

# **Tensile Property of candidate material for spallation target vessel after irradiation**

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# Materials

- Austenitic stainless steel 316 is the best understood one with a large database of neutron irradiation.
- There are another types with different kinds of modification, which includes JPCA (Japanese primary candidate alloy) and 316F.
- JPCA is developed to reduce a swelling under neutron irradiation.

# Chemical compositions

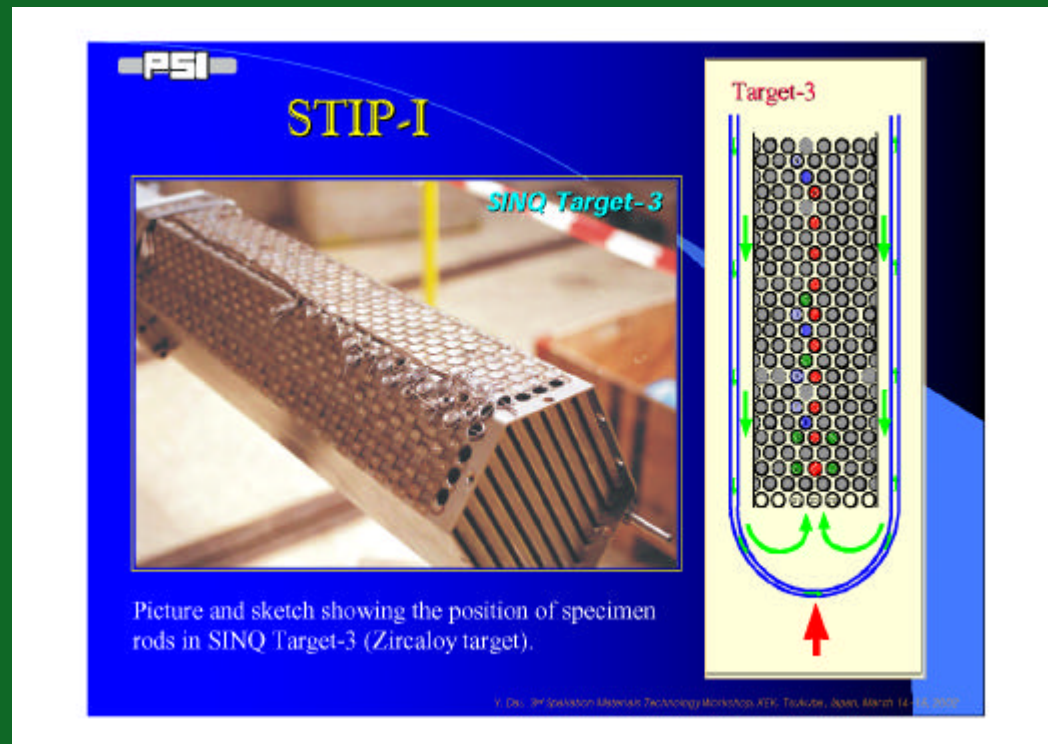
Steel	Fe	Cr	Ni	Mo	Mn	Ti	Co	Cu	B	C	Si	P	S	N	Ta
316L	Bal	17.17	12.24	2.31	1.75		0.077	0.07	.0009	0.019	0.35	0.02	.0007	0.073	0.002
Ec316LN	Bal	17.45	12.2	2.5	1.81					0.024	0.39			0.067	
JPCA	Bal	14.14	15.87	2.29	1.54	0.22	0.028		.004	0.058	0.50	0.026	.004	0.03	
316F	Bal	16.79	13.95	2.34	0.23		<.001	<.01		0.040	0.04	<.003	.002	0.011	

# Manufacturing process

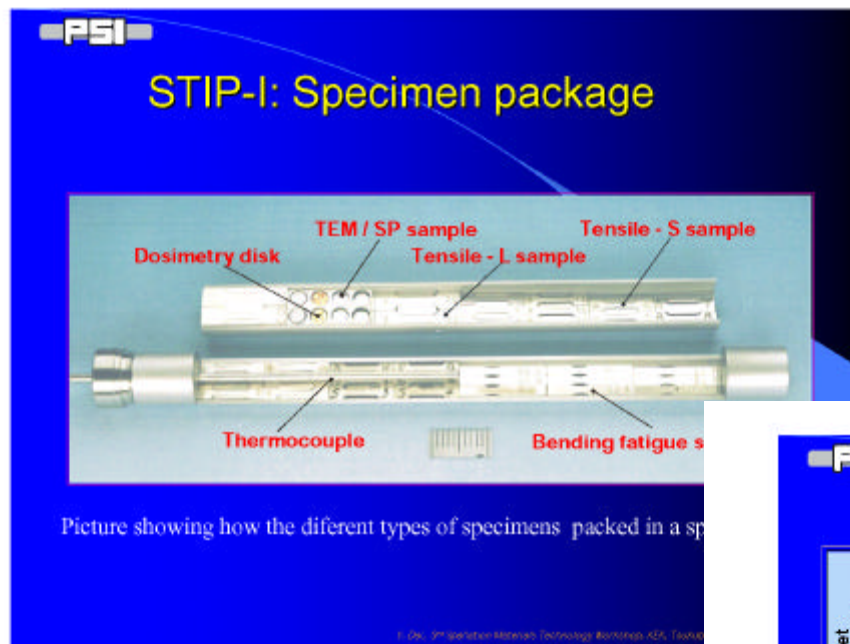
- SA JPCA
  - > Vacuum induction melting, 2tons.
  - > Vacuum arc re-melting, 1.5tons.
  - > Cutting.
  - > Soaking, 1250°C, 16hs.
  - > Forging, 1200°C.
  - > Hot rolling.
  - > Cutting.
  - > Intermediate annealing, 1150°C/1h/WQ.
  - > Straightening.
  - > Cutting 15t x 300W x 500L.

# SINQ Target Irradiation Program STIP

- STIP-1 was carried out from July 1998 to December 1999 in SINQ. More 1500 samples were irradiated to a maximum dose of 12.5 dpa and He concentration of 900 appm.

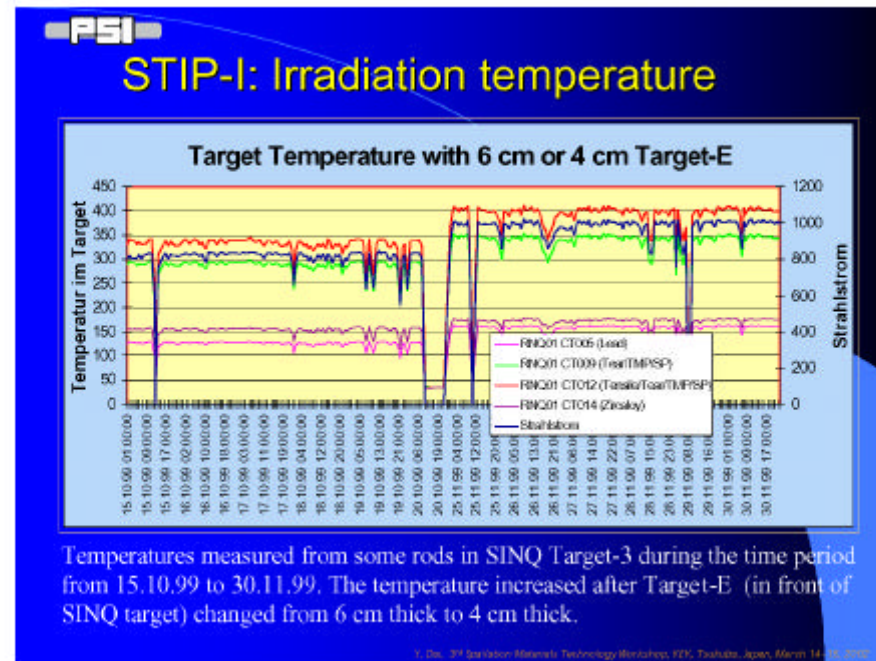


# Specimen package and temperature



Picture showing how the different types of specimens packed in a specimen package

Y. Oka, PSI Radiation Materials Technology Workshop, K2, Tsukuba



# International collaboration

PSI

## STIP-I PIE program

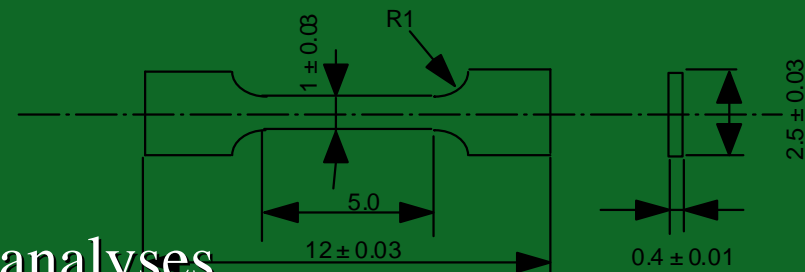
Tensile	B-fatigue	Tear	Bend bar	Charpy	S.Punch	TEM
CEA	PSI	PSI	FZJ	PSI	FZJ	CEA
FZJ	JAERI		PSI		PSI	FZJ
JAERI						JAERI
PSI						PSI
						PSI

- ✍ The samples were delivered to CEA, FZJ, JAERI in 2001.
- ✍ The main results will be obtained in 2001 and 2002.

V. Dai, 3rd Spallation Materials Technology Workshop, KEK, Tsukuba, Japan, March 14-16, 2002

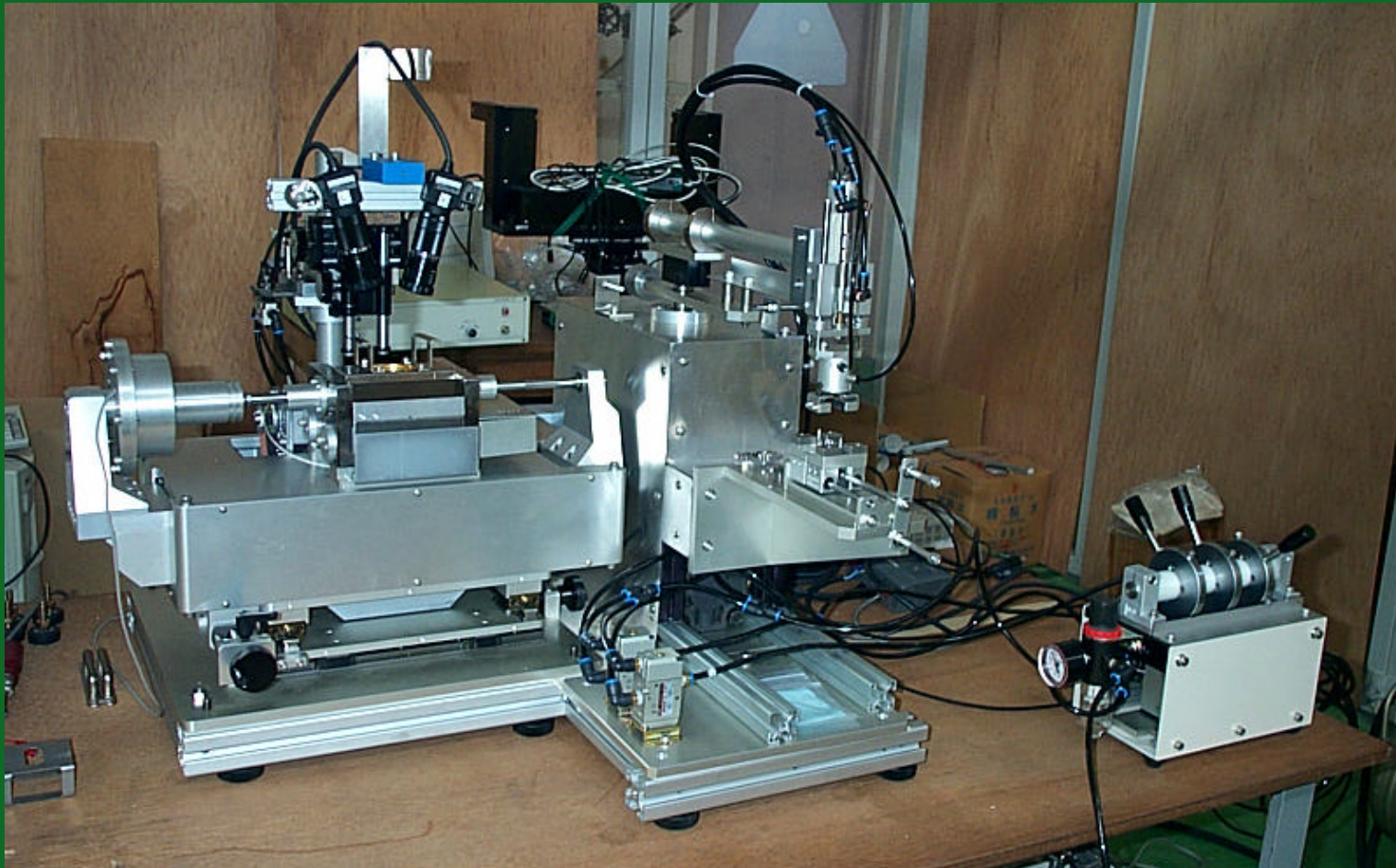
# Post Irradiation Experiment at JAERI

- Materials
  - > JPCA-SA, 316F-SA, 316F-CW
- Incident proton energy :580MeV、
- Specimen temperature :80? 400°C
- dpa(proton+spallation neutron) 3.5? 11.8 dpa
- Calculated gas production :He:70appm/dpa、  
H:500appm/dpa
- Tensile test
  - > At RT and 250°C in air
  - > Pulling speed: 0.2mm/min
  - > Strain measured by image analyses
- Fractography



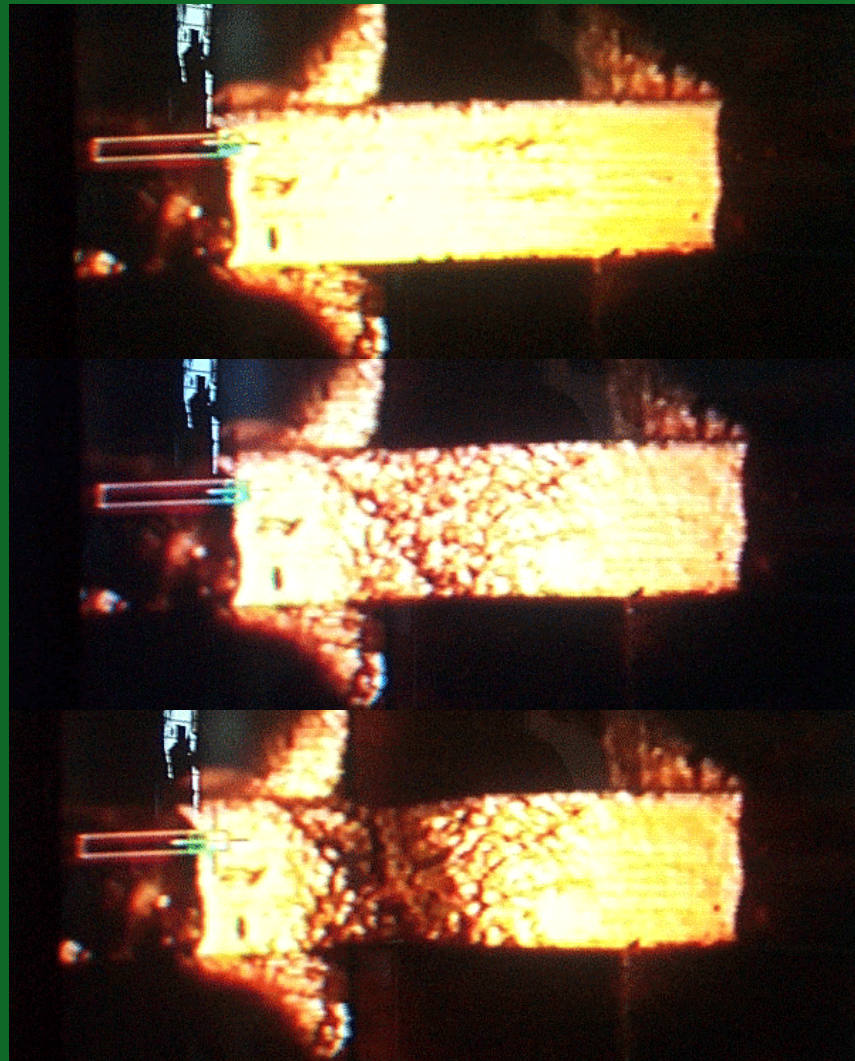


# Pulling Tester



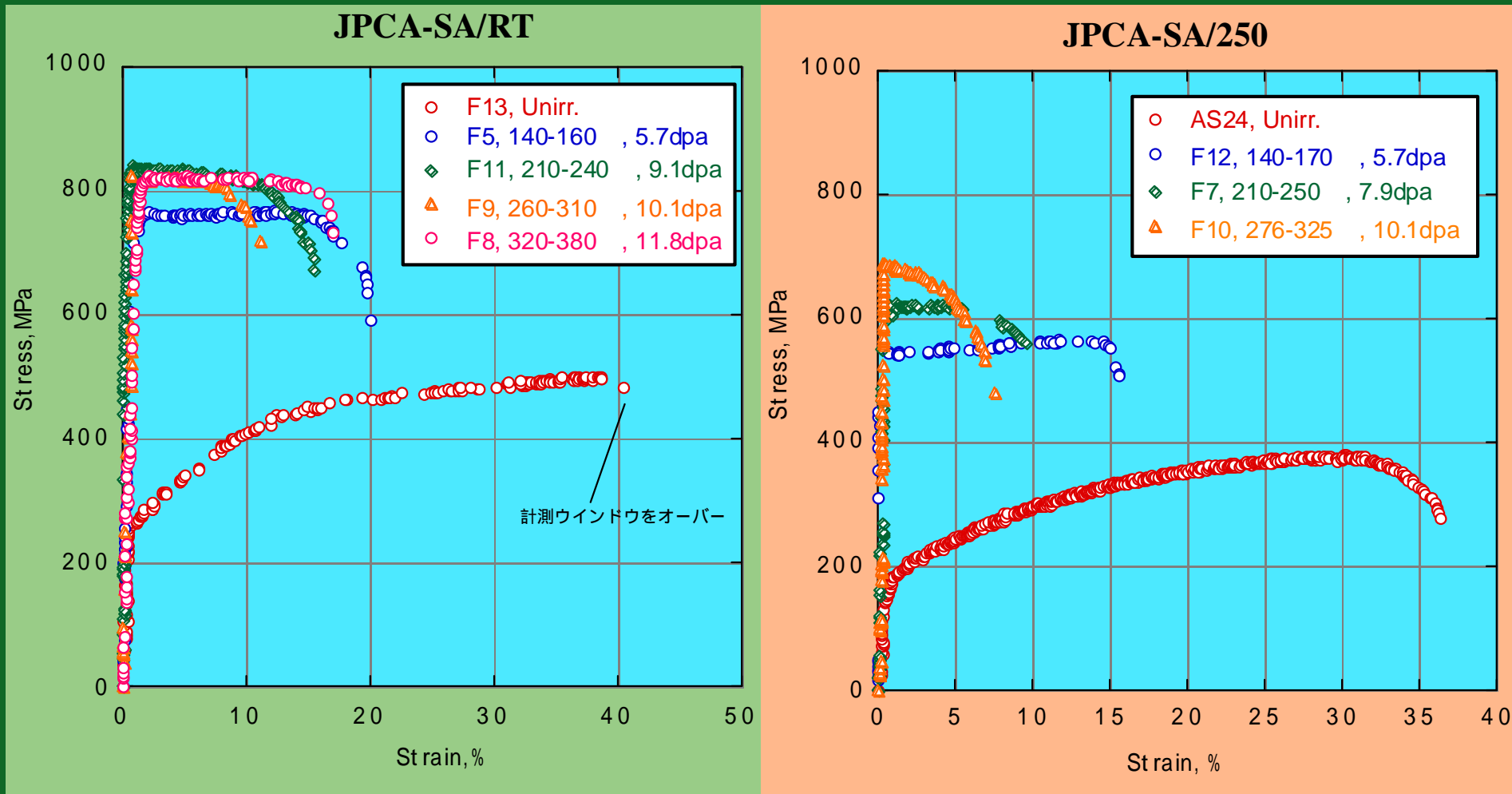
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# Image analyses of specimen at 250°C

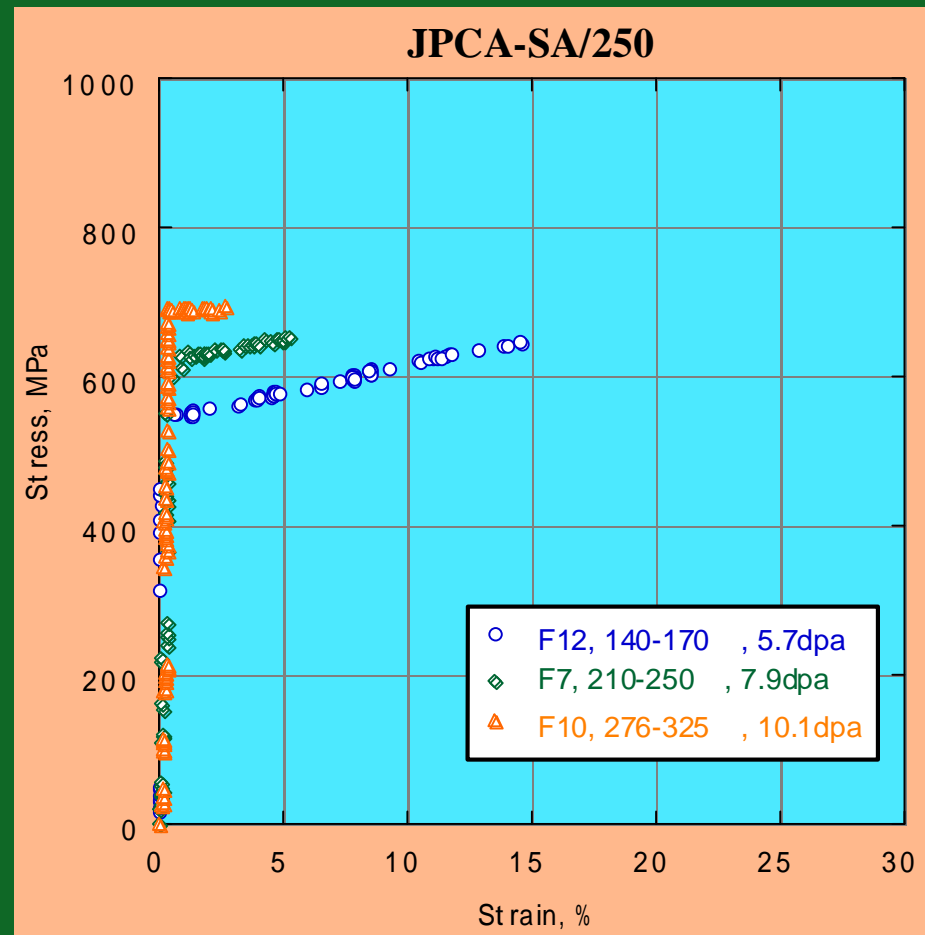
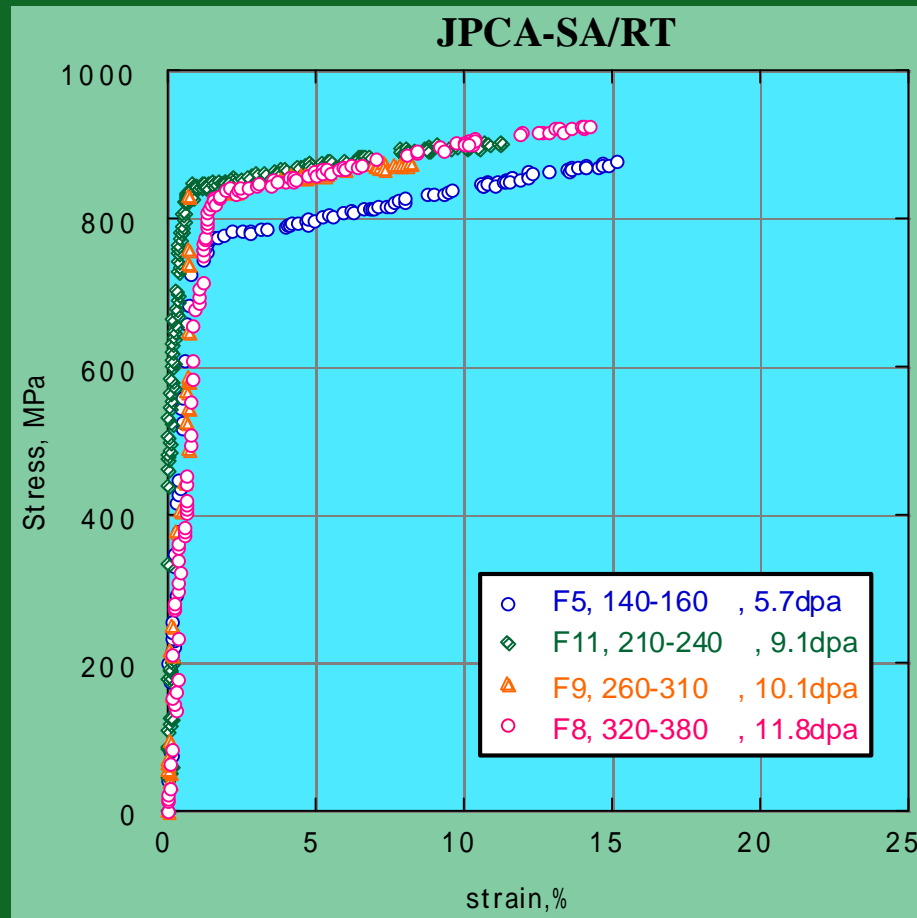


KIKUCHI, N-TAC 10/2002 at JAERI

# SS curves of JPCA-SA at RT & 250°C



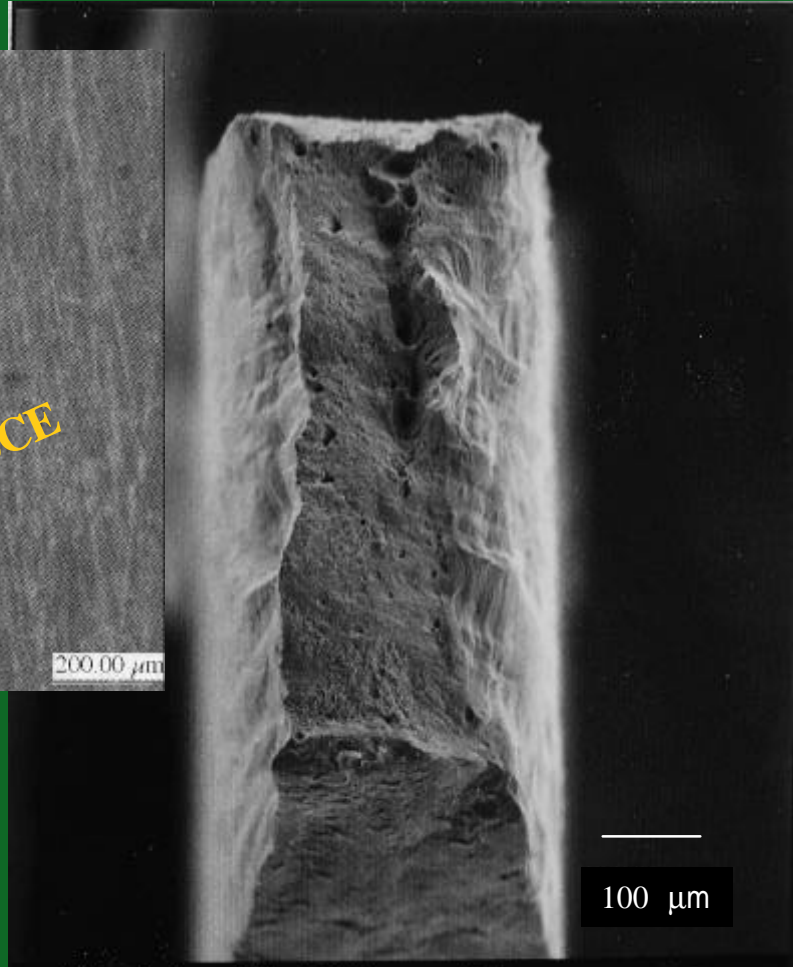
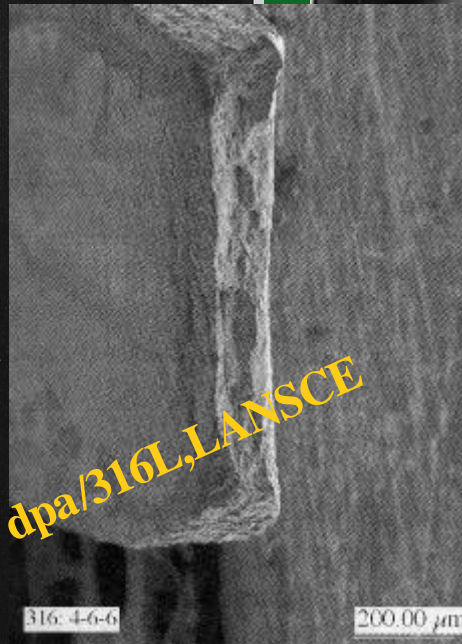
# True strain - true stress curves of JPCA-SA



# Ductile Fracture Surface at max dpa tested at RT & 250°C

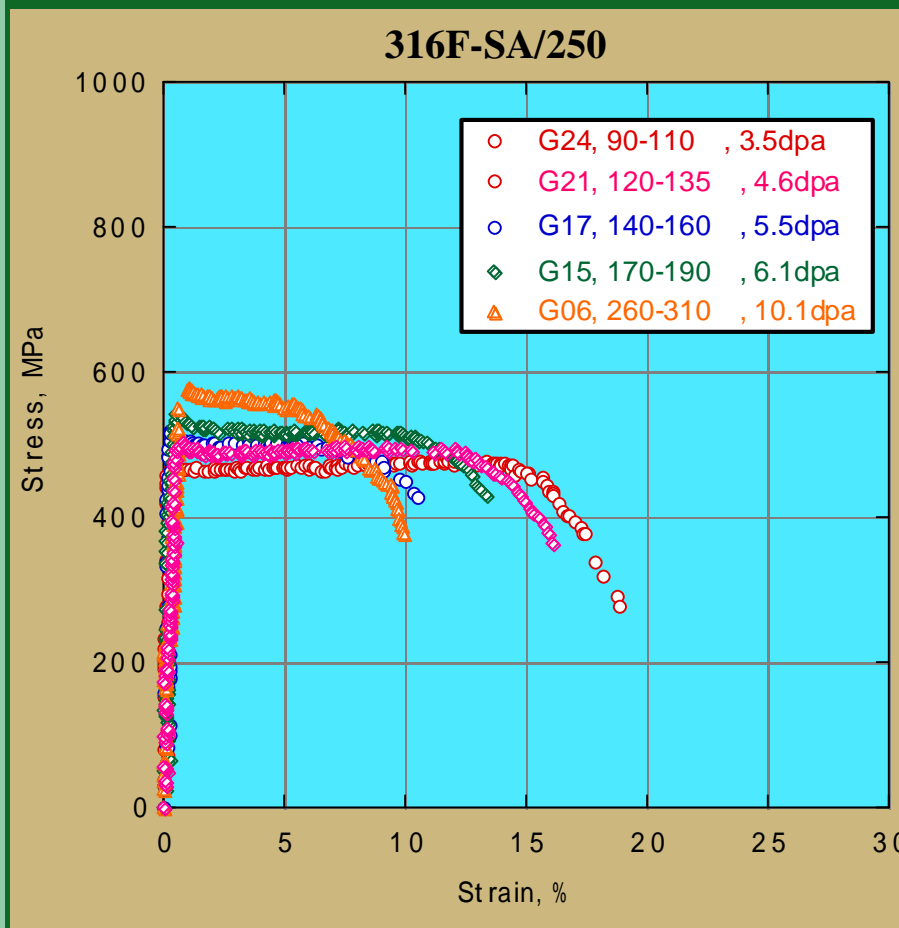
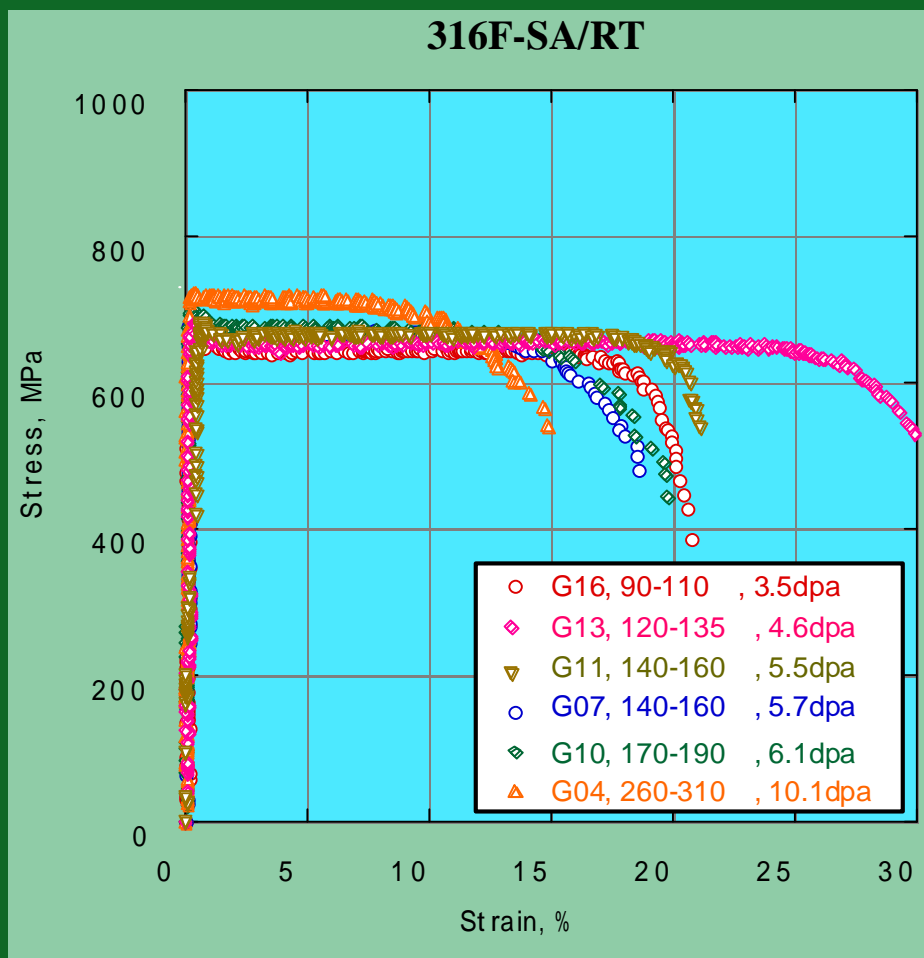


JPCA-SA, F9, RT, 260-310 , 10.1 dpa

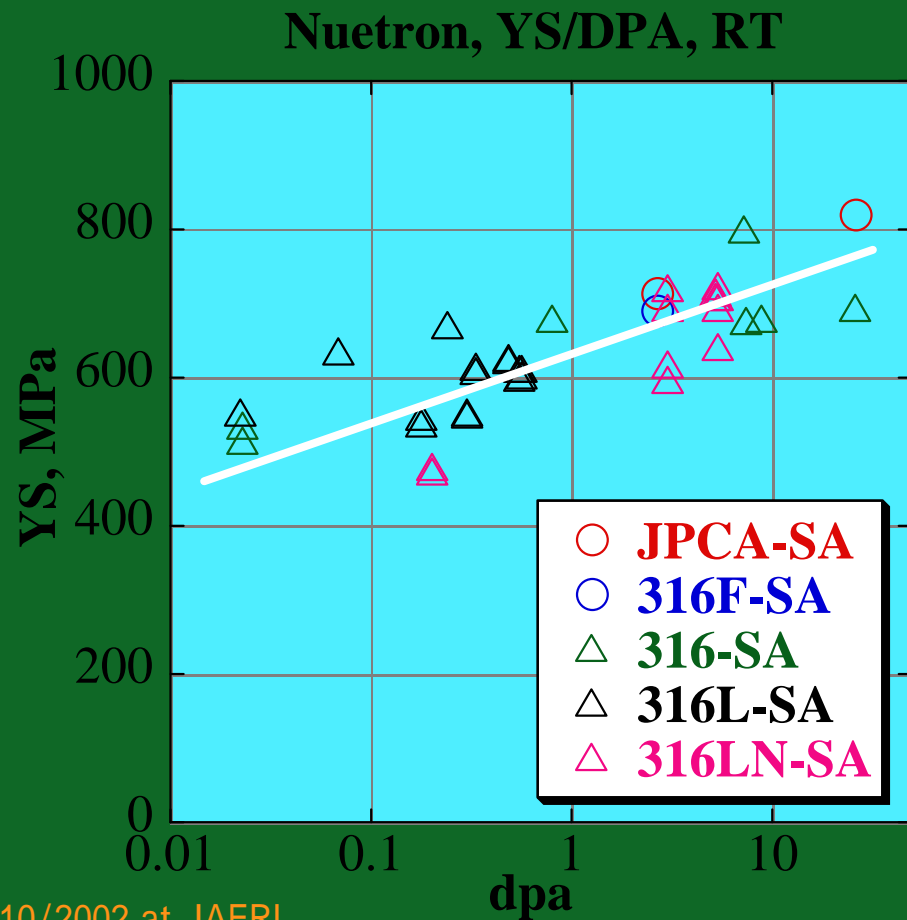
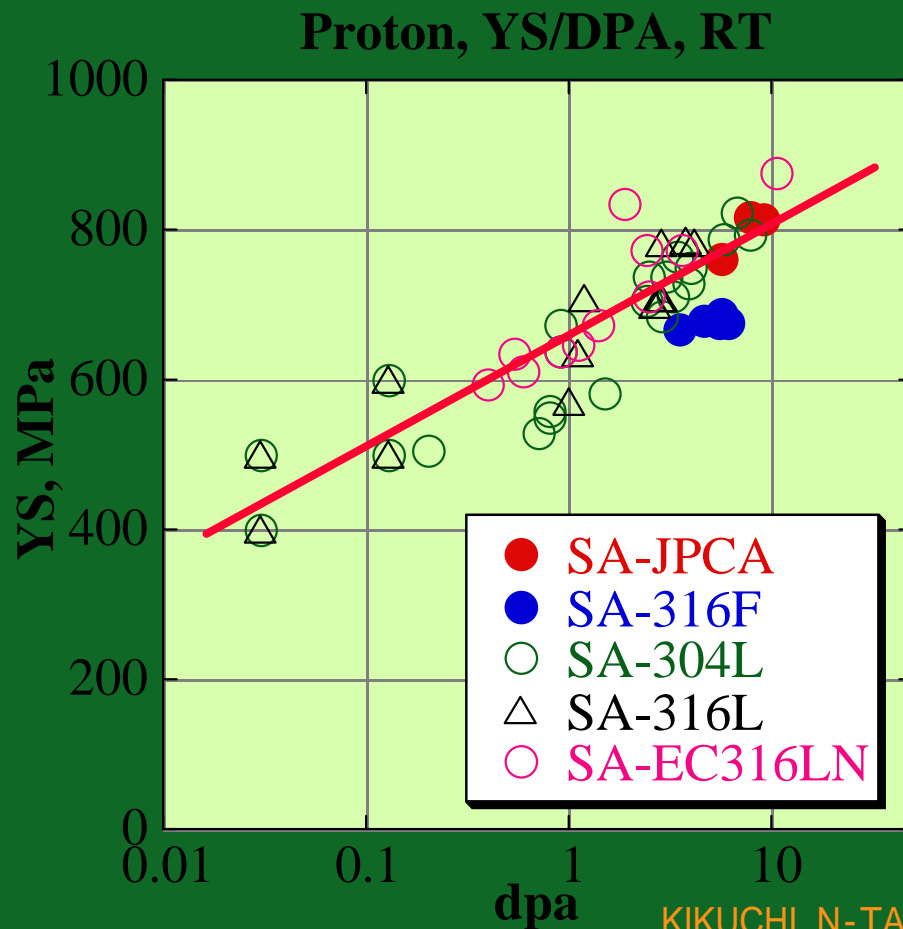


JPCA-SA, F10, 250°C, 276-325°C, 10.1 dpa

# SS curves of 316F-SA

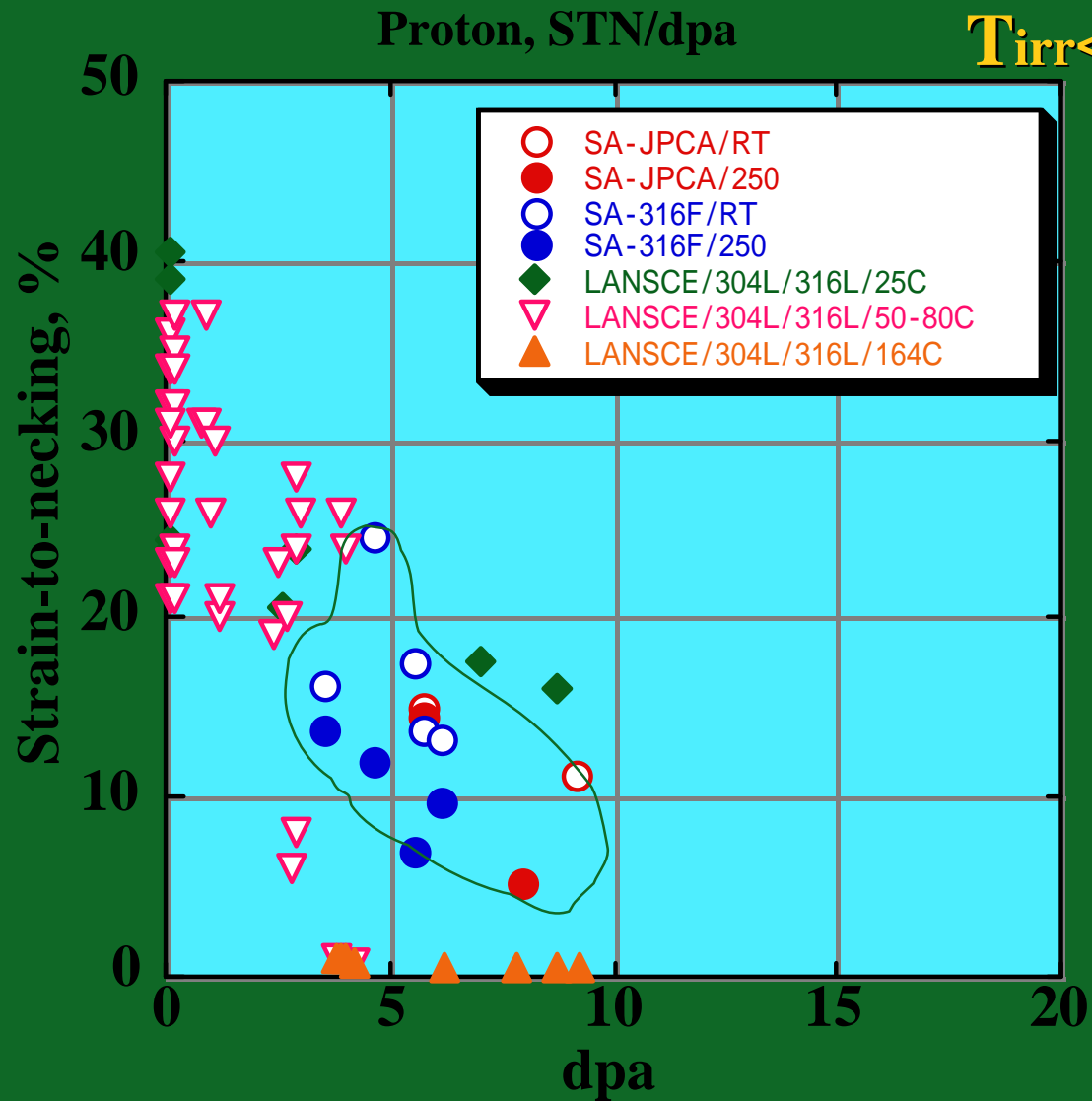


# Dpa-YS plots in spallation and fission at Trr. 250



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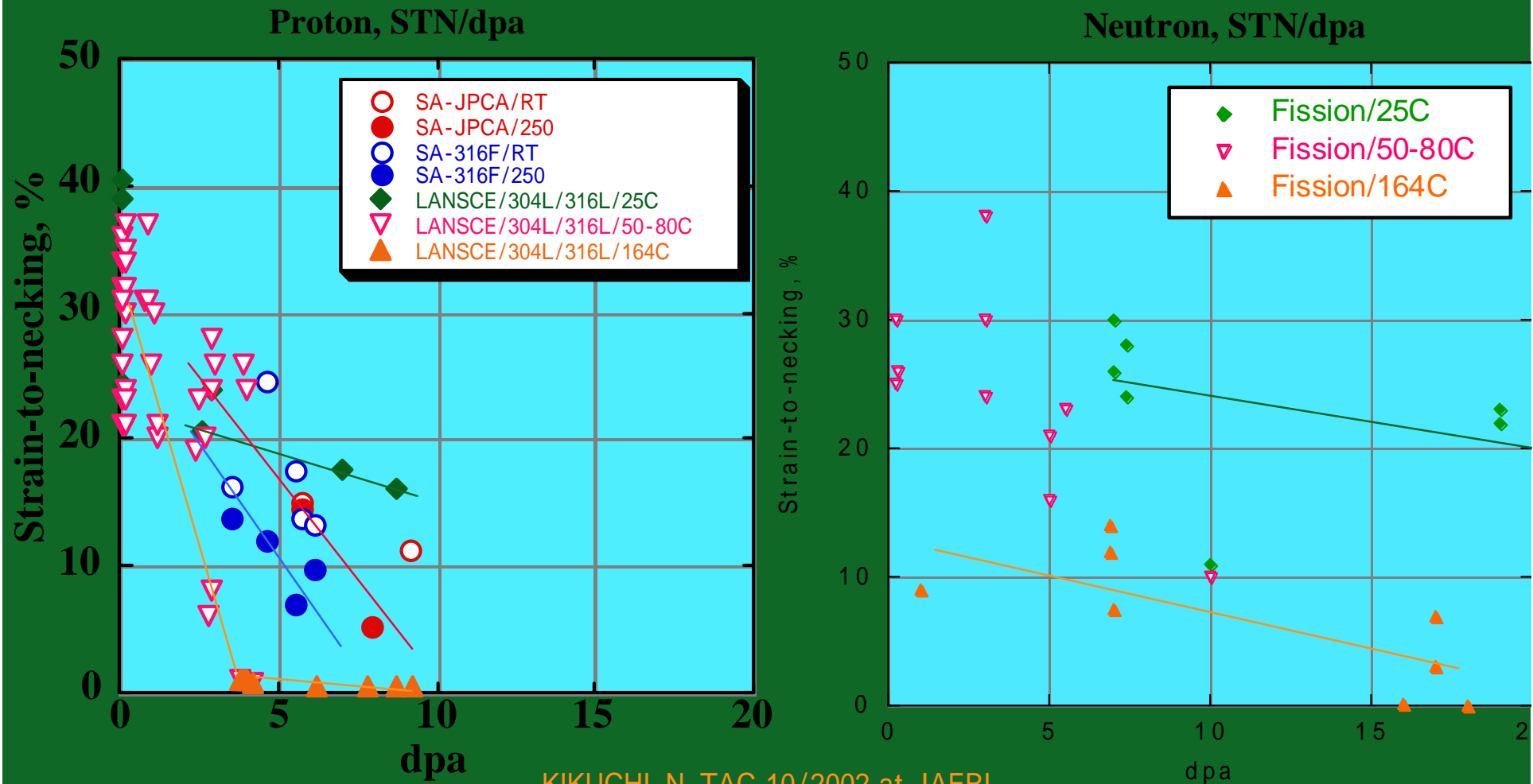
# Comparison of irradiation property of JPCA and 316F in SINQ with 316L/304L in LANCE(S. Maloy) at $T_{irr} < 250^{\circ}C$





# Comparison of STN in spallation with those in fission at $T_{irr} < 250^{\circ}\text{C}$ .

## Re-plotting our data on LANCE plots



KIKUCHI, N-TAC 10/2002 at JAERI

# Summary

- Irradiation results of JPCA in spallation could be understood by a trend in neutron radiation.
- An increase of YS as well as a decrease of STN due to radiation damage in spallation is slightly larger than those in fission.
- We never experienced fully lost of STN around 4dpa in JPCA, as reported for 316L/304L in LANSCE.
- Fatigue test is under way in Hot Cell.