



High-Throughput Processing of Long-Length IBAD MgO and Epi-Buffer Templates at SuperPower

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HTS Solutions for a New Dimension in Power

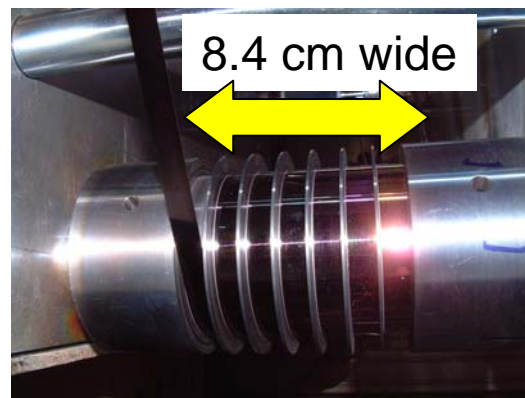
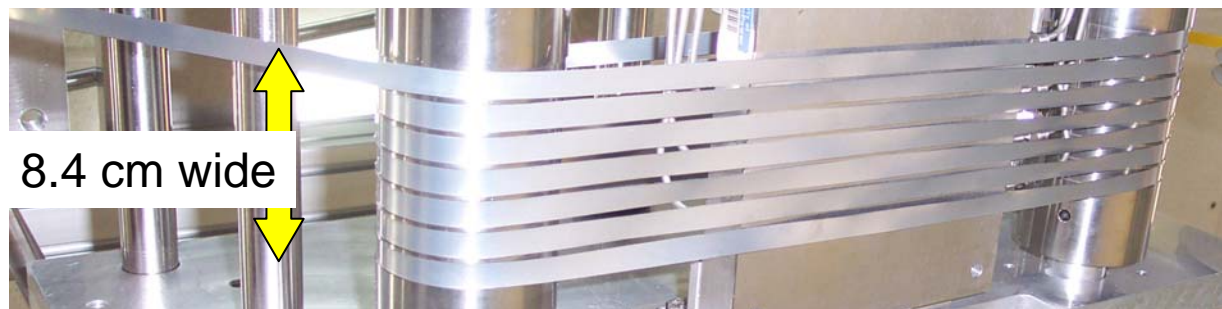
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Objective: Extend helix tape handling system to all processes for long piece lengths & high throughput



Our use of in-situ processes allows us a choice between processing a wide tape or a narrow tape with helix tape handling

We chose helix tape handling because of the immense advantages it provides and the demonstrated benefits of a multipass process.

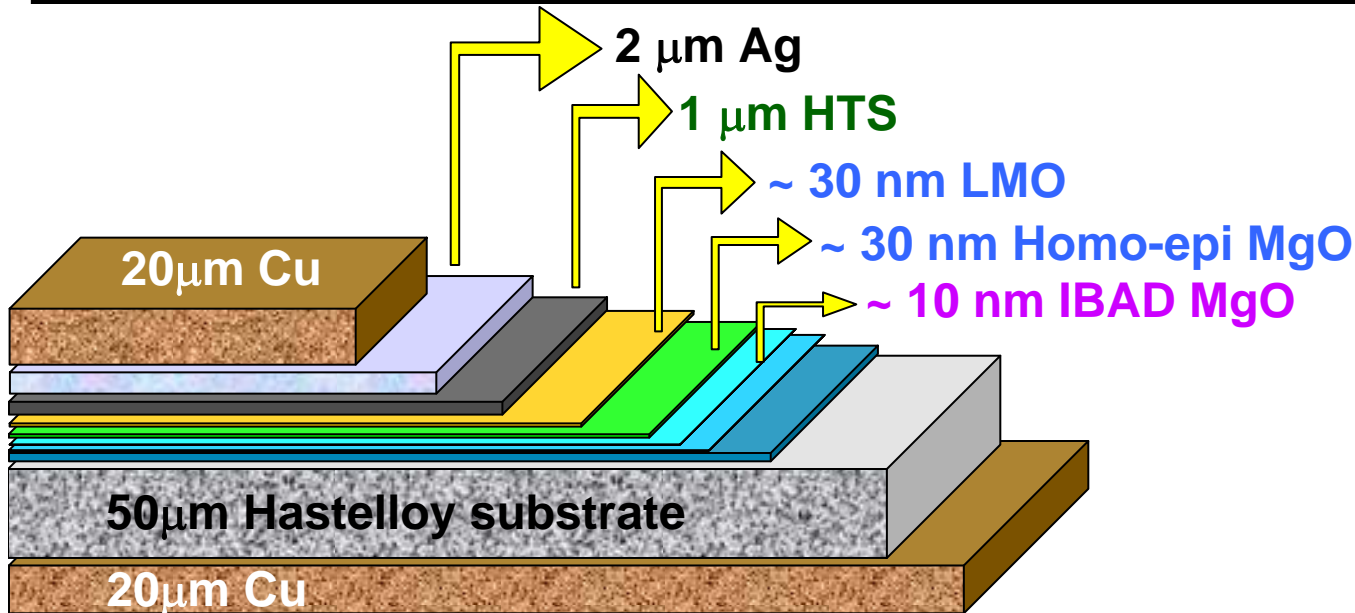


- ☑ Much longer (> 5 times) single piece lengths - important for wire customers who are already used to several 100 m to 1000 m of 1G
- ☑ Much shorter (> 5 times) process times for the same piece length
- ☑ Less concern with uniformity across width (5 times narrower)

Pilot Production Equipment was upgraded in FY06 for high throughput processing of all layers



	FY05 status	FY06 plan
IBAD	Helix tape handling YSZ: 1 m/h	Transition to IBAD MgO in Pilot IBAD. Modify hardware accordingly.
Buffer	n/a	New Pilot Buffer system with helix tape handling
MOCVD	Single tape: 5 m/h	Retrofit with helix tape handling; Increase deposition zone length & width

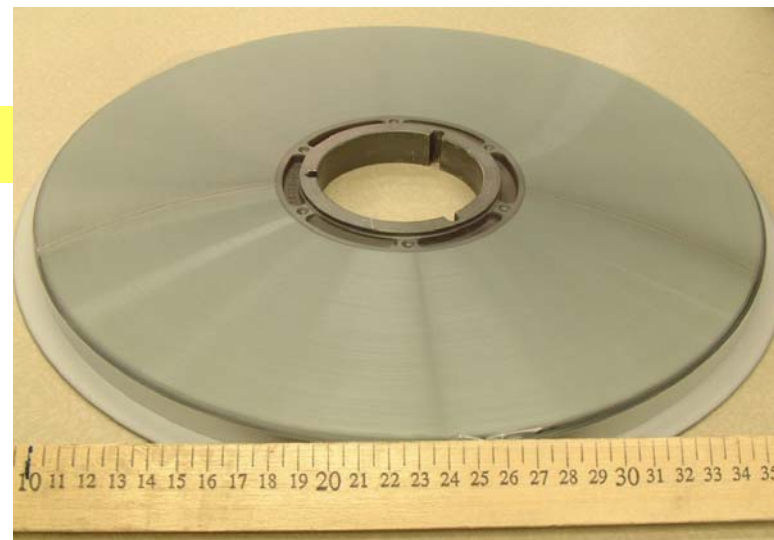
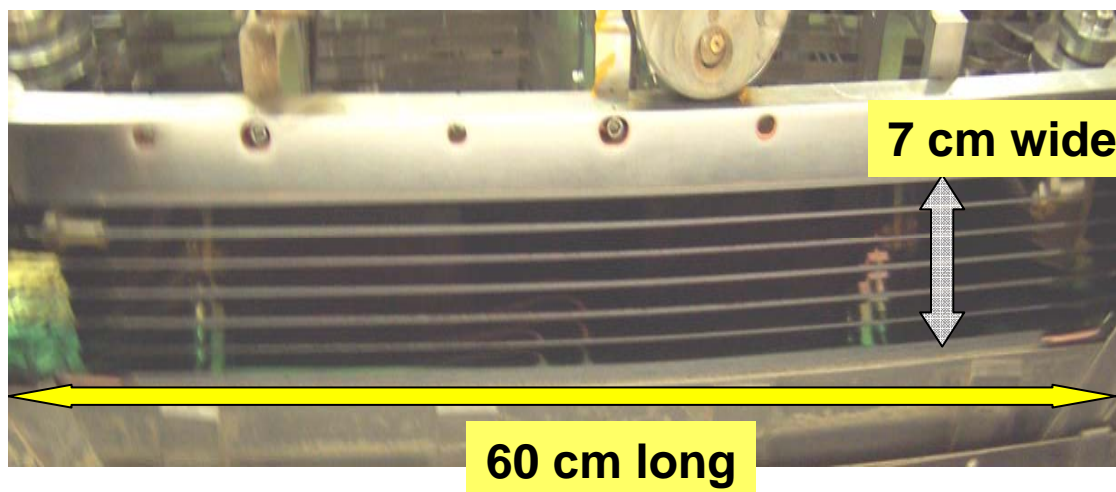


Tremendous challenge to successfully implement modifications in *three* critical equipment *simultaneously* & then routinely produce *10,000 m* of conductor for delivery to Albany Cable Project

High-throughput IBAD MgO has been transitioned to Pilot IBAD system

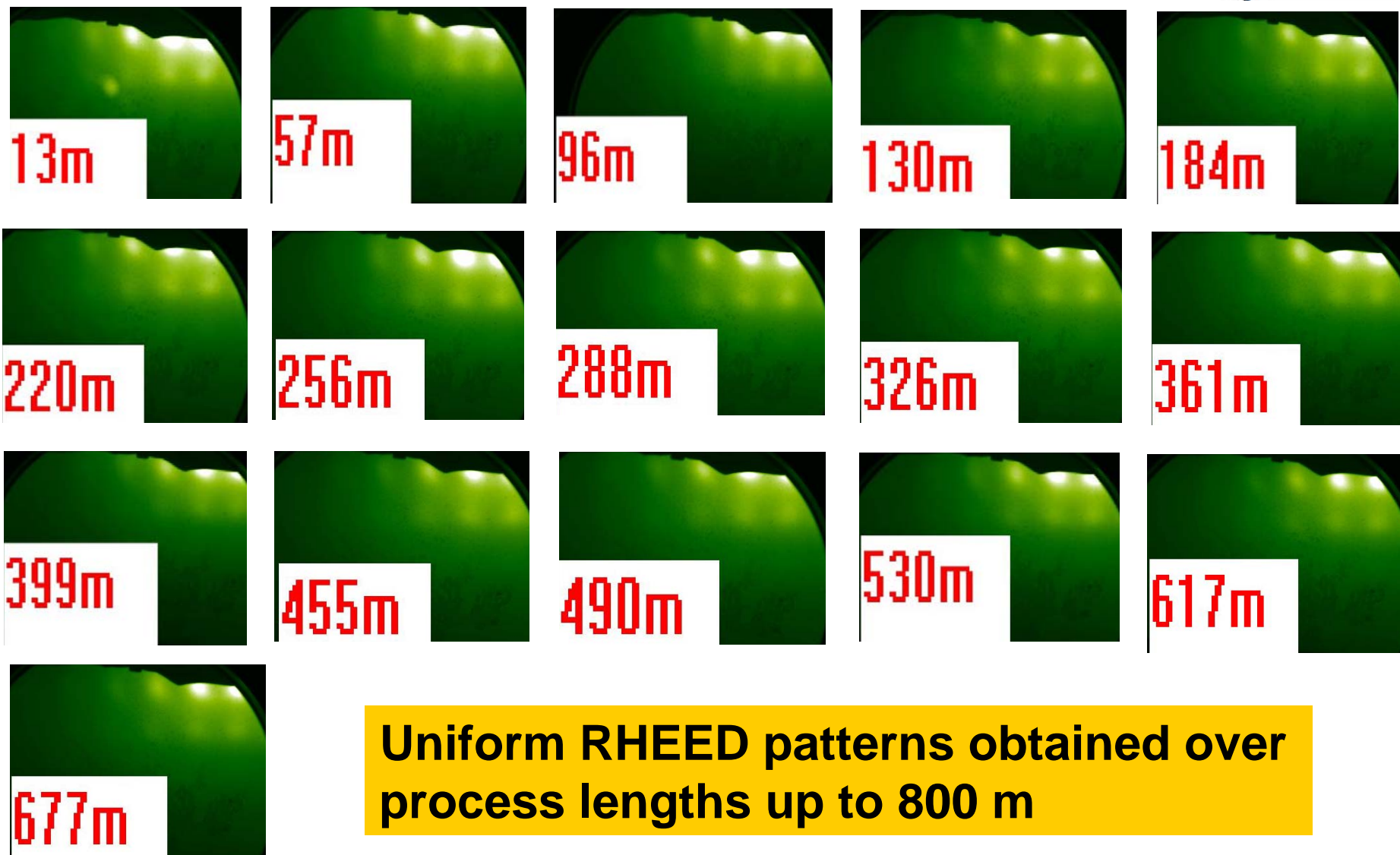


- Pilot IBAD system:** Helix tape handling with a deposition zone length of 60 cm, 6 tape wraps. With IBAD YSZ, yielded ~ 1 m/h.
 - With IBAD MgO would enable linear tape speeds > 100 m/h (or a throughput > 300 m/h of 4 mm wide tape)



IBAD MgO tapes up to 570 m long have been produced with a deposition zone of 42 cm & a speed of 65 m/h of 12 mm wide tape i.e. 195 m/h of 4 mm wide tape

Up to 570 m long single-piece IBAD MgO tapes routinely processed in Pilot IBAD with good & uniform texture

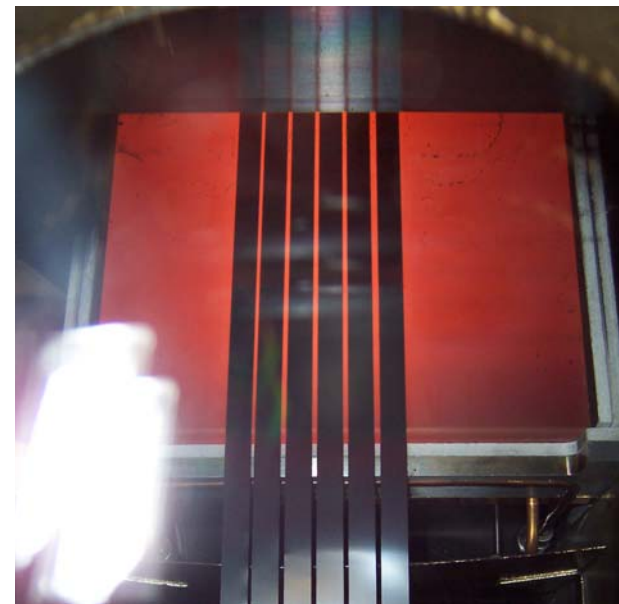
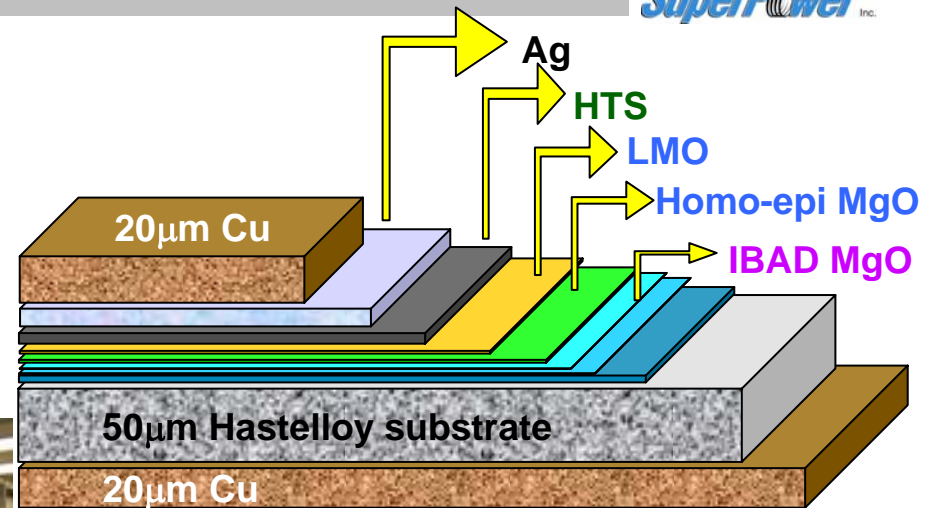


Uniform RHEED patterns obtained over process lengths up to 800 m

Pilot Buffer System has been established for long-length, high-throughput buffer layers for IBAD MgO

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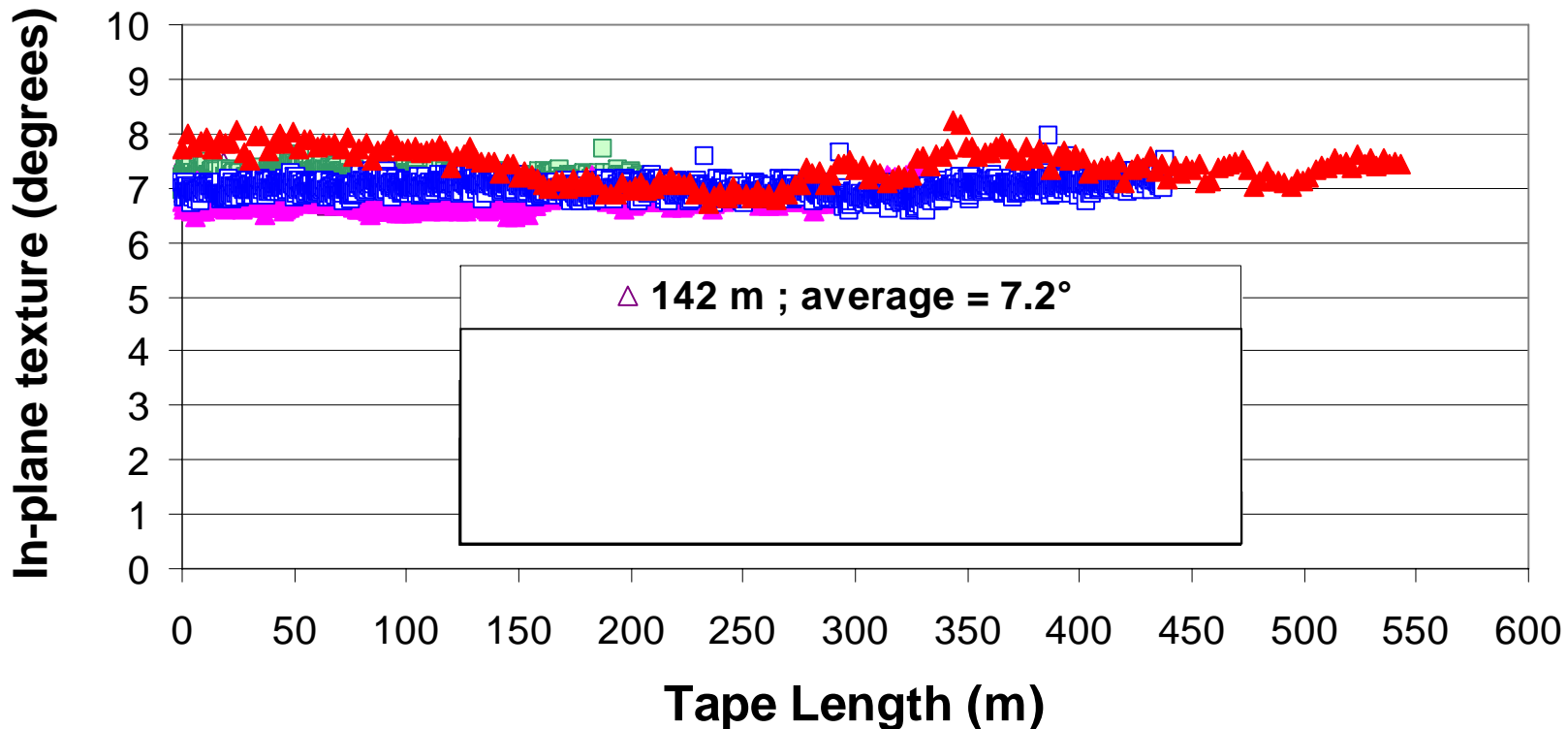
- Two chambers for sequential deposition of 2 buffers (homo-epi MgO & LMO) on IBAD MgO
- Helix tape handling in both chambers, each with 12 tape wraps. Deposition zone length in each chamber = 0.3 m
- Spool boxes for 1 km single-piece lengths



550 m long tapes have been produced in Pilot Buffer system at linear speeds of 40 m/h



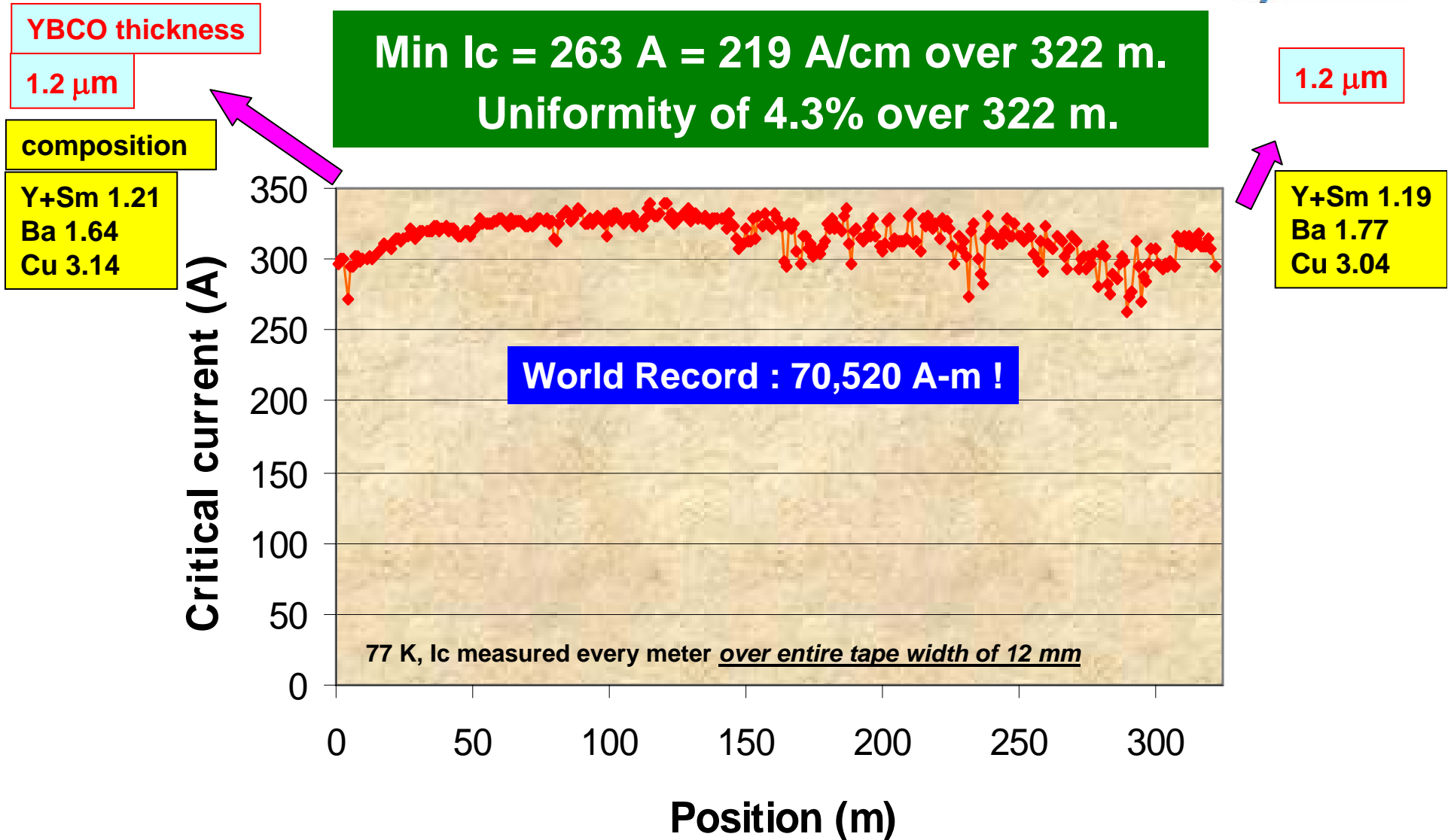
Using only 6 of the 12 tape tracks in helix tape handling in Pilot Buffer system, 40 m/h tape speed is routinely used to produce up to 550 m lengths of homo-epi MgO and LMO on IBAD MgO.



In-plane texture of LMO over 550 m produced at 40 m/h = 7.4°

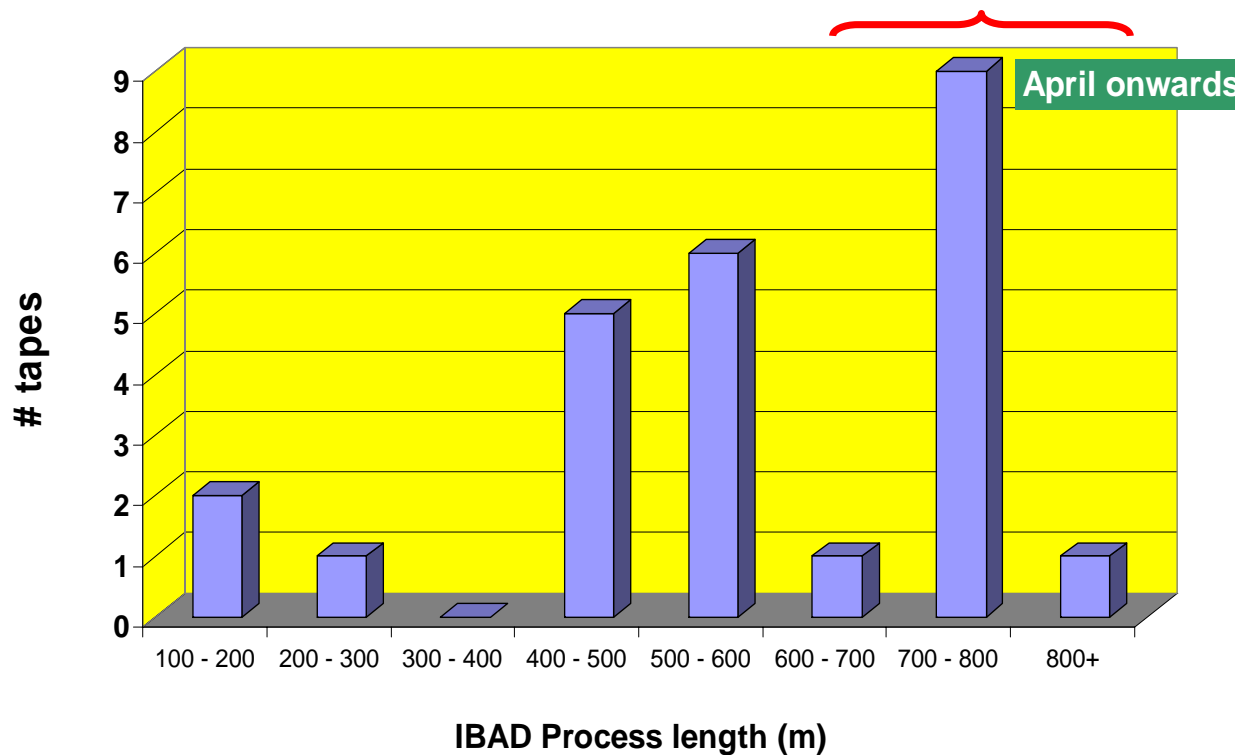
Retuning of MOCVD process based on XRD data yielded high I_c over 300 m with excellent uniformity

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Routine production of IBAD MgO now: **700 – 800 m per run**

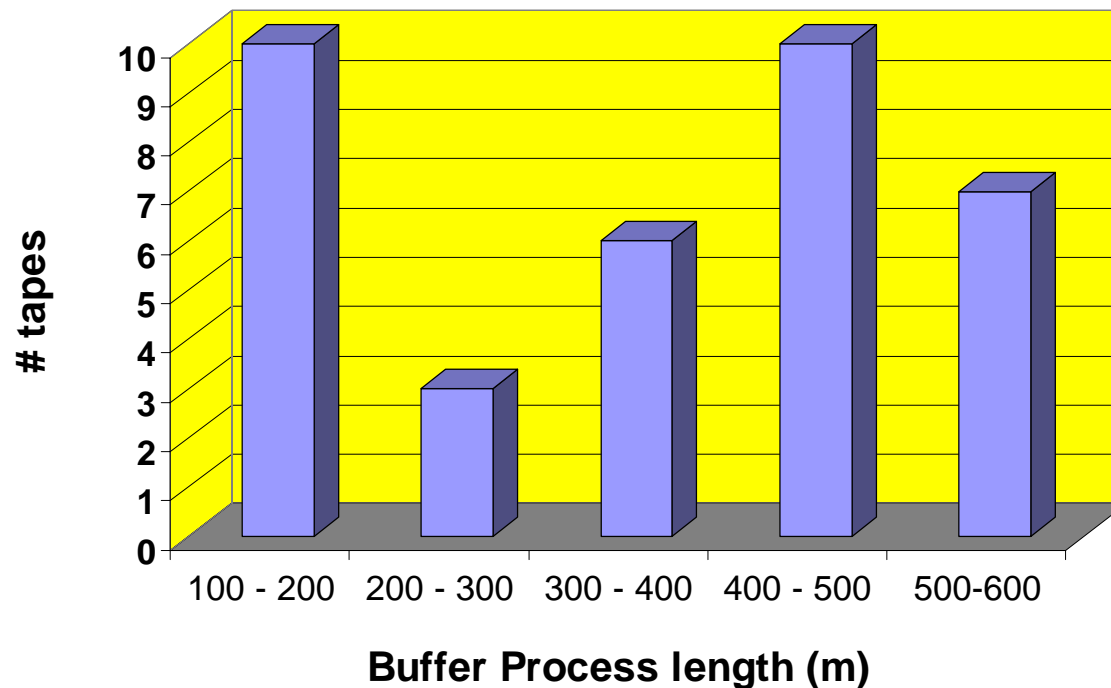
- Process length increased to ~ **770 m** with two single-piece lengths
- Single piece lengths up to 570 m – limited by substrate
- 25 production runs yielding 14,660 m** of 12 mm wide IBAD MgO tapes produced in **the last 5.5 months – equivalent to 43,980 m of 4 mm wide tape**



Routine production of Homo-epi MgO & LMO buffers now **500 – 600 m lengths per run**



- Process length has been typically 400 – 500 m. Now 500 – 600 m
- No change in process parameters since the beginning of production!
- Single piece length up to 570 m – limited by substrate.
- 37 production runs yielding 12,520 m of 12 mm wide buffer tape equivalent to 37,560 m of 4 mm wide tape produced in the last 4 months**



Summary

SuperPower has successfully transitioned from low-throughput IBAD (ion beam assisted deposition) YSZ technology to high-throughput IBAD MgO technology.

Pilot-scale IBAD system and pilot-scale epi-buffer deposition system have been established, each with the capability of producing single-piece lengths over 1000 m.

IBAD MgO buffer stack and their processes have been developed together with high throughput where each layer in the buffer stack is processed at 40m/h tape speed or higher during our Phase I scale-up. 700-800m IBAD MgO tape per run is routinely produced in pilot IBAD system with single piece tape length ~ 570m. 400-550m epi-buffer tape per run is routinely produced in pilot buffer system.

High-throughput IBAD MgO buffer gives better texture of YBa₂Cu₃O₇ (YBCO) film compared with IBAD YSZ, and superior superconducting properties. World record critical current * length value of > 70,000A-m was obtained with the high throughput IBAD MgO buffers