RF-Gun Workshop Committee Feedback

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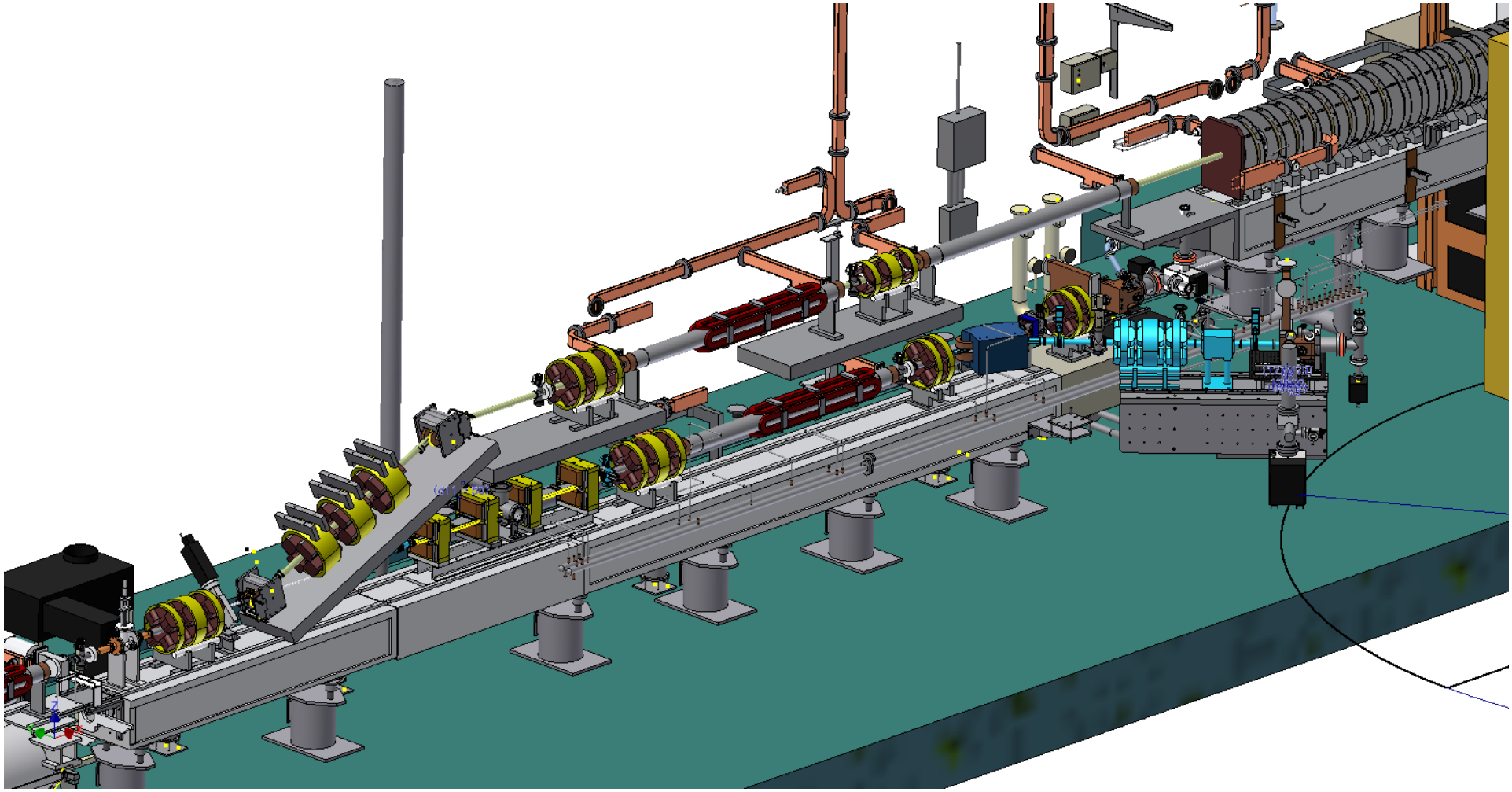
RF gun review @ KEK, February 19 and 20, 2015

The Review Committee “Philosophy”

- Any component integrated into the accelerator system must be Reliable, Maintainable, Reproducible
- Start with a simple, robust system. Improve it and add features step by step afterwards
- Cost is not irrelevant

The Committee Knows…

- SuperKEKB requires state-of-the-art RF guns and drive lasers
- New hardware, must be designed and built, some items without precedent
- Resourceful group, modest size, must now finish the R&D phase, and move to "production" phase
- SuperKEKB Phase 1 operations begin January 2016, 10 months from now. Colleagues expect reliable beam soon



This came as a surprise … a new beamline using the old thermionic gun and now two quasi-travelling wave guns

How to Interpret?

- Management is getting worried
- Too many ideas, at this stage of the project
- The gun/laser group still faces big technical challenges, and the clock is ticking

What are the laser challenges?

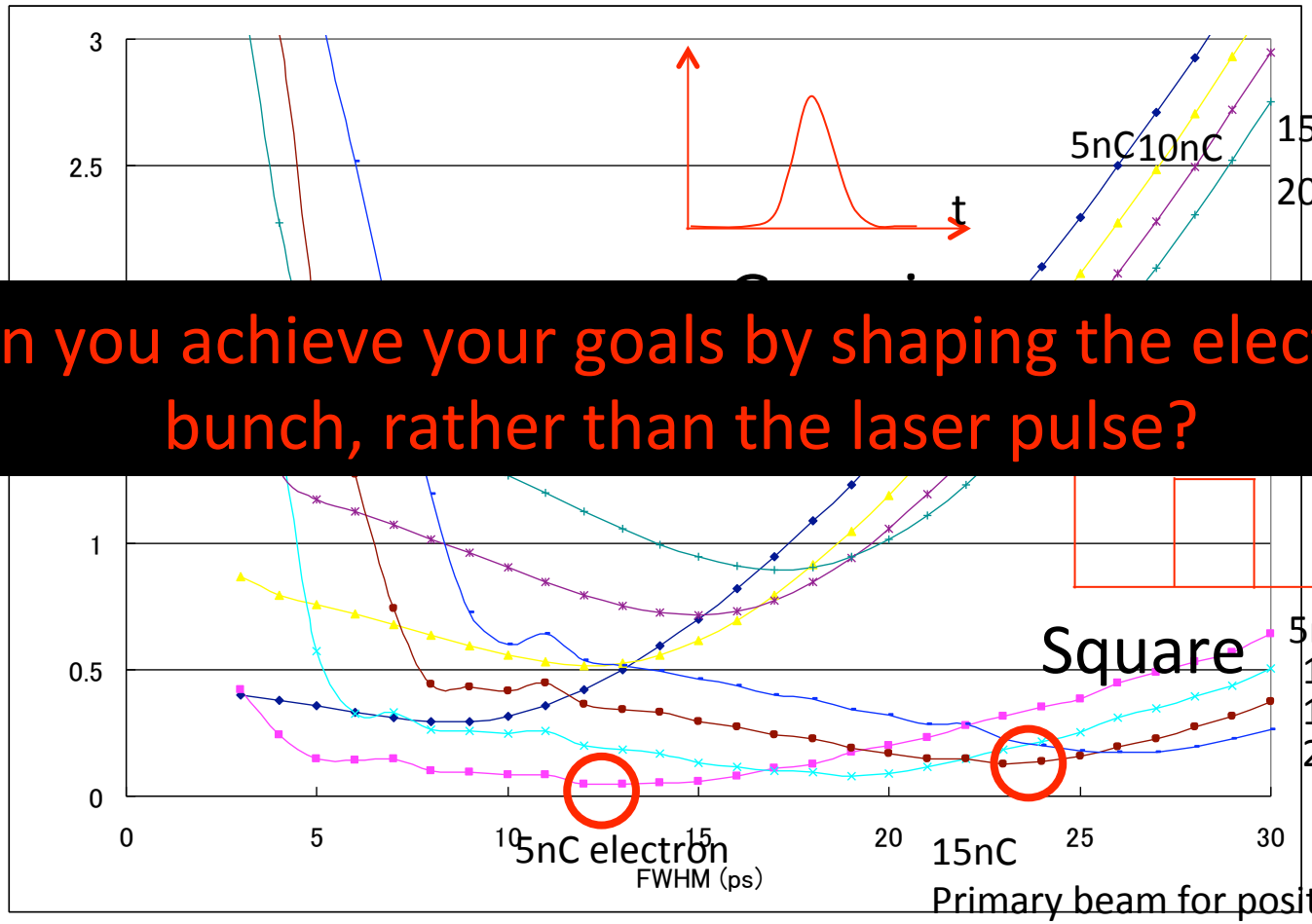
- Timing synchronization
- Amplitude noise
- Laser temporal pulse shaping
- Amplified spontaneous emission
- Two bunch generation
- Reliable delivery of light to photocathode
- The Committee can't tell how many rf gun problems are due to drive laser issues

Recommendations

- Develop a “simple” laser system without temporal pulse shaping: a simplified master oscillator, and more rugged Nd:host free-space amplifiers
- Yes, it’s somewhat contradictory for Committee to say “you have too many ideas” and then suggest new things for you to try!
- timing and amplitude instability. Determine where to devote your effort for the biggest return
- Purchase commercial components when possible. Oscillators and fiber amps, free-space amps?
- Do not modify the thermionic gun

Energy spread reduction using temporal manipulation

Energy spread of 0.1% is required for SuperKEKB synchrotron injection.



Can you achieve your goals by shaping the electron bunch, rather than the laser pulse?

- When the charge distribution is uniform in a cylinder, the energy spread of the bunch is lower than the result of Gaussian charge distribution.
- For the laser source, the pulse width should be reshaped to rectangle structure.

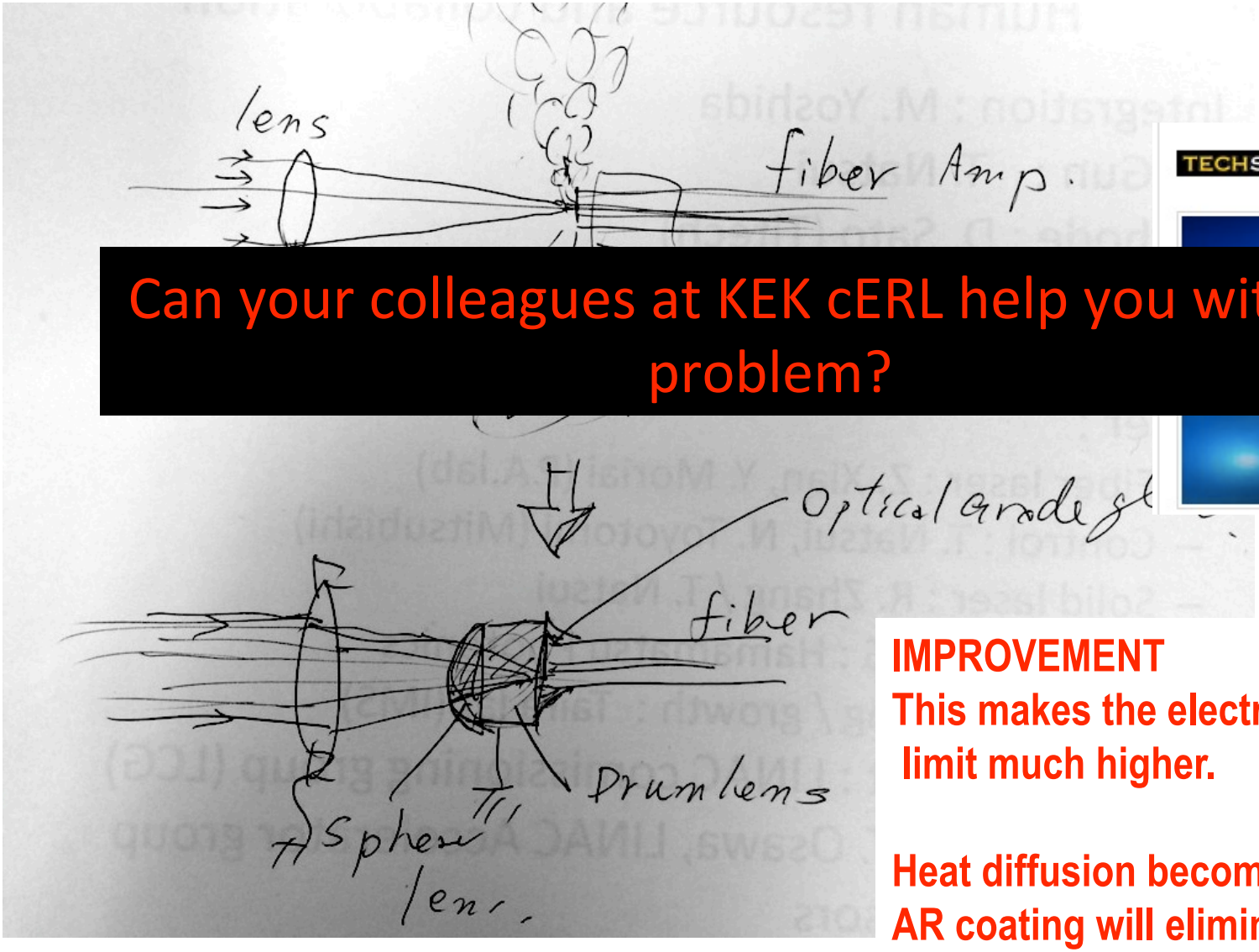
Two bunch generation

- By eliminating pulse shaping task from laser system, does it become easier to generate two bunches?
- Replace Yb:disk with rugged Nd:host amplifier material: less thermal lensing, more uniform gain applied to both pulses?

Preparing for Production Running

- Improve the environment for laser systems: temperature, vibration, “wind”
- Consider normal incidence laser illumination of the cathode. Or, effective normal incidence, using grating or prism
- Implement a laser imaging system to minimize pointing instability, learn from LCLS
- Shutter in front of gun + virtual cathode diagnostics to set laser spot size at the photocathode, to avoid accidental tight focus and damage
- Harmonic crystals need to be carefully installed: temperature, vibration. Transporting UV light not trivial

How to avoid damaging fibers?



Can your colleagues at KEK cERL help you with this problem?

Careful alignment will be important.

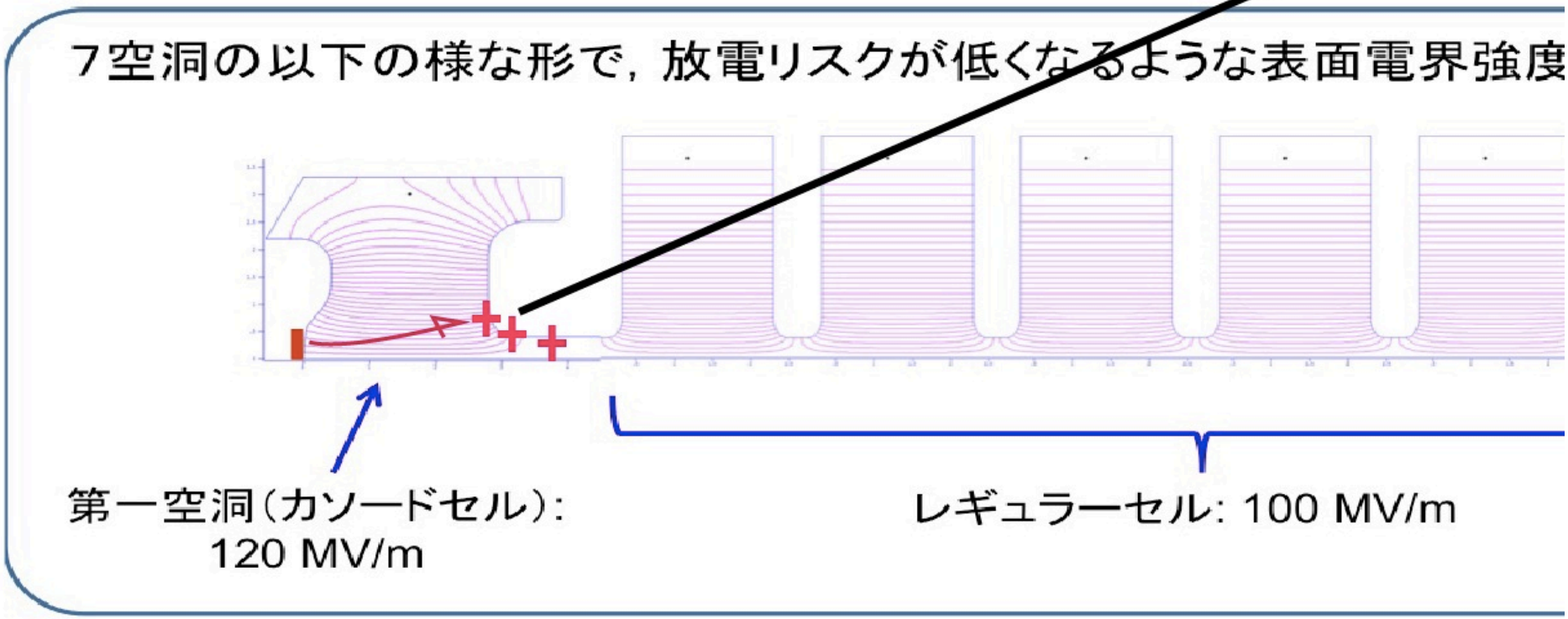
IMPROVEMENT

This makes the electric field discharge limit much higher.

Heat diffusion becomes much better.
AR coating will eliminate reflection from output side, stable operation.

Degradation of RF-Gun cavity

IrCe cathode has low work-function 2.57eV
It might be a source of discharge, suppttering on anode.



DAW has better shape (larger anode bore).
How to clean up suppeterd material?

Photocathode and RF-gun

- Committee congratulates the team for discovery of IrCe phptocathode
- Committee congratulates the team for the invention of quasi-traveling wave side coupled RF-gun, which will preserve emittance from the cathode to relativistic energy
- Drive laser issues appear to dominate the group's attention, making it difficult to work on gun and photocathode issues…
- Review Committee will provide a detailed summary report. We intend to evaluate SuperKEKB laser specifications against other existing laser systems