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Tokamak Neutron Diagnostics Based on the Superheated Fluid Detector (SHFD)

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Rezumat

1. A fost elaborata o solutie constructiva pentru un model experimental de unitate de detectie mono-canal bazata pe detectori cu fluid supraîncălzit (DFSI). Lantul mono-canal de detectie va utiliza un sistem de inregistrare si transmisie in format video a imaginii detectorilor cu fluid supraincalzit. Sistemul se bazeaza pe componente video comerciale si a fost conceput pentru achizitionarea si transmisia imaginilor la distanta (peste 50 m).

Principalele componente ale modelului experimental de unitate de detectie cu DFSI sunt:

-set de detectori tip DFSI
-sistem optic de preluare a imaginii detectorilor
-camera video tip DMK21 BF04
-convertori tip OL1394sc
-cablu optic
-interfata IEEE1394a
-PC dedicat

Sistemul urmeaza a fi asamblat si testat in semestrul 2, 2006.

2. Au fost efectuate doua teste de masura a fluentei de neutroni la instalatia JET utilizand cate doua seturi de detectori cu fluid supraîncălzit (DFSI). In ambele teste nu s-a inregistrat un semnal util datorita nivelului scazut al fluentei de neutroni. Fluenta scazuta a fost determinata atat de nivelul redus al emisiei de neutroni cat si de distanta mare la care au putut fi amplasati detectorii (in afara halei tokamak, la capatul liniei optice KH2). Programul experimental de la JET din primul semestru 2006 nu a mai permis alte teste.

Part 1 Experimental Model for a One-channel SHFD Detection Unit

1. Introduction

The conceptual design of a Superheated Fluid Detector Detection Unit (SHFD-DU) was presented in [X] and its main components are shown schematically in Fig. X.

The collimated neutrons are detected by the superheated fluid detector (SHFD), the detection process being followed by the generation of gas bubbles within the detector. The neutron fluence (neutrons/cm^2) is measured by counting the generated bubbles recorded on the detector image. Within the SHFD Detection Unit, the detector image is projected on an image capture device (a CCD or CMOS chip) whose data is acquired and (temporarily) stored locally. The image data is transferred by a high-speed data line to a remote, high capacity, image processing and analysis computer system. From the processed SHFD image the time resolved neutron fluence is determined with a time resolution limited by the SHFD response.

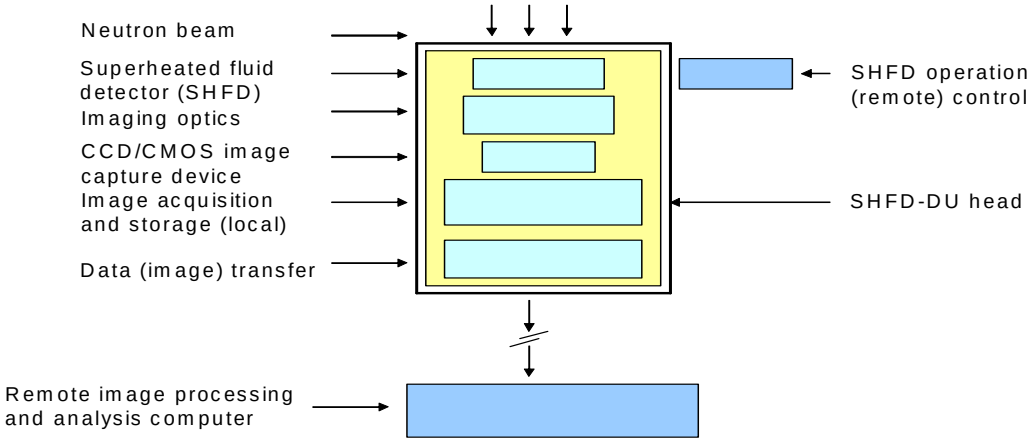

Fig. X Proposed structure of a SHFD Detection Unit (SHFD-DU)

The design and construction of a SHFD-DU with the structure proposed in Fig. X is strongly dependent on the parameters and especially the geometry of the detectors. Custom designed and built detectors are needed, and these would require substantial research and development. It was thus proposed to use commercially available SHFD's, the so-called "bubble detectors", for a first implementation of a neutron detection unit: an experimental model for a one-channel SHFD detection unit (Fig. Y). One important feature of the proposed experimental model is the possibility of remote (distance of over 50 m) acquisition and transfer of the detector image.

2. Experimental model

The neutron flux generated by a fusion plasma is detected by a set of bubble detectors placed as close as possible to the plasma neutron source (Fig. Y).

The image of the detectors containing the bubbles generated by the neutron flux is optically focused to the surface of the CCD image detector. Various combinations of lenses and optical rings are to be used in order to accommodate the different shapes and dimensions of the neutron detectors. The detectors will be illuminated by an external light source.

The detector optical image is digitised by a 12 bit ADC converter, and then converted in a standard IEEE 1394a bit stream. These operations are done by means of the DMK21BF04 video camera.

The IEEE1394a electronic digital image is converted to an optical cable signal by the OL1394sc converter. This device will transmit the bit stream at 400MB/s to another OL1394sc device, which, in turn, will convert again the signal to the standard IEEE1394a. Finally the detector image data is transferred to a dedicated PC by means of a IEEE1394a interface.

3. Future work

The main components of the experimental model presented in Fig. Y have been purchased and the detection channel will be assembled during the second half of 2006. It is proposed to test the operation of the experimental model on a smaller fusion plasma device (the IPF-2/20 plasma focus device at NILPRP, Magurele) before proposing its installation on a tokamak machine.

4. References

[X] V. Zoita, A. Patran, A. Pantea, I. Tiseanu, T. Craciunescu, G. Craciun
"Tokamak Neutron Diagnostics Based on the Superheated Fluid Detector (SHFD)"
Association EURATOM-MEdC, Annual Report 2005

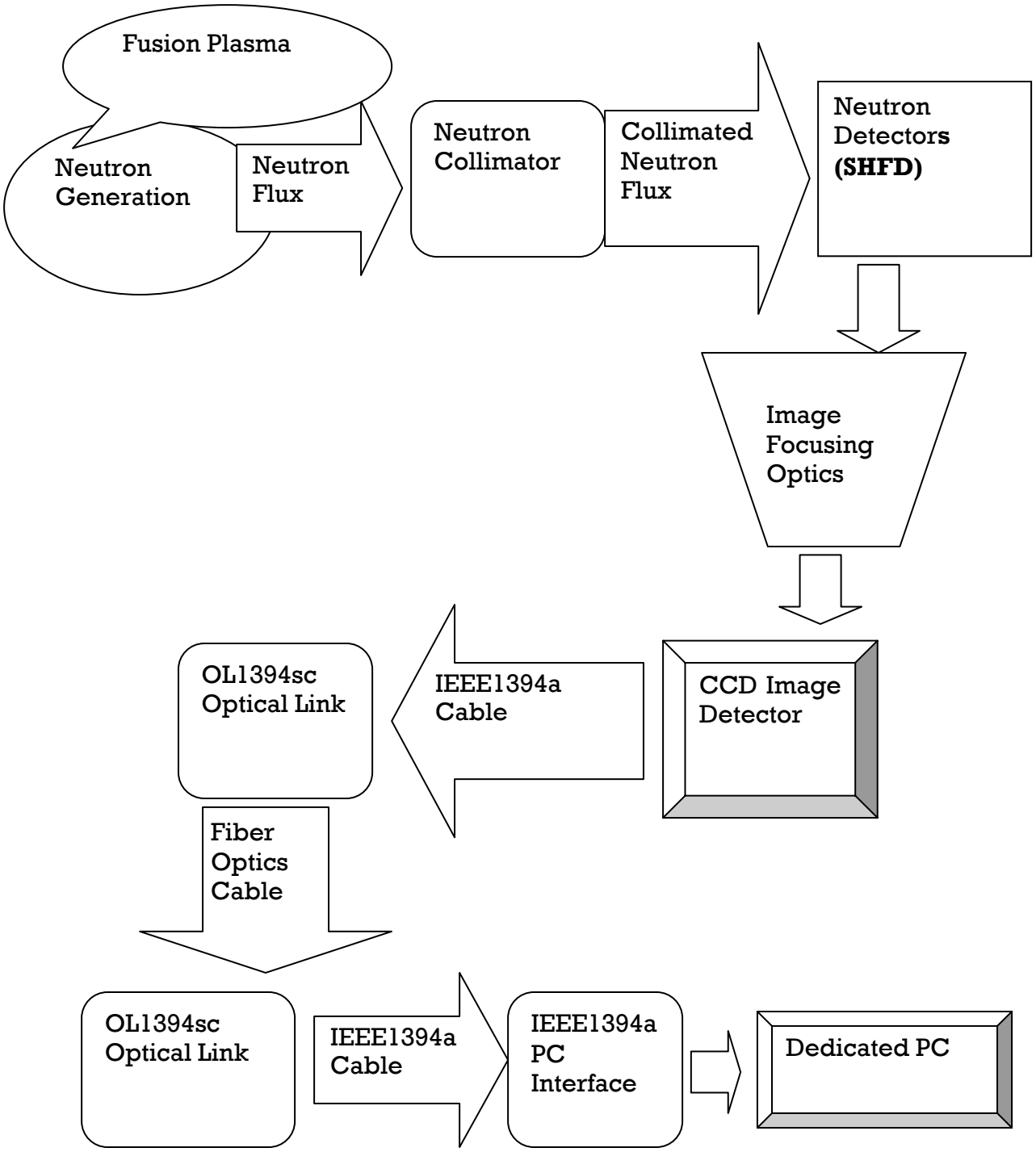

Fig.Y Block diagram for the experimental model of one-channel SHFD detection unit

Part 2 SHFD Tests on the JET Tokamak

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