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Status of poloidal CHERS analysis

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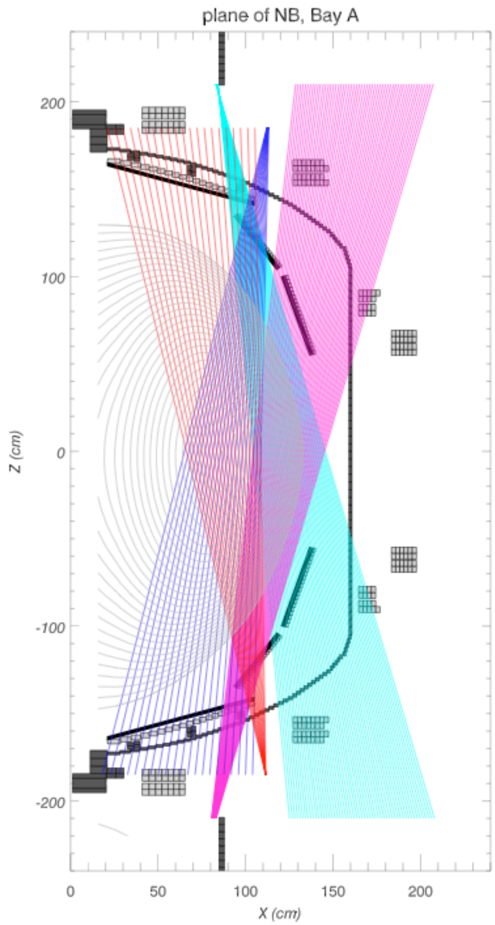
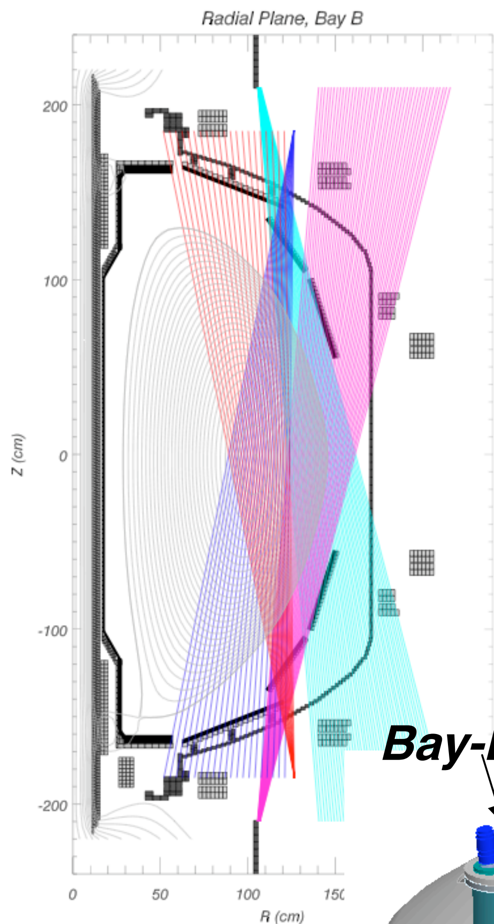
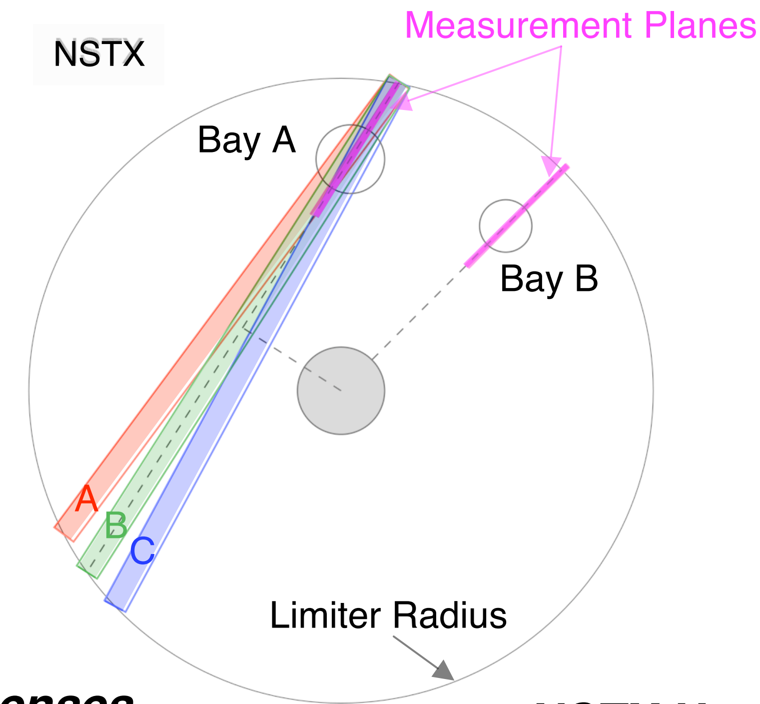
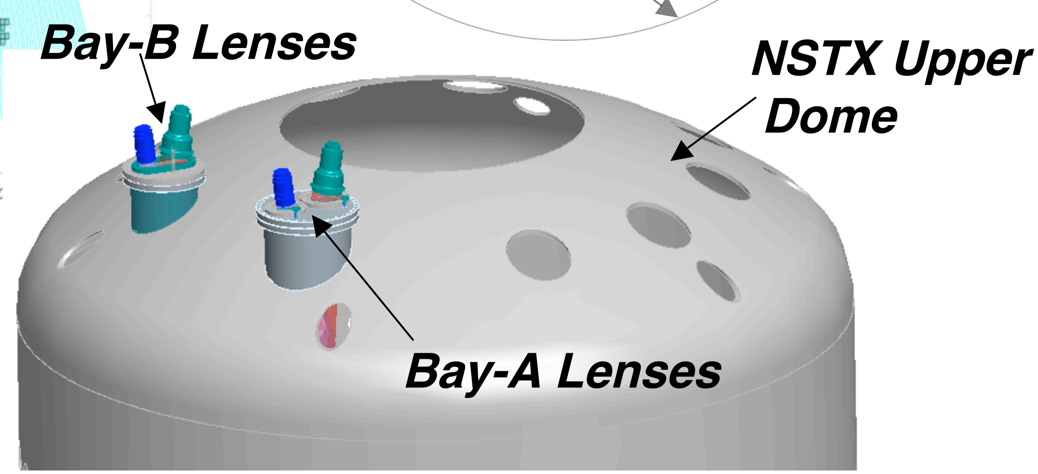
NSTX Results Review
September 15-16, 2009

Unique Up/Down Symmetric Active and Passive Views



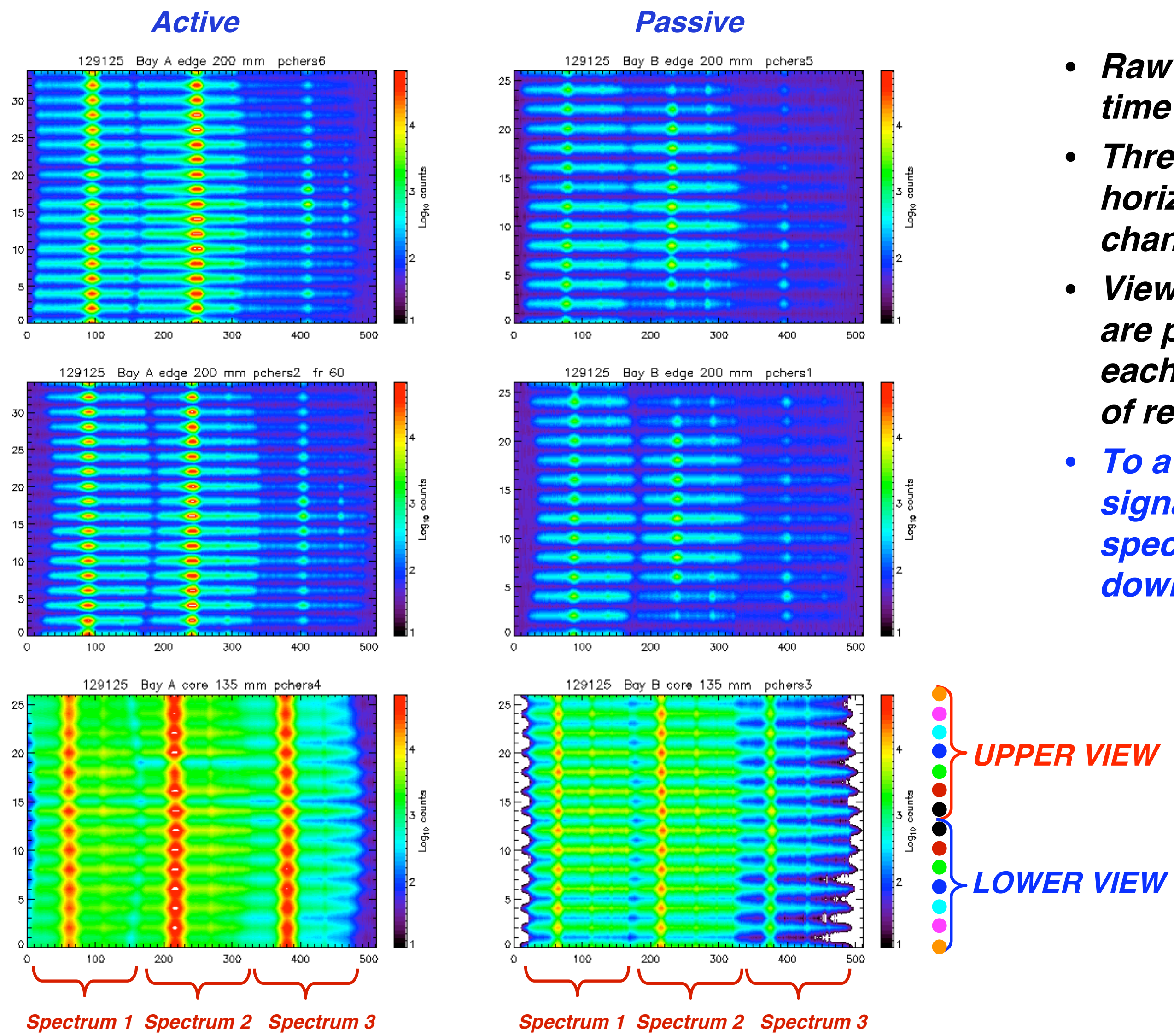






- ***Eight lenses at 4 locations***
- ***276 optical fibers for pCHERS***
- ***FIDA shares collection optics***
- ***Poloidal ERD shares optics on Bay B top***

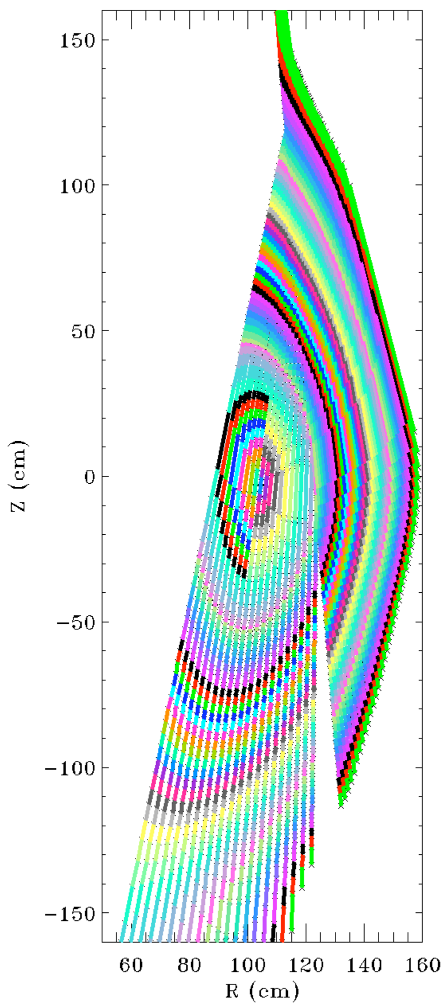
Routine Collection of pCHERS data

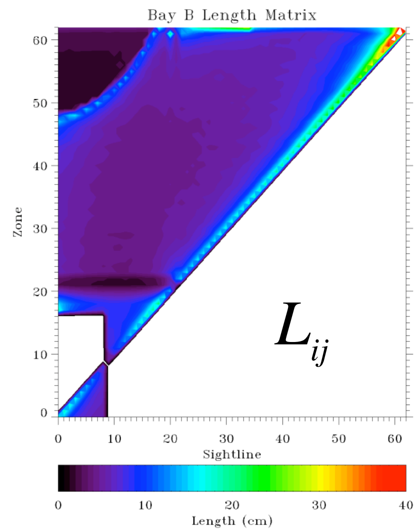


- ***Raw data from 6 detectors for one time point, 276 spectra.***
- ***Three spectra separated horizontally increase number of channels per detector.***
- ***Views from upper and lower ports are positioned symmetrically on each detector to improve accuracy of relative wavelength shifts***
- ***To avoid saturation of the C VI signals, the active viewing spectrometers have been stopped down to f/4 or f/2.8 from f/1.8***

Inversion Matrices for Passive Emission

- *EFIT equilibrium is used to compute inversion matrices for passive emission*
- *Measured Brightness along a sightline can be related to local emissivity*
- *The inverted velocity is obtained using two matrix inversions*



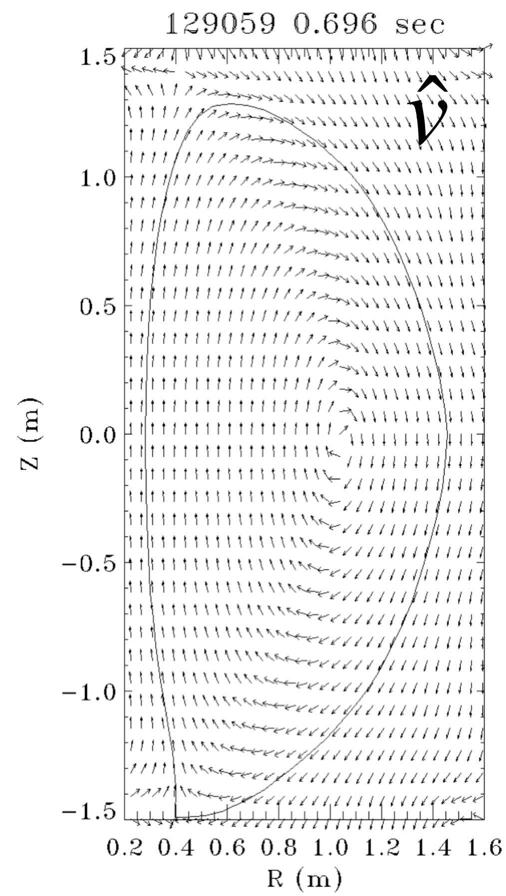


$$4\pi B_i = \sum_j L_{ij} E_j \qquad E_j = 4\pi \sum_j L^{-1}_{ji} B_i$$

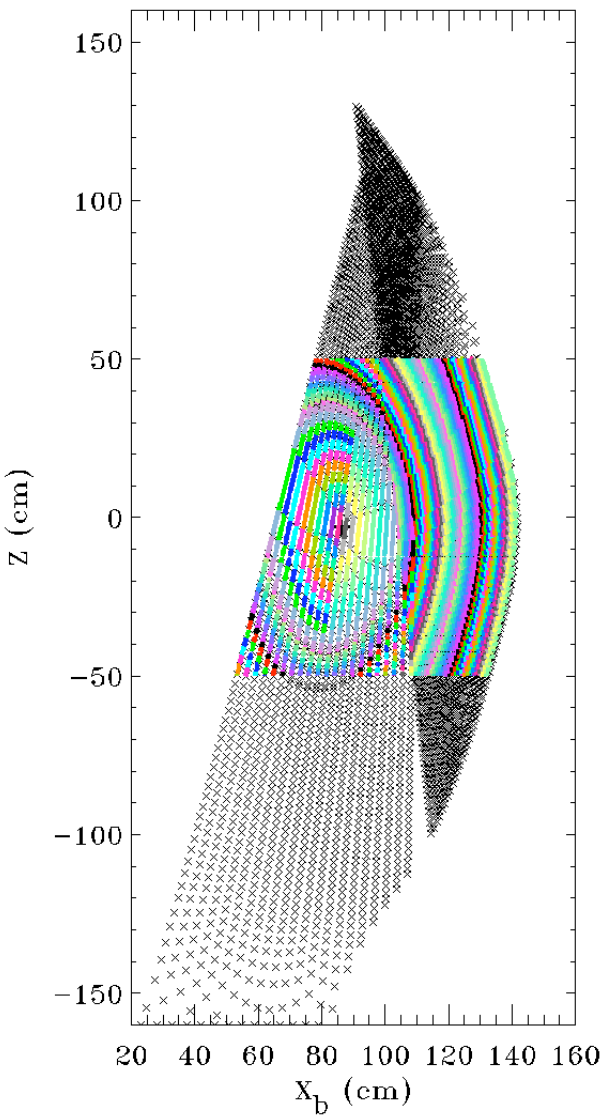
$$4\pi B_i u_i = \sum_j L_{ij} E\left(\hat{s}_i \cdot \vec{v}_j\right) = \sum_j L_{ij} E_j v_j \cos\theta_{ij}$$

$$M_{ij} \equiv L_{ij}\left(\hat{s}_i \cdot \hat{v}_j\right) = \sum_j L_{ij} \cos\theta_{ij}$$

$$v_j = \frac{E_j v_j}{E_j} = \frac{\sum_i M^{-1}_{ji} B_i u_i}{\sum_j L^{-1}_{ji} B_i}$$



Inversion Matrices for Active Emission



- *The Charge Exchange emission varies along the line of sight (i)*
- *Midplane profiles of local T_e, N_e, T_i, V_ϕ, N_c are mapped into 2D*
- *A 2D beam attenuation gives N_{beam} vs zone (j) and height (k) in the plane of measurement*
- *A weight matrix (computed CX emissivity) and directional information are used to construct an inversion matrix*
- *Local velocity is obtained using differential measured velocity, which removes non-poloidal velocity components*

$$W_{ijk} = E_{ijk}^{CX} = n_j^C n_{jk}^{beam} \langle \sigma^{CX} v \rangle_{ijk}^{eff}$$

$$L_{ij} = \sum_k L'_{ijk}$$

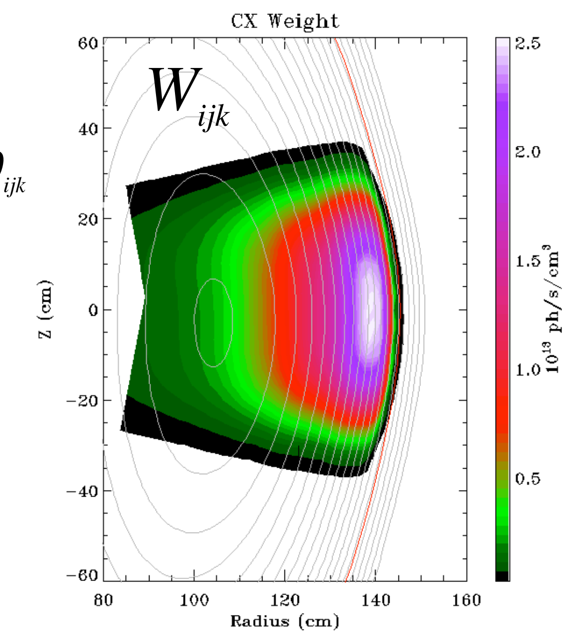
$$2\pi \left(B_i u_i^{UP} - B_i u_i^{DOWN} \right) = \sum_{j,k} L'_{ijk} W_{ijk} \cos\theta_{ijk}$$

$$Q_{ij} \equiv \sum_k L'_{ijk} W_{ijk} \cos\theta_{ijk}$$

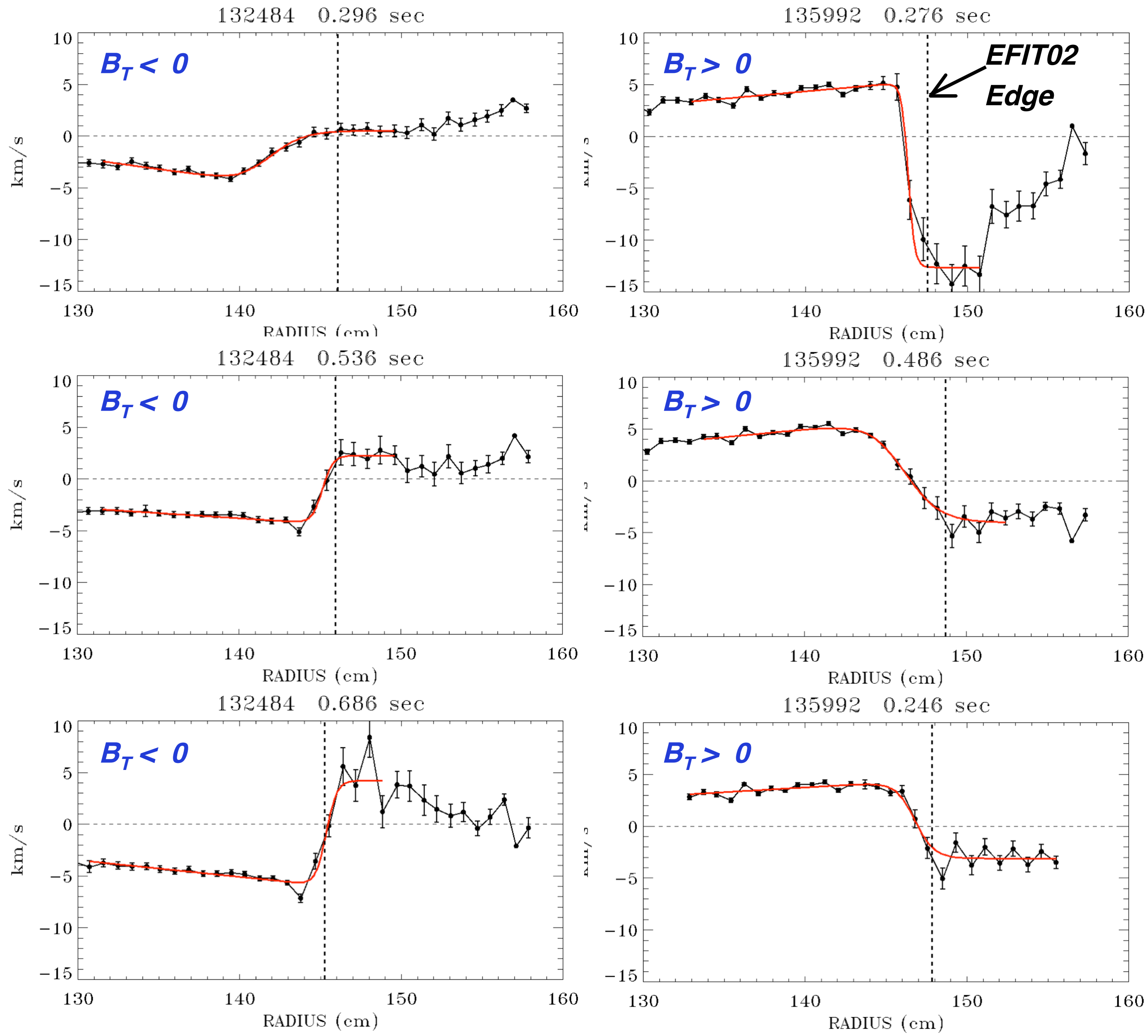
$$4\pi B_i = \sum_{j,k} L'_{ijk} W_{ijk} = \sum_{j,k} P_{ijk}$$

$$u_i^{diff} = \tfrac{1}{2}\left(u_i^{UP} - u_i^{DOWN} \right) = \sum_j Q_{ij} \Big/ \sum_{j,k} P_{ijk}$$

$$v_j = \sum_j Q_{ji}^{-1} u_i^{diff} \sum_{j',k'} P_{ij'k'}$$

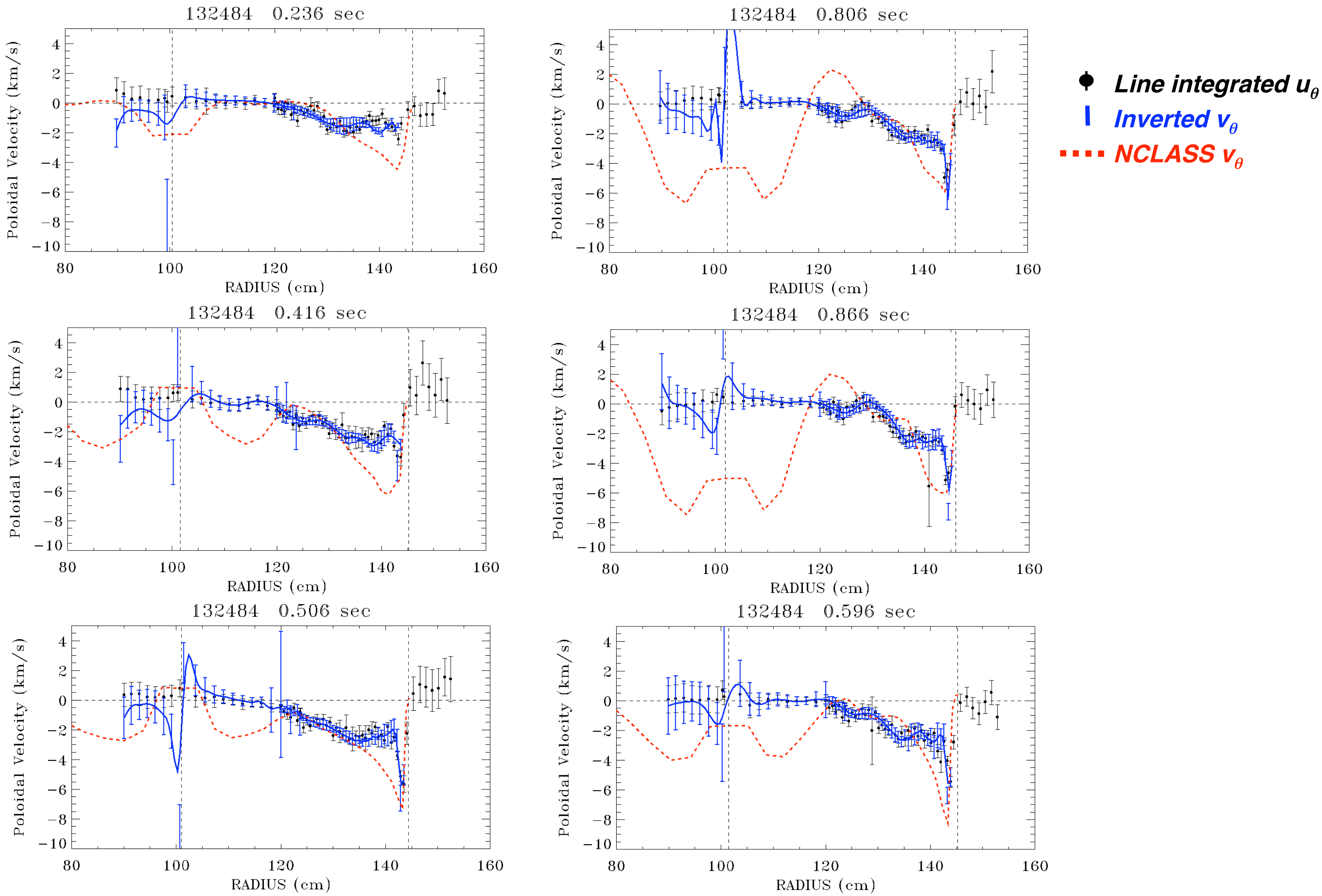


Direction of V_θ Reverses when B_T is Reversed

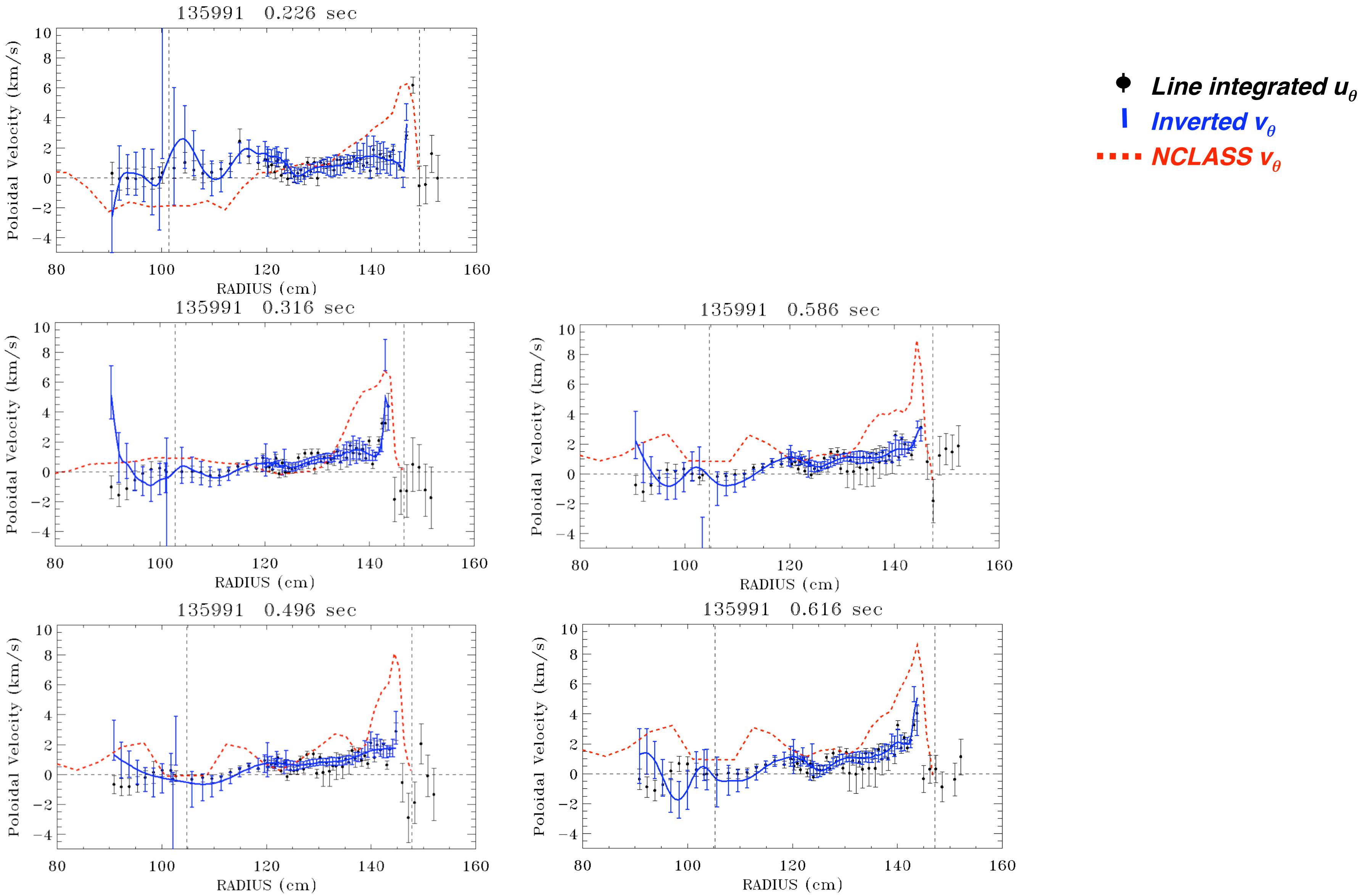


- ***Passive C VI emission from edge extends into SOL.***
- ***Line integrated velocity reverses sign across separatrix***
- ***Modified hyperbolic tangent fit might be used to determine location of edge .***
- ***E_r determination at edge possible when combined with passive toroidal view.***
- ***Change in direction of poloidal velocity with B_T is expected from force balance equation if plasma pressure and E_r are relatively unchanged, i.e. value and sign of $V_\theta B_T$ must be unchanged***

Comparisons of Measured velocity to NCLASS



Comparisons of Measured velocity to NCLASS (Reversed B_T)



Summary

- *MPTS, EFIT, CHERS essential for poloidal CHERS analysis*
- *Noisy data requires smoothing for inversion*
- *Inverted velocity similar to line-integrated:*
  - *Sharp features can be revealed with inversion*
  - *Smearing in core large (<30 cm), but core velocity near zero*
- *Preliminary comparisons to NCLASS*
- *May be necessary to run NCLASS as post processor*
- *GTC-NEO with impurity has been run for select cases*
- *Analysis code ~10,000 lines*
- *CPU time 40-50 minutes for long discharge,*
  mainly due to computation of weight matrix
- *Need to identify shots for virtual scans, ∇T, Ip, B_T, etc.*