

# Integrated Data Acquisition, Storage and Retrieval for Glass Spherical Tokamak (GLAST)

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## ABSTRACT

- A steady state Data Acquisition (DAQ) system for Glass Spherical Tokamak (GLAST) is presented here.
- This system is established to acquire, display, store and process the data attained from different diagnostics which are helpful for plasma startup studies.
- This poster presents the evolution of the hardware setup and software implementation of the DAQ system for GLAST Tokamak.

## BACKGROUND

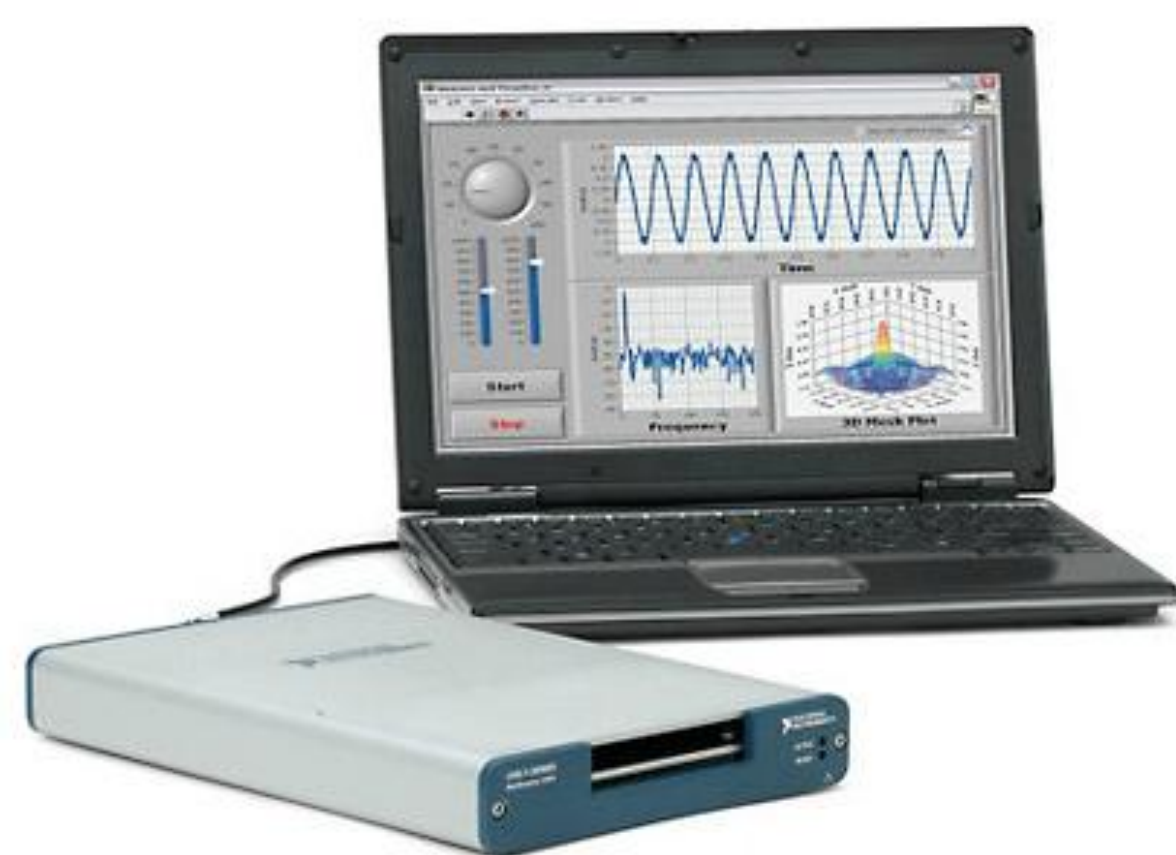
- GLAST is a series of Glass Spherical Tokamaks (GLAST I, II & III) with insulating vacuum vessel. The major radius (R) and minor radius (r) of the chambers are {(15cm, 9cm), (15 cm, 9cm), (20cm,10cm)} respectively.
- The purpose of these experiments is to understand the startup of the plasma and sustaining it for a sufficiently long time.
- Initially a 12 channel data acquisition system comprising of oscilloscopes (TDS and MSO series of Tektronix) served the purpose to acquire the data from very basic diagnostics, i.e., Rogowski coil for plasma current, loop voltage, plasma flux loops, langmuir probe, microwave intensity, photodiodes, Toroidal Field (TF), Central Solenoid (CS) and Poloidal Field (PF) load currents etc.
- A 16 Channel DAQ system using NI-6363 USB X series DAQ cards and indigenously developed signals conditioning module has been added in the prevailing data acquisition system.
- The software layer is developed using LabView and Matlab.
- The main features of the DAQ system include system configuration, shot implementation, data saving, data presentation and data sharing between connected users.

## DAQ PLATFORM

### DAQ Hardware

DAQ Hardware comprises of:

- **Signal Conditioning Modules** (Buffers / Gain/ Attenuation stages) developed on site using Texas Instruments' low noise operational amplifiers OPA-637.
- **National Instrument's DAQ Card (NI-USB 6363)** having 16 bit resolution and 32 (single ended)/ 16 differential analog voltage inputs, 48 digital I/O and sampling rate of 2MS/s.



NI-USB 6363



Signal Conditioning Module

### DAQ Software

It is responsible for real time control of Input Range, Input type (Diff. or Referenced Single Ended (RSE) or Non-RSE) and Acquisition Speed. DAQ Software comprises of:

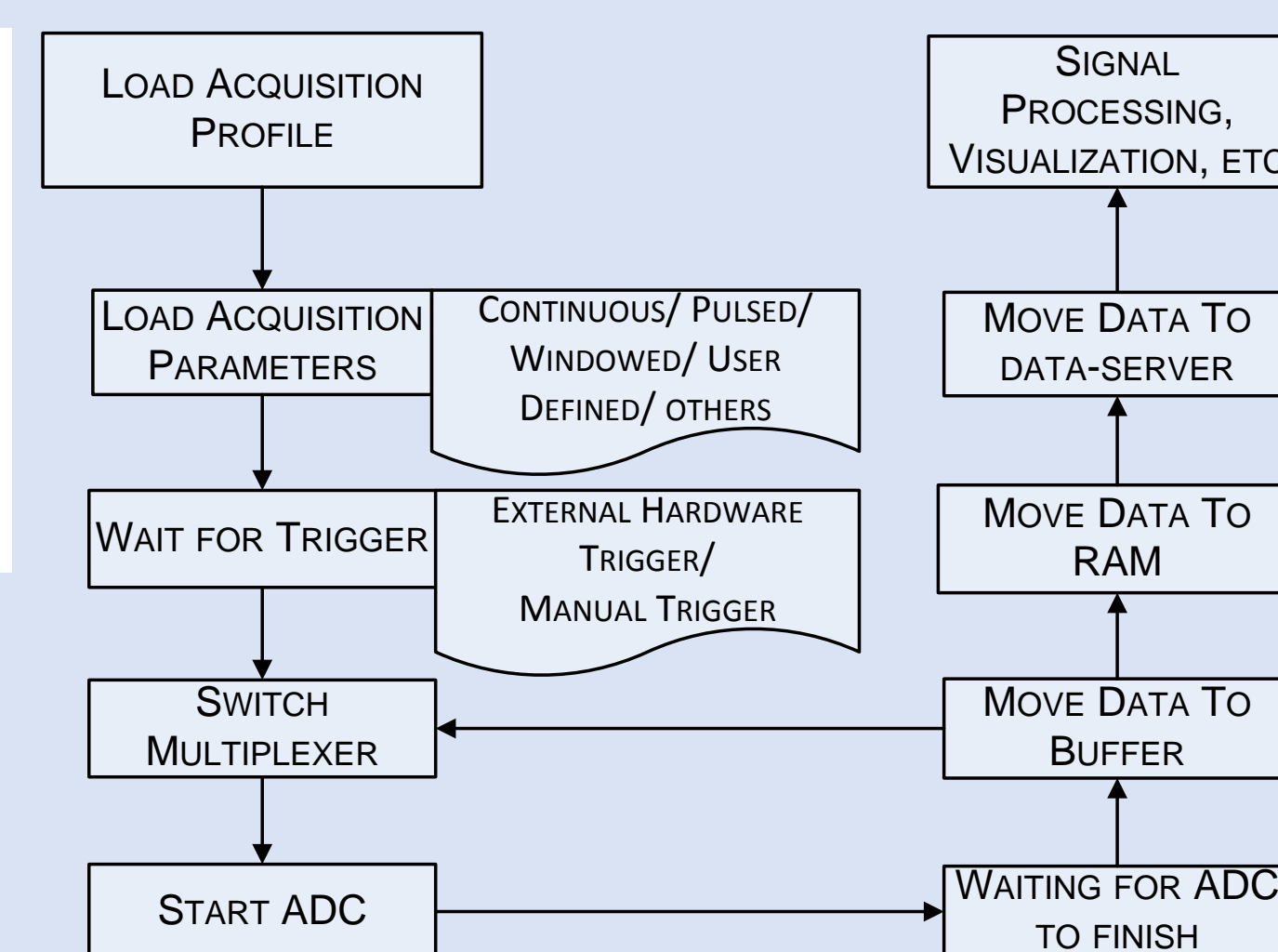
- **Labview** for software layer development of the NI DAQ hardware.

It includes the shot configuration GUI, routines for acquiring and saving the data to database and presentation of the acquired data.

- **Matlab** for the post processing of the acquired data, i.e., numerical integration of magnetic diagnostics data.

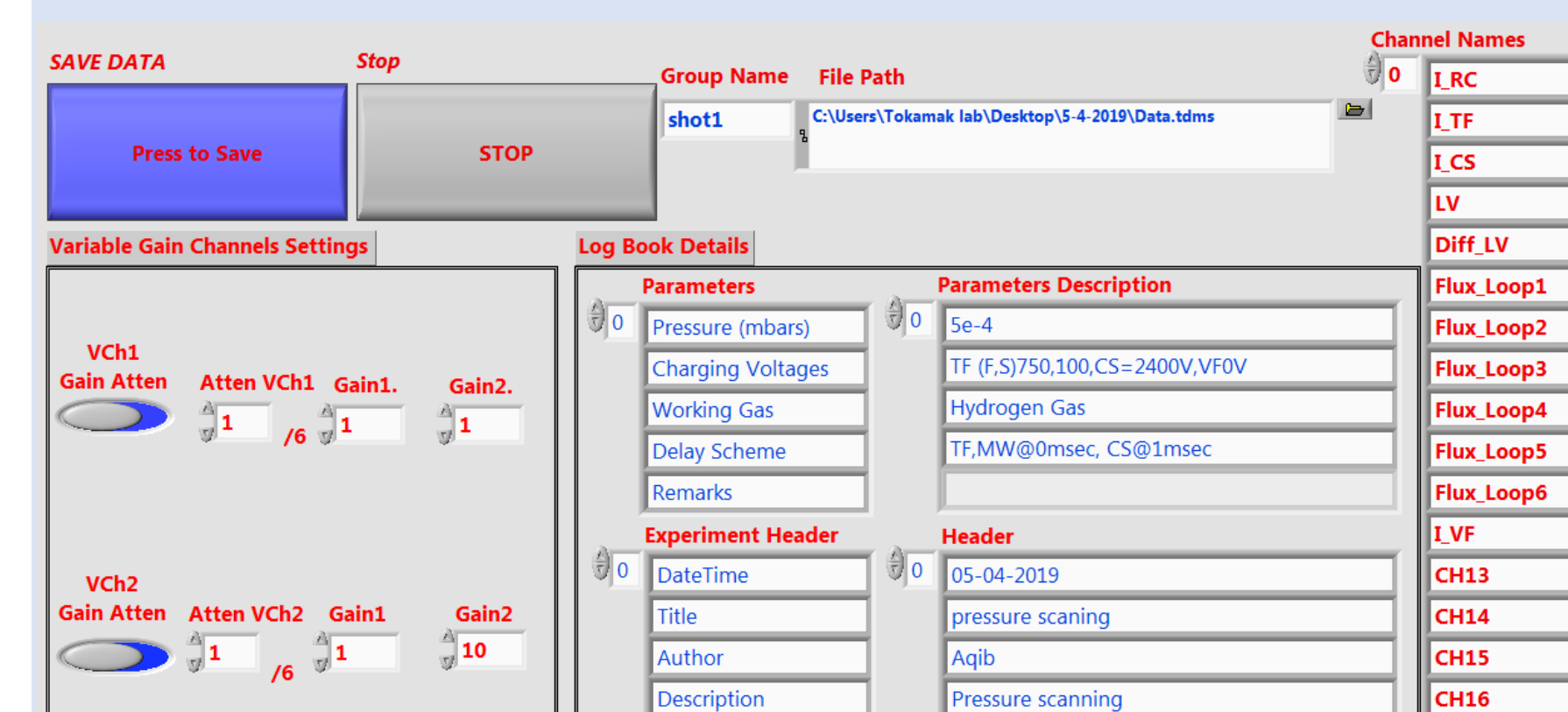
## DATA ACQUISITION CYCLE

- The acquisition process starts from loading the acquisition profile and parameters. The operator enters the particulars about the shot.



- An on site developed trigger and timing center generates the trigger for different systems and instrumentation.

- After the issuance of trigger, the acquisition process starts and ends with data stored in database and signals display on display panel



## DATA STORAGE

- Technical Data Management Streaming (TDMS) is introduced in LabView for the purpose of logging the measurement data. GLAST DAQ system uses the same for experimental data format and storage.
- TDMS file contains two types of data: Meta data & Raw data.
- Meta data contains the information about the channels, their properties and groups properties etc. It also serves as a log book of GLAST experiments containing information about each shot, i.e., delay schemes between firing of capacitor banks (TF, CS, PF field coils, Microwaves etc.) & Working Gas and Pressure, remarks about shot etc.

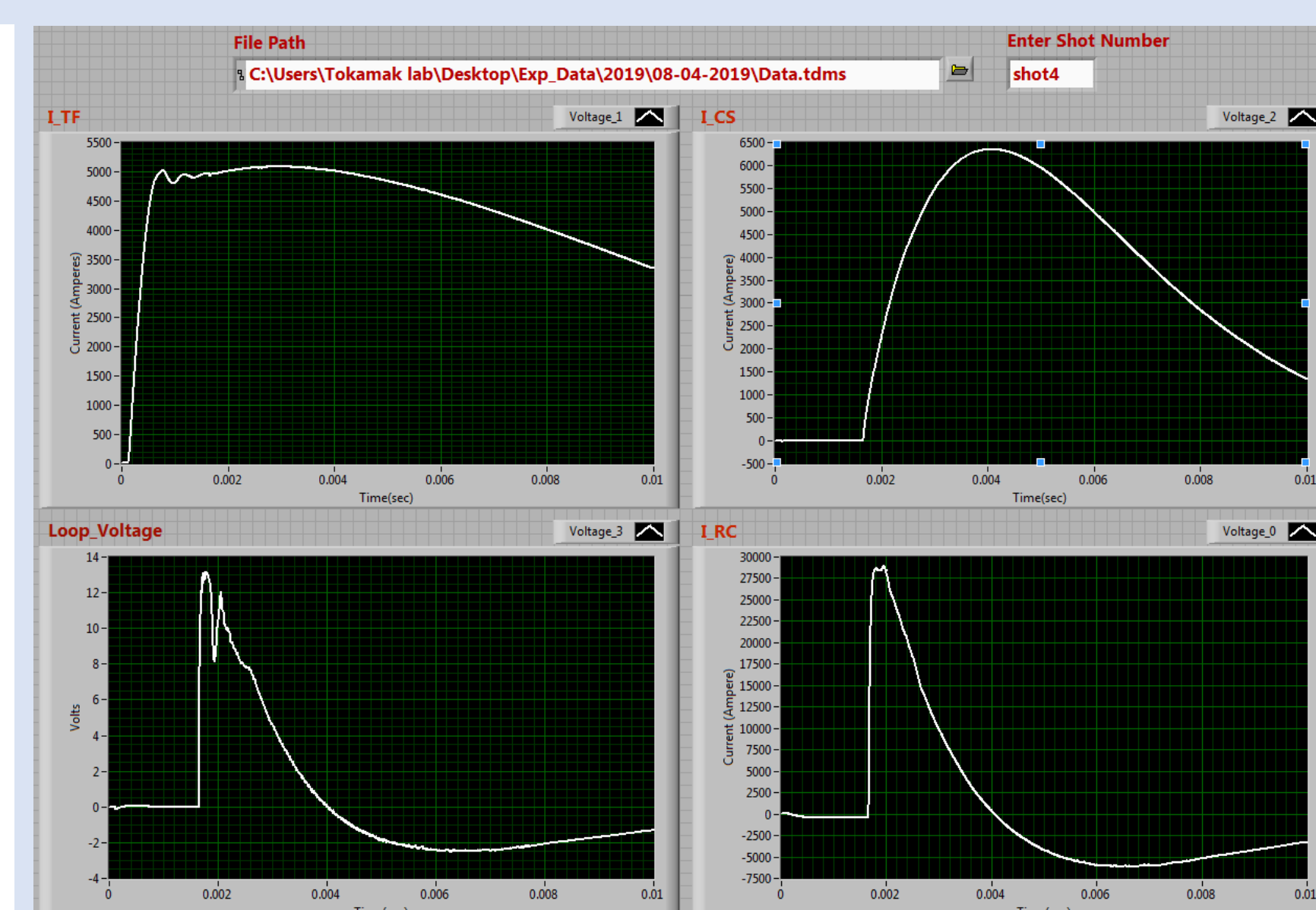
Root Name	Title	Author	Date/Time	Groups	Description
Data	pressure scanning	Aqib	05/04/2019 12:00:00 AM		Pressure scanning by using TF, CS and hydrogen gas
Group	Channels	Description	Charging_Voltages	Delay_Scheme	Pressure
shot1	16	TF # (S)750,100,CS-2400V,VF0V	TF.MV@Imsec,CS@1msec	Pressure	Vacuum Status
shot2	16	TF # (S)750,100,CS-2400V,VF0V	TF.MV@Imsec,CS@1msec	2 exp -4	Hydrogen Gas
shot3	16	TF # (S)750,100,CS-2400V,VF0V	TF.MV@Imsec,CS@1msec	2 exp -4	Hydrogen Gas
shot4	16	TF # (S)750,100,CS-2400V,VF0V	TF.MV@Imsec,CS@1msec	2 exp -4	Hydrogen Gas
shot5	16	TF # (S)750,100,CS-2400V,VF0V	TF.MV@Imsec,CS@1msec	2 exp -4	Hydrogen Gas
shot6	16	TF # (S)750,100,CS-2400V,VF0V	TF.MV@Imsec,CS@1msec	2 exp -4	Hydrogen Gas
shot7	16	TF # (S)750,100,CS-2400V,VF0V	TF.MV@Imsec,CS@1msec	2 exp -4	Hydrogen Gas
shot8	16	TF # (S)750,100,CS-2400V,VF0V	TF.MV@Imsec,CS@1msec	2 exp -4	Hydrogen Gas
shot9	16	TF # (S)750,100,CS-2400V,VF0V	TF.MV@Imsec,CS@1msec	2 exp -4	Hydrogen Gas
shot10	16	TF # (S)750,100,CS-2400V,VF0V	TF.MV@Imsec,CS@1msec	2 exp -4	Hydrogen Gas
shot11	16	TF # (S)750,100,CS-2400V,VF0V	TF.MV@Imsec,CS@1msec	2 exp -4	Hydrogen Gas
shot12	16	TF # (S)750,100,CS-2400V,VF0V	TF.MV@Imsec,CS@1msec	2 exp -4	Hydrogen Gas
shot13	16	TF # (S)750,100,CS-2400V,VF0V	TF.MV@Imsec,CS@1msec	2 exp -4	Hydrogen Gas

- Raw data contains the actual data samples of all DAQ channels.

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## DATA PRESENTATION

- A dedicated Virtual Instrument (VI) has been developed to view the data from the experimental shots.
- This GUI also provides the basic mathematical operations to be performed on data of different channels.



## CONCLUSION

- A plug and play Data Acquisition System has been built using National Instruments DAQ Cards.
- The acquisition, storage, data presentation and retrieval are the integral part of GLAST DAQ system.
- Experimental Physics and Industrial Control System (EPICS) based experimental control is the next task for GLAST experiments.

## ACKNOWLEDGEMENTS / REFERENCES

- Asenjo, J., Vargas, V. I., & Mora, J. (2018). Control and data acquisition system for SCR-1 Stellarator. *Fusion Engineering and Design*, 129, 263-268.
- Ling, B. (2013). Multi-channel data acquisition system based on LabVIEW. *Nuclear Electronics and Detection Technology*, 33(1), 19-22.