PWO Crystal Production and Quality Control at SIC

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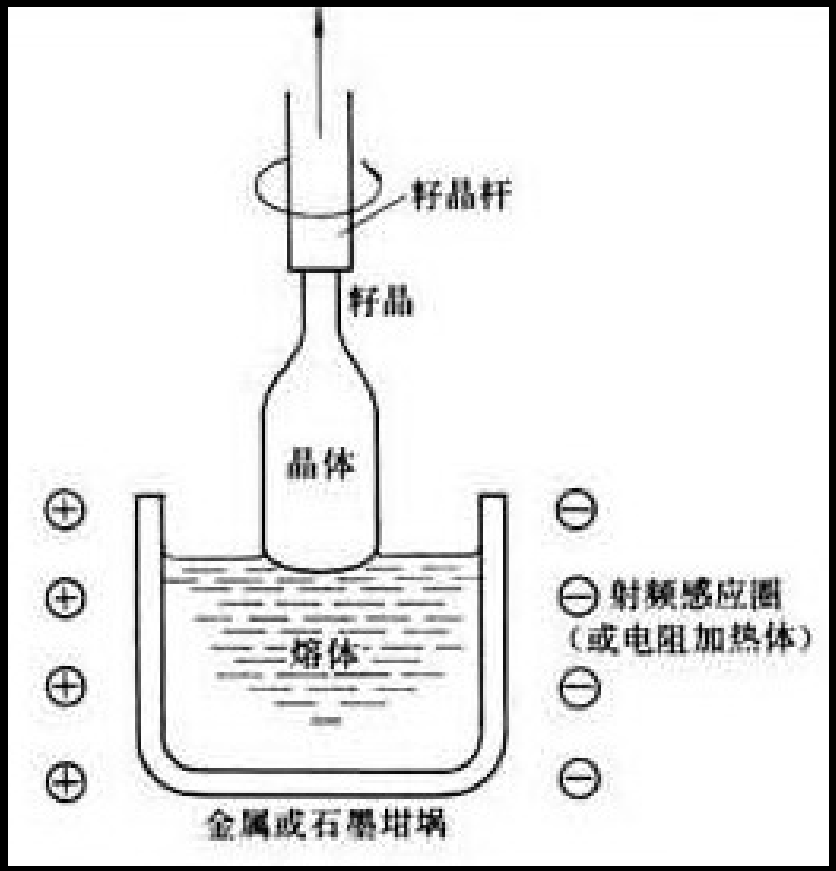
SIC and JLab. Collaboration meeting, Shanghai, 2018.07.23

Outline

1. Modified Bridgman method
2. PWO crystals production
3. PWO quality control
4. Summary

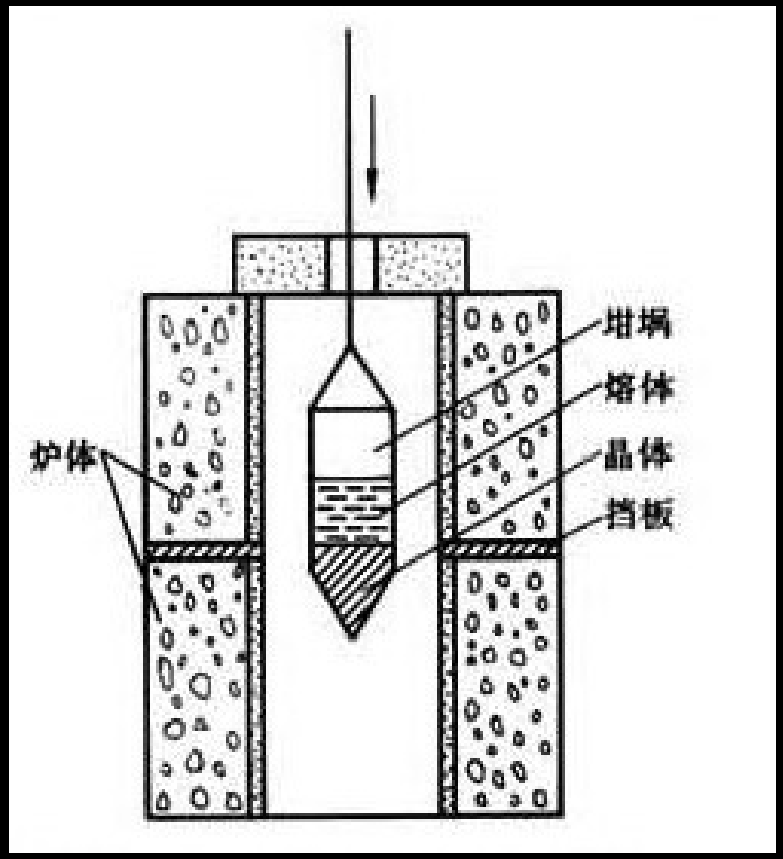
Crystal Growth

Czochralski



High quality
High cost
High temperature

Bridgman

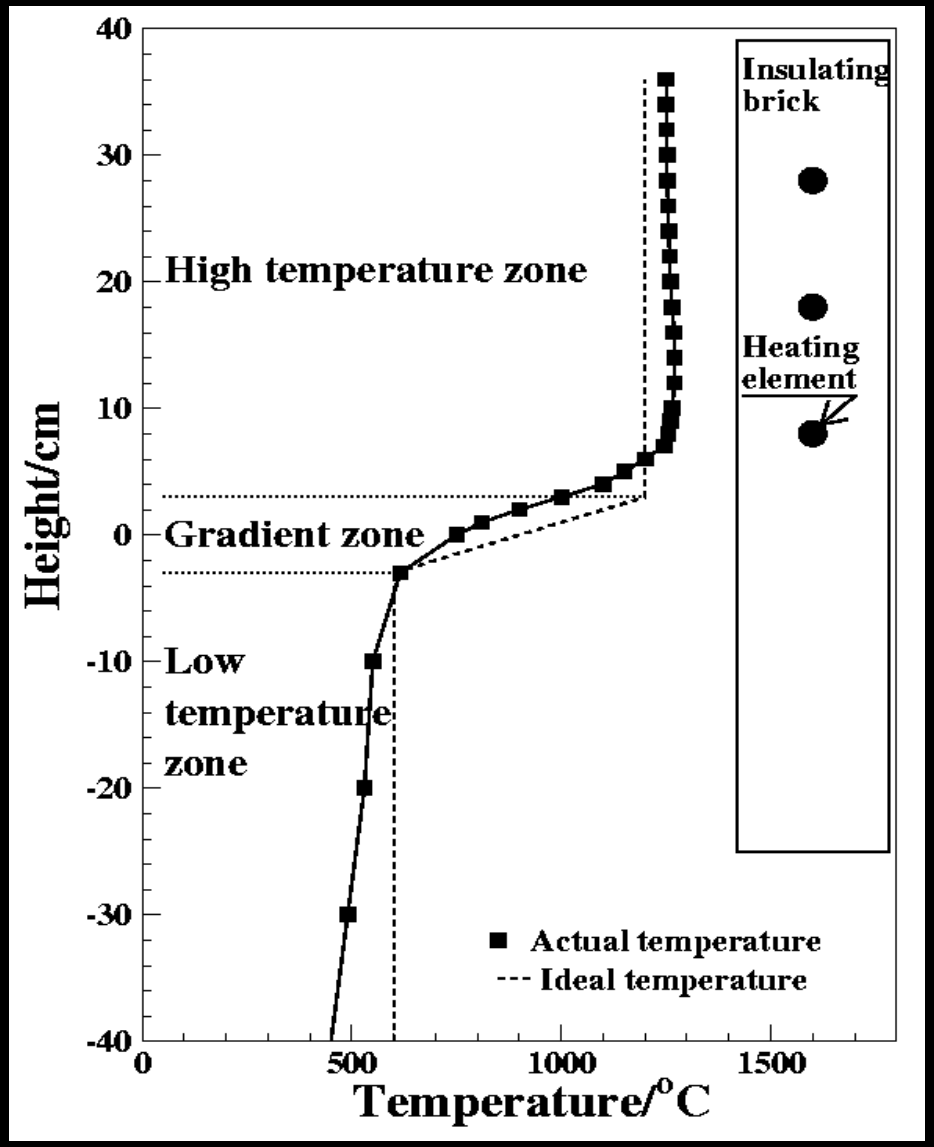


High efficiency
Low cost
High flexibility

Modified Bridgman Method

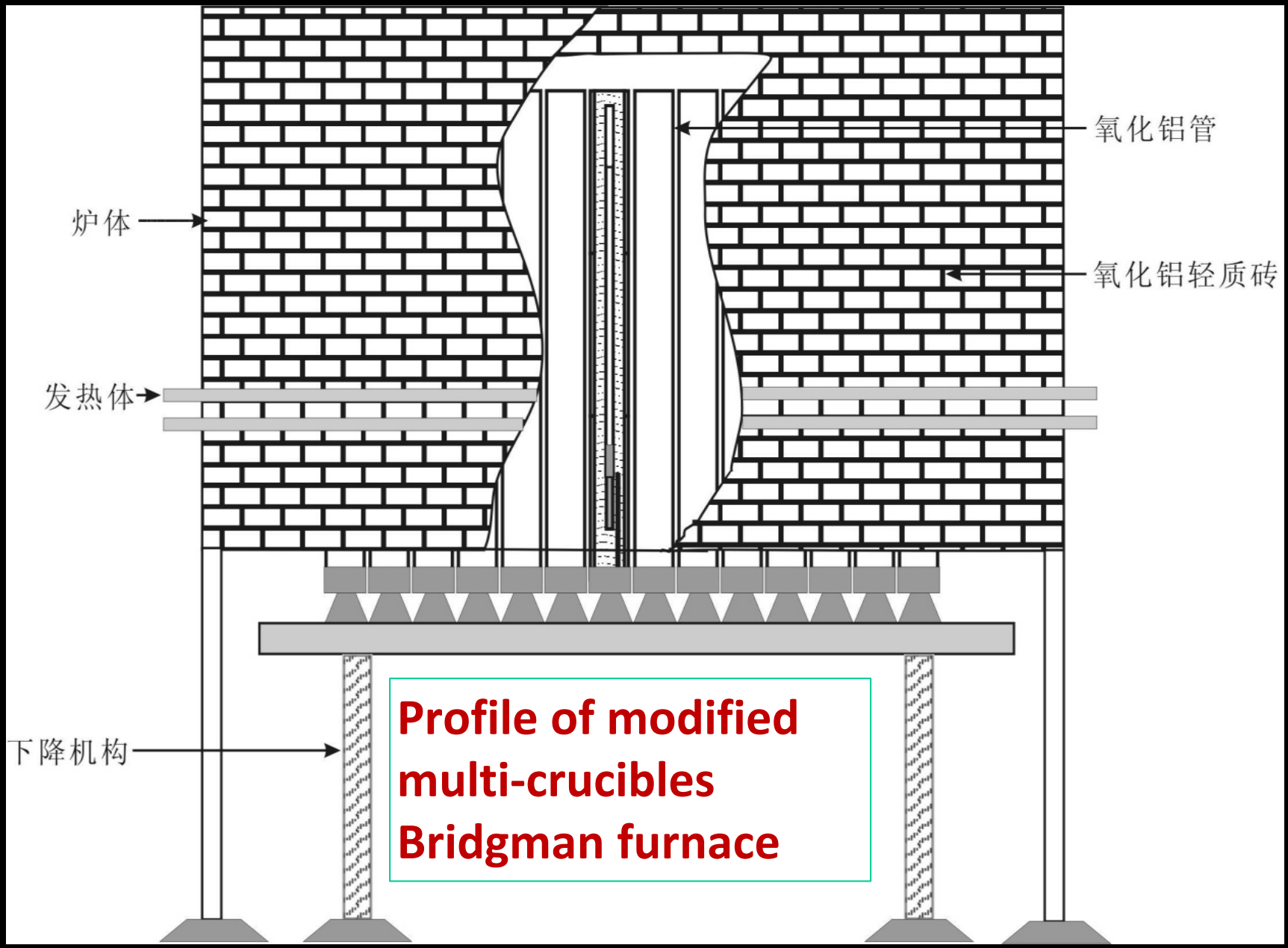
PWO Crystal Growth Parameters

- ✓ Speed：0.4-0.6 mm/h
- ✓ Gradient：20-50 C/cm
- ✓ Furnace temp：1170 C
- ✓ Seeding temp: 1045 C



Furnace temperature profile

Modified Bridgman Method

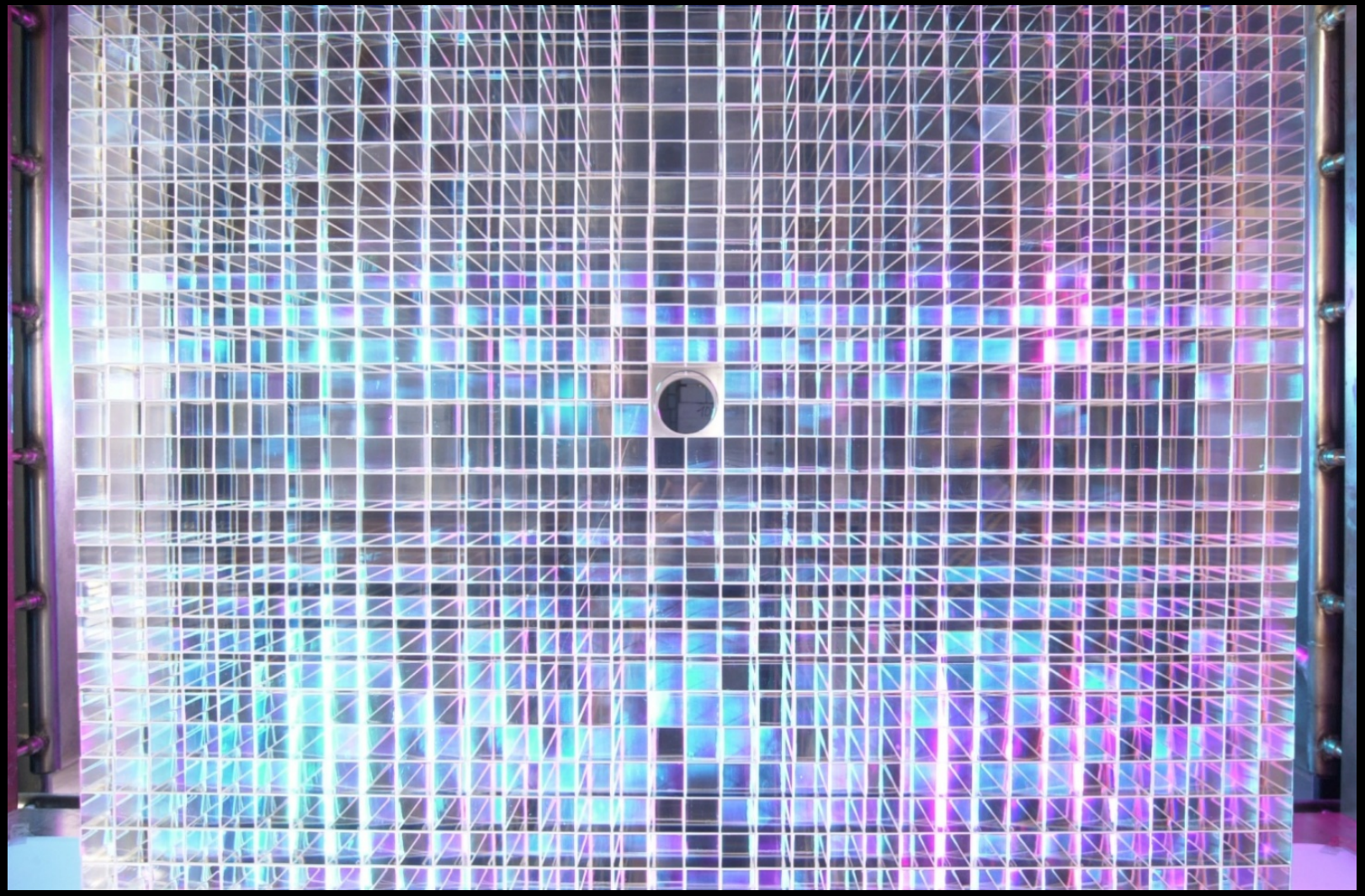


Profile of modified multi-crucibles Bridgman furnace

Since 1928 SICCAS

PWO CX for PrimEx

中国科学院上海硅酸盐研究所
Shanghai Institute of Ceramics
Chinese Academy of Sciences



2001.5-2002.6, SICCAS provided PrimEx all 1275 PWOs.

Since 1928 SICCAS

PWO CX for PrimEx

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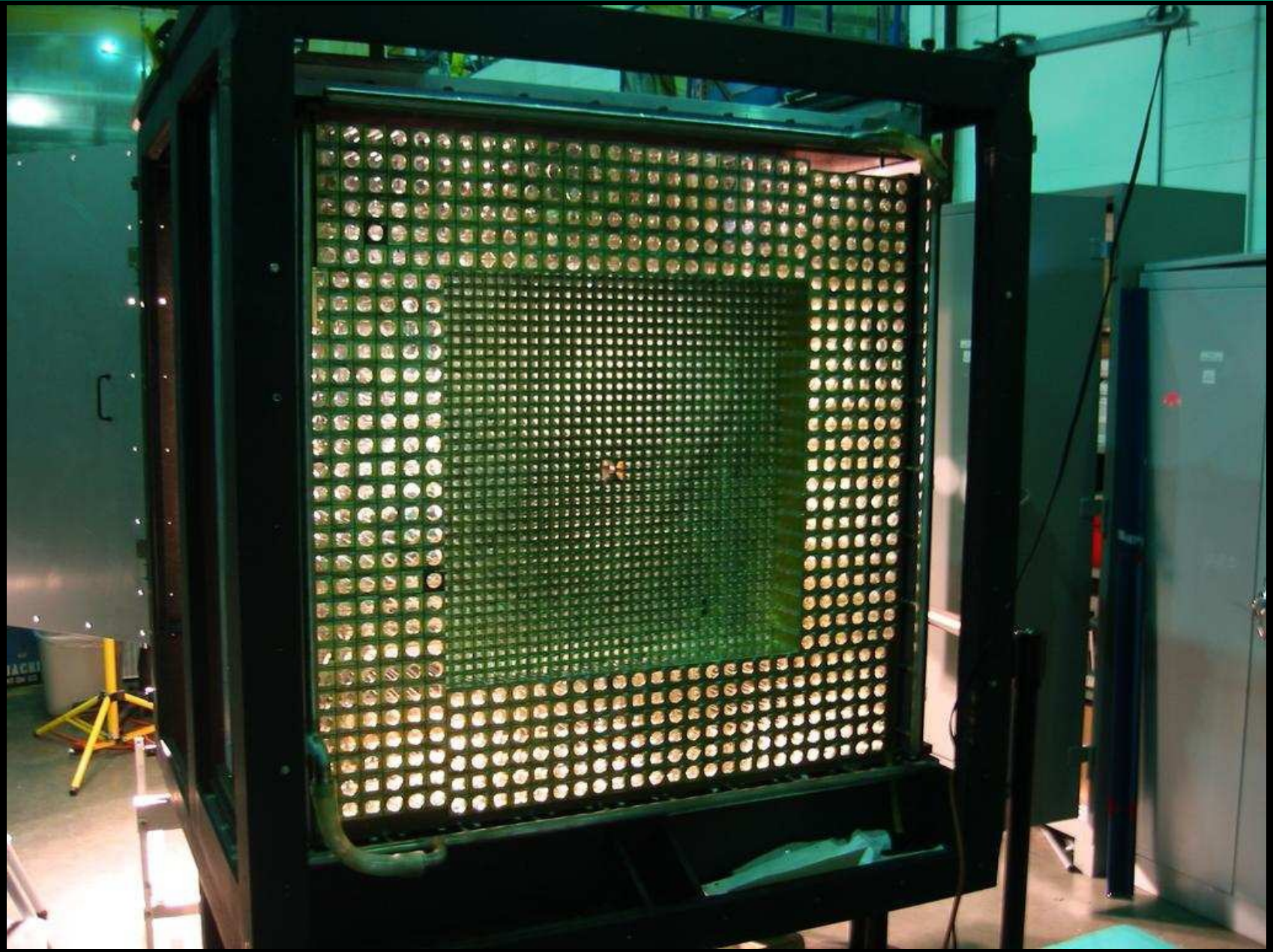

Since 1928 SICCAS

PWO CX for CMS

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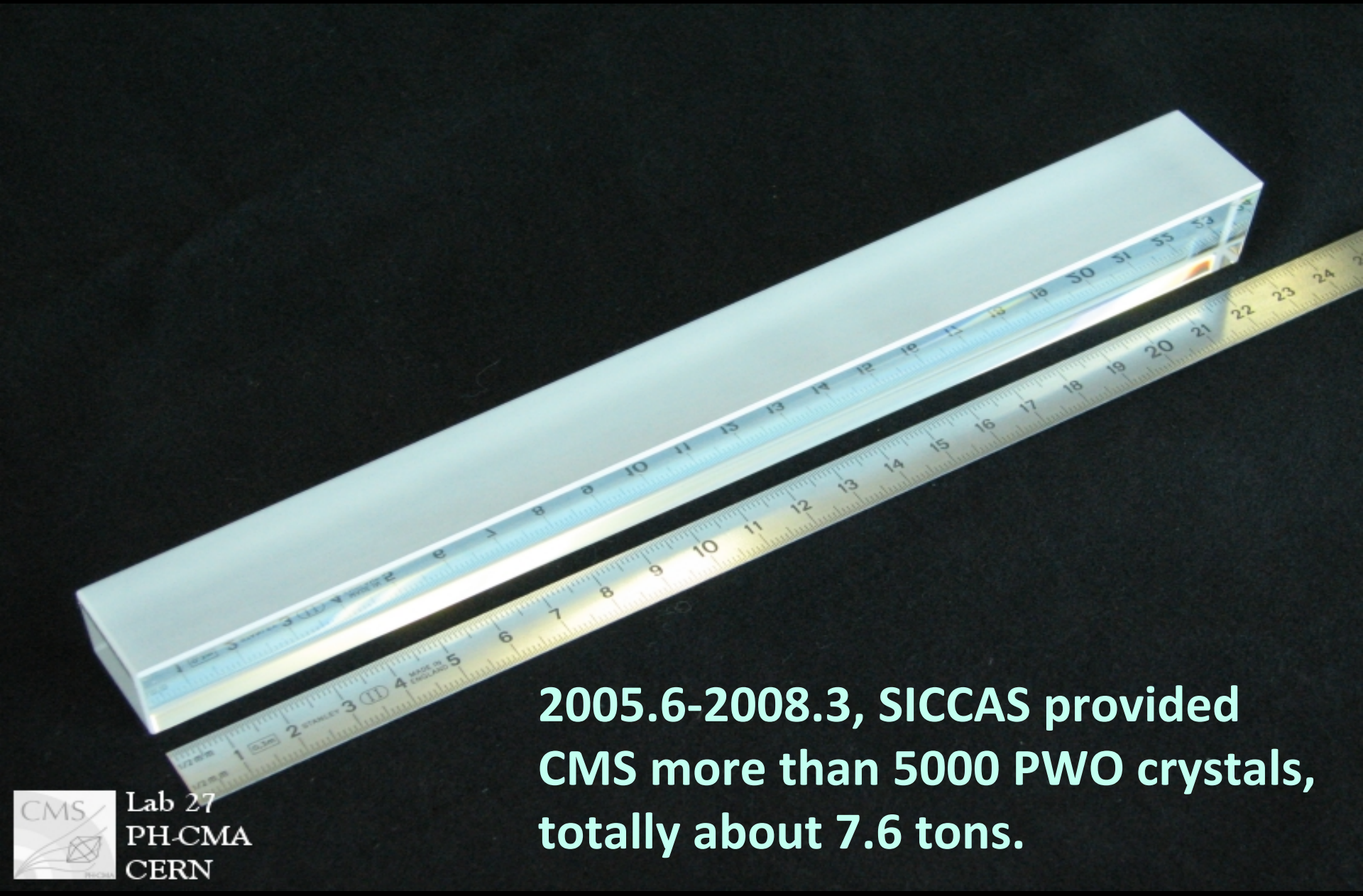


2005.6-2008.3, SICCAS provided CMS more than 5000 PWO crystals, totally about 7.6 tons.

Lab 27
PH-CMA
CERN

PWO Production

Process flow diagram

Weighting

Polycrystalline

Shaping

Seeding

Crystal Growth

Ingots

Annealing

Machining

Test Bench

Products

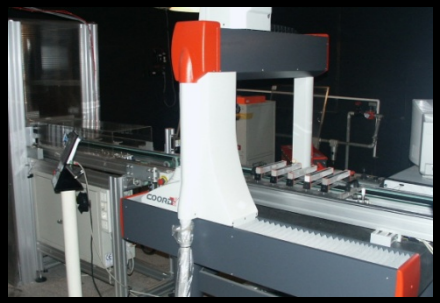
Recycle

Leak Checking

Crucibles

Refining

Pt Fragments



PWO Production

Production procedures:

1. Weighting
   PbO/WO_3 + 150ppm Y
2. Polycrystalline
   Mixture sintered/melted
3. Shaping
   Compounds into crucibles with seeds
4. Seeding
   Crucibles into furnace and heated
5. Crystal growth
   Seeding temp reach and growth starts

PWO Production

Production procedures:

6. Ingots
   After finish, ingots got from crucibles
7. Annealing
   Low temp annealing to remove tension
8. Machining
   Cutting, grounding and polishing
9. Test bench
   Transmittance, light yield and RH
10. Products
    About 8 weeks needed

PWO Production

Key points:

1. Lead time: 3-6 months

Furnace tuning, raw material ordering, Pt rental

2. PbO material

Environmental policy restrict the PbO production

3. Uniformity

30 cx in one growth, no forced convention

4. Crystal yield

Growth * machining * performance

PWO Quality Control

1. PbO material

For each batch, to grow one sample to verify the quality. Second source may be needed.

2. Uniformity

New furnaces are planned to be set up.

3. Radiation hardness

Gamma-ray irrad facility has been moved. UV irrad will be applied to the ingots to verify its RH.

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Summary

1. The PWO crystals can be produced with the Bridgeman technique.

2. Due to the environmental policy, PbO material supply is being reduced, and there is no nearby Gamma ray irrad facility.

3. New furnaces are planning to be set up.

Thanks!