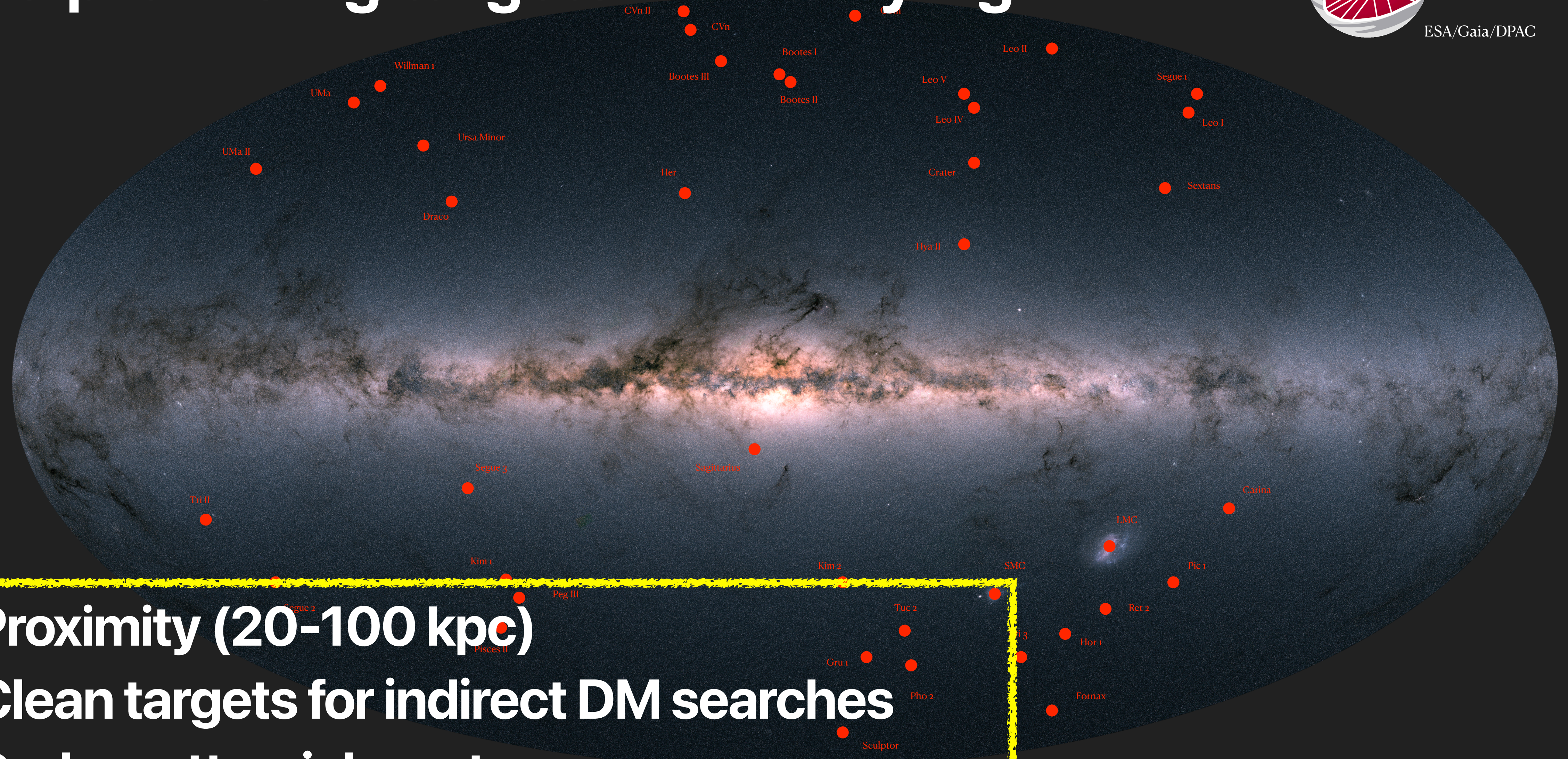


Tracing the invisible: Dark Matter in Dwarf Spheroidal Galaxies

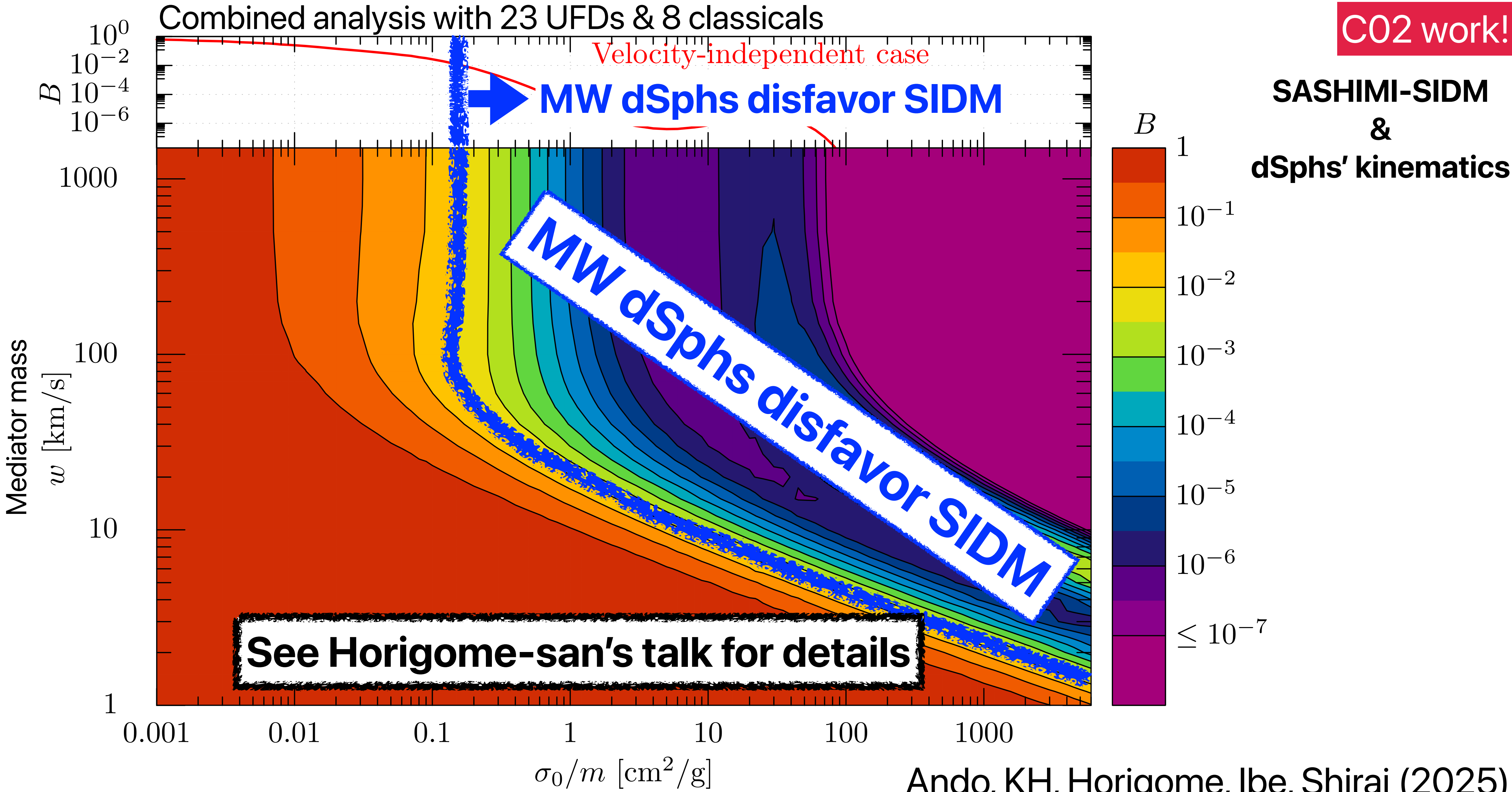
Kohei Hayashi (NIT, Sendai college)

Dwarf spheroidal galaxy (dSph): the promising targets for studying DM



- Proximity (20-100 kpc)
- Clean targets for indirect DM searches
- Dark-matter rich system

Stringent constraints on SIDM using the dSphs



B04 work!



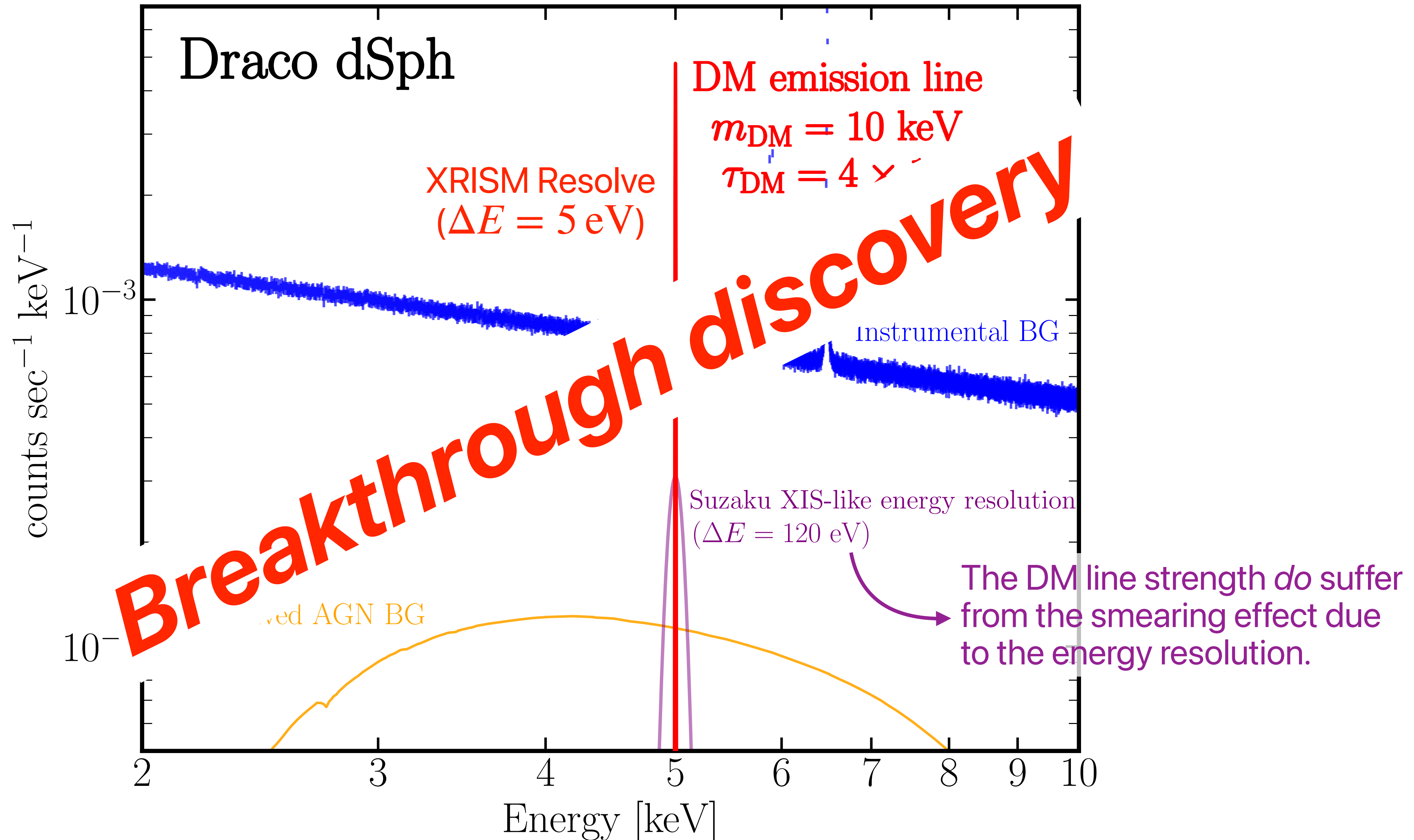
XRISM



Draco

- Proximity (20 Mpc)
 - Clear target for indirect DM searches
 - Dark matter halo may be
- Preparing for XRISM GO proposal by
KH, M. Takada, A. Simionescu, N. Yamasaki, S. Shirai, S. Matsumoto, H. Murayama, K. Hayashi

Search for narrow DM emission lines from Draco



$\rho_{\text{DM}} - \beta_{\text{ani}}$ degeneracy

Ex. Spherical Jeans eq.

$$\frac{\partial[\nu(r)\sigma_r^2(r)]}{\partial r} + \frac{2\nu(r)\beta_{\text{ani}}(r)\sigma_r^2(r)}{r} = -\nu(r)\frac{GM_{\text{DM}}(r)}{r^2}$$

$$M_{\text{DM}}(r) = \int_0^r 4\pi s^2 \rho_{\text{DM}}(s) ds$$

$$\beta_{\text{ani}}(r) = 1 - \frac{\sigma_t^2(r)}{2\sigma_r^2(r)}$$

Integrating along *line-of-sight*

$$\sigma_{\text{l.o.s.}}^2(R) = \frac{2}{\Sigma(R)} \int_R^\infty dr \left(1 - \beta_{\text{ani}} \frac{R^2}{r^2}\right) \frac{\nu(r)\sigma_r^2(r)}{\sqrt{1 - R^2/r^2}}$$

Degeneracy occurs between velocity anisotropy parameter and dark matter density profile because we only have *line-of-sight* information.

$\sigma_{\text{l.o.s.}}^{(\text{Theory})}$

FIT

$\sigma_{\text{l.o.s.}}^{(\text{obsrved})}$

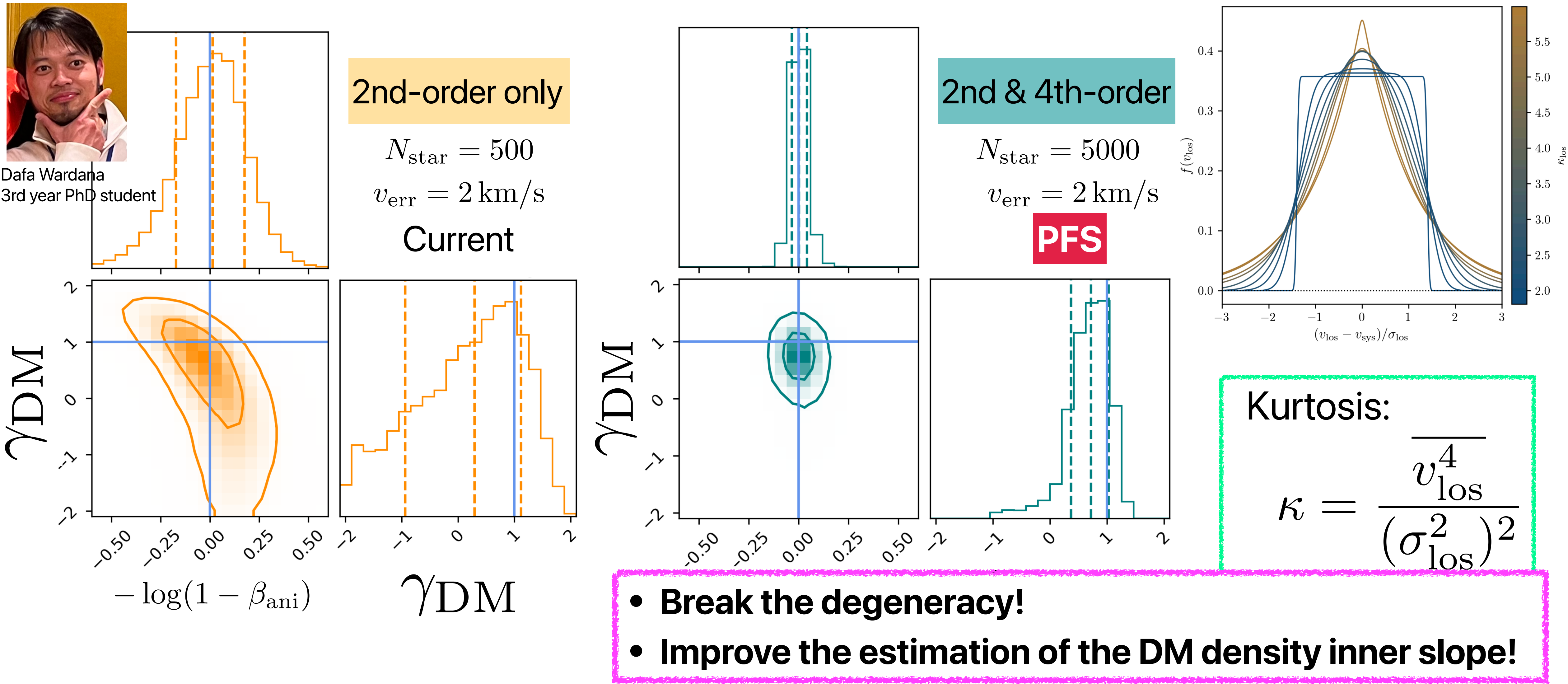
How to break the degeneracy?

- Higher-order line-of-sight velocity moments
- Additional kinematic information
- Relax spherically symmetrically assumption

Higher order vel. moment dynamical analysis

Wardana, Chiba, KH (2025, published in ApJ)

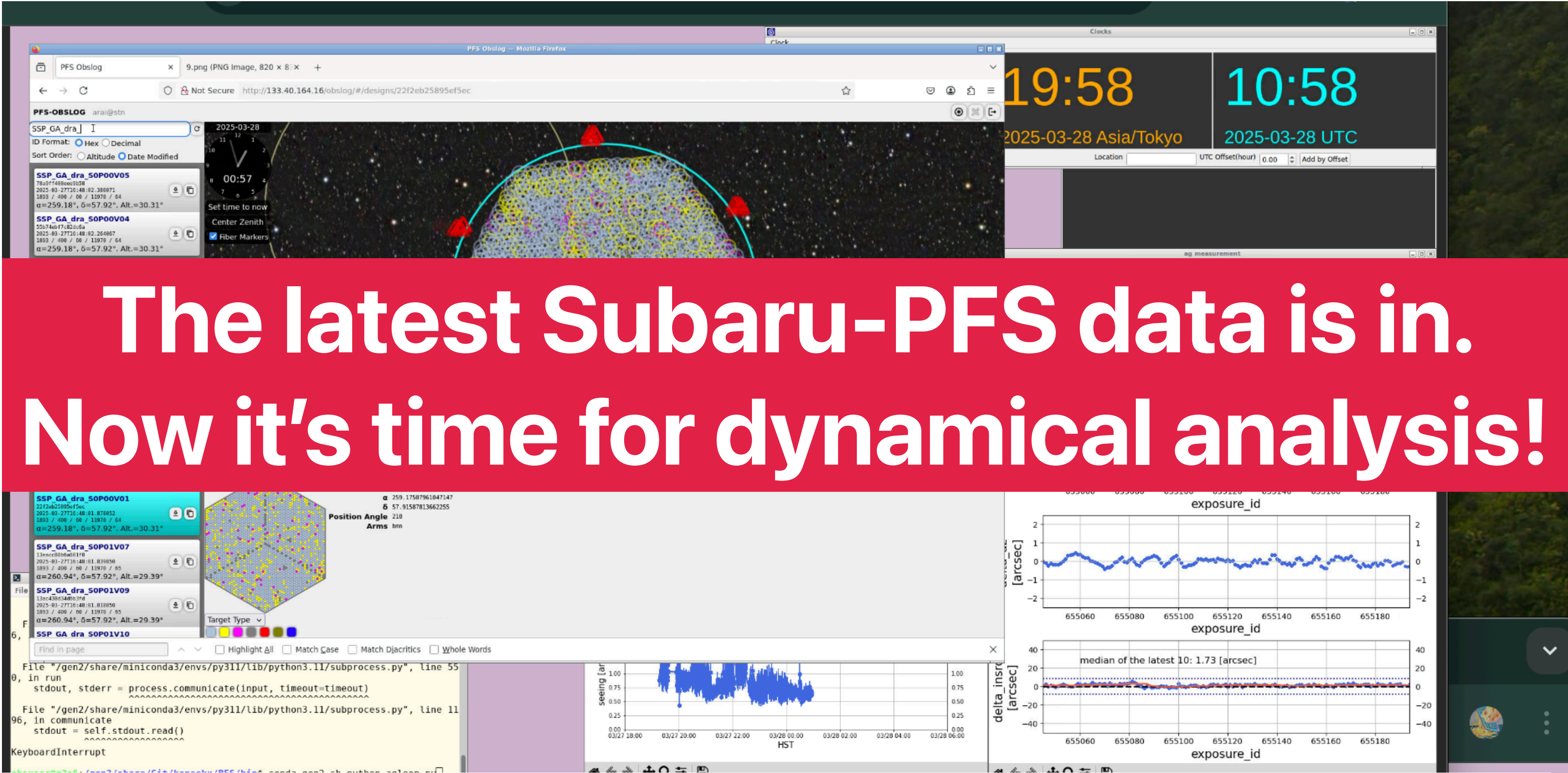
- **Non-Gaussianity of line-of-sight velocity distribution** is a powerful tool for estimating a DM density profile!
- The large number of kinematic sample should be required.



Subaru-PFS has begun!

B02 work!

Not a mock anymore... PFS has actually observed Draco!



The first PFS-SSP observing run got Draco and Ursa Minor data.

Take Home Message

- **Dwarf spheroidal (dSph) galaxies** on small scales are **ideal laboratories** for studying the fundamental nature of dark matter.
- We are pursuing the mystery of dark matter through detailed studies of Galactic dSphs.
- However, **large uncertainties** still exist in the inferred **dark matter density profiles** of dSphs, mainly due to **model assumptions** and **data limitations**.
- **Subaru-PFS has now begun operations!**
- With Subaru-PFS, we will be able to **obtain high-quality spectroscopic data** and place **stringent constraints** on the dark matter density of dSphs.

Thank you so much for your continued support since 2021!