RF Power Distribution for 8-Pack Phase II

Christopher Nantista

ISG-X

SLAC

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8-Pack Phase II

NLC/~~J~~GLC R2 requirement: “a linac subunit test”

rf power distribution

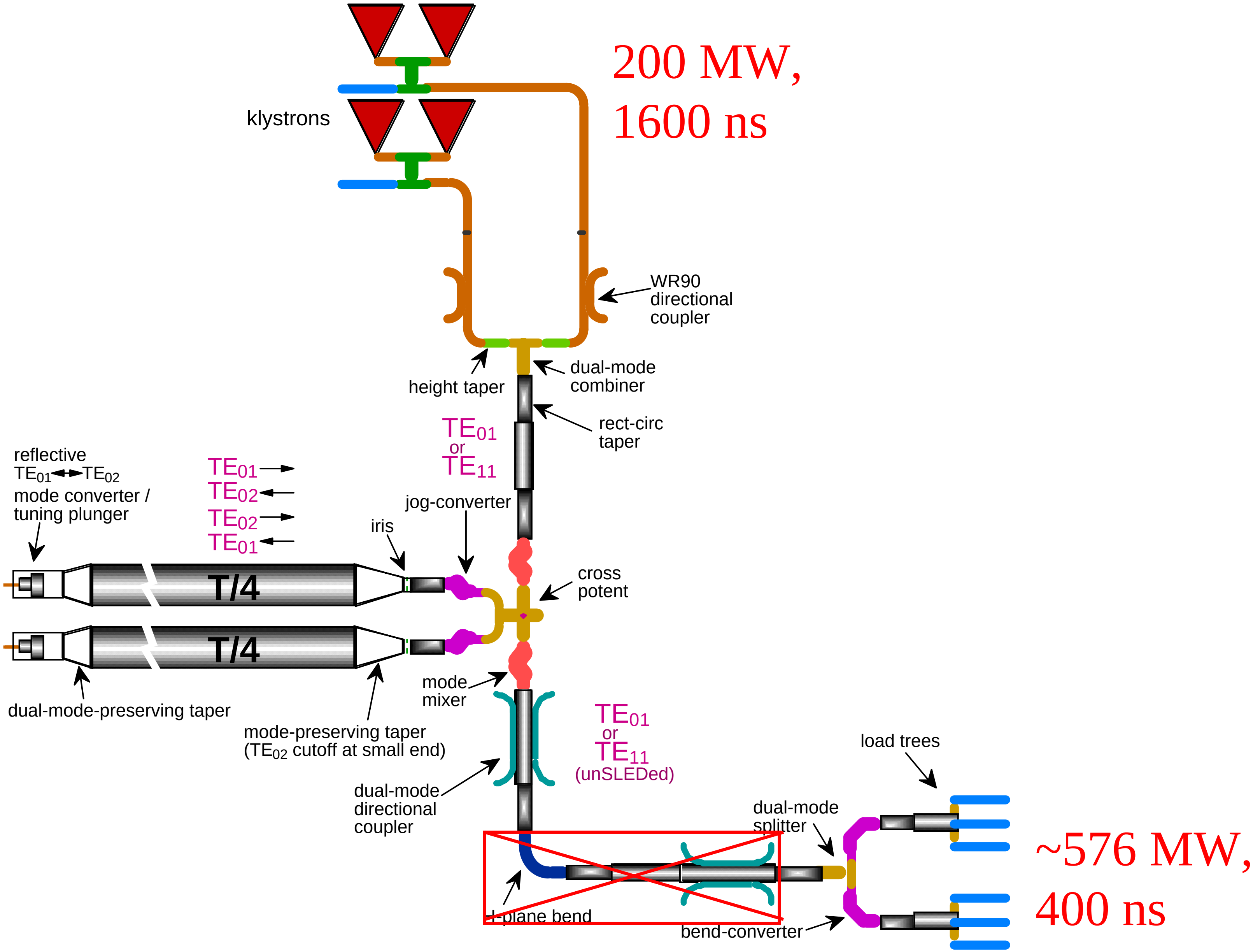
dual-moded SLED-II

eight 60cm structures

Goals:

- Transport several hundred megawatts of X-band rf
- Divide power between structures
- Test novel components at full power/full rep rate
- Gain experience in NLC/JLC rf distribution system design

8-Pack Phase I RF System



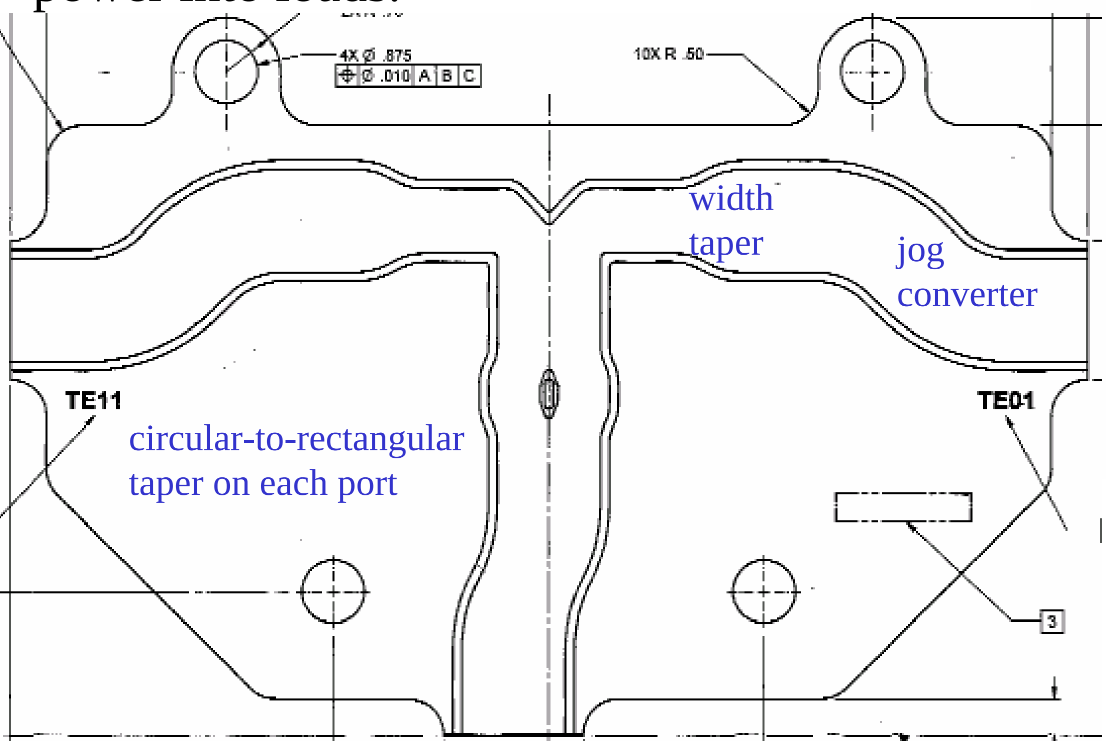
8-Pack RF Power Budget

XL4 klystrons:	4×50 MW =200 MW
transmission to SLED-II:	×.90
SLED-II gain:	×3.0–3.2
	540 – 576 MW
transmission to structures:	×.90
	486 – 518 MW
	÷ 8
	~ 60 – 65 MW/structure

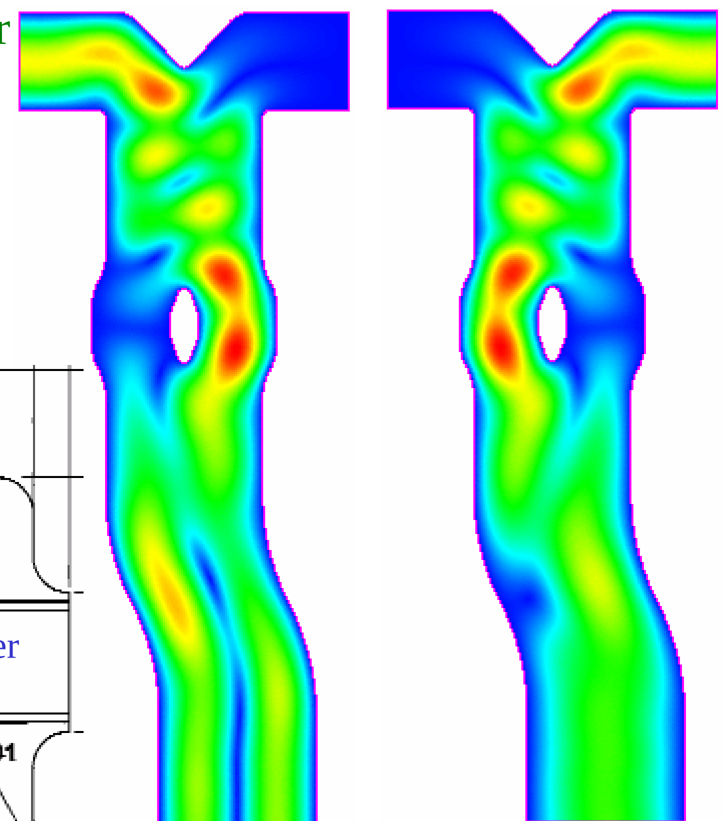
Mode Stripper

Phase-I configuration carries misphased/mismatched input power past SLED-II to the load tree in the TE_{11}(TE_{10}) mode.

To continue the distribution system single-moded, we provide a separate matched path for this power into loads.



to accelerator distribution



to loads

TE_{20} TE_{10}

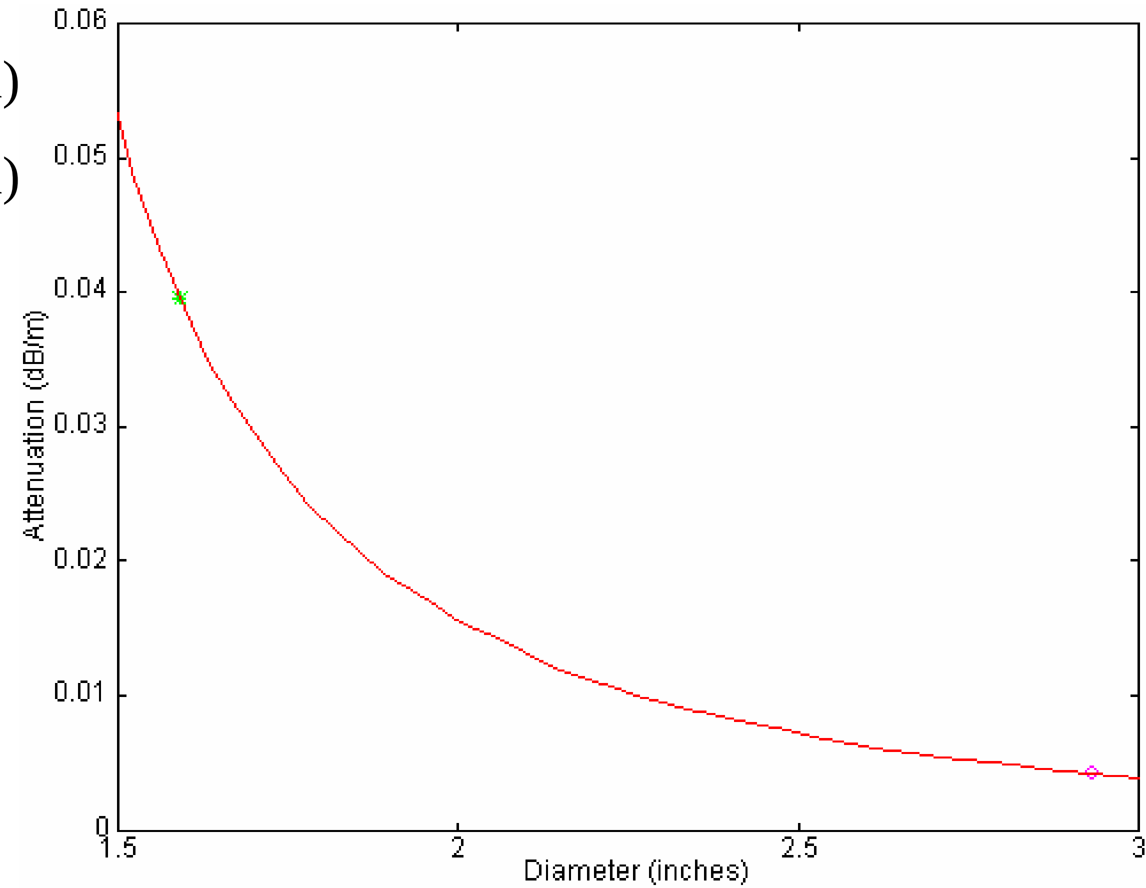
@ 576 MW: $|E^s_{max}|$ = ~48.5 MV/m

TE_{01} Attenuation in Transfer Lines

WC159: -0.0395 dB/m (0.9%/m)

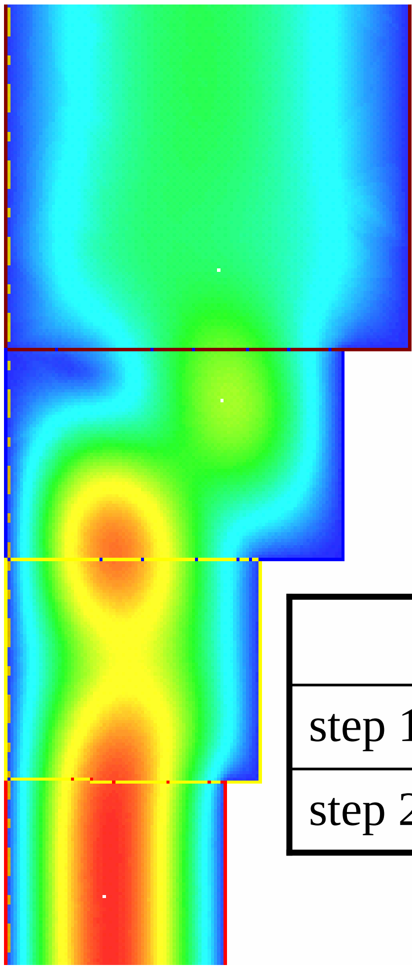
WC293: -0.00427 dB/m (0.1%/m)

So, if going along the bunker, across the roof, down into the bunker and along the accelerator amounts to ~10 m, the cost of staying in WC159 could approach 8% of the power.



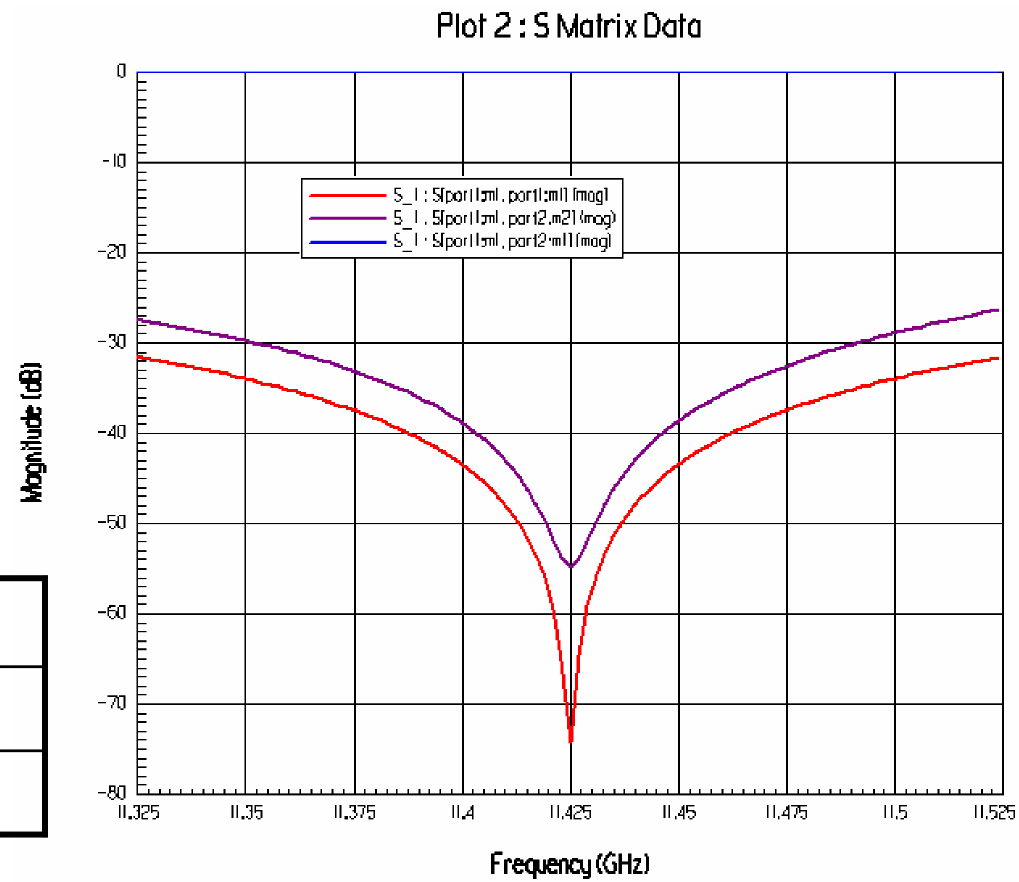
TE_{01} 1.600” ↔ 2.930” Diameter Step Taper

WC293



WC160

	diameter	length
step 1	1.847”	0.805”
step 2	2.450”	0.763”

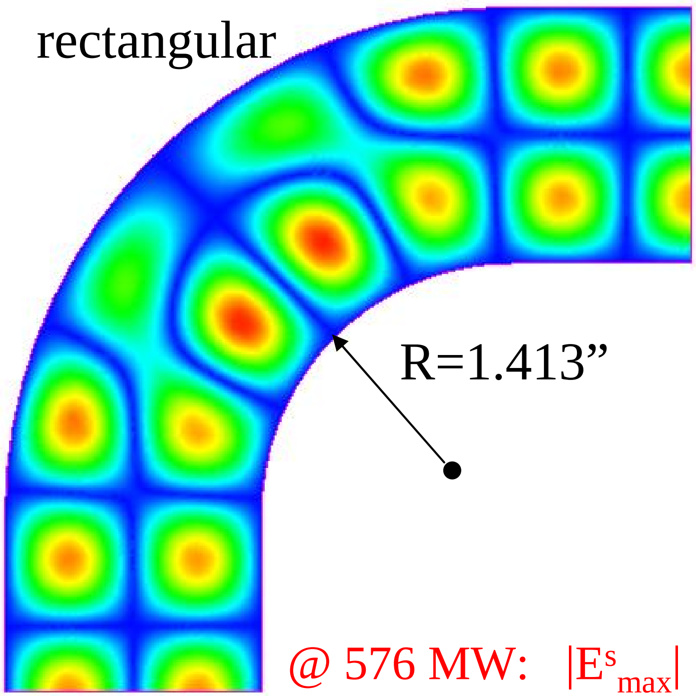


	port1:m1	port2:m1	port2:m2
port1:m1	(0.00031,-134.148)	(1.00000, -4.840)	(0.00188, 13.605)
port2:m1	(1.00000, -4.840)	(0.00031, -55.817)	(0.00188, -11.199)

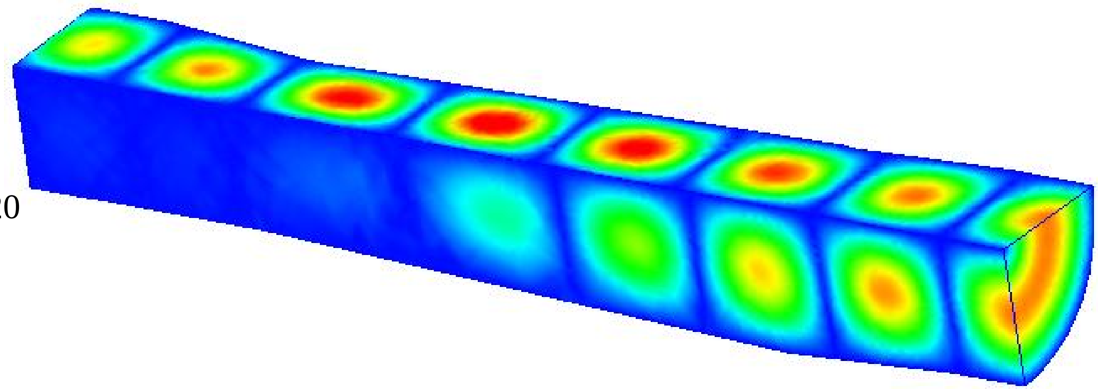
Bends

90º bends in WC293 are composed of: diameter step tapers, circular-to-rectangular tapers, and an overmoded, overheight rectangular waveguide H-plane bend.

Since we are no longer dual-moded, there is no H-plane/E-plane distinction, and we can use this bend to turn in any orthogonal direction.

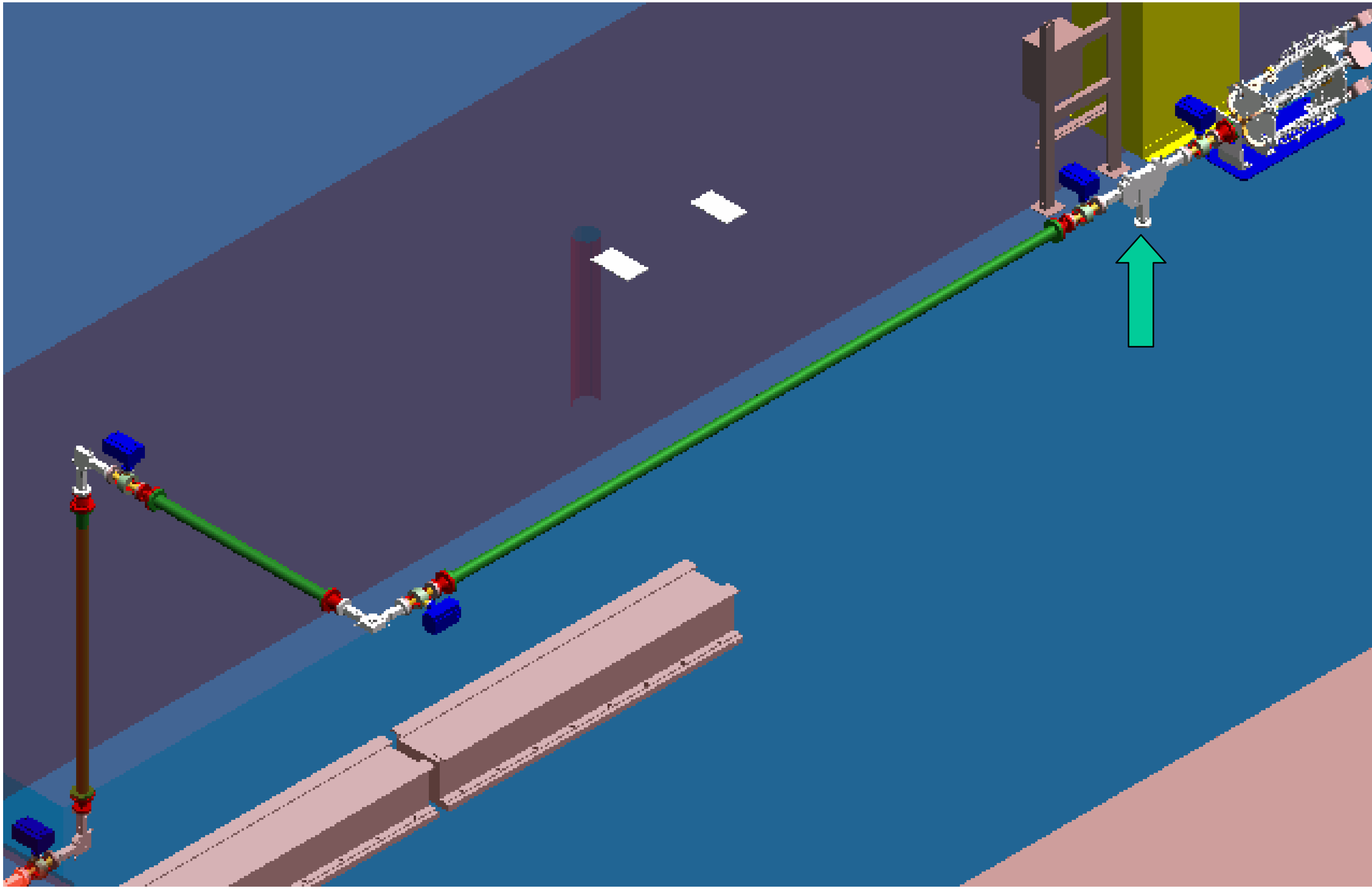


@ 576 MW: $|E^s_{max}|$ = ~36.0 MV/m



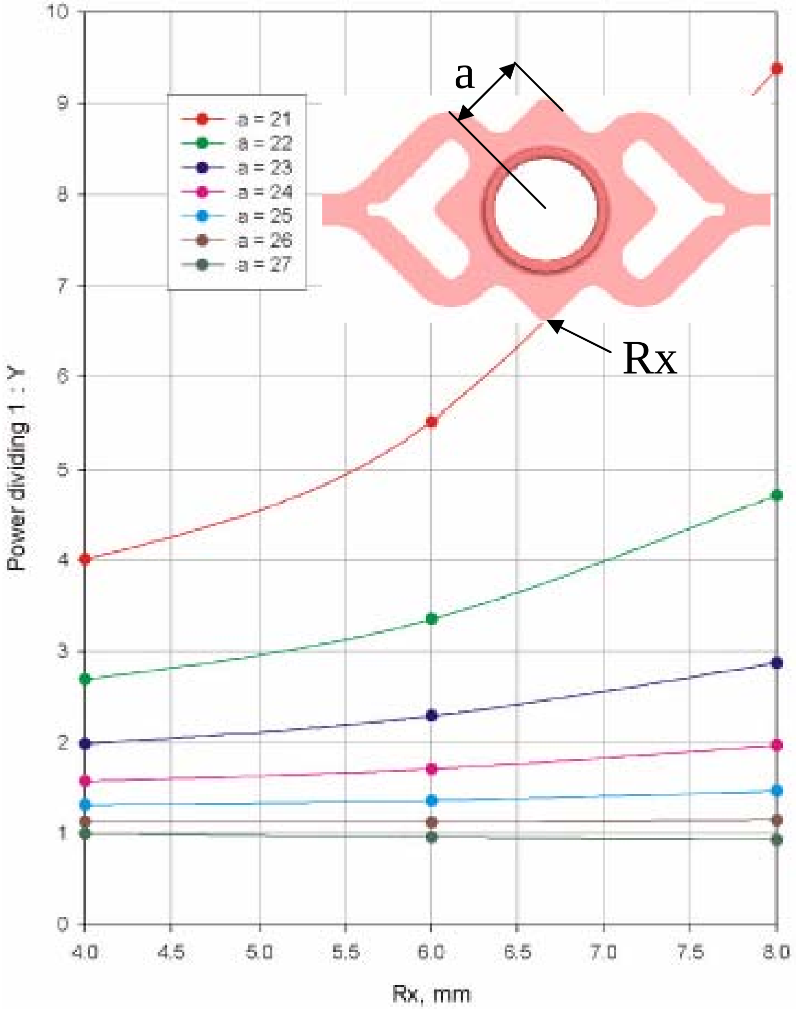
@ 576 MW: $|E^s_{max}|$ = ~36.3 MV/m

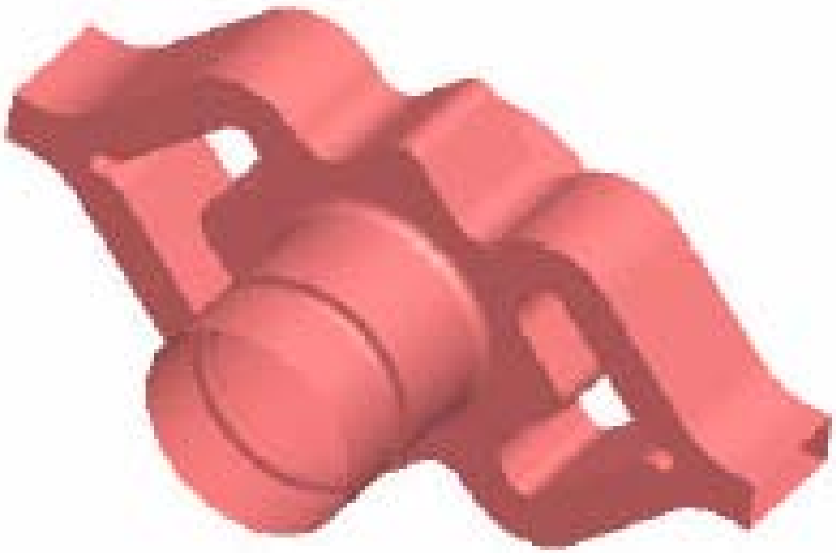
Mode Stripper and Transfer Line



TE_{01} Tap-Off

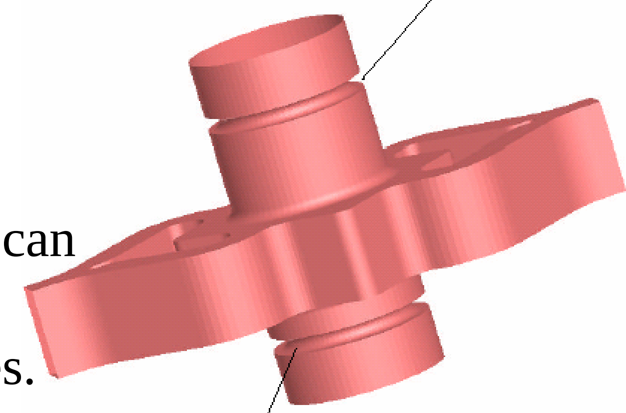
Sergey Kazakov





OR:

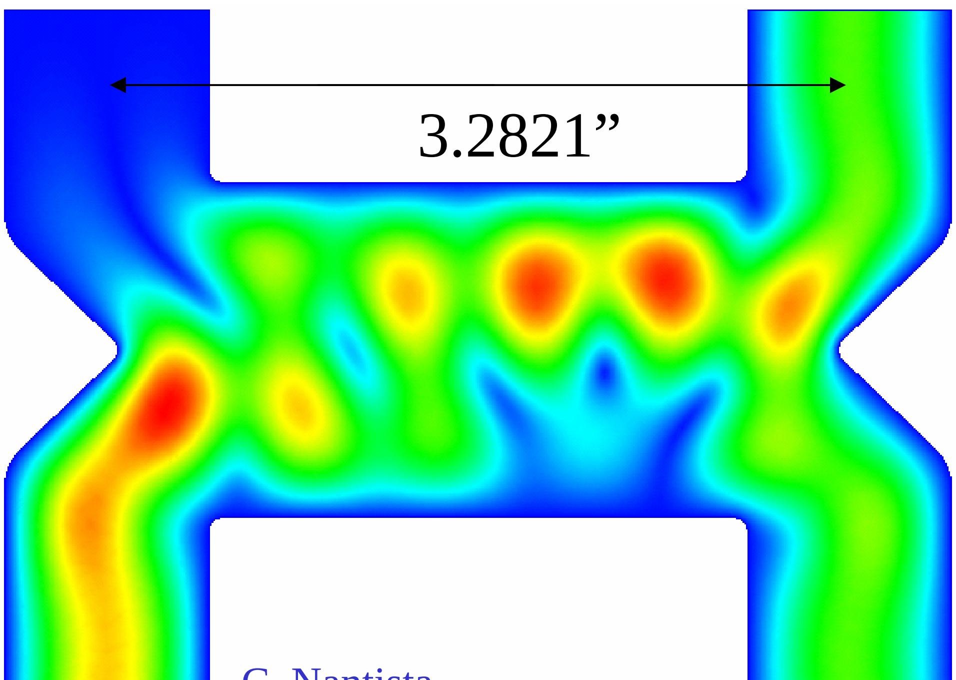
Dividing ratio can be changed by using two irises.



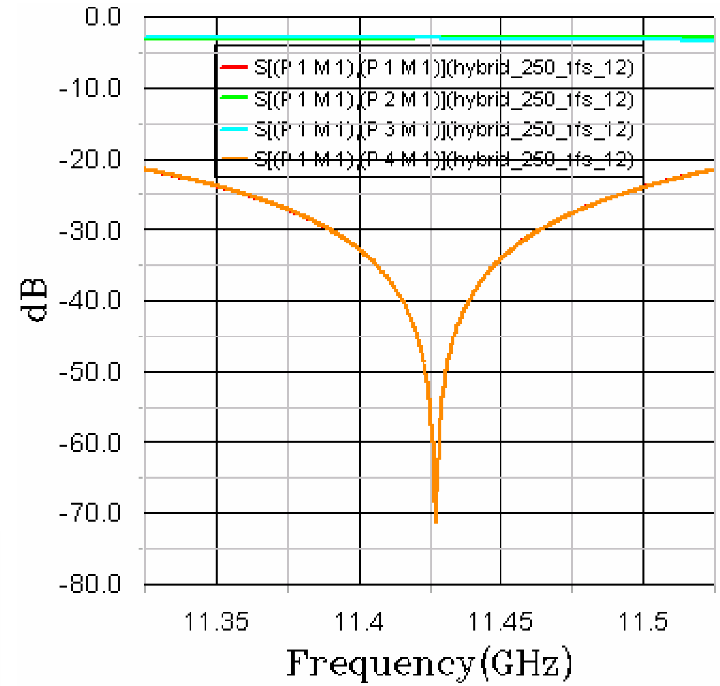
Magic-H Hybrid

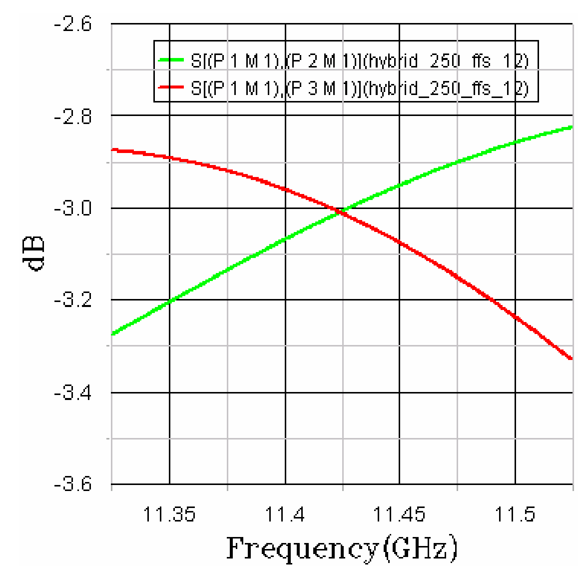
	(P 1 M 1)	(P 2 M 1)	(P 3 M 1)	(P 4 M 1)
(P 1 M 1)	0.0028	0.7071	0.7071	0.0028
(P 2 M 1)	0.7071	0.0028	0.0028	0.7071
(P 3 M 1)	0.7071	0.0028	0.0028	0.7071
(P 4 M 1)	0.0028	0.7071	0.7071	0.0028

@ 576 MW: $|E^{s}_{max}|$ = ~44.7 MV/m

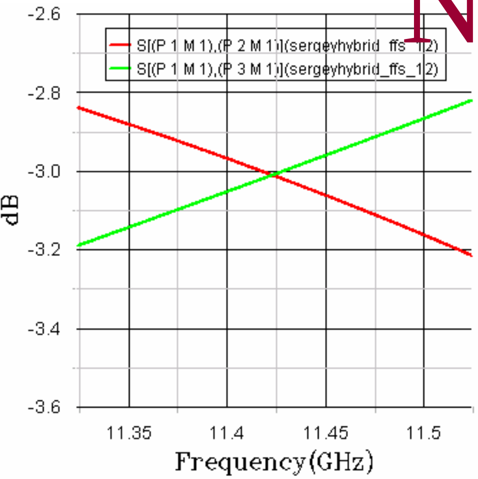


C. Nantista

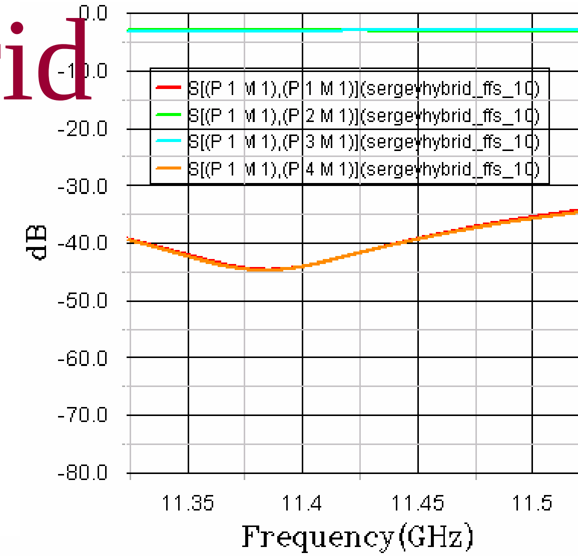




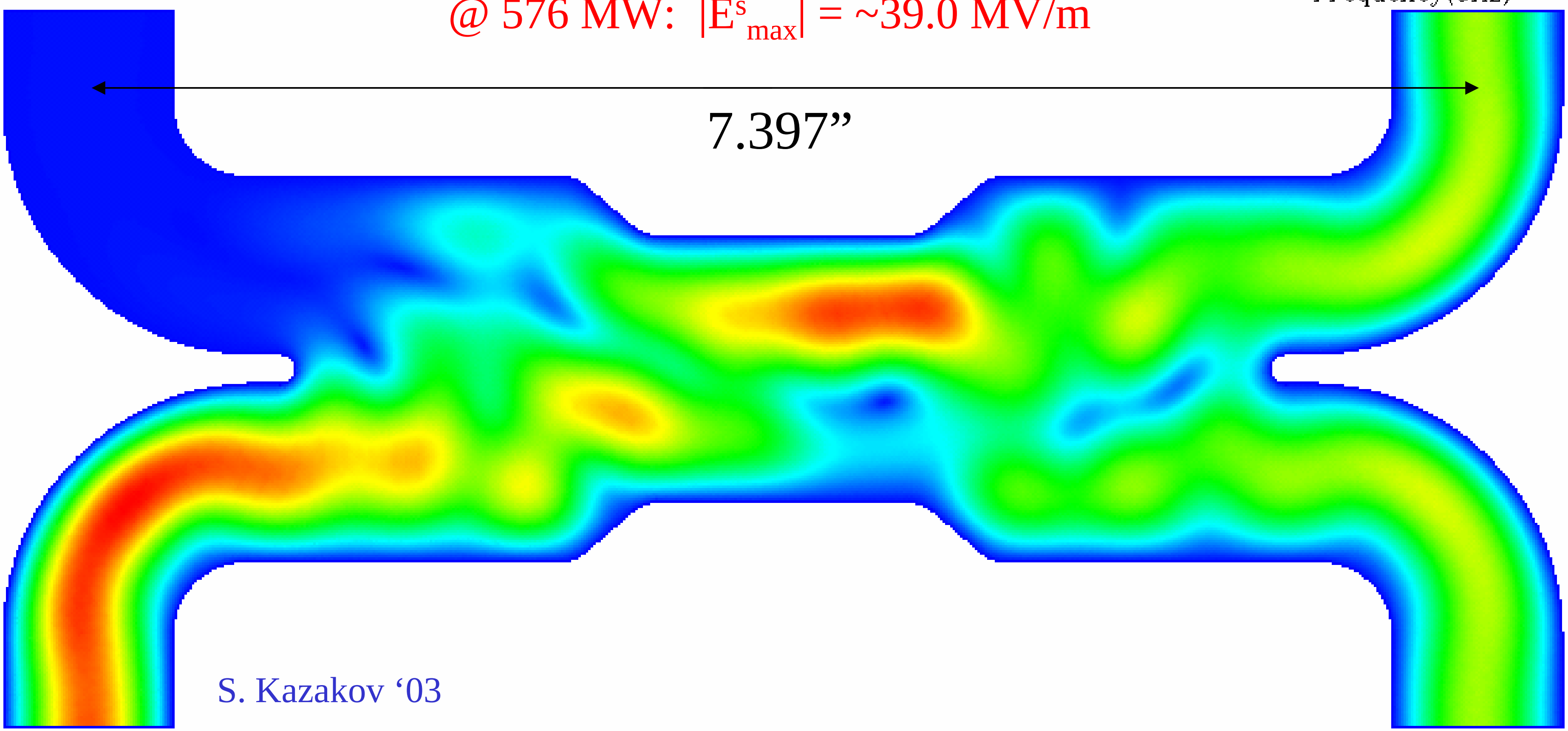
New Kazakov Hybrid



(P 1 M 1)	(P 2 M 1)	(P 3 M 1)	(P 4 M 1)
0.0080	0.7069	0.7072	0.0080
0.7069	0.0080	0.0080	0.7072
0.7072	0.0080	0.0080	0.7069
0.0080	0.7072	0.7069	0.0080

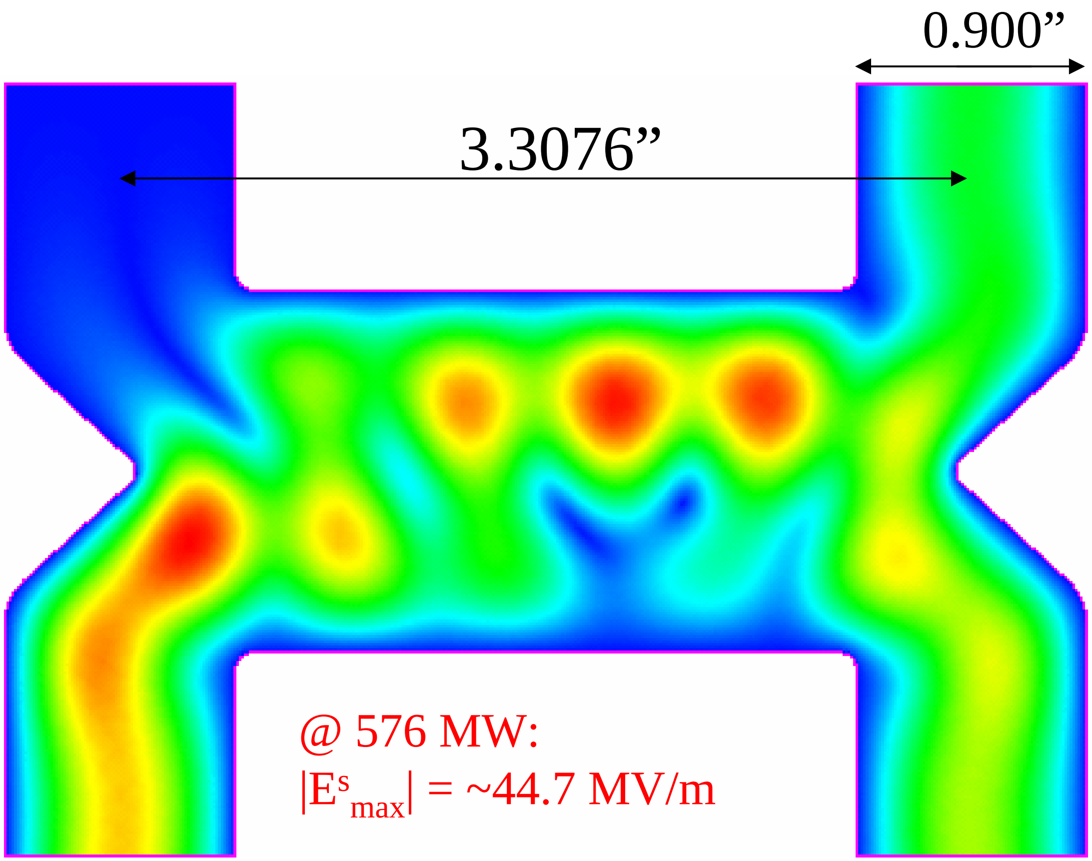


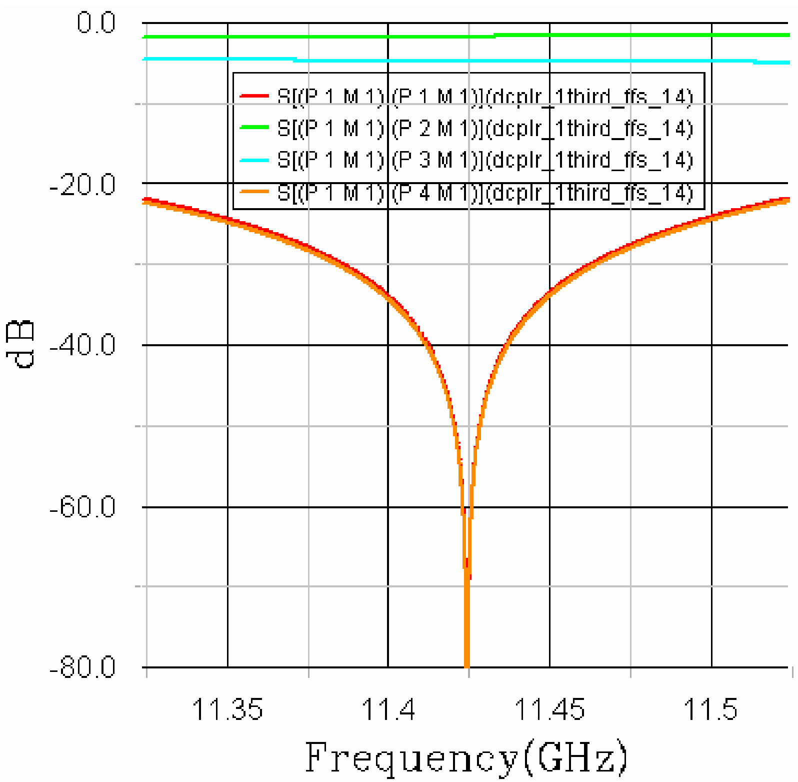
@ 576 MW: $|E^s_{max}|$ = ~39.0 MV/m



S. Kazakov ‘03

-4.77 dB (1/3) Directional Coupler



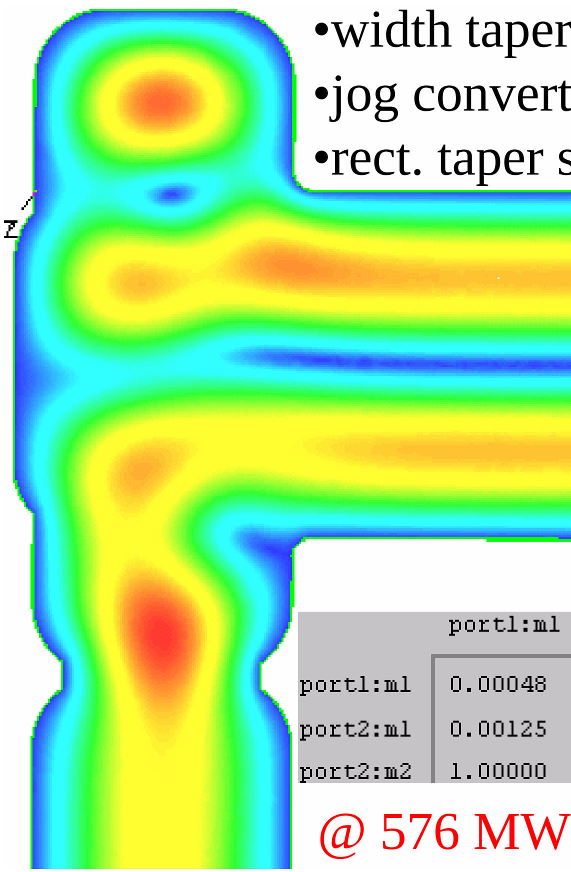


	(P 1 M 1)	(P 2 M 1)	(P 3 M 1)	(P 4 M 1)
(P 1 M 1)	0.0005	0.8166	0.5772	0.0004
(P 2 M 1)	0.8166	0.0005	0.0004	0.5772
(P 3 M 1)	0.5772	0.0004	0.0005	0.8166
(P 4 M 1)	0.0004	0.5772	0.8166	0.0005

C. Nantista ‘03

Compact TE_{10}-TE_{20} Transformer*

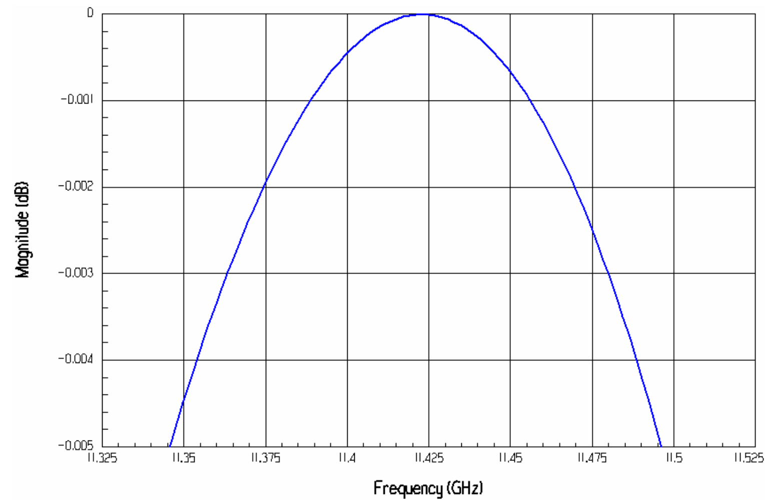
Replaces:
- mitred bend
- width taper
- jog converter
- rect. taper section of rect.-circ. taper.



1.204”

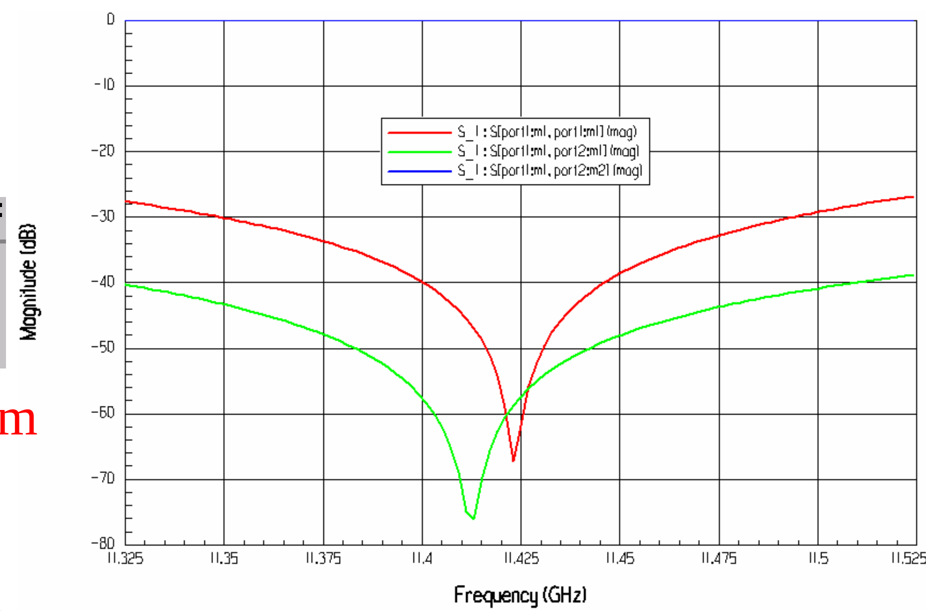
0.900”

matched to circ.-rect. taper



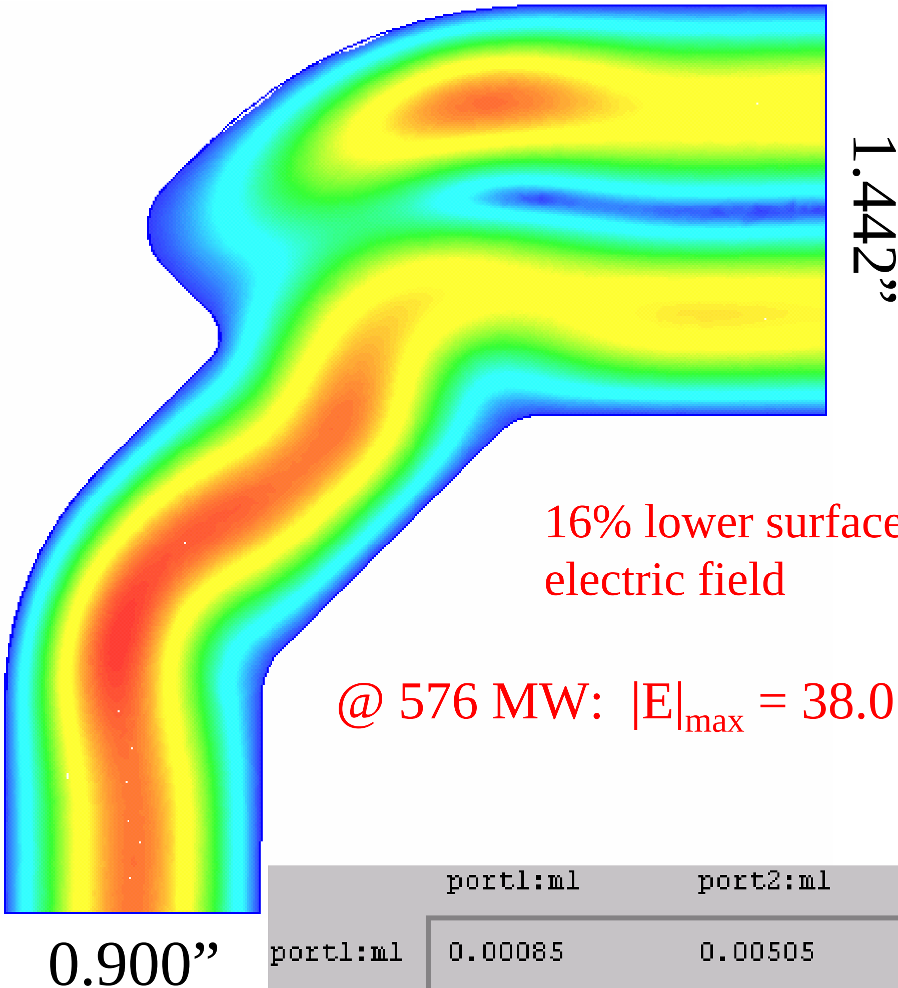
	port1:m1	port2:m1	port2:m2
port1:m1	0.00048	0.00125	1.00000
port2:m1	0.00125	1.00000	0.00125
port2:m2	1.00000	0.00125	0.00048

@ 576 MW: $|E|_{max}$ = 45.4 MV/m



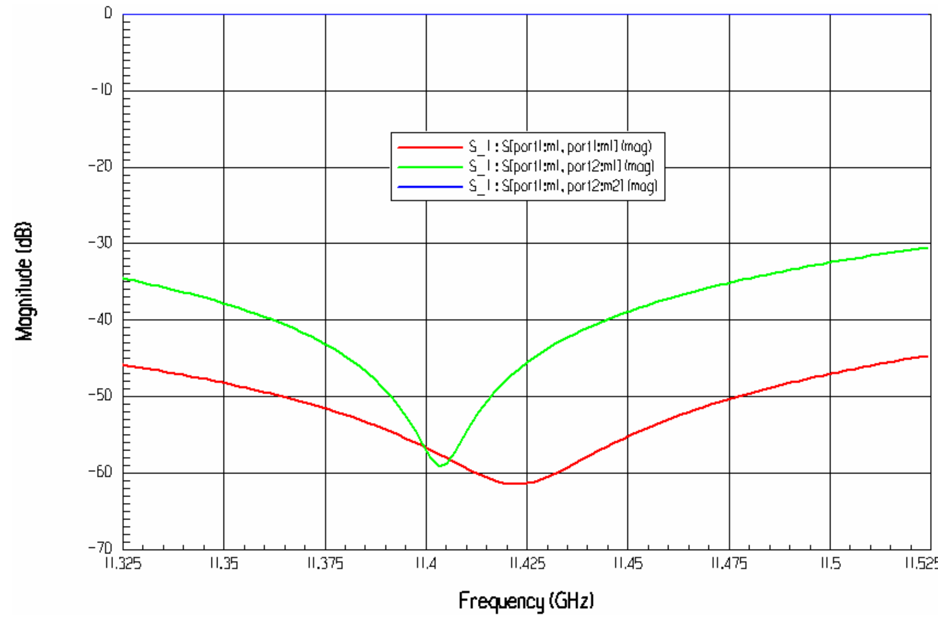
* inspired by Sergey Kazakov’s converter for TE_{01}/TE_{02} window.

Alternate TE_{10}-TE_{20} Transformer

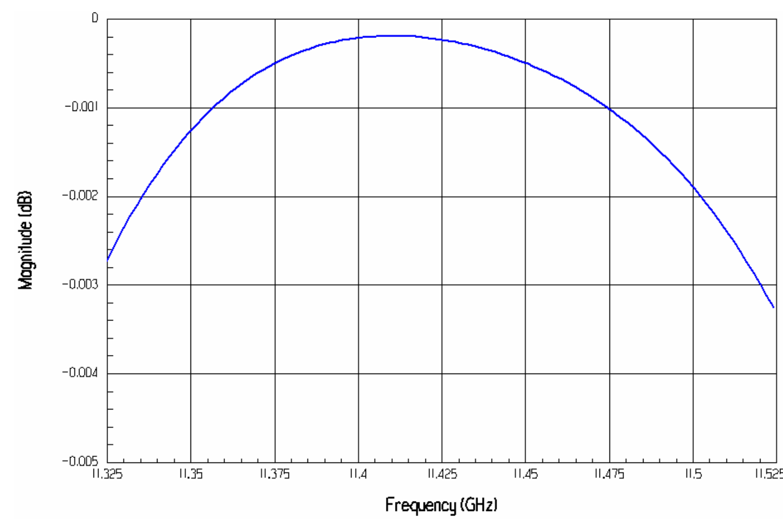


16% lower surface electric field

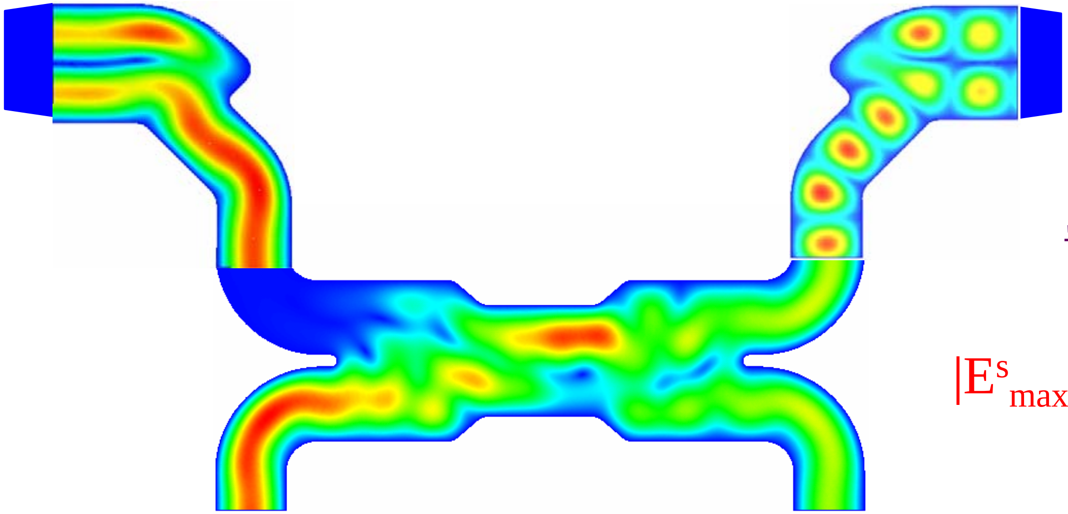
@ 576 MW: $|E|_{max}$ = 38.0 MV/m



	port1:m1	port2:m1	port2:m2
port1:m1	0.00085	0.00505	0.99999
port2:m1	0.00505	0.99997	0.00505
port2:m2	0.99999	0.00505	0.00084

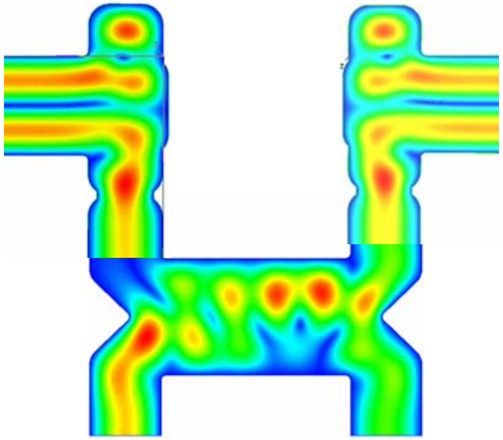


S. Kazakov ‘03



576 MW

$|E^s_{max}|$ = ~ 39 MV/m



$|E^s_{max}|$ = ~ 45 MV/m

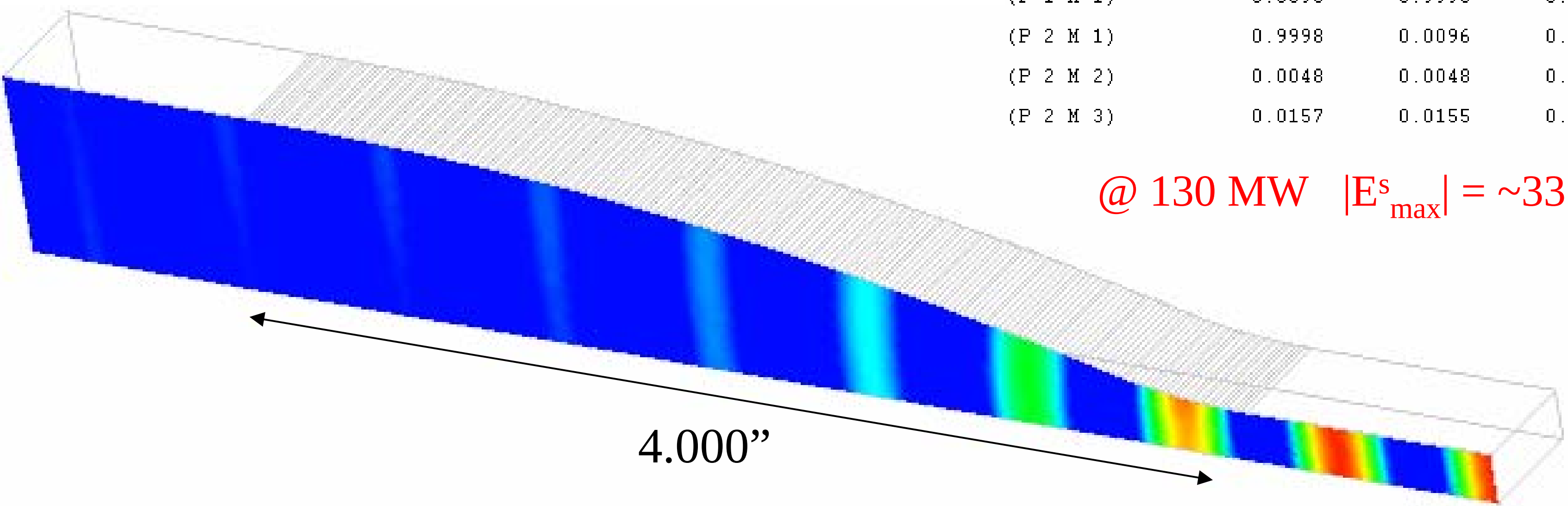
(15% higher)

Height Taper (0.400”→1.435”)

blended arc height taper

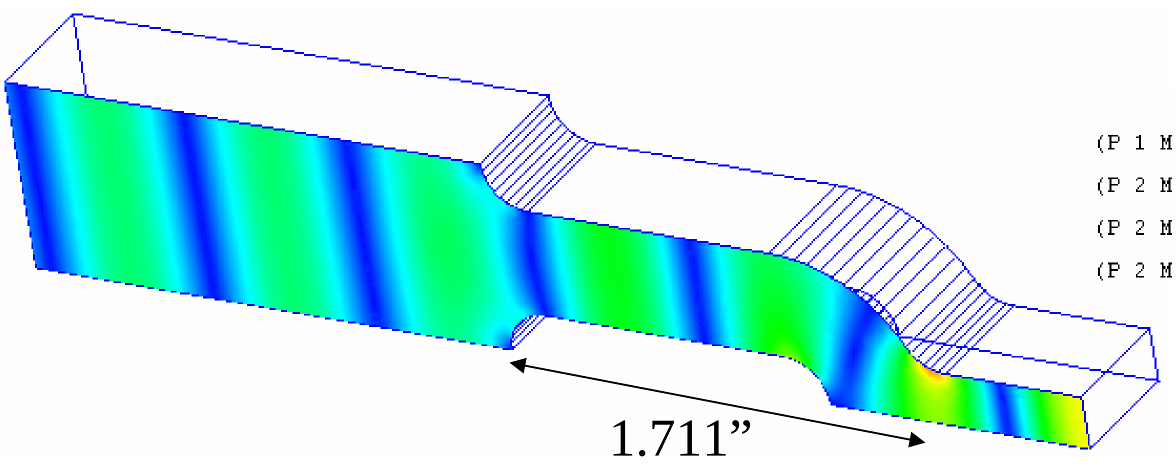
	(P 1 M 1)	(P 2 M 1)	(P 2 M 2)	(P 2 M 3)
(P 1 M 1)	0.0093	0.9998	0.0048	0.0157
(P 2 M 1)	0.9998	0.0096	0.0048	0.0155
(P 2 M 2)	0.0048	0.0048	0.8243	0.5662
(P 2 M 3)	0.0157	0.0155	0.5662	0.824

@ 130 MW $|E^s_{max}|$ = ~33.0 MV/m



S. Tantawi ‘02

septum height taper

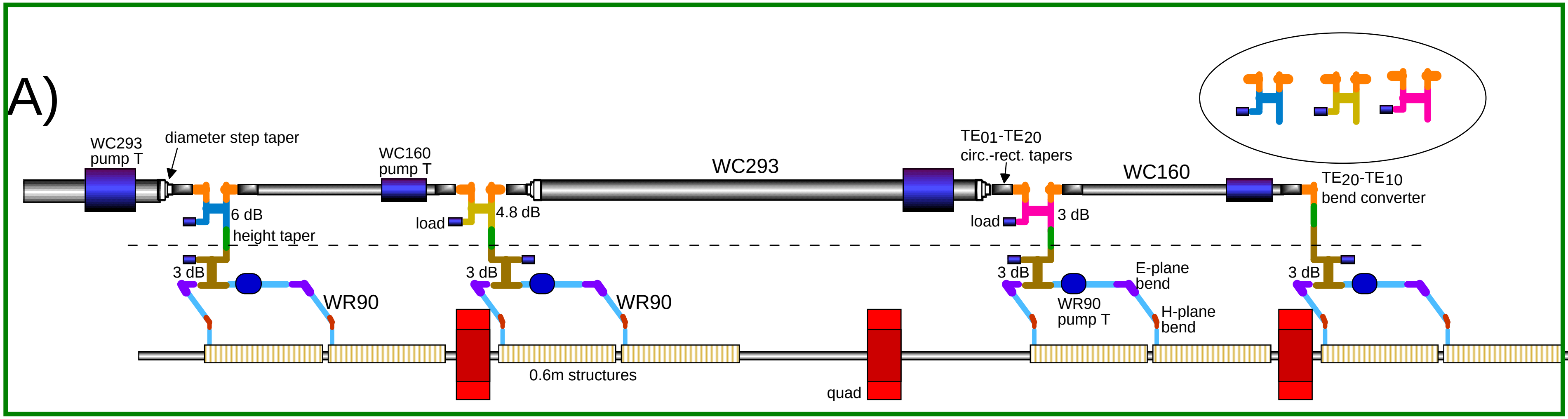


	(P 1 M 1)	(P 2 M 1)	(P 2 M 2)	(P 2 M 3)
(P 1 M 1)	0.0021	1	0.0002	0.0008
(P 2 M 1)	1	0.0021	0.0002	0.0008
(P 2 M 2)	0.0002	0.0002	0.8879	0.4601
(P 2 M 3)	0.0008	0.0008	0.4601	0.8879

@ 130 MW $|E^s_{max}|$ = ~43.1 MV/m

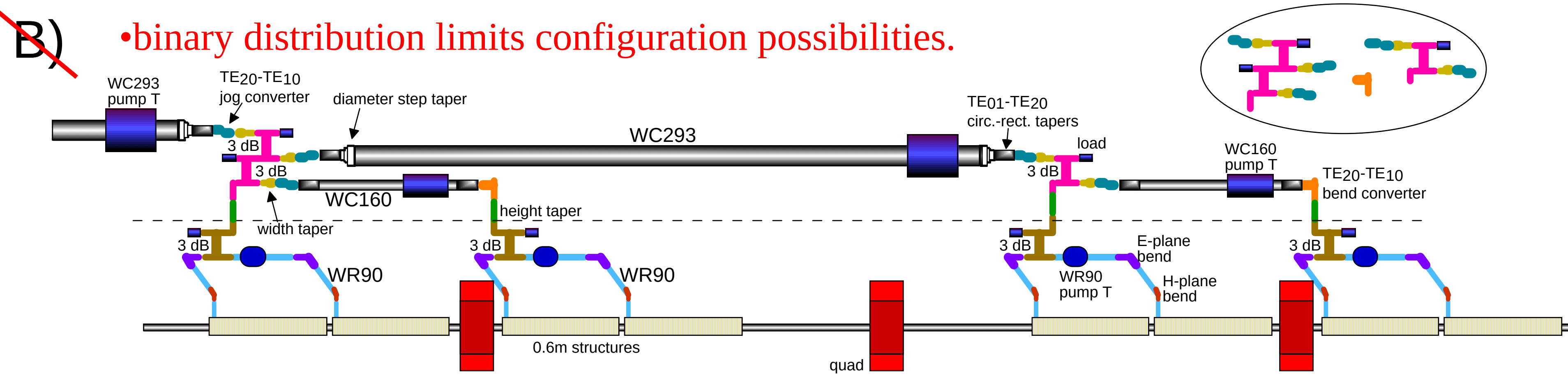
C. Nantista ‘02

Feeding Options



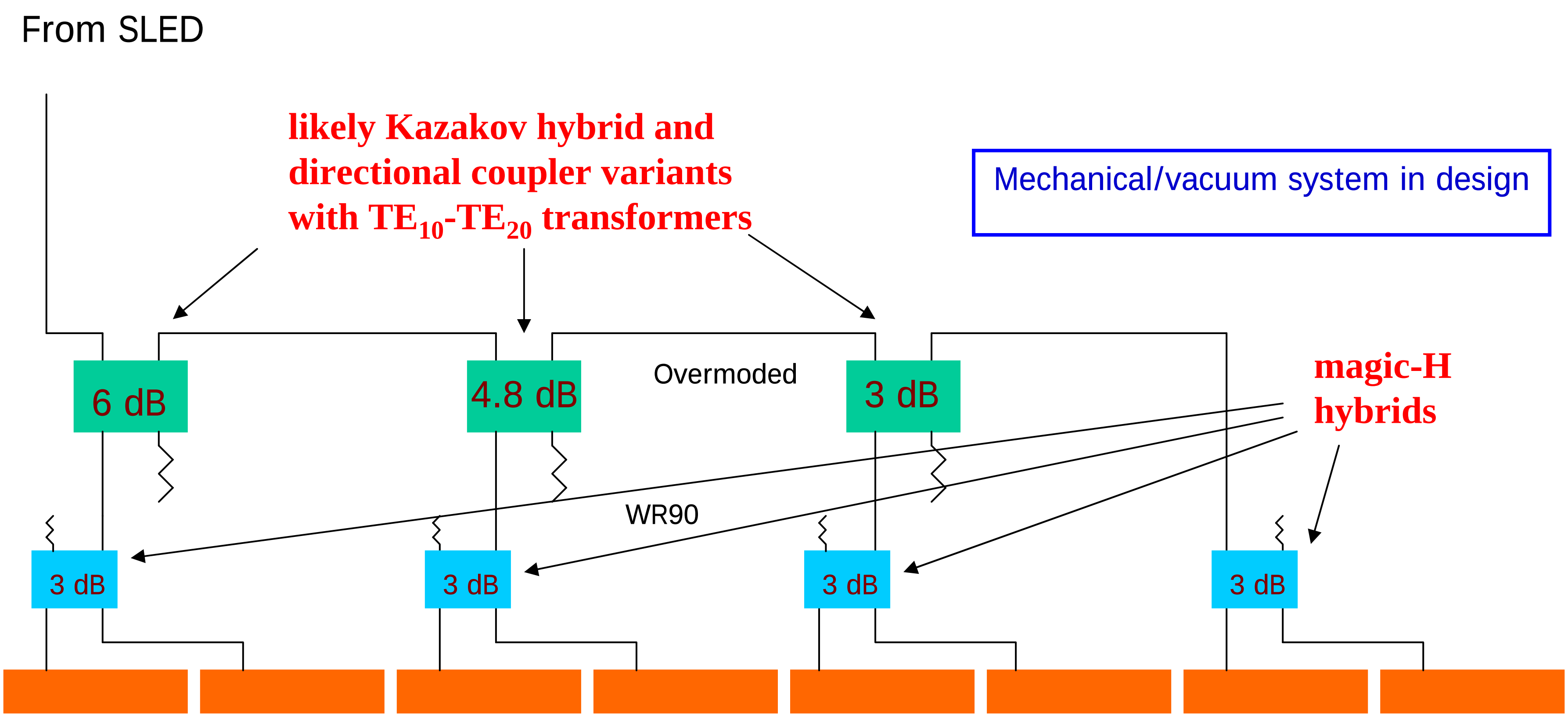
•greater potential for resonance problems in parallel transmission lines.

•binary distribution limits configuration possibilities.



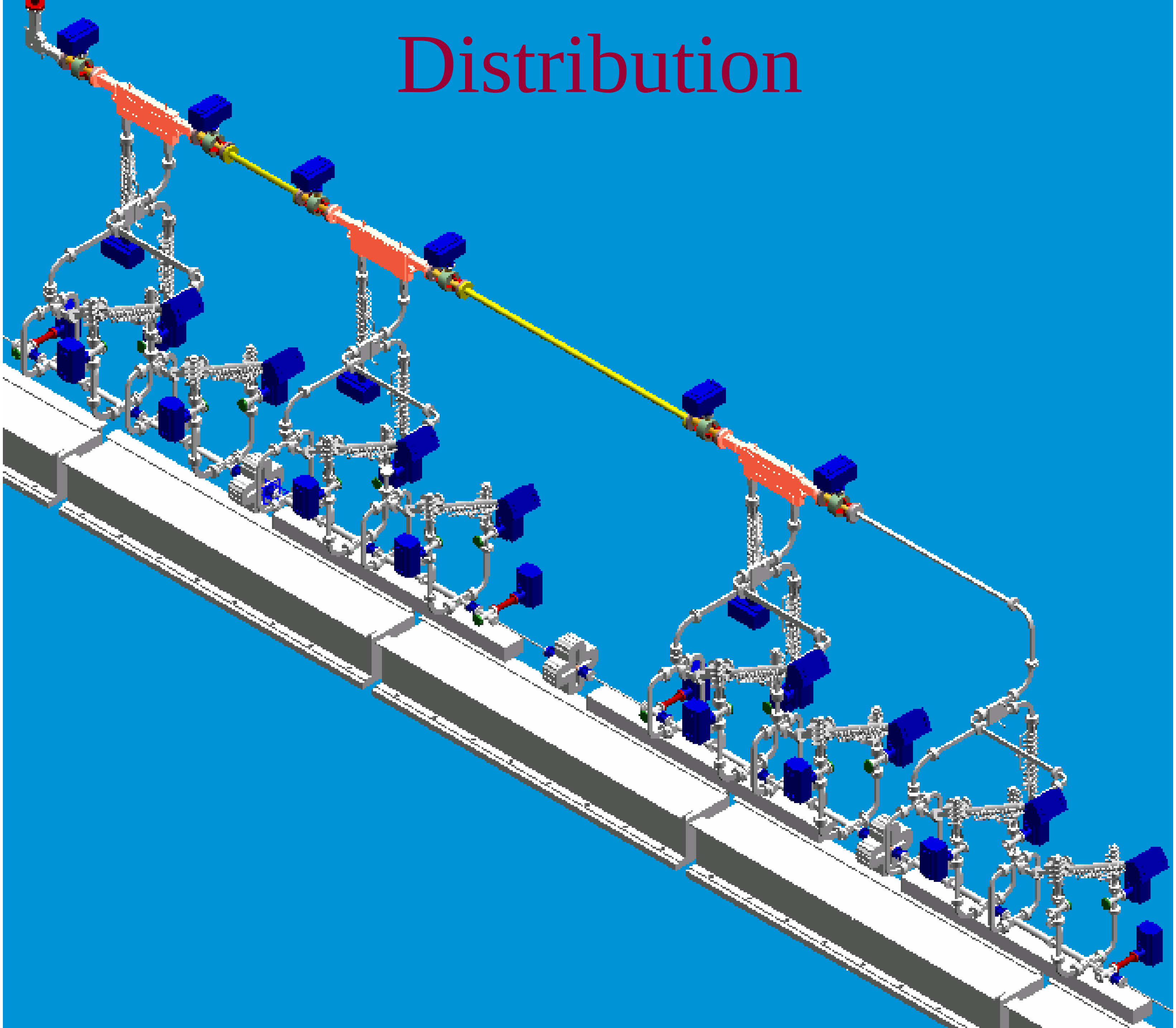
Phase 2 8-Pack Layout

Schematic of the power handling to the beamline



slide from D. Schultz

Distribution



Conclusions

The 8-Pack Phase-II rf distribution system rf design is largely done, with a few details yet to be decided on. (who, what, where, when, why, how?)

It is a collaborative effort between SLAC and KEK.

Mechanical design and fabrication has begun.

Installation should begin in October and finish in early November.