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Science Projects of PANSY Radar

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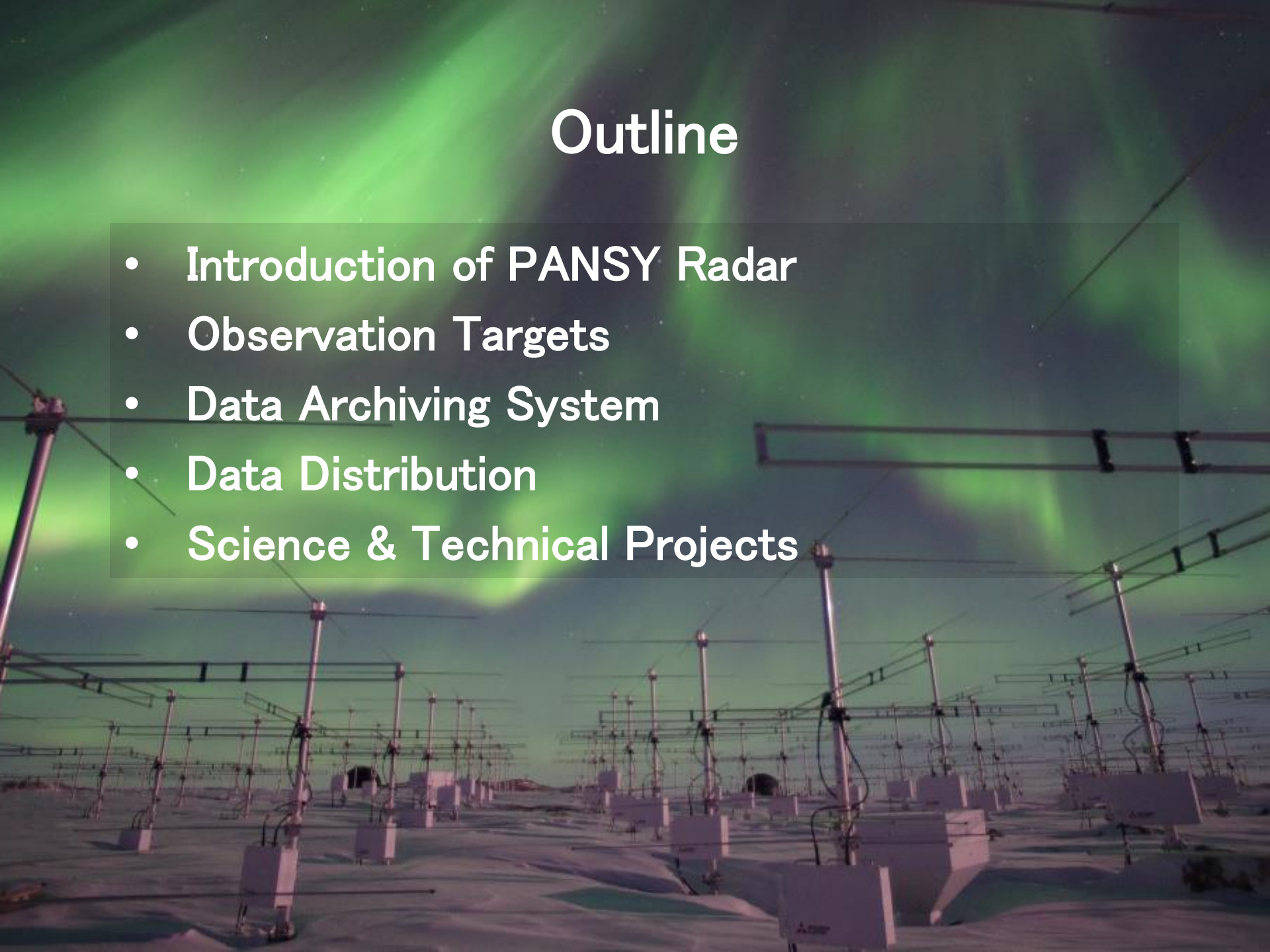
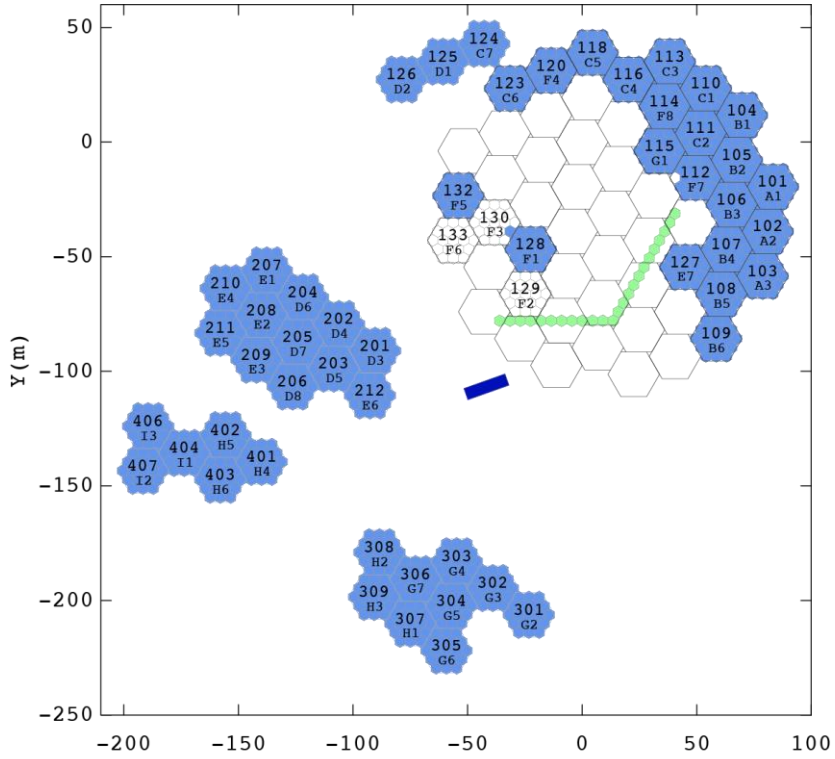
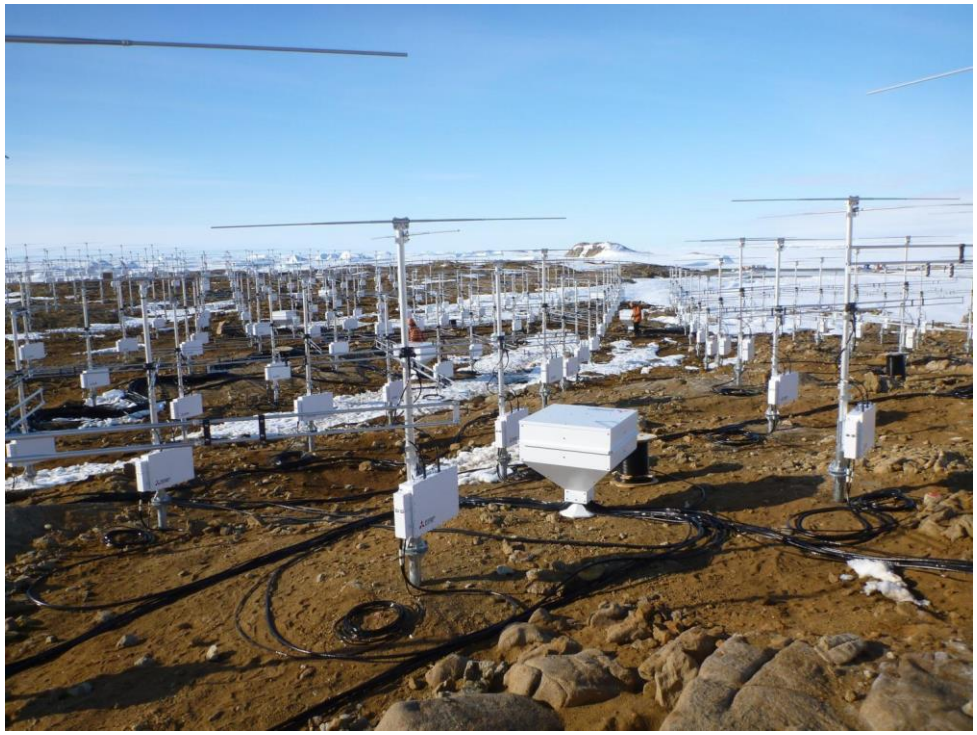


Outline

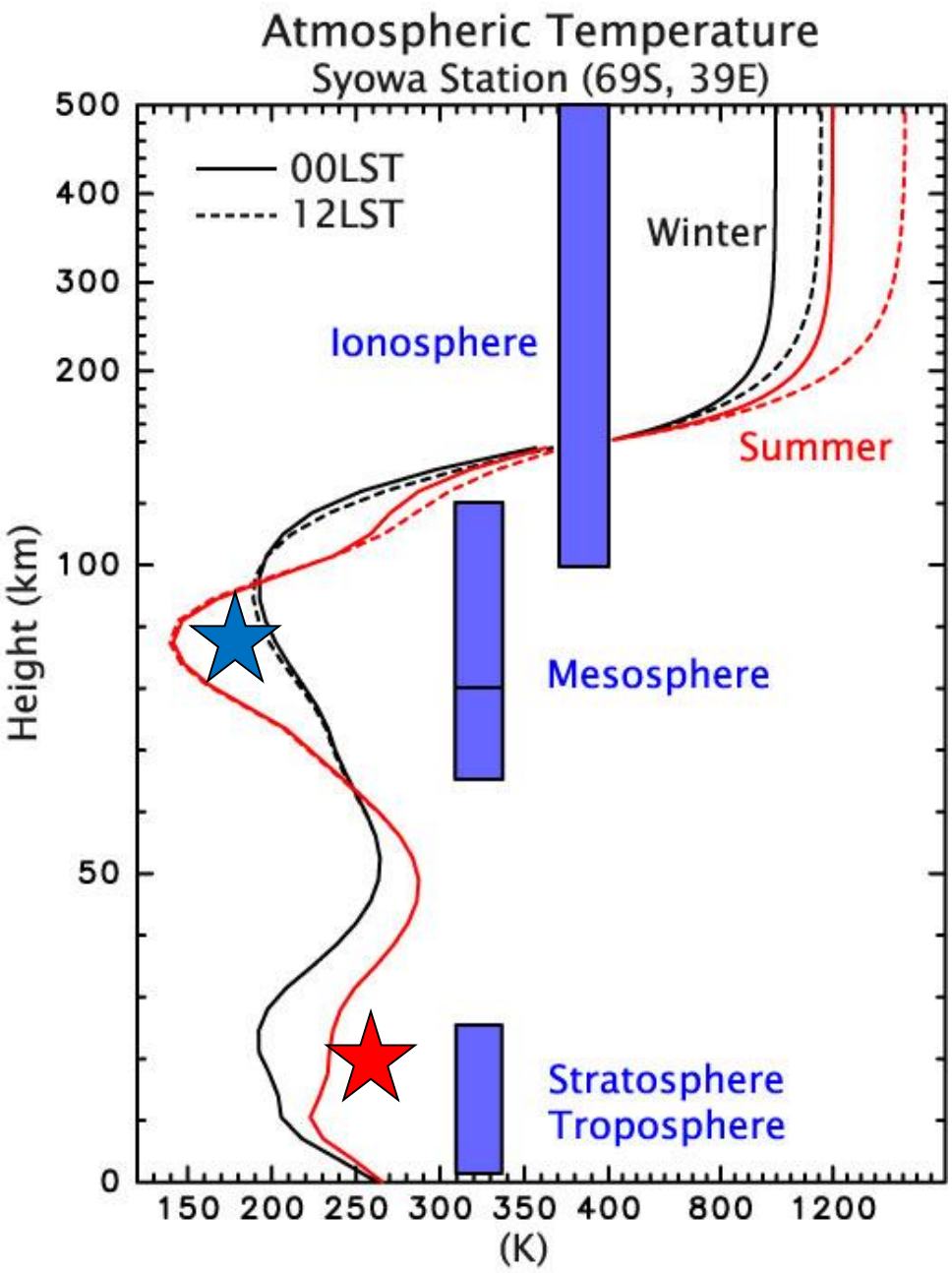
- Introduction of PANSY Radar
- Observation Targets
- Data Archiving System
- Data Distribution
- Science & Technical Projects

Antenna arrangement has been changed in 2012 to avoid severe snow accumulation.





Temperature Profile above Syowa Sta.



PANSY Radar & the Data Archiving System

PANSY Radar

Antennas & Power Amps:
Main 1045
FAI (Aux) 24
Aperture 18326 m^2
Transmital Pow.
at peak: 500kW
on ave: 25kW
Frequency: 47.0 ± 0.5 MHz
Digital Receiver:
Main: 55 ch
FAI Aux: 8 ch

Radar Output

Data Rate
Regular: 4.3 GByte/day
High-Speed: 1.0 TByte/day

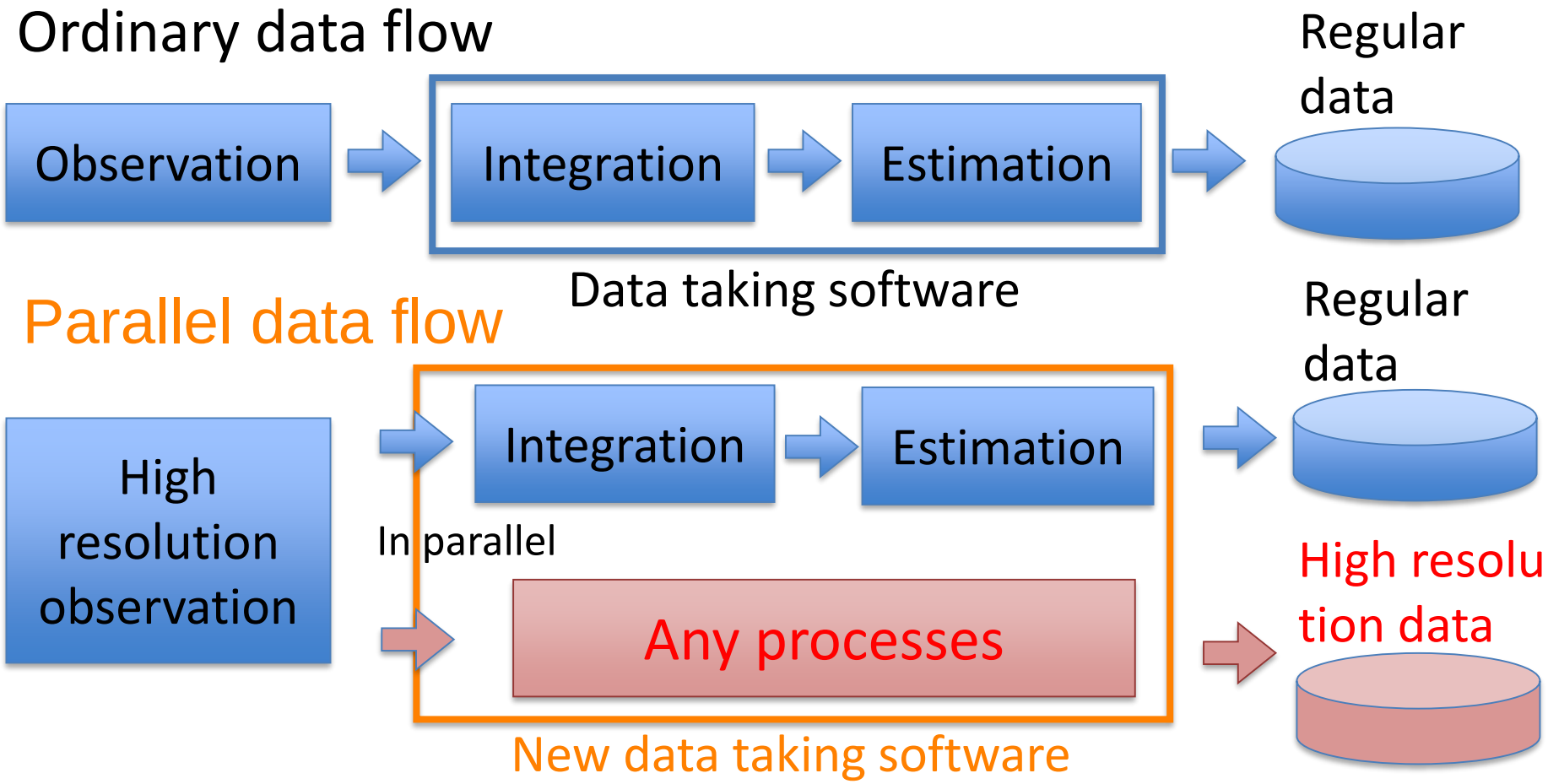
Data Archiving System (PANDA)

At Syowa, PANSY Obs. hut:
Sever: 14
Storage: 500 TByte
At Syowa, Data Proc. Blt:
Sever: 4
Storage: 200 TByte
At NIPR (Tachikawa Campus)
Server: 9
Storage: 400 TByte
At Univ. Tokyo
Sever: some
Storage: 500 TByte
At Kyoto Univ.
Storage: 100 TByte

Reduce data are transferred through the satellite.
The full data set is transported on RAID HDDs by the ship once a year.

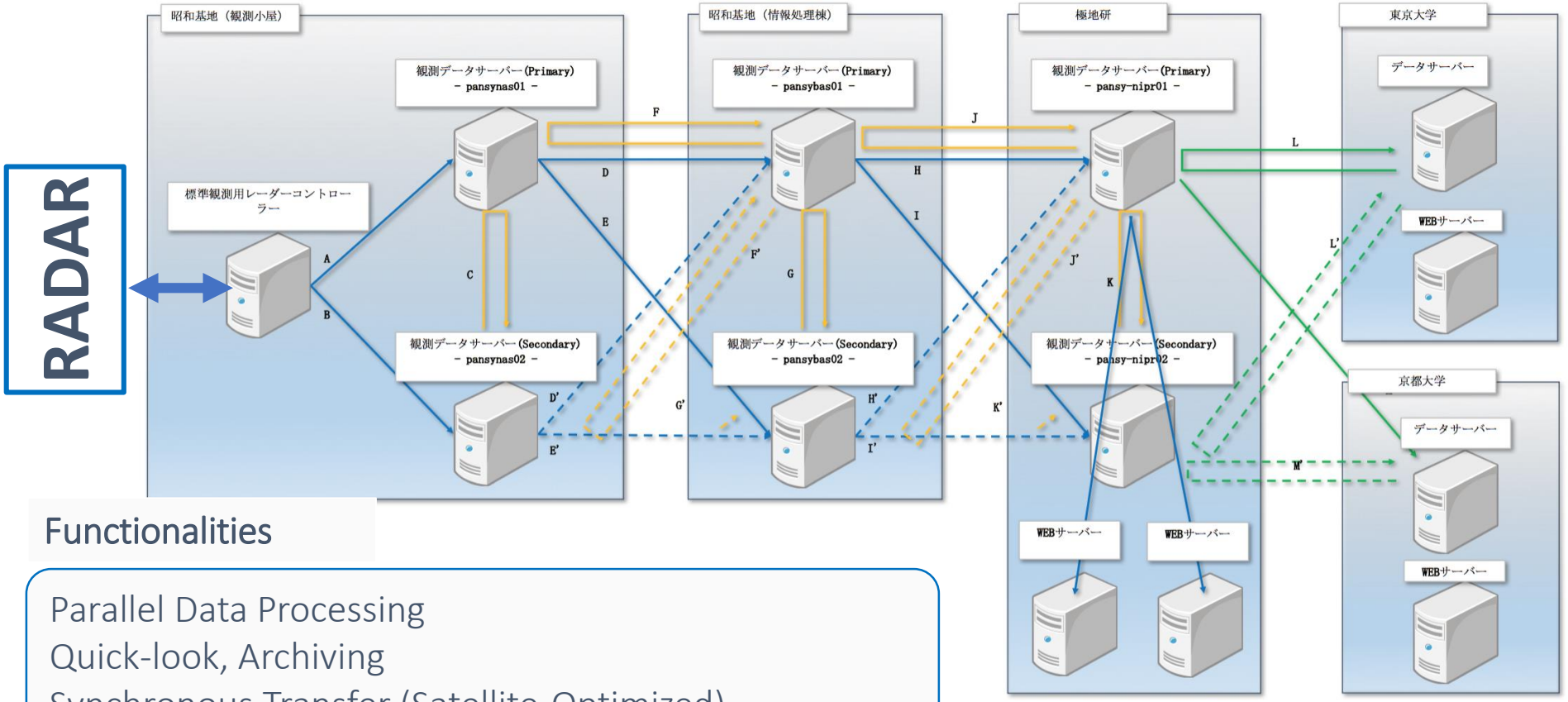
Real Time Data Processing System

Multiple data processing scheme can be applied realtime in parallel.



To be performed with 44-core computers from December 2019.

PANSY Archiving System (PANDA)



Functionalities

- Parallel Data Processing
- Quick-look, Archiving
- Synchronous Transfer (Satellite-Optimized)
- Automatic Re-Route in Error
- Automatic Consistency Check
- Automatic Recovery
- Database Management
- Web-based GUI
- Search & Display

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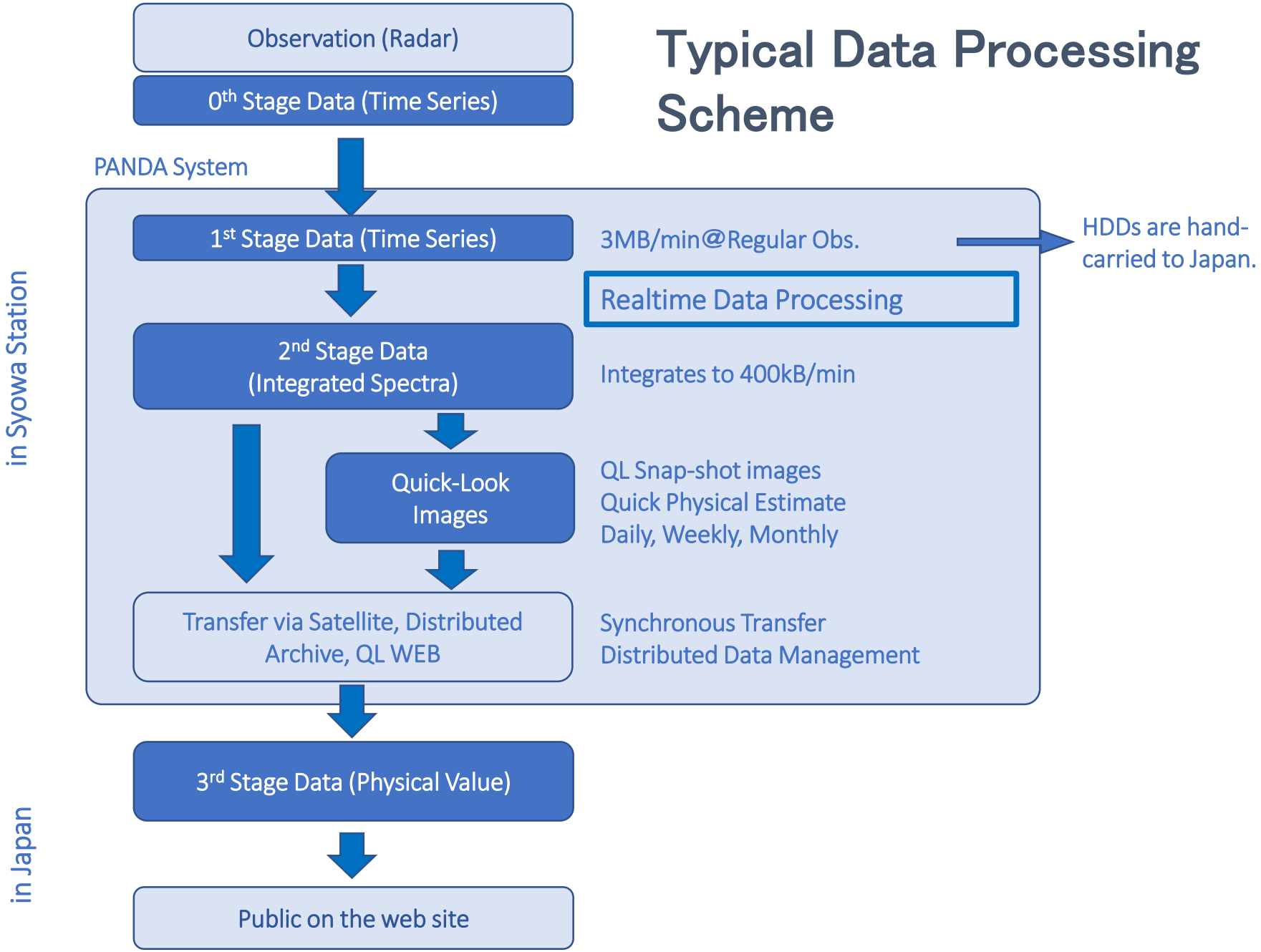
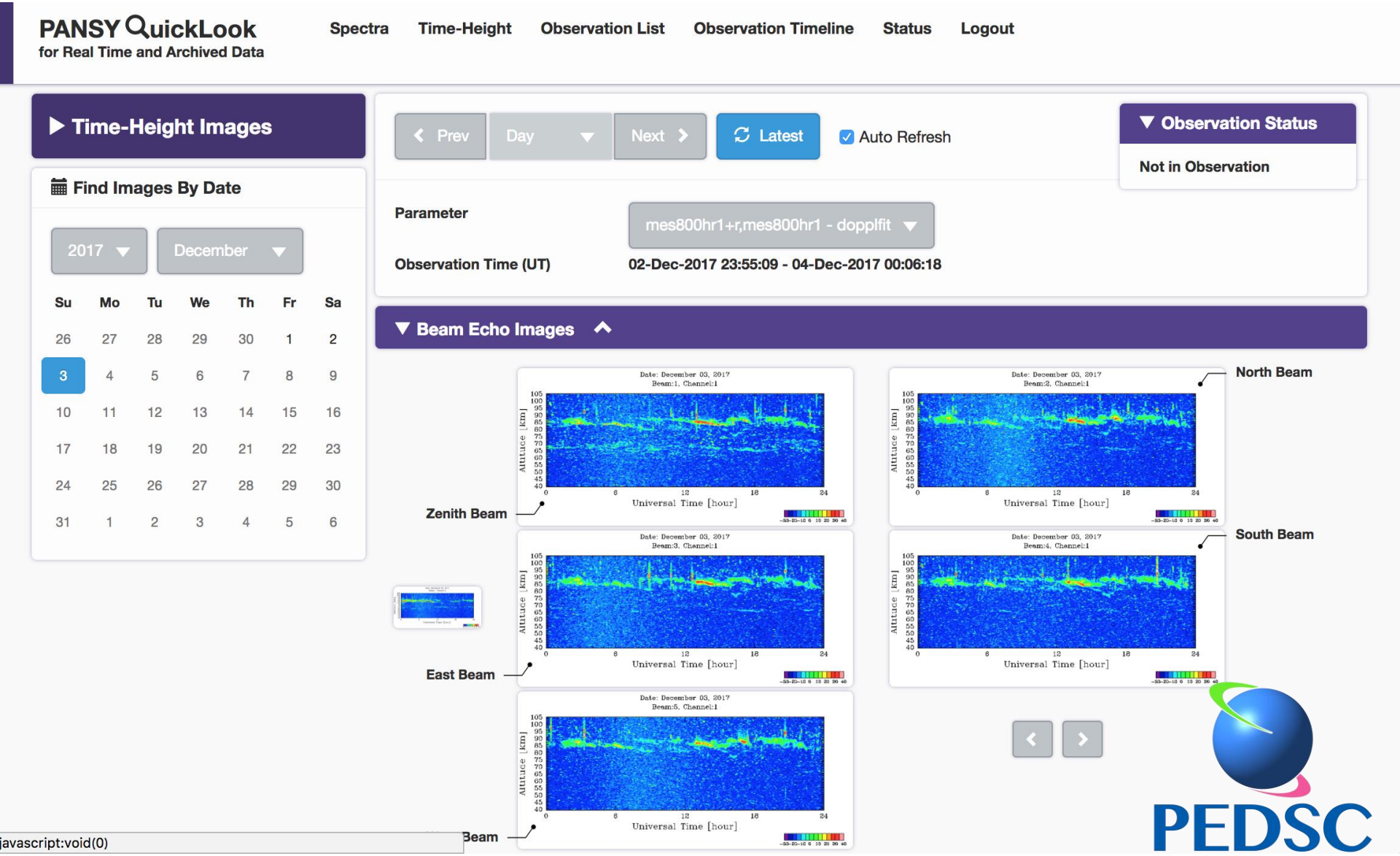
Typical Data Processing Scheme



Quick-Look Viewer (Time-Height Section)



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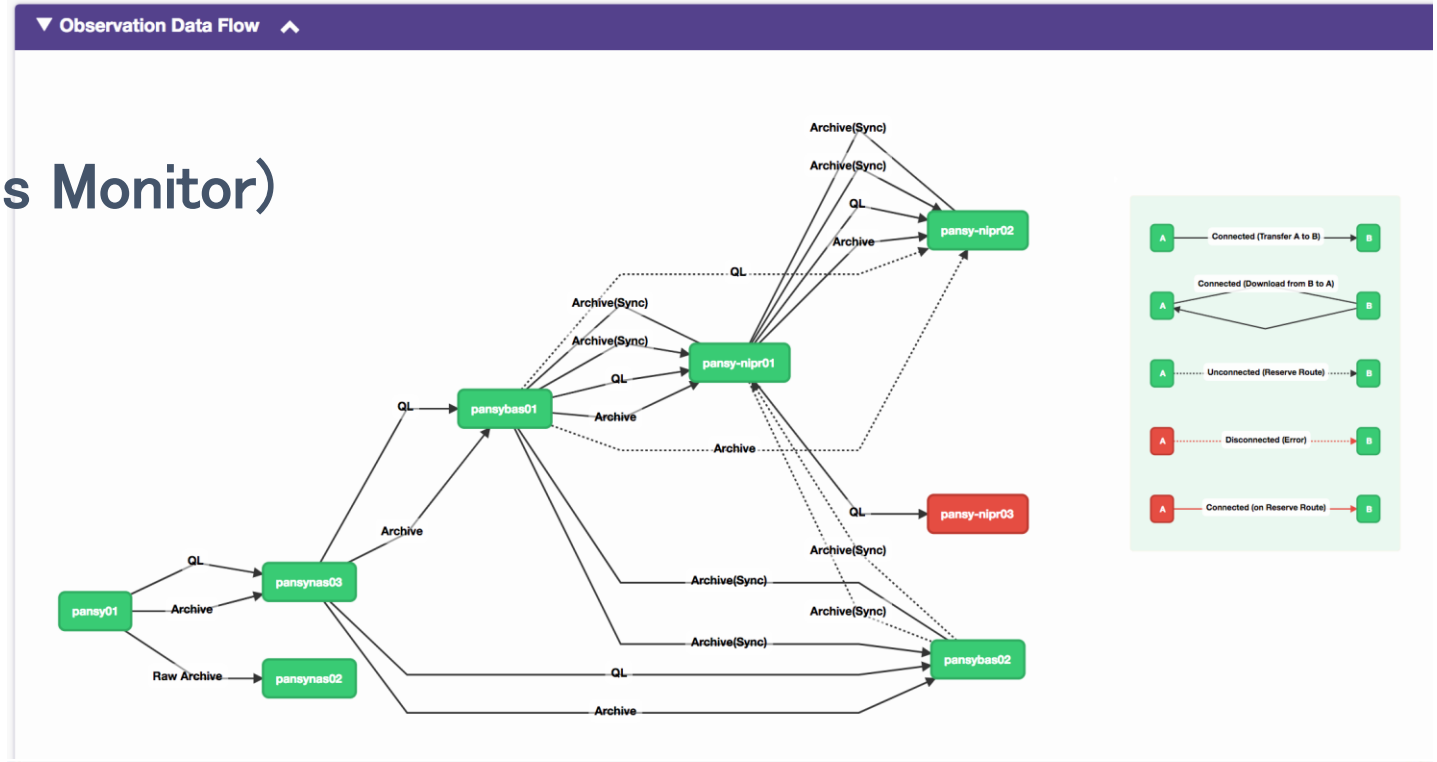
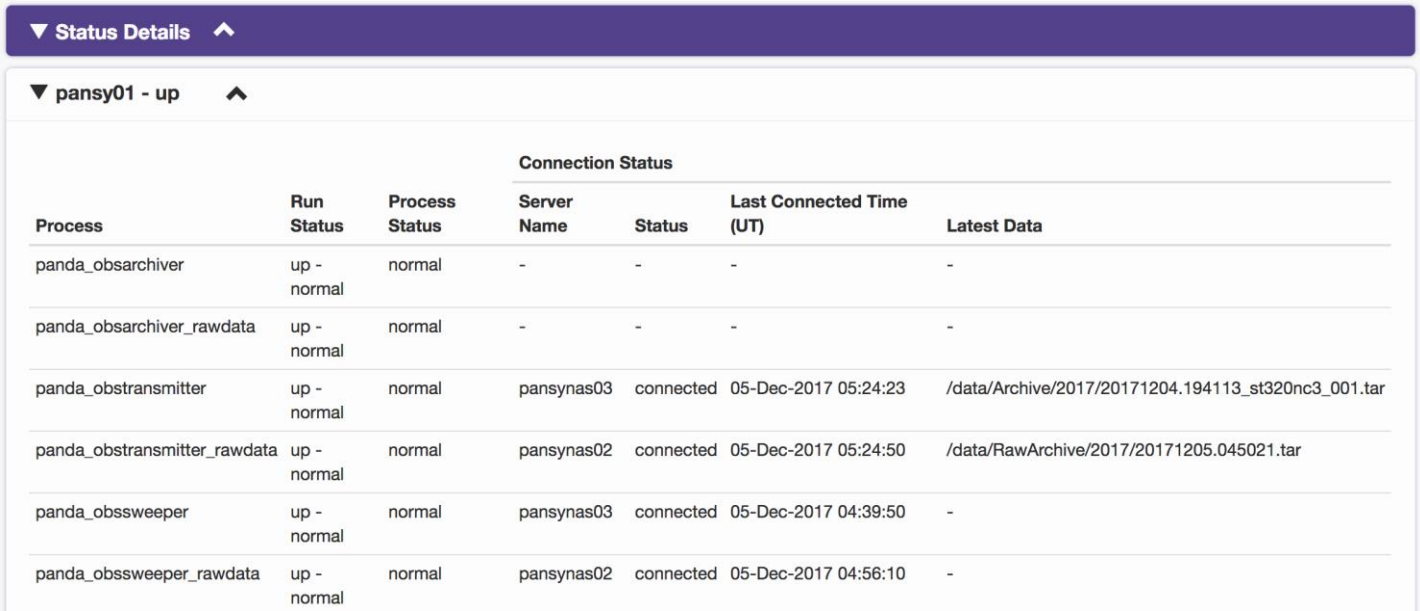
QL Viewer
(System Status Monitor)



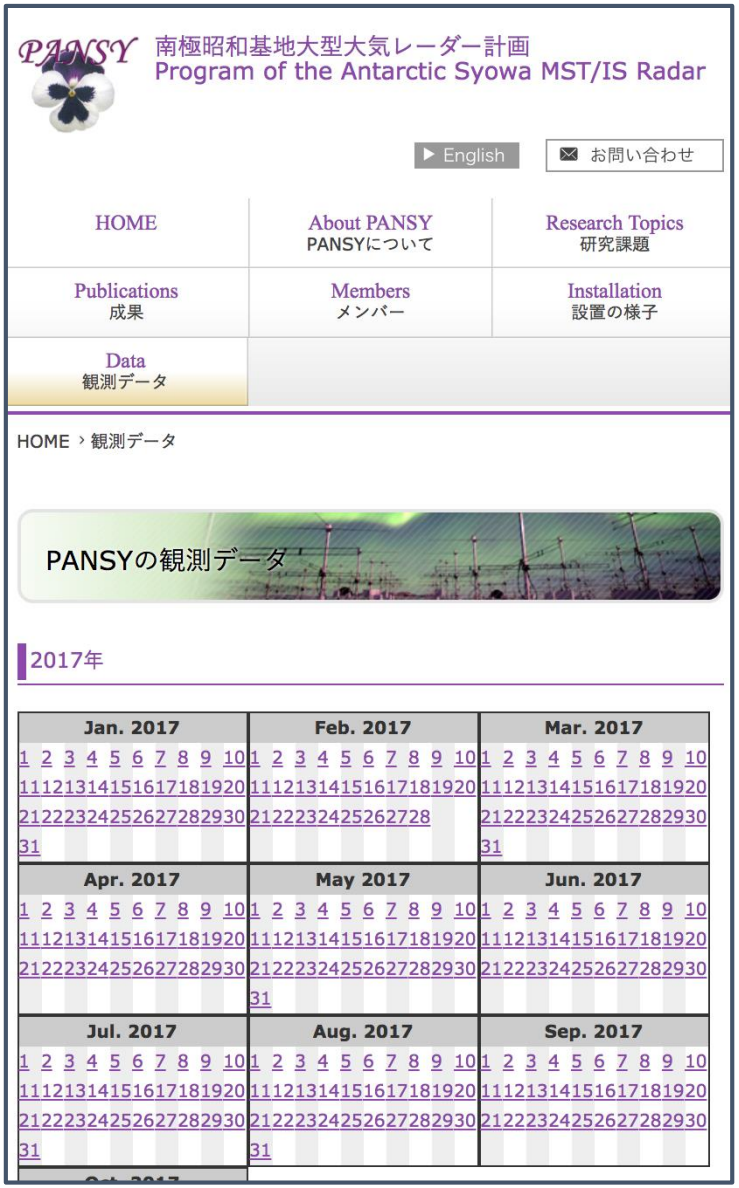


Process	Run Status	Process Status	Connection Status: Server Name	Connection Status: Status	Connection Status: Last Connected Time (UT)	Latest Data
panda_obsarchiver	up - normal	normal	-	-	-	-
panda_obsarchiver_rawdata	up - normal	normal	-	-	-	-
panda_obstransmitter	up - normal	normal	pansynas03	connected	05-Dec-2017 05:24:23	/data/Archive/2017/20171204.194113_st320nc3_001.tar
panda_obstransmitter_rawdata	up - normal	normal	pansynas02	connected	05-Dec-2017 05:24:50	/data/RawArchive/2017/20171205.045021.tar
panda_obssweeper	up - normal	normal	pansynas03	connected	05-Dec-2017 04:39:50	-
panda_obssweeper_rawdata	up - normal	normal	pansynas02	connected	05-Dec-2017 04:56:10	-

Data Sharing

- Processed wind estimates (6-hourly) are open to the public on the web site.
  http://pansy.eps.s.u-tokyo.ac.jp/data/

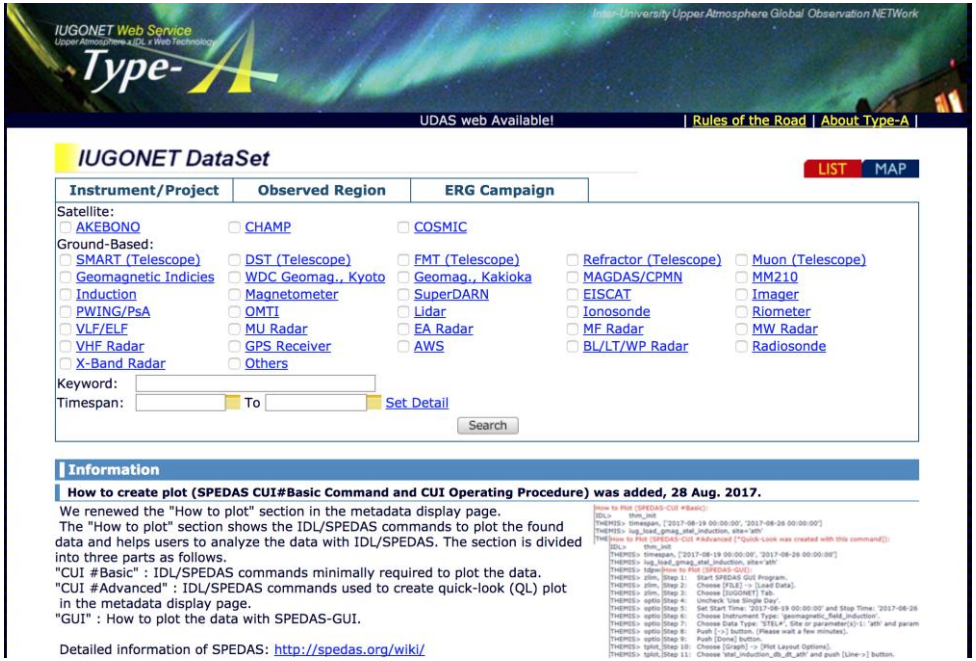
- This will be upgraded to 30-min resolution next year, and the DOIs will be tagged.



Data Distribution

- Data currently in public are to be registered to IUGONET by Mar 2018.
- Further coming data will also be registered as it will be in public on the web site.

IUGONET (www.iugonet.org)
Metadata database



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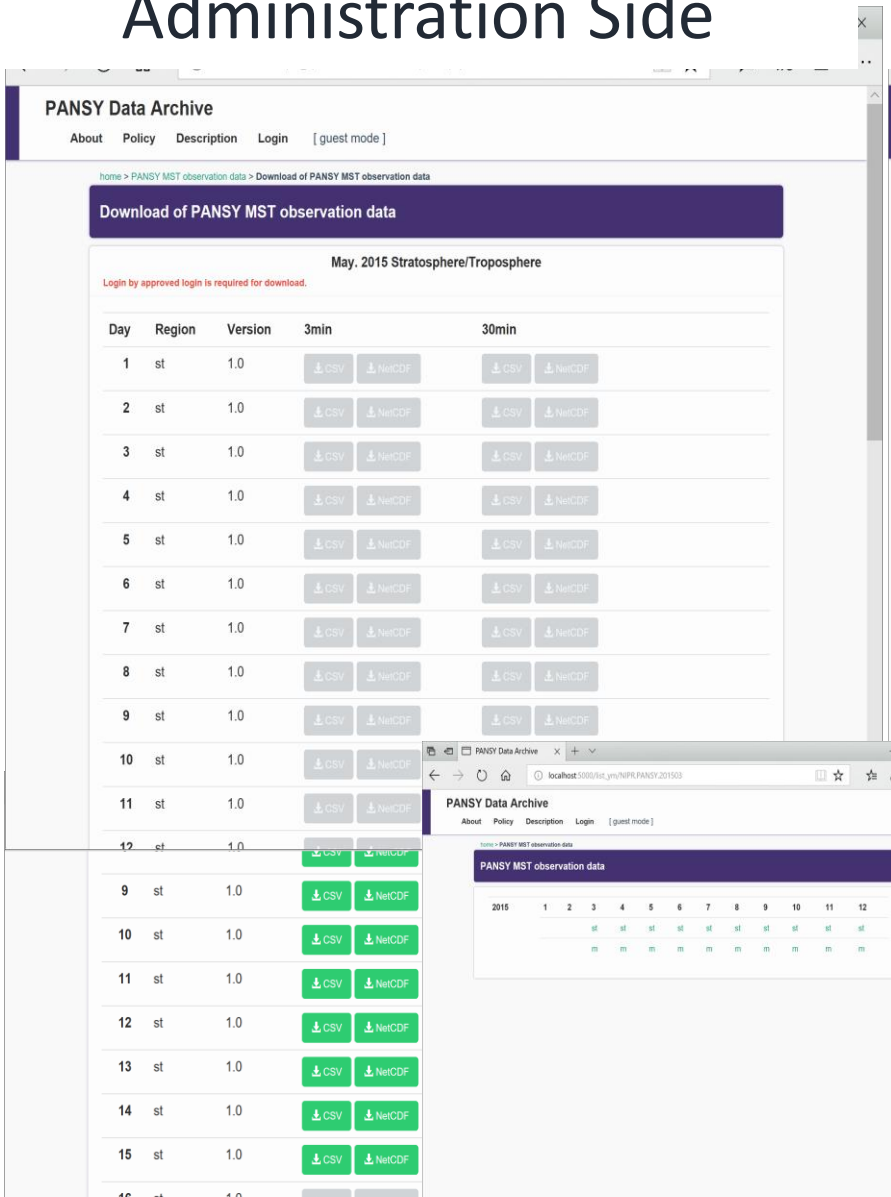
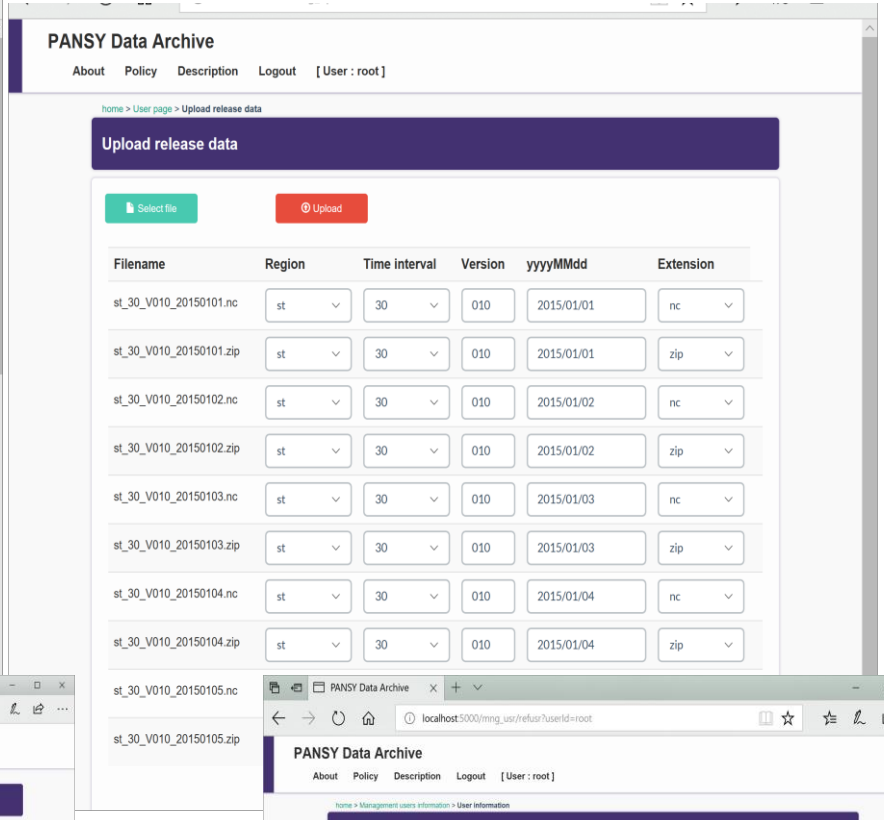
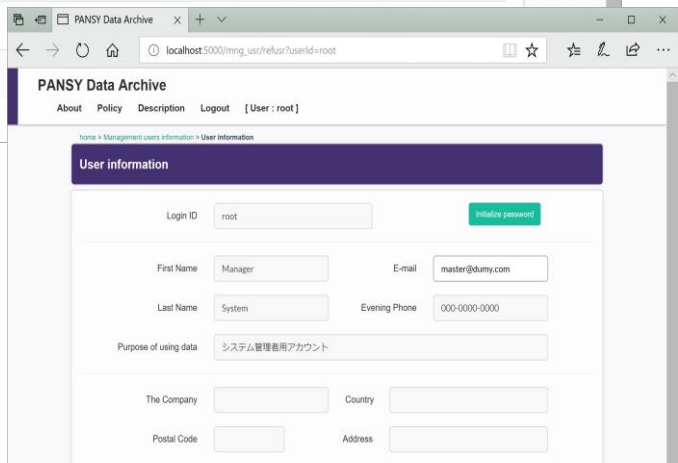
Data Publication Web Site (in preparation)

Administration Side



Public Side

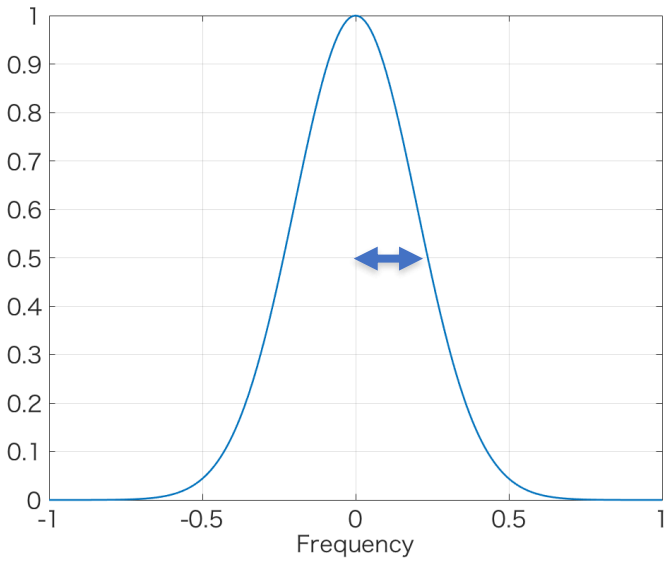




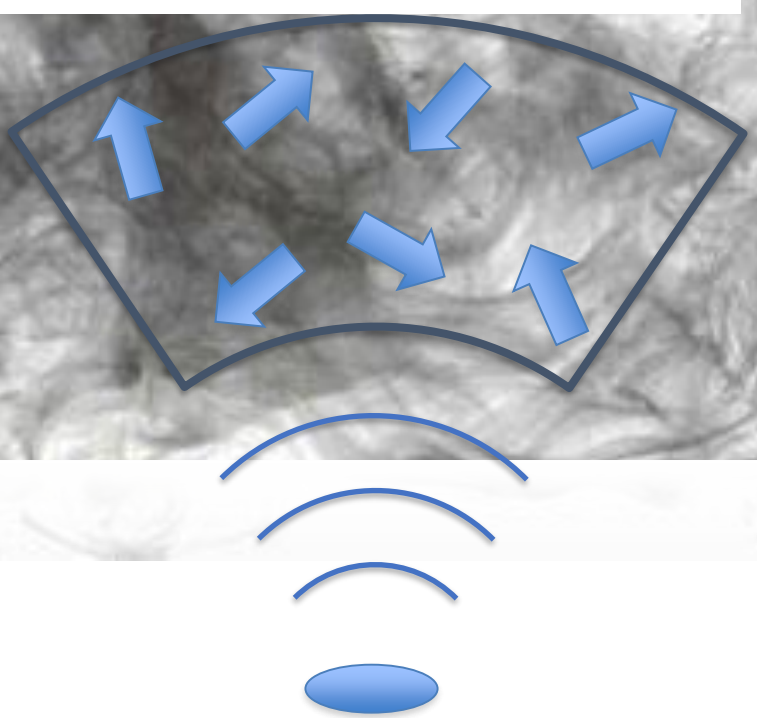
風速スペクトルと乱流パラメータ

乱流による速度分散がスペクトルの広がりに寄与する

風速スペクトル



散乱ボリューム内の乱流

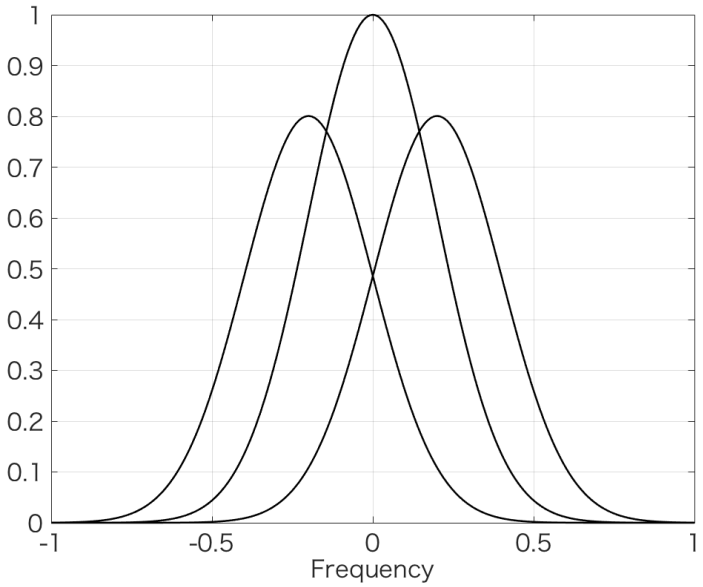


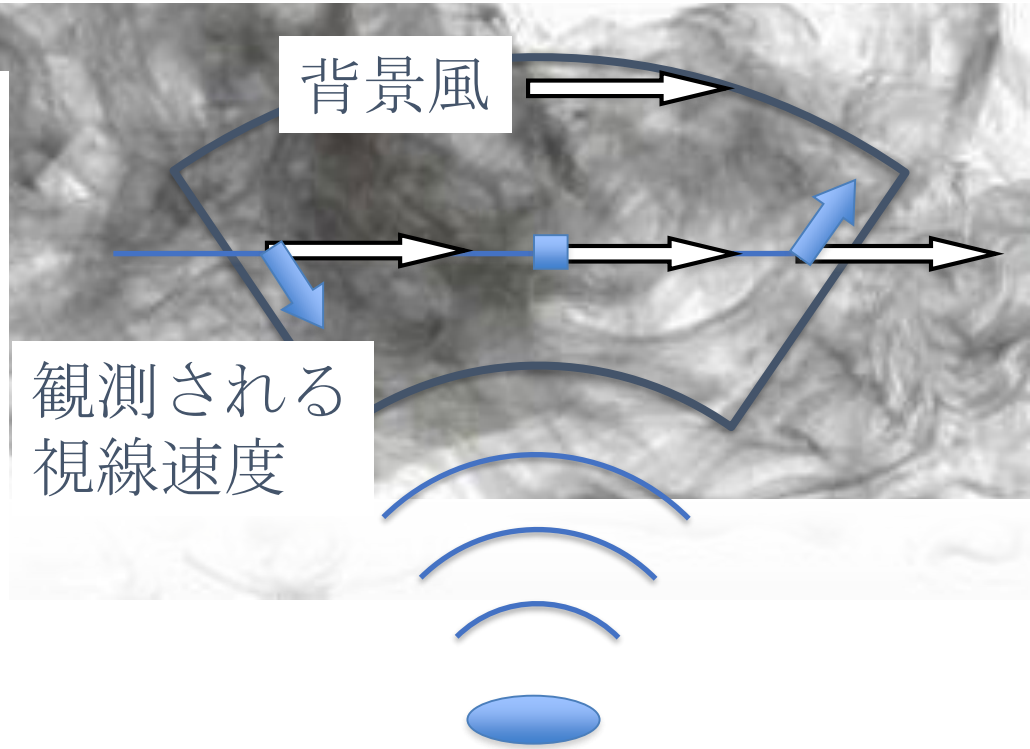
エネルギー消散率 ε が $\sigma_T^2 = K\varepsilon^{2/3}$ から求まる

ビームブロードニング

一様な背景風がビーム広がりのために スペクトル幅に寄与

風速スペクトル

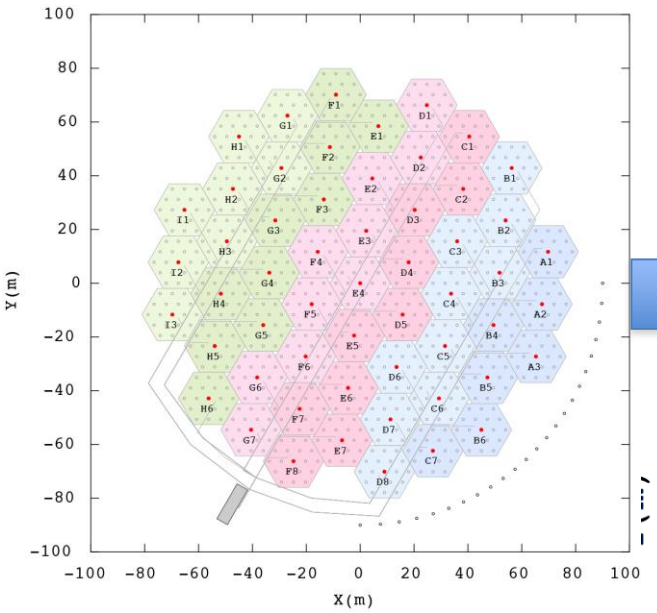




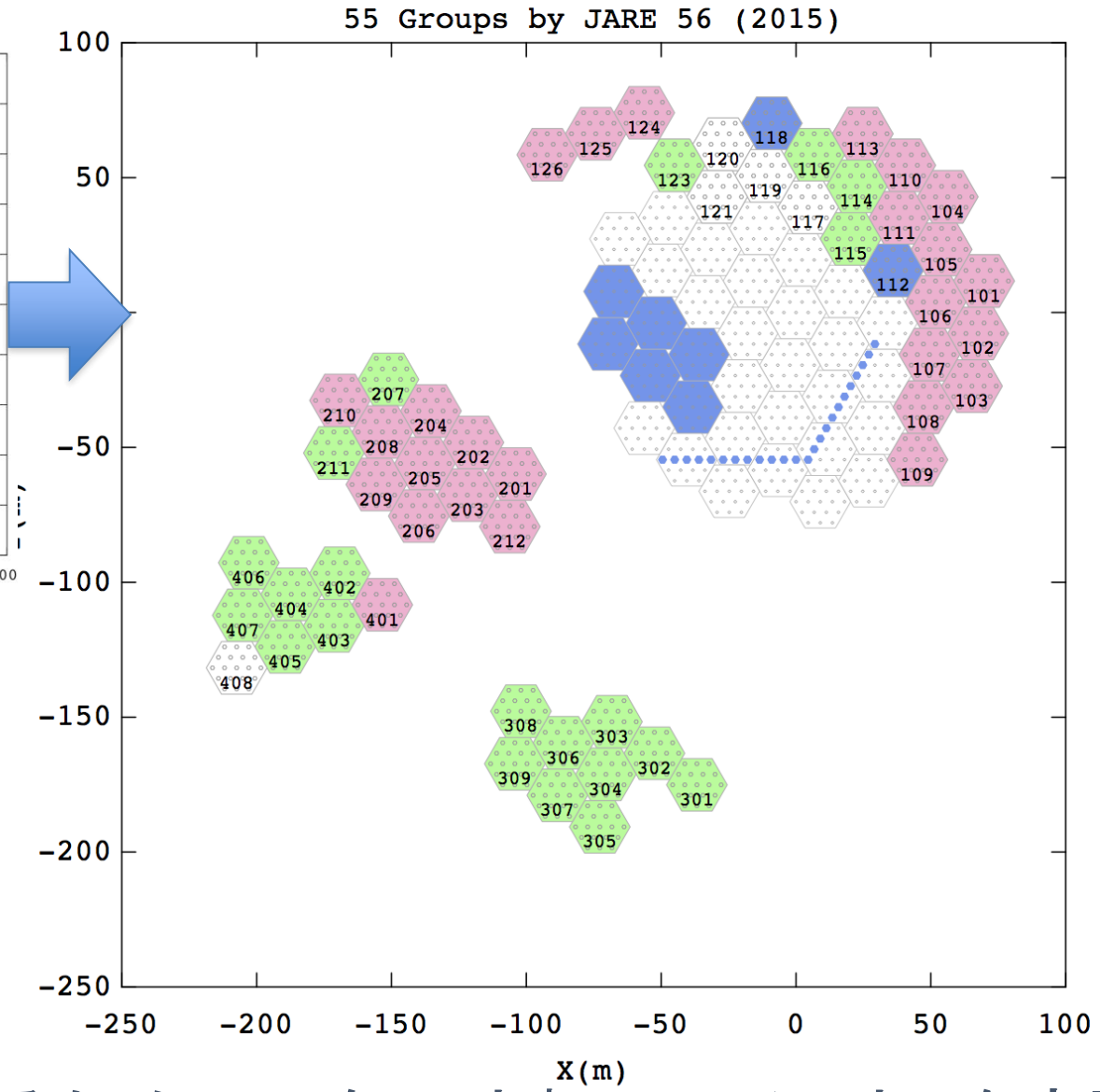
この効果が非常に大きく乱流パラメータを得るためには
除去する必要がある．ビーム形状と風速で決まる．

PANSYのアンテナレイアウト

2011



オリジナル配列

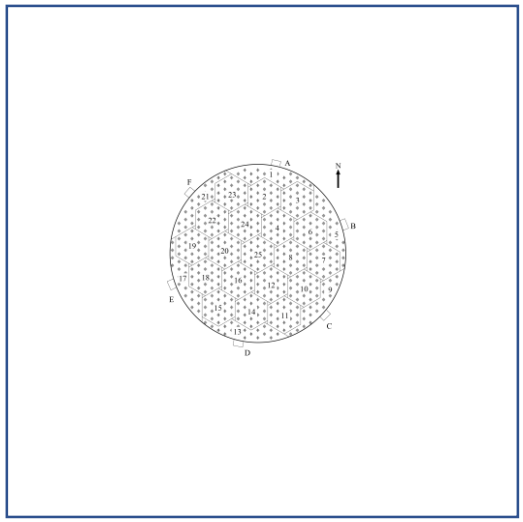


雪による埋没を避けるため2012年に大幅にレイアウトを変更

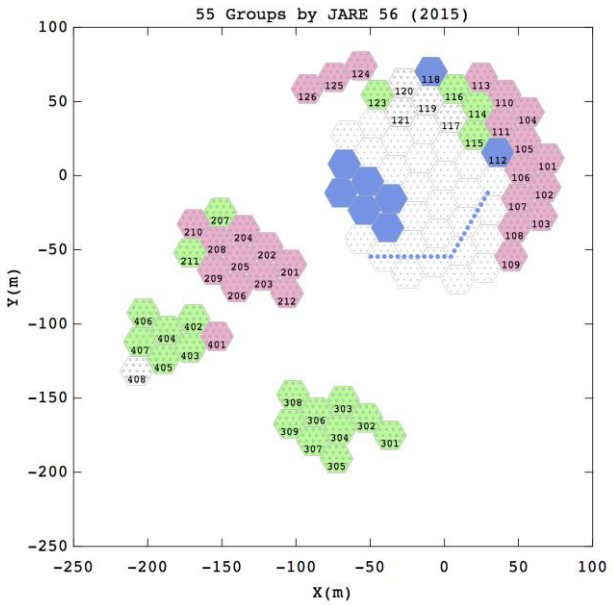
PANSYのアンテナレイアウト

アンテナ配置

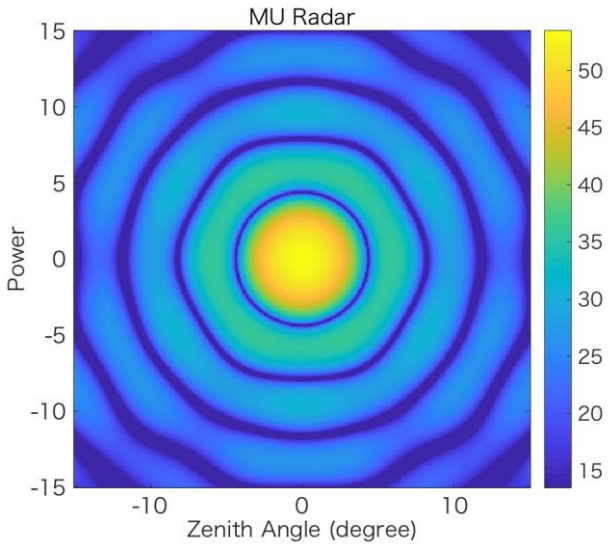
MUレーダー



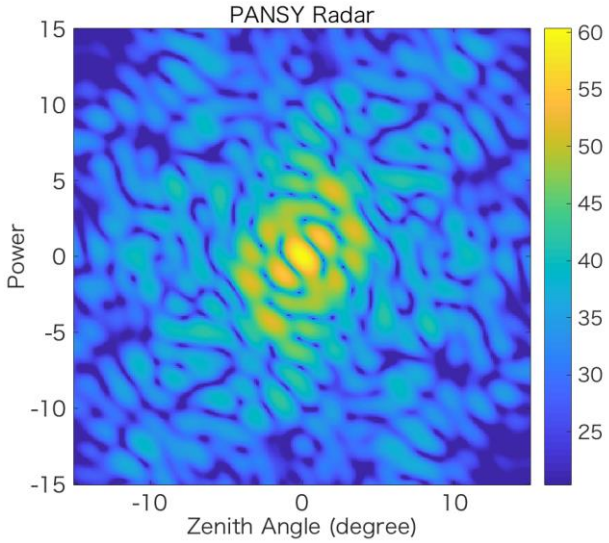
PANSYレーダー



ビームパターン

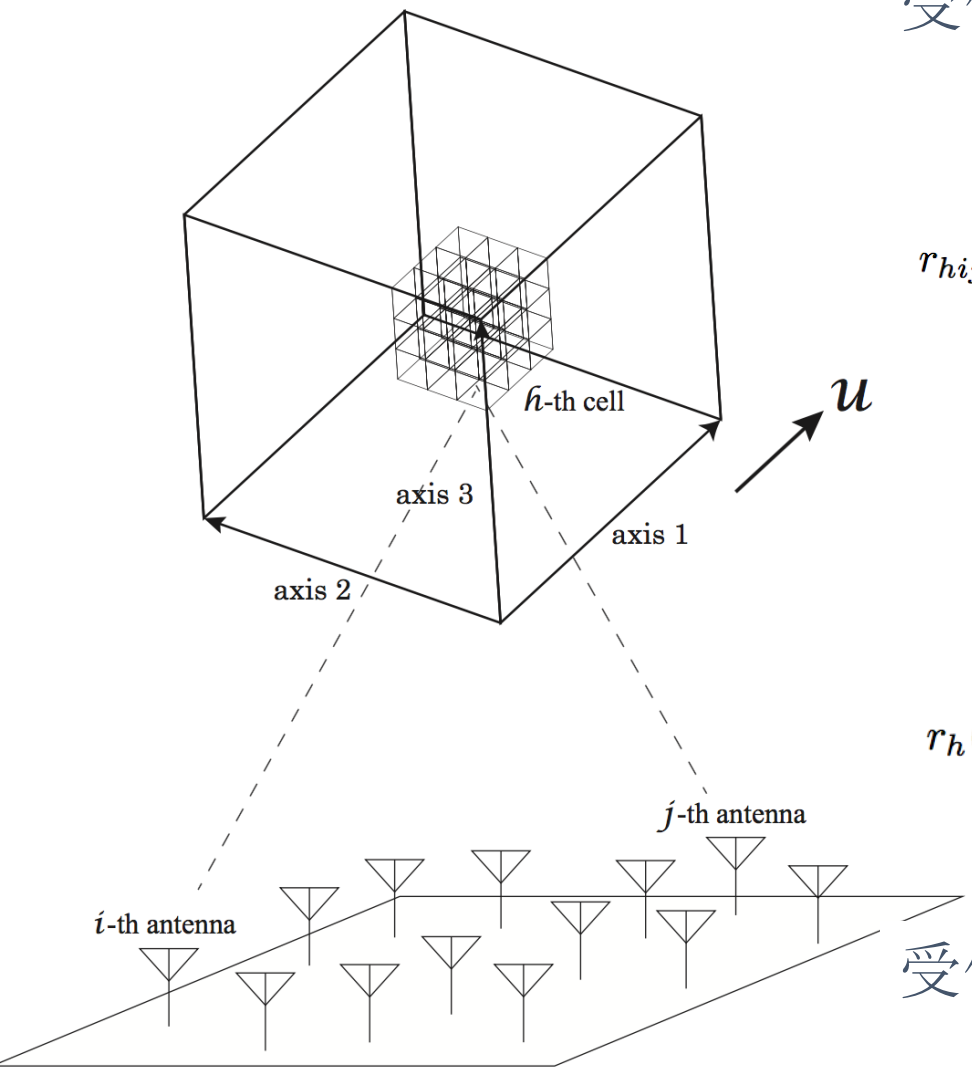


サイドローブ小
対称性高



サイドローブ高
対称性低

フィールドグリッド化



受信信号を離散形式で定式化

p： 送信フィルター（送信波形）

q： 受信フィルター

$$r_{hij}(t_n) = \int_0^{t_\Delta} f_h\left(t_n + T - \frac{|\boldsymbol{x}_h - \boldsymbol{x}_i|}{c}\right) p_i\left(T - \frac{|\boldsymbol{x}_h(t_n) - \boldsymbol{x}_i| + |\boldsymbol{x}_h(t_n) - \boldsymbol{x}_j|}{c}\right) q_j\left(T - \frac{2R}{c}\right) \mathrm{d}T.$$

$$= f_h(t_n) \int_0^{\iota_\Delta} p_i\left(T - T_{hij}(t_n)\right)\, q_j\left(T - T_R\right)\, \mathrm{d}T.$$

$$r_h(t_n) = f_h(t_n) \sum_i^{N_{\mathrm{ant}}} \sum_j^{N_{\mathrm{ant}}} g_{hij}(t_n)$$

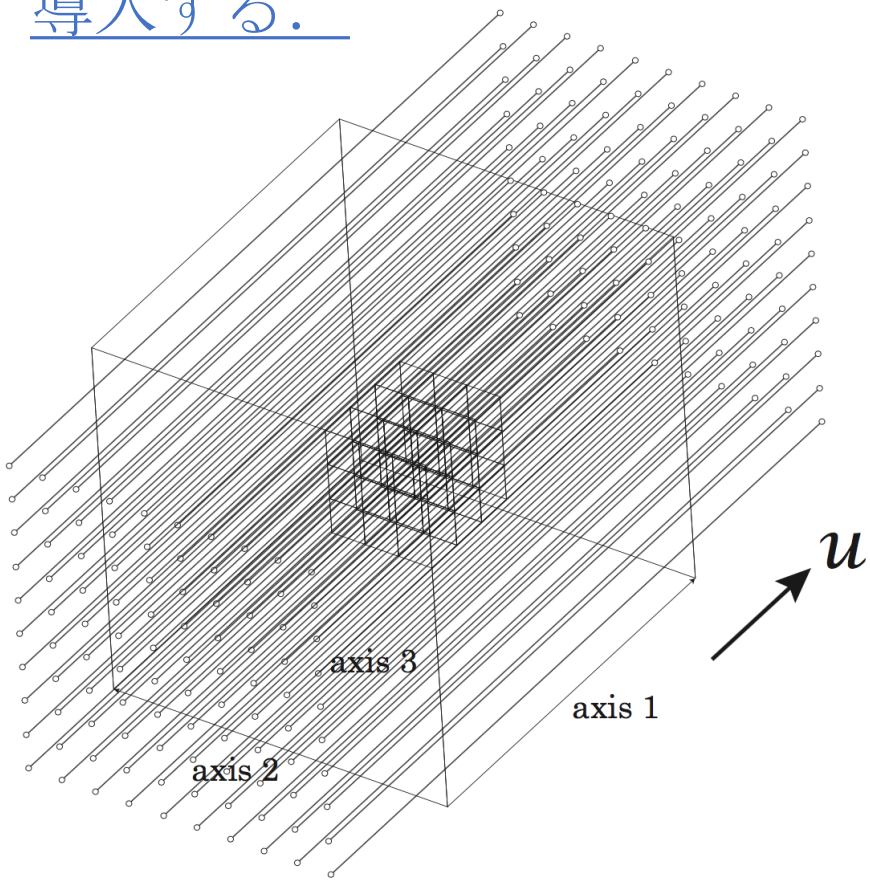
$$= f_h(t_n)\, g_h(t_n),$$

受信信号r(t)は，

$$r(t) = \sum_h f_h(t)\, g_h(t).$$

１次元スペクトル観測理論

風速ベクトルに沿って空間を１次元化し，スライス毎の $f(\boldsymbol{x}, t)$ の独立性の仮定を導入する．



ビーム全体のACFを
スライス毎のACFの和として

$$G(\tau) = \sum_m \sum_l G_{lm}(\tau)$$

where

$$G_{lm}(\tau) = \sum_k g^*_{lm}\left(t + \frac{kL}{|\boldsymbol{u}|}\right) g_{lm}\left(t + \frac{kL}{|\boldsymbol{u}|} + \tau\right)$$

と定義すると，
受信信号のACF（の期待値）は

$$R(\tau) = F(\tau)\, G(\tau)\, W(\tau)$$

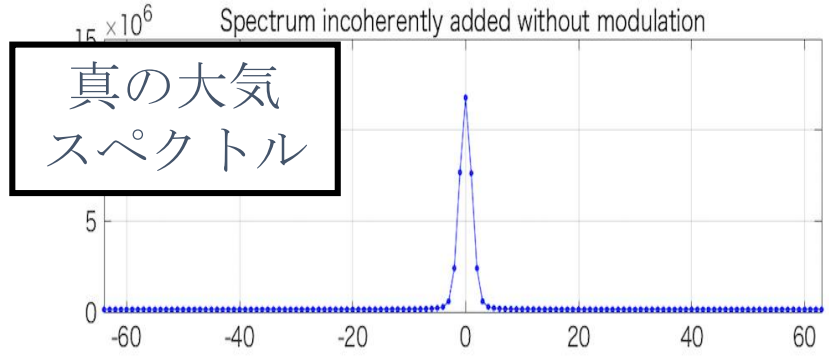
F： 乱流ACF（スペクトルのFT）
G： ビームフィールドACF
W： 時間窓ACF

となることが示される．

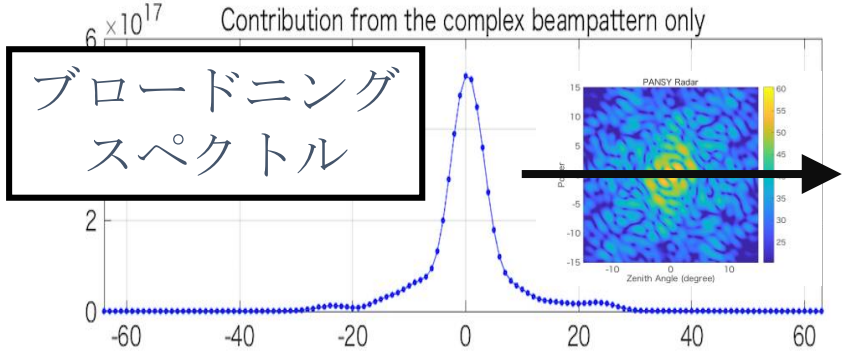
Nishimura et al., *IEEE Trans GRS*, condinally accepted, 2019

ブロードニングの風速方位角依存性

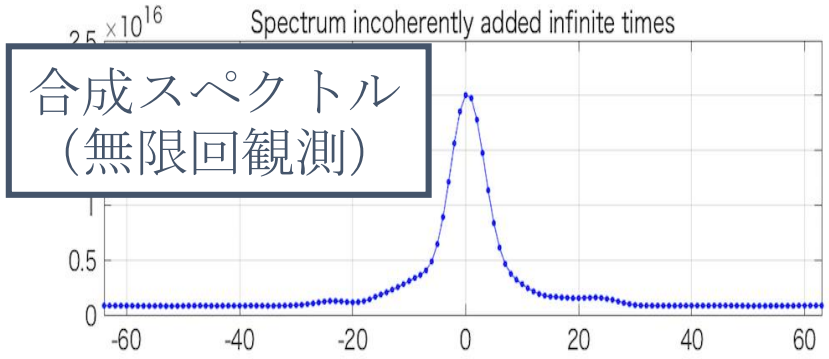
真の大気スペクトル

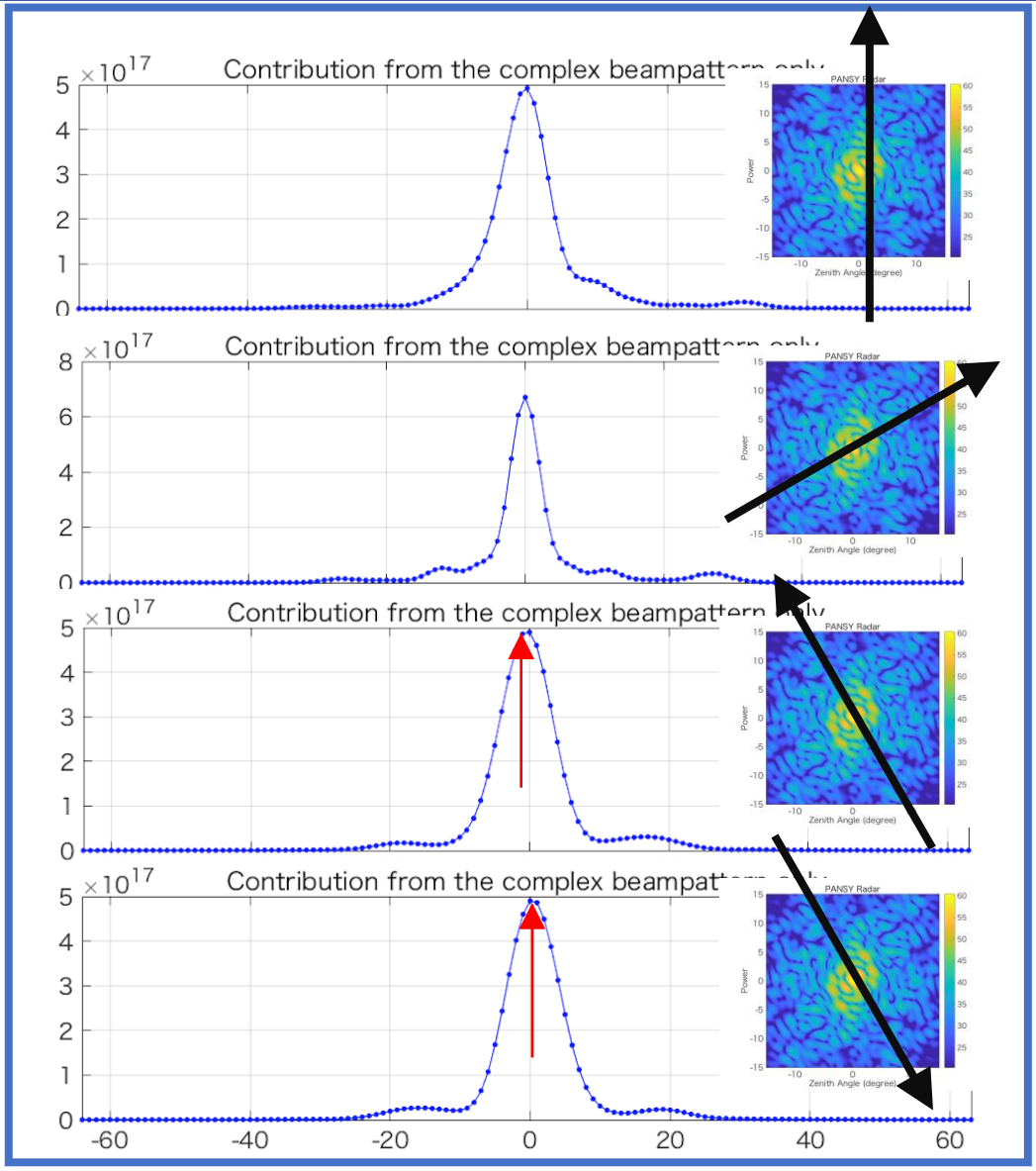


ブロードニングスペクトル



合成スペクトル（無限回観測）





方位により幅が異なるだけでなく，周波数オフセットも存在する．

パラメータ推定：パワースペクトルの確率分布

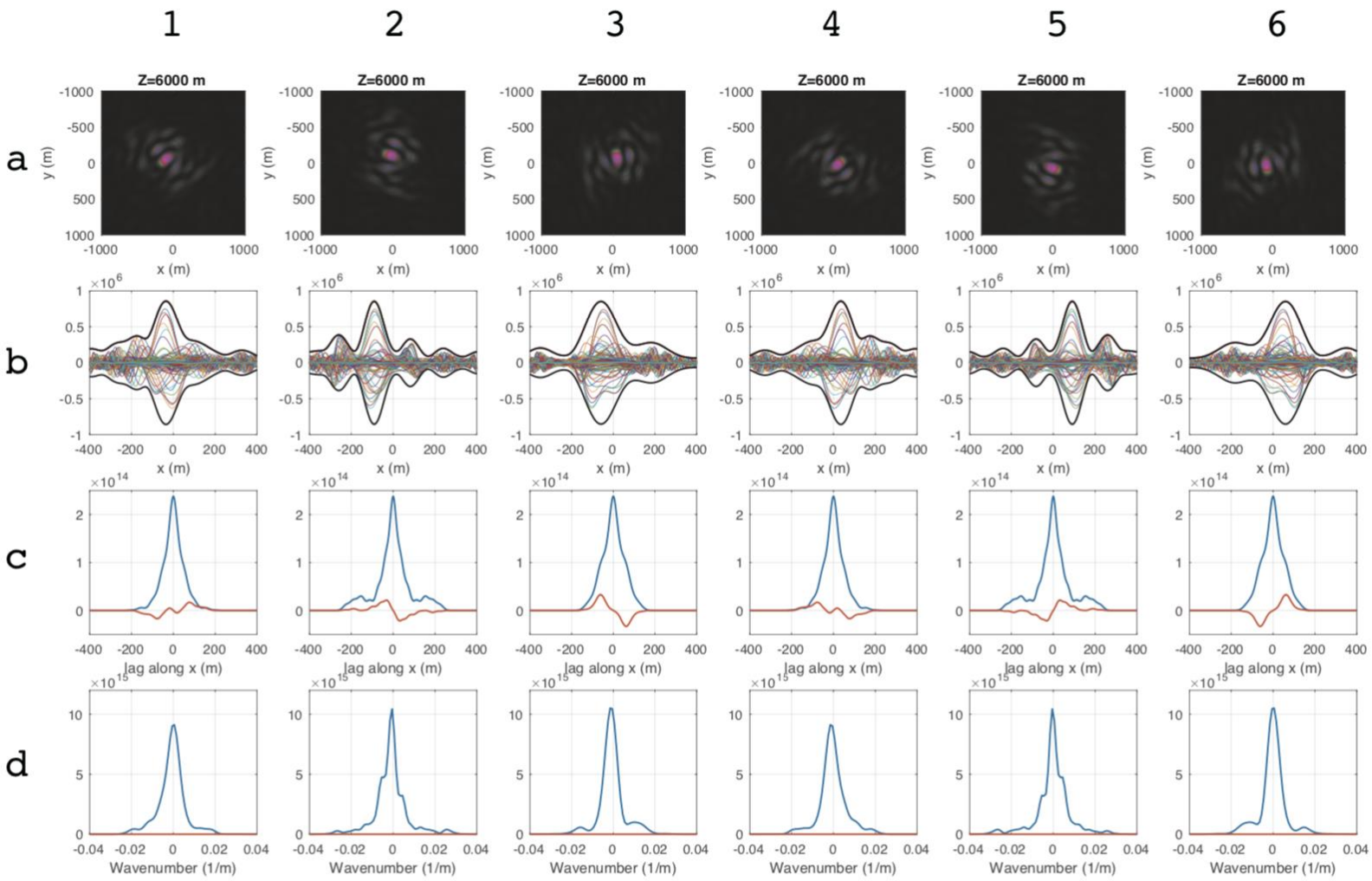
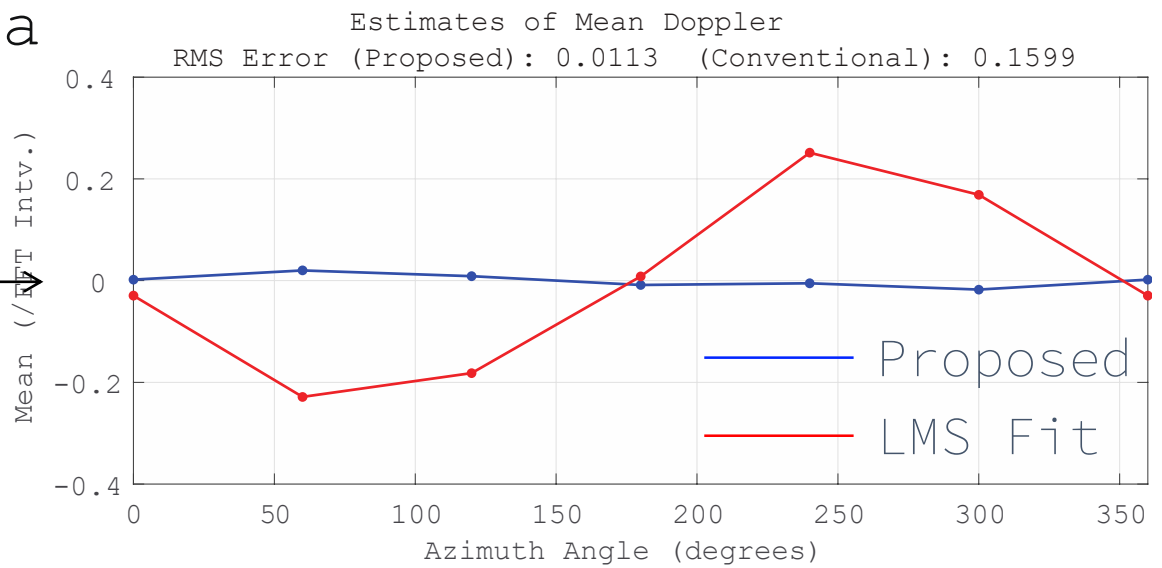


Fig. 5. Complex beam patterns, $G(\tau)$ and $\mathcal{F}[G(\tau)]$, at height z=6000 m, calculated with respect to PANSY radar, are plotted. Columns 1–6 are associated with an azimuthal rotation angle of 0°, 60°, 120°, $\cdots$, 300°, respectively. Rows: (a) Complex beam pattern intensity and color are given by amplitude and phase, respectively. When the rotation angle is 0°, the x-axis agrees with the physical x-axis. (b) Sections of the complex beam patterns plotted in Row (a). Thin colored lines show the x-sections at different y intercepts. Thick black lines show their RMS envelopes. (c) Sum of ACFs of the sections of the complex beam pattern, $G(\tau)$ in the text, but plotted as functions of the distance in meter unit along the x-axis. Blue and red lines indicate the real and imaginary parts, respectively. (d) The Fourier transforms of the $G(\tau)$ shown in Row (c), $\mathcal{F}[G(\tau)]$ are plotted as functions of wavenumber (1/m). The wavenumber can be converted to velocity simply by multiplying $|\boldsymbol{u}|$.

デブロードニングシミュレーション結果

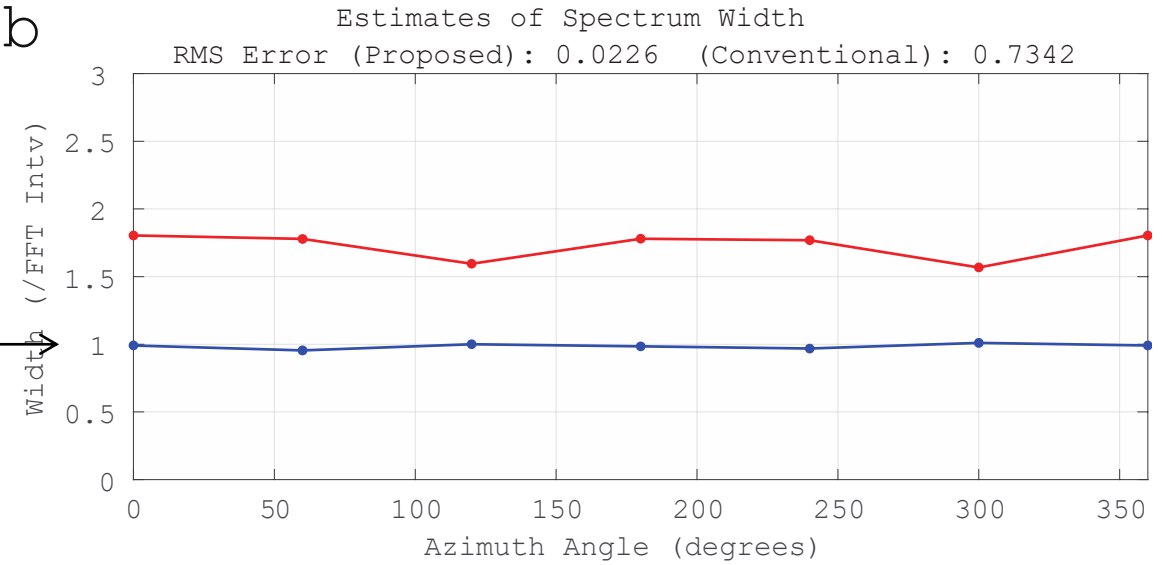
ドップラーシフト
推定値

真値



スペクトル幅
推定値

真値



Nishimura et al., *IEEE Trans GRS*, condinally accept