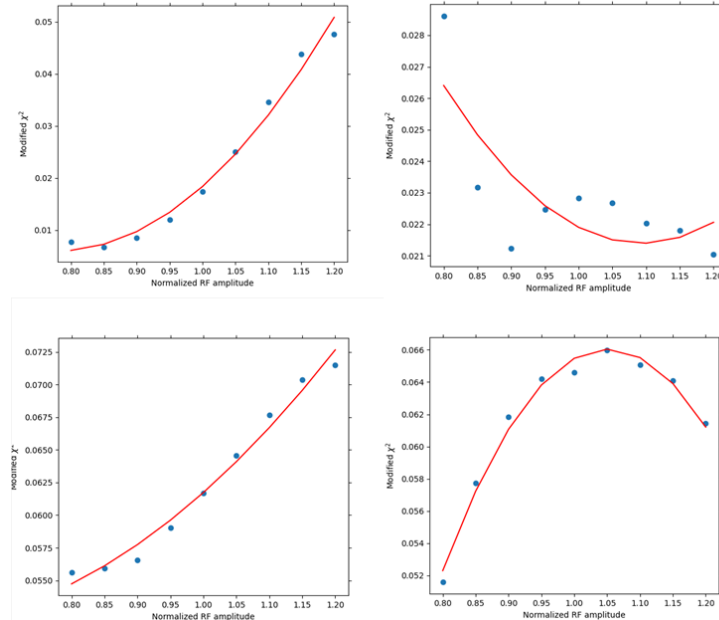
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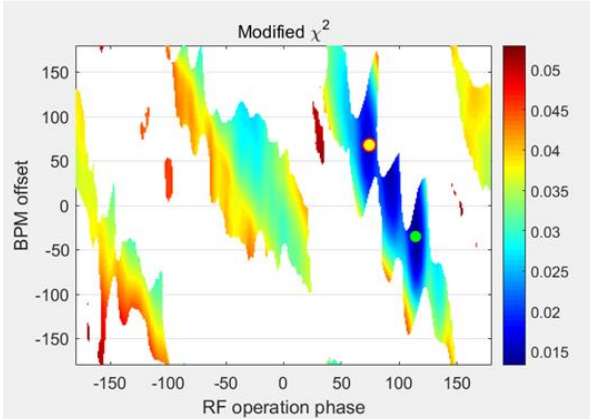
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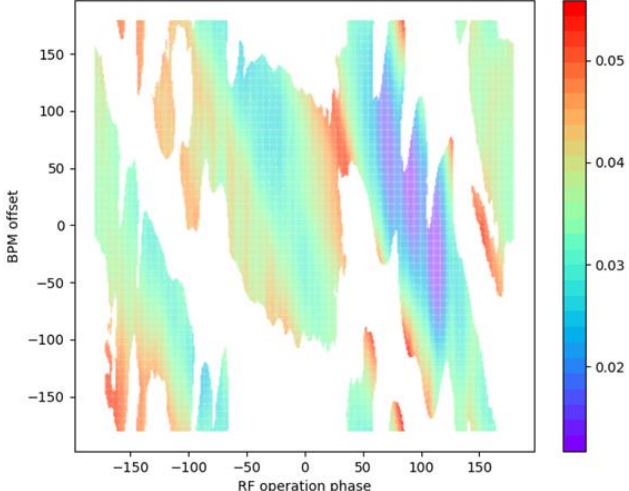
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the original result on the Matlab



The result on the python