

# High Pressure Oxygen Furnace

Neutron Scattering Group  
Lab 1-12, Bldg. 555  
Brookhaven National Lab

Manufacturer:  
American Isostatic Presses (AIP)  
Columbus, OH

Technical expert and operator:  
Kim Mohanty

Hot Isostatic Press = HIP

Max pressure = 100 kpsi (6.9 kbar)  
Max temperature = 1200°C  
Gas = 20%O<sub>2</sub> + 80%Ar  
(1.4 kbar O<sub>2</sub> partial pressure)  
Sample volume = 1" diam, 6" high



Furnace insert; samples  
are loaded into Al<sub>2</sub>O<sub>3</sub>  
before placing in furnace



Pressure vessel and yoke



# Operation

## History

Nov. 2011: Installation at BNL  
Feb. 2012: Start of acceptance testing  
Nov. 2012: Operational readiness evaluation  
Apr. 2016: Final contract milestone/payment  
Oct. 2016: HIP status Operational

## Recent runs

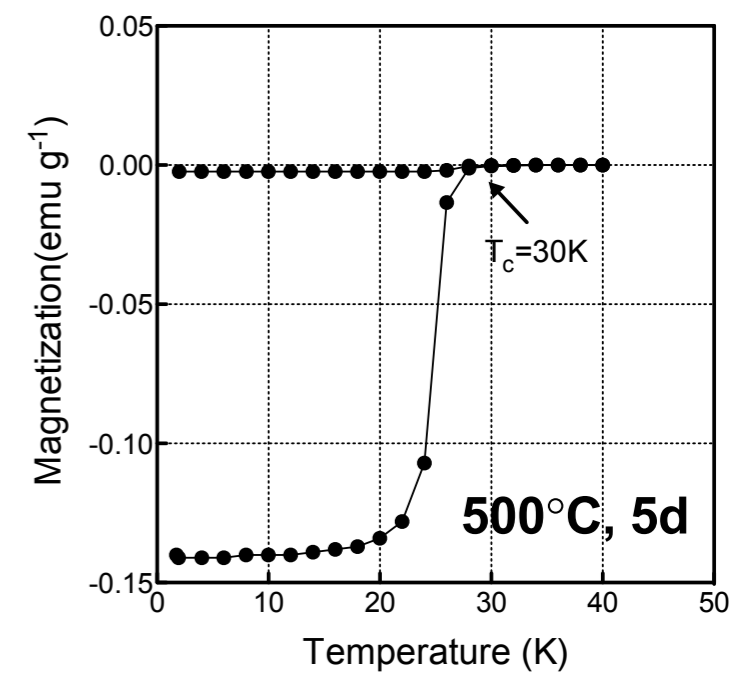
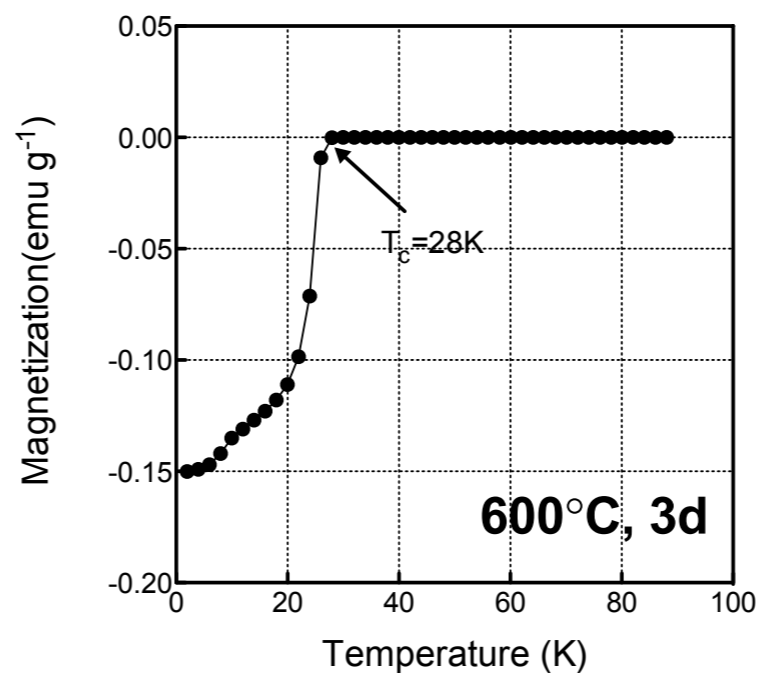
Mar 29, 2016 (80 ksi, 1150C, 3 h)  
Mar 28, 2016 (99 ksi, 1180C, 15 h)  
Nov 3, 2015 (99 ksi, 500C, 5 days)  
Oct 29, 2015 (99 ksi, 500C, 1.5 days)  
Aug 5, 2015 (99 ksi, 600C, 7 h)

## Some crystals tested 1200 C, 18 h

Composition	% O change
YNiO <sub>3-δ</sub>	0.2
YSrNiO <sub>4-δ</sub>	9.8
NdNiO <sub>3-δ</sub>	15.6
Y <sub>2</sub> BaNiO <sub>5+δ</sub>	4.2
La <sub>1.875</sub> Sr <sub>0.25</sub> NiO <sub>4+δ</sub>	2.1

(by mass change)

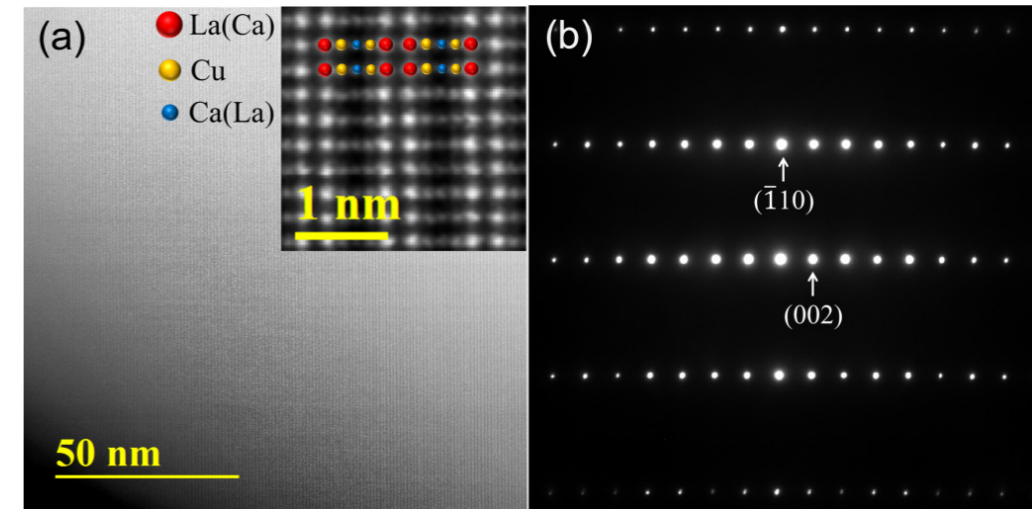
## Crystals of La<sub>2</sub>CuO<sub>4+δ</sub> after annealing



Ruidan Zhong and Genda Gu

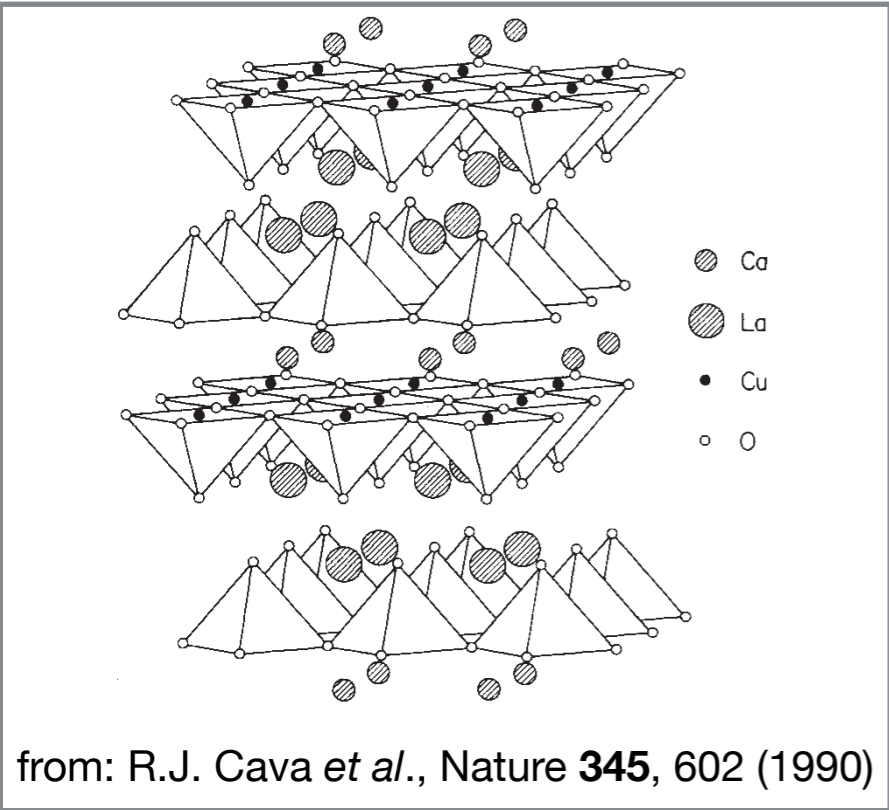
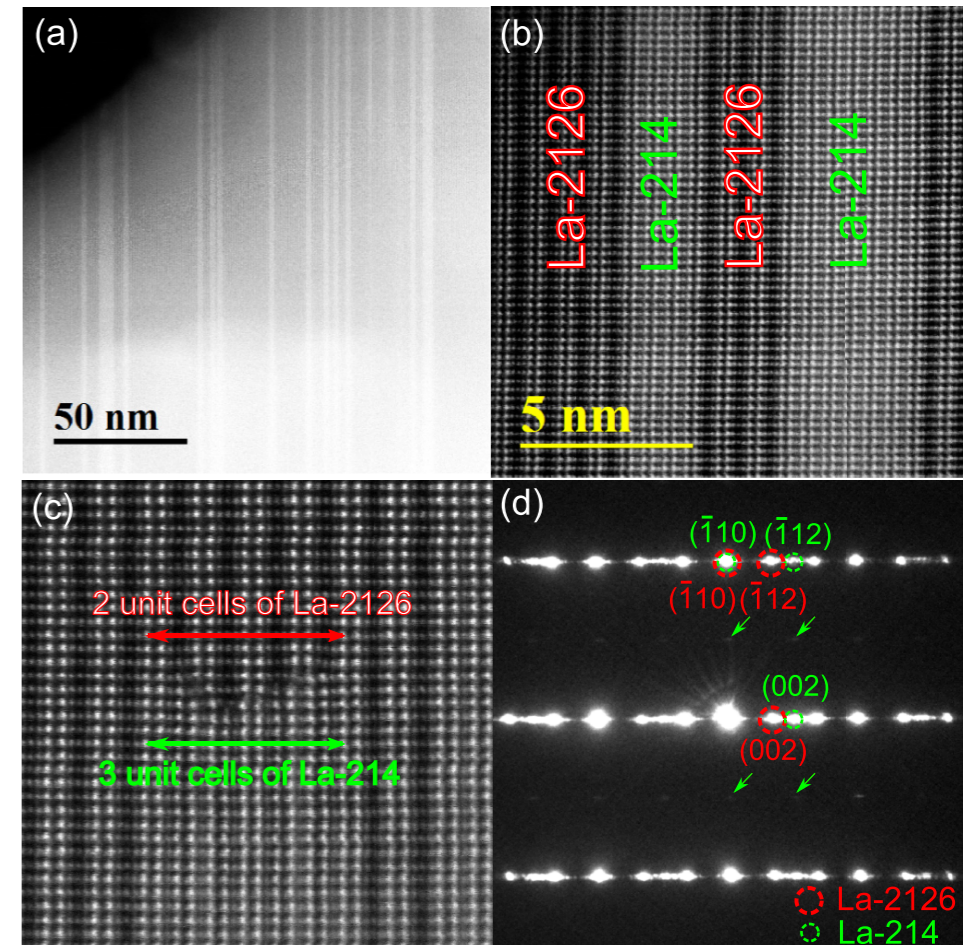
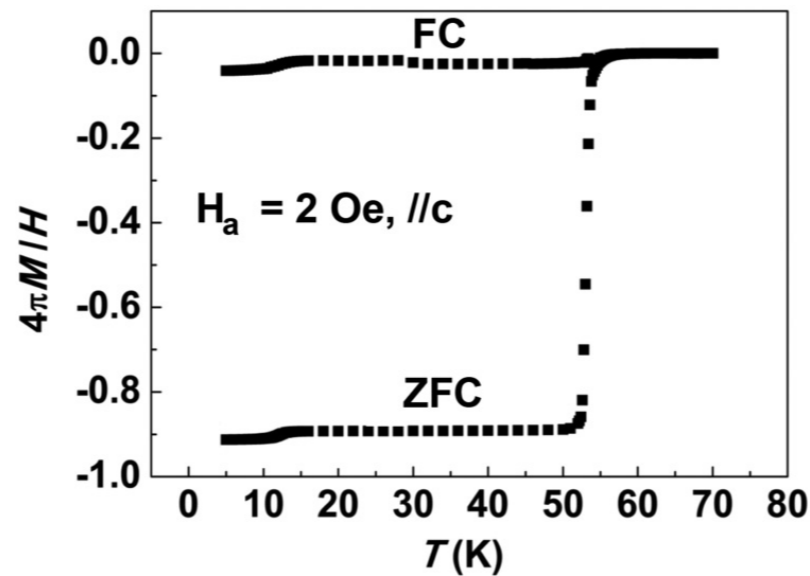
# La<sub>1.9</sub>Ca<sub>1.1</sub>Cu<sub>2</sub>O<sub>6+δ</sub>

as grown:



after annealing:

TEM

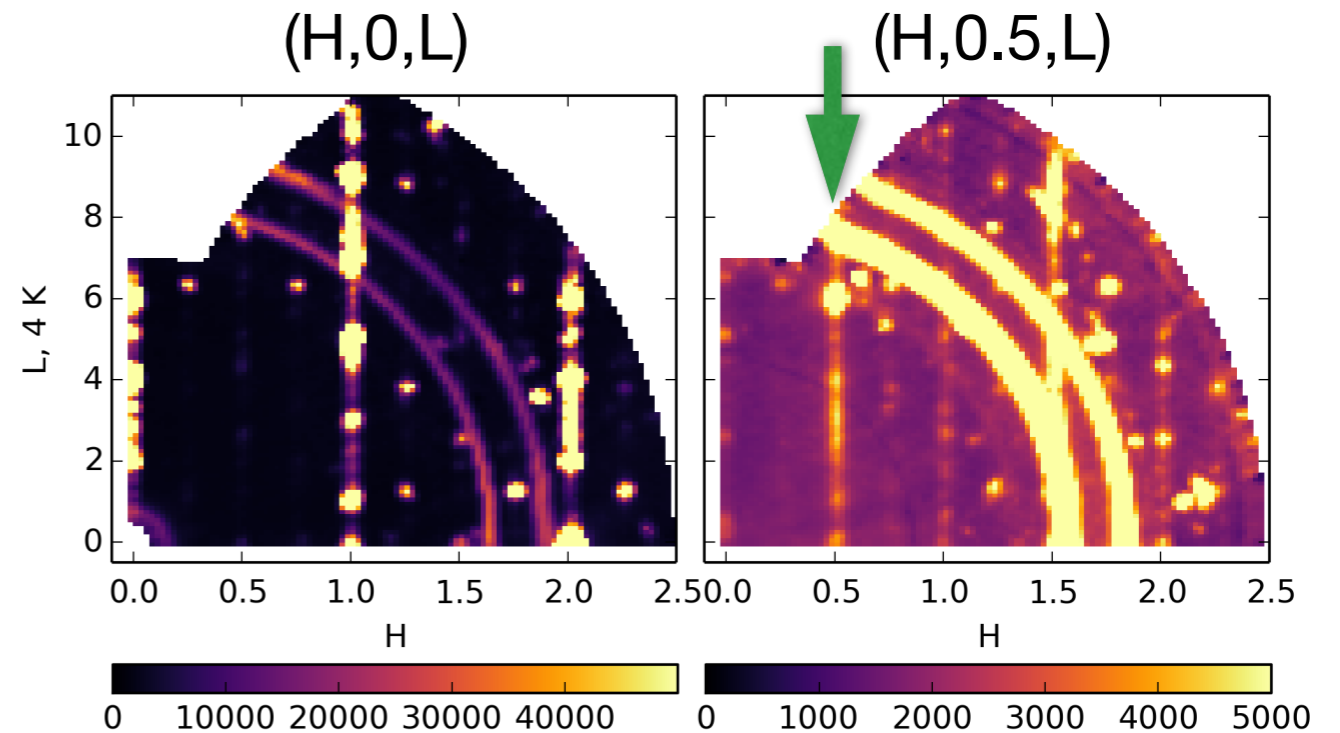


- Crystal grown by TSFZ
- 8 mm diam x 10 mm
- Annealed 1200°C for 10h
- **As grown**: non-superconducting
- **After annealing**:  $T_c = 53.5$  K

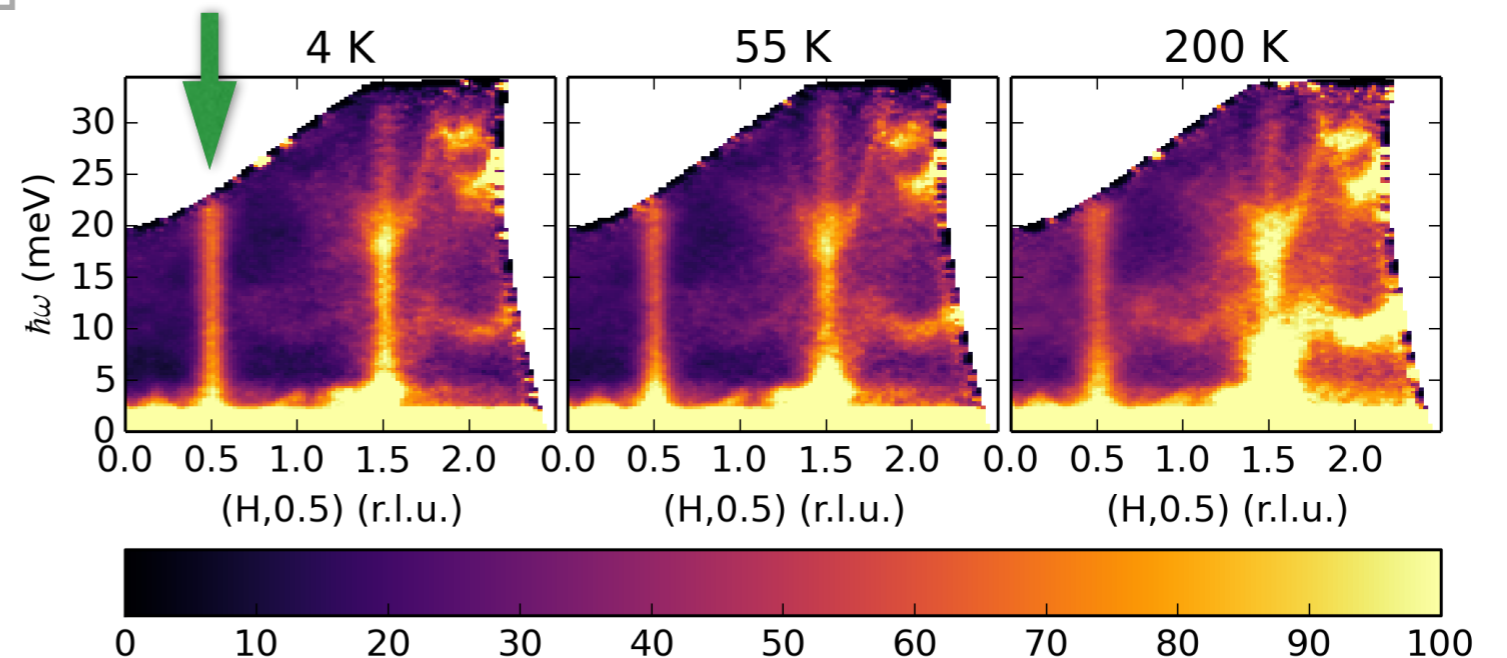
# $\text{La}_{1.9}\text{Ca}_{1.1}\text{Cu}_2\text{O}_{6+\delta}$

- Crystal grown by TSFZ
- Annealed in 20%  $\text{O}_2$ 
  - 1180 C/100 kpsi/10h
  - 1150 C/ 90 kpsi/ 5h
  - 1130 C/ 80 kpsi/16h
- $T_c = 45$  K
- Neutron scattering measurements at SEQUOIA/SNS
- John Scheeloch, Genda Gu, Guangyong Xu (unpublished)

## Elastic scattering



## Inelastic scattering



↓  
Magnetic scattering