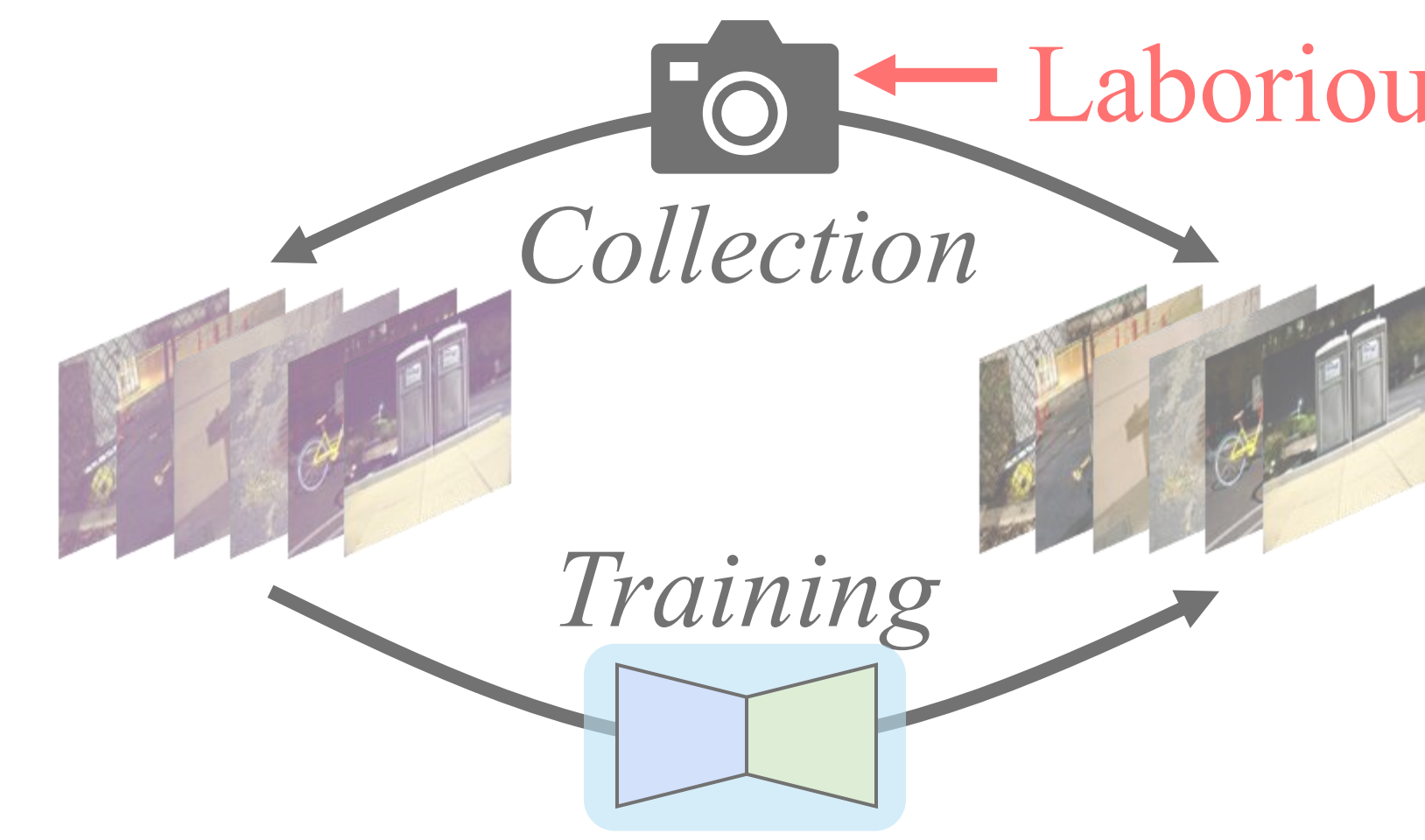


# Lighting Every Darkness in Two Pairs: A Calibration-Free Pipeline for RAW Denoising

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 \*Equal contribution. #C. L. Guo is the corresponding author.

## Timeline

Training with Paired Real Data:



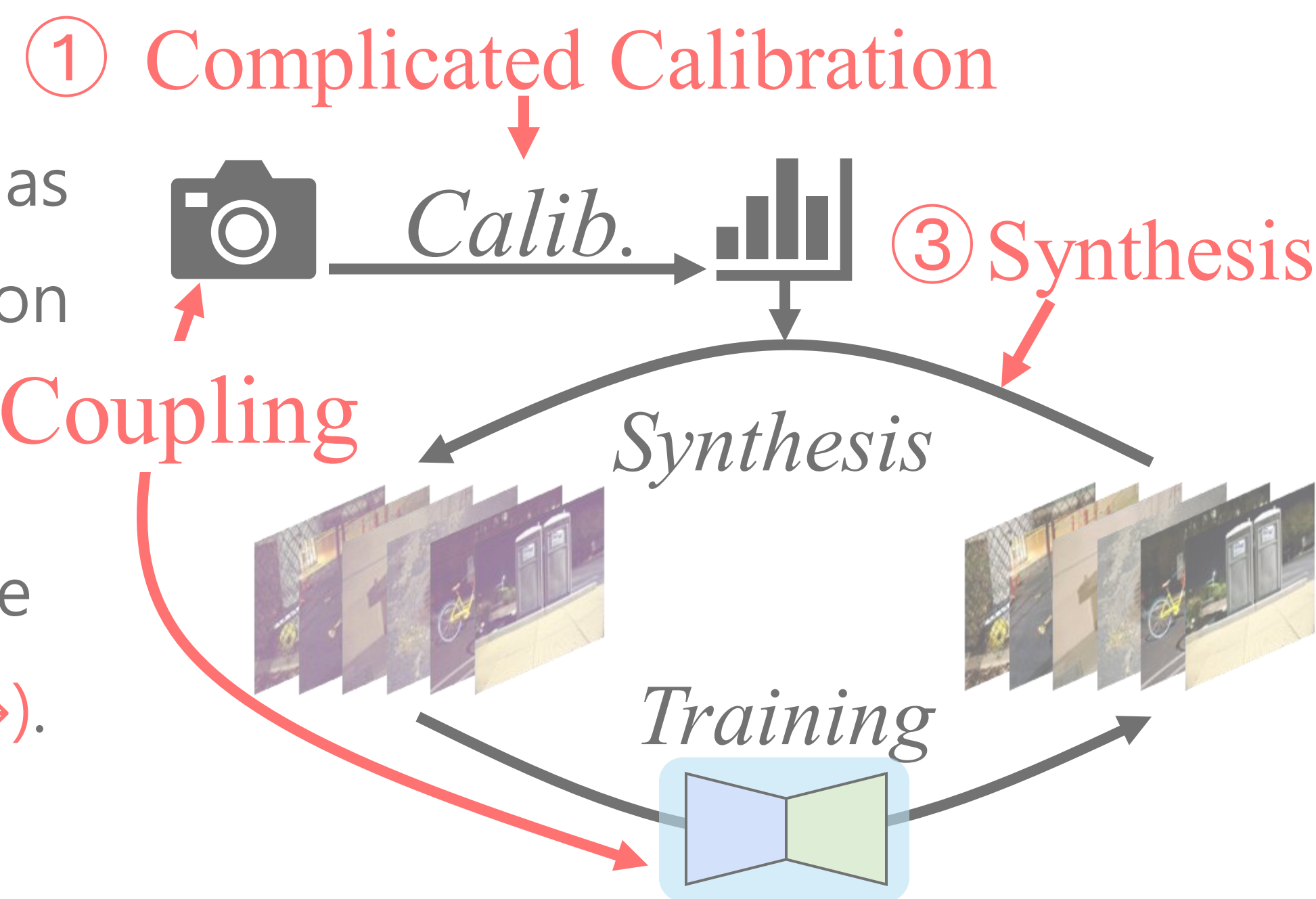
**SID (CVPR 2018)**

- For each camera, SID requires a large-scale dataset.
- The data collection procedure is laborious and time-consuming.

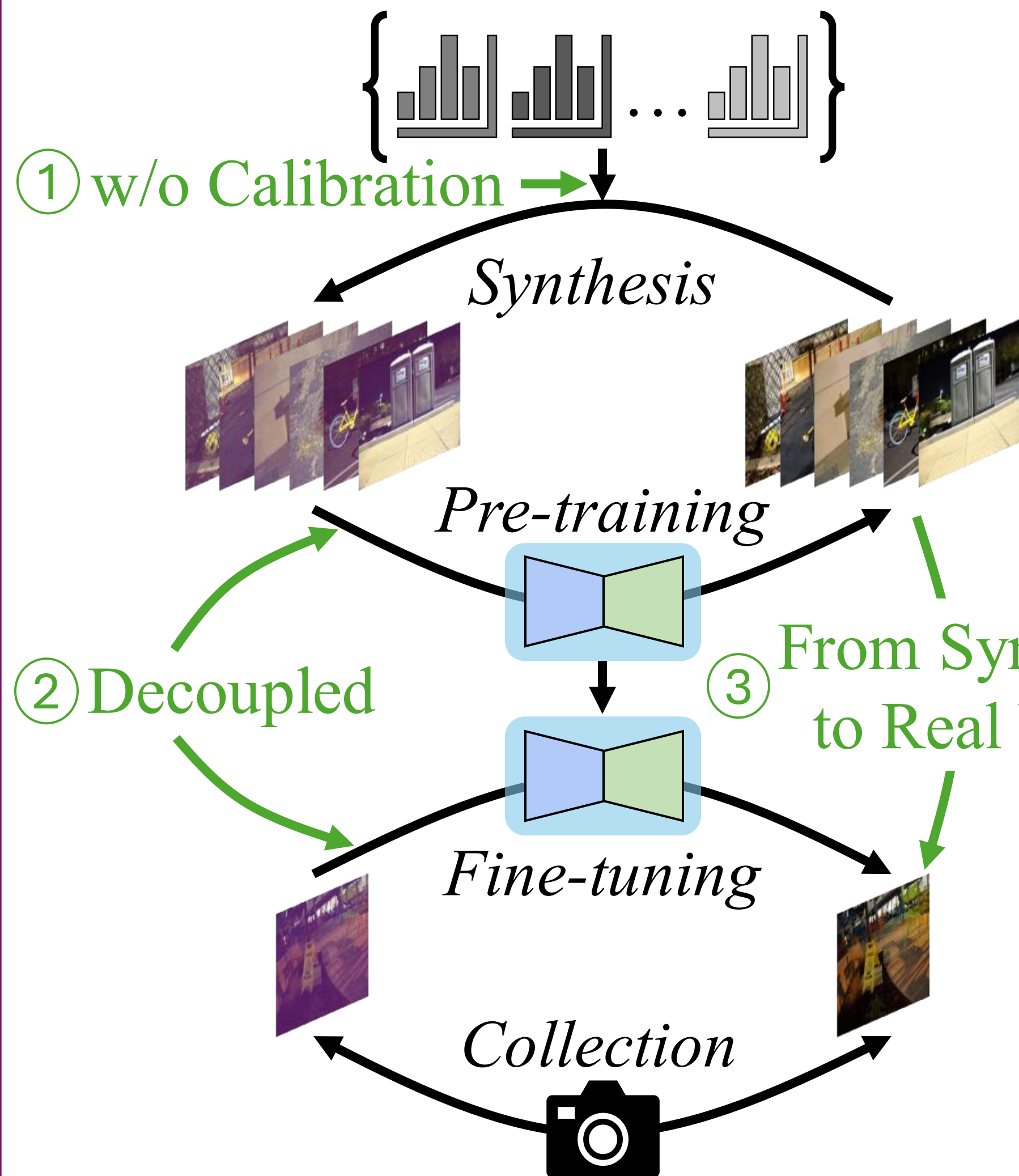
Training with Calibrated Noise Model:

**ELD (CVPR 2020)**

- Calibration-based methods has proved their effectiveness on modeling noisy pairs.
- However, these methods are suffering from 3 problems (→).



Training with Few-shot Pairs:



**LED (ICCV 2023)**

- A totally calibration-free pipeline for RAW image de-noising.
- Loosen the coupled de-noising network and camera model.
- Fine-tuning with real paired data enables the network to remove real noise.

## Tired for Calibrating the Noise Model? Try Our LED!

2 pairs for each ratio + 1.5k iterations = SOTA Performance!

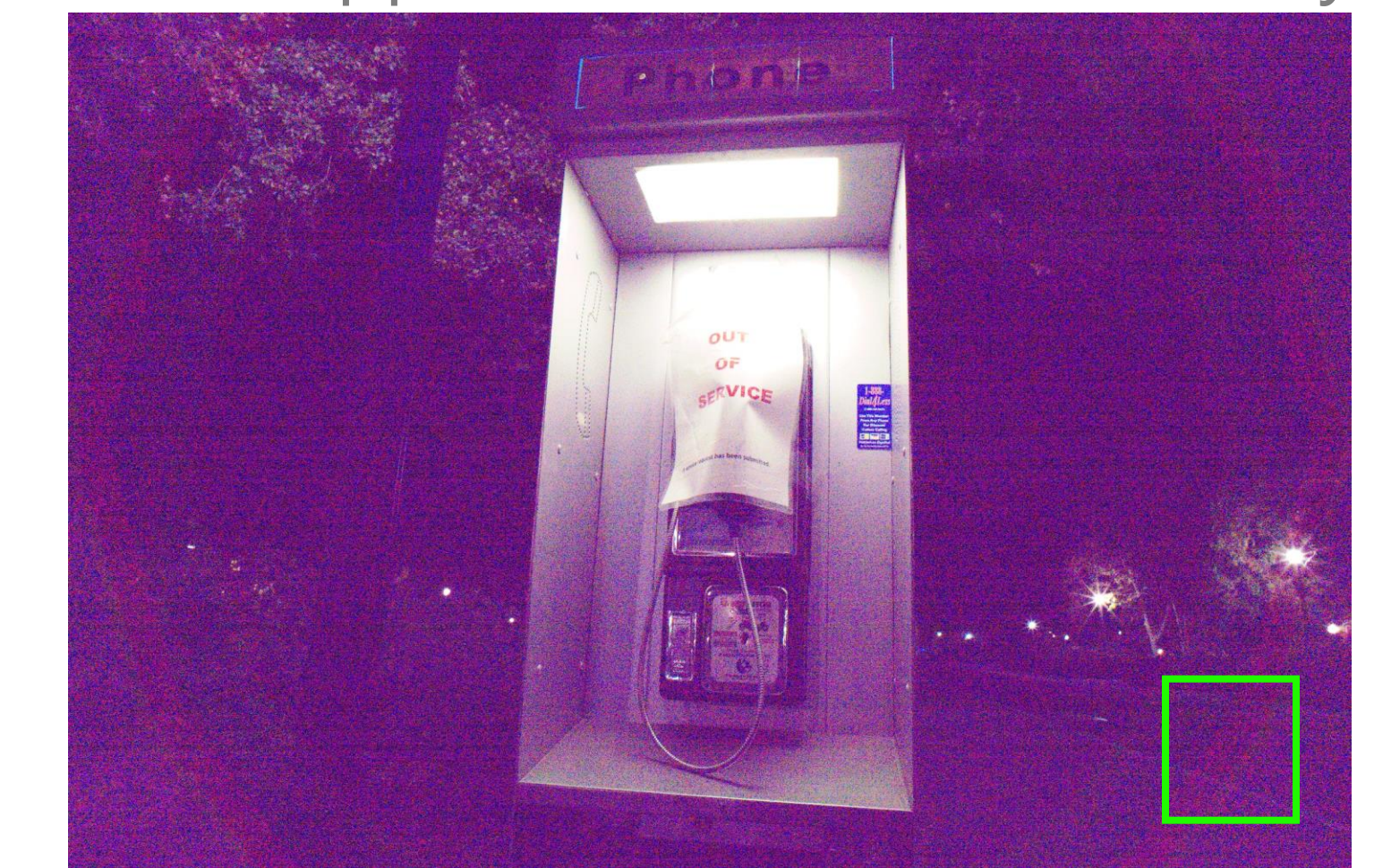
```

2023-07-16 21:41:09,032 INFO: End of training. Time consumed: 23:42:27
2023-07-16 21:41:09,033 INFO: Save the latest model.
2023-07-16 21:41:15,461 INFO: Validation SIDSonyPaired100
# psnr: 42.0811
# ssim: 0.9550
2023-07-16 21:41:21,843 INFO: Validation SIDSonyPaired250
# psnr: 39.4613
# ssim: 0.9340
2023-07-16 21:41:29,654 INFO: Validation SIDSonyPaired300
# psnr: 36.8701
# ssim: 0.9203

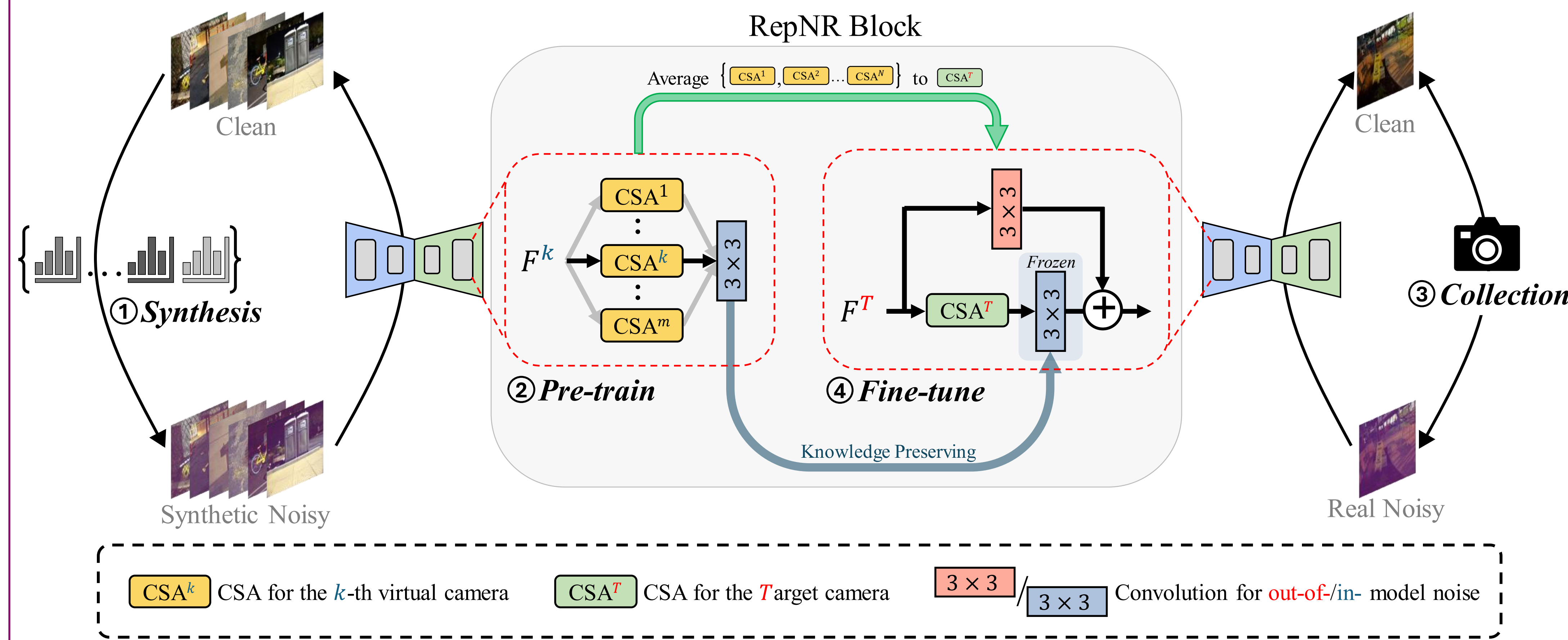
2023-07-16 21:26:03,931 INFO: End of training. Time consumed: 0:03:43
2023-07-16 21:26:03,931 INFO: Save the latest model.
2023-07-16 21:26:13,230 INFO: Validation SIDSonyPaired100
# psnr: 42.3397 ↑ 0.2568
# ssim: 0.9549
2023-07-16 21:26:20,423 INFO: Validation SIDSonyPaired250
# psnr: 39.6064 ↑ 0.1451
# ssim: 0.9370
2023-07-16 21:26:29,060 INFO: Validation SIDSonyPaired300
# psnr: 36.9314 ↑ 0.0613
# ssim: 0.9256
    
```

- Compared with the SOTA ELD (training with PMN's strategy) (left), LED (right) only requires 0.26% of the training time (and 5% of the training data, which denotes the data requirement for calibration in ELD), while demonstrating a significant performance improvement on the SID Sony dataset!

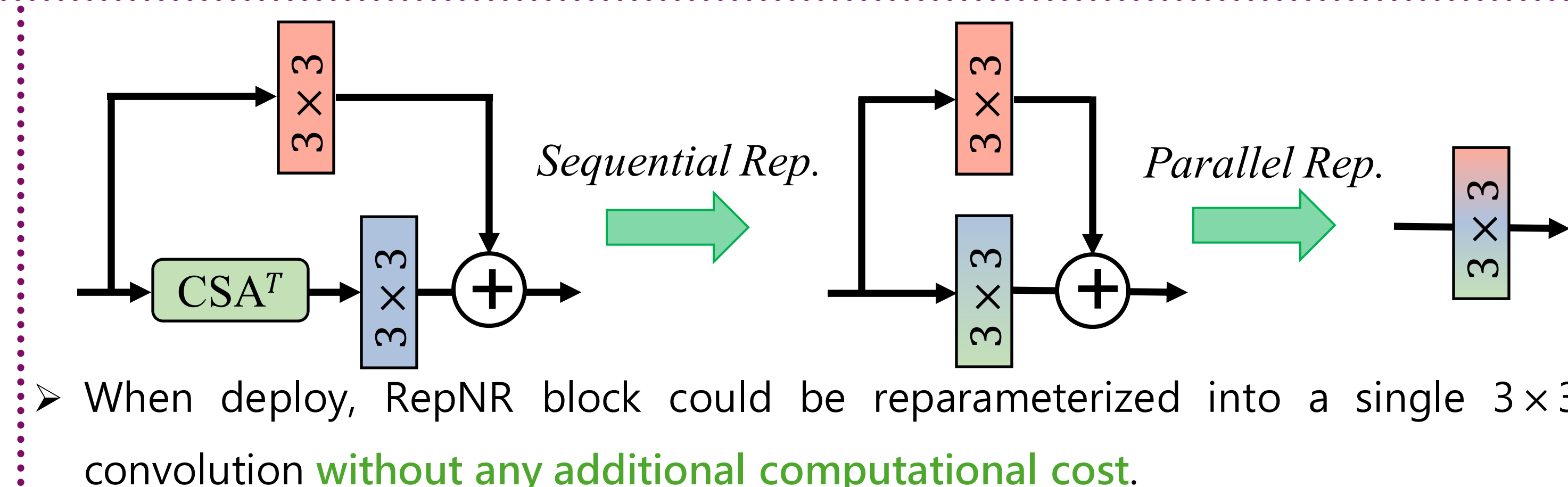
Removing the Out-Of-Model Noise!  
 LED could suppress the artifact caused by lens.



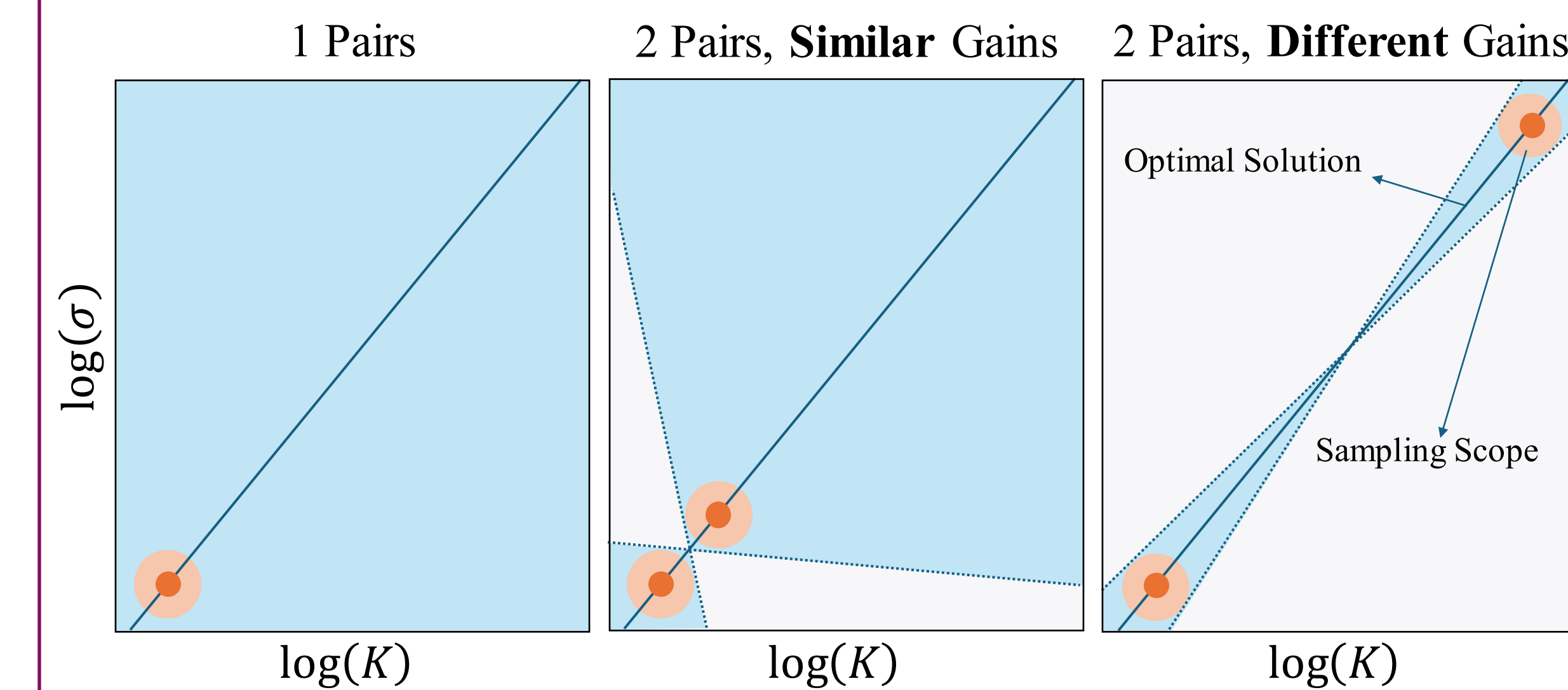
## Structural Modification without Additional Cost



- Random sample virtual camera sets.
- Select the  $k$ th virtual camera and synthesize, pre-train the de-noising network with  $k$ th CSA activated.
- Finetuning the network with few-shot paired data collected by the target camera.
- Details can be found in main paper.



## Why with Two Pairs?



- As it is known to all, the camera's gain and noise variance have a log linear relationship, as illustrated in the above graph.
- With just two pairs of images, LED can effectively learn this linear relationship, as two points are enough to determine a straight line. Their ISO setting should be significant different for better fitting.

Feel free to contact us!  
 欢迎与我们随时交流!

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 xiaojw@mail.nankai.edu.cn