



Status of X-band pulse compressors at Tsinghua University

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CLIC Workshop, 22-26 January 2018



Outline

➤ Backgrounds

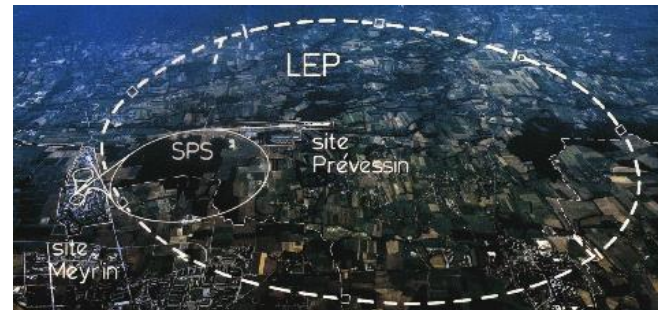
- Correction cavity chain for CLIC
- X-band pulse compressor for TTX
- X-band two stage pulse compression
- Summary





Backgrounds

- Pulse compressors in electron-positron collider
 - Circular electron-positron collider
 - LEP (Large Electron-Positron collider): LIPS
 - BEPC&BEPC II (Beijing Electron Positron Collider): SLED
 - Linear electron-positron collider
 - VLEPP: BOC
 - NLC/GLC: SLED II
 - JLC: SLED II



[1] <http://home.cern/about/accelerators/large-electron-positron-collider>

[2] 1992-CERN-Igor-Status VLEPP RF Power Multiplier (VPM)

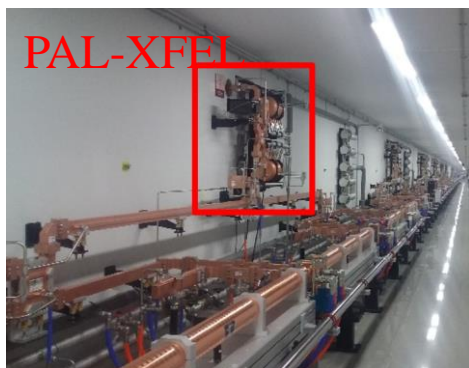
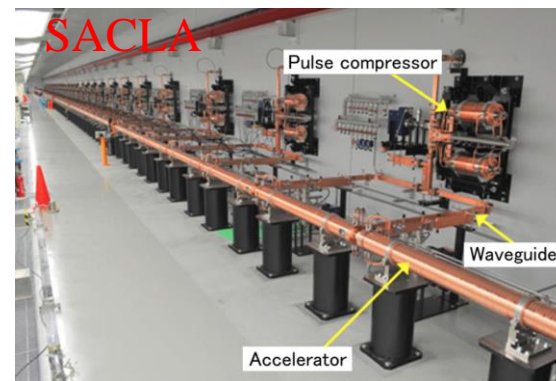
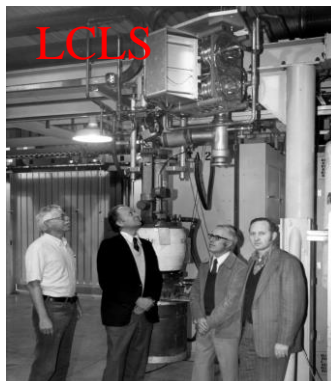




Backgrounds

□ Pulse compressors in FELs

- LCLS
- SACLA XFEL facility
- PAL-XFEL
- SINAP-SXFEL
- SwissFEL



[1] 1974-SLAC-Z. D. Farkas-A METHOD OF DOUBLING SLAC' s ENERGY

[2] Mitsubishi Heavy Industries Technical Review Vol. 49 No. 2 (June 2012)

[3] C-band RF pulse compressor for SwissFEL, IPAC 2013 Conference, Shanghai, China, 2013.

[4] 2016-CLIC_workshop-Progress_in_C-band_and_X-band_technology_at_SINAP_Fang





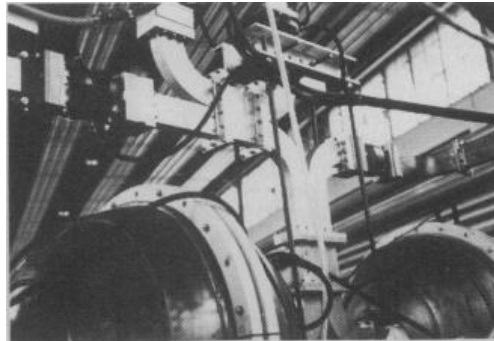
Backgrounds

1974,SLAC,S-band



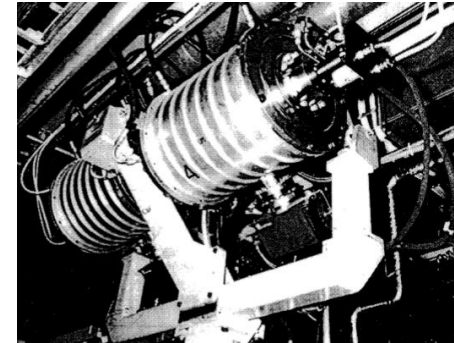
Cylinder Cavity: TE_{015}

1983,CERN,S-band



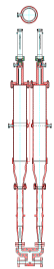
Spherical Cavity : TE_{461}

1984,CERN,S-band



Cylinder Cavity: TE_{038}

2009,CERN&SLAC&CEA,X-band



Cylinder Cavity : TE_{01} & TE_{02}

2013,CERN,X-band



Cylinder Cavity : $TE_{0,1,32}$

2016,SLAC,X-band



Spherical Cavity : TE_{114}

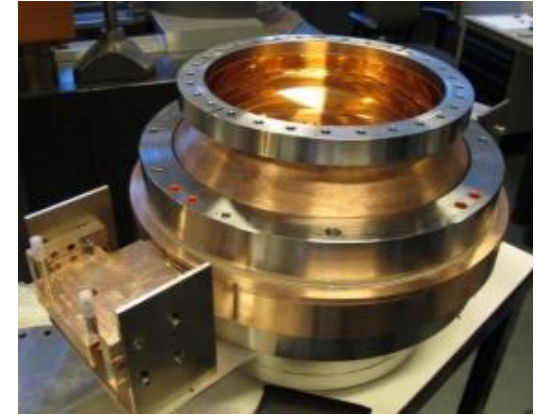
- [1] 1974-SLAC-Z. D. Farkas-A METHOD OF DOUBLING SLAC' s ENERGY
- [2] 1983-A. Fiebig and R. Hohbach STUDY OF PEAK POWER DOUBLERS WITH SPHERICAL RESONATORS
- [3] 2004-CERN-Note-High-power_Microwave_Pulse_Compression_of_Klystron
- [4] 2010-RuPac-A 12 GHZ PULSE COMPRESSOR AND COMPONENTS FOR CLIC TEST STAND
- [5] 2016-ipac16-Wanjuwen-R&D FOR A SUPER COMPACT SLED SYSTEM AT SLAC





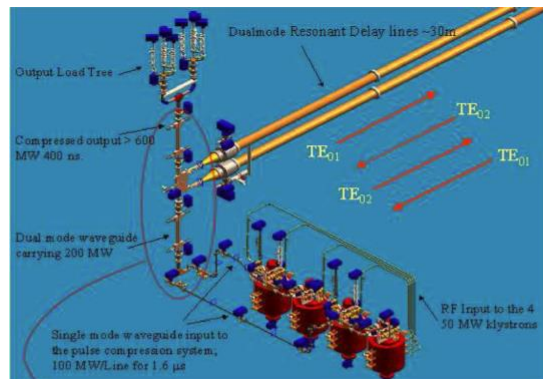
Backgrounds

1990, Igor, For VLEPP, $TM_{25,1,1}$ 2000, CERN, For CTF3, $TM_{10,1,1}$ 2012, PSI, For SwissFEL, $TM_{18,1,1}$



2005, SLAC, For NLC (11.424 GHz)

2006, CERN, For CLIC (30 GHz)



[1] 1994-KEK-Linac-DEVELOPMENT OF AN RF PULSE COMPRESSOR

[2] 2013-CERN-Igor-X-band SLED type Pulse Compressor

[3] 2016-CLIC_Weekshop_PSI_FEL_BOC

[4] 2005-SLAC-SamiG.-PRST-High-power multimode X-band rf pulse compression system for future linear colliders

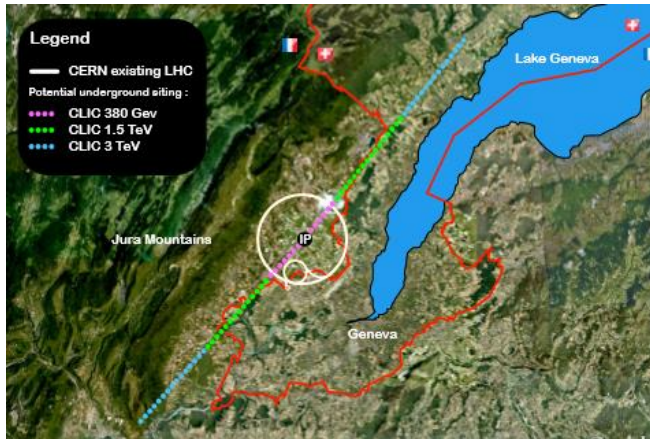
[5] 2006-CERN-Igor-EPAC-STATUS OF 30 GHZ HIGH POWER RF PULSE COMPRESSOR FOR CTF3





Backgrounds

Klystron-based CLIC



High power test facility at Tsinghua



Future hard X-ray FEL in SINAP, Shanghai





Outline

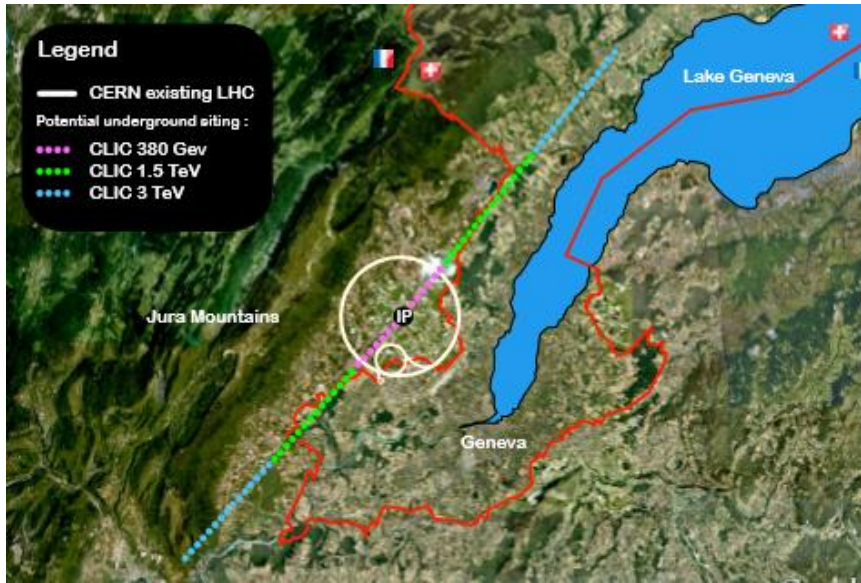
- Backgrounds
- **Correction cavity chain for CLIC**
- X-band pulse compressor for TTX
- X-band two stage pulse compressor for SINAP
- Summary



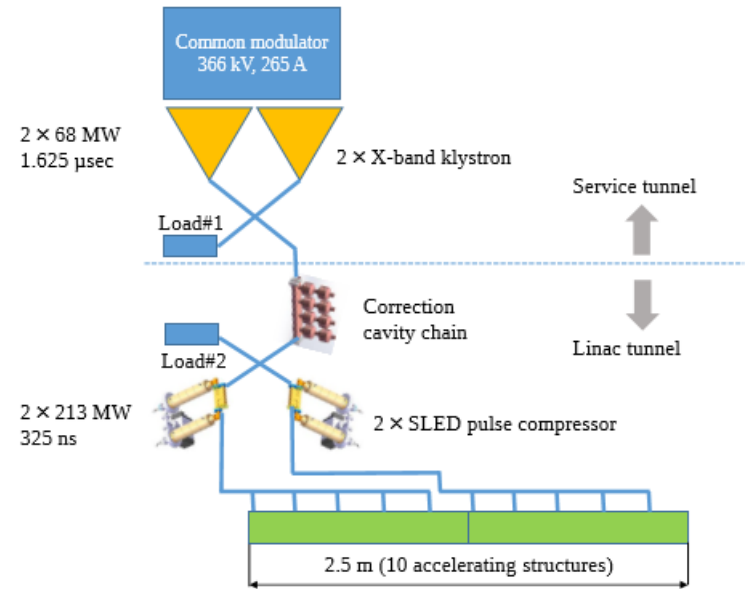


Correction cavity chain for CLIC

◆ 380GeV stage klystron based CLIC



CLIC footprints near CERN (three stages)



Proposed RF unit

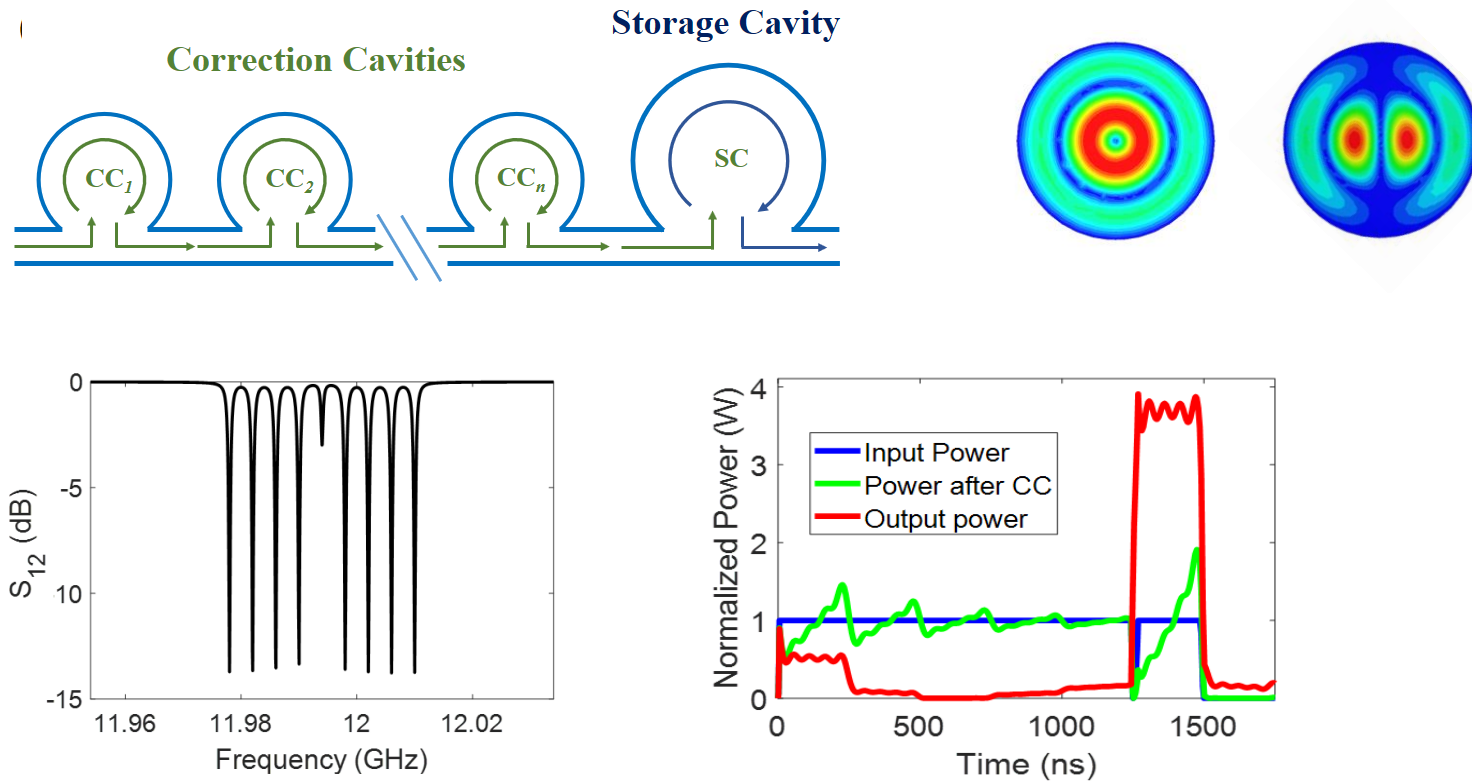
[1] Updated baseline for a staged Compact Linear Collider, edited by P.N. Burrows, P. Lebrun, L. Linssen, D. Schulte, E. Sicking, S. Stapnes, M.A. Thomson, CERN-2016-004 (CERN, Geneva, 2016),





Correction cavity chain for CLIC

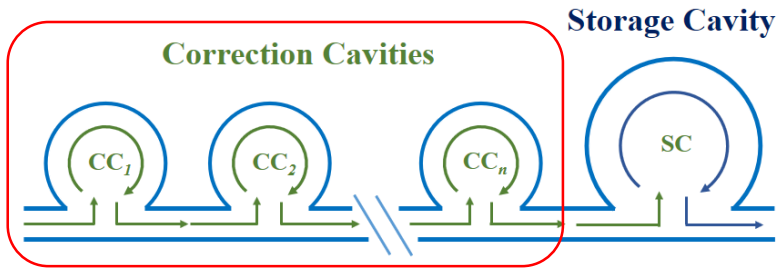
◆ Design of correction cavity chain for CLIC



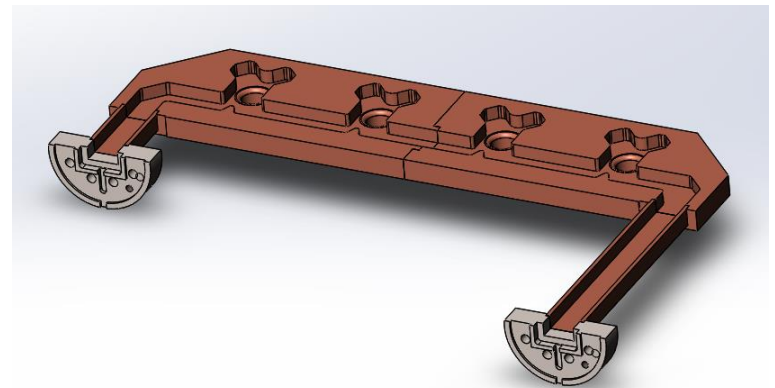
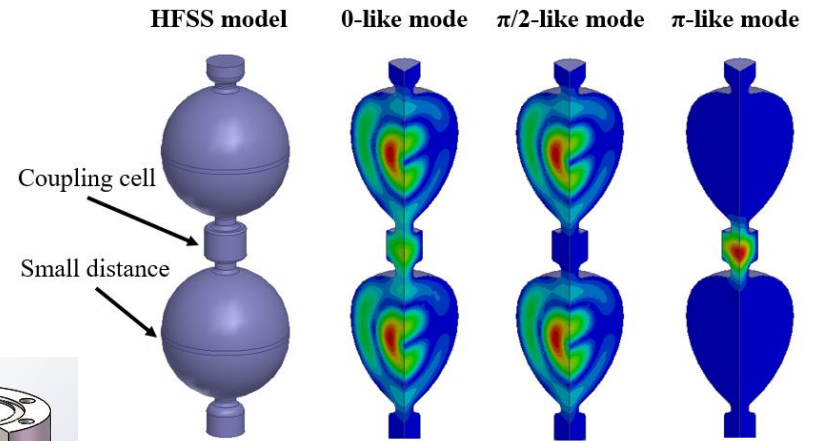
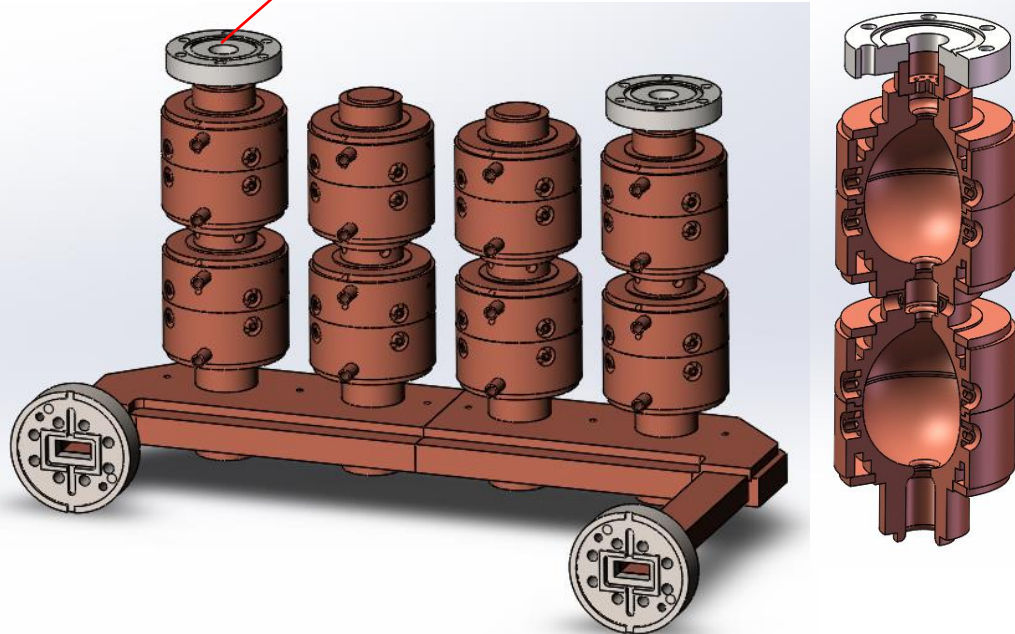
[1] Ping Wang, Hao Zha, Igor Syratchev, Jiuru Shi, and Huaibi Chen, [rf design of a pulse compressor with correction cavity chain for klystron-based compact linear collider](#), Phys. Rev. Accel. Beams 20, 112001 (2017)



◆ Mechanical design

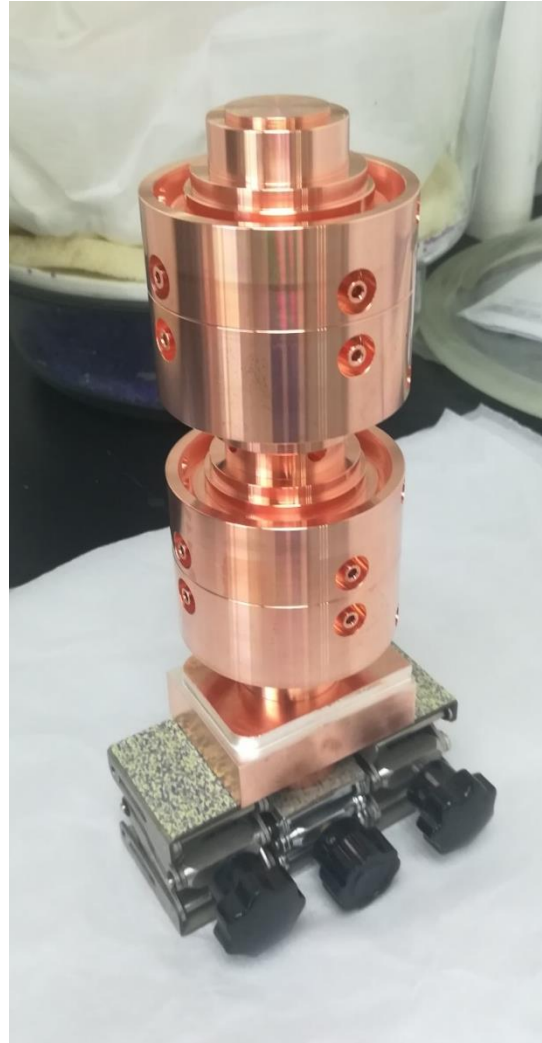


For vacuum pumping



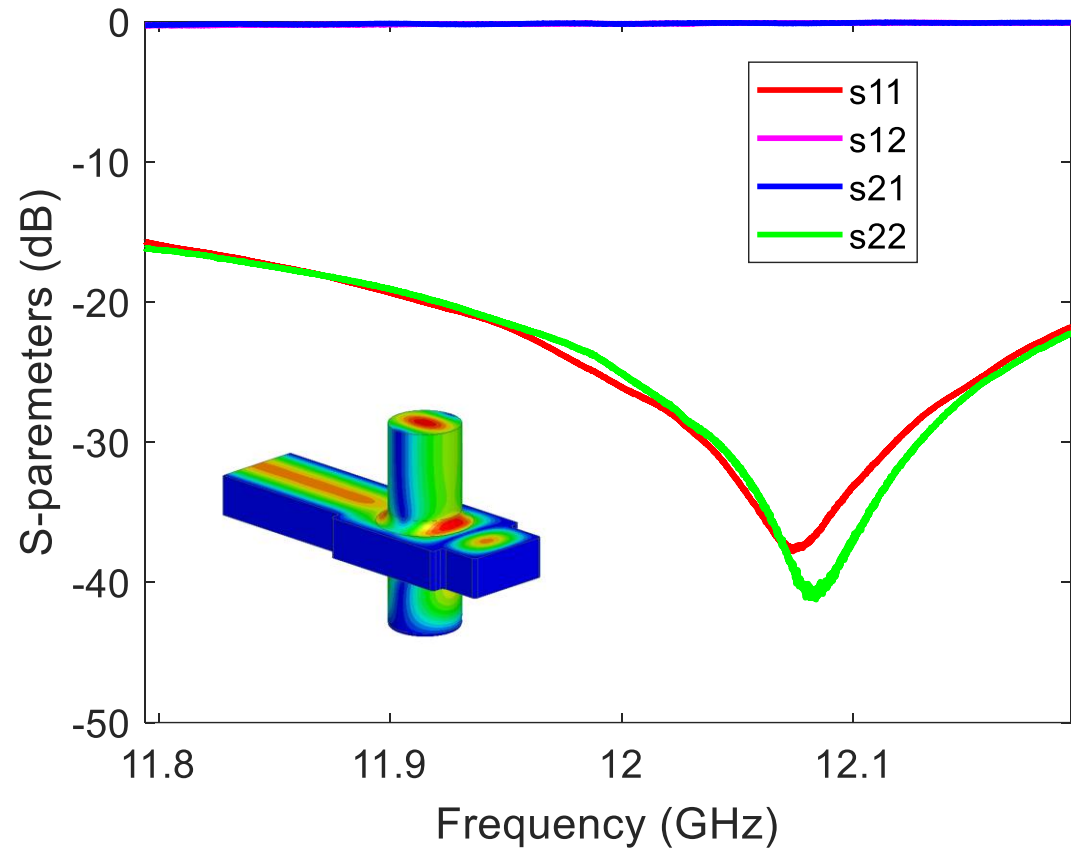
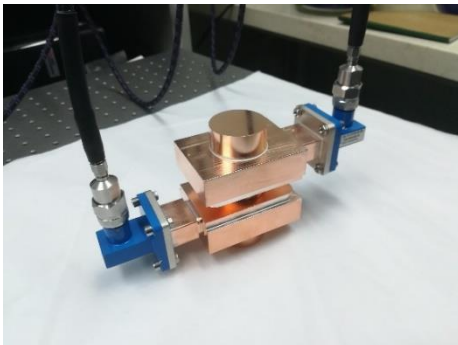


Correction cavity chain for CLIC



Correction cavity chain for CLIC

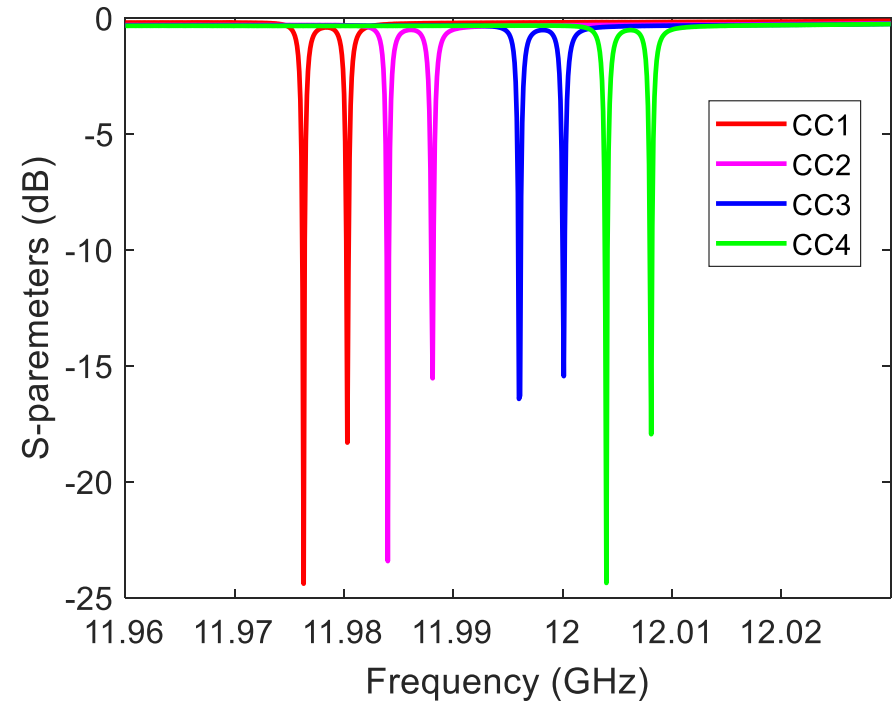
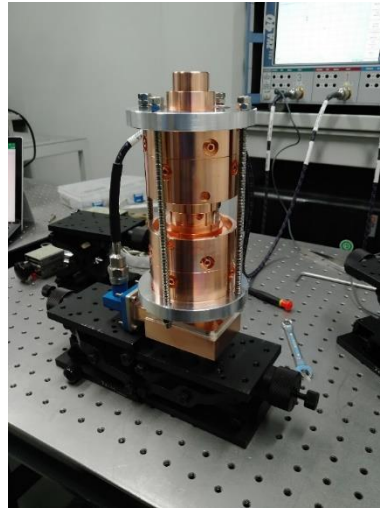
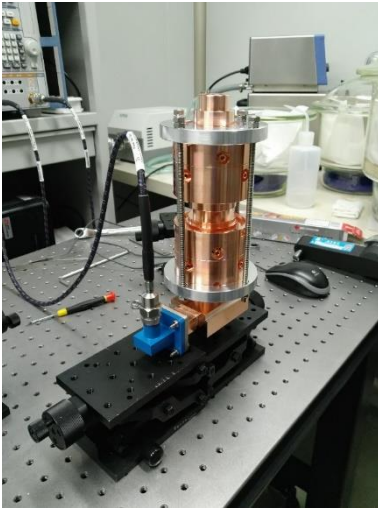
- ◆ Simplified mode launcher for cold measurement of CC





Correction cavity chain for CLIC

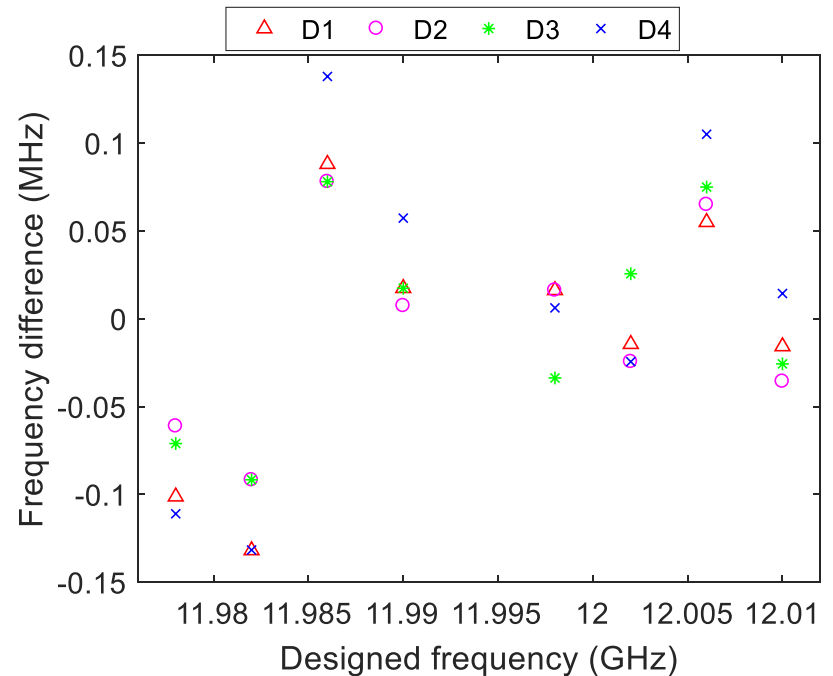
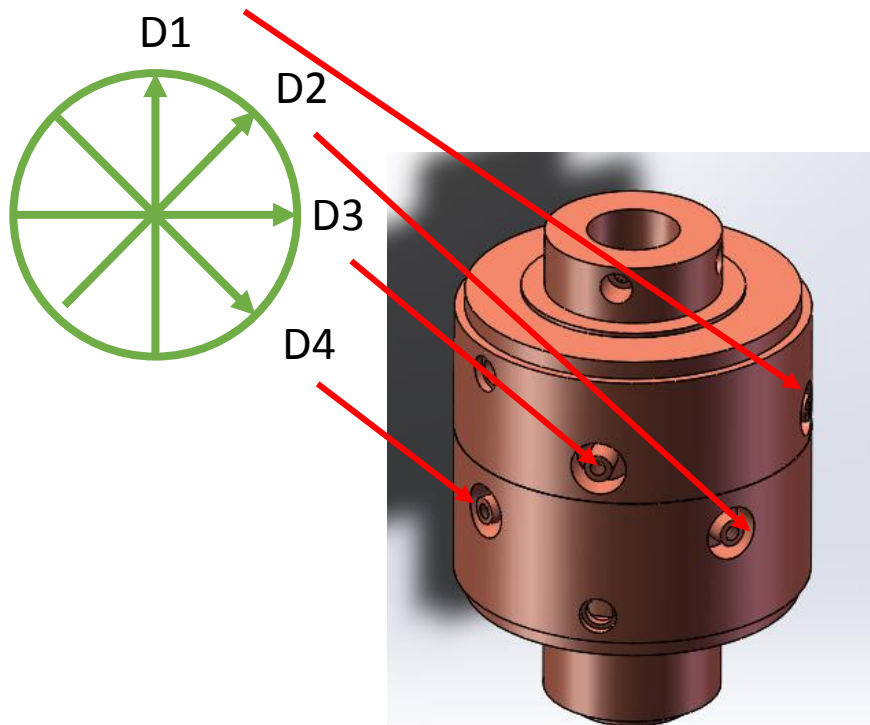
- ◆ Cold measure of CC before brazing
- Before brazing, the unloaded quality factors were less than the designed ones.
- The torque was 1 N·m.





Correction cavity chain for CLIC

- ◆ Preliminary tuning of CC before brazing
 - The frequencies of four directions were tuned by cutting off a little bit of the resonant cavities.
 - Working temperature of CC is 30 °C.





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- X-band two stage pulse compressor for SINAP
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X-band pulse compressor for TTX

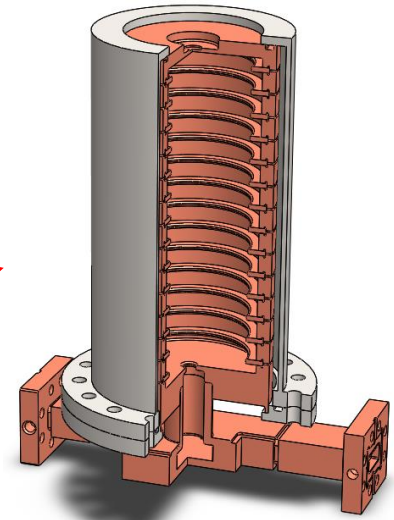
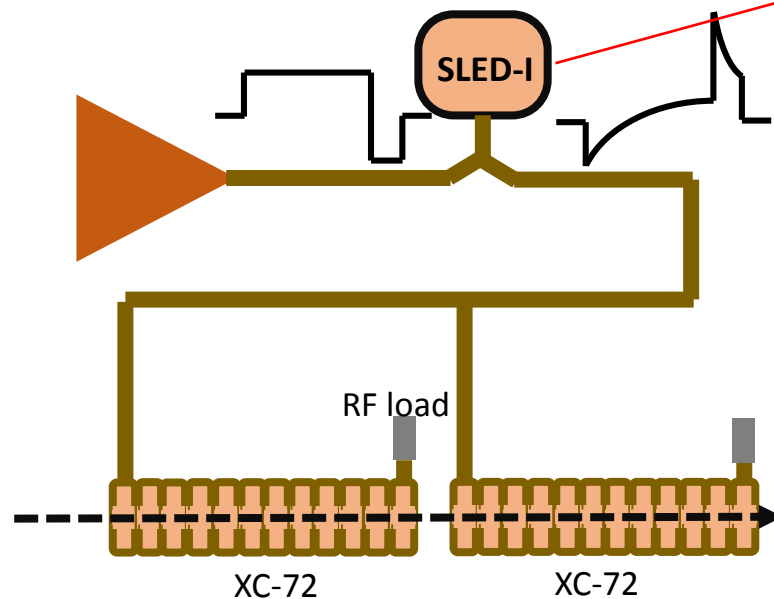
◆ X-band RF system for TTX

➤ X-band Klystron:

- 11424 MHz,
- 50 MW, 1.5 us

➤ Pulse compressor:

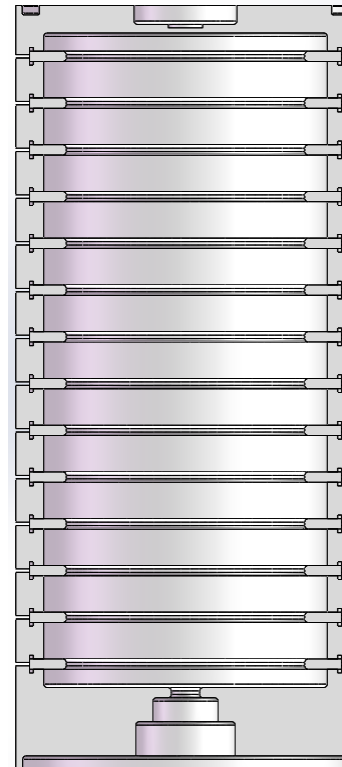
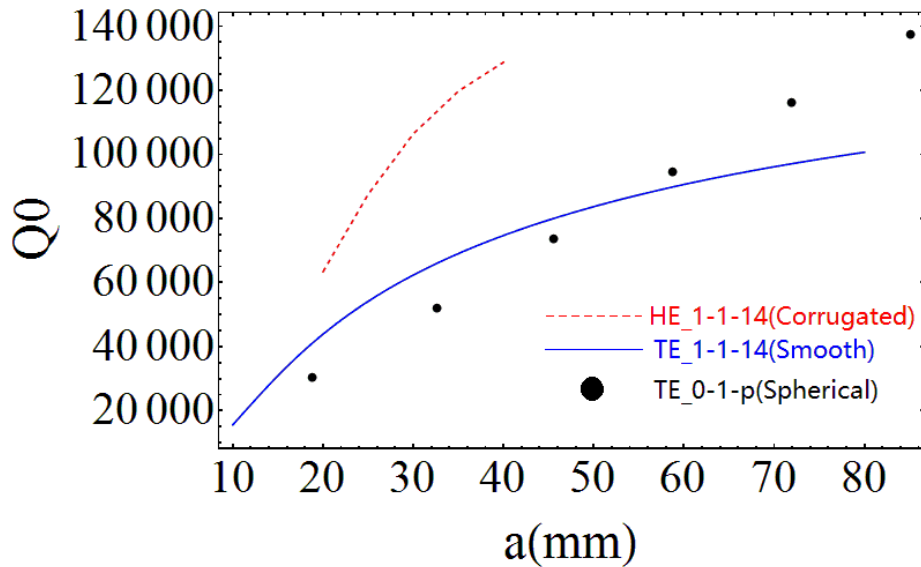
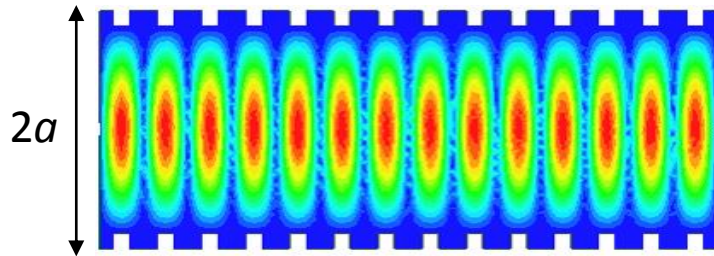
- $Q_0=120,000$
- $\beta = 3.5$





X-band pulse compressor for TTX

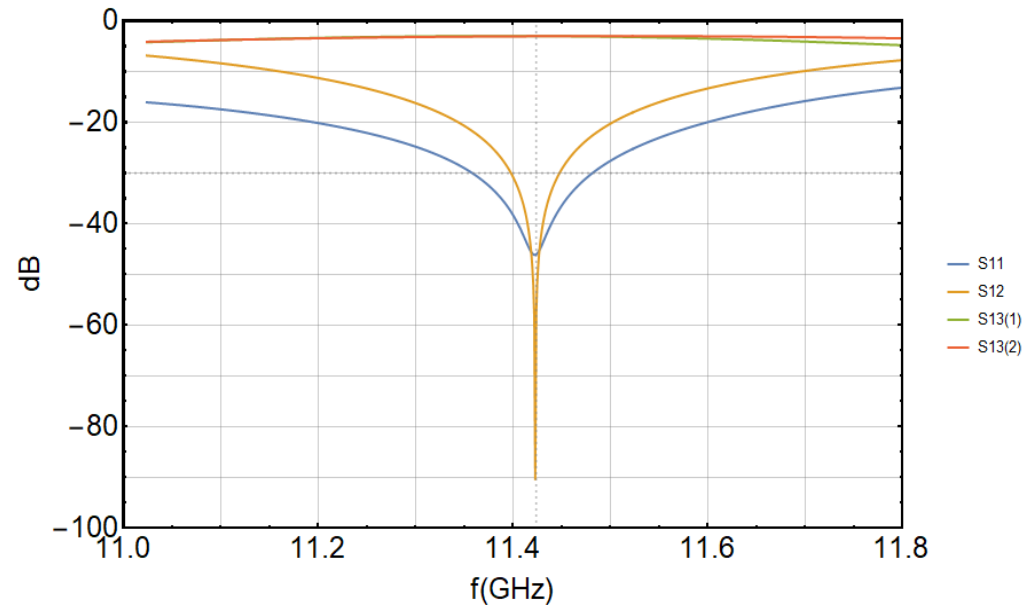
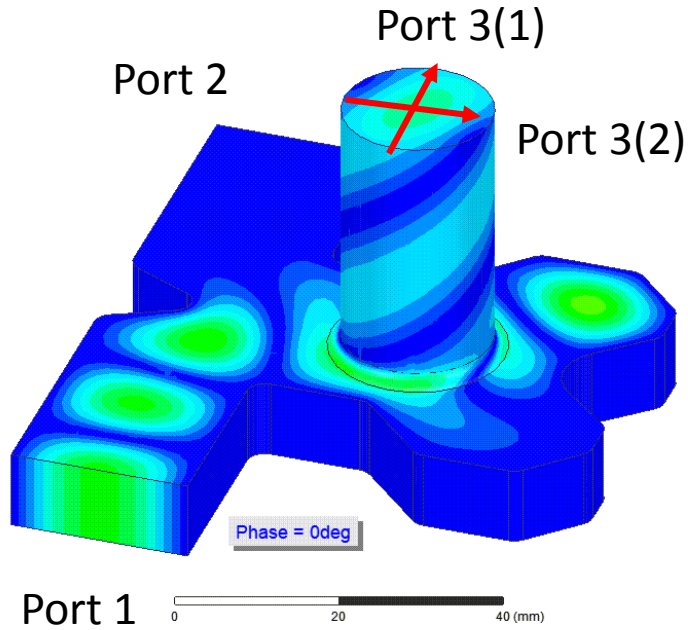
◆ Design of Corrugated Wall Cavity





X-band pulse compressor for TTX

- ◆ Design of RF polarizer
- The circular waveguide at the bottom was removed





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two stage pulse compression

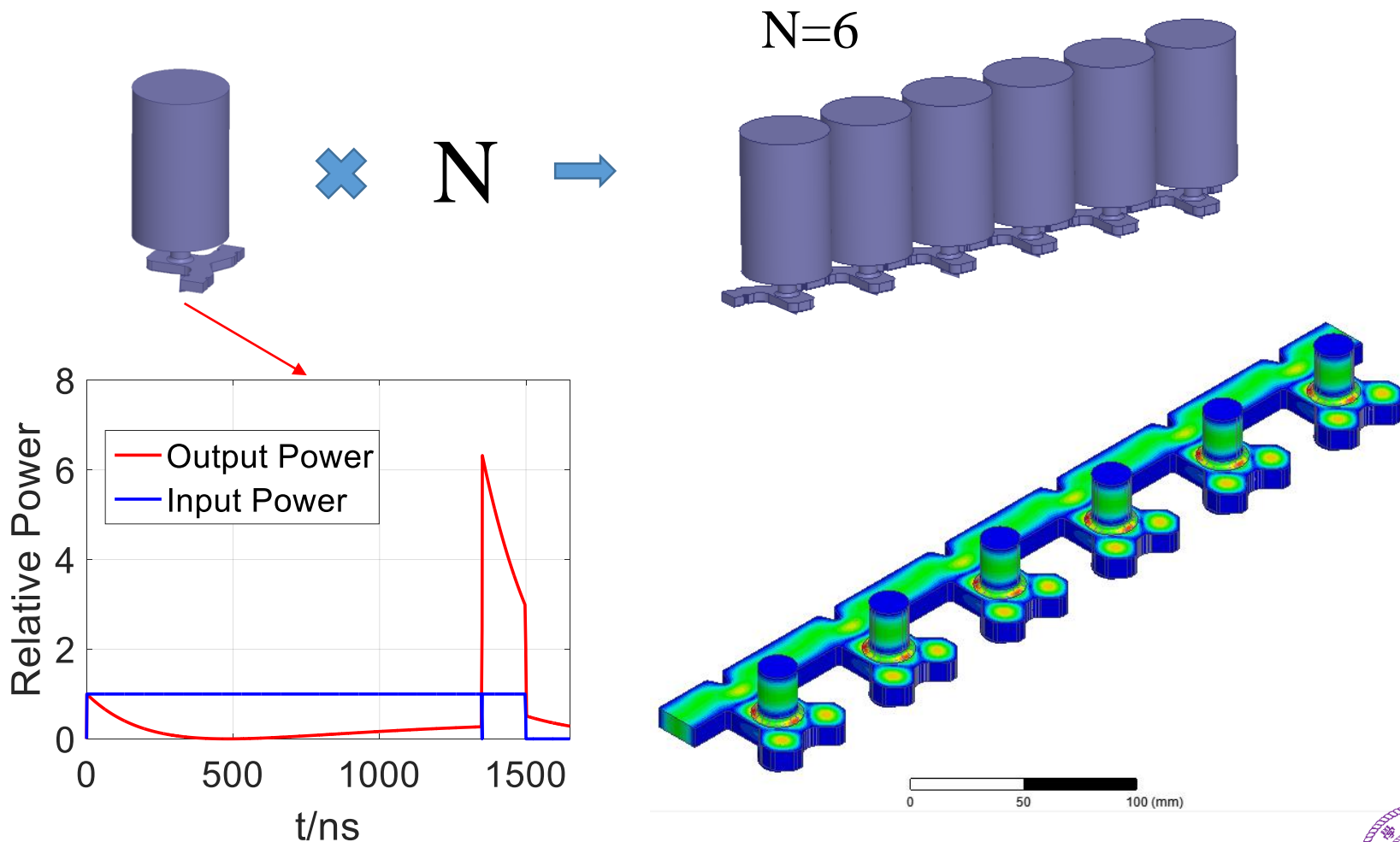
- ◆ Single stage pulse compression
 - ◆ Limited compression power gain
- ◆ klystron available to generate 6MW 4 μ s RF pulse
 - ◆ For ~100ns accelerating structure need very high compression ratio
- ◆ Two stage pulse compression
 - ◆ SLED-II type
 - ◆ With correction cavity to make flat pulse.





X-band two stage pulse compression

◆ Preliminary RF designs

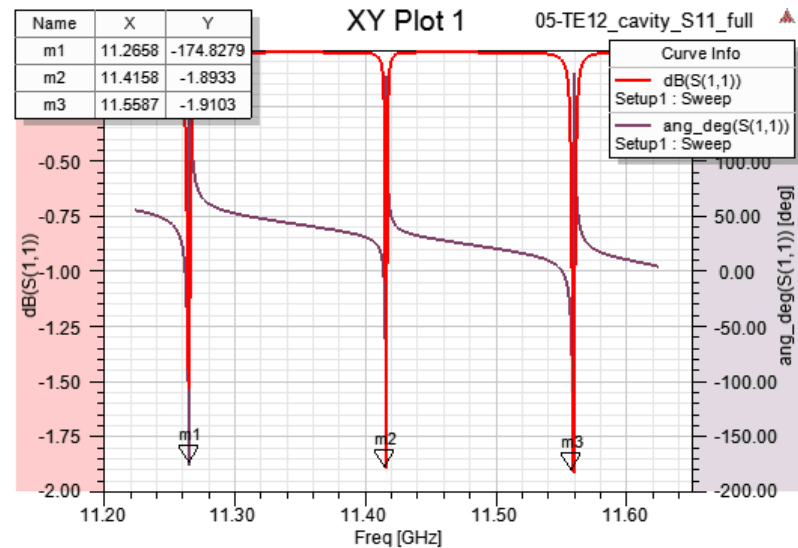
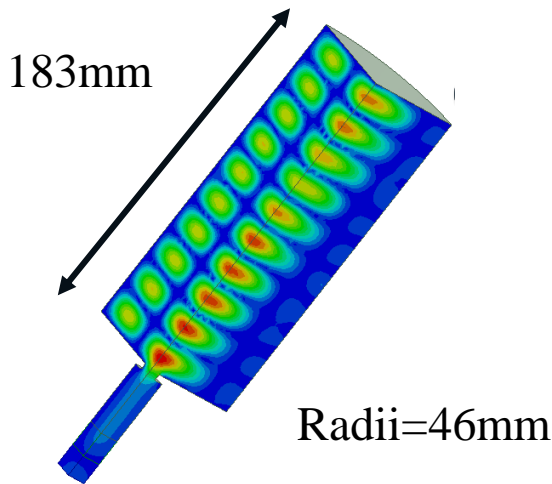
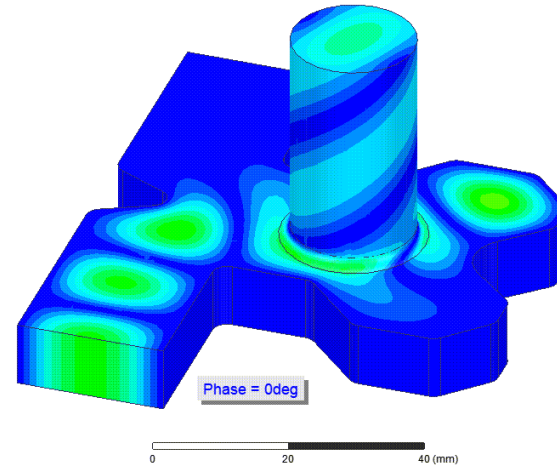
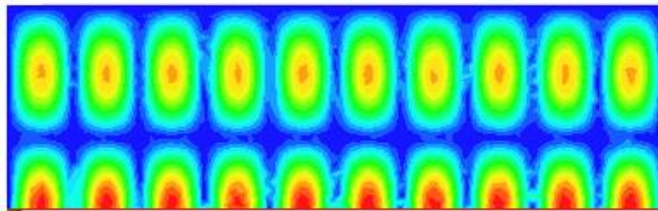




X-band two stage pulse compression

◆ Preliminary RF designs

$Q_0=100,000$

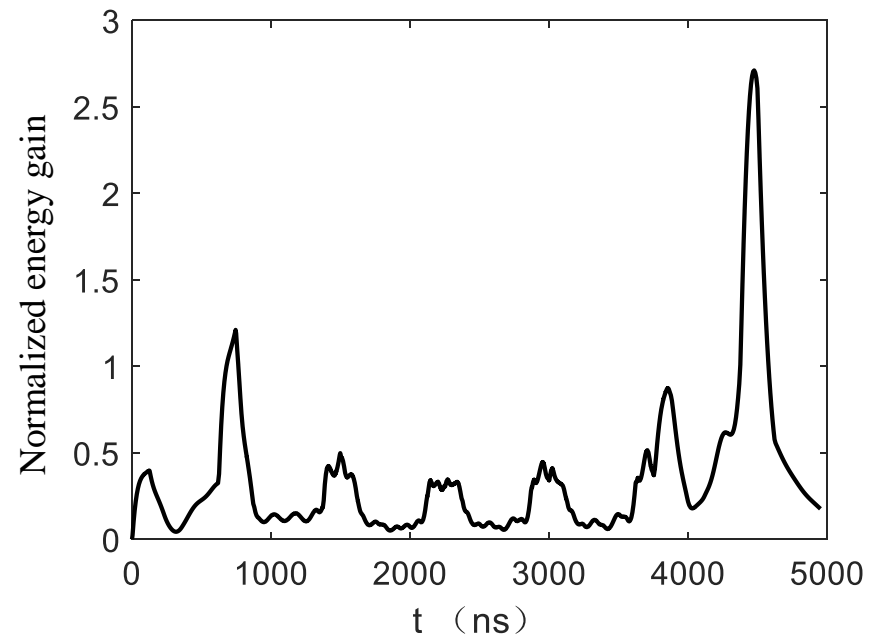
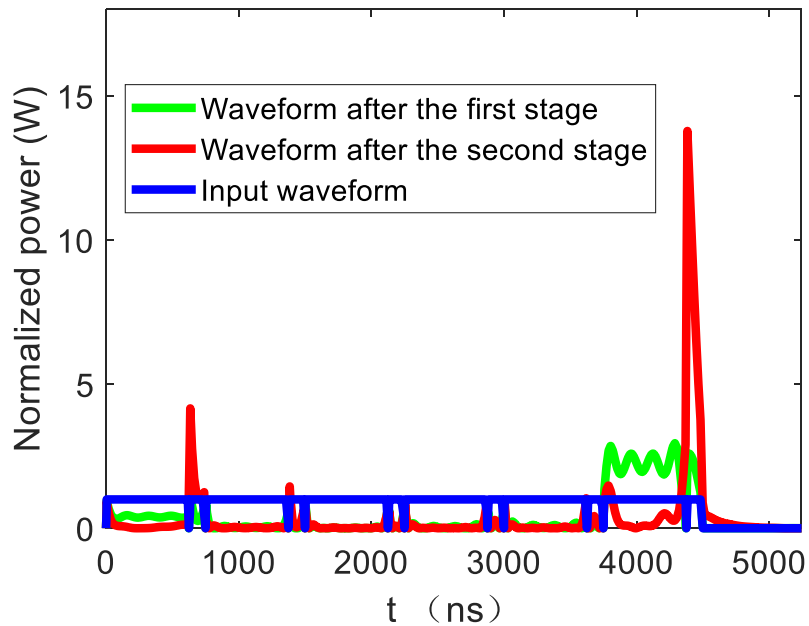




X-band two stage pulse compression

◆ Design of RF polarizer

- Quality factors of the first and second stages are 100,000.
- The quality factor is 8000 and the filling time is 125 ns.





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Summary

- The correction cavity chain was preliminarily tuned and the brazing will be carried out soon. It will be installed in X-box2 at CERN
- The pulse compressor based on corrugated wall cavity was fabricated and it will be installed on the X-band high power test facility at Tsinghua.
- The two stage pulse compressor was preliminarily studied. Will be tested on 6MW long pulse klystron.





Thanks for your attention !

CLIC Workshop, 22-26 January 2018

