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# Lessons Learned from Tevatron Crystal Channeling

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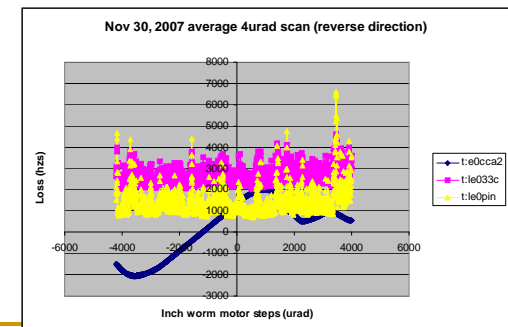
Dean Still

March 24, 2009

# Lessons Learned 2007

## 2007:

- Conducted ~ 28 hours of End of Store study in 2007 dedicated to demonstrating channeling with the strip crystal.
- Unfortunately **channeling was never demonstrated in this strip crystal**. There is much speculation about the crystal itself and this crystal on Oct 23, 2008 was returned to V. Guidi (INFN) for characterization and analysis.
- There were many lessons learned in 2007:
  - For part of the studies, crystal had gross alignment error.
  - Many problems with the goniometer- coupled angular/hor motion, vibration, dragging motion, ect.
  - Learned the instrumentation was inadequate.
  - Needed well characterized crystals.
  - Needed more and better simulations.
  - Needed a more formal status/collaboration to conduct beam studies under.



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## Lessons Learned 2008

### 2008:

- Implemented many changes from 2007 including:
  - Hardware modifications to goniometer
    - New angular swing motion linear actuator vacuum feedthru with external stepper motor and limit switches
    - Angular positioning of the crystal in steps of 1.36 microradians
    - Max angular angle = 70mrad instead of 8mrad.
    - New horizontal insertion drive slide is self-locking lead-screw type, not affected by vacuum load.
    - New horizontal insertion drive stepper motor with hand crank, in case of motor or controls failure the crystal can be extracted out of the beamline by hand cranking
    - Linear motion .00005" per step.
    - All goniometer modifications have worked well – but there have been problems with the crystal angle wandering due to motor heating and recently experiences with possible heating from the tunnel.

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## Lessons Learned 2008 (2)

- Instrumentation:
  - Attempted using a *high gain paddle in Tevtron flying wire* – appears that the number of particles in the channeled beam too low intensity to detect with the method.
  - *Telescoping scintillator paddles* that are gated in bunch and abort gap have worked well and are the best indicators for making sense out of channeled beam.
  - The telescoping *Pin detector* that is 9 inches from crystal has worked well in the past at least to determine when the crystal is in the beam and is some times useful for seeing channeling BUT since Dec 10 the Pin detector is swamped by background and is sensitive to all tevatron loss no abort gap or bunch discrimination. Very insensitive when the crystal is far in the beam.
  - CDF and D0 halo monitors have such low backgrounds that is difficult to see channeling effects.

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## Lessons Learned 2008 (3)

- Simulations:
  - *Many questions concerning effects of miscut angle and beam dynamics. Large effort has been underway to attempt to answer these.*
- Operations and Controls:
  - The horizontal motion can be placed by feedback on a blm. This works well. The angular motion needs better feedback controls to help with keeping angle at channel point and also bringing crystal to channel point initially.

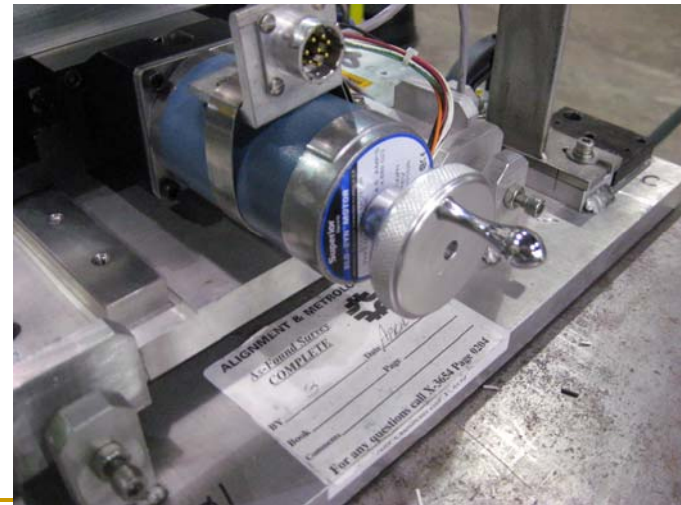
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# Backup slides

# Crystal Collimator Modifications

## Major modifications in 2008

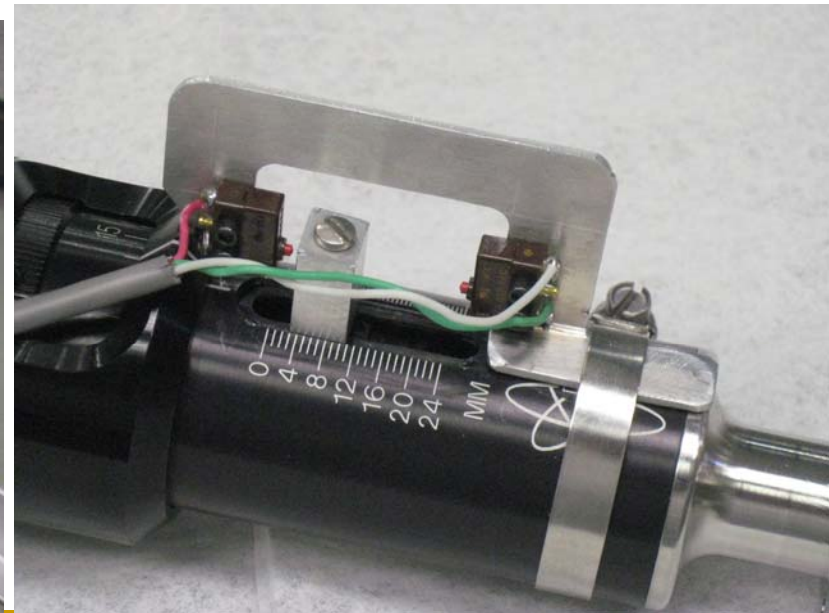
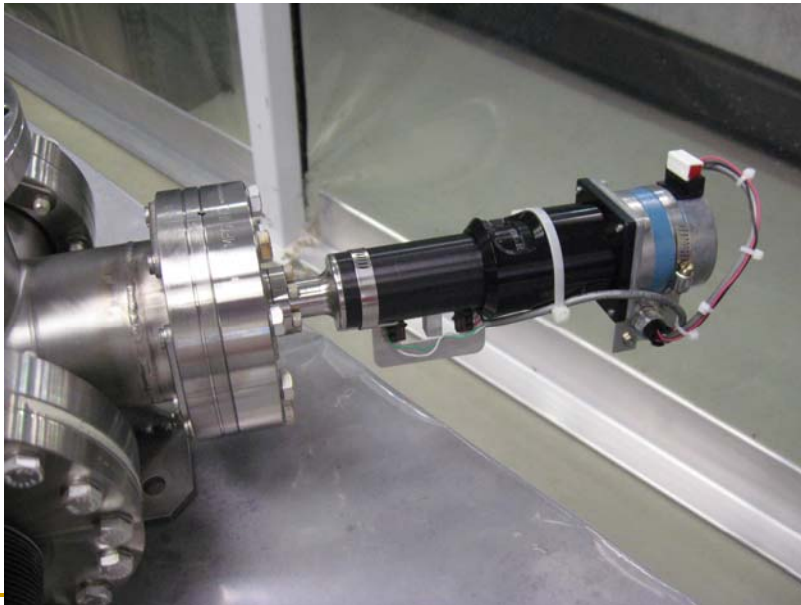
- New horizontal insertion drive slide is self-locking lead-screw type, not affected by vacuum load
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- Linear motion .00005" per step



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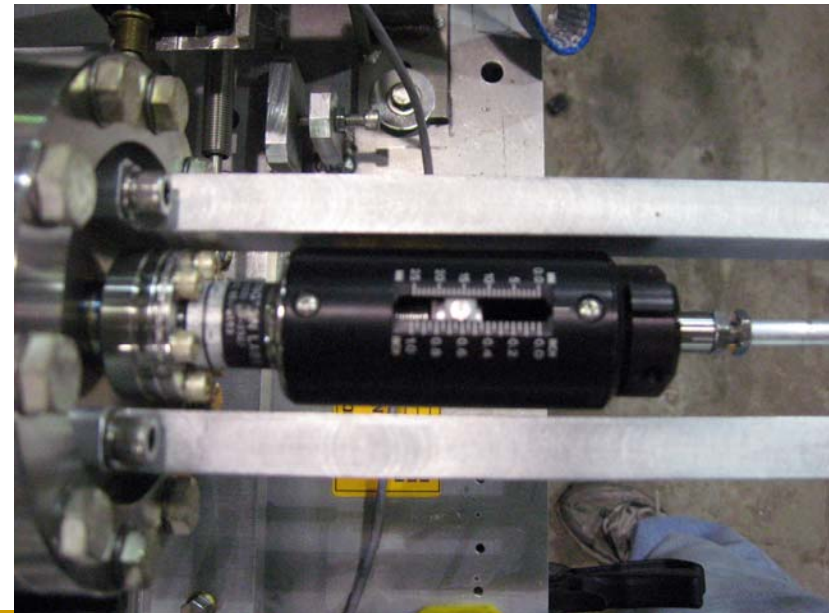
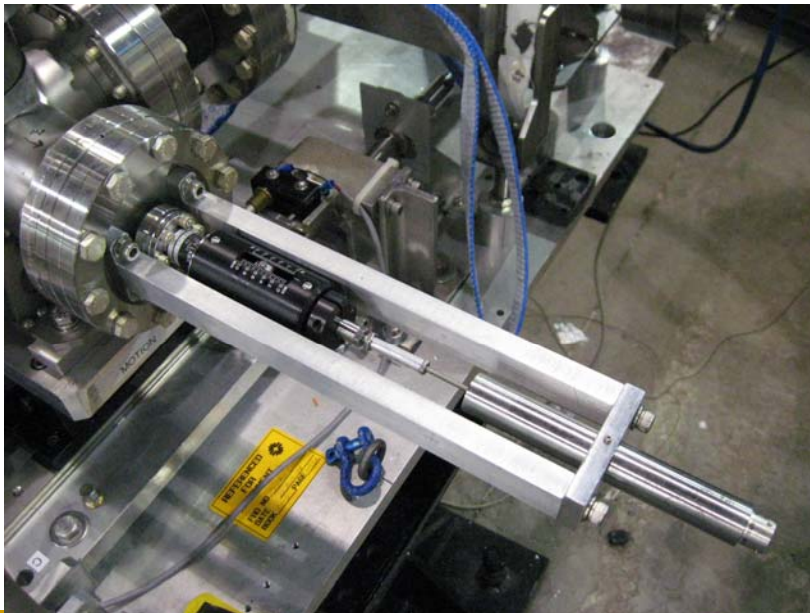




# Crystal Collimator Modifications

Major modifications in 2008

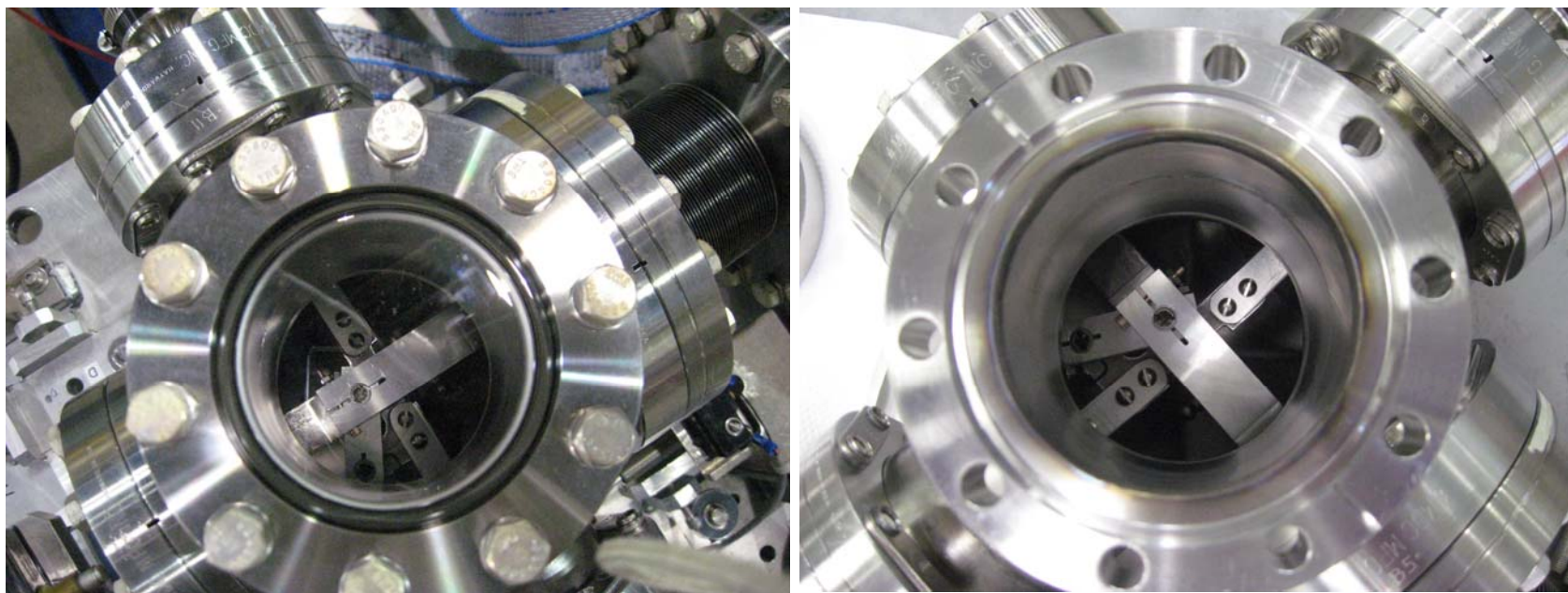
- New linear feedthru with external LVDT and visual position indicator for angular swing motion
- Angular measurement 2.1 microradians



# Crystal Collimator Modifications

Major modifications in 2008

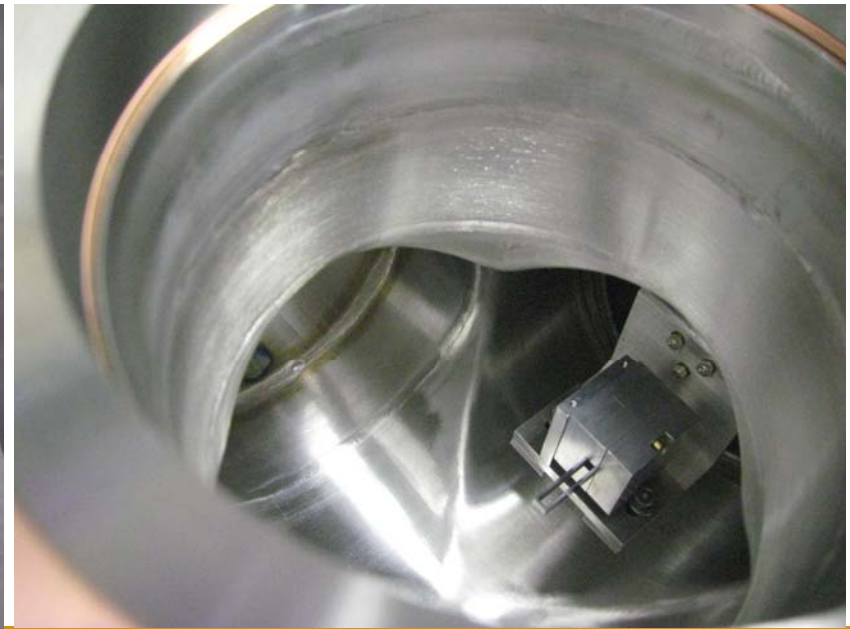
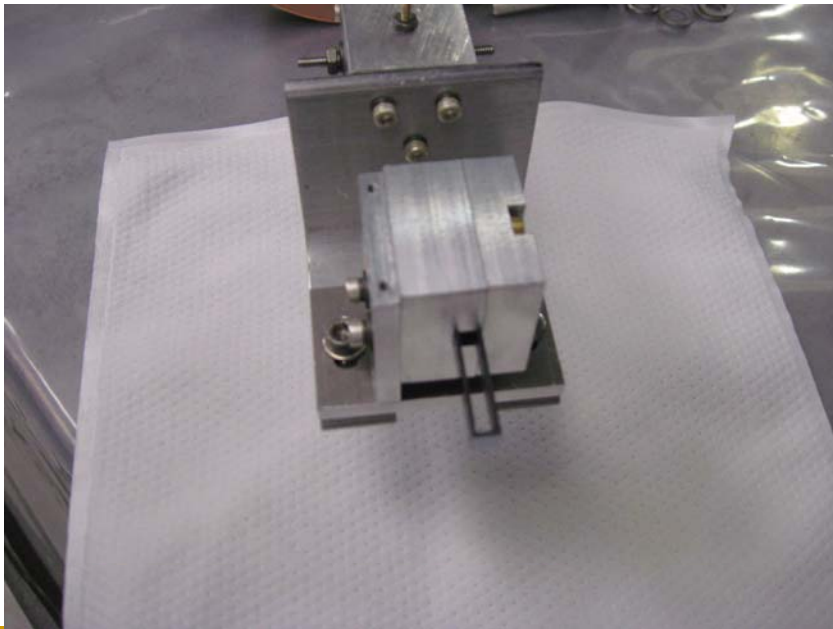
- Glass viewport to observe angular swing motion



# Crystal Collimator Modifications

Major modifications in 2008

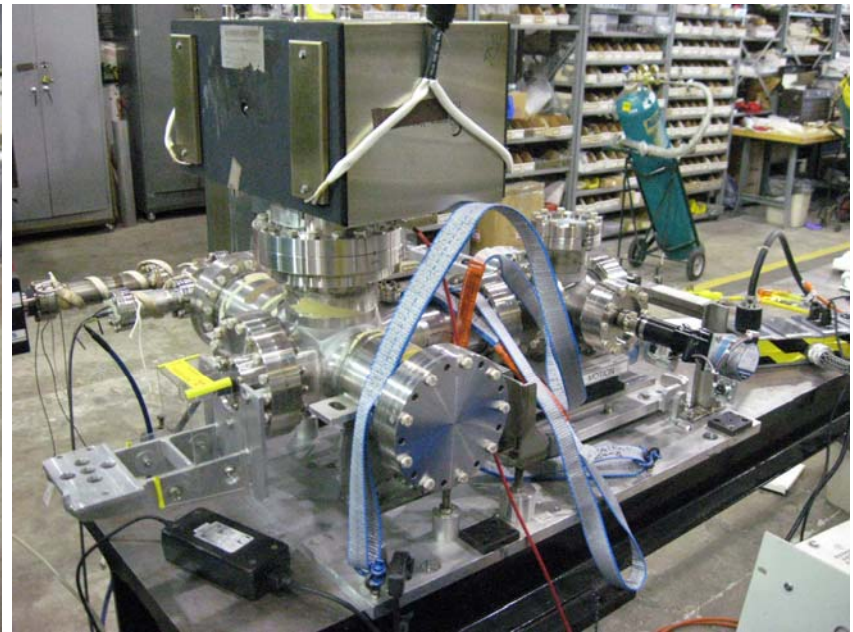
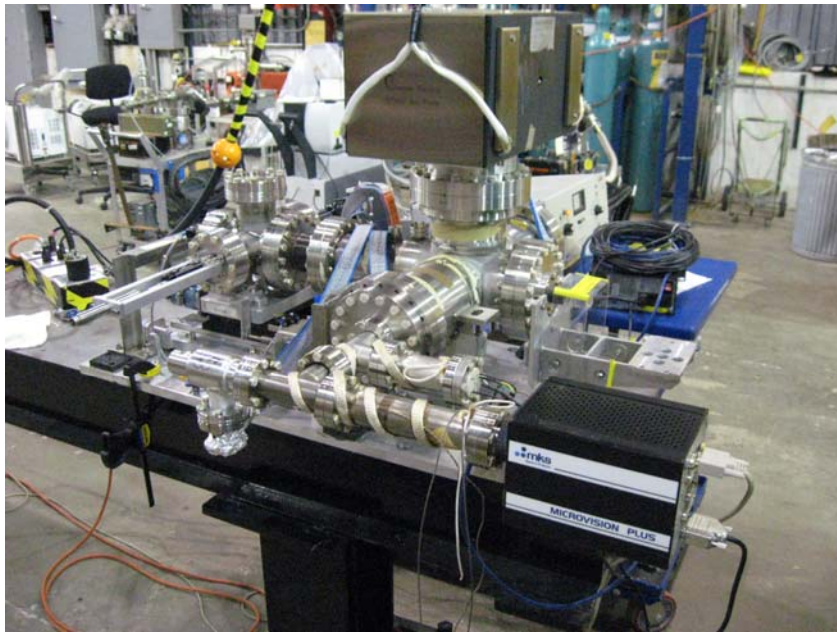
- Repaired vibration problem with crystal mounting bracket
- Repaired dragging arm problem with angular swing motion
- Original o-shaped RHIC crystal installed again



# Crystal Collimator Modifications

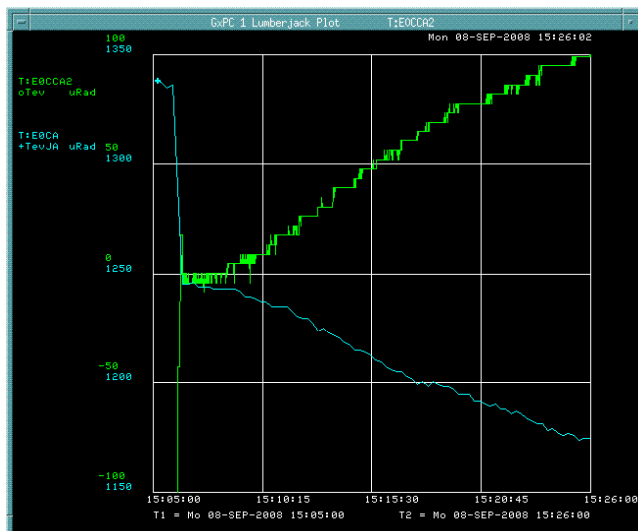
Major modifications in 2008

- Operated under vacuum
- Vacuum chamber baked
- Vacuum certified
- Ready to install on 12 hr access

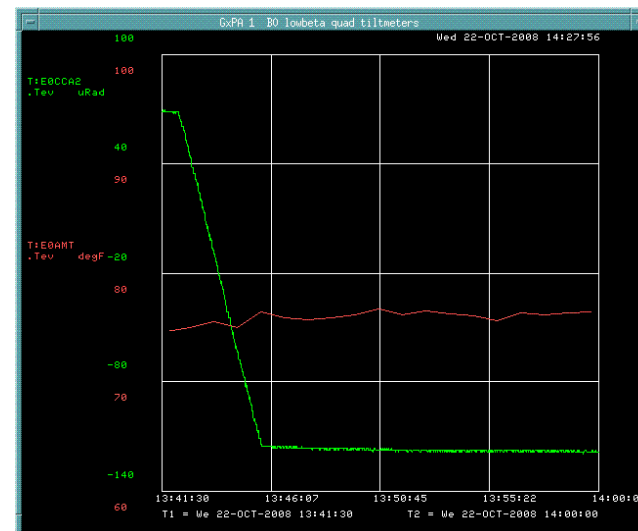


# Current Problem after Installation

- There was an drift of the angular motion after it has been moved and left at a fixed angle due to heating in a miswired motor.
- This limited the mininum step size to ~ **8 urad/step**
- This was fixed last week!

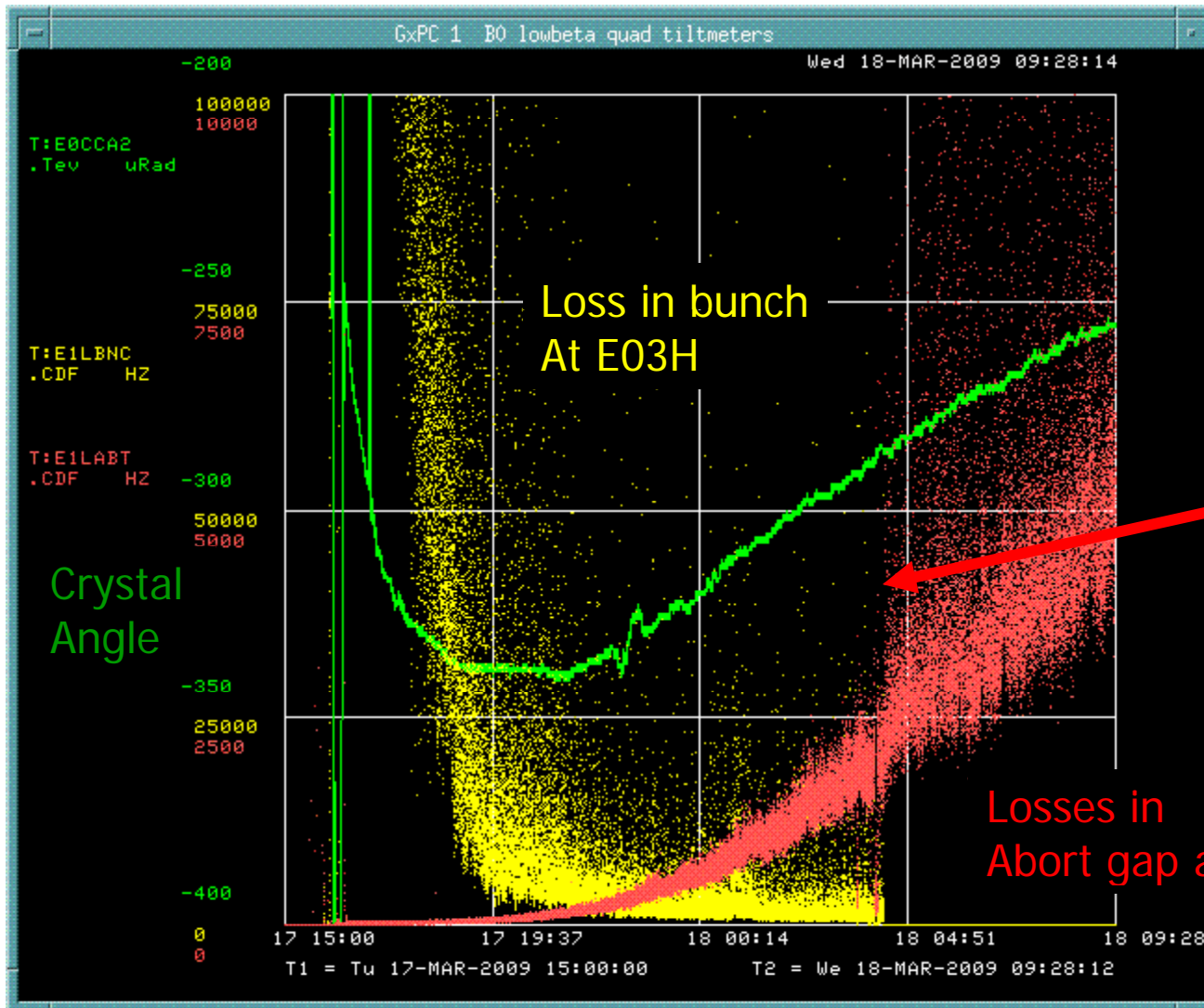


Angle drift ~100urad from motor Heating.



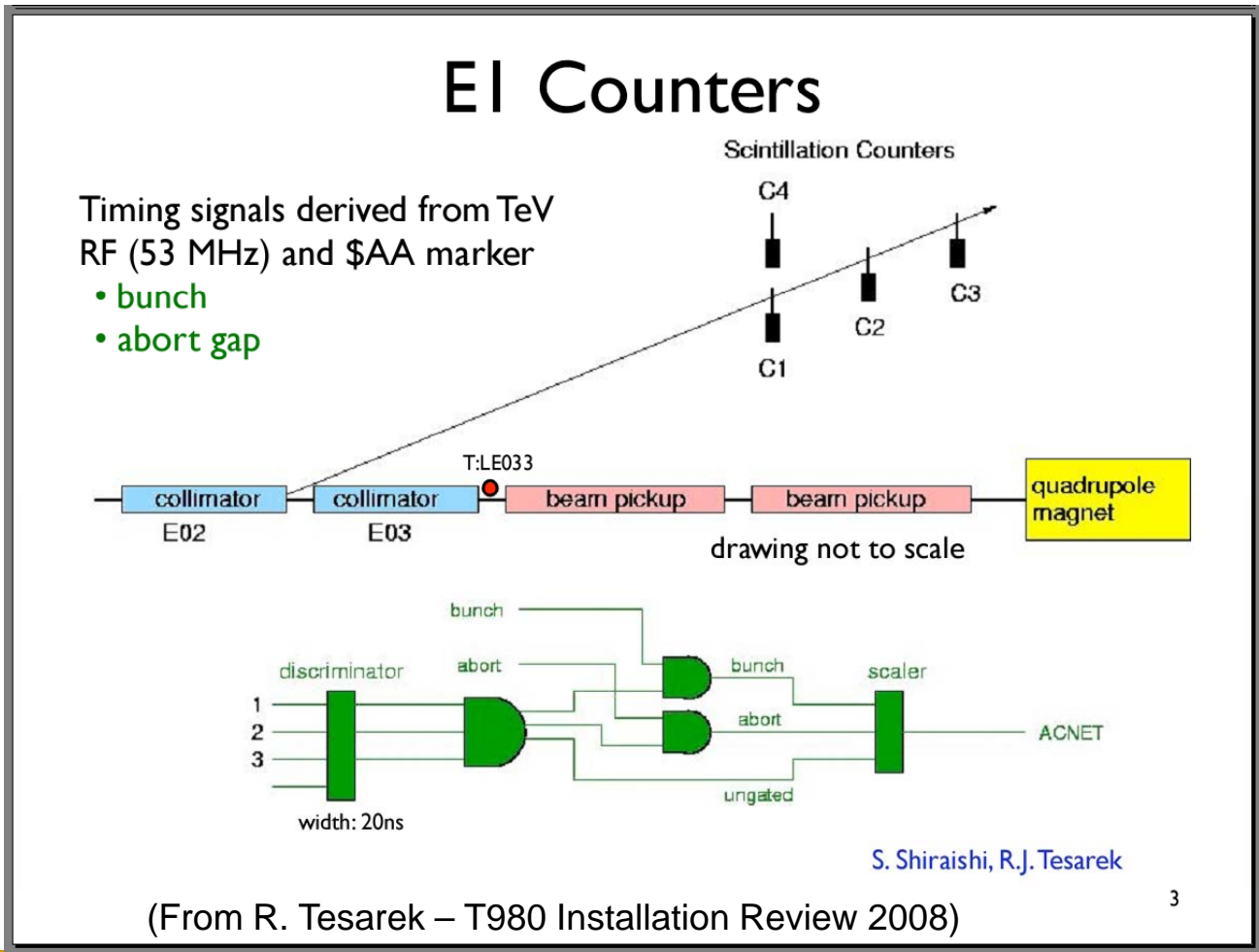
After motor was rewired- drift is fixed

# Angular motion over store 6903



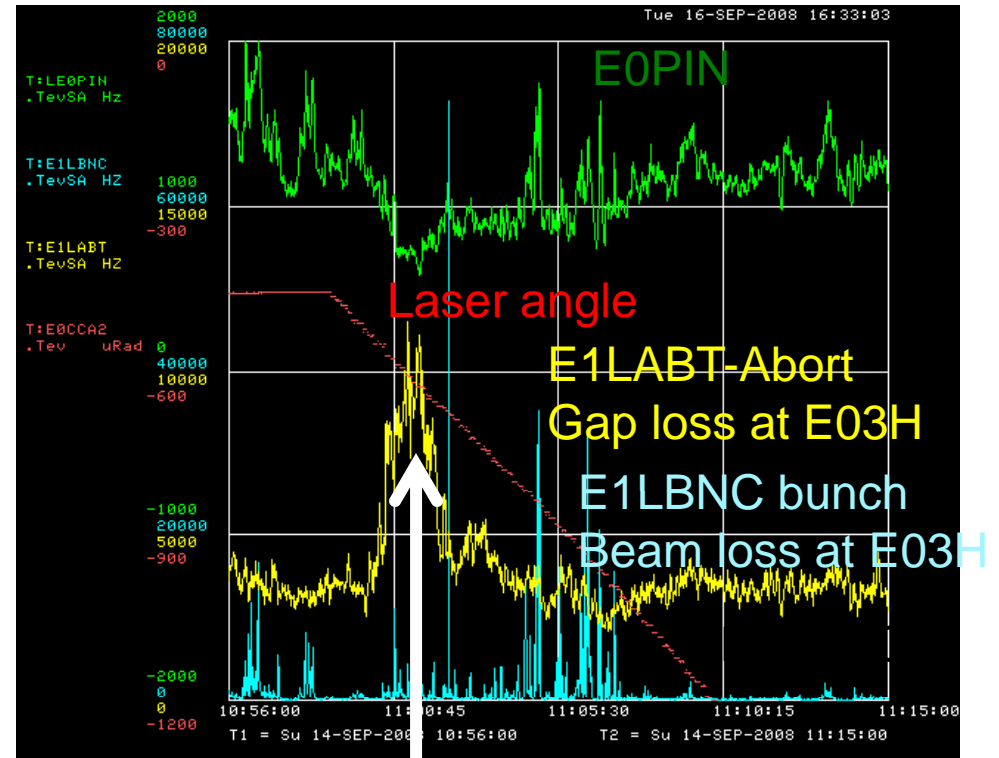
This is drift of angle  
During store. This is  
Channel point.

# E1 Counters



# Channeling Beam in the Abort Gap

- The main contribution of beam that is channeled and hitting the E03H collimator is from the abort gap.

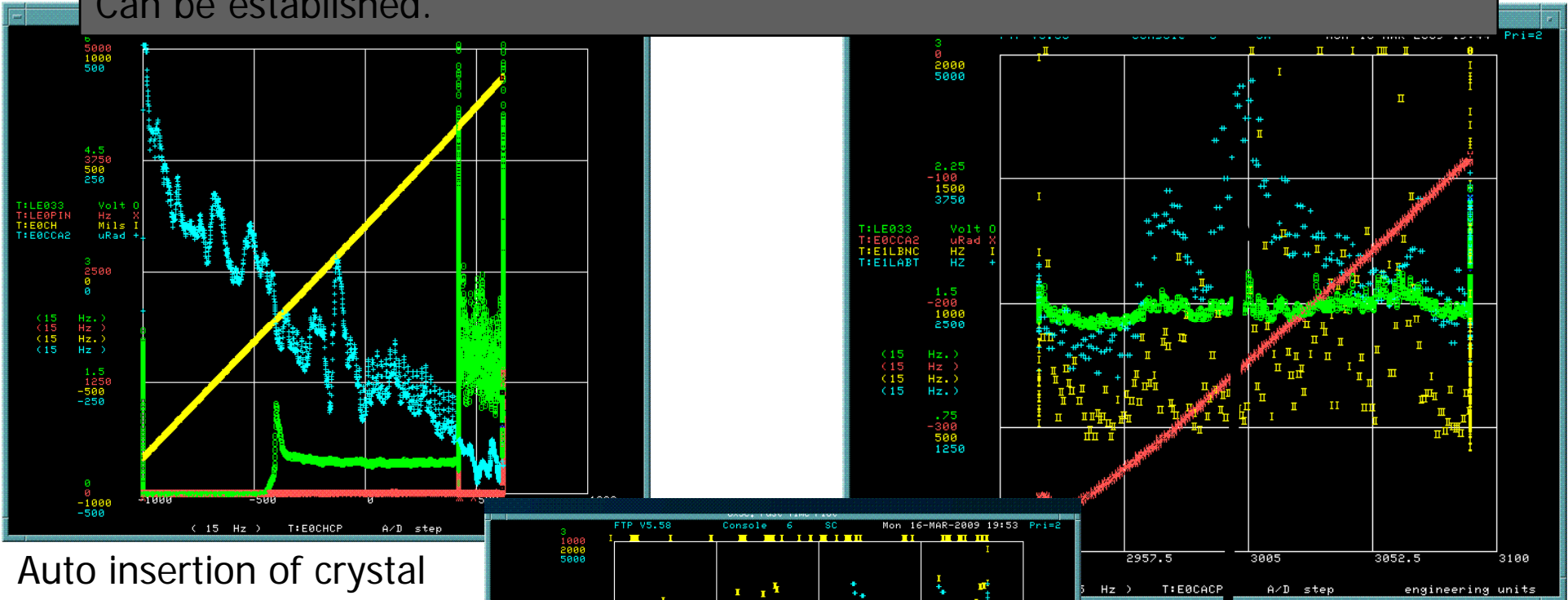


Channel



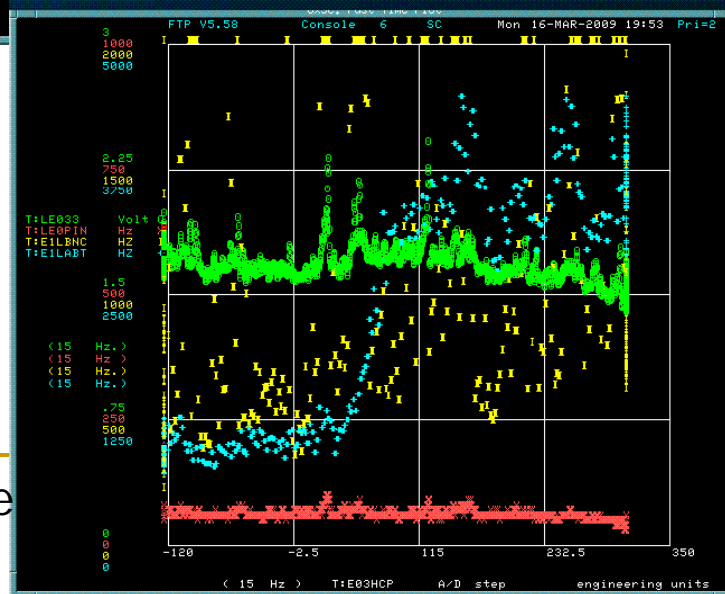
# EOS for 6901

Used EOS of 6901 to test full auto insertion of crystal and check that channeling can be established.



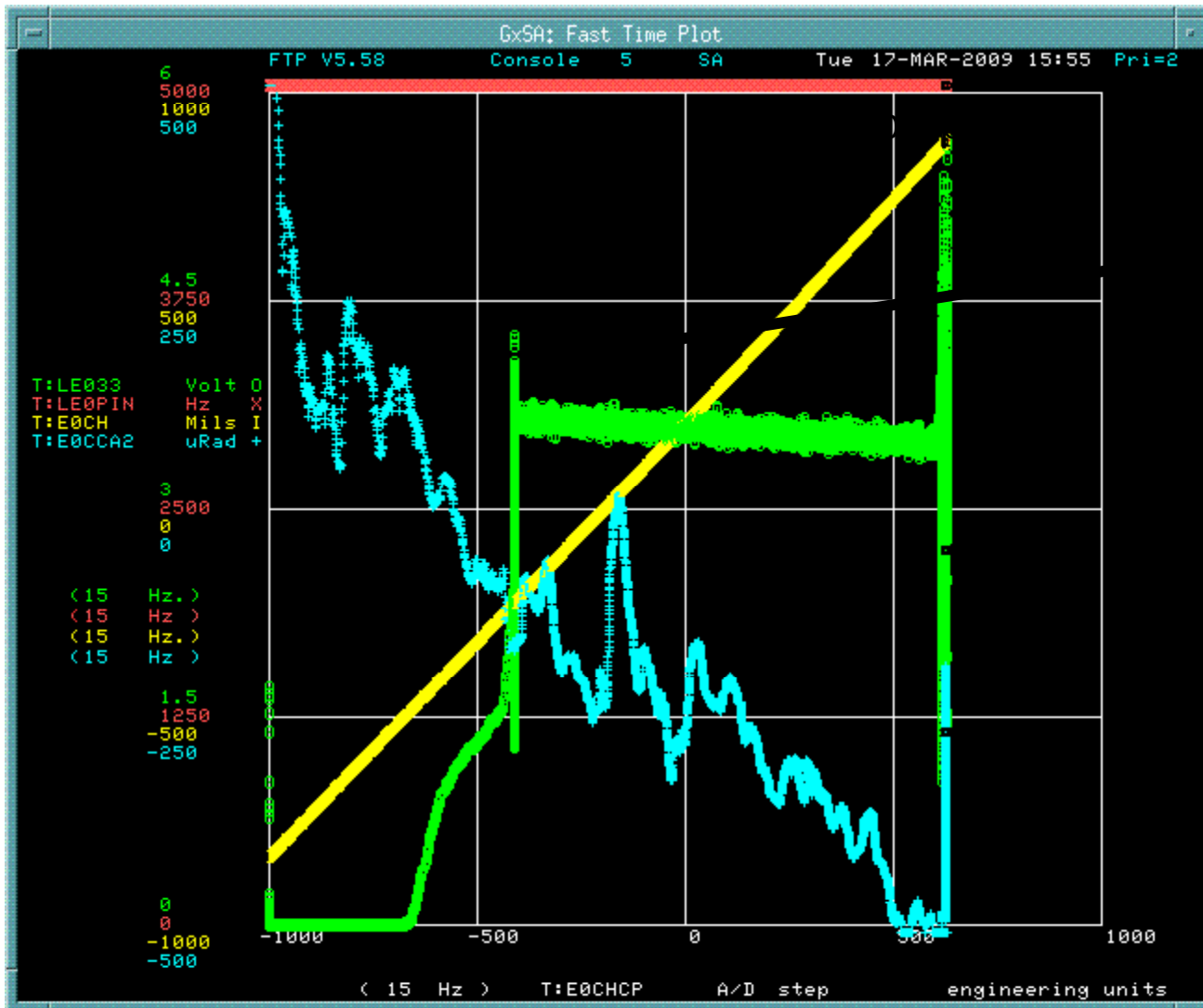
Auto insertion of crystal  
Horizontal worked well

After angle set to  
Channeling, completed  
E03H scan to verify channe



Setting the crystal angle  
To channeling

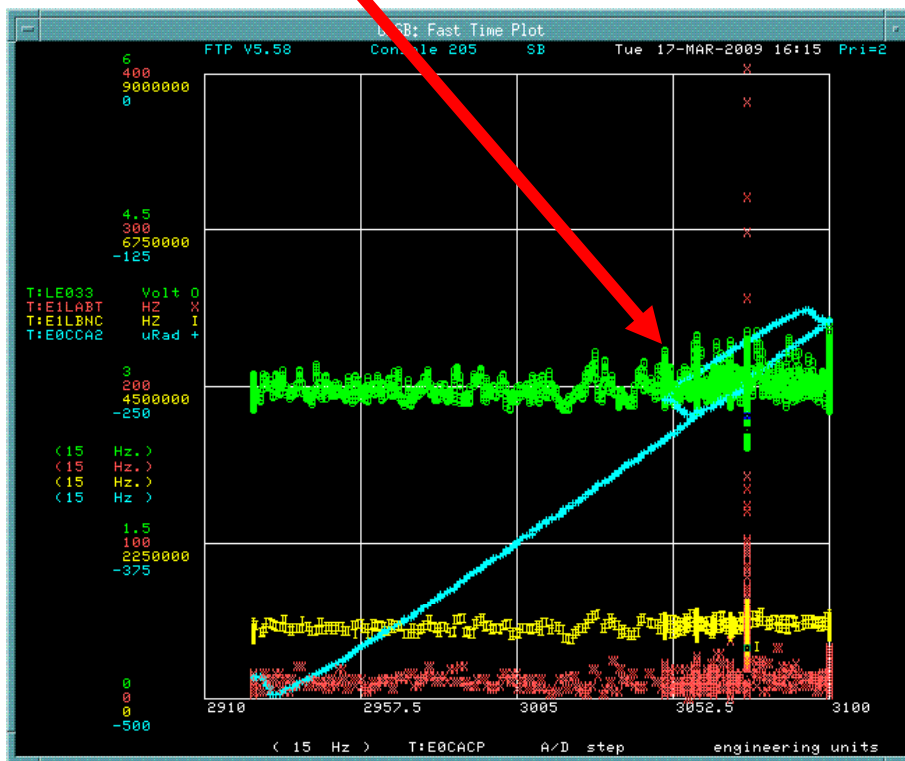
# Store 6903 moving TEVCOL



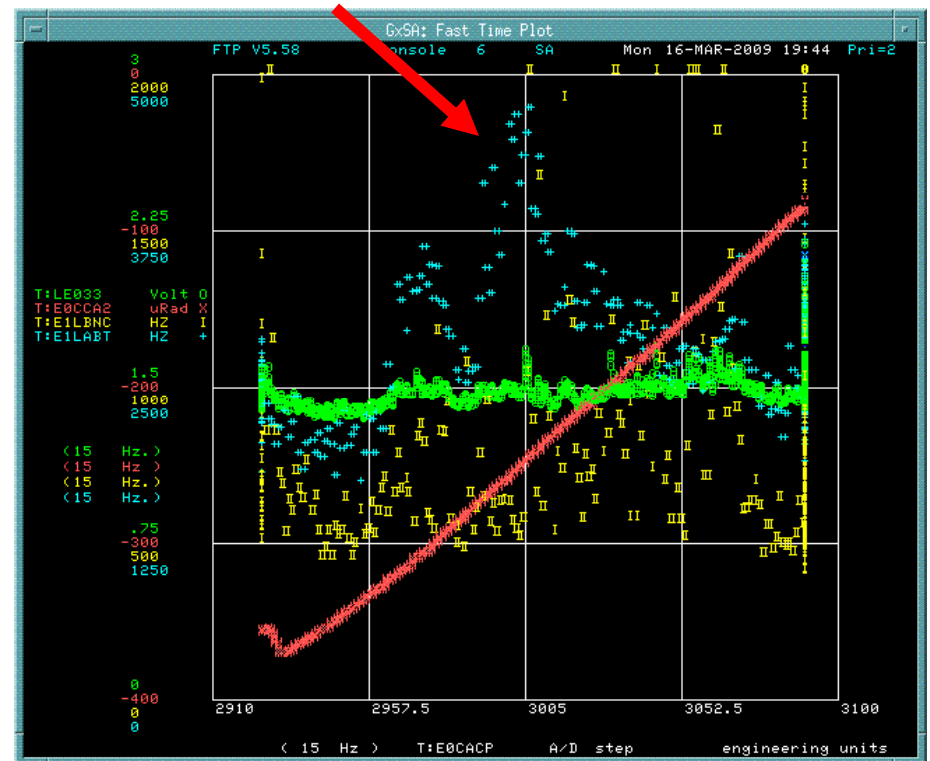
Crystal stopped early

# Finding the channeling difficult

Store 6903 BOS No clear channel point



Store 6901 EOS clear channeling



Channeling should be  $\sim -250\text{urad}$