Physics issues toward CT reactors

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- Our CT community left

  "several important physics unsloved".

We have to solve them to proceed from CE to a new POP class experiment.

Still far from CT reactor
but it can be one basic strategy
for CTs to survive for next 10 years.

Difference between CTs and STs ?

The CTs do not have physical background to start a new POP class experiment?

----------**Short Confinement Time??**

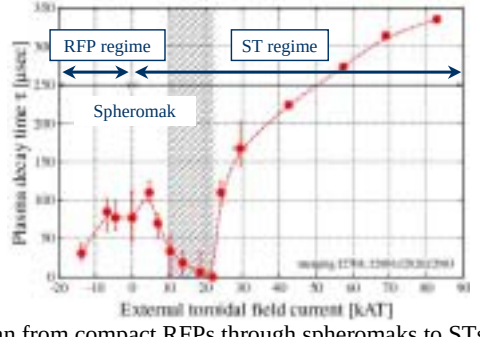
----------**Our community is a bit isolated from main stream (tokamak people etc.).**

Proposal

Let's think how tokamak people think about CTs!

-MFT??(LLNL, Tacceti)

Decay times of CTs are much shorter than STs.
Some countermeasure is needed!!



q-scan from compact RFPs through spheromaks to STs
(Tsuruda et al. TS-4 Data)

Any key to explain / fix the poor confinement?

The countermeasure depends on the KYE PHYSICS left unsolved.

FRC ------its **BASIC STABILITY**

Key?------its two fluid / kinetic stability most probably related with the confinement.

Spheromak ------Suppress its **DYNAMO**

Key?------ balanced current drive (PCD) probably improve its confinement.

FRC: Two Fluid / Kinetic Relaxation Theory

1) Extension of Taylor Theory

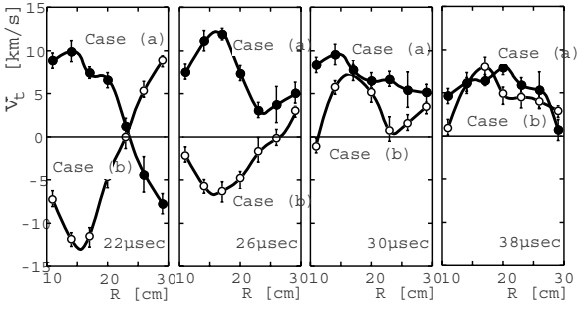
	One Fluid	Two Fluid	kinetic
Zero-Beta	Taylor Theory	Steinhauer & Ishida (Geren)	?
Finite-Beta	Kondo?		?

2) Kinetic / Two Fluid Simulation

Belova (PPPL), Horiuchi, Ohtani(NIFS) et al.

FRC: Experimental evidence for two fluid / kinetic relaxation

1) Toroidal Flow of FRC (TS-3&4)



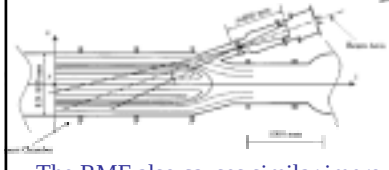
The SSX (Brown, Cothran) also have velocity measurement.

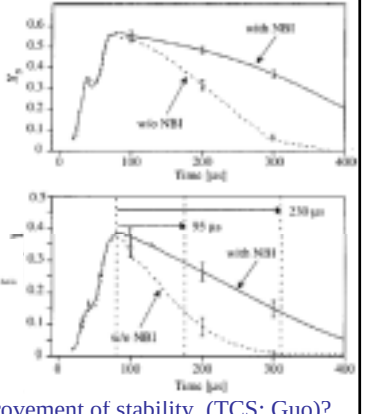
FRC:

Just a small power of NBI improved the confinement time of FRC significantly.

Ion flow effect on FRC equilibrium

FIX Data (Asai, Inomoto et al.),

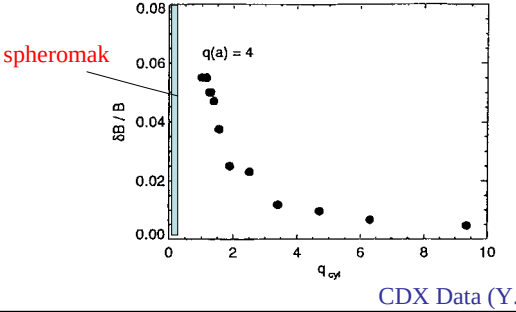




The RMF also causes similar improvement of stability (TCS: Guo)?

Spheromak: ΔB/B increases inversely with q-value.

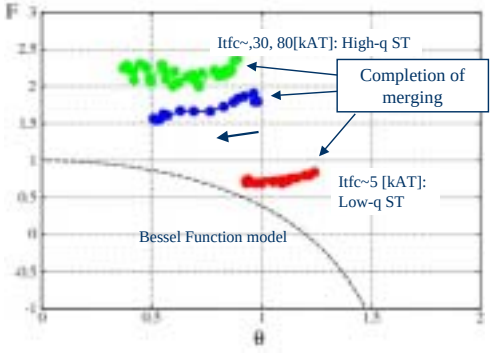
Low-q plasmas tends to suffer from the confinement degradation due to magnetic fluctuation.



CDX Data (Y. S. Hwang et al.)

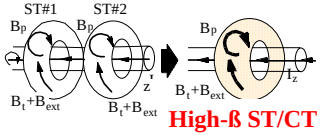
The STs can maintain the non-relaxed state

⇨ Better Confinement?.



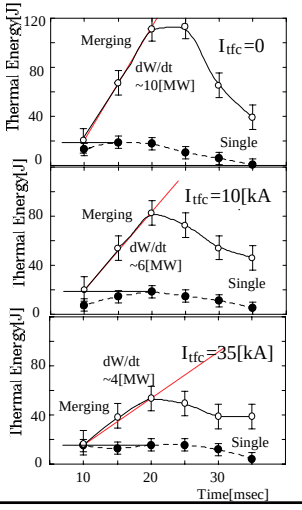
F-θ diagram

High heating energy >10MW is obtained by CT/ST merging



High-ß ST/CT

Thermal energies of single (dotted line) and merging (solid line) STs/ spheromaks



FUTURE DIRECTION

Proposal:

1) Stepup from Decaying Experiment

- **FRC** -----Mostly decaying experiment
  Initiation of NBI, RMF
  They are still far from OH operation in tokamaks
- **Spheromak** -- history of helicity injection
  But confinement degradation caused by dynamo and electrode discharge

FUTURE DIRECTION

2) Reactor-relevant research

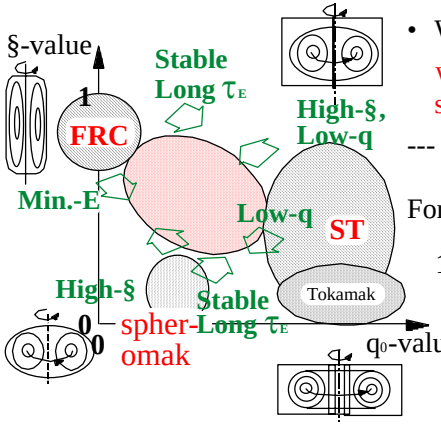
---Need to have eyes of Tokamak people.

---Pay more attention to future upscale!

- Does RMF degrade the poor confinement?
- Does helicity injection degrade?

1) Can we remove conductors ?---- Thin Shell?
2) Reactor-relevant STARTUP/HEATING
3) Reactor-relevant CURRENT DRIVE

3) Optimization of CTs --Boundary Study



- We may have wide range of solutions.

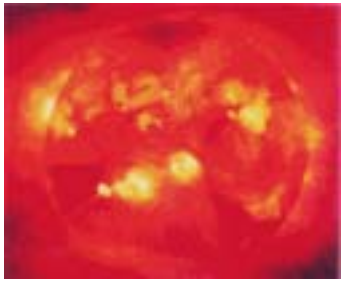
--- ST is our son!

For example,

1) FRC-ST boundary
2) FRC-spheromak boundary

If all of those are unsuccessful???, then 4) Extension to Plasma Physics

- Several extensions to interesting Physics.
  - --Solar physics
  - --Magnetosphere
  - --Space Physics



- However, we should not escape to Physics!