Summary:

Diagnostics & Actuators

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FILTERSCOPE IMPLEMENTATION DURING FIRST OPERATIONS AT KSTAR

Filterscope status and plans (D. Hillis, ORNL):

- **Initial measurements of D-alpha recycling from inboard limiter in first KSTAR discharges. Has a fully operational diagnostic and data acquisition system and several people spent time on site to establish this**
- **Filter system to measure Z_eff and impurity monitoring system can be promoted in the context of the current program.**
- **Array for divertor system can be assessed by two parties to come up with with port and fund.**
- **Proposes an "Ohmic H-mode" experiment to provide interesting result for IAEA.**
- **Pellet injector available and could be installed (ENEA/ORNL project). Question of need, timing and budget. Interest in high-field side pellet injection.**
- **Identified what has to be done for the high field side launcher: test of the pipe to be installed on KSTAR and tested on the ORNL injector system ($15k). This fund can raised either from US or KSTAR.**
- **Very interesting experience as first remote collaborator: Generally positive, but required some 3 months to gain network access to data from outside of KSTAR laboratory. Need to establish a remote access plan for all collaborators**

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ADVANCED VISUALIZATION DIAGNOSTICS - I

- **ECEI & MIR (C. Domier):**

  ECEI has successfully obtained very intriguing Te fluctuation images from TEXTOR showing the high-field-side effects of sawteeth on temperature inversion, and energy outflow, contrary to most theoretical models of reconnection:

  - Demonstrates the value of direct imaging for elucidating new physics

- **Moved system to AUG, and developing a system for DIII-D.**
  KSTAR design well under way for 2 & 3.5 T systems, mulitichannel (up to 768) for 2D ECEI measurements

- **MIR and MDIR (Microwave Doppler Imaging Reflectometer) for KSTAR plans underway**

- **This work will be well matched with the POSTECH proposal, to be decided in May**

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ADVANCED VISUALIZATION DIAGNOSTICS - 2

BES (G. McKee):

- **Core and Edge 2D density fluctuation/turbulence imaging capability**
- **System deployed on D3D and being developed for NSTX**
- **KSTAR can benefit from similar spectral features and new preamplifier electronics**
- **KSTAR Port M optics, window and lens pre-conceptual design developed**
- **Port space and necessary viewing throughput a challenge, but can be achieved**
- **Window material an issue, thin first window possibility**
- **Shutter activated during discharge?**
- **Together with CER/MSE system on the same cassette, this will be reinitiated since NBI program on KSTAR is accelerated.**

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ADVANCED VISUALIZATION DIAGNOSTICS - 3

X-ray imaging spectroscopy (Choe (KAIST) / Bogatu (FAR-TECH):

- **A many-channel system (e.g. 240) can provide detailed measurements of MHD, transport, impurity profiles**
- **AXUV diodes/in vacuum preamps are an enabling technology**
- **Multi-color concept with 50 micron/250 micron Be filter for narrow spectral isolation**
- **X-ray Ross Filter: Difference signal, if well-balanced, is a very narrow band filter, can provide very fast measurements of impurity evolution and transport during Sawteeth, ELMs.**
- **Perhaps there will be funding from KAIST side and hope US side will do the same.**

ADVANCED VISUALIZATION DIAGNOSTICS - 4

Visualization data analysis (T. Munsat, Colorado Univ.):

- **"Rich, dense" data sets from visualization diagnostics (SXR, BES, ECEI) can provide information on many details of the nonlinear dynamics of turbulence and related phenomena**

- **Application of techniques such as Bi-spectral analysis:**
  Examines nonlinear coupling by measuring the phase coherency of modes satisfying $\omega_1 + \omega_2 = \omega_3$ and $k_1 + k_2 = k_3$, i.e, are there nonlinear interactions taking place

  - *Can be utilized to compare more directly with models/simulations of instability dynamics*

- **Velocimetry methods can track motion of turbulent eddy structures, which provides another field of fluctuation characteristics that provides flows and can be compared with models.**

- **This program will also be supported from POSTECH program and hope the US side can do the same. This was pushed forward in 2007 US-KSTAR program and did not go through.**

- **This brings up a very important issue:**

  If, by chance, we are successful in deploying and implementing these advanced visualization diagnostics, what do we do with the resulting data stream?!? Tremendous physics insight with proper resources

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ECCD/LHCD LAUNCHER STATUS

ECCD Launcher/LHCD status (B. Ellis):

- **Presented a 2-year diagnostic work plan**
- **Has successfully developed multiple ECCD launchers for DIII-D.**
- **For ECCD launcher, KSTAR may take a fast track without cooling system, which will be delivered in time with less funding.**
- **POSTECH program includes this together with the key LHCD work for the design of the critical parts.**

DISCUSSION - I

- ORNL needs to know what to do about pellet injection. KSTAR needs this capability, but will not need until they obtain high-density discharges that can benefit from pellet fueling
- High-field side capability should be implemented soon and doesn't require large funding
- Divertor viewing system should be implemented, in sync with divertor installation.
- What diagnostics needed to ascertain H-mode? (Filterscopes, density, pedestal?)

DISCUSSION - 2

- **CER/MSE/BES are strongly integrated: share a small, narrow port (Bay M) that views beam with very good geometry for optimized spatial resolution.**

  - *Windows, shutters, optics, fibers layout needs to be integrated. Thought is that perhaps KO fabricates port, while US provides diagnostic optical tables, optics, etc. Need to know shutter requirements, capabilities: BES requires large (8" window), should be shuttered during discharge (if t_pulse > 10 sec.) can this be implemented.*

- **Anticipating need in 2012-2013, given beam deployment.**

- **KSTAR needs to know beam modulation requirements for diagnostics to specify power supplies. Suggested to 50 Hz (10 ms on/10 ms off) modulation is useful for CER background subtraction. Faster would be better.**
  For BES, no modulation required

- **What is the structure of NFRI, KO University programs and US university programs, collaborations, programs, funding stream?**

DISCUSSION - 3

Data Archival:

- **Will "Mega" data storage be available (Peta data storage?).**
  With multi-channel, high-speed and very long pulses, data records have the potential to become enormous.

- **Data acquisition requirements, standards, limitations?**

- **Data archival? Ultimately the data is the experiment. How will it be archived, secured and access provided?**
  Sentiment is that each diagnostic provides it's own data acquisition system, but that permanent archival, access and storage is responsibility of KSTAR program.

- **Networking, timing, clocks, need to be provided.**

- **Uniform control packages (e..g, Labview), or does each diagnostic provide its own?**

- **Data analysis (e..g, IDL very common among US fusion scientists.**
  Will we be able to access data and process with IDL codes?)

DISCUSSION - 4

- **Computer support by KSTAR program? Needs to be local.**
- **Contacts need to be established at KSTAR and remote collaborators. US collaborators in particular will need an on-site contact to coordinate many issues.**
- **The collaborators view their work as part of a scientific program, not just a collection of hardware**
- **Possible need for Memorandum of Understanding between collaborators and KSTAR as to data access, guidelines, usage, analysis, presentation, reports, publications.**
  A "Data Usage Policy" would be useful. This is down the road, but never too early to discuss.

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