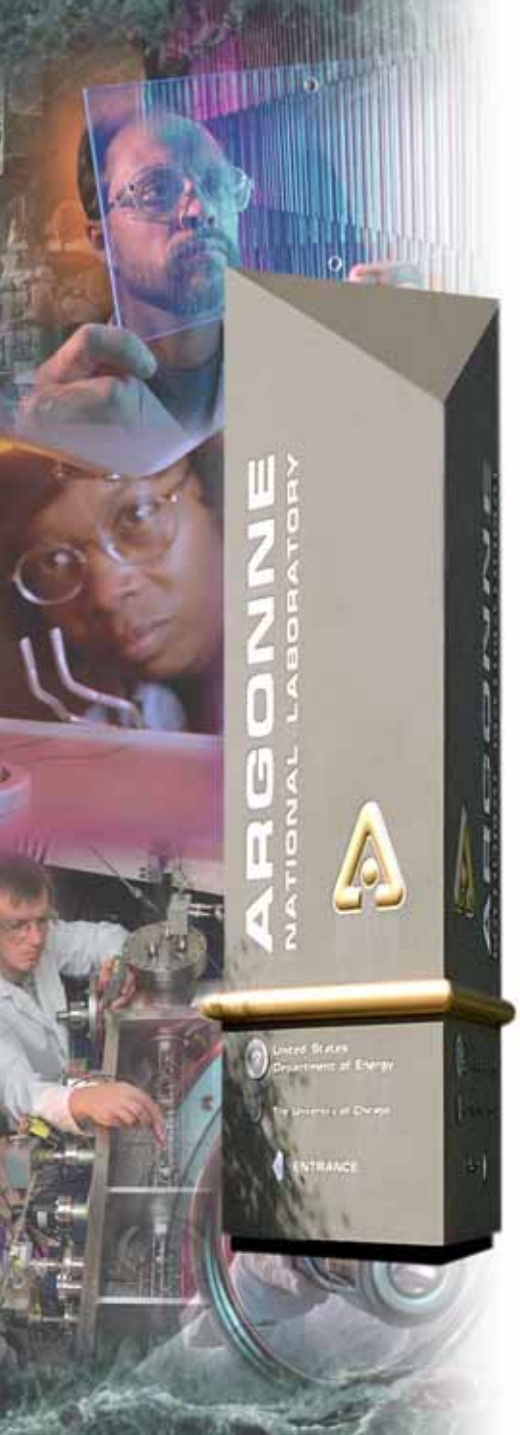

Front End and Beamline Critical Components

Presented to APS / User Monthly Operations Meeting

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Office of Science
U.S. Department of Energy

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Update

The results of recent thermal analysis of front end and beamline critical components

- **Front end component analysis has been conducted by Yifei Jaski**
- **Beamline component analysis has been conducted by Vishwanath Ravidranath and Sushil Sharma**

All components are evaluated on common models

Operations Limits

- **Maximum temperature on Glidcop surface < 300 °C to prevent creep**
- **Maximum temperature on cooling channel wall< water boiling temperature at the channel pressure to maintain single phase heat transfer, which is ~ 150 °C**
- **Maximum von Mises stress < yield stress (300 MPa ~ 450 MPa depend on the Glidcop stock size)**

- **All models created in ProE for input to ANSYS FEA**
- **Beam profile is precisely calculated and applied to the model**
- **Cover all load cases – move beam in the mask aperture to identify the worst case**

Front Ends

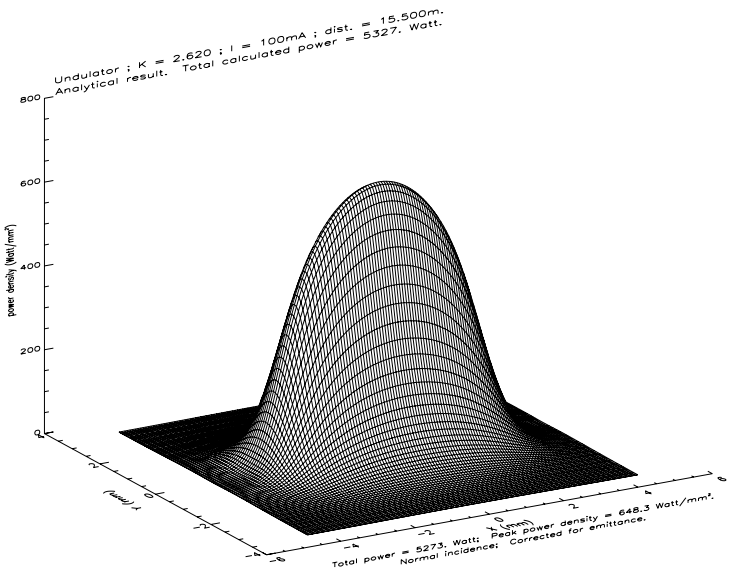
Overview of FE Components

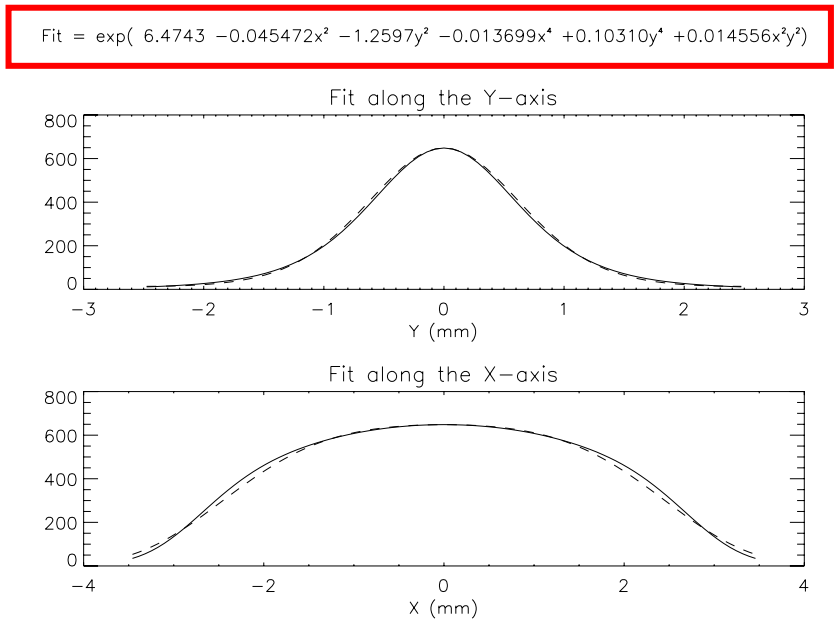
Component	FEv1.2u	FEv1.5 (sector 16, 22, 31, 32)
BM mask	B7-60	B7-70
1st fixed mask	M1-30	M1-40
2nd fixed mask	M2-20	M2-40
3rd fixed mask	L5-83 (exit mask)	M2-50
4th fixed mask		M4-40 (exit mask)
1st photon shutter	P1-20	P2-30
2nd photon shutter	P2-20	P2-30
Filters	W1-91	none
Be windows	W1-93/94	W1-82

Calculations are for 100 mA stored beam with Undulator A at 11 mm

Front Ends

Heat Load Calculation



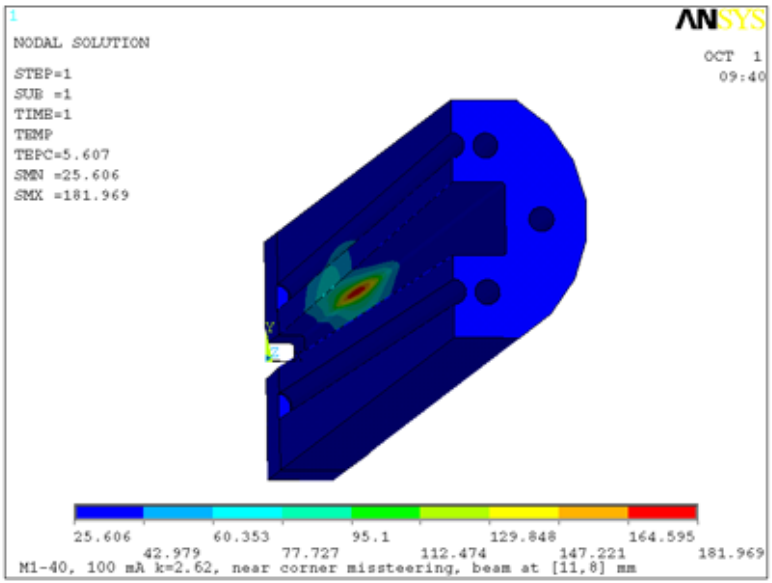


- **Calculate SR beam profile**
  - By SRUFF – a SR source calculation package written in IDL by Dr. Mati Meron at CARS and contributed to APS. A GUI was developed by Tim Stern, a summer student at XFE group in summer 2003. SRUFF outputs a Gaussian formula up to 4th order

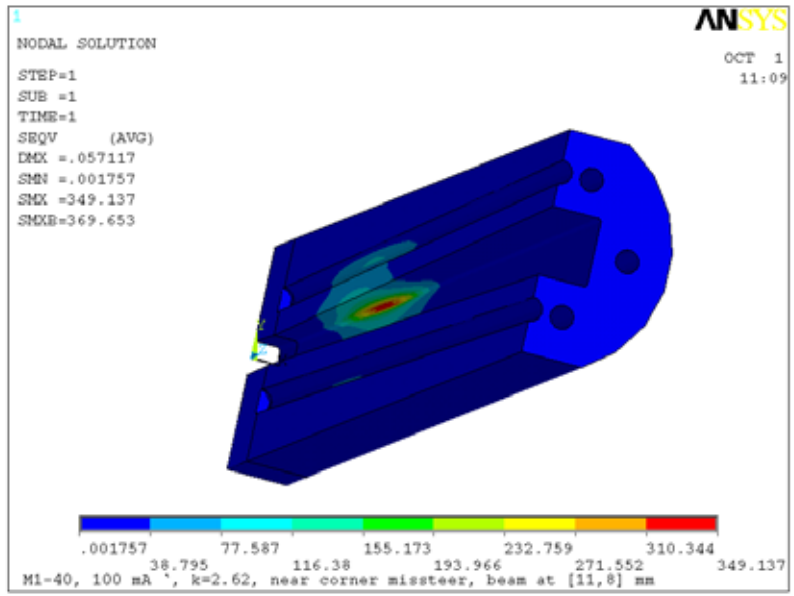
Front Ends

Temperature and Stress Results

- Calculate temperature field
- Using temperature as body load, calculate the stress field
- Repeat same procedure for different beam missteering scenarios to find the worse case



M1-40 temperature at 100 mA, 11 mm gap, h=0.015



M1-40 von Mises stress at 100 mA, 11 mm gap, h=0.015

Beamlines

- There are 66 components (masks/ beam stops in 28 ID beamlines) which are interlocked to PSS for radiation safety protection
- Analysis performed on following standard components

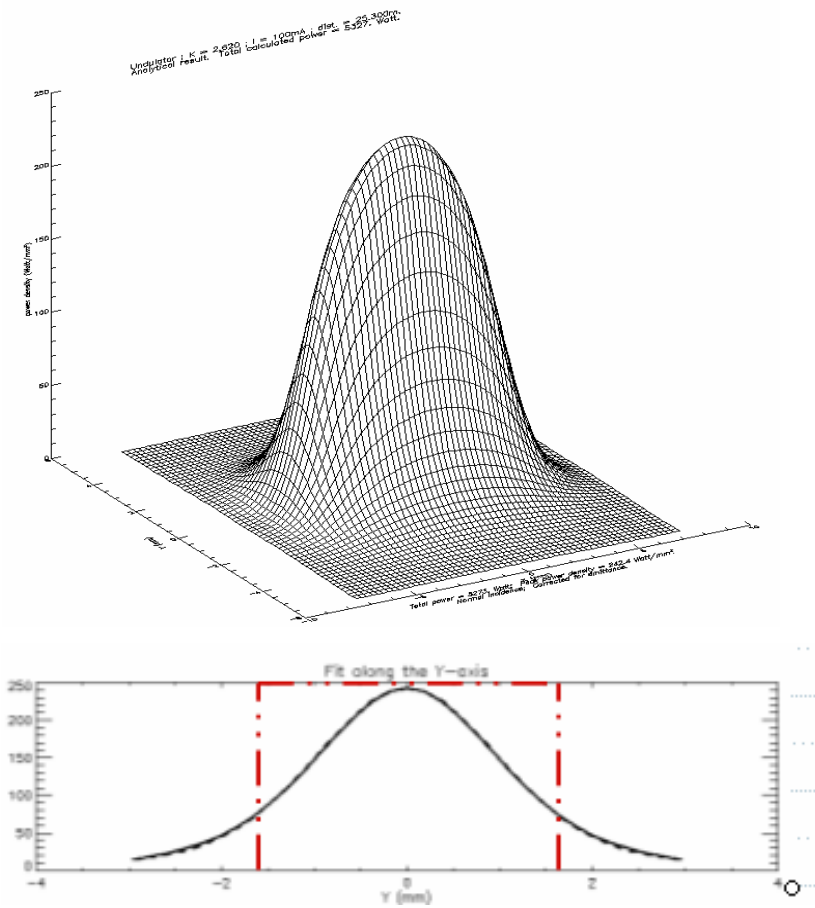
NO.	Components	Distance from the Undulator Source
1	L5-83: front-end exit mask for all version 1.2 front ends	25.3 m
2	M4-40: front-end exit mask on version 1.5 front-ends	25.3 m
3	M7-20: front-end exit mask for 4ID	25.3 m
4	M4-30: front-end exit mask	26 m
5	M7-41: beam-line splitter mask for 4ID	26 m
6	M9-30: white beam stop and pink beam mask	30 m
7	P5 Integral Shutter	30 m
8	P4-20: shutter	30 m
9	P4-31: shutter for 4ID	30 m
10	P4-50: shutter	30 m
11	P4-41: shutter for 4ID	60 m
12	K5-50: white beam stop for 4ID	77 m

- ***This list accounts for only 20 of the 66 beamline components!***
- ***Pink beam (white beam reflected of mirrors) components need to be carefully evaluated***

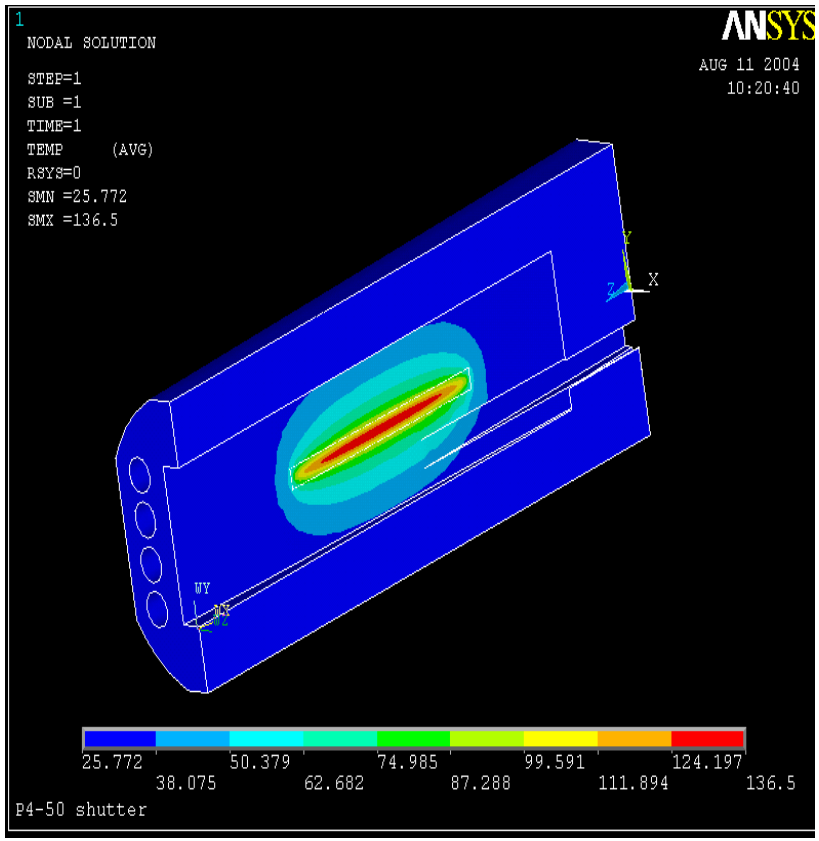
Beamlines

Heat Load Calculation

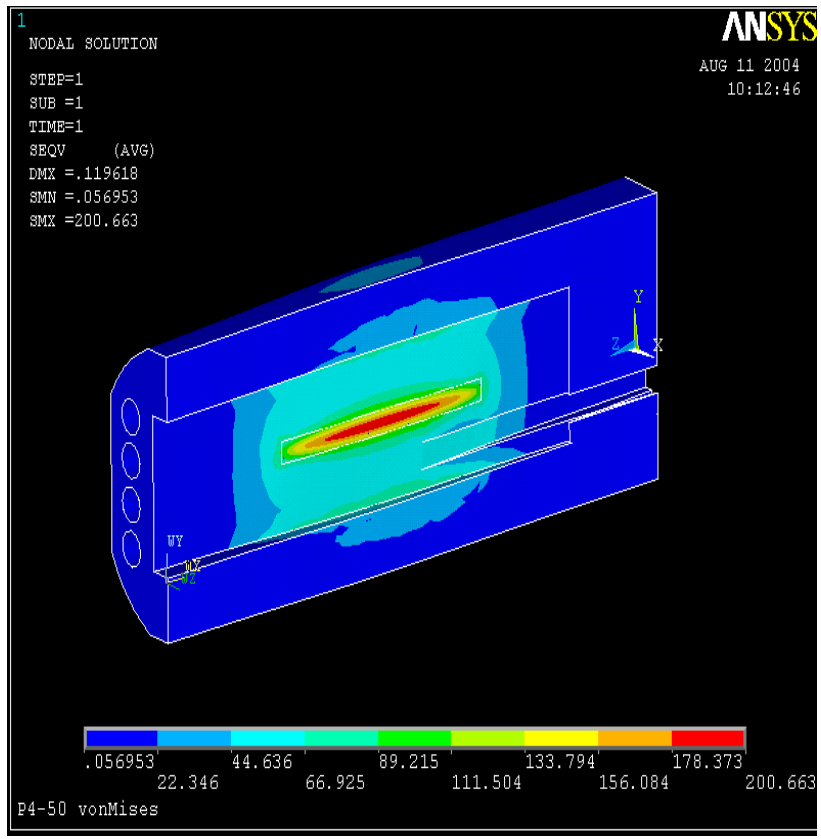
Parameter	Value
Beam current (mA)	100
Undulator period length λ (cm)	3.3
Length of undulator (m)	2.4
Minimum gap (mm)	11
Number of periods	72
Relativistic gamma	13700
Deflection parameter K	2.62
Horizontal beam size σ_x (mm)	0.352
Vertical beam size σ_y (mm)	0.018



Temperature and Stress Results



P4-50: Temperature Contours



P4-50: von Mises Stress Contours

Beamlines

Results

Components	Temperature (°C)	von Mises Stess (MPa)	Channel Wall Temperature (°C)
Masks			
L5-83 front end exit mask	195	378	98
M4-30 front end exit mask	96	151	55
M4-40 front end exit mask	178	350	68
M7-20 front end exit mask	156	274	68
M7-41 beamline splitter mask	172	240	73
M9-30 white beam stop and pink beam mask	210	285	80
Shutters			
P5-20 shutter	238	280	95
P4-20 shutter	144	183	84
P4-30 shutter	121	175	57
P4-41 white beam stop	186	175	94
P4-50 shutter	137	201	62
K5-50 white beam stop	175	312	135

Conclusions

Front Ends

- The FEv1.2u can operate with one undulator A at 11 mm gap (k=2.62) upto 130 mA
- Although the photon shutters (P2-30) in FEv1.5 can safely operate at above 200 mA, the stress on masks are far above the limit at 150 mA. Overall, the FEv1.5 can only operate at 130 mA under current criteria
- 3-ID can operate at 115 mA
- 4-ID with UA at 9.5 mm gap and CPU can operate at 100 mA. Gap restriction is necessary at higher current

Beamlines

- For beamline components evaluated to date results show that conservative design criteria are met (with some exceptions, e.g. K5-50) for a beam current of ~ 140 mA