NEWSdm collaboration meeting @ Capri, Italy
29 May 2018

Recent upgrade status of PTS3

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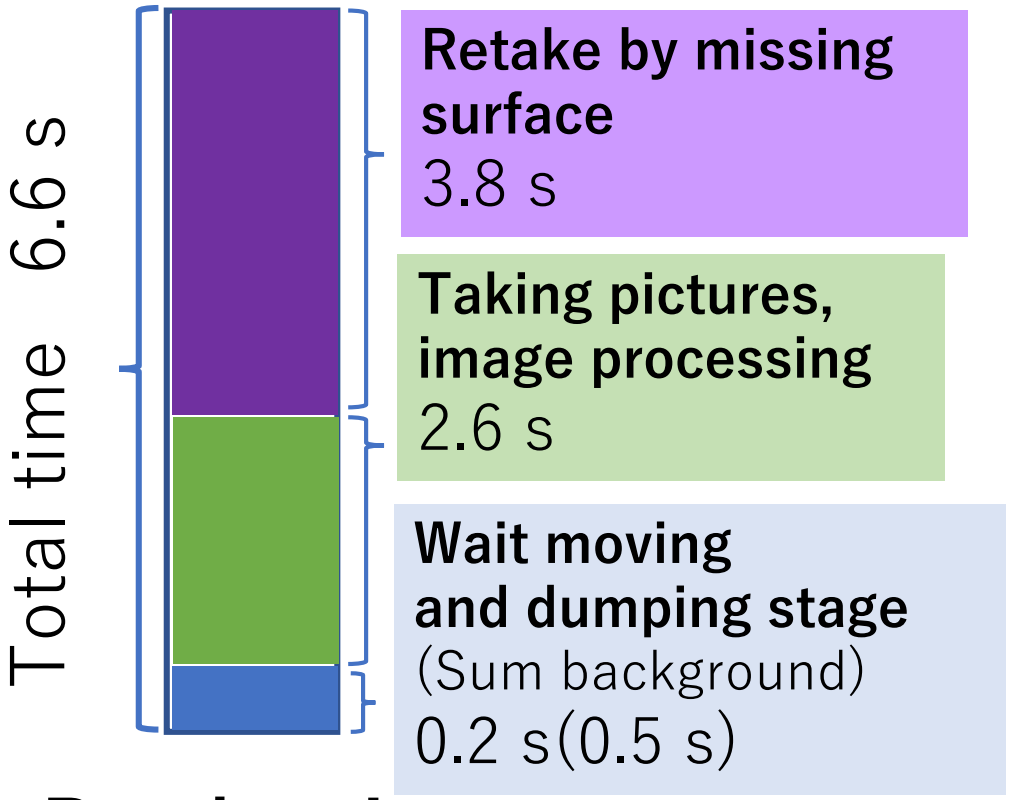
Contents

- Current PTS3’s status
  - Problem for scanning speed
  - Recognize surface

- Possibility for new 1st selection method

Problem for scanning speed

Scanning time for each view in PTS2



Retake pictures
1.43 times/View

Scanning speed
7.12g/year

Solved this time

Improve recognize surface method

- **increase success rate of recognizing surface**
  1.43 -> ~ 0 times/view

total time 2.8 s /view: **7.12 → ~16 g/year**

Shorten image processing and taking picture time

- **Improve image process speed**
  2.6 -> 0.1 s/view (2 MB * 96 picture/view)
  (73.8 -> 1920 MB/s)
- **Change camera**
  150 -> 1000 fps (0.6 -> 0.1 s)

total time 1 s/view : **16 -> 47 g/year**

Shorten moving and dumping time

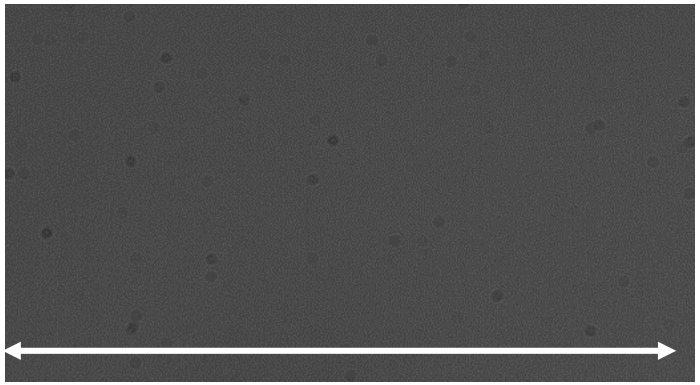
- **speed up stage velocity**
- **use stroboscopic light**(reduce dumping effect)
  0.5 -> 0.1 s/view

total time 0.1 s/view : **47 -> 470 g/year**

How to recognizing surface previously?

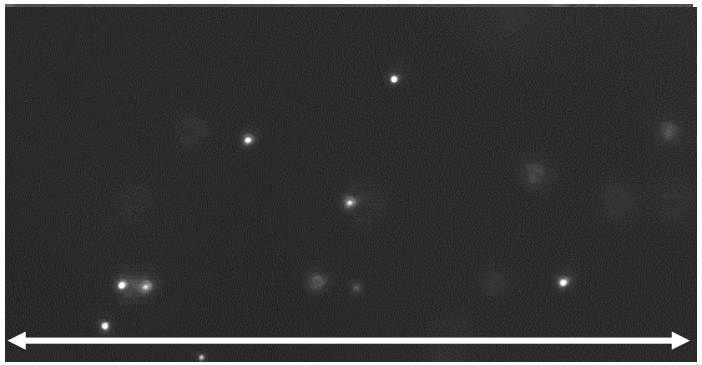
Number Of Grain(Nog)
= Number of pixel which consist of event

Before surface

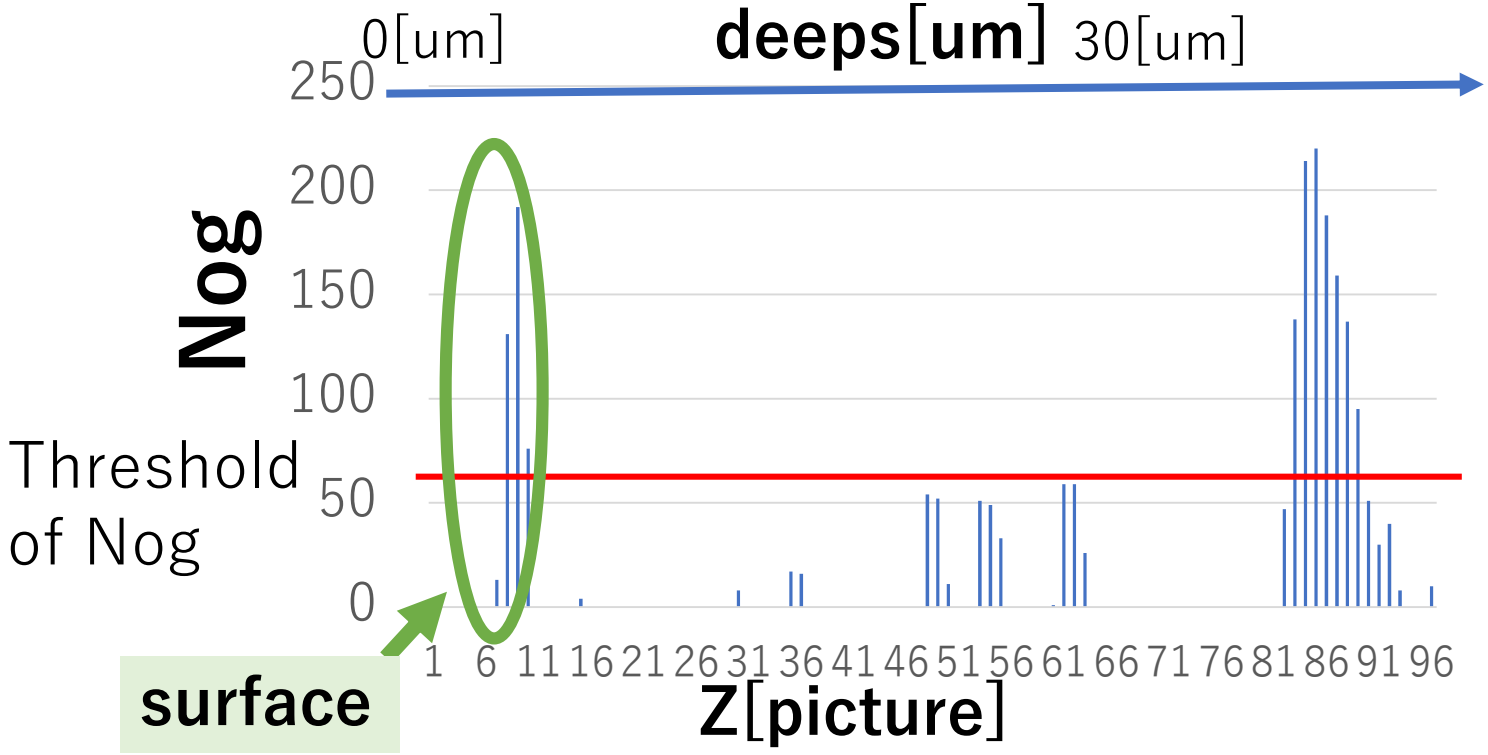


25um

At Ag Nano coat



25um

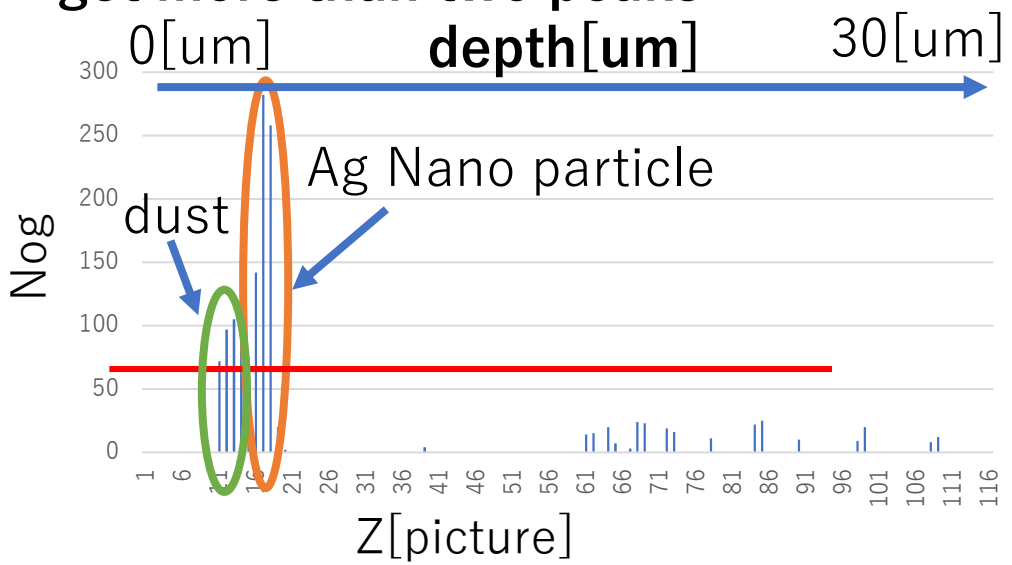


If scanning position is corrected adequately,
Number of retaking is increased

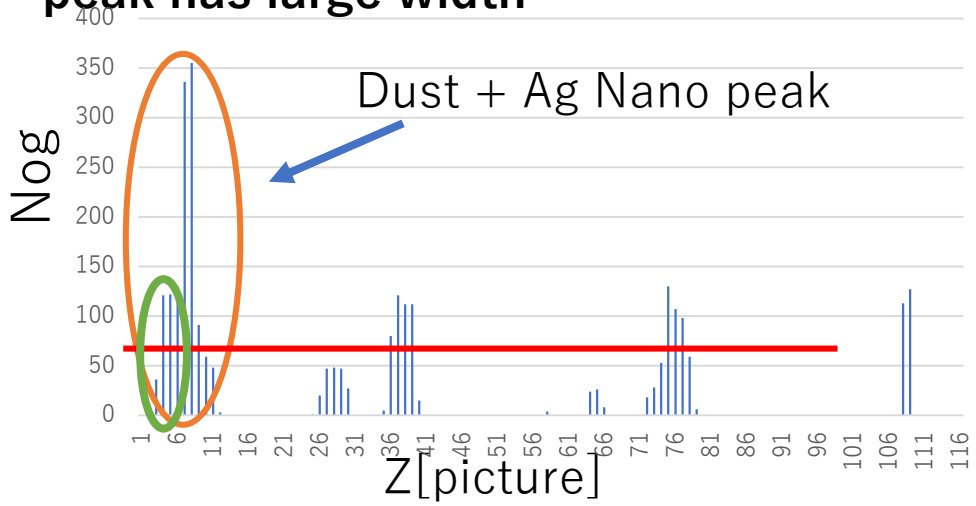
Improve method of recognizing surface

problem1. misrecognize surface by dust

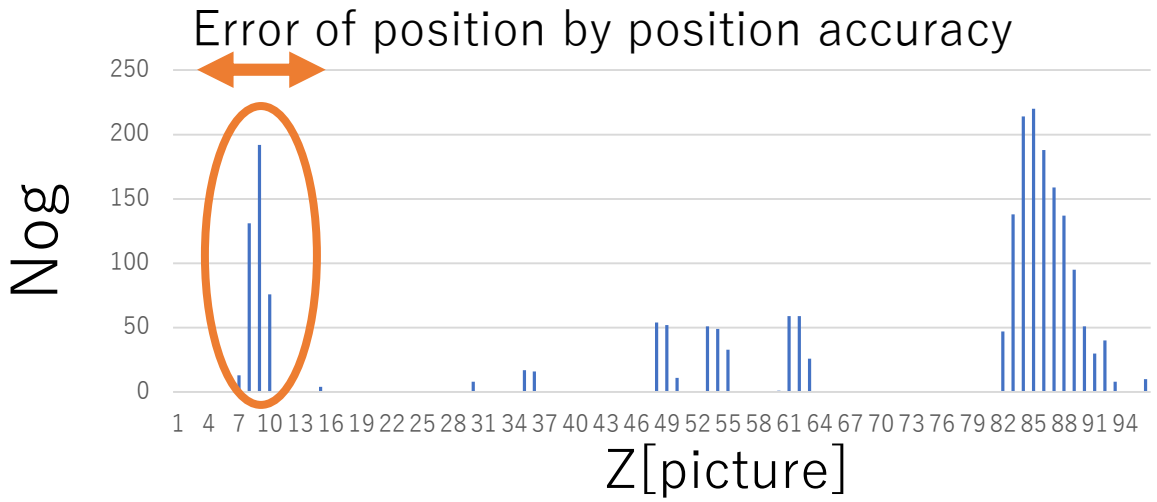
・**get more than two peaks**



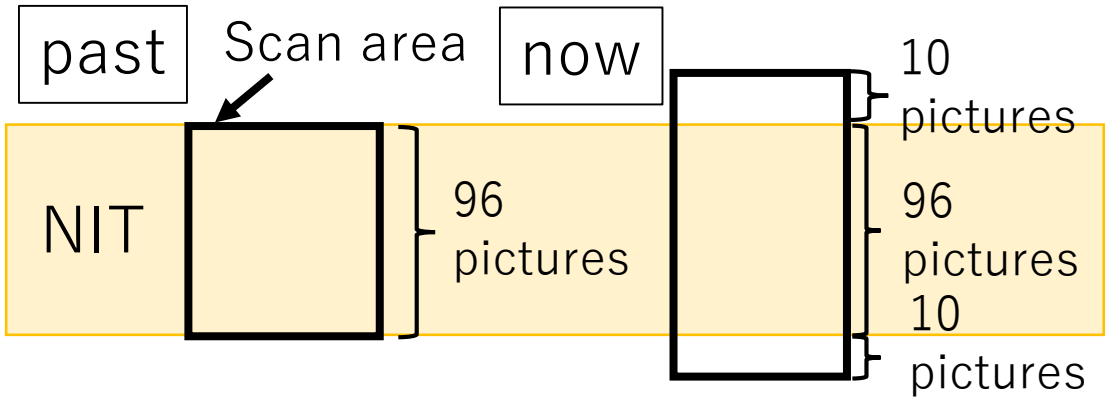
・**peak has large width**



Problem 2. Error of surface by position accuracy



remedial measures



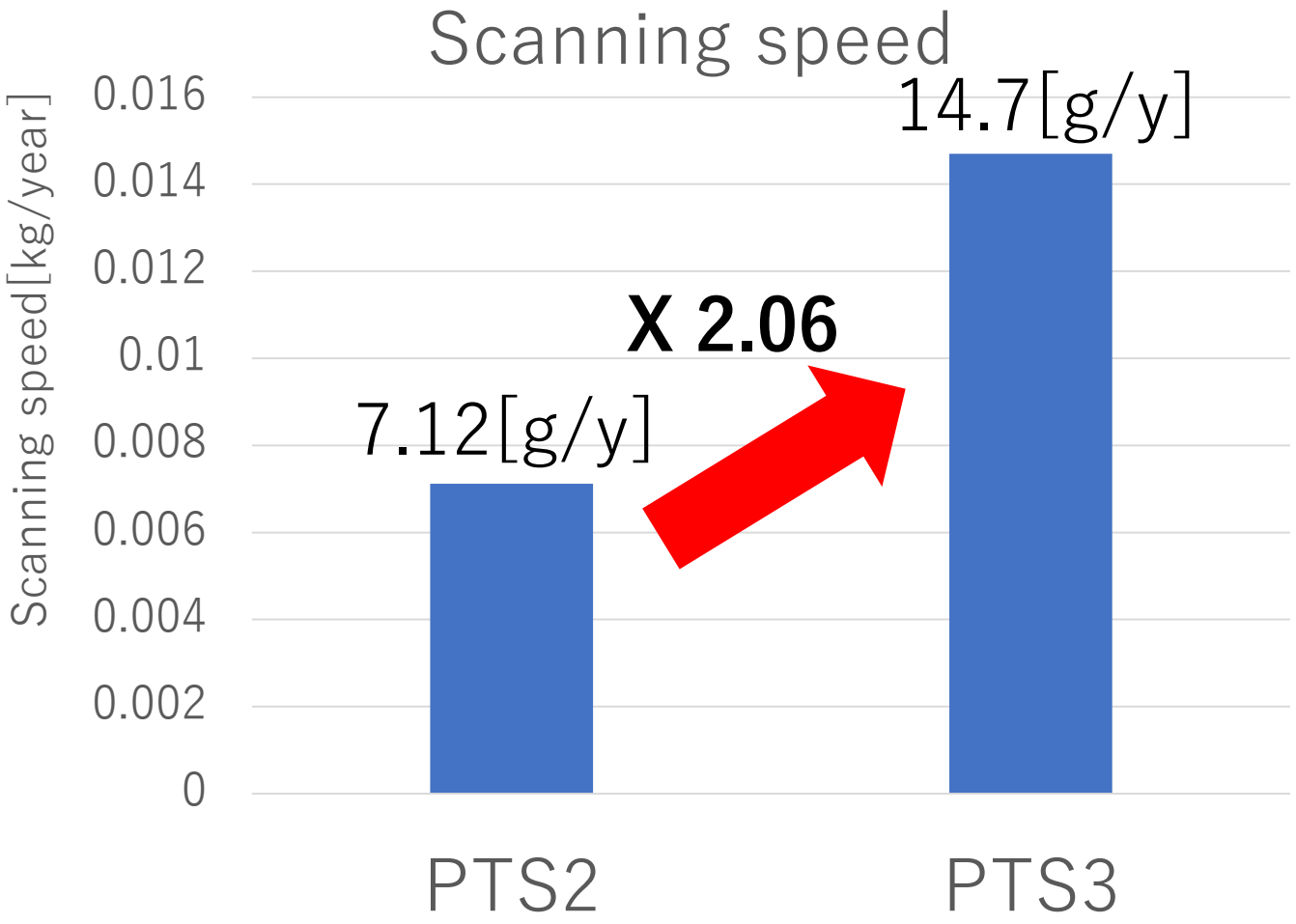
Result of improving recognize surface method

Retake pictures

1.43 times/view

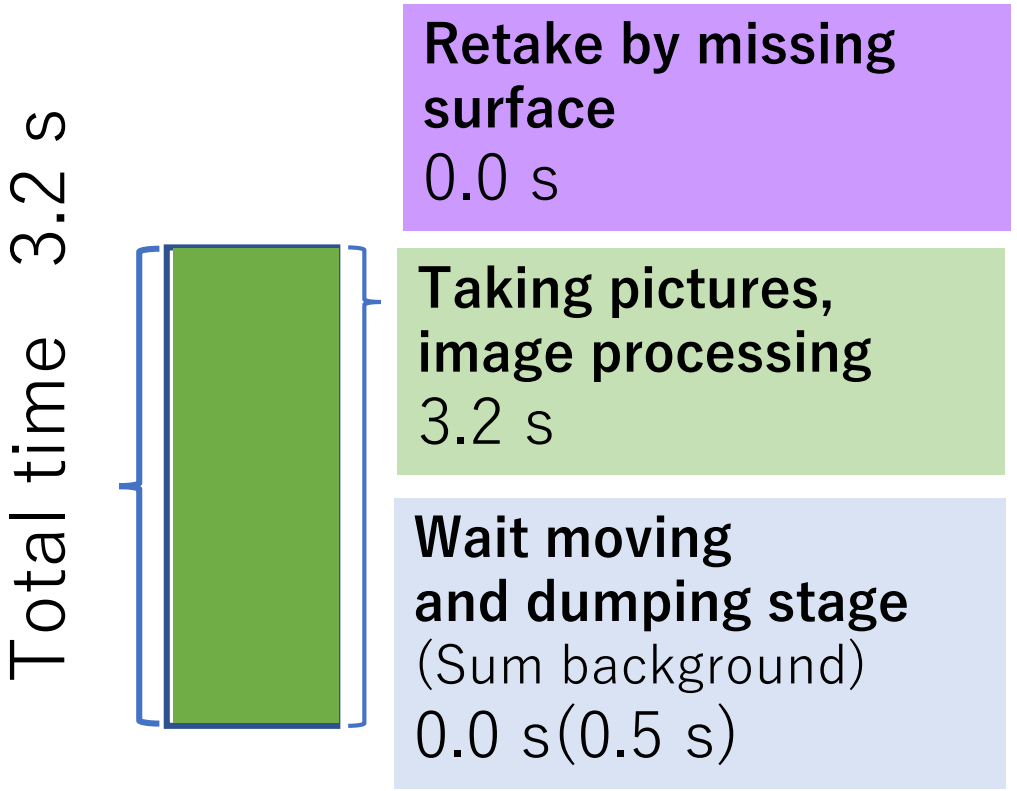
1/72 !

0.02 times/view



Problem for scanning speed recently

Scanning time for each time in PTS2



Scanning speed
14.7 g/year

Solved this time

Improve recognize surface method

- **increase success rate of recognizing surface**
  1.43 -> ~ 0 times/view

total time 2.8 s /view: **7.12 → 14.7 g/year**

Next Goal !!

Shorten image processing and taking picture time

- **Improve image process speed**
  2.6 -> 0.1 s/view (2 MB * 96 picture/view)
  (73.8 -> 1920 MB/s)
- **Change camera**
  150 -> 1000 fps (0.6 -> 0.1 s)

total time 1 s/view : **16 -> 47 g/year**

Shorten moving and dumping time

- **speed up stage velocity**
- **use stroboscopic light**(reduce dumping effect)
  0.5 -> 0.1 s/view

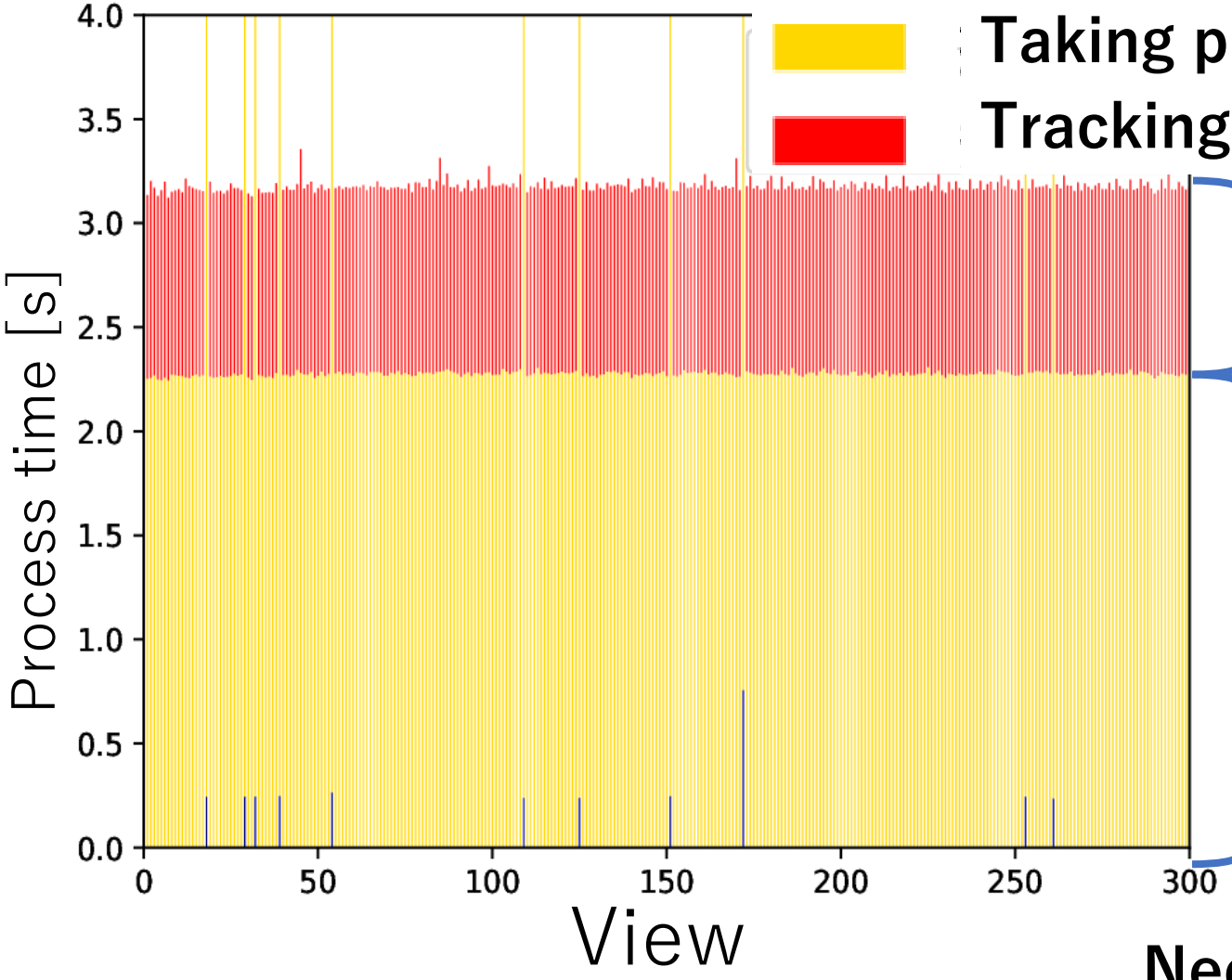
total time 0.1 s/view : **47 -> 470 g/year**

image processing and taking picture time

Moving & dumping stage

Taking picture & recognize surface

Tracking (Ellipse fitting) & save picture



Tracking 0.6 s + save picture

Taking picture 0.6 s
+ image process ~ 1.7 s
(filtering ,binarization etc.)

Need to shorten image processing speed for increase scanning speed!!

Conclusion & Future plan

- **Conclusion**

- PTS3's scanning speed achieved **14.7 g/year** by improving recognize surface method.
- Next bottle neck for scanning speed is image processing time.

- **Future plan**

- **Shorten time of image processing**
  - Process parallelization by using GPU

- **Shorten time of taking pictures**
  - Use high speed camera (150 fps -> 1000 fps)

  <-need to use strong intensity light source(ex: Laser diode)

- **Goal** : image processing time 3.2 -> 0.1 s/view
- By upgrading these, scanning speed achieve 47 g/year

Possibility for new 1st selection method

outline

- By using new optical system, phase contrast microscope, we aim to get new information ; phase of optical image.

- By using this information, we search possibility whether new analysis method, which have high BG rejection power, can be established or not ?

Observation condition

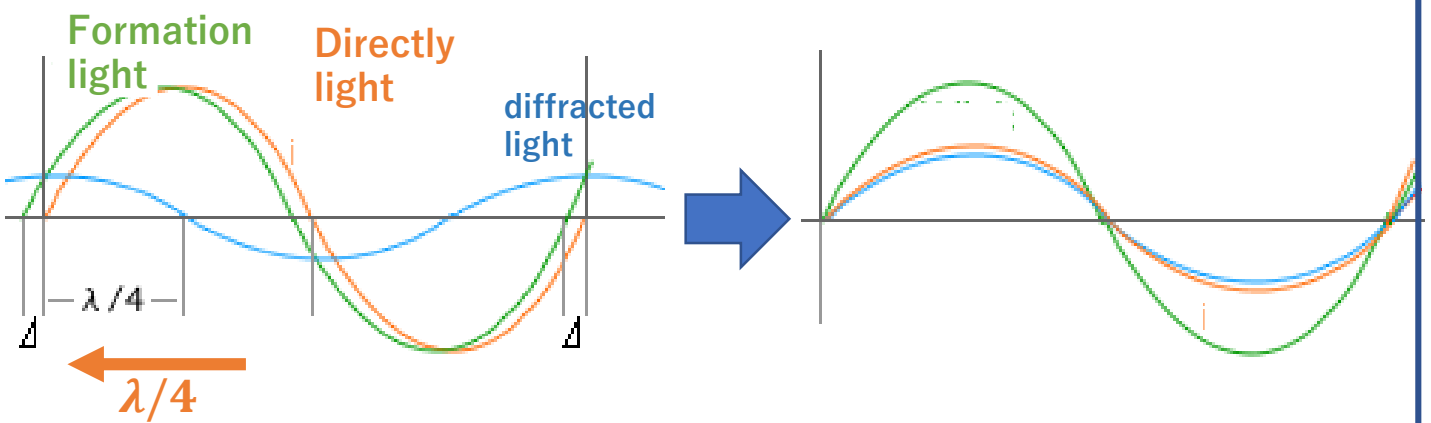
Optics conditions
- phase contrast
- Transmission

Sample
- 40nm Ag Nano particle
- 150keV carbon ion

Light source
- Halogen lamp

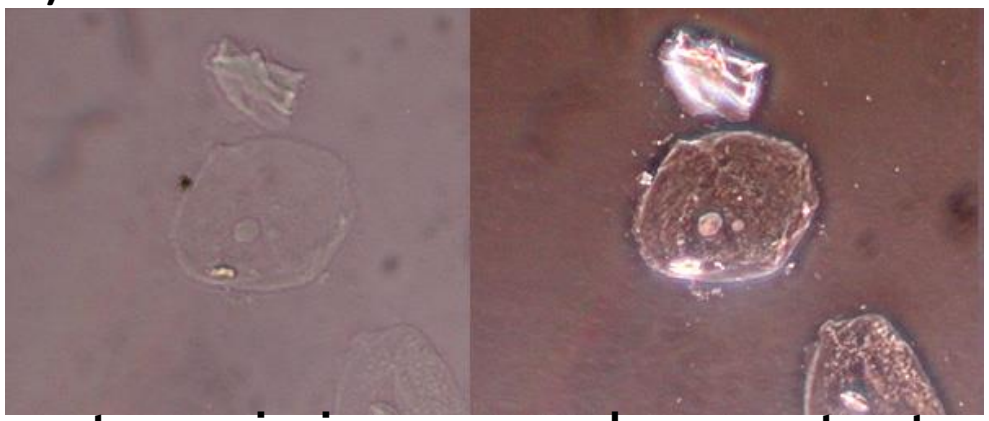
What is phase contrast microscope ?

- Phase contrast microscope use the information of difference phase between direct light and diffracted light.
- In phase contrast microscope, the difference is converted to contrast.
- Phase contrast microscope is mainly used in biology to observe transpicuous cells.



http://www.nikon-instruments.jp/jpn/learn-know/microscope-abc/learn-more-microscope/about-phase-difference-observation

Ex) buccal mucosa cells



transmission **phase contrast**

https://ja.wikipedia.org/wiki/%E4%BD%8D%E7%9B%B8%E5%B7%AE%E9%A1%95%E5%BE%AE%E9%8F%A1

Comparison (event count)

How to count
1. I took 10 sample's pictures for each condition.
2. After that, processed and binarized all images .
3. I counted remain events whose size is more than 5 and less than 100.

result

Event density [/(10um)^3]

6.7%

	transmission	phase contrast	epi-illumination (advisory)
40 nm Ag Nano particle	0(≦0.014)	1.40	20.9±1.1

Event density [cm^2]

25.8%

	transmission	phase contrast	Epi-illumination (advisory)
150 keV carbon ion	8.1e+003	7.0498e+006	2.7296e+007

3.30677e+006
(ellipticity >1.3,minor > 4)
BG 119
light source Hg-Xe, 450nm

Possibility of new analysis method with phase contrast

- Phase contrast microscope have high efficiency for carbon sample.
- If the cause of seeing carbon sample well is difference of Nano scale construction,

  -> event which can be observed by phase contrast is track.
- So, by using phase contrast microscope, we can reject part of back ground events.

advantage

- We can reject BG event which we can't reject by ellipse fitting.
- Since we need not use shape of optical image for event selection, we need not use high magnification and NA objective lens.

  →easy to increase scanning speed

- I'm going to evaluate effect of phase contrast by comparing same event which observed with epi-illumination and phase contrast.

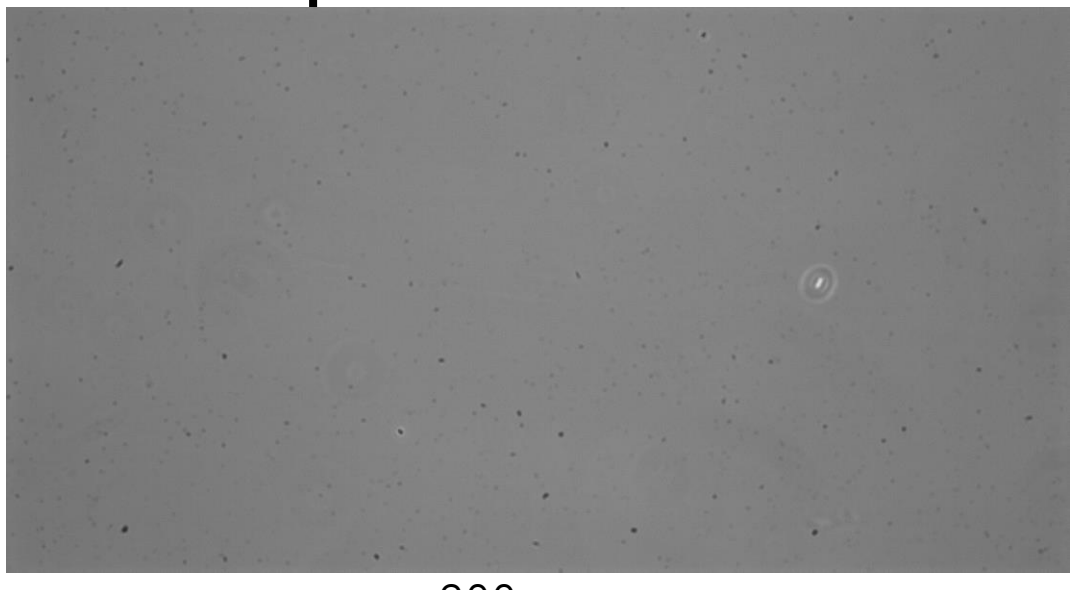
Back up

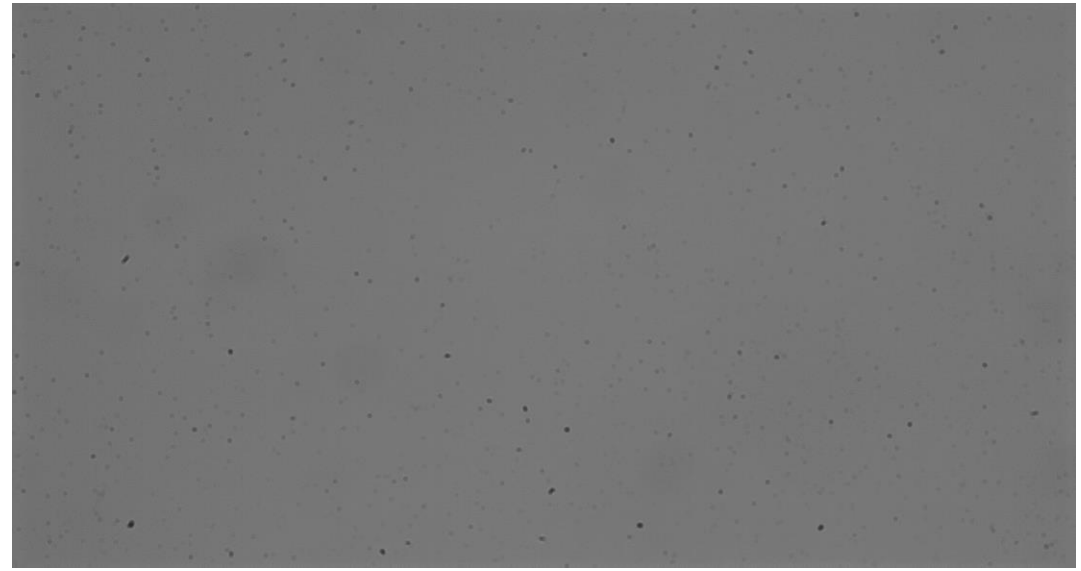
40nm silver Nano particle

phase contrast

transmission

original





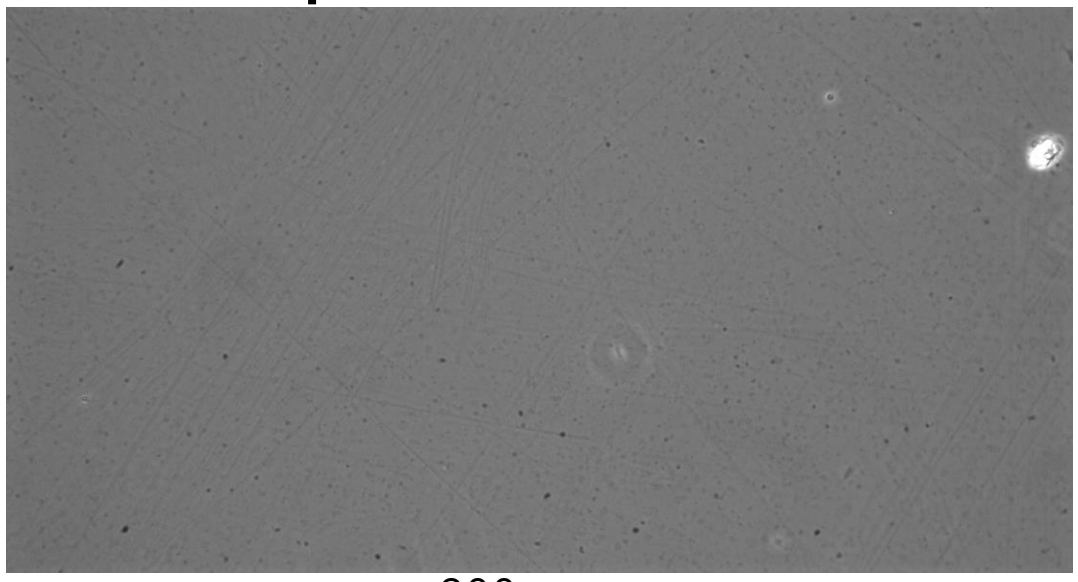
After binarization

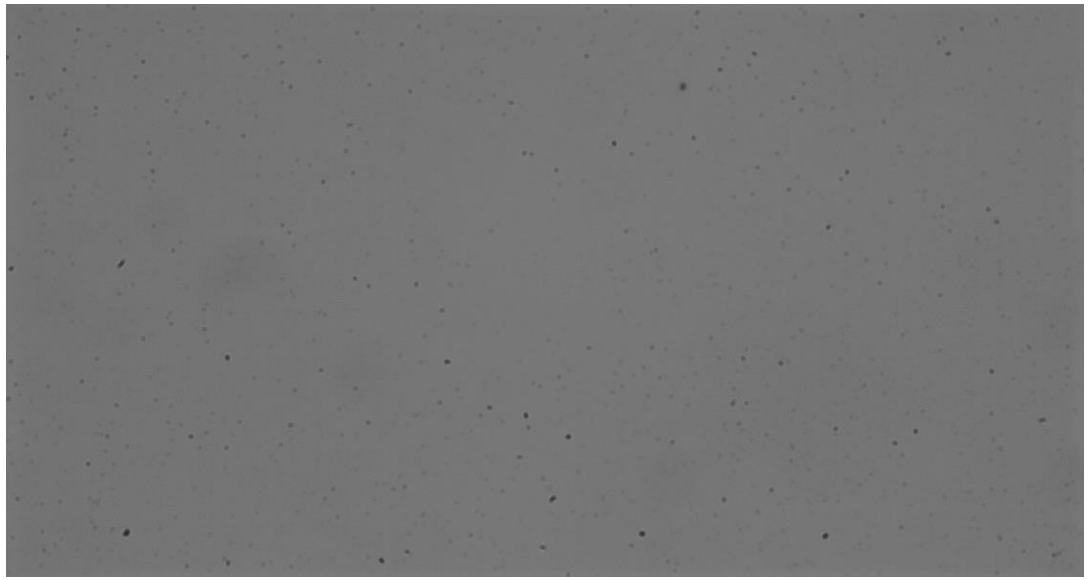
150 keV C ion beam

phase contrast

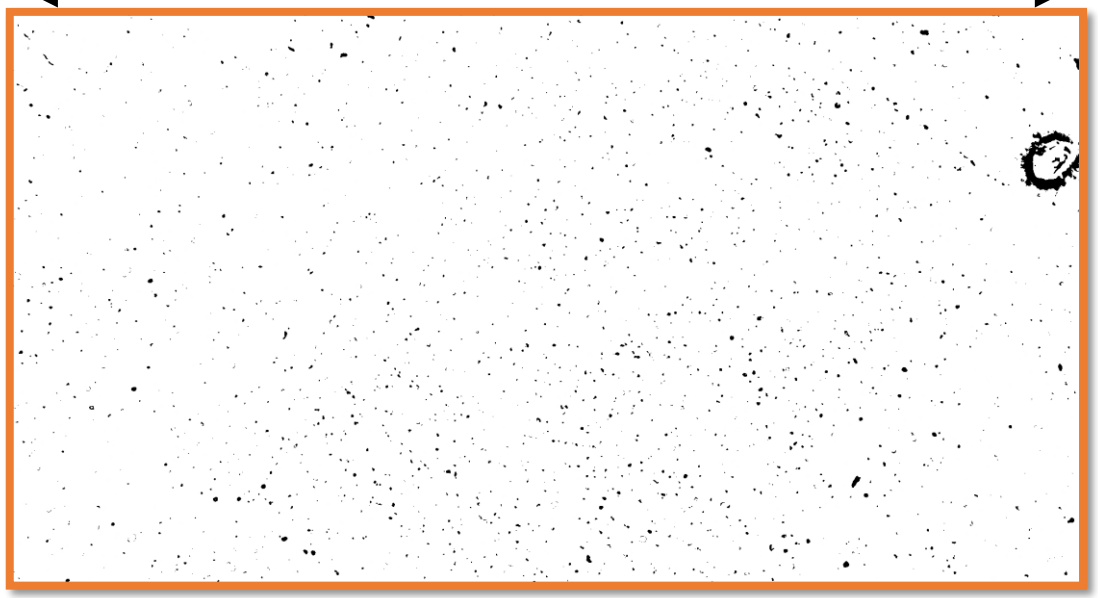
transmission

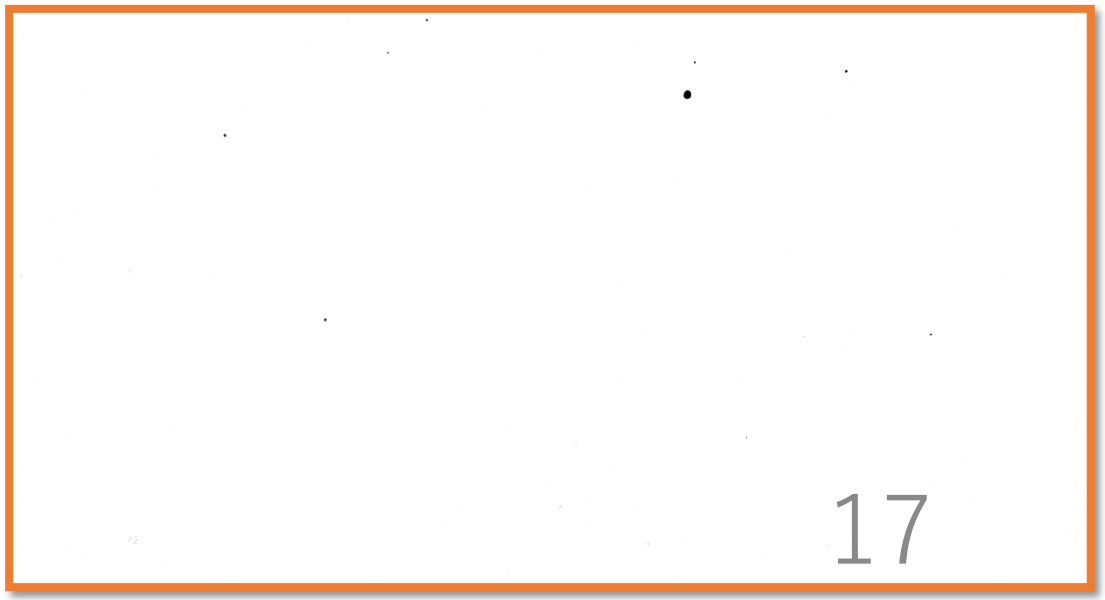
original





After binarization





Observation conditions

Optics conditions

- phase contrast
- Transmission

Light source

- Halogen lamp

Background brightness

- 117

Objective lens

- phase contrast Plan Fluor x100, NA=1.30
- Transmission Plan Flour x100, NA=0.7

Imaging lens

- X 0.55 (sum of magnification is x55)

Camera

- 2M pixel CMOS camera

観察条件

光学条件
- 位相差
- 透過

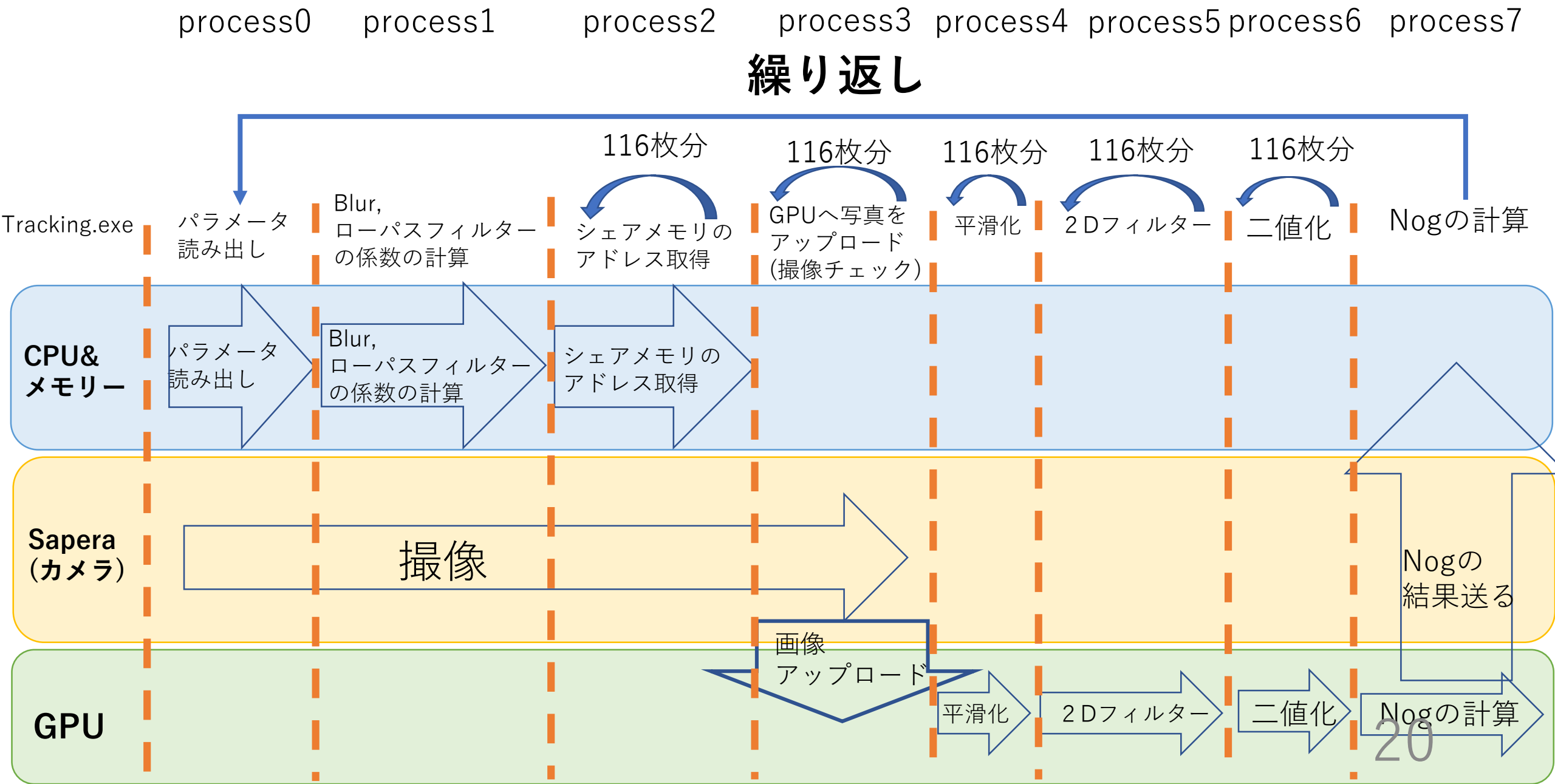
光源
- ハロゲンランプ

背景輝度
- 117(光源強度と露光時間を調節して合わせた)

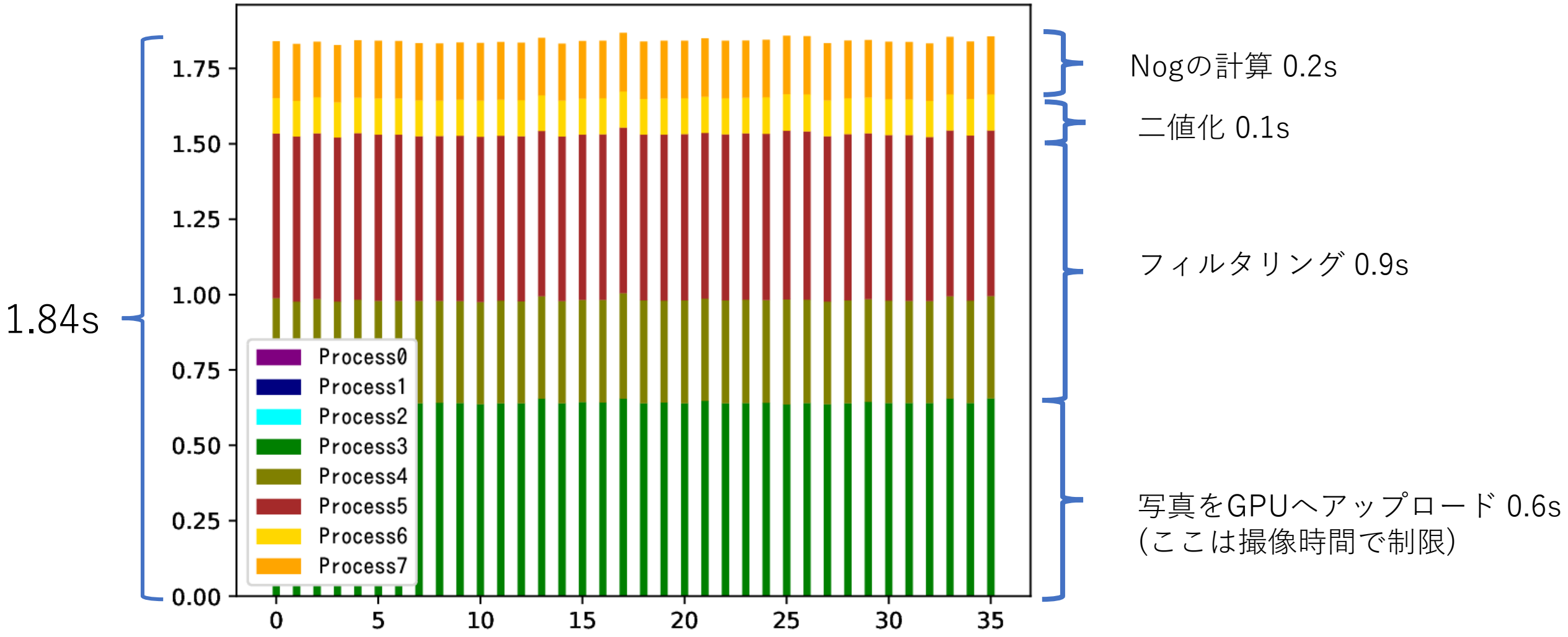
対物レンズ
- 位相差　　Plan Fluor x100, NA=1.30
- 透過　　Plan Flour NA=0.7

カメラ
- PTS3の2M CMOSカメラ

Loop1(スキャン時間の黄色の部分,"BasicBinaryImageFilter_GPU“)



Loop1の各プロセスにかかっている時間



フィルタリングの時間が支配的
今後のことを考えるとNogの計算と二値化の時間の短縮も目指したい

解決策

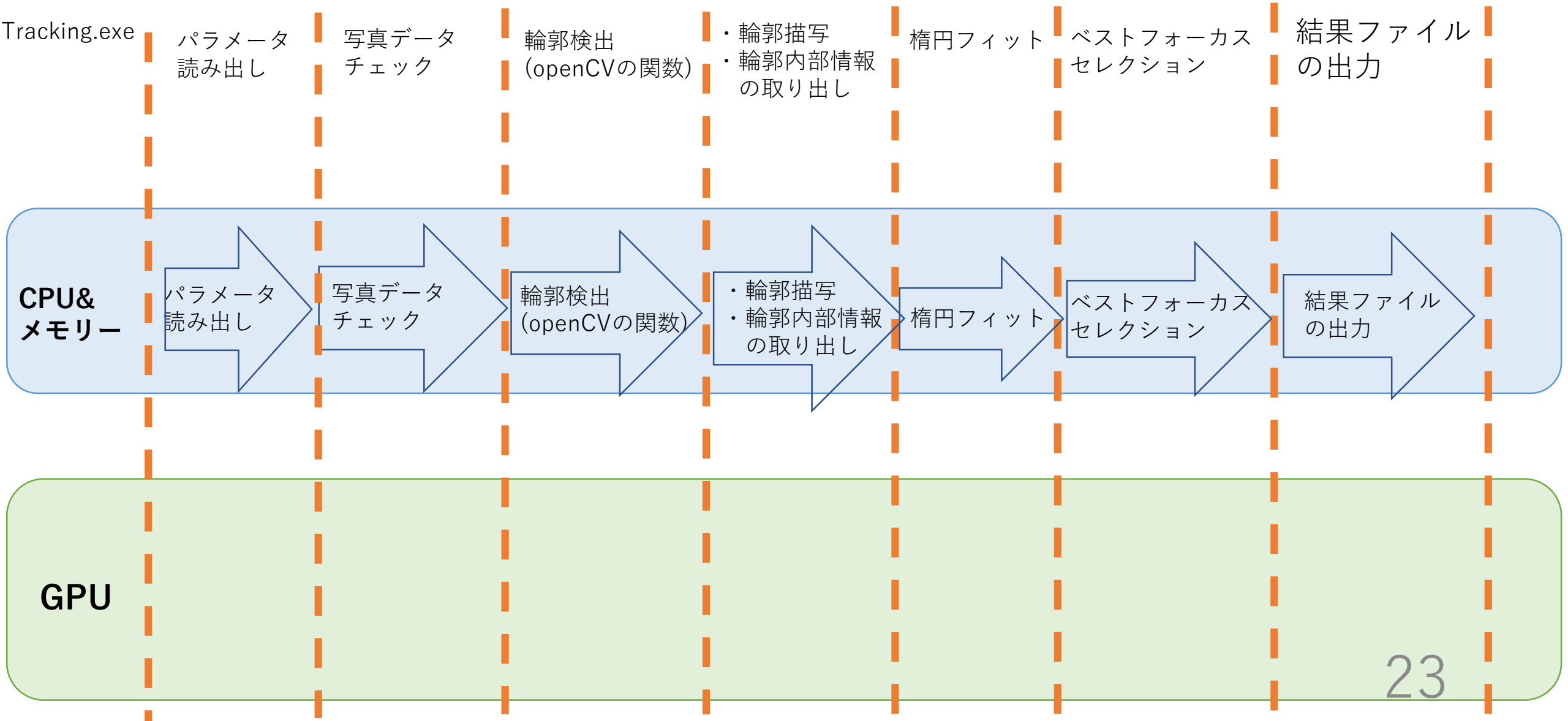
- 処理をGPUを使用して並列化する！
  →実はHTSで解決済み
  →プログラムをHTSから引っ張ってくると解決できる？

と思ったけど処理内容が若干違ったのでまずは2つの処理でどう違うか検証
→Tracking.exeと同じような処理を手元の画像を使って処理できるような
　プログラムを新規作成する

- この実装が完了次第、HTSの関数引っ張ってきて処理がどう違うか検証する。

(そもそも平滑化と2Dフィルターを2つ使う意味は？)
(平滑化することによって解像度が落ちている？→今の処理が最適？)

Loop2(スキャン時間の赤色の部分、Tracking部)



改善策

Tracking

- 現状Trackingは 0.656s　かかっている。
- 処理の最適化、パイプライン化、並列化等
- →こちらは今まで最適化されてきてなかったので
- 　改めて効率化を目指したプログラムに書き直す必要あり！

Save

- 画像保存時間は5.852sかかる？(新しいHDDはもっと早いのに…原因は…？)
- なるべく写真を保存しなくてもよい状態を目指す！

目標　上記を合わせて 0.1s/View

- これが達成できれば47g/View(1s/View)を達成できる。

今後

PTSの速度アップに向けて

- **ソフトウェアの改良**
  - Tracking.exeの処理検証用のプログラムの作成
  - Loop1の画像処理をHTSから移植、PTS用に改変
  - Loop2(Tracking、Save)の処理の効率化の検討
  - PTSで行われている処理の最適化の検討(画像フィルターのお勉強)

- **撮像速度向上に向けて**
- カメラの速度アップ
  - 光源の増強
    - LED用光軸の設計

- **その他**
- ISVHCRI(ポスター発表)(5/22)
- NEWSdm Collaboration meeting(5/29~30)