Study of CHI Mechanisms by the Dynamo Probe Head

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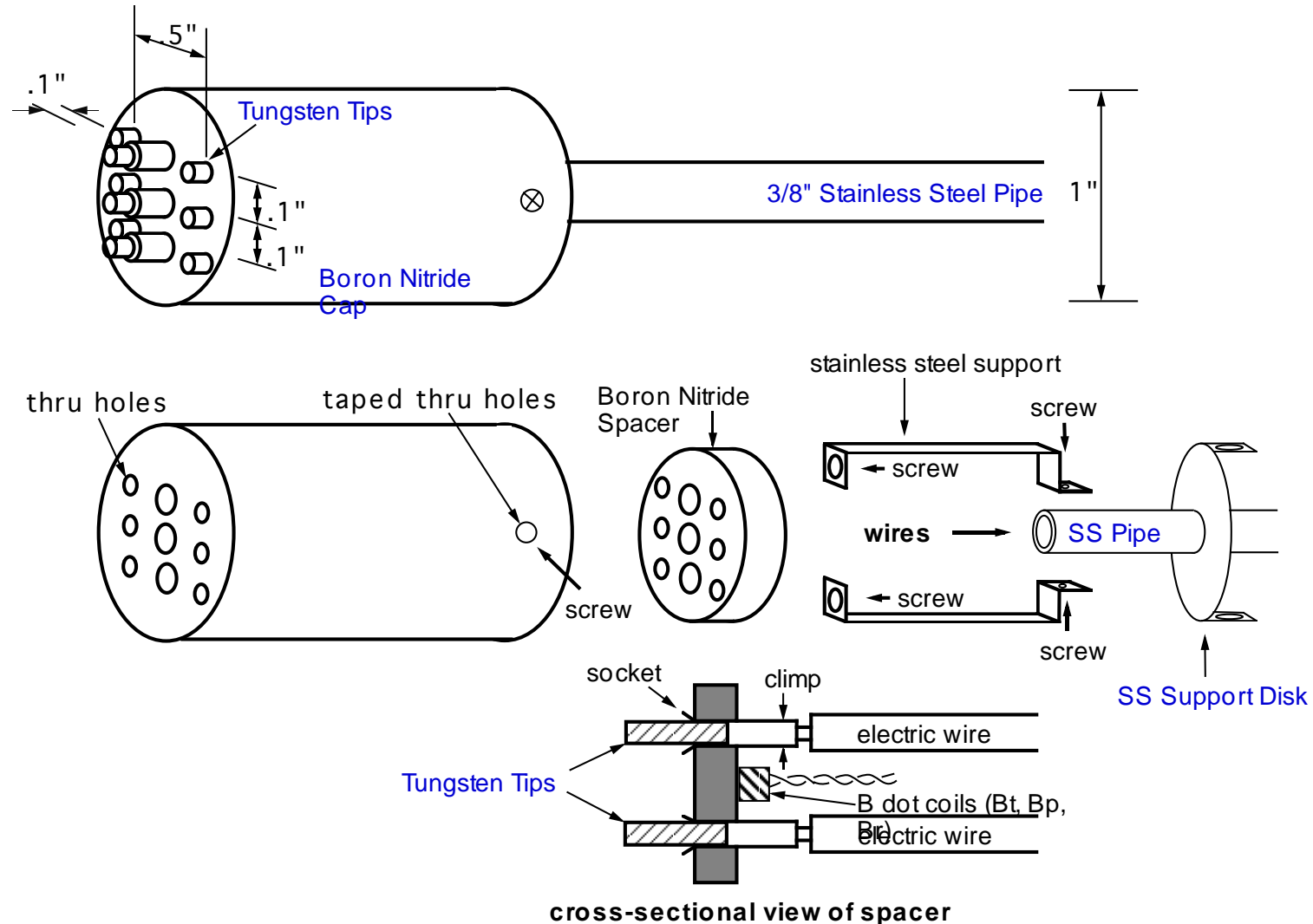
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NSTX Research Forum
September 2002

Introduction

- **Parallel current and magnetic helicity is transported inwards to sustain the plasma current during CHI.**

- **Understanding mechanism(s) of CHI is crucial to assess its effects on confinement and feasibility for current drive in ST.**

- **Three models proposed for the CHI mechanism:**
  - Plasmoid ejection model --- 2D reconnection
  - Turbulent EMF model (the α dynamo effects) --- 3D MHD or two-fluid dynamics
  - "Rotomak" model --- 2D two-fluid dynamics

- **The dynamo probe head will provide crucial information on these models by directly measuring the candidate terms due to fluctuations.**

Conceptual Design of The Probe
(Consisting of 3 Triple Probes and 3 Magnetic Probes)

5"

.1"

Tungsten Tips

.1"

.1"

3/8" Stainless Steel Pipe

1"

Boron Nitride Cap

thru holes

taped thru holes

Boron Nitride Spacer

stainless steel support

screw

screw

wires

SS Pipe

screw

screw

screw

SS Support Disk

socket

climp

electric wire

Tungsten Tips

B dot coils (Bt, Bp, Br)

electric wire

cross-sectional view of spacer

Measured and Deduced Quantities

- **Measured Fluctuations:**
  - $\left(\tilde{\phi}_f, \tilde{T}_e, \tilde{n} \right)$ **at 2 poloidal and 2 radial locations**
  - $\left(\tilde{B}_\theta, \tilde{B}_\phi, \tilde{B}_r \right)$ **at one location**

- **Deduced Fluctuations**

$$\left(\tilde{E}_\theta \approx -\frac{\Delta \tilde{\phi}_s}{r \Delta \theta}, \tilde{E}_r \approx -\frac{\Delta \tilde{\phi}_s}{\Delta r} \right)$$

$$\left(\nabla_\theta \tilde{p}_e \approx \frac{\Delta \tilde{p}_e}{r \Delta \theta}, \nabla_r \tilde{p}_e \approx \frac{\Delta \tilde{p}_e}{\Delta r} \right)$$

- **The terms needs to determine current (helicity) transport are**

$$\underbrace{\frac{\langle \tilde{E}_\theta \tilde{B}_\theta \rangle}{B_0} + \frac{\langle \tilde{E}_r \tilde{B}_r \rangle}{B_0}}_{\text{MHD dynamo}} + \underbrace{\frac{\langle \tilde{B}_\theta \nabla_\theta \tilde{p}_e \rangle}{en} + \frac{\langle \tilde{B}_r \nabla_r \tilde{p}_e \rangle}{en}}_{\substack{\text{diamagnetic dynamo} \\ \text{(two-fluid effect)}}}$$

Planned Activities in FY03

- Finish manufacturing and installation by the next run (J. Boedo of UCSD)
- Onsite conditioning and system-debugging (J. Boedo, H. Ji, H. Kugel)
- Preliminary tests (H. Ji, J. Boedo)
- Initial measurements (H. Ji, R. Raman, J. Boedo)