A Charged Fusion Product Diagnostic for NSTX

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Goal of the Diagnostic:

- Obtain time-dependent information on the proton emission profile
- Achieve a time resolution down to 1-2 ms
- Provide new information on fast ion transport
- Potential for other ion detection: ^{3}He, ^{3}H
- Rev. Sci. Instrum. **81**, 10D301 (2010)

Principle

detect protons from:

$$d + d \rightarrow p + {}^{3}H$$

dominated by neutral beam and plasma ion interactions

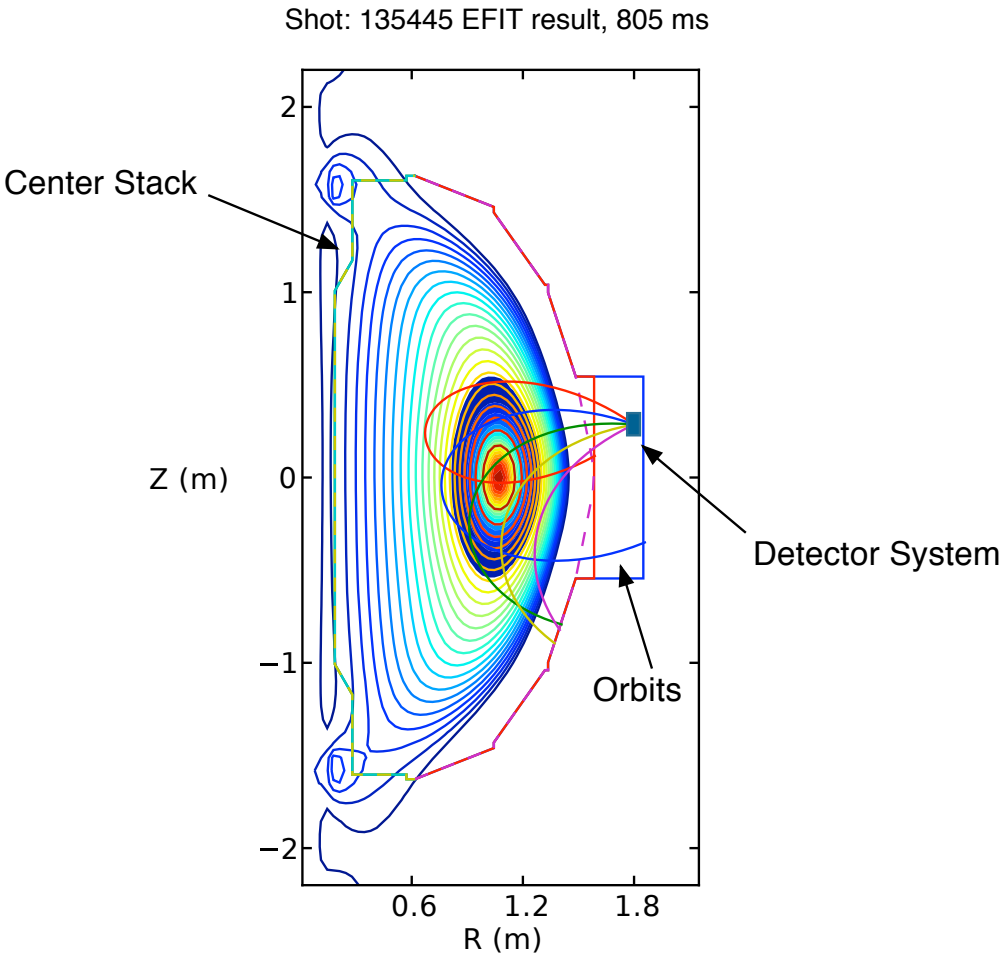
Kinematics:

T_p = 3.02 MeV
T_T = 1.01 MeV
p = 75 MeV/c

Advantage at NSTX:

- proton is not confined in the magnetic field of NSTX
- proton frequently does not complete a full gyro orbit before it exits the plasma
- proton trajectory similar to a view chord of an X-ray camera

Measurement technique:



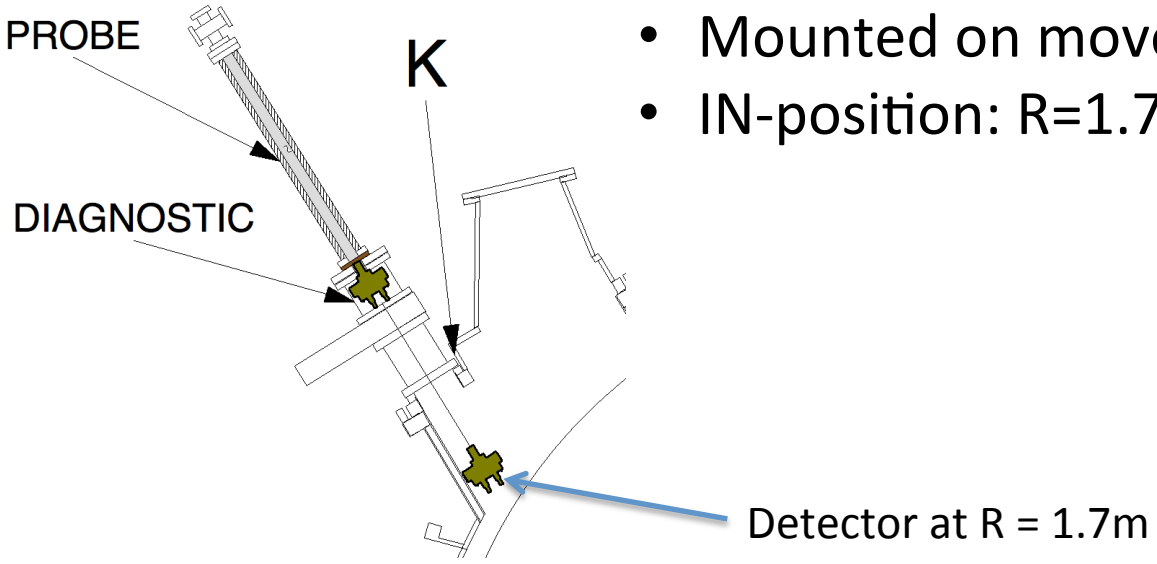
- array of proton detectors views different parts of the plasma
- each detector-collimator system defines a phase space volume
- proton orbits conserve phase space
- every proton emitted in the corresponding phase space volume is detected
- view path is determined by calculating the time-reversed proton orbit for a proton entering along the collimator-detector center line
- observed proton rate is a measure of the integrated emissivity along the view path

Proton measurements have been carried out previously:

- W.W.Heidbrink, J.D.Strachan, Rev. Sci. Instrum, **56**, 501 (1985)
- J.D. Strachan, Rev. Sci. Instrum., **57**, 1771 (1986)

Current Review: Prototype

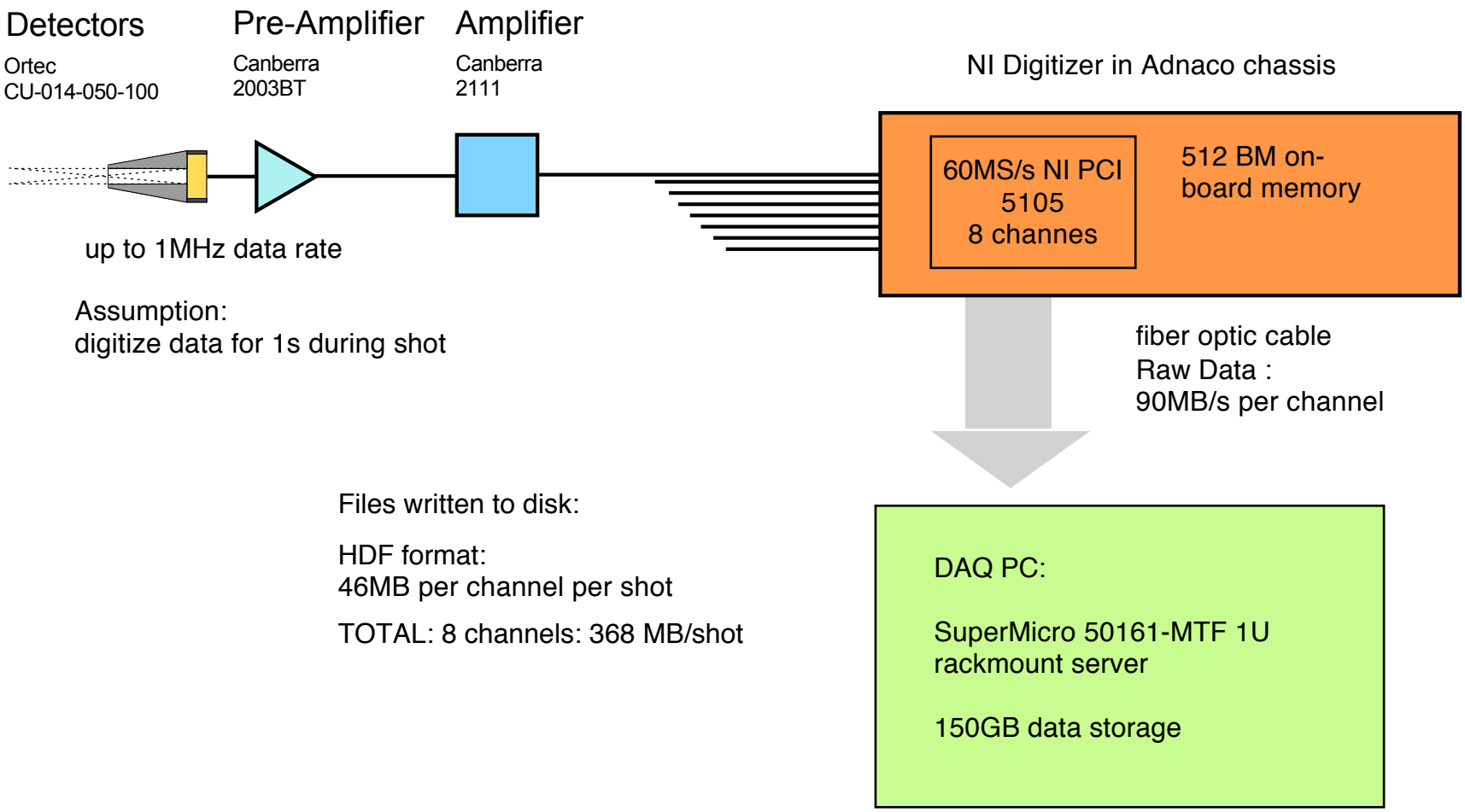
- Prototype: 2 detectors
- Flexible orientation around 3 axes
- Study signals and rates
- Optimize detector arrangement and location for full array of 8 detectors
- Location: Bay K
- Mounted on moveable probeshaft
- IN-position: R=1.7m, Z = 0.286m



Chits from PDR

1. Need to assess impact of possible data storage requirements on MDS+ and disk usage
2. Connector to diode pins need to be NSTX vacuum compatible including cables
3. Need to have a method to measure or confirm the angle of the detector housing with respect to the mounting shaft.

DAQ setup


Detectors
Ortec
CU-014-050-100
Pre-Amplifier
Canberra
2003BT
Amplifier
Canberra
2111
NI Digitizer in Adnaco chassis
60MS/s NI PCI
5105
8 channes
512 BM on-
board memory
up to 1MHz data rate
Assumption:
digitize data for 1s during shot
fiber optic cable
Raw Data :
90MB/s per channel
Files written to disk:
HDF format:
46MB per channel per shot
TOTAL: 8 channels: 368 MB/shot
DAQ PC:
SuperMicro 50161-MTF 1U
rackmount server
150GB data storage

Chit 1

Raw data rates:

- DAQ rates: 60MS/s 12 bit : 90MB/s uncompressed
- 500ms data at 60MS/s saved as compressed hdf file:23 MB ⇒ 46Mb for 1s discharge/channel
- 8 channels and 50 shots per day: 18GB/day
- 90Gb/Week or 4.7TB per year if raw data

Data reduction:

- Pulse height analysis of raw data
- Store data as pulse height and time sequence: uncompressed data reduction by a factor of ~10 ⇒ 470Gb/yr or 250Gb/yr compressed
- Pulse height spectrum for time slices: 1000 spectra with 1000 bins ⇒ 6.4MB/shot, 320MB/day, 1.6GB/wk, 83GB/yr (using CERN Root system)

- Raw data: stored locally
- Pulse height analyzed data stored on MDS+: 80 - 250GB/yr when instrument is continuously operated

Chit 2

- Detector is connected to coaxial cable via a BNC connector
- Cable and connector manufactured by Accu-Glass Products Inc
- Connection to vacuum feed through depending on standards used in NSTX
- Possibility: Accu-Fast 500 & corresponding vacuum feed through
- Phosphor Bronze washer inside the detector is not expected to be a problem

Accu-Glass Assemblies

Properties of Accu-Glass Cable & Connectors

- Materials: SS, Kapton, PEEK
- Max. Bake Temp. :250C
- Max Operating Temp. : 250C
- Max. Vacuum Level: $1x10^{-10}$ Torr
- Wire Gauge: 26 AWG
- Contact Material: BeCu, Au-plt
- Part Number: 110181.53 (with Accu Fast)
- Part Number: 110776 (without Accu Fast)
- Length 39”

Chit 3

- Assortment of installable stops allow the detectors to be oriented in predetermined angles when not in vacuum
- Angles are measured before installation
- Stops are installed temporarily to align the detectors
- Not used in vacuum
- Stops are used in both axes
- See R. Valenzuela Perez presentation