A Demonstration of High-Gradient Acceleration

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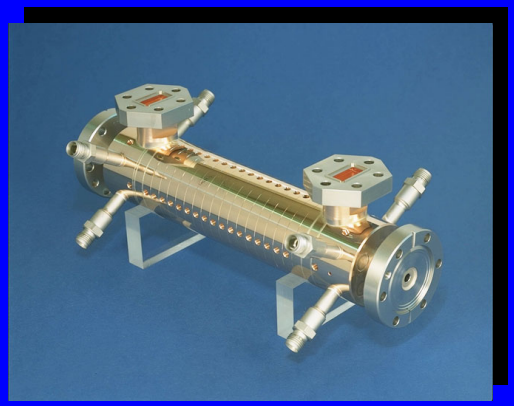
Acceleration in CLIC -

30 GHz, 150 MV/m, 150 ns
130 MW, 20 J

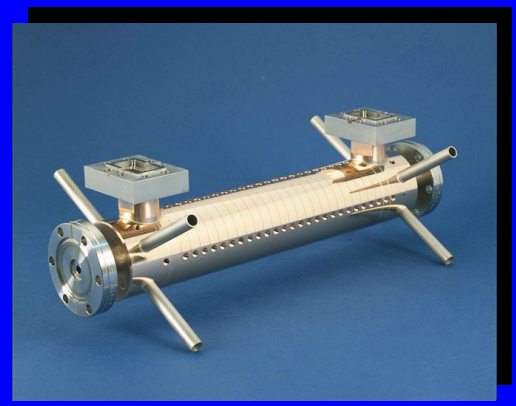
Background,

Early successes for gradient at X-band, 150 ns

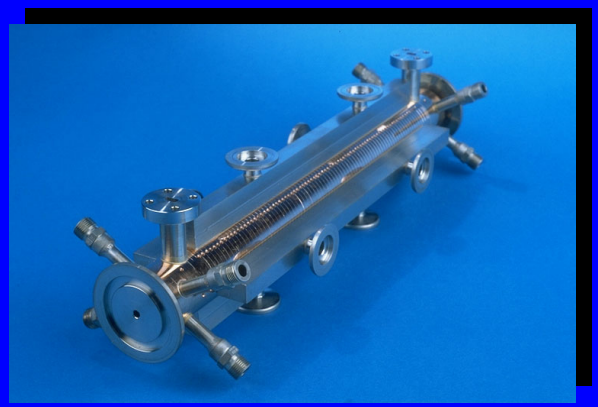


138 MV/m
Power limited
At KEK

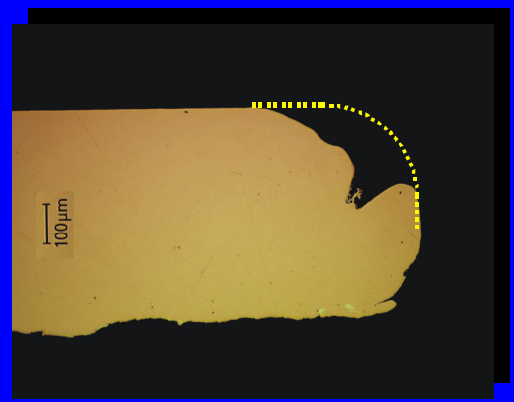
153 MV/m
At SLAC



But spectacular failure at 30 GHz, 15 ns



60 MV/m
At CERN



Problems for NLC structures too…

Is the difference fundamental? Yes.

- Surface electric field enhancement in coupler
- Something* related to a/λ - 0.11 vs 0.2

Solutions to coupler found

But,

Lower limit to a/λ - transverse wakefields

* A subject on its own…

Radically different solution needed -

New materials for high gradients

Tungsten, molybdenum, rhodium

- High melting point,
- Low vapor pressure
- High electrical conductivity
- Plenty of high voltage/power applications

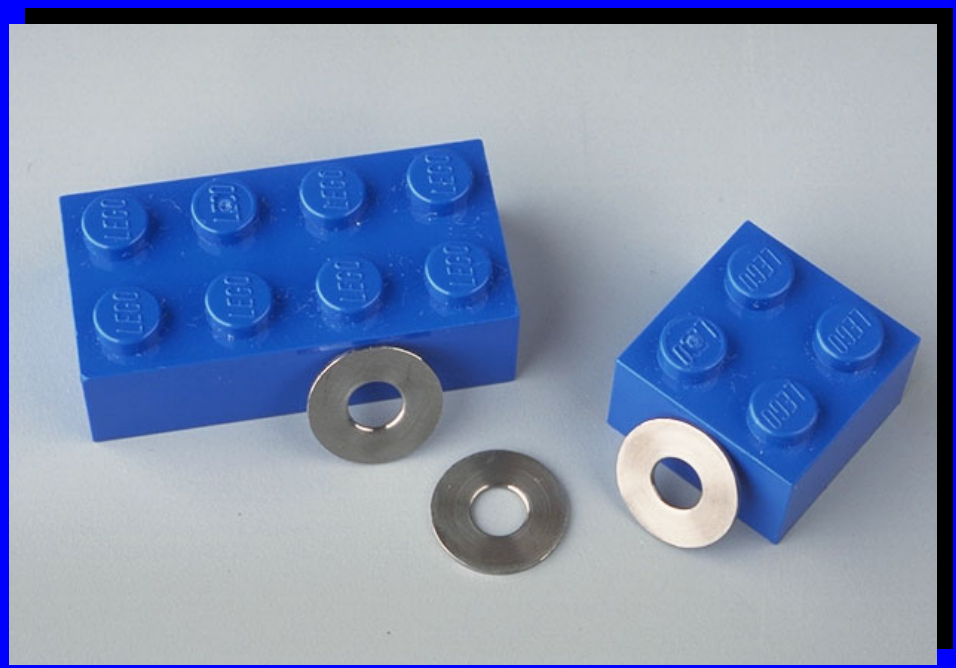
To:

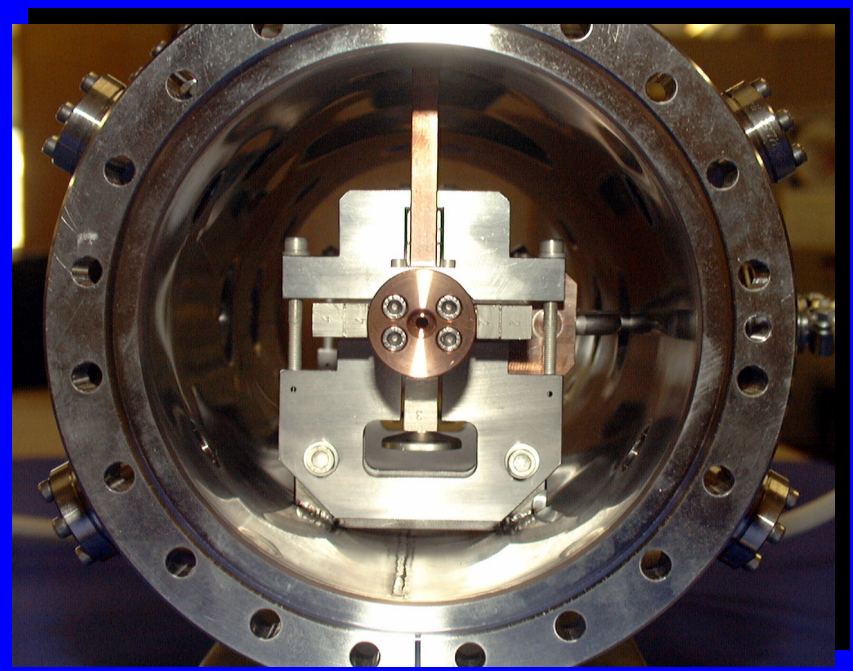
Support a higher surface electric field
Survive the effects of an rf arc (20 J remember)

First test of new materials in rf structures,

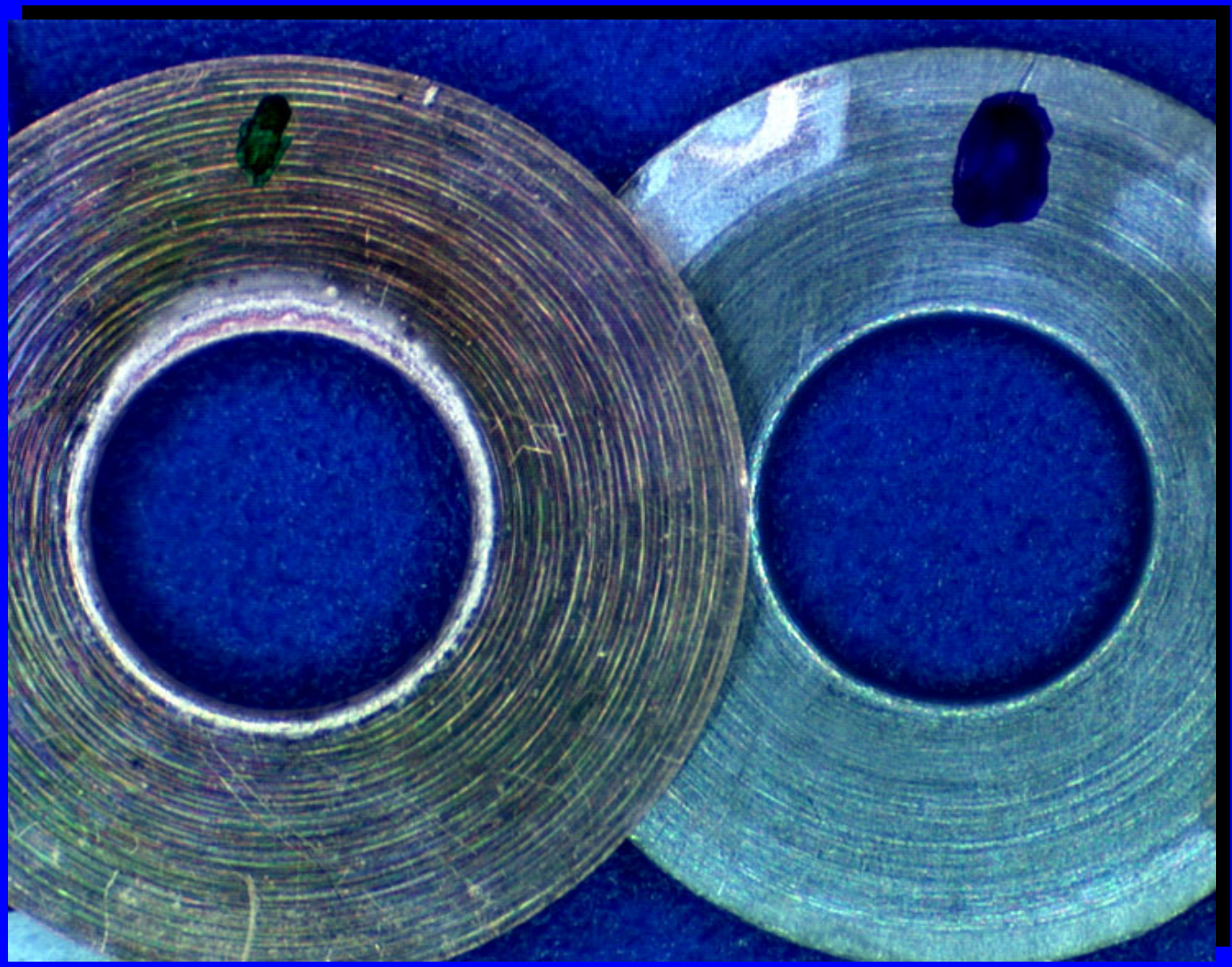
End 2001, in CTFII of W coupler iris in copper structure gave very encouraging results –

- 70 MV/m, limited by surrounding copper
- coupler damage eliminated





Copper and Tungsten after conditioning

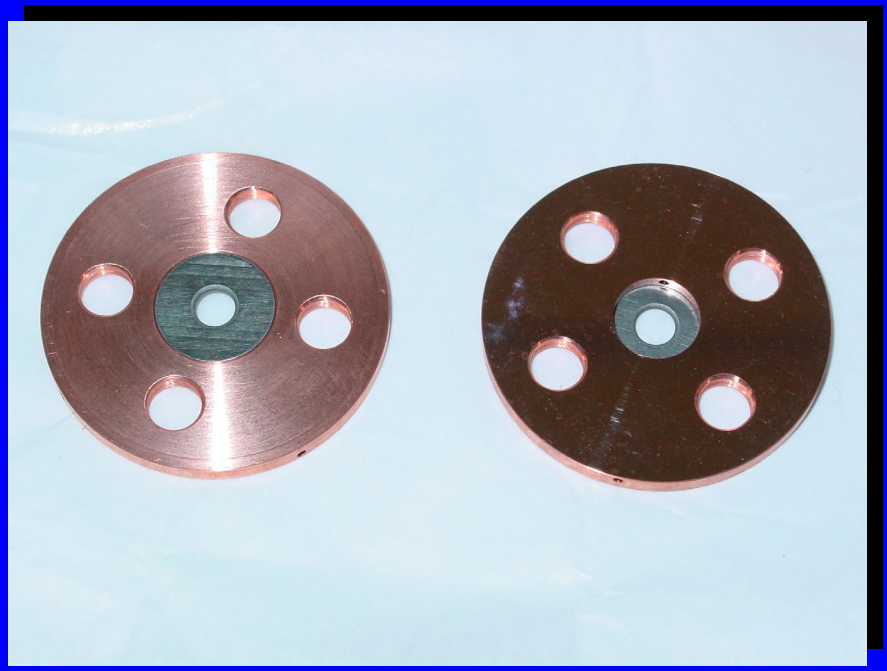


Systematic testing of materials

Test a series of structures of standardized design to compare the relative performances of Cu, W and Mo.

Frequency	29.985 GHz
Number of cells	30+2 matching cells
Phase advance	$2\pi/3$
Beam aperture	3.5 mm
Group velocity, v_g/c	4.6 %
Fill time	8.3 ns
$E_{surface}/E_{accelerating}$	2.2
Power for $E_{accelerating}$=150 MV/m	56 MW

Standardized 30 cell W, Mo and Cu iris structures

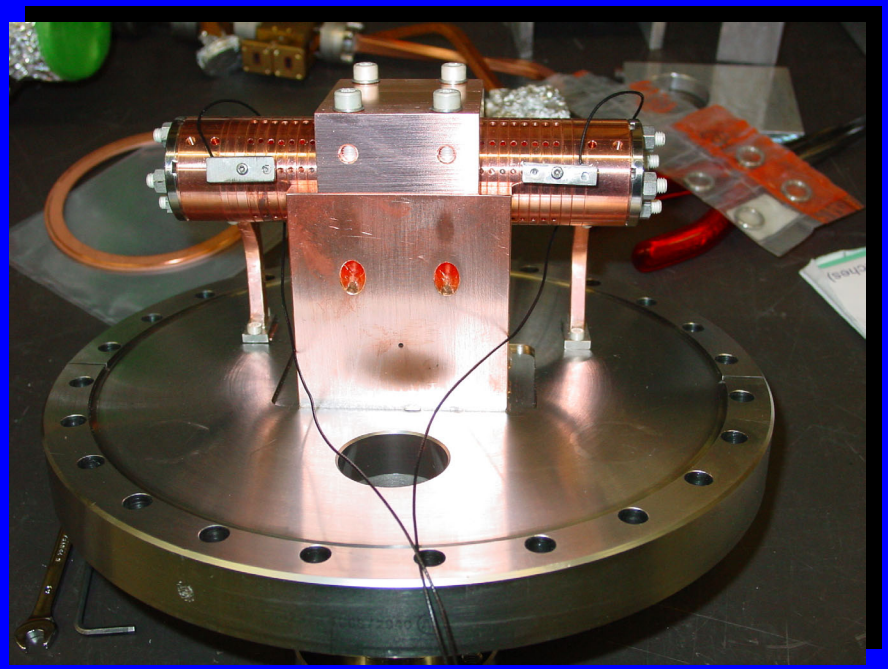


Assembly by bolting

Cu, W and Mo

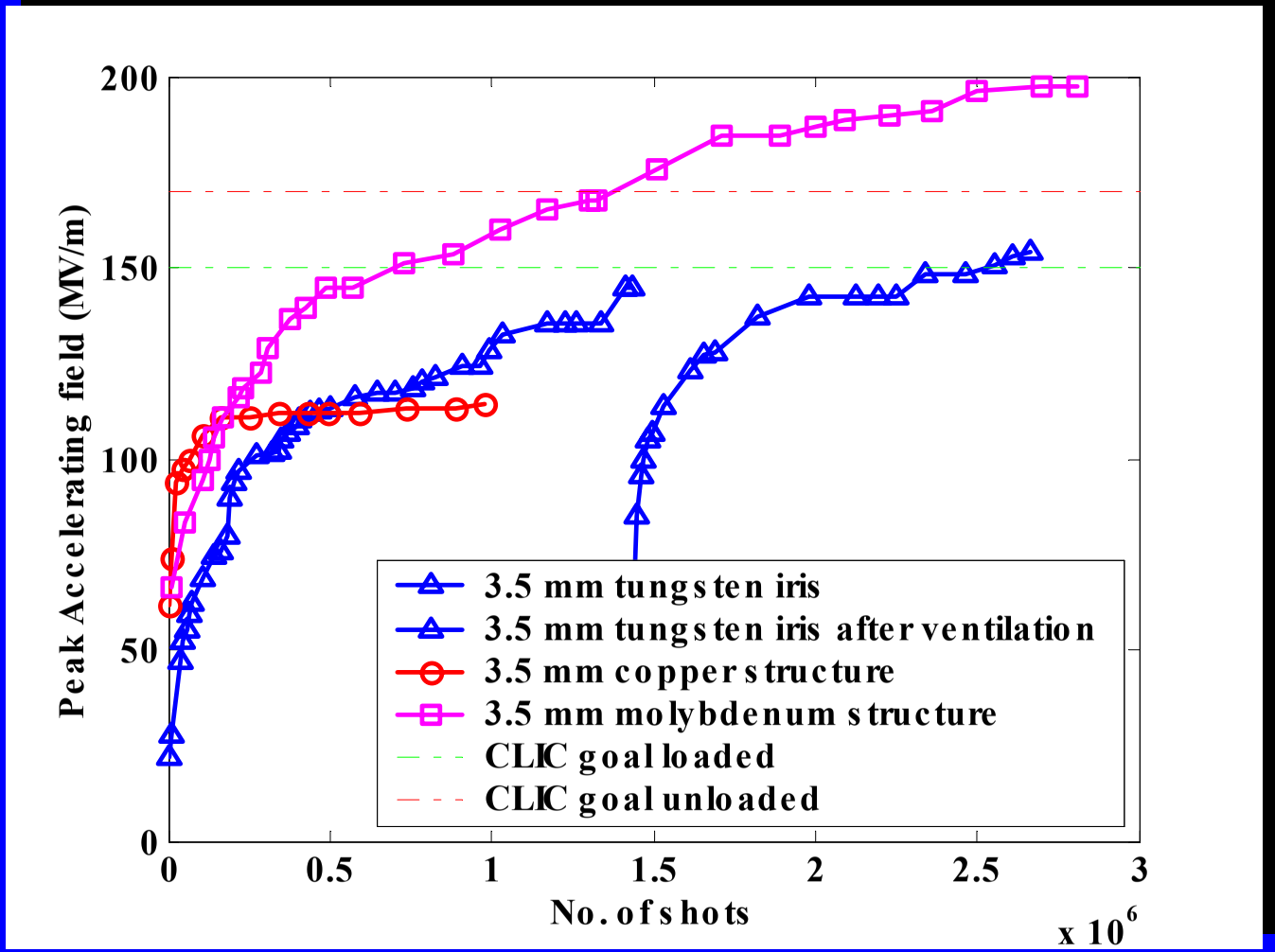
Standardized tests in CTFII with 15 ns pulses

Vacuum can mounting for fast turn-around



Installation in CTFII

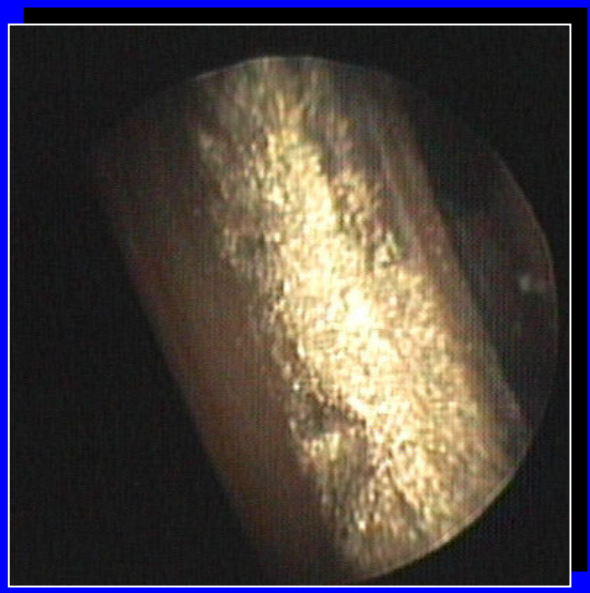
Conditioning results



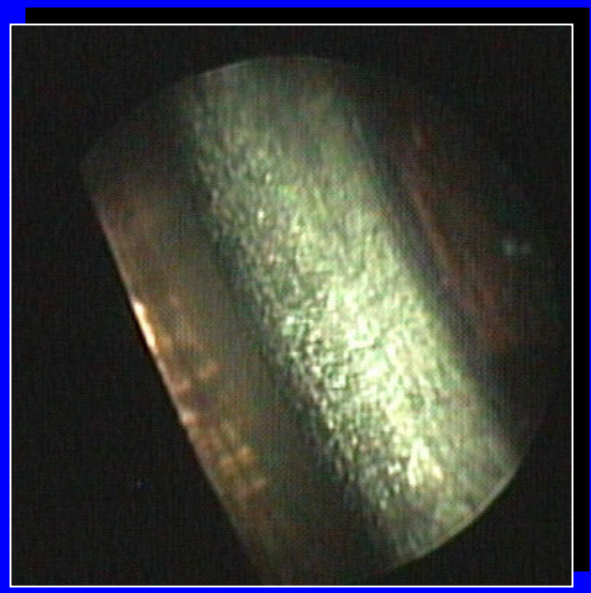
Field levels calibrated by accelerated beam!

Effect on surface

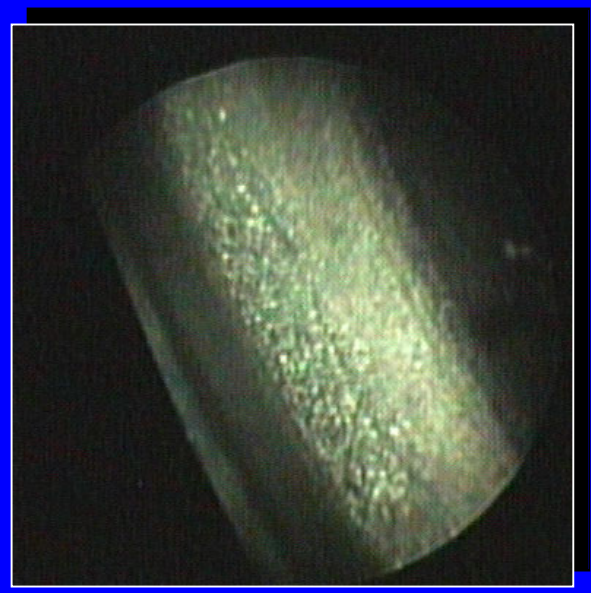
Copper 260 MV/m



Tungsten 340 MV/m



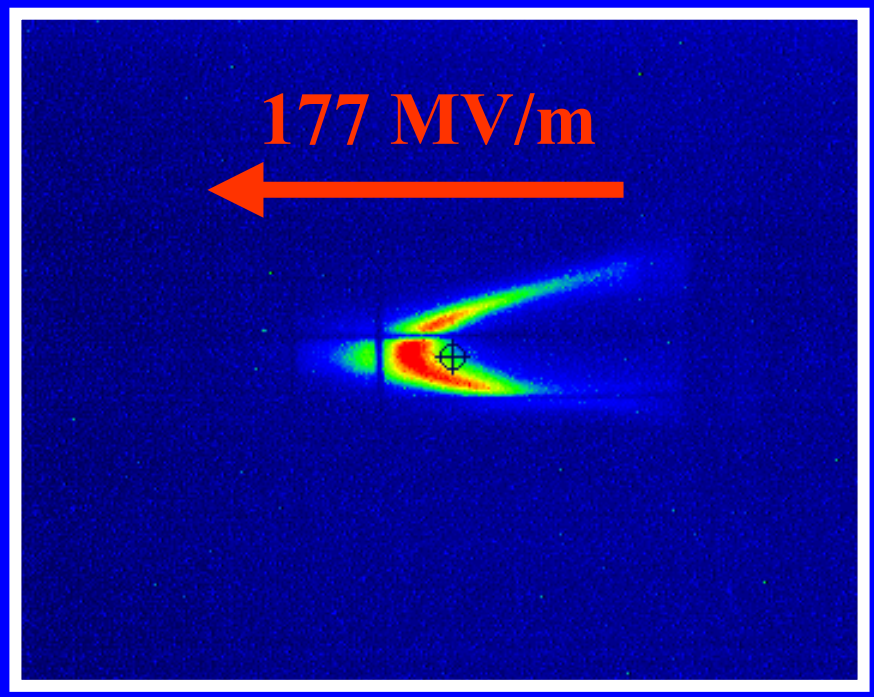
Molybdenum 426 MV/m



Results summary (15 ns)

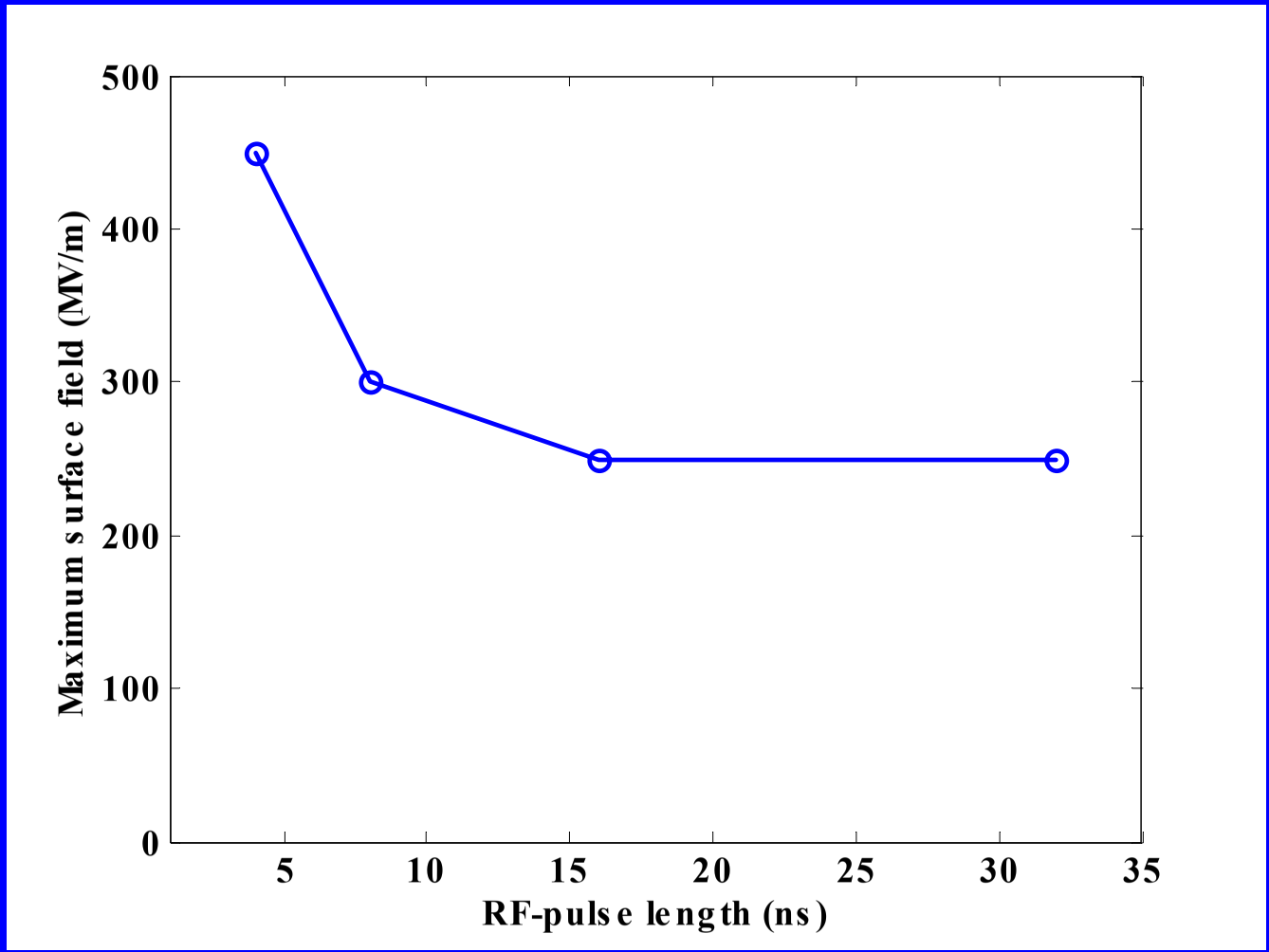
Structure	Peak accelerating	Average accelerating	Peak surface
Copper	110 MV/m	100 MV/m	260 MV/m
Tungsten	150 MV/m	125 MV/m	340 MV/m
Molybdenum	193 MV/m	153 MV/m	426 MV/m

177 MV/m average acceleration gradient at 30 GHz with 8 ns RF pulses



228 MV/m peak acceleration gradient

Pulse length dependence of Cu structure



32 ns point made using pulse stretcher.

Dramatic improvement from new materials, many new questions to address,

A view to the future.

Next: W and Mo scaled to X-band tests at SLAC, 30 GHz, 200 ns at CTF3